Taxonomic studies on *Musa* L. cultivars (Musaceae) in South India

Thesis submitted to the
University of Calicut for the
award of the degree of

DOCTOR OF PHILOSOPHY IN BOTANY

SREEJITH P. E.

ANGIOSPERM TAXONOMY & FLORISTICS DIVISION
DEPARTMENT OF BOTANY
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Calicut University P. O., 673 635, Kerala, India

Dr. M. SABU M.Sc., Ph.D.
Professor
Principal Investigator, DST/MoEF/KSCSTE Projects
Angiosperm Taxonomy and Floristics Division

Mamiyil
Olavanna P.O.
Calicut 673 019
Kerala

CERTIFICATE

This is to certify that the thesis entitled, **"Taxonomic studies on *Musa* L. cultivars (Musaceae) in South India"** submitted to the University of Calicut, for the award of the degree of **Doctor of Philosophy in Botany,** is a bona fide record of the original research work carried out by **Mr. Sreejith, P.E.** at Angiosperm Taxonomy and Floristics Division, Department of Botany, University of Calicut under my supervision and guidance and no part of the present work has formed the basis for the award of any other degree/diploma to any candidate of any University previously.

C.U. Campus

24.06.2016

Prof. M. Sabu

Phone: 09447636333 (Mob.); 0495-2431545 (Res.); Email: msabu9@gmail.com

DECLARATION

I, Sreejith, P.E., hereby declare that the thesis entitled "**Taxonomic studies on *Musa* L. cultivars (Musaceae) in South India**" submitted to the University of Calicut, for the award of the degree of Doctor of Philosophy in Botany is a bona fide record of the original research work carried out by me under the supervision and guidance of Dr. M. Sabu, Professor, Department of Botany, University of Calicut and that it has not been submitted earlier either in part or full for the award of any degree/diploma to any candidate of any University.

C.U. Campus **Sreejith P.E.**
24.06.2016

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CONTENTS

INTRODUCTION

Plants, especially the angiosperms, are well known for their implausible diversity in its number, range of habitat and morphology (Taylor & Hickley, 1997) and provide sustenance to humankind with a large variety of food crops such as cereals, pulses, vegetables, fruits, etc. India has a tradition of great concern for its natural resources with a variety of climatic conditions and consequently, a very rich and varied flora. According to Karthikeyan (2000), there are altogether 20141 taxa of angiosperms under 2991 genera and 251 families in India, which include 17527 species, 296 subspecies, 2215 varieties, 33 sub varieties and 70 forma. However, the very recent estimate accounts a total of 18043 known species of angiosperms in the country, which represents 6.72% of the total world flora (Arisdason & Lakshminarasimhan, 2016).

The primary tropical Zingiberales are phylogenetically embedded within the derived Eumonocots (along with Arecales, Commelinales and Poales) as one of the most morphologically distinctive and widely accepted natural or monophyletic groups of monocotyledonous plants (Kress *et al.*, 2002). The members are mostly restricted to the tropics (Kress, 1990; Smith *et al.*, 1993). Tomlinson (1962) explained the diagnostic features of Zingiberales based on the morphological and Anatomical studies.

All Zingiberales are rhizomatous herbs, leaves with open or ligulate sheaths, lamina entire and lateral veins diverging from the midrib. Leaves supervolute in which one-half of the blade completely rolled around the other during development. Hairs usually unicellular and stomata are associated with two parallel subsidiary cells. The hypodermis with colourless cells and the air canals present in the leaves and stem are segmented by transverse diaphragms with stellate cells. Silica cells or stegmata are found associated with vascular bundles except in roots. Inflorescence is a raceme, terminal or lateral. Bracts are usually very conspicuous and attractive. Flowers zygomorphic and perianth well distinguished in to calyx and corolla. Stamens either 1 or 5; reduced stamens represented by lateral staminodes. Ovary inferior, trilocular with numerous ovules. Seeds are endospermic and arillate.

Within the order Zingiberales, two informal groups (‘banana families’ and ‘ginger families’) have been recognized. The ‘banana families’ corresponds to Musaceae *sensu lato* (*s.l.*) which includes taxa now generally accepted to be separate families, namely Musaceae *sensu stricto* (*s.str.*), Heliconiaceae (*Heliconia* L.), Strelitziaceae (*Strelitzia* Banks, *Ravenala* Adans., *Phenakospermum* Endl.) and Lowiaceae (*Orchidantha* N.E.Br.) (Petersen, 1889; Lane, 1955; Dahlgren *et al.*, 1982; Liu *et al.*, 2010). Musaceae *s.str.* were isolated from Musaceae *s.l.* by Nakai (1941) and Hutchinson (1964), and was shown to be monophyletic with the basal-most lineage in the order Zingiberales (Kress, 1990, 1995; Kress *et al.*, 2001).

According to the recent and the most accepted phylogenetic systems of classification proposed by Kress (1990) Zingiberales are considered as a monophyletic clade of eight families *viz.,* Musaceae, Strelitziaceae, Lowiaceae, Heliconiaceae, Costaceae, Zingiberaceae and Marantaceae.

FAMILY MUSACEAE JUSS. (1789)

Musaceae have been considered as one of the most ancient families within the order Zingiberales and consist of three genera *Musa* L., *Ensete* Horan. and *Musella* (Franch.) H.W.Li (Tomlinson, 1962; Kress 1990, 1995; Kress *et al.*, 2001). The members of family Musaceae are mostly grow in damp and humid places and infrequently in secondary forests. Some species can withstand in the extreme dry conditions and grow at high elevations. The centre of distribution of Musaceae is considered as South and South-East Asia, but also seen in African countries.

The family consists of large rhizomatous perennial or monocarpic herbs with well developed aerial shoots except in the genus *Ensete*.

Inflorescence is terminal on the large pseudostem formed by the folding of leaf sheaths. Flowers are zygomorphic, epigynous, and unisexual, but bisexual flowers are also common in some wild forms. Musaceae can be distinguished from other families of the order Zingiberales by the presence of tall pseudostem, long inflorescence, five fertile stamens and a sixth much reduced staminode in male flowers and the occurrence of large fruits which are edible or not.

Indian wild Musaceae are represented by two genera – *Ensete* and *Musa*, and are mainly distributed in North-East India, Western Ghats, Eastern Ghats and Andaman and Nicobar Islands (Joe, 2015). The former is very much distinct from the latter by its non-stoloniferous habit and is only propagated by means of seeds. Both genera are economically important with some members having high medicinal value. Male buds of some taxa are used as vegetables and young parts of some species are used for preparing chutneys. Taxa with erect inflorescences have much ornamental potential and can be introduced to home gardens. Joe (2015) revised the Indian Musaceae and reported 41 wild taxa (39 taxa in *Musa* and 2 in *Ensete*) from India. Besides these wild forms, a number of cultivated bananas are also grown in India since time immemorial.

GENUS *MUSA* L. (1753)

The genus *Musa* was established by Linnaeus (1753) in the first edition of *Species Plantarum* based on a plant growing under the glass house in the garden of Mr. George Cliffort in Netherlands. In the first edition of *Species Plantarum* (1753), he described two species *Musa paradisiaca* L. and *M. bihai* L. Subsequently, Linnaeus (1759, 1763) described two more species, *M. sapientum* and *M. troglodytarum* L. But earlier in 1736, he (Linnaeus, 1736) himself had described the banana as *M. cliffortiana* (this might be described as a "pre-Linnaean" Linnaean name). Also, the pre-Linnaean Botanist George Eberhard Rumphius described the genus in 1747 (Rumphius, 1747). But all these names are not in use now. *M. paradisiaca* and *M. sapientum* are now treated as hybrid cultivars, and *M. bihai* is being transferred to the genus *Heliconia* L. Since *M. paradisiaca* was the first species recognized by Linnaeus while establishing the genus *Musa*, it was later designated as conserved type of the genus *Musa.*

Many taxa were added later by many authors to the genus *Musa* also, the status of many was altered. At present the genus in India include 39 wild taxa including 26 species 12 varieties and 1 subspecies (Joe, 2015).

Besides these wild seeded bananas, the family is famous for cultivated, seedless, edible forms. Banana (*Musa* cultivars) is one of the major food crops globally and are grown and consumed in more than 100 countries throughout the tropics and subtropics (Valmayor *et al.*, 2000). It is recognized as the fourth most important food crop (after rice, wheat and maize) in the developing countries (Valmayor *et al.*, 2000). It is the largest and most economically important genus in the family with an evidence of cultivation dating to 4000 BC in New Guinea (Denham *et al.*, 2003, 2004). But in India, bananas are highly interwoven with the national history, heritage and cultures of several civilizations and societies from the pre-historic times and thus encompass a great socio-economic significance, particularly in regions that had been influenced in the past by Hindu and Buddhist cultures (Reynolds, 1951). The earliest literature references of bananas in India were in the two epics, *Ramayana* and *Mahabharatha*, and the Pali Budhist canon, both of the fifth and sixth century BC. Theophrastus (371–287 BC) mentioned the distribution and use of banana in India, as did Pliny the Elder (23–79 AD) in his *Naturalis Historia*. *Susruta Samhita*, the first Sanskrit medical treatise (4th century) mentions various medicinal uses of banana (Reynolds, 1951). It was also mentioned by Rheede (1678) in his '*Hortus Malabaricus*', a work comprised of medicinal plants of Malabar region of Kerala. De Langhe (1995) also gave a brief history of the domestication of bananas and claimed that there was written (Sanskrit) references to bananas as early as 500 BC. Nayar (2010) also noticed the earlier mentions of banana as being used for fruit, in rituals and for medicinal purposes in India. It has been rightly referred to as '*Kalpatharu'* (a plant of all virtues) in Sanskrit indicating to its multifaceted uses by humans (Uma, 2006).

The present work deals with the taxonomy of *Musa* cultivars in South India based on morphological and phytochemical characteristics. The term 'cultivar' is derived from the words, cultivated variety. According to ICNCP (Brickell *et al.*, 2009) "*A cultivar is a taxon that has been selected for a particular attribute or combination of attributes, and that is clearly distinct, uniform, and stable in its characteristics and that, when propagated by appropriate means, retains those characteristics*".

Origin and evolution of cultivated bananas

Original bananas were seeded and nonedible forms growing in damp and humid forests. The slow decline in the seed fertility followed by increase in parthenocarpic level might be the reason for the evolution of edible bananas. Early men's selection and further perpetuation of these forms for its pulpiness might have resulted in the present forms of cultivars (Uma *et al.,* 2005a). According to Simmonds and Shepherd (1955), *Musa acuminata* Colla and *M. balbisiana* Colla are two wild species from which almost all the edible bananas have originated. So they are considered as the '*Adam'* and '*Eve'* of present day bananas. Uma *et al.* (2005a) explained the process of evolution as to be initiated with the South East Asian species *M. acuminata.* The further human intervention and movement brought this species in to Indian subcontinent, where it crossed with *M. balbisiana* resulted in the development of earliest bispecific types with *M. acuminata* contributing to 'A' genome and *M. balbisiana,* to 'B' genome. Differential combination of these two wild species resulted in the development of a broad spectrum of genomic groups ranging from diploid to tetraploids (AA, AB, AAA, AAB, ABB, AABB, ABBB, etc.) (Uma *et al.,* 2005a).

The bispecific origin of edible bananas was first mentioned by Kurz (1867) and fall in oblivion till Cheesman (1947, 1948) recognised it and later Simmonds and Shepherd (1955) experimentally proved it by crossing *M. acuminata* and *M. balbisiana.* Simmonds and Shepherd (1955) compared their result with cultivated varieties, both morphologically and cytologically, and came into a conclusion that the edible bananas were evolved from *M. acuminata* and *M. balbisiana* in five main stages. (**Fig. 01**)

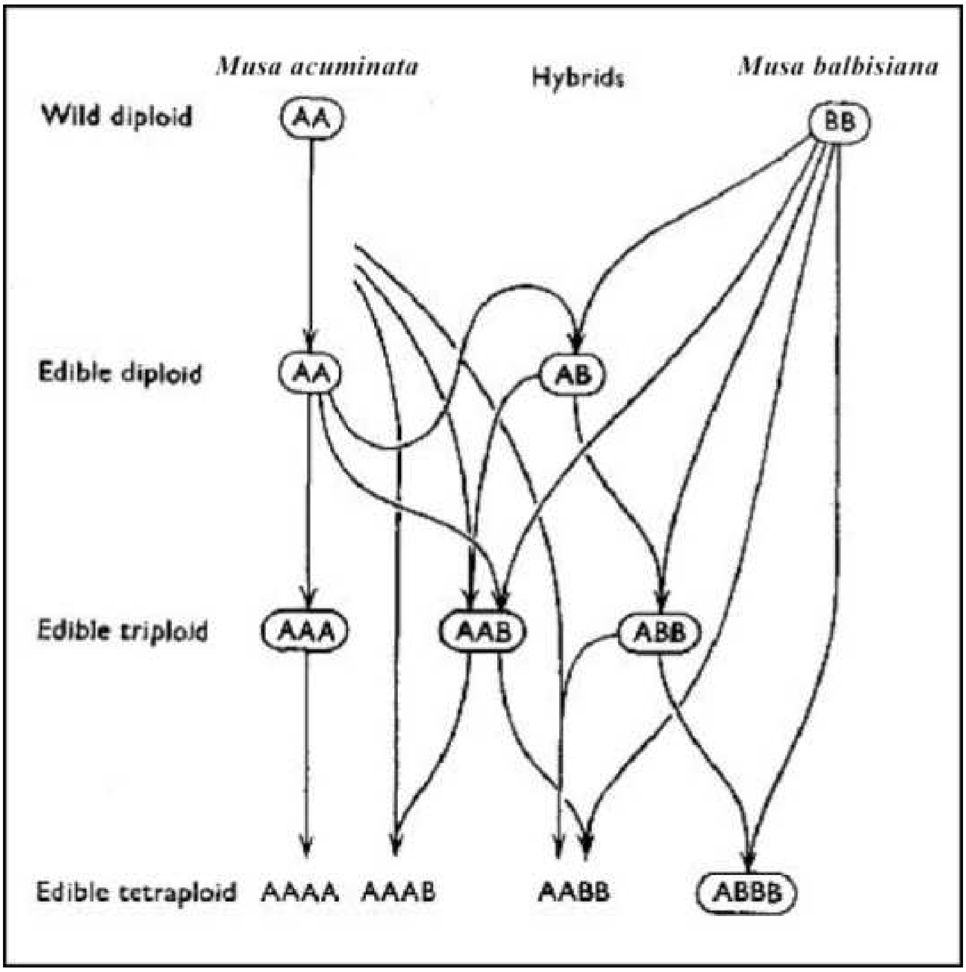

Fig. 01. **The evolution of the banana complex**: A, *M. acuminata;* B, *M. balbisiana.* Genotypes known to occur naturally are encircled, those known only from experiment are not encircled. Origins from diploid *M. acuminata* in which the parent might have been either wild or edible are shown as lines of indefinite origin. Crossing of tetraploid by diploid as a source of triploids has been neglected because natural tetraploids are very rare; many triploids have been made experimentally in this fashion (adopted from Simmonds & Shepherd, 1955).

Here the triploids were developed by the fertilization of diploid egg cell with the haploid pollen and this development of triploids was considered as an important step in the evolutionary process (Simmonds, 1962). These triploids have been widely accepted by the farmers and successfully exploited by the breeders due to many useful traits such as sturdiness, robustness and pulpiness. According to Uma *et al.* (2005a), the individual or combined contribution of four major factors *viz.,* parthenocarpy, sterility, polyploidy and the added advantages of vegetative propagation for perpetuation of useful traits plays a major role in the evolution of present day bananas.

Nomenclature of cultivated bananas

Bananas are known under enormous number of names. The generic name *Musa* is rooted in Sanskrit word *Moca* or may have derived from the Arabic world *Mauz, Mouz* or *Mauwz*, which is used for banana (Rumphius, 1747; De Candolle, 1886; Nayar, 2010; Hakkinen *et al*., 2012; Joe, 2015). The Arabic name for banana '*Mauz*' is also mentioned in Rheede's '*Hortus Malabaricus*'. He also used other names *viz*., *Bala*, *Vazha* as in Malayalam and *Kela* as used in Sanskrit. But Hyam and Pankhurst (1995) believed that the generic name in turn, may have been applied in honour of Antonius Musa (63–41 BC), a physician to Octavius Augustus, the first Emperor of Rome. Pliny the Elder in his *Naturalis Historia* knows it as '*Pala'*. According to Sturler (1863), Kurz (1878) and Hakkinen *et al*. (2012), it is probably derived from the Malabar name for banana '*Panan'* (finger) [actually '*Pazham*' or '*Palam*'] which is the etymological origin of the word "banana" ['*banan'* is the word used for 'fingers' in Portuguese]. The early Portuguese travellers called it '*figuo d' India'* (Indian fig), a name applied to a variety of East and West Indian tropical fruits that was already been mentioned by Linnaeus (1753).

A nomenclature review of cultivated banana shows that, Linnaeus (1736) first described the banana as *Musa cliffortiana* (this might be described as a pre-Linnaean Linnaean name). Later he himself established the generic name *Musa* in *Species Plantarum* (Linnaeus, 1753), the publication that marks the start of the present formal botanical nomenclature, with two species – *Musa paradisiaca* L. and *M. bihai* L. (*Heliconia bihai* (L.) L.) (*Musa paradisiaca* L. being the type of the genus *Musa* – designated by Adanson, *Fam.* 2: 525, 580. 1763). Linnaeus (1763) added two more species – *Musa sapientum* L. and *M. troglodytarum* L. Later Argent (1993) designated the lectotype of *M. paradisiaca* with "*Musa cliffortiana*" (Musa Cliff., Linnaeus, *s.n.*1736). And the later name *M. sapientum* was typified by Cheesman (1948) with "*Musae fructu breviore spadix floriger in magnitudine naturali* " (in Trew, PI. Select., 4, t. 22. 1752).

The later authors followed the Linnaean systems of classification and the whole cultivated bananas were divided into two species (*M. paradisiaca* and *M. sapientum*). They also tried to differentiate the banana and plantains based on the palatability and starch content but it would not work in all taxa especially in South and South East India because of the presence of large number of starchy cooking bananas. Roxburgh (1814, 1824) and Kurz (1867) included *M. paradisiaca* under *M. sapientum* and applied to the later name *M. balbisiana*.

Willdenow (1806) first attached the vernacular names to the Linnaean epithets ('Gemeiner Pisang' under *M. paradisiaca* and 'Bananen pisang' under *M. sapientum*). Kurz (1865/66, 1878) was the first to state a belief that the majority of banana varieties (cultivars) are descended from the species that he first called *Musa samiarium* Rumphius, and later corrected to *M. acuminata* Colla. But he could not connect this species with *M. paradisiaca.*

Many other taxonomists of South and South East Asia also found that the original scientific names were inadequate to address the great diversity in its place of origin and evolution. This resulted in the publication of many other scientific names. Thus by 1948, about 50 binomials had been proposed for banana. However, Cheesman (1948) did not favour giving taxonomic status to any of the several distinctive genome groups or clones of the banana and indicated that *M. paradisiaca* should be used, as it had priority over *M. sapientum.*

Jacob worked on the variability and diversity of banana and plantain in South India and proposed a new nomenclature for the cultivated bananas, *i.e., Musa sapidisiaca* K.C.Jacob – by combining the two Linnaean species *M. paradisiaca* and *M. sapientum* in his monograph on Madras Banana (Jacob, 1952). He gave the varietal status to all *Musa* cultivars under the new species *M. sapidisiaca*. Since the parental name, *M. sapidisiaca* was published without a proper diagnosis, the name *M. sapidisiaca* was invalid and thus all the varietal names published under this are also invalid.

The endless coining of new names to the banana cultivars was put to an end by Simmonds and Shepherd (1955). They experimentally proved that the Linnaeus classification was based on hybrid progenies of two species *M. acuminata* and *M. balbisiana*. They also suggested a nomenclatural system for the cultivated bananas. According to this, the genome nomenclature was more appropriate for naming taxa and proposed that the generic name be followed by a letter combination indicating the ploidy and the genome sets, followed by the cultivar/cultivar group name. The cultivars in each subgroup show little genetic diversity and are derived from each other through somatic mutations.

Later in 1992, Espino *et al.* suggested that all the hybrids of *M. acuminata* and *M. balbisiana* can be referred to as the *Musa* × *paradisiaca* L. and all the hybrid cultivars can be classified under *Musa* × *paradisiaca*. This was latter recognized by the International Code of Nomenclature for Cultivated Plants (Trehane, 1995). Thus according to the latest rules and recommendations regarding the nomenclatural systems (ICN & ICNCP), a three-tier system of nomenclature (already proposed by Simmonds & Shepherd, 1955) is found more appropriate and is followed here for naming the banana cultivars. In this system, all *Musa* cultivars derived from the pure *M. acuminata* (AA, AAA, etc) and *M. balbisiana* (BB, BBB, etc) lines can be represented by the parent name and a letter combination representing the parent and ploidy level in parenthesis, followed by the cultivar name in single inverted coma (‘’) and all others (hybrids of *M. acuminata* and *M. balbisiana*) can be denoted as: *Musa* × *paradisiaca* L. (AB/AAB/ABB/….) ‘Cultivar name’.

Later various authors list out the names and synonyms of *Musa* cultivars in different regions. Venkataramani (1945) gave a short description of some South Indian banana cultivars and treated under the heading ‘*Descriptions of Varieties*’, and here the names and synonyms were extracted from the monograph on Madras bananas by Jacob (1952). Uma and Sathiamoorthy (2002) primarily divided all Indian banana cultivars in to different Genome/Subgroups under which the cultivar names and synonyms were listed.

India has been the largest producer of bananas with an annual production of 16 million tones from an area of 0.4 million ha and accounts for nearly 15 percent of global production (Uma, 2006). In India, the diversity and distribution is more in South India compared with other states. Hence the present study deals with the taxonomy of South Indian bananas (*Musa* cultivars). Along with the morpho-taxonomic characterization, GC-MS analyses of the fruit pulps of selected 13 cultivars are also included in this work.

Even though cultivated bananas have attracted a good deal of research in many countries including India over many years in many aspects, most of them didn’t have a botanical identity and there is no authentic and a comprehensive taxonomic work of the cultivated bananas anywhere in India.

Names of the cultivars

Most of the cultivated bananas were growing in different places are known by different local or common names. But each local language has its own general names for banana, *viz.,* Malayalam – *Vazha*; Tamil – *Valai*;

Kannada – *Bale*; Telugu – *Arati* and each cultivars also have their own local names. The same cultivar may known in different names in different places and in different languages, and different cultivars may also known in same name in different places. This resulted a much confussion while dealing with the cultivars. Also some introduced cultivars are known in the name of the places from where it came (as the culivar *Poovan* is also known as *Mysore* in some areas as it was introduced from the Mysore area).

Here in this work, the most of the cultivar epithets were extracted from Jacob (1952) and in some cases, the mostly used common names were selected. This can be treated as the standardised common names to the South Indian *Musa* cultivars and are enumerated in the **Table 07** (see Chapter 11, p. 221) along with the local names, localities where they are largely grown for an easy reference. The cultivars that are introduced from abroad and cultivated widely in South India are also included in this treatment and in such cases the names widely used in their original locations were used here.

Objectives of the study

- Taxonomic and morphological studies of *Musa* cultivars in South India.
- Extensive survey and field exploration of South Indian *Musa* cultivars (with every effort to study the variation within the cultivars in different geographical locations).
- Preparation of a detailed taxonomic account of the South Indian *Musa* cultivars with descriptions, photographs, ecology, distribution and a dichotomous key for the identification of all taxa.
- Preparation of herbarium and pickled specimens of South Indian *Musa* cultivars for further references.
- Resolving nomenclatural problems of all taxa under study.

- Conservation of live germplasm in the Calicut University Botanical Garden (CUBG).
- Preparation of database of all taxa in South India based on live collections.
- Construction of a phenogram based on morphological traits.
- GC-MS analysis of fruit pulps for the identification of fatty acids and volatile compounds and their comparison.

Importance of the investigation

Taxonomic study on the *Musa* cultivars in South India is chosen for the present study because of the lack of comprehensive taxonomic work on this group. As the plants are very common and highly interwoven with the everyday life of men, since time immemorial and a lot of research works were done and are going on in many aspects, except taxonomy. The lack of botanical identity and the confusions prevailing in the nomenclature of cultivated bananas strengthened the need of this work.

The confusion and the controversy began since the publication of the first species by Linnaeus (1753) based on the cultivated forms and the later workers also published many such names in the subsequent years till Cheesman (1947). Even though the code accepted a standard nomenclatural system for the cultivated bananas, the later authors failed to follow that, as a result the situation got worsened. In addition to this, the lack of properly identified specimens, and detailed description, high range of variation and lot of synonymy strengthened the situation.

Banana is considered as a very good and nutritive fruit crop, and the fruit features form the important key character for the discrimination of taxa. The phytochemical analysis of the fruit pulp using GC-MS techniques were also done to support the classification. This is the first attempt to analyse and compare the fatty acids and volatile compounds present in the fruit pulp of South Indian bananas.

In this context, a detailed taxonomic study of the South Indian *Musa* cultivars was proposed and the present study would be helpful to provide botanical identity to all *Musa* cultivars in South India. In addition, a dichotomous key, detailed description, and colour photographs for the easy identification of all taxa are also provided.

REVIEW OF LITERATURE

Taxonomy and Floristics

The first authentic account of the taxonomy of tropical plants especially the Indian plants was given by Rheede (1678–1693) in his book *Hortus Malabaricus*, (Manilal, 2003) which includes short description and figures of nearly seven hundred plants in Malabar area (published in twelve volumes). The plants were identified by local Malayalam names and printed in four different scripts.

Linnaeus (1751) first used the term *'Scitamentum'* for a group of plants distinguished by their agreeable, useful and valuable qualities (Roscoe, 1828). Linnaeus in his *Species Plantarum* (1753) described 9 genera and 18 species under 'Monandria Monogynia' which include 14 Scitaminean taxa and some unrelated taxa like *Boerhavia* L. and *Salicornia* L. Later in 6th edition of *Genera Plantarum,* he added two more genera (*Thalia* L. and *Hippuris* L.) under this group.

Bentham and Hooker (1883) recognized 4 tribes in their Ordo (family) Scitamineae, such as Zingibereae, Maranteae, Canneae and Museae. Petersen (1889) raised the rank of these four tribes to family status and subdivided the new family Musaceae in to two tribes Museae (*Musa*, *Ravenala* Adans. & *Strelitzia* Banks) and Heliconieae (*Heliconia*). *Orchidantha* N.E.Br., the sole genus in the Lowiaceae was excluded from Scitamineae of Bentham and Hooker, but recognized as a possible member of the group by Petersen (1889).

Schumann in *Das Pflazenreich* (1900) subdivided the order Scitamineae in to subfamilies. He recognized two subfamilies within Zingiberaceae – the Costoideae and Zingiberoideae and three in Musaceae – Musoideae (*Musa*), Strelitzioideae (*Strelitzia, Ravenala* and *Heliconia*) and

Lowioideae (*Orchidantha*). Further subdivision divided the Strelitzioideae in to Strelitzieae (*Strelitzia* and *Ravenala*) and Heliconieae (*Heliconia*).

Hutchinson (1934, 1959, 1973), who used the ordinal name Zingiberales (after Nakai, 1941), accepted the Schumann's divisions, but raised it to the rank of family, Strelitziaceae (including *Heliconia*) and Lowiaceae. He also further subdivided the Zingiberaceae into four tribes of equal status.

Nakai (1941) first suggested that the rank of Costoideae and Heliconieae be raised to the family status. Tomlinson (1960, 1962, 1969) accepted Nakai's classification and explained the diagnostic features of Zingiberales based on the morphological and anatomical studies. The subsequent authors like Stebbins (1974), Takhtajan (1980), Cronquist (1978, 1981), Dahlgren and co-workers (Dahlgren & Rasmussen, 1983; Dahlgren *et al*., 1985) and Kress (1990) have followed Nakai and Tomlinson in the recognition of eight families in the order Zingiberales, *viz.,* Musaceae, Strelitziaceae, Lowiaceae, Heliconiaceae, Zingiberaceae, Costaceae, Cannaceae, and Marantaceae.

Kress (1990) analysed the evolutionary relationships of the families of the order Zingiberales based on the principles of phylogenetic systematics and proposed a new phylogenetic classification based on the cladogram, which recognizes eight families, two superfamilies and five suborders within the order Zingiberales.

Musaceae have been considered by many specialists of Zingiberales as a basal lineage in the order Zingiberales with close relationships to Strelitziaceae, Lowiaceae and Heliconiaceae (Tomlinson, 1962; Kress 1990, 1995; Kress *et al*., 2001). However, the rapid radiation of these four families in the order approximately 110 million years ago (Kress & Specht, 2005; Liu *et al*., 2010) had resulted in limited sequence divergence among them, and hence only limited support for this basal position.

Joe *et al.* (2014) reported 31 taxa under the family Musaceae and is largely distributed in North-eastern states, the Western Ghats, the Eastern Ghats and Andaman and Nicobar Islands. Presently, Indian Musaceae consists of 41 taxa under two genera (Joe, 2016).

Reynolds (1951) studied the historical background and earliest evidences of banana cultivation, and reported that it is highly interwoven with the history, heritage and culture of several civilizations and societies of south and southeast Asia from prehistoric times especially in Hindu and Buddhist culture. In India, banana has been known for its antiquity from its mention in '*Ramayana*' (2020 BC), Koutilya's '*Arthasastra'* (300-400 BC), and its presence in paintings and sculptures of Ajantha and Ellora Caves (600 BC). De Langhe (1995) has given a brief history of the domestication of bananas and claimed that there was written (Sanskrit) references to bananas as early as 500 BC.

Linnaeus (1753) established the genus *Musa* in his famous work '*Species Plantarum'*. Linnaeus published two species *Musa paradisiaca* (1753) and *M. sapientum* (1763). But actually, the plant is described much erlier (*i.e.,* in 1736) by Linnaeus (1736) himself as *Musa cliffortiana* and also by an another pre-Linnaean botanist Rumphius (1747).

Sagot (1887) pave the foundation for the classification of the genus *Musa,* but a comprehensive account of the family was given by Cheesman (1947–1950) and he also delimited the taxa within the genus. Cheesman (1947) erected four sections within the genus *Musa* followed by the fifth section by Argent (1976). But the recent authors reduced these to three (Wong *et al.*, 2003) and then to two (Häkkinen, 2013) based on the molecular analysis. Nayar (2010) recognized 81 species in the genus *Musa* by considering the enumeration of Cheesman (1947–1950), Simmonds (1957) and Häkkinen and Vare (2008). Very recently Joe (2015) revised Indian Musaceae reported 41 taxa under 2 genera (39 taxa under *Musa* and 2 under *Ensete*).

The classification and the study of interrelationships of the *Musa* cultivars are incomplete and contradictory due to the lack of proper descriptive study (Linnaeus, 1753; Baker, 1893; Schumann, 1900; Jacob, 1934, 1952; Venkataramani, 1945; Heslop & Schwarzacher, 2007; Nayar, 2010). The importance of a detailed descriptive study of banana cultivars was stressed by Teodoro (1915) and supported by Baker (1893), Cheesman (1934) and others.

Subsequent authorssuch as Baker (1893), Bentham and Hooker (1883) Karthikeyan, *et al.* (1989), etc. accepted the Linnaean names and the whole cultivated bananas were divided into two species (*M. paradisiaca* and *M. sapientum*). This classification was based on limited number of specimens available there. They also tried to differentiate the banana and plantains based on the palatability and starch content. The commonest name *M. paradisiaca* is applied to the plantains and *M. sapientum* to the bananas by various authors (Cheesman, 1948; Dodds & Simmonds 1948a). However, many authors pointed out that the distinction between plantain and banana is quite artificial and it would not work in all parts, especially in South and South East Asia because of the presence of large number of starchy cooking bananas. This resulted in the publication of many other scientific names. By 1948, about 50 binomials had been proposed for banana, but Cheesman (1948) did not favour giving taxonomic status to any of the several distinctive genome groups or clones of the banana and indicated that *M. paradisiaca* should be used, as it had priority over *M. sapientum*. But some authors like Roxburgh (1814, 1824), Kurz (1867), etc. considered *M. paradisiaca* to be included in *M. sapientum* and applied to the latter name *M. balbisiana*. Later workers proved that the two names published by Linnaeus (1753, 1763) were not true species, but hybrid cultivars and were later typified.

While Jacob (1934, 1942a, 1942b) worked on the variability and diversity of banana and plantain in India and proposed a new nomenclature for the cultivated bananas, *Musa sapidisiaca* by combining the two Linnaean species *M. paradisiaca* and *M. sapientum,* in his monograph on Madras Banana (Jacob, 1952). But this name is invalid due to the lack of a diagnosis or description. He gave the varietal status to all the *Musa* cultivars under the new species *M. sapidisiaca*. Many other taxonomists of South and South East Asia also found that the original scientific names were inadequate to address the great diversity in its place of origin and evolution. This resulted in the publication of many other scientific names.

Kurz (1878) was the first to state a belief that the majority of banana varieties (cultivars) are descended from the species that he first called *Musa samarium* Rumphius, and later corrected to *M. acuminata* Colla. This was later recognized by Cheesman (1947, 1948). Simmonds and Shepherd (1955) provided an experimental proof by crossing *M. acuminata* and *M. balbisiana* and came into a conclusion that the edible bananas were evolved from *M. acuminata* and *M. balbisiana* in five main stages. This is also supported by the chromosome studies by Cheesman (1932, 1934), Cheesman and Larter (1935) and Dodds and Pittendrigh (1946).

The natural hybrids of *M. textilis* with *M. acuminata*, *M. balbisiana, M. schizocarpa* and the cultivated bananas have been reported by several authors (Spencer, 1953; Shepherd & Ferreira, 1982; Stover & Simmonds, 1987; Daniells *et al.,* 2001).

Simmonds and Shepherd (1955) identified fifteen diagnostic traits to differentiate *M. acuminata* and *M. balbisiana* and proposed a scorecard to identify the genomic status of cultivated bananas. Simmonds (1966) also provided a key to the groups of the edible bananas. Latter, the score card was later first modified by Silayoi and Chom Chalow in 1987 and by Singh and Uma (2000).

Simmonds (1962) wrote a book entitled "*The Evolution of the Bananas*", in which he discussed the evolution of the present day bananas in eight chapters and can be divided in to two parts. In the first part, a survey of the relationships and the evolution of the wild plants were explained and in the last four chapters, he explained the principles behind the evolution. Many authors like Kahl (2004), Heslop-Harrison and Schwarzacher (2007) and Nayar (2010) also gave an overview on the origin and evolution of present day bananas.

Simmonds (1966) adopted a new nomenclatural system for the cultivated bananas; a three-tier system including generic name, genomic group and the cultivar/cultivar group name (based on ICNCP).

Later in 1992, Espino *et al.* suggested that all hybrids of *M. acuminata* and *M. balbisiana* can be referred to as the *Musa* × *paradisiaca* and the name is later recognized by the International Code of Nomenclature for Cultivated Plants (Trehane, 1995) and International Code of Botanical Nomenclature (Article H10.2 in ICBN – 2000).

The biological evolution and nomenclature of banana plant was well described by different authors such as Greuter (1995), Karamura (1988), Valmayor *et al.* (2000), Daniells *et al.* (2001) and Mohaputra *et al.* (2010). The names and synonyms of *Musa* cultivars in different regions were published by different authors (India – Venkataramani, 1945; Uma & Sathiamoorthy, 2002; Southeast Asia – Valmayor *et al.,* 2000; etc.)

Valsalakumari *et al*. (1985) studied the variability and genetic divergence among the Indian cultivated bananas. Nayar *et al.* (1979) also noticed the significant variation within the clones. Rajamanickam and Rajmohan (2010) estimated the genetic diversity by studying the twenty eight banana cultivars of Kerala and Tamil Nadu and classified them in to six clusters by considering 23 characters. But, here the clustering was not influenced by the genomic constitution.

Variation in *Musa* germplasm maintained in various national and international gene-banks were evaluated by different authors using morphological or molecular data and this provided some useful information for the betterment of crops (Ortiz, 1997). He (1997) also evaluated the morphological variation of *Musa* germplasm maintained in the gene-bank of the International Institute of Tropical Agriculture in South-eastern Nigeria using qualitative and quantitative data and also proposed a new scientific nomenclature for the triploid cultivars. Wang *et al.* (2009) gave a brief description of banana cultivars (15 cultivars) available from the University of Hawaii Seed Program along with photographs.

Phylogeny and Evolution

Crow (1926) has presented an excellent argument in defence of phylogenetic approaches to taxonomy, the following exempt being typical: "The relationships of organisms with one another are not theoretical interpretations at all, but descriptions of the actual facts of the relationship of parts of one organism to another. Phylogeny consists of theories and hypotheses formed from these facts. Phylogeny can give little satisfaction to those who desire absolute truth, but those who hold a partial view to be better than none at all may find it an interesting study"

Tropical Zingiberales are phylogenetically embedded within the derived eumonocots (Arecales, Commelinales and Poales) and includes many conspicuous taxa (Kress *et al*., 2002). The first attempt to interfere historical relationships of eight families of the Zingiberales using phylogenetic systematics was carried out by Dahlgren and Rasmussen (1983). Kress (1990) proposed a phylogenetic classification based on the cladogram and recognized two superfamilies (Zingiberariae and Cannariae), eight families (Musaceae, Strelitziaceae, Lowiaceae, Heliconiaceae, Zingiberaceae, Costaceae, Marantaceae and Cannaceae) and five suborders (Musineae, Strelitzineae, Lowineae, Heliconineae and Zingiberineae) within Zingiberales. Phylogeny Group (2016) also puts the genus *Musa* within Zingiberales, one of four sister Orders in the monophyletic group Commelinids, along with Poales (grasses), Commelinales and Arecales. According to Kress (1990) and Smith *et al.* (1993) the family Musaceae is found paraphyletic with Cannaceae.

Based on the molecular data, Li *et al.* (2010) suggested that the family Musaceae is monophyletic, and the genus *Musella* may be congeneric to *Ensete,* but didn't give a strong evidence to merge these two genera.

Several authors investigated phylogenetic relationships within the family based on molecular data (Faure *et al.,* 1994; Carreel *et al.,* 1994; Wong *et al.,* 2003; Liu, *et al.,* 2010; Christelová *et al.,* 2011; etc.). Simmonds and Shepherd (1955) first explained the origin of present day cultivated bananas which paved way to classification, taxonomy and phylogeny of the family Musaceae and more over to the cultivated bananas. Modern taxonomic studies using isozymes (Espino & Pimentel, 1990) and molecular markers (Jarret, 1990) confirmed this multi-specific origin of edible bananas.

Molecular studies were also used to find the correct parental lieage way at evolution. The studies on the mitochondrial genome by Faure *et al.* (1994) followed by Carreel *et al.* (2002) revealed the involvement of two subspecies of *M. acuminata viz., M. acuminata* subsp. *banksii* and *M. acuminata* subsp. *errans* in the evolution of present day banana cultivars.

Mustaffa and Sathiamoorthy (2005) using RAPD analysis of Indian bananas found that the 28 genotype studied were clustered in to two and all AA and BB genotype, are coming under each cluster.

Thomas-Hall *et al.* (2007) isolated fifty seven distinct *rbcS* sequences from six accessions of banana cultivars and conducted phylogenetic and molecular analysis of the ribulose-1, 5-bisphosphate carboxylase small subunit gene family in banana. The analysis using maximum parsimony distance tree resulted in the identification of six *rbcS* gene subfamilies and one pseudogene. Retnoningsih (2009) analysed the phylogenetic relationship of Indonesian banana cultivars using molecular approach and chromosome karyotype and proposed a molecular based classification of the Indonesian banana cultivars.

Opara *et al.* (2010) analysed the genetic diversity in banana cultivars from the South of Oman using AFLP markers and classified them based on phylogenetic, hierarchical clustering and principal component analyses. In this they scored 1094 bands using twelve primers and eighty two unique markers were also identified which also revealed that AFLP can be used to distinguish banana cultivars.

Christelová *et al.* (2011) conducted a multi gene sequence-based phylogeny of the family Musaceae and studied the evolutionary relationships within the Musaceae family using 13 species and DNA sequences obtained from a set of 19 unlinked nuclear genes. Saraswathi *et al.* (2011) analysed the diversity of Indian cooking bananas (ABB) by using 125 accessions through morphotaxonomic and molecular characterisation and identified 71 distinct accessions.

Boonruangrod *et al.* (2011) tried to elucidate the phylogenetic relationship of *M. acuminata, M. balbisiana* and their hybrids using markers specific to both cytoplasmic and nuclear DNA and identified the putative family trees suggesting simple ways for the evolution of the present-day bananas.

Various fingerprinting techniques such as isozyme analysis (Bhat *et al.,* 1992), RFLP (Jarret *et al.,* 1992; Kaemmer *et al.,* 1992; Bhat *et al.,* 1994; Carreel *et al.,* 2002; Ude, *et al.*, 2002a, 2002b; Nwakanma *et al.*, 2003a, 2003b; Ge *et al.,* 2005; Raboin *et al.,*2005; Mustaffa & Sathiamoorthy, 2005; Brown *et al.,* 2009; Nadiya *et al.*, 2010), rRNA spacer length heterogeneity (Lanaud *et al.,* 1992), ISSR markers (Godwin *et al.,* 1997), STMS (Grapin *et al.,* 1998; Kaemmer *et al.,* 1997), AFLP (Loh *et al.,* 2000; Wong *et al.,* 2001; Ude, *et al.*, 2002a, 2002b; Noyer *et al.,* 2005; Opara *et al.,* 2010, Wongniam *et al.*, 2010), RAPD (Pillay *et al.*, 2000; Venkatachalam *et al.*, 2008), SSR (Ude *et al*., 2002b), microsatellite (Buhariwalla *et al.*, 2005; Retnoningsih, *et al.*, 2011), IRAP markers (Teo *et al.*, 2005), etc. have been used to study the genetic diversity, genomic constitution and taxonomy of cultivated bananas.

Among these, AFLP technique is found more reliable, robust and which reveals significant polymorphisms and hence, widely used for genetic diversity studies of banana (Vos *et al.*, 1995; Mueller & Wolfenbarger, 1999; Crouch *et al.*, 1999; Ude *et al.*, 2002b).

RAPD techniques are widely used for the better characterization of individual accessions and identify duplicates and also to track clonal variants (Williams *et al.*, 1990; Jerret *et al.*, 1993; Howell *et al.*, 1994). Menon *et al.* (2004) evaluated the genetic diversity of South Indian banana cultivars representing five genomic groups using RAPD markers and identified 35 distinct clones.

De Langhe *et al.* (2005) attempted to link the results from the MolT and NMT on a set of representative African plantain cultivars by integrating morphological and molecular taxonomy. Brown *et al.* (2009) evaluated the genetic diversity of twenty seven banana cultivars in Mauritius using RAPD markers. Based on RFLP analysis, Raboin *et al.* (2005) concluded that the *Cavendish* and *Gros Michel* (*Grand naine*) had a common diploid ancestor.

Raboin *et al.* (2005) studied the genetic diversity and evolution of triploid export banana cultivars using molecular techniques. Nair *et al.* (2005) reported a PCR based molecular marker specific for B genome and designed a primer to identify the B genome. 36 South Indian banana cultivars were tested with this primer and found that it is useful to identify the presence of B genome and its intensity and thus the ploidy level of the B genome. But they suggested further studies with competitive PCR for clarification.

Cluster analysis from a RAPD study comprising 76 plantain cultivars by Crouch *et al.* (2000a, 2000b) showed weak correlation between the cluster and the morphological groups based on bunch type and plantain structure.

In some cases the molecular data can be used to understand the correct genomic state of the cultivars, which in some cases may not be identified by the morpho-taxonomic scoring system. Pillay *et al.* (2000) classified

‘Monthan Saba’ and ‘Bluggoe’ under ABB group based on the molecular data, but it is controversial with the previous classification based on the morphological data, where it was under BBB group. Similarly the tetraploid clone ‘Klue Tiparot’ (ABBB) had been reclassified as triploid ABB (Jenny *et al.,* 1997; Horry *et al.,* 1998).

A multi gene sequence-based phylogeny of the family Musaceae was done by Christelova, *et al.* (2011). Nineteen gene-based markers were developed and are used for the phylogenetic analysis. It supported the possibility of merging the sections *Rodochlamys* and *Eumusa* and also provided the first estimates of divergence time for individual *Musa* sections and genome groups.

Musa genome structure was already revealed by various authors (Baurens *et al.,* 1996; D’Hont *et al.,* 2000; Valarik *et al.,* 2002; D’Hont *et al.,* 2012; etc.) and the haploid genome of *Musa* species was estimated as varying between 560 to 600 Mb in size (Lysak *et al.,* 1999; Kamate *et al.,* 2001).

Genetic maps have been developed (Fauré *et al.,* 1993; Noyer *et al.,* 1997; Vilarinhos *et al.,* 2006 & Tropgenedb) and recently, BAC resources were generated for both *M. acuminata* (Ortiz-Vazques *et al.,* 2005; Vilarinhos *et al.,* 2003) and *M. balbisiana* (Safar *et al.,* 2004). A cytogenetic map based on BAC-FISH is being anchored to genetic maps in order to better characterize structural variation among *M. acuminata* genomes (Vilarinhos *et al.,* 2006). These resources will pave the way for studies of *Musa* genome structure and evolution through comparisons with other monocot and eudicot genomes.

Teo *et al.* (2005) studied the insertional polymorphisms of the elements using nine primers (including two newly designed) facing outwards from the LTRs and RT (reverse transcriptase) domain of the retrotransposon. The primers generated specific amplification patterns showing the universal applicability of this marker type. These IRAP markers (Inter-Retrotransposon

Amplified Polymorphism) can be used to distinguish the A and B genomes and thus between banana cultivars.

According to Van de Peer *et al.* (2008) the whole genome duplication (WGDs) has played a major role in angiosperm genome evolution and the first evidence of a WGD event in the *Musa* lineage was reported by Lescot *et al.* (2008). The whole banana genome project was over and D'Hont *et al.* (2012) identified 36,542 protein coding gene models in the *Musa* genome.

Faure *et al.* (1994) conducted controlled and reciprocal crosses in *Musa* that demonstrated strong bias towards maternal transmission of chloroplast DNA, but showed the unusual phenomenon of paternal transmission of mitochondrial DNA in *M. acuminata*. And the study was extended by Carreel *et al.* (2002) to analyse the origins of more than 300 *Musa* genotypes, leading to the conclusion that most cultivars are linked to two subspecies of *M. acuminata viz.*, *M. acuminata* subsp. *banksii* and *M. acuminata* subsp. *errans*, through their mitochondrial genomes.

Li *et al.* (2010) constructed the phylogeny of the family Musaceae, with a special reference to the infrageneric classification of the genus *Musa* based on the studies on multiple nuclear and chloroplast DNA fragments. This does not support the widespread hybridisation of *M. acuminata* and *M. balbisiana,* since they were placed in two different subclades; but suggested that the wild *Musa* specimens. of this clade can be used as a genetic resource for the production of new ones.

According to Němcová *et al.* (2011), comparative sequence analysis of single-copy genes is a powerful tool for resolving the evolutionary history of Musaceae and is complementary with the analysis of the ribosomal DNA ITS1-5.8S-ITS2 region and DArT markers analysis.

Martin *et al.* (2013) reported the assembly, annotation and structure analysis of the complete chloroplast genome of banana (*M. acuminata* subsp. *malaccensis*), first time in the order Zingiberales and reported new polymorphic markers. Davey *et al.* (2013) generated and annotated a draft reference *Musa* B-genome and demonstrate with 36,638 predicted functional gene sequences.

Dang *et al.* (2014) reported significant reduction of gene expression and enzyme activity in banana by analysing the RNAi-induced gene silencing achieved for both at transient and stable level.

Origin and domestication of cultivated banana were also evaluated by various molecular data mainly from chloroplast and nuclear genes (Li, *et al.,* 2013). Jourda *et al.* (2014) analysed the impact of WGDs on the evolution of banana gene families involved in the ethylene biosynthesis and signalling, a key pathway for banana fruit ripening.

The total genome size of *Musa* was already revealed by Dolezel *et al.* (1994) and according to Lysak *et al.* (1999) the unreplicated haploid genome size of *M. acuminata* (600 Mbp) is much higher than that of *M. balbisiana* (550 Mbp). Based on this several BAC clone libraries were developed within a year, from both A and B genome diploid *Musa* species with a total genomic coverage of more than 30 times (Vilarinhos *et al.*, 2003; Safa´r *et al.*, 2004; Ortiz-Vazquez *et al.*, 2005, Musagenomics, 2007).

The *Musa* Genomics Resource Centre was established in the Czech Republic and by 2007, 42 BACs totalling 3.3 Mbp (starting with Aert *et al.*, 2004) and 4.5 Mbp of BAC end sequences (Cheung & Town, 2007) were published. These allow an overview of the *Musa* genome showing that it has 47% GC content, the development of large numbers of PCR-based markers, and a comparison of genes and genomic structures with other species.

Anatomy

The anatomical studies of the members of the order Zingiberales by Tomilson (1956, 1959, 1960, 1961a, 1961b) revealed many interesting facts and more over, which paved the base of classification of this group.

Solereder and Meyer (1930) gave the first comprehensive account of the anatomical features of the family Musaceae (which include other members like *Musa, Ensete, Ravenala, Heliconia, Strelitzia* and *Orchidantha*). A detailed anatomical study of the 'Gros Michal' banana was done by Skutch (1927, 1930, 1932), but the major drawback is the absence of a comparative study with any of the other taxa. Later, Tomlinson (1957) attempted to classify the older Musaceae based on the anatomical studies and he suggested to separate the genus *Orchidantha* from other members and also gave evidences to raise it to another family Lowiaceae.

Skutch (1927) revealed the basic structure and nature of banana based on his studies with 'Hort. Gross Michel'. He explained the external structure as well as the internal anatomy under twenty two separate headings.

Stace (1980) reported that the anatomical characters are virtually unaffected by the environment and are more conservative. Many workers used it as a very good tool in the classification (Carlquist, 1961; Triplett & Kirchoff, 1991; Osuji, 2006; Fingolo *et al.*, 2012).

Triplett and Kirchoff (1991) studied the laminar architecture and anatomy in Heliconiaceae and Musaceae, (15 species of *Heliconia*, 3 species of *Musa*, and 1 species of *Ensete*) compared the data using statistical tools and prepared a general description for the anatomy of both the families. Kirchoff (1992) also studied the ovary structure and anatomy of Heliconiaceae and Musaceae which gave the anatomical background of the floral development in Musaceae and compared with that of related family Heliconiaceae.

Osuji (2006) suggested that the epidermal characters of *Musa* is characteristic and can be used as a tool for classification. Fingolo *et al.* (2012) also supported this and they characterised the bract and floral parts of *M. acuminata* in order to identify it even in powdered condition.

Sumardi and Wulandari (2010) tried to describe the anatomical and morphological characters of five Indonesian *Musa* cultivars and noticed the differences in the arrangements of vascular bundle, stomatal distribution, number of subsidiary cells, palisade number and size of air space in petiole. They also provided a general anatomy of almost all parts of banana based on this study.

Harijati *et al.* (2013) compared the anatomical and structural characteristics and the fibres' tensile strength of common banana cultivars used for wrapping of food items and noticed that those with greater number of layers of cells in leaf with broader fibres are more suitable for wrapping of items.

The anatomical changes in the fruit peel of banana during fruit development were best explained by Amnuaysin *et al.* (2012) based on his studies in 'Hom Thong' banana. They also explained the changes in colour, structure and firmness in maturation and ripening of fruit.

Cytology

Since 1940's the morphological studies of the plant and fruits were widely used to determine the ploidy and genome constitution of banana accessions and later the methods of numerical taxonomy have refined the approach (Simmonds & Weatherup, 1990; Ortiz, 1997; Ortiz *et al.*, 1998; Pollefeys *et al.*, 2004). It is much simplified by the application of flow cytometric analysis (Dolezel & Bartos, 2005) and resulted more accurate and rapid surveys without growing mature plants. Osuji *et al.* (1997) reported that the most cultivars have the complete set of 11 chromosomes by *in situ* hybridization to chromosome preparations using DNA probes that label the A and B ancestral genomes separately. But D'Hont *et al.* (2000) reported some abnormalities.

Tischler (1910) found that some Java bananas have 24 and 16 chromosomes and reported that the basic chromosome number of banana is 8. But later, Cheesman (1932) sugests that the basic haploid chromosome number of banana is 11 and the common edible bananas were triploids. It was later confirmed by Cheesman and Larter (1935) and Agharkar and Bhaduri (1935). Stover and Simmonds (1987) also reported that edible bananas exist in diploid, triploid and tetraploid forms with 22, 33 or 44 chromosomes. With the light of his experience, Cheesman (1934) concluded that fertile *Musa* species are diploids and the majority of the edibles are parthenocarpic triploids and some are diploids.

Wilson (1946) conducted the meiotic studies of five triploid clones of *Musa*, in order to assess inter- and intra-varietal variations and to determine the relationships between their cytological and breeding behaviours.

Karamura (1988) reported that the diploid *M. acuminata* (AA) gave rise to triploid AAA by meiotic chromosome restitution, while interspecific hybridization between these *M. acuminata* types (AA & AAA) and *M. balbisiana* (BB) resulted in various AAB and ABB types of today. Richardson *et al.* (1965) also reported the existence of other combinations such as ABBB, AAAB and AABB in South East Asia.

According to Udall and Wendel (2006) polyploidy plays an important role in crop improvement. Hamill *et al.* (1992) proved that it had to be a promising way of increasing productivity in banana. The morphological characters, pollen characteristics, stomatal size, density and their chloroplast density tend to vary with ploidy level of banana genotypes (Blomme & Tenkouano, 1998; Valsalakumari & Nair 1998; Ganga & Chezhiyan, 2002; Obeleba *et al.*, 2006).

Very little data about the morphology of the chromosomes have been obtained by the earlier workers except for Shepherd (1959), who used the squash technique for preparation of somatic plates. It is interesting to note from his drawings that the previous workers (Cheesman & Larter, 1935; Chakravorti, 1951) have certainly exaggerated the frequency of trabants and secondary constrictions.

Roy and Sharma (1951) conducted the chromosome studies of twenty common banana cultivars in Bihar using Gentian violet stain after fixing in Randholph's modified Navashin's fluid.

Mahanty (1970) tried to compare the different groups within the order Zingiberales and discussed the evolution of chromosome complements in these families, also recognised three subgroups within the family Musaceae (*s.l.*) and gave the status of subfamilies.

Agarwal (1983) conducted meiotic studies in seventeen South Indian bananas and noticed different cytological abnormalities. This study also reports that the disorganization of chromosomes and microspores at different stages leads to the sterility in diploids.

Agarwal (1988) also conducted a detailed study on the meiotic behaviour of *M. acuminata, M. balbisiana* and eleven banana cultivars grown in India, for identifying the best parents for the breeding programme to produce triploids and concluded that meiotic events leading to the formation of male gametes do not necessarily reflect the events taking place in formation of female gametes.

Bakry and Shepherd (2008) developed a new protocol to determine the chromosome number in bananas by counting the chromosomes in root tip squashes. They used the orcein stain after treated with 8-hydroxyquinoline and also standardized the time.

Reproductive biology

Pollination biology

Many authors worked on the pollination aspects of banana, in order to understand the absence of seeds in the normal bananas. Dodds (1945) reported that even though there is normal pollen tube growth in *Musa*, the failures of fertilization is quite frequent in the cases of both the wild and diploid cultivars. And according to Simmonds (1962) the mechanisms of the pollen tube failure are unknown and a significant limitation on fertility.

Fortescue and Turner (2005a) noticed some micropylar exudates in *Musa* and *Ensete* and studied its function and constitution and concluded that it is not linked to sterility in edible triploids.

Fortescue and Turner (2005b) studied the association between low temperatures and anatomical changes in pre-anthetic ovules of *Musa* and found that low temperature is associated with abnormal development of the megasporangium when it is differentiating, 3–6 weeks before emergence in the subtropics.

The earlier workers like Dodds (1945), Shepherd (1954) and Simmonds (1962) doubtfully states that the ovules of triploid plants are believed to contain a certain number of 'morphologically' mature embrysacs at the time of anthesis. But later Fortescue and Turner (2005c) studied the effects of sterility on the growth and development of the ovules and its tissue and came to the conclusion that almost all diploids and triploids had an embryo sac, but in most of the triploids it is incorrectly placed which leads to a higher percentage of sterility in triploids. They also reported that the 'B' genome in the edible triploid cultivars was associated with a 2.4-fold increase in the number of correctly positioned embryo sacs and this may contribute to the increased fertility associated with the 'B' genome.

The anatomy of ovule ontogeny in the family Musaceae was well studied by Fortescue and Turner (2005d) and concluded that the anatomical development of ovules in all members of the family Musaceae, both *Musa* and *Ensete,* undergo similar pattern of ontogeny except the size of the ovule.

Embryology

Normally the cultivated edible bananas fails in setting seed due to many reasons. It may be due to, multiple archesporia, irregular shaped tetrads and development of spores other than the chalazal spore (Dodds, 1945; Dodds & Simmonds, 1948b; Simmonds, 1962) or mismatching of chromosomes leads to embryo sac failure (Shepherd, 1954; Simmonds, 1962); genetic imbalance in triploids (Shepherd, 1954).

Palaeontology

The order Zingiberales has a rich fossil record of both vegetative and reproductive remains extending from the Late Cretaceous to the Pliocene from throughout the New World and Eurasia (Jain, 1965; Koch & Friedrich, 1970; Daghlian, 1981; Boyd, 1992; Manchester & Kress, 1993; Rodriguez-de la Rosa & Cevallos-Ferriz, 1994; Fischer *et al.*, 2009). But the fossils attributed to the order have been difficult to classify to family because the variation of characters that distinguish families in the order, in particular of fruits and seeds, are not known comprehensively (Rodriguez-de la Rosa & Cevallos-Ferriz, 1994).

Fossil zingiberid leaves from India have been placed in *Cannaites intertrappea* Trivedi & Verma (Cannaceae), and *Musophyllum indicum* Prakash *et al.* (Musaceae), and are known in association with the pseudostem *Musocaulon indicum* Jain (Musaceae), and the inflorescence axis *Musostrobocaulon skutchii* Bonde (Musaceae) (Jain, 1963a, 1965; Trivedi & Verma, 1971; Prakash *et al.* 1977; Bonde, 2008). All these fossils came from the Deccan Interappen Beds in India, which range in age from Maastrictian to Eocene in age (Bonde, 2008).

Benedict (2012) reported that the Zingiberalean fossils are unknown from Asia with the exception of *Musophyllum nipponicum* Tanai, a single Oligocene leaf from Hokkaido, Japan. Its assigning to Musaceae has been questioned by Boyd on the basis of departure angles of the secondary veins and he recommends it not be considered a part of Musaceae, Strelitziaceae or Heliconiaceae (Tanai, 1970; Boyd, 1992).

Rodriguez-de la Rosa and Cevallos-Ferriz (1994) had described two fossil genera of Zingiberales from the Late Cretaceous (Campanian) of Coahuila, Mexico based on permineralized fruits and seeds. The first one is named as *Striatornata sanantoniensis* Rodriguez-de la Rosa & Cevallos-Ferriz has a triloculate fruit with numerous seeds and is placed in the family Musaceae based on the presence of a chalazal chamber, a character reported by Manchester and Kress (1993) as a synapomorphy for Musaceae. A second taxon from the same strata, *Tricostatocarpon silvapinedae* Rodriguez-de la Rosa & Cevallos-Ferriz, is also included in Zingiberales based on the characters of triloculate fruits with axile placentation and operculate seeds with a seed coat construction similar to other fossil members classified in the order. However, they could not be placed in a family, in part, because of a lack of diagnostic information about seeds of extant taxa (Rodriguez-de la Rosa & Cevallos-Ferriz, 1994).

Many authors such as Manchester and Kress (1993), Manchester (1994, 1995) had isolated seeds and single fruits of *Ensete* from North American sides and reported with short descriptions.

Jain (1963b, 1965) isolated and described the fossil *Musa cardiosperma* Jain based on well-preserved permineralized fruits and seeds and placed within the family Musaceae due to its similarity with *Musa*. Later authors such as Bande and Prakash (1986), Mehrotra (2002) and Bonde (2008) found that the fruits found in compression preservational states from the Decans that are considered to be conspecific with *M. cardiosperma* were named *Callistemonites indicus* Bande *et al.* But the re-examination of the fruits of *M. cardiosperma* by Manchester and Kress (1993) proposed that the fossil seeds lack essential characters of Musaceae, in particular, the chalazal chamber, which was proposed as a synapomorphy for the family and suggested to retain it as a member of Zingiberales but not placed in any particular family (Manchester & Kress, 1993; Rodriguez-de la Rosa & Cevallos-Ferriz, 1994; Benedict *et al.*, 2007; Benedict, 2011).

Various authors such as Berry (1925), Manchester and Kress (1993), Rodriguez-de la Rosa and Cevallos-Ferriz (1994), Cheesman (1948) and Jain (1960), worked on the Zingiberaceaen fossils of South America and a detailed discussions were made.

Recently, Benedict (2012) studied the Zingiberalean fossils from the Late Paleocene of North Dakota, USA and their significance to the origin and diversification of Zingiberales and described some new fossil materials, compared their relationships with the existing Zingiberales and also discussed the variation of fruits and seeds within the group.

Phytochemistry

Members of the order Zingiberales have been attracted since long due to their culinary uses and biological and pharmaceutical activities (Pancharoen *et al*., 2000).

According to Simmonds (1954a), the difference between *M. acuminata* and *M. balbisiana* derivatives in respect of browning lies in the availability of an oxidisable substrate rather than in the possession of the necessary enzyme. Griffiths (1959, 1961) identified the substrate as 3, 4-dihydroxyphenyl-ethilamine (DHPE) and is a marker for A genome.

Simmonds (1959) first noticed that there are a number of significant biological differences between the various groups of bananas and suggested that it can also be used as a tool to differentiate *M. acuminata* and *M. balbisiana* derivatives. The fruits of *M. balbisiana* lines are found more starchy, more acidic, less aromatic, contain more vitamin C and are less liable to phenolic browning.

Some pigments can also be used to classify the bananas and also to find the interrelationship between wild and other cultivated bananas. The presence of anthocyanins in the bracts of banana have been reviewed by various authors like Simmonds (1954a, 1954b), Horry and Jay (1988a, 1988b), etc. The distribution of various anthocyanidins among different banana cultivars gave good support to the taxonomic ordering within the genus (Horry & Jay 1988a, 1988b; Javed *et al.,* 2001).

Ali (1992) isolated and elucidated the structure three trihomoneoclerodane diterpenoids from the chloroform extract of the seeds of *M. balbisiana.* Pascual-Villalobos and Rodri´guez (2007) assessed the chloroform and acetone extract of the seeds of *M. balbisiana* in the diet for toxicity against the flat grain beetle and reported effective.

The chemistry of banana fruit and the changes during development and ripening were studied by various workers (Hubbard *et al.*, 1990; Seymour, 1993; Cordenunsi & Lajolo, 1995; Adão & Gloria, 2005; Fils-Lycaon *et al.*, 2011) and they reported that at the initial stages of development, it imports sucrose and accumulates carbohydrate in the form of starch. While on ripening it converts in to soluble sugars such as sucrose and then to glucose and fructose, which resulted sweetness. The enzymes involved in these conversion and the factors involved in these actions were also studied by various authors (Hubbard *et al.*, 1990; Cordenunsi & Lajolo, 1995; Nascimento *et al.*, 1997; Nascimento *et al.*, 2000; Purgatto *et al.*, 2001; Rossetto *et al.*, 2003).

Fils-Lycaon *et al.* (2008) proposed some protocols for the biochemical characterization of banana fruits by measuring few key biochemical parameters such as soluble sugars, organic acids, free ACC and *in vitro* ACC oxidase. Gibert *et al.* (2009) assessed the morphological, physical and chemical characteristics of twenty three unripe Colombian *Musa* cultivars. The PCA (Principal Component Analysis) shows the strong relation between some of the varietal characteristics and the consumption pattern.

Fungo and Pillay (2011) evaluated the β-carotene content of selected banana genotypes from Uganda and noticed a wide variability of β-carotene within the group and reported a high value of 2594.0 µg/ 100 g. in pulp from

Papua New Guinea. They also noticed a positive correlation between the pulp colour intensity and the β-carotene concentration. This correlation was already reported much before by Krinsky (1998) and Russel (1998).

Amnuaysin *et al.* (2012) reported the presence of parenchyma cells with rod-shaped starch granules in the fruit peel of banana and the starch contents increases with fruit maturation and get diminished on ripening. Goulao and Oliveira (2008) already reported that the starch contents in the banana fruit converted to sugar during ripening and this gave the sweetness of ripened fruit.

Esau (1978) reported the presence of pectin in the fibre cell wall and on ripening it is converted in to soluble forms resulted the swelling of cell wall (Rosli *et al.,* 2004). Kallarackal *et al.* (1986) reported tannin and three more colloidal suspensions in the latex of banana such as lipid globules, lutoid and cytoplasmic fragments. The presence of tannin, a polyphenolic compound, causes astringency in fruits (Goldstein & Swain, 1963). These astringent tastes get reduced during ripening by the conversion of tannin in to some insoluble compounds (Lizada *et al.,* 1990). Amnuaysin *et al.* (2012) also noticed the presence of tannin in the banana fruit.

According to Doymaz (2010) bananas are rich in nutrients, starch, sugar and vitamins A and C, potassium, calcium, sodium and magnesium. Santos *et al.* (2010) conducted a preliminary study of the chemotaxonomy on the cadenced tannin of the green banana flesh and found that the total tannin content was highly variable depending on the genotypes and the growing conditions of the plants.

Priya Darsan *et al.* (2012) evaluated the polyphenolic content and antioxidant activity of methanolic extract of ‘Pisang Awak’ banana. Recently, Khawas *et al.* (2014) studied the nutritional composition of culinary banana (ABB genome) at different developmental stages and reported that the young stages fruit has rich amount of antioxidants, amino acids and fatty acids but is replaced with starch at maturity followed by the gradual decline of the ash, phenolic and protein. At the ripening stage the softening of tissue resulted the increase in moisture content (Onwuka & Onwuka, 2005). These changes in the chemical composition was already reported in the desert bananas by the earlier workers (Marriott *et al.,* 1981; Yang & Hoffman, 1984; Cheirsilp & Umsakul, 2008; Emaga *et al.,* 2008).

Many authors reported different biological activities in different parts of banana plant such as leaves (Yakubu *et al.,* 2007), roots (Mallick *et al.,* 2007), flower (Sing, 2008), fruits (Ojewole & Adewunmi, 2003), stem (Kailash & Varalakshmi, 1992; Kailash *et al.,* 1993) and seeds (Mallick *et al.,* 2006).

Musa textilis, commonly called as Abaca is widely used to produce high quality paper pulp and a detailed study of the chemical composition of the leaf fibre by Riäo and Gutierrez (2006) revealed that the fibre contains 13.2% lignin. The GC-MS analysis of this fibre released predominantly compounds arising from lignin and phydroxycinnamic acids, with high amounts of 4-vinylphenol.

Hossain *et al.* (2011) studied the antidiarrheal, antimicrobial and antioxidant activities of banana seeds and is an experimental basis to understand the use of it as traditional medicine.

Jahan *et al.* (2010) reported excellent antimicrobial activity of *Musa* samples in alcoholic extraction with 50% ethanol for 24 hours. Ehiowemwenguan *et al.* (2014) studied the antibacterial and phytochemical studies on the banana fruit peel and reported that the ethanolic extract of the banana peel had significant *in vitro* broad spectrum antimicrobial activity and this also justified the use of banana fruit peel in the traditional medicine.

The antioxidant activity of the banana fruit and pulp were analyzed by various authors (Someya *et al*., 2002; Wall, 2006; Lim *et al*., 2007). Recently, Gonzalez-Montelongo *et al*. (2010) identified the most effective extraction conditions that produce maximum antioxidant activity. Baskar *et al.* (2011) also evaluated and compared the phytochemical content and the antioxidant activity in peel extracts of nine local South Indian banana cultivars and suggested that they are useful to combat free radical mediated diseases. They reported that the cultivars *Monthan* and *Rasthali* had highest free radical scavenging activity and *Karpooravalli, Rasthali, Neypoovan, Poovan* had highest phytochemical content.

Prabha *et al.* (2011) investigated the anti-ulcer activity of banana on peptic ulcer and concluded that it contains some compound like leucocyanidin in the banana is responsible for this activity. Adinarayana and Babu (2011) investigated the antioxidant activity of the ethanolic extract of the *M. acuminata* rhizome and proved its significant antiproliferative and antioxidant activities.

The *in vitro* bioactivity and phytochemical screening of methanolic extract of *M. acuminata* flower by Sumathy *et al.* (2011) revealed that it is a very good antioxidant source like butylated hydroxytoluene (BHT) and also confirmed the presence of glycosides, tannins, sapponnins, phenols, steroids and flavonoids. The proximate, mineral, vitamin and other phytochemical compositions of plantain bract were assessed by Adeolu and Enesi (2013).

According to Baye *et al.* (2006) the quality and quantity of primary metabolites may vary with the environmental and genetic variations of the plant. Recently the carotenoids and phenolic acids profile of the pulp fruits of banana genotypes was determined by Borges *et al.* (2014). The preliminary metabolic constituents of the bract of *M. acuminata* was investigated by Gunavathy *et al.* (2014) and it revealed the presence of alkaloids, flavonoids, terpenoids, coumarins, phenols, tannins, glycosides, steroids and saponins in different solvents.

Ibukun *et al.* (2012) investigated the effect of ripening on the antioxidant properties and phytochemical constituents of plantain. The antimicrobial and antifungal activity of the banana extract were studied by different authors (Rao *et al.,* 2012; Kumar *et al.,* 2014; Ray & Ghatak, 2013; Ahmad *et al.,* 2015).

The chemotaxonomy had proven very significant role in the taxonomy of banana since long. Simmonds (1954a, 1954b) and Horry and Jay (1988a, 1988b) also worked on the chemical profile of cultivated banana and proved that some pigments like anthocyanin and their distribution among different banana cultivars gave good support for the banana taxonomy. Subsequently Javed *et al.* (2001) described the relationship between the different wild Malaysian bananas based on the distribution of anthocyanins. The chemical constituents of the *Musa* pseudostem was evaluated by various authors (Akpabio *et al.,* 2012; Apriasari *et al.,* 2014).

Someya *et al*. (2002) and Nguyen *et al.* (2003) analyzed the total phenolic content of banana fruit peel and reported that it ranges from 0.90 to 3.0 g/100g dry weight. According to the recent works (Someya *et al*., 2002; Kondo *et al*., 2005; Sulaiman *et al*., 2011) the banana peel contain higher phenolic compounds than that of pulps. The total phenolics, flavonoids and antioxidant activity of the powdered banana pulp and peel were analyzed by Fatemeh *et al.* (2012) and compared the influence with respect to different varieties, parts and stage of development.

Ekwenchi and Yaro (2012) isolated some important organic compounds such as Saturates, aromatic and polar compounds by anaerobic fungal degradation of banana leaves. Silva *et al.* (2014) isolated and identified three triterpenes and a mixture of two sterols from banana fruit peel, which support the uses of banana in the folk medicines (against leishmaniasis). Sreejith *et al.* (2016) reported 15 compounds from *Karivazhai* with a very high concentration of 1-Heptatriacotanol (56.48%) with antimicrobial activity.

Cultivation practices

The cultivation practices and distribution of banana cultivars were explained by various authors. Ortiz (1997) gave a general introduction to the diversity and also the world wide distribution of bananas. Dadzie and Orchard (1997) published the major post harvest criteria and methods for the general selection/screening of new *Musa* hybrids, which is a very good guide to the farmers, breeders and researchers.

According to Heslop-Harrison and Schwarzacher (2007) banana is the fourth most important crop in the developing countries and second in production after cereals (FAO, 2009; Mohapatra *et al.*, 2010) but the major challenges to the production are the virulent diseases, abiotic stresses and the money problems (Heslop-Harrison & Schwarzacher, 2007).

Some works in respect of the cost effectiveness in the production of some banana cultivars are also done by various authors. Rohilla *et al.* (2004) conducted a series of studies to evaluate the effect of fortified fertilizers on the growth and yield of Robusta cultivar and reported that the fortified fertilizers from different livestock manure had a significant effects ($P<0.05$) and can be best utilised for the farmers. More *et al.* (2005) also suggested that the drip irrigation may reduce the labour utilization and in the broader aspects can be applied as cost effective method.

Kavaskar and Govind (2006) explained the major factors influencing the adoption level of banana farmers based on the study among 120 banana farmers of Thiruvannamalai district.

According to Soltani *et al.* (2011) the changes in fruit colour is an important indicator to identify stage of crop maturity and the pulp to peel ratio coupled with total soluble sugars are the most important parameters for harvesting (Adao & Gloria, 2005; Khawas *et al.,* 2014).

Micropropagation

Suman *et al.* (2012) studied the diversity of genome and ploidy in banana and their effect on tissue culture responses and found that the triploids shows better response towards 2,4-D, IAA, KIN and BAP followed by tetraploids and diploids. They also reported that the genomic constitution also effects the tissue culture responses; *i.e.*, The genotype with more 'A' genomes gave better response than those with 'B' genome for all tissue culture responses except somatic embryogenesis.

Jhurree-Dussoruth and Kallydin (2011) tested eleven different media for the weaning of banana plants, which are low coast and locally available and reported that the usage of medium with sterile soil + manure mix will reduce the hardening coast by 90%.

Crop improvement

Genetic approaches are now a days widely used to improve the banana by integrating genetical, evolutionary and structural data, which allows targeted breeding and transformation (Heslop-Harrison & Schwarzacher, 2007). Azhar and Heslop-Harrison (2008) analyses the diversity of Resistance genes (R genes) in cultivated and wild bananas and revealed its identity, nature and evolutionary diversity, which may be used for breeding programmes.

Aquil *et al.* (2012) studied possibilities of the genetic transformation and the Micropropagation for the crop improvement of banana and it is identified as a new technique for the enhancement of banana production especially against biotic and abiotic stresses.

Pathology

Banana suffers from several dangerous and devastating diseases (Robinson, 1996) which constrain banana production, leading to plantations becoming uneconomic and being abandoned. The major diseases includes panama disease (*Fusarium oxysporum* f.sp. *cubense*), bacterial wilt (*Xanthomonas* sp.), banana bunchy top virus (BBTV), banana streak virus (BSV), genus Badnavirus, freckle (*Cladosporium musae*), *Phyllostictina musarium*, *Cordana* and Moko disease (*Ralstonia solanacearum*), Burrowing nematodes (*Radopholus similis* and *Pratylenchus* spp.), weevil (*Cosmopolites sordidus*) and pests (Heslop-Harison & Schwarzacher, 2007; Tripathi *et al.,* 2008)

According to Moore *et al.* (1995) panama disease 'is widely regarded as one of the most destructive plant diseases in recorded history', which would affect 85% of the total global production and is caused by a soil born fungal pathogen *Fusarium oxysporum* f.sp. *cubense*. The fungus shows high phylogenetic diversity with a number of races (Ploetz & Churchill, 2011) and according to Hwang and Ko (2004) and Daly and Walduck (2006) cannot be destroyed completely by any chemical fungicide or soil fumigants, or by other cultural practices. Waalwijk, *et al.* (2011) developed a new molecular diagnostic tool for the early detection of *Fusarium* attacks in the banana. Dita *et al.* (2011) also reported a standardised rapid and reliable green house bioassay for this pathosystem.

Black leaf streak, caused by *Mycosphaerella fijiensis*, is another very important and most destructive leaf disease of banana especially in Malaysia. It leads to significant decline in yield and fruit quality due to reduction of photosynthetic sites in the functional leaves. (Then & Palaniappan, 2011).

Molecular techniques were also used to identify and also for the characterization of banana pathogens which will be very much helpful in resistance breeding. Selvarajan *et al.* (2010) reported that the DNA components of BBTV infected Hill banana collected from Tamil Nadu shows a high degree of similarity with the corresponding sequences of BBTV isolates originating from India and abroad. Many others also isolated DNA from the BBTV and characterised its genome (Amin *et al.,* 2008; Bell *et al.,* 2002; Burns *et al.,* 1995; Harding *et al.,* 1993; Karan *et al.,* 1994; Karan *et al.,* 1997).

Uses

Banana is highly interwoven with the normal life and culture of human and each and every parts of banana is useful for specific purposes, hence aptly referred as '*Kalpatharu*'. The uses of banana and its by-products can be traced from very ancient literature. An overview of the Banana and its by-product utilization was given by Mohapatra, *et al.* (2010). It acts both as a staple food in some parts due to the high starch content (Heslop-Harrison & Schwarzacher, 2007) and also as a major cash crop according to FAOStat (2007).

Banana is the second largest produced food crop after citrus, contributing 16% of the world's total fruit production (FAO, 2009; Mohapatra *et al.*, 2010) and is used for different proposes such as a fruit crop, vegetable, medicine and cosmetics (Frison & Sharrock, 1999; Amnuaysin *et al.,* 2012). Almost all parts of banana contain many nutritive compliments including minerals and fibres and were used for making many types of food items (Fingolo *et al.*, 2012).

Due to the high cellulose content in the plant parts it can be better used in pulp and paper industry and also as/in natural purifier, recycling, bioremediation etc. Uma *et al.* (2005b) evaluated six common cultivars in different ploidy level for their suitability for fibre industry and reported that '*Pachanadan'* and '*Poovan'* (AAB genome) has higher fibre yield than others.

Various parts of banana plant are also used as medicine from the ancient time onwards (Amit & Shailandra, 2006) and some of its medicinal effects were later proved. Kumar *et al.* (2012) studied the traditional and medicinal uses of banana and explains its nutritional value and medicinal properties in detail. The roots are used as anthelmentic, aphrodisiac and laxative (Gangwar *et al.,* 2012). The fresh fruit is used for peptic and duodenal ulcers (Jain & Sharma 1967; Ivan, 2005). Till date different parts of banana have been studied for antiulcerogenic (Sanyal *et al.*, 1961; David *et al.,* 1999; Goel & Sairam, 2002), hypoglycaemic (Dhanabal *et al.,* 2005; Oke *et al.,* 1999), hypolipidemic (Gomathy *et al.*, 1989), antimicrobial (Managathayaru *et al.,* 2004), antihypertensive (Anonymus, 2003). The pseudostem and fruit peel of banana also reported to have some analgesic property (Vogal & Vogal, 2002; Jain *et al.,* 2007; Gangwar *et al.,* 2012).

The parts used for curing various diseases includes the flowers (bronchitis, dysentery, ulcers and diabetics), the astringent plant sap (hysteria, epilepsy, leprosy, fevers, hemorrhages, acute dysentery, diarrhea, hemorrhoids, insect and other stings and bites), young leaves (burns and other skin afflictions), unripe peel and leaves (dysentery, diarrhea and also for treating malignant ulcers) (Girish & Satish, 2008). According to Bhat *et al.* (2010), the banana roots can be used to treat digestive disorders, dysentery and other ailments and the seed mucilage for diarrhea.

Ivan (2005) reported different amino acids like threonine, tryptamine, tryptophan, flavonoids and steroids in banana fruits. Fungo and Pillay (2011) noticed a wide variability of β-carotene within the group of Uganda banana and reported a high value of 2594.0 µg/100 g. in the edible pulp from Papua New Guinea genotype and suggested it as a good source of vitamin and can be used to eradicate the vitamin deficiency.

Khawas *et al.* (2014) studied the nutritional composition of culinary banana (ABB genome) at different developmental stages and reported that the nutritional composition is affected by various growth stages. It may also open a new source as an ingredient for developing products and also as a potential source of starch extraction.

Apart from its use as a valuable food item, banana fruits and the different part of plant find varied uses in various folk practices, customs, religious rituals and medicine among the villagers and tribal communities of the country, which are oral in tradition (Pushpangadan *et al.*, 1989). It is also considered to signify plenty and fertility and that is why it is placed at the entrance of houses and temples on special religious functions and ceremonies like marriage.

Pushpangathan *et al.* (1989) explained some lesser known and traditional and folk uses of banana mainly stressing on Indian culture and practices and most of them are very old and unwritten practices in the villages and tribes.

Morton (1987), Gunaseelan (2004) and Bori *et al*. (2007) reported various industrial applications of banana peel, including bio-fuel production, bio-sorbents, pulp and paper, cosmetics, energy related activities, organic fertilizer, environmental cleanup and biotechnology related processes.

AREA OF STUDY

The present study area is South India, which includes five political states, *viz.,* Andhra Pradesh, Karnataka, Telangana, Tamil Nadu and Kerala and the union territory of Puducherry (**Fig. 02**). This region stretches between 8º – 18º North latitude and 74º – 85º East longitude and covers an area of 4,67,186 sq. km. It is the southern part of Deccan Plateau, and is bounded on the north by states of Goa, Maharashtra, Chhattisgarh and Odisha, on the east by the Bay of Bengal, on the south by the Indian Ocean and on the west by the Arabian Sea.

A land area can be identified along/closely with the natural environment and it includes the soil and the topography along with the physical features (climate, temperature, etc.).

Topography

It exhibits diverse habitats and vegetations and can be divided in to four major divisions such as (1) the mountain region in the east and west, (2) the undulating midland with hill rocks, (3) the northern plains and (4) the sloping coastal strips.

The mountain regions in South India include the Western Ghats and the Eastern Ghats. Western Ghats runs about 1600 km along the western boarder of the Deccan Plateau, parallel to the Arabian Sea. It starts from the river valley of Tapti and runs through Maharashtra, Karnataka, Kerala and Tamil Nadu to the tip of peninsular India. It has an average elevation of 1200 m with the highest peak at Anamudi (2695 m). It has great ecological significance and the UNESCO had declared it as one of the world heritage sites. It is also one of the hotspot regions in India.

Eastern Ghats is the discontinuous mountain ranges along the eastern coast of India and it stretches a distance of about 1700 km starting from the

Mahanadi basin in the north to the Nilgiri Hills in the south. It has an average elevation of 600 m with the highest peak at Shevaroy Hills (1700 m). Eastern Ghats exhibits a high rate of endemism and the Government of India so far identified 14 protected areas from this region.

Five major rivers, *viz.,* Godavari, Krishna, Tungabhadra, Kavery and Vaigai passes through South India and these along with their tributaries form the major water sources.

Phytogeographical divisions

After a detailed floristic survey, Botanical Survey of India recognized eleven phytogeographic zones of India (Hajra *et al.,* 1996) and also provided a detailed description of their vegetative types. They are:

1. North-West Himalayas
2. Indo-Gangetic plains
3. Eastern Himalayas:
    a. Sikkim
    b. Arunachal Pradesh
4. North-Eastern India and North Bengal
5. Central India
6. Arid zone
7. Northern Western Ghats and northern West Coast
8. Southern Western Ghats, West Coast & Lakshadweep
9. Deccan
10. Eastern Ghats – Coromandel Coast
11. Andaman & Nicobar Islands

Out of this eleven zones, South India falls under the following five zones, *viz.,* Central India, Northern Western Ghats & Northern West Coast, Southern Western Ghats & West Coast, Eastern Ghats & Coromandel Coast and Deccan. This can be broadly classified in to two major botanical provinces – the Deccan (major part stretching from the mountain ranges of central India to the southern end, *i.e.*, Kanyakumari and is bordered by the Eastern Ghats and Western Ghats on the eastern and western sides, respectively) and the Malabar (a long and narrow strip of land running parallel to the coast of Lakshadweep Sea west of Western Ghats and south of Konkan region).

Soil

It is the upper layer of loose surface material, composed of a mixture of minerals, dead remnants of plants and animals, water and air. It is the by-product of continuing interaction between the parent material, local climate, plants, animals and other organisms and so it varies from place to place. Since the soil act as a platform for the existence of plants such as an anchoring media and the source of nutrients for the existence, growth and development, it is considered as an important segment of an ecosystem.

Out of the six soil types identified in India five (except Desert soil) are present in South India. They are:

1. Alluvial soil

It is the most important and most productive soil type in India and is also present in the fringes of southern peninsula – mainly in the river valley, flood plains and deltas. Even though it has a higher proportion of clay and are more sticky, its texture may vary from sandy loam to clay and its colour may also varies from grey to reddish brown. It has a rich source of potassium and is deficient in nitrogen and organic matter but are suitable for almost all crops.

2. Black soil

It is mainly found in the Deccan larva region, and in South India it is also present in small parts of Kerala, Karnataka, Andhra Pradesh, Telangana and Tamil Nadu. It is formed by the disintegration of volcanic basaltic lava. The presence of compounds like aluminium and iron make its colour black. It had a low permeability and is impregnable with more or less clay texture. The most important characteristics of this soil are its ability to retain moisture even during dry season. It forms wide cracks during summer due to moisture loss and it swells and become sticky when saturated. This helps the soil to be deeply aerated and oxidised and imparts fertility. This soil is more favourable for the cultivation of crops like cotton, sugarcane, wheat, and other fruit crops.

3. Red soil

It is the major soil type in South India and it covers the major parts of Tamil Nadu, Karnataka, Telangana, Andhra Pradesh and Kerala. This type of soil is formed from the crystalline rocks like granite, gneisses and the abundant ratio of iron compounds make this soil deep reddish. But they are deficient in organic matter and hence less fertile, compared to other types. But the productivity can be raised through irrigation and application of fertilizers. This soil is suitable for rice, millets, maize, groundnut, tobacco and fruits.

4. Laterite soil

The lateritic soil is commonly found in the high altitude and heavy rainfall areas of Kerala, Karnataka and Tamil Nadu and are generally formed under hot and humid climatic conditions. This soil is generally infertile due to the accelerated leaching of nutrients. The main characteristic features of this soil include extreme hard texture, complete chemical decomposition of the parent rock, complete leaching of silica and reddish brown colour due to the presence of oxides of aluminium and iron and the lack of humus. The common cultivated crops in the lowland areas includes rice, sugarcane, millets, etc.

whereas the tropical plantations of rubber, coffee and tea are common in uplands.

5. Mountain Soil

The mountain soils are complex and extremely varied. The soils vary from deep alluvium in the river basins and lower slopes to the highly immature residual gravelly on higher altitudes. The types of crops vary with type of land but some crops like potato can be grown in almost all areas.

Climate

Based on the ratio of rainfall to evapo-transpiration, Chowdhury and Sarwade (1982) classified the homoclimatic regions of India into five categories, *viz.*, (1) Arid region, (2) Semi-arid region, (3) Sub-humid region, (4) Humid regime and (5) Super-humid regime. Out of these, four are present in South India. A semi-arid climate is experienced in the costal parts of Andhra Pradesh, certain interior parts of Karnataka and in some districts of Tamil Nadu. Whereas the Northern coastal parts of Andhra Pradesh, southern districts of Karnataka and northern Tamil Nadu experience a dry, sub-humid climate, while the coastal Karnataka and northern Kerala have moist, sub-humid type of climate. The humid regime predominates in the southern districts of Kerala and at higher elevations around Coonoor and Ootacamund in Tamil Nadu, where as super-humid regime occupies only at Kodaikanal of Tamil Nadu.

Even though South India exhibits a typical tropical climate which is mainly influenced by monsoons, it experiences three seasons, *viz.,* (1) Summer, (2) Monsoon and (3) Winter.

1. Summer (March to May)

Almost dry seasons prevail from March to May. The average temperature is 31 – 42ºC and it may climb up to 47ºC in some areas.

2. Monsoon

South Indian states exhibits either one of the monsoon wind, *viz.,* south-west monsoon or monsoon (June to August) or north-east monsoon or post-monsoon (October to November). Since the south-west monsoon accounts for most of the rainfall in the region it is generally known as monsoon and the latter treated as post-monsoon.

2a. South-west monsoon or monsoon (June to August)

The south-west monsoon winds enter the South Indian sea towards the end of May or the beginning of June. It then splits in to two and one of which enter in to the Arabian Sea and hits the Western Ghats. This wind then moves northwards along Western Ghats giving rain to the coastal areas of the western part of Western Ghats. Since the wind does not cross the Western Ghats, the eastern part of the Western Ghats will not receive much rain. The other part of the south-west monsoon causes rain in the north-east India. It gives heavy rain in the coastal and Western Ghats. During this season, the cloudy sky causes temperature to fall a little, but humidity rises to its maximum for the year.

2b. North-east monsoon or post-monsoon (October to November)

The south-west monsoon begins to withdrawn by the first week of October. The withdrawing south-west monsoon winds are replaced by the north-east monsoon winds. Around September, with the sun fast retreating south, the northern land mass of the Indian subcontinent begins to build over northern India. Since the Indian Ocean and its surrounding atmosphere retain its temperature, the cold wind will sweep down from the Himalayas and the Indo-Gangetic plain towards the vast spans of the Indian Ocean. This is known as north-east monsoon or retreating monsoon, and here the total rain fall is low when compared with the south-west monsoon.

3. Winter (November to February)

The winter commences more or less by the end of November and it continues till the end of February. Once the monsoon subsides, average temperature gradually falls across India and it may reach up to 16-10ºC. in South India. The Western Ghats including the Nilgiri range, the temperature fall below zero. Indian Ocean exerts a strong moderating influence on the weather of coastal areas.

Temperature

Temperature is the intensity of heat and it decreases from equator to poles. The factors influencing the temperature of an area include, altitude, latitude, humidity, wind current, etc. South India experiences a wide range of temperature from 15–40ºC in different areas. In some areas, at extreme conditions, it may fall below freezing or may rise up to 45ºC.

MATERIALS AND METHODS

Literature survey

All relevant information related to the taxa under study were collected from various sources, such as libraries of Institutions and information retrieval systems. Electronic sources like internet and INFO-NET facilities were also utilized. The literature retrieval system of Biodiversity heritage library of New York Botanic Garden (http://www.biodiversitylibrary.org), botanical literature from the Missouri Botanical Garden Library (http://botanicus.org), JSTOR (http://www.jstor.org), other websites like http://www.bananas.org/ and other databases were also utilized. Some information – both formal and informal, were received through direct contact to experienced farmers and subject experts and also through various institutions.

Specimen collection

Extensive field trips were conducted throughout South India for the collection of specimens. The specimens available in different gardens and in the personal collections of various farmers from different parts of India were also studied. Both vegetative and reproductive parts of the taxa were collected after taking photographs of entire plant, leaf, inflorescence, buds, flowers, infructescence, fruits, etc. All the field observations such as habit, habitat, height of the plant, nature of leaves, stem girth, flower colour, shape of the fruits, number of fruits/bunch, number of suckers, etc. along with their growth pattern, requirements, yield, uses, area of cultivation, diseases and other threats were noted in the field book. For detailed observation, a *Musa* descriptor was prepared for collecting data from field (**Appendix I**). Reproductive structures such as flowers, fruits, etc. were preserved in Poly Vinyl Chloride (PVC) bottles with Formalin-Acetic acid-Alcohol (FAA) for further studies. Geographic location was noticed with the aid of a GPS (Garmin 76cSx).

Conservation of South Indian banana cultivars

The fresh rhizomes collected from the field were planted in the Calicut University Botanic Garden Germplasm Conservatory for cultivated bananas (*Musa* Garden) for further studies. Which are all growing well in '*Musa* Garden' of Calicut University Botanical Garden (CUBG). The traditional banana cultivation methods were employed for conservation. All accessions collected were properly labelled with standard metallic T-labels (15 × 5 cm) indicating the details such as collection number, name of the cultivar and collection locality.

Herbarium preparation

The specimens of appropriate size with relevant parts were collected from the field and sealed in polyethylene covers after treating with formaldehyde. Herbaria were prepared following wet method (De Vogel, 1987; Forman & Bridson, 1998). The dried specimens were mounted on standard handmade sheets (28 × 42 cm) and labelled properly with standard labels (14.5 × 11 cm), after including all the relevant information.

Descriptions

The cultivars were described based on living plants grown in the garden. The materials collected were brought to laboratory for detailed study and identification. Photographs of the plant and floral parts were also taken in the field itself. Measurements of plant and different parts were noticed using measuring tape or with a photo scale. In order to maintain stability, some standard uniform techniques were followed. The descriptions were made by using a modified *Musa* descriptor originally published by INIBAP/IPGRI. The descriptions were prepared for each cultivar from 3–5 specimens to incorporate the range of variation within the cultivar.

The vegetative characters were noticed within fifteen days of the emergence of inflorescence and the fruit bunch and fruit characters were noticed at the fruit maturity and ready for harvest. The pseudostem height was measured from the ground level to the point of emergence of inflorescence and the pseudostem aspects/circumference were noticed at a height of one meter from the ground level. Leaf characters were noticed from the third fully opened leaf from the top. The length of the petiole was measured from the point of divergence from the pseudostem to the point of insertion of the lamina. Similarly the length of lamina was noticed from the point of insertion of lamina to the extreme leaf tip and the width was measured at the maximum widest area of the leaf. The female bract and flower characters were taken from the second hand and the male bract and flower characters from the third male hand (after the basal female hands). The measurements of bracts and tepals were taken after stretching-out the specimens. The length of compound tepal was measured including the lobes and that of free tepal included the length of acumen if present. The length of peduncle was measured from the point of emergence from the pseudostem to the first fertile hand and the length of fruit was measured from the base of pedicel to the fruit apex. The general morphology of the plant is represented in **Fig. 03.** Photographs of essential parts were taken with Sony cyber-shot DSC-H2 and Canon Powershot G12 cameras.

Assigning tentative genomic status

The genomic statuses of the collected cultivars were assigned using the 15 characters (see p. 71, **Table 01**) identified by Simmonds and Shepherd (1955). Here each plant is scored from 1 to 5 for each character in such a way that the traits mentioned under *Musa acuminata* were given the score of 1 and those matching with *M. balbisiana* were scored as 5. The intermediate expressions of characters were given a score of 2, 3 or 4 according to their intensity. So each plant will get a total score, ranging from 15–75. The total score thus obtained were compared with the score card (see p. 72, **Table 02**) proposed by Singh and Uma (1996).

Nomenclature

A modified three-tyre system of nomenclature for the *Musa* cultivars (originally proposed by Simmonds, 1966) recognized by the ICN and ICNCP (Espino *et al.,* 1992; Trehane, 1995; McNeill *et al.*, 2012) was followed for the naming the banana cultivars. Here all the names were started with the binomial depending on the parent followed by the letter code denoting the genomic constitution as well as the ploidy level (*i.e*., AA & AAA for diploid & triploid *M. acuminata*; AB, AAB & ABB for diploid and triploid hybrids; etc.). This was followed by the cultivar name in single inverted comas.

For a pure line cultivar (*i.e*., pure *M. acuminata* and *M. balbisiana* lines), the name of the parent is used as the binomial whereas for the hybrids, the name *Musa* × *paradisiaca* is used (Trehane, 1995). And the names used in the book 'Madras Bananas' (Jacob, 1952) were accepted here as the cultivar name.

Citations

Citations of all taxa published were obtained from Index Kewensis and IPNI. The database of the International Plant Names Index (IPNI) (http://www.ipni.org), Plant list and 'World checklist of selected plant families', a database of Royal Botanic Garden, Kew, (http://apps.kew.org) were also utilized. The citations of periodicals were abbreviated using *Botanico-Periodicun-Huntianum* (B-P-H) (Lawrence *et al.*, 1968) and IPNI and the details of Authors were obtained from *Taxonomic Literature* (Stafleu & Cowan, 1976-1978).

Author names were given following *Authors of Plant Name Index* by Brummitt and Powell (1992) and IPNI. Acronyms of herbaria were used according to Index Herbariorum (Thiers, 2011). For nomenclature clarifications ICN (Melbourne code) (McNeill *et al.*, 2012) and ICNCP (Brickell *et al.*, 2009) were used.

Data base for *Musa* cultivars in South India

A database was prepared for *Musa* cultivars in South India with the details such as correct name, synonyms, local names, distribution, ecology, uses, etc. More than 100 photographs are also included. Introduction, area of cultivation, description and photographs are presented. A CD was prepared with the advanced version of the software Visual FoxPro (VFP Version 6) with the help of a computer programmer.

Phenetics

Twenty four *Musa* cultivars – Operational Taxonomic Units (OTU) (Sneath & Sokal, 1973) in South India were considered for this study. Fifty morphological characters showing significant variations among OTUs were considered. This includes both vegetative (13 characters) and reproductive (37 characters) phases. PAUP* 4.0b 10^{beta} version software is used for the analysis and for the construction of tree, Unweighted Pair Group Method with Arithmetic Mean (UPGMA) method (optimality criterion = distance; Branch swapping algorithm – Tree Bisection Reconnection (TBR); Bootstrap = 100) was used. Here the qualitative characters were directly converted to numeric codes using different character states. For the analysis, all the fifty characters were plotted against the 24 OTUs using character codes and this tabulated data was used for the construction of phenogram.

PHYTOCHEMISTRY

Plant material collection

The mature unopened fruit pulps of South Indian *Musa* cultivars conserved at CUBG were used for the study. Thirteen cultivars were selected for the phytochemical analysis (see p. 241, **Table 08**). The voucher specimens were deposited at Calicut University Herbarium (CALI).

Sample extraction

The fully matured and unripe fresh fruits were collected, removed the peel and shade dried at room temperature after slicing. This dried pulp was powdered using a mixer grinder. Twenty grams of the powder was weighed and were subjected to extraction with methanol using Soxhlet apparatus at 65ºC; the solvent was recovered under reduced pressure in Rotary evaporator at 54ºC and stored in refrigerator. This crude extract was subjected to GC-MS analysis at National Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram.

Gas Chromatography-Mass Spectrometry (GC-MS) analysis

Gas chromatographic analysis was performed using GCMS-TQ8030 SHIMADZU. The samples were injected in to a GC equipped with a MS and a medium polar capillary column Rxi-5Sil MS, (30 m × 0.25 mm I. D., 0.25 µm). The oven program had an initial temperature of 60ºC for 2 minute, then increased to 200ºC for 2 minute at the rate of 5ºC /min which was further increased to 220ºC for one minute at the rate of 3ºC/min. Finally temperature was increased to 250 ºC at the rate of 6ºC/min for 7 minute. Total run time was 50 minutes. The detector temperature and injection temperature were set 250ºC. Helium was used as the carrier gas (purity 99.999% at a flow rate of 1mL/min). The samples were injected in the split less mode. The ion energy used for the electron impact ionization (EI) mode was 70eV. The mass range scanned was 100-1000 *m/z.*

Identification of compounds

The essential chemical constituents (fatty acids & volatile compounds) were identified by matching mass spectra with spectra of reference compounds in mass spectral library of NIST and WILEY. The relative amounts of individual components were expressed as percent peak areas relative to total peak area.

PRESENTATION OF DATA

The introductory part begins with a brief account of the family then of the genus *Musa,* followed by a brief account of the banana cultivars (*Musa* cultivars) with notes on the origin of cultivated bananas and their naming. The introduction is followed by the significance of the work in the present context, proposed objectives of the work and the review of literature. The review part is presented in the chronological order and which covers all relevant works in all fields such as taxonomy, phylogeny, anatomy, cytology, reproductive biology, palaeontology, agronomy, phytochemistry and cultivation practices. This is followed by a brief notes on the topography, Phytogeographical divisions, soil, climate and temperature in South India, the study area. Then explained the detailed description of the materials and the methodology followed in this study.

This is followed by the result and discussion, and here the entire data is presented in two sections – Morpho-taxonomy and Chemotaxonomy. The morpho-taxonomy part starts with the classification and in which a general outlines of the earlier classifications of *Musa* and its treatment in major works in India followed by the infra-generic classification or sectional classification of the genus and the classification of cultivated bananas. The genomic classification of cultivated bananas proposed by Simmonds and Shepherd (1955) is followed here.

The chapter systematic treatment begins with the treatment of the genus *Musa* and then the two progenitors of cultivated bananas – *M. acuminata* and *M. balbisiana.* Treatment includes citation, type, detailed description, flowering and fruiting, distribution, ecology, cytology, pollination, uses (if any) and variation (if any). This is followed by key to the *Musa* cultivars in South India and the cultivars are presented in genomic groups (from AA to ABB). Within the genomic groups the cultivars are presented in the alphabetical order. The details such as citation, standard specimen, local names, detailed description, flowering and fruiting, distribution/cultivation, cytology, notes and specimens examined are provided along with colour plates for each taxon. A comparative morphology of the cultivars is provided and based on which a phenogram is prepared at the end of the systematic part.

A database on South Indian *Musa* cultivars was also prepared based on all available data and is presented and discussed after the systematic treatment and comparative morphology.

The second part deals with the chemotaxonomy, which starts with a general overview of the earlier work followed by the results and discussion. Methanolic extracts offresh fruit pulp of 13 South Indian banana cultivars were subjected to the GC-MS analysis. The major compounds were listed with their retention time for each cultivar. The specific compounds were also presented in the form of a table with their chemical formula, molecular mass, retention time and area percentage. Reported bioactive compounds and their activities were also discussed in the discussion part.

This is followed by the summary, references, index to scientific names, vernacular names and appendix. A total of 55 figures are also included in this thesis.

CLASSIFICATION

In the earlier days botanists classified plants based on resemblance in habit and general characters which led to associating those most similar and trying to find logical justification (Blunt, 1971). The first artificial classification of plant was based on the structure of fruits and seeds and was published by an Italian physician and Botanist, Caesalpino (1583). According to Stafleu (1969), "he is considered as the first in a series of systematists who struggled between 'artificial' and 'natural', between logical divisions and natural affinity, and between theory and practice". Linnaeus in his '*Classes Plantarum*' (Linnaeus, 1738) and '*Philosophica Botanica*' (Linnaeus, 1751) outlined the systems of his predecessors, especially Ray (1682) and Tournefort (1698).

Linnaeus (1753) in his '*Species Plantarum*' described 2 species of *Musa, viz*., *M. paradisiaca* and *M. bihai* L. under *Polygamia Monoecia*. Later in *Systema Naturae*, Linnaeus (1759) described *M. sapientum* with *M. paradisiaca*. In the second edition of *Species Plantarum*, Linnaeus (1763) included one more species *M. troglodytarum* L. in addition to three species already described by him. But all these names are not in use now. *M. paradisiaca* and *M. sapientum* are now treated as hybrid cultivars, and *M. bihai* is being transferred to the genus *Heliconia* L.

The genus *Musa* was established by Linnaeus (1753) in his famous work '*Species Plantarum'* which includes two species. Linnaeus published two species, *Musa paradisiaca* (1753) and *M. sapientum* (1763). But Linnaeus (1736) himself had described banana as *Musa cliffortiana* (this might be described as a "pre-Linnaean" Linnaean name) but before 1753 itself the genus has already been described by the pre-Linnaean botanist Rumphius (1747).

Adanson (1763) considered maximum number of characters for classification and included *Musa* with many other genera under a single family Zingiberes Adans. Jussieu (1789) divided the plants on the basis of their natural affinity and classified monocotyledons into three distinct classes, *viz*. *Stamina Hypogyna*, *Stamina Perigyna* and *Stamina Epigyna*. The *Stamina Epigyna* was further divided into 4 orders, *viz*., Musae, Cannae, Orchideae and Hydrocharides. He treated almost all Scitaminea under two natural orders - Cannae and Musae and the genus *Musa* under 'Musae' along with *Heliconia* and *Ravenala.*

Roxburgh (1814, 1824) arranged plants based on Linnaean sexual mode of classification. Link (1821) also followed this classification, but he treated the genera like *Heliconia* and *Strelitzia* Banks under Musaceae in '*Pentandria Monogyna*', (excluding *Musa*). Agardh (1822) included *Musa* along with *Heliconia, Urania* Schreb., and *Strelitzia* under the orders Musaceae.

Dumortier (1829) recognized two orders under the class Gynopetalae, *viz*., Cannarieae and Orchidarieae. And the class Cannarieae was further divided into three families such as Curcumaceae, Cannaceae and Musaceae. Musaceae includes *Heliconia, Musa, Ravenala* and *Strelitzia*.

Endlicher (1837) classified class Scitamineae into 3 orders such as Zingiberaceae, Cannaceae and Musaceae; Zingiberaceae into 2 tribes - Heliconieae (*Heliconia*) and Uranieae (*Musa*, *Strelitzia* and *Ravenala*). But Meissner (1842) and Spach (1846) includes *Phenakospermum* Endl., *Sterlitzia*, *Ravenala* and *Musa* under the tribe Uranieae.

Hasskarl (1844) divided class Scitamineae into 3 orders - Zingiberaceae, Cannaceae and Musaceae. The order Musaceae consists of the genera *Musa* and *Ravenala*.

Horaninow (1862) classified Scitamineae into 4 cohorts (families), *viz*., Marantaceae, Cannaceae, Amomaceae and Musaceae. The family Musaceae was subdivided into two tribes, *viz*., Heliconeae (*Heliconia*) and Strelitzieae (*Ensete*, *Musa*, *Urania* and *Ravenala*).

Bentham and Hooker (1883) proposed a new classification for the family Scitamineae based on degree of fusion of perianth parts, the number of fertile stamens and staminodes, number of locules per anther, type of style and stigma, number of ovules per locules and shape of embryo. They grouped 36 genera of Scitamineae under four tribes, *viz.,* Canneae (1 genus), Maranteae (10 genera), Museae (4 genera - *Musa, Ravenala, Strelitzia* and *Heliconia*) and Zingibereae (21 genera). And later Petersen (1889) in Engler and Prantl's *Naturlichen Pflanzenfamilien* raised the tribes of Scitamineae to four families, Zingiberaceae, Marantaceae, Cannaceae and Musaceae. He further classified the family Musaceae into two tribes, *viz.,* Museae and Heliconieae and the genus *Musa* comes under the tribe Museae.

Baker (1892) followed Bentham and Hooker's classification of the order Scitamineae with minor rearrangements in the constituent taxa. According to him, the tribe Museae includes *Musa* and *Lowia* Scort.

Schumann (1900) in Engler's *Das Pflanzenreich* divided Musaceae into three subfamilies - Musoideae, Strelitzioideae, and Lowioideae. Then the subfamily Strelitzioideae in to two tribes - Strelitzieae (*Ravenala* & *Strelitzia*) and Heliconieae (*Heliconia*). Subfamily Lowioideae consists of *Lowia* and *Orchidantha* N.E.Br. and Musoideae with a single genus *Musa*. He retained three subgenera circumscribed by Baker (1893) under genus *Musa*.

Nairne (1904) divided order Scitamineae into 3 tribes: Zingibereae, Maranteae and Museae. He discussed briefly the genus *Musa* along with *Ravenala* under Museae.

Hutchinson's first and second edition of *The Families of Flowering Plants* subsequently spilt Musaceae into Musaceae and Heliconiaceae. Musaceae consist of two genera *viz., Musa*, and *Strelitzia*, and Heliconiaceae consist of *Heliconia* (Hutchinson, 1934, 1959, 1973; Kress, 1990).

Hutchinson used the ordinal name Zingiberales, accepting the divisions of Schumann (1900).

Nakai (1941) raised subfamily Costoideae and Heliconieae to the family rank. He also had given separate family status and was the first author to differentiate the eight families recognized today as Musaceae, Strelitziaceae, Lowiaceae, Heliconiaceae, Zingiberaceae, Costaceae, Marantaceae and Cannaceae for various groups.

The later authors such as Tomlinson (1962, 1969), Stebbins (1974), Takhtajan (1980), Cronquist (1978, 1981) and Dahlgren *et al.* (1985) accepted Nakai's concept and division of 8 families of Zingiberales based on morphological and anatomical investigations.

Kress (1990) analysed the evolutionary relationships of the eight families of the Zingiberales based on the principles of Phylogenetic systematics. He classified Zingiberales into 5 suborders *viz*. Musineae (Musaceae), Strelitzineae (Strelitziaceae), Lowineae (Lowiaceae), Heliconineae (Heliconiaceae) and Zingiberineae. Kress *et al*. (2001) revised the classification of Zingiberales and included the family Musaceae under superorder Musineae. Mabberley (2005) divided family Musaceae into three subfamilies *viz*., Strelitzioideae, Musoideae and Heliconioideae. APG III (2009) treated Musaceae under the order Zingiberales with the other 7 families. But the most accepted classification is by Kress *et al*. (2001).

Infrageneric classification of *Musa*

The genus *Musa* was first classified by Colla (1820) into two groups such as, '*Spermophorae*' and '*Aspermae*' based on the presence or absence of seeds and each were further divided into two subgroups based on the inflorescence nature. Later Spach (1846) divided the genus in to two sections based on the plant habit.

This is followed by Sagot (1887) who proposed a rational grouping of the species in to – 'Giant bananas' (*Musa Ensete* type), 'Bananas with fleshy fruits often edible', and 'Ornamental bananas'. Baker (1892) also followed this, but formally divided into three subgenera such as, *Physocaulis* (stem bottle-shaped; flowers many to a bract; petal usually tricuspidate; fruits not edible), *Eumusa* (stem cylindrical; flowers many to a bract; petal ovate-acuminate; bracts green, brown or dull violet; fruit usually edible) and *Rhodochlamys* (Stem cylindrical; flowers few to a bract; petal linear; fruits usually not edible; bracts bright-coloured, often red). Almost all species of this 'Giant bananas' of Sagot and *Physocaulis* of Baker was later transferred into the genus *Ensete* by Cheesman (1947).

Subsequently Cheesman (1947) classified the genus *Musa* based on morphological characters coupled with chromosome numbers into four sections, *viz*., ***Eumusa*** (x = 11), ***Rhodochlamys*** (x = 11), ***Australimusa*** (x = 10) and ***Callimusa*** (x = 10). His classification and the characters separating the four sections are given:

A. Chromosome number x = 11. Bracts usually more or less sulcate, often more or less glaucous, rarely or never polished, convolute or more or less imbricate in the bud, usually strongly revolute on fading. Seeds occasionally sub-globose, more often dorsi-ventrally compressed, sometimes lenticular, smooth, tuberculate, or irregularly angulate, with a marked or obsolete umbo opposite to the hilum.

1. Inflorescence pendent or semi-pendent from the first, the fruits reflexing in development towards the base of the rachis. Flowers many to a bract, in two series. Bracts commonly dull-coloured, green, brownish or dull purple. Pseudostems commonly exceeding 3 m high .... Section ***Eumusa***

2. Inflorescence erect, at least at the base, so that the fruits do not reflex in development but point towards the apex of the rachis. Flowers few to a bract, usually in a single series. Bracts brightly coloured, often red. Pseudostems commonly less than 3 m high......... Section ***Rhodochlamys***

B. Chromosome number x = 10. Bracts plane, firm in texture, polished on the outside, rarely or never glaucous, strongly imbricate in the bud, not or only slightly revolute on fading.

3. Seeds sub-globose or more or less dorsiventrally compressed, smooth, striate, tuberculate or irregularly angulate, with a marked or obsolete umbo opposite to the hilum corresponding to a small perisperm chamber within .... Section ***Australimusa***

4. Seeds cylindrical, barrel-shaped, or top-shaped, marked externally by a transverse line or groove, above which they are warted, tuberculate or variously patterned, below usually smooth; internally with a well-developed perisperm chamber above the same line, this chamber empty in the ripe seed... Section ***Callimusa***

Argent (1976) added one more section based on one species from Papua New Guinea – *M. ingens*, (*Ingentimusa* with basic chromosome number, x = 14). But the recent authors reduced these to three (Wong *et al.,* 2003) and then to two (Häkkinen, 2013) based on molecular analysis. So according to the recent literature the genus *Musa* has only two sections – sect. *Musa* and sect. *Callimusa*. In India, only one section, i.e., *Musa* sect. *Musa* is present and all edible cultivated bananas are coming under this section.

Nayar (2010) recognized 81 species in the genus *Musa* by considering the enumeration of Cheesman (1947–1950), Simmonds (1957) and Häkkinen and Vare (2008). But the later revision of the family Musaceae in India by Joe (2015) altered the status of many taxa and also reported some new ones. He reported 39 taxa under the genus *Musa* from India alone which includes 26 species, 12 varieties and 1 sub species.

Classification of cultivated bananas

The classification and the interrelationships of the *Musa* cultivars (banana) are incomplete and contradictory due to the lack of proper descriptive study (Linnaeus, 1753; Baker, 1893; Schumann, 1900; Jacob, 1934, 1952; Venkataramani, 1945; Heslop & Schwarzacher, 2007; Nayar, 2010). The importance of a detailed descriptive study of banana cultivars is stressed by Teodoro (1915) and is supported by Baker (1893), Cheesman (1934) and others.

The major workers like Baker (1892, 1893), Bentham and Hooker (1883) and Karthikeyan *et al*. (1989) accepted the Linnaean names and treated the whole banana cultivars under two species - *M. paradisiaca* and *M. sapientum*. They also tried to correlate the names 'banana' and 'plantain' to these binomials, and the commonest name *M. paradisiaca* is applied to the plantains and the *M. sapientum* to the bananas by various authors (Cheesman, 1948; Dodds & Simmonds, 1948b). But many authors pointed out that the distinction between plantain and banana is quite artificial and it would not work in all parts especially in South and South East India, because of the presence of large number of starchy cooking bananas. And the later authers published many other scientific names. But Cheesman (1948) did not favour giving taxonomic status to any of the several distinctive genome groups or clones of *Musa* cultivars and indicated that *M. paradisiaca* is valid, as it has priority over *M. sapientum*. But some authors like Roxburgh (1814, 1824) and Kurz (1878) regarded *M. paradisiaca* to be included in *M. sapientum* and applied the name *M. balbisiana* to the latter.

Subsequent workers (e.g. Cheesman, 1947, 1948; Simmonds & Shepherd, 1955, etc.) proved that the two names published by Linnaeus (1753, 1763) were not true species but cultivars and was later typified. The first name *M. paradisiaca* was typified by Argent (1993) with "*Musa cliffortian*" (in Linnaeus, Musa Cliff., unnumbered plate, 1736) and the latter name by Cheesman (1948) with *"Musae fructu breviore spadix floriger in magnitudine naturali."* in Trew, PI. Select., 4, t. 22. 1752.

Later in 20^{h} century, Jacob (1934, 1942a, 1942b, 1952) worked on the variability and diversity of banana and plantain in India and proposed a new nomenclature for the cultivated bananas - *Musa sapidisiaca* K.C.Jacob by combining the two Linnaean species *M. paradisiaca* and *M. sapientum* in his monograph on Madras Banana (Jacob, 1952). But this name is invalid due to the lack of a diagnosis or description. He gave varietal status to all the *Musa* cultivars under the new species *M. sapidisiaca*. Many other taxonomists of South and South East Asia also found the original scientific names were inadequate to address the great diversity in its place of origin and evolution. This also resulted in the publication of many other scientific names.

Kurz (1878) was the first to state a belief that the majority of banana varieties (cultivars) are descended from the species that he first called *Musa samarium* Rumphius, and later corrected to *M. acuminata* Colla., but he did not connect this species with *M. paradisiaca.* Willdenow (1806) is the first to attach vernacular name to the Linnaean epithets ('Gemeiner pisang' under *M. paradisiaca* and 'Bananen pisang' under *M. sapientum*).

The endless coining of new names to the cultivated bananas were put to an end by Simmonds and Shepherd (1955), by suggesting that the Linnaean classification was based on hybrid progenies of two species *M. acuminata* and *M. balbisiana*. But actually the bispecific origin of edible bananas was first mentioned by Kurz (1865/66) and fall in oblivion till Cheesman (1947, 1948) recognized it and later Simmonds and Shepherd (1955) experimentally proved it by crossing *M. acuminata* and *M. balbisiana.* Simmonds and Shepherd (1955) compared their result with cultivated varieties, both morphologically and cytologically and came into a conclusion that the edible bananas were evolved from *M. acuminata* and *M. balbisiana* in five main stages. This is also supported by the chromosome studies by Cheesman (1932, 1934), Cheesman and Larter (1935) and Dodds and Pittendrigh (1946).

The natural hybrids of *M. textilis* with *M. acuminata*, *M. balbisiana* and the cultivated bananas have been reported by several authors (Spencer, 1953; Shepherd & Ferreira, 1982; Stover & Simmonds, 1987; Daniells *et al.,* 2001).

Genomic classification and nomenclature of cultivated bananas

Simmonds and Shepherd (1955) identified fifteen diagnostic traits to differentiate the progenitors of present day bananas, *i.e.*, *M. acuminata* and *M. balbisiana* (**Table 01**) and proposed a scorecard to indicate the relative contributions of the two wild species and thus for assigning the tentative genomic status of the banana cultivars (for details see Materials and Methods – Assigning tentative genomic status, p. 60). Simmonds (1966) also provided a key to the groups of the edible bananas. The score card was later modified, first by Silayoi and Chom Chalow in 1987 and then Singh and Uma (2000) based on their work with the accessions at the NRCB (**Table 02**).

Table 01: Morpho-taxonomic scoring system for genomic classification of banana cultivars (Simmonds & Shepherd, 1955)

Sl. No.	Character	*Musa acuminata*	*Musa balbisiana*
1.	Pseudostem colour	More or less heavily marked with brown black blotches	Blotches slight or absent
2.	Petiolar canal	Margins erect or spreading with scarious wings below not clasping pseudostem	Margins not winged below clasping pseudostem
3.	Peduncle	Usually downy, hairy and short	Glabrous
4.	Pedicel	Short	Long
5.	Ovules	Two regular rows in each locule	Four irregular rows in each locule
6.	Bract curling	Bracts reflex and roll back after opening	Bract lift but do not roll back
7.	Bract shape	Lanceolate or narrowly ovate, tapering sharply from the shoulder	Broadly ovate, not tapering sharply
8.	Bract apex	Acute	Obtuse
9.	Bract shoulder	Usually high (ratio less than 0.28)	Usually low (ratio more than 0.3)
10.	Bract colour	Red, dull purple or yellow outside and pink dull purple or yellow inside	Distinctive brownish purple outside and bright crimson inside
11.	Colour fading	Inside bract colour fades to yellow towards base	Inside bract colour continuous towards base
12.	Bract scars	Prominent	Scarcely prominent
13.	Free tepal of male flower	Variably corrugated below the apex	Rarely corrugated tip
14.	Male flower colour	Creamy white	Variably fleshed with pink
15.	Stigma colour	Orange or rich yellow	Cream, pale yellow or pale pink

Table 02: Modified score card for assessing tentative genomic groups (Singh & Uma, 2000)

Genomics	**Score card**		
	Simmonds & Shepherd (1982)	**Silayoi & Chom Chalow (1987)**	**Singh & Uma (1996)**
AA/AAA	15–23	15–25	15–25
AAB	24–46	26–46	26–45
AB/AABB	49	-	46–49
ABB	59–63	59–63	59–65
ABBB	67	-	66–69
BB	70–75	70–75	70–75

A detailed survey of the relationships and the evolution of the wild and cultivated bananas and the principles behind the evolution were discussed by Simmonds (1962). Many others like Kahl (2004), Heslop-Harrison and Schwarzacher (2007), Nayar (2010) also gave an overview on the origin and evolution of present day bananas.

Simmonds (1966) adopted a new nomenclatural system for the cultivated bananas; a three-tyre system in which the generic name is followed by the group (a letter combination denoting the parents – A & B and the ploidy level) in bracket and is again followed by the cultivar/ cultivar group name in single inverted commas (based on ICNCP).

Later in 1992, Espino *et al.* suggested that all hybrids of *M. acuminata* and *M. balbisiana* can be referred to as the *Musa* × *paradisiaca* and the name is later recognized by the International Code of Nomenclature for Cultivated Plants (Trehane, 1995) and International Code of Botanical Nomenclature (Article H10.2 in ICBN – 2000).

Based on the available literature regarding the nomenclatural history and naming of banana (*Musa* cultivars) it is concluded that, all cultivars derived from the pure *M. acuminata* (AA, AAA, etc) and *M. balbisiana* (BB, BBB, etc) lines can be treated under their respective parents and all others (hybrids of *M. acuminata* and *M. balbisiana*) can be denoted as *Musa* × *paradisiaca* L.

SYSTEMATIC TREATMENT

Musa L.

Musa L., Sp. Pl. 2: 1043. 1753, Syst. Nat., ed. 10. 1303, Sp. Pl., ed. 2., 2: 1477. 1763; Colla, Mem. Reale accad. Sci. Torino 25: 344. 1820; Kuntze, Revis. Gen. Pl. 2: 692. 1891; Baker, in Hook.f., Fl. Brit. India 6: 261. 1892, Ann. Bot. 7: 205. 1893; Trimen, Fl. Ceylon 4: 265. 1898; K.Schum. in Engl., Pflanzenr. 4(45): 13. 1900; Prain, Bengal Pl. 2: 1051. 1903; C.E.C.Fisch. in Gamble, Fl. Pres. Madras 3: 1496. 1928; Argent, Notes Roy. Bot. Gard. Edinburgh 35: 80. 1976; Manilal & Sivar., Fl. Calicut 289. 1982; Chandrab. & N.C.Nair, Fl. Coimbatore 289. 1987; Manilal, Fl. Silent Valley 316. 1988; Karthik. *et al.,* Fl. Ind. Enum. Monocot. 4: 104. 1989; K.M.Mathew, Fl. Palni Hills 1281. 1999; B.K.Sinha, Fl. Great Nicobar Island 451. 1999; T.L.Wu & W.J.Kress, in C.Y.Wu & P.H.Raven, Fl. China 24: 298. 2000; K.G.Bhat, Fl. Udupi 638. 2003; Subba Rao & Kumari, Fl. Visakhapatnam Distr. (Andhra Pradesh) 2: 264. 2008; Bhagat, Shimpale & R.B.Deshmukh, Fl. Baramati 297. 2008; Sunil & Sivad., Fl. Alappuzha Dist. 687. 2009; Hakkinen, Taxon 62(4): 810. 2013; A.Joe , Tax. Rev. family Musac. India 143. 2015.

Type: *Musa paradisiaca* L., Sp. Pl. 2: 1043. 1753 (*typ. cons.*) [Current status: Hybrid (*Musa* × *paradisiaca*)].

Perennial rhizomatous herbs, plants suckering, clump forming or not, spreading or not spreading; rhizome running or not; suckers 2–9, vertically arranged or angled. Pseudostem cylindrical or indistinctly swollen at base, mature pseudostem stout or slender, 60–1130 cm high, 10–140 cm circumference at base, slender or stout, normally green or in different shades of green and yellow or black with or without pigmentation and with or without black or blackish brown blotches at tip; blotches may be absent or if present, it may be small and scattered to large and extensive patches; glabrous or glaucous, more glaucous towards apex region, glaucous nature prominent at young stages; underlying colour light green to maroon, sap watery or milky. Leaf habit erect to drooping; lamina 98–380 × 40–90 cm, oblong-lanceolate or oblong or obovate to elliptic; adaxially green or green with yellow tinge, dull; abaxially medium green or with greyish appearance, glaucous or glabrous, base symmetric or asymmetric, both sides pointed or rounded or both auriculated or one pointed and other rounded; apex truncate or acute or one side oblique and other truncate, sometimes with a tendril like appendage; midrib adaxially light green, abaxially yellowish green with or without pink or yellowish or purple or pinkish maroon tinge, glabrous or glaucous. Petioles 18–85 cm long, green or yellowish green, slightly glaucous to glabrous, petiole canal with margins overlapping to spreading; blotches present at base, brown or red-purple or black; petiole bases winged with smooth or wrinkled margins, clasping the pseudostem or not. Inflorescences erect to pendulous with or without curve; peduncle 8–80 cm long, green or with a gradient of green to yellow, with or without pigmentation/patches, glabrous or glaucous or hairy. Sterile bracts 1–4, 24–63 × 6–19 cm, lanceolate, abaxially a variable of greenish yellow to brick red, slightly glaucous or glabrous; adaxially creamy white to brick red with or without colour fadings, mostly shiny; deciduous or persistent. Female bud normally lanceolate or lanceolate at least at the emerging stage or cylindrical or intermediate or ovate-oblong; tip convolute or imbricate. Female bracts lanceolate to obovate, 14.5–53 × 4.5–16 cm, abaxially creamy white to violet purple or to dark red, glaucous or slightly glaucous, smooth or grooved; adaxially creamy white to reddish brown, shiny, with or without colour fadings; lifting 1–2 bracts at a time, reflexed and revolute or not revolute, persistent or deciduous; Basal 1–18 bunches female or bisexual. Bracts and flowers inserted independently on the axis. Female flowers 1–30 per bract in one or two rows, 6.4–13.7 cm long, colour may vary from cream to orange-red. Compound tepal 2.8–5.3 × 1.2–2.3 cm, cream to orange-red, with or without pink/purplish flush, ribbed at dorsal angles, divided only to the apex; lobes 5, outer lobes much longer than inner, marginal two lobes with small horns. Free tepal 1.9–3.9 × 1.1–2.6 cm, translucent cream or white with or without pigmentation, boat-shaped or hood-shaped, apex corrugated or not with or without a short acumen. Stamens 1–5, 3.5–4.5 cm long, cream; filament 1.7–2 cm long, cream or white; anthers 2.1–2.4 cm long, cream or white. Staminodes present or absent, if present 2–6, 0.8–5.2 cm long, cream or creamy yellow with or without pigmentation. Ovary 2.9–10 cm long, cream to pink or red or its gradients, glabrous or hairy, straight or curved, with ovules in 2 rows or 4 rows per locule; style 2–4 cm long, cream or white with or without pigmentation, straight or curved, inserted or exserted; stigma globose, grey-brown to dull white or cream or creamy yellow, sticky. Male bud lanceolate or intermediate or top-shaped or ovoid in advanced blooming, convolute or imbricate, rachis falling vertically or erect or sub-horizontal or arched, green, glabrous with or without grooves, rachis disintegrate after production of some male flowers or continues to grow even after the ripening of fruits. Male bracts lanceolate, 9.5–30 × 5–16 cm, adaxially pink-purple or lilac or pale lilac or yellowish green or purplish or pink or brown-purple with green striations or yellow-orange combined with brick red or variables of red with red margin or deep maroon with yellow margins or dark brown purple and yellow towards apex through lines or violet-purple or crimson red or yellowish-orange or red-purple with yellow apex or green or brown-purple with yellow apex or red with green apex or red with yellow apex or red-purple with yellow striations, apex straight or curved, glabrous or glaucous, abaxially pink-purple with yellow apex or dark red with white-pink striations or pale lilac or cream with pink tinge or cream or yellow, glabrous, shiny, apex acute, lifting 1–2 bracts at a time, revolute or not revolute, bracts persistent or deciduous, bract scars prominent. Bracts and flowers inserted independently on the axis. Male flowers in 1–2 rows per bracts, 3.8–7.2 cm long, deciduous with the bracts. Compound tepal 2.7–5.7 × 0.6–1.9 cm, creamy to orange-red with or without pigmentation, apex curved backwards, ribbed at dorsal angles, divided only at the apex; lobes 5, outer and the middle lobes much longer than inner, marginal lobes with small horns. Free tepal 1.2–4 × 0.8–2.3 cm, cream or white, translucent or opaque, with or without pigmentation, boat-shaped, corrugated or not at apex, with or without a short acumen. Stamens 5 or 5 (+ 1 much reduced staminode), 3–6.1 cm long, exserted; filaments 1.5–3.2 cm long, cream or white; anther 1.5–3 cm long, colour may be white/creamy white to pink/red, apex curved backwards. Ovary 0.7–2.4 cm long, rudiment, creamy white to red with or without pigmentation, straight or curved; style 2–4.3 cm long, glabrous, straight or curved, white or cream with or without pigmentation; stigma grayish white to orange or reddish brown, globose. Fruit bunch lax or compact, with 3–18 hands and 4–35 fruits per hand, in 1–2 rows, fruits pointed upwards on nearly horizontal or sub-horizontal or pendulous or erect axis. Fruits 5–34 cm long, straight or curved, rounded or slightly or pronouncedly ridged, pedicelled; pedicel 0.2–5 cm long, glabrous or hairy; apex pointed or lengthily pointed or blunt-tipped or bottle-necked or truncate with or without floral relicts; fruit peel varies highly – green or pink or red or maroon or silvery at maturity, greenish yellow or pale yellow or dull yellow or pink or red or maroon or orange when ripen, pulp cream or creamy white or orange. Seeds many, 30–250 per fruits, 0.2–1.4 cm, warty or smooth, round to angled, black or brown.

Flowering & Fruiting: Throughout the year depending up on climate, altitude and availability of water.

Distribution: It is tropical in distribution especially in south and southeast Asia, *viz.,* Sri Lanka, through India, Bangladesh, south and southeast China, Myanmar, Laos, Vietnam, Cambodia, Thailand, Malaysia, Indonesia, Philippines, and New Guinea (Nayar, 2010). Maximum species diversity in peninsular Malaysia and Indonesia (Cheesman, 1947; Simmonds, 1962; Argent, 1976). In India its maximum diversity and distribution is found in the Northeastern States (Joe, 2015).

The genus is also well known for the seedless edible bananas and are widely cultivated in the tropical areas. India is famous for the diversity of cultivated edible bananas, and banana is the second largest fruit crop cultivated in India after mango.

Ecology: Majority of wild species occur in the dense forests, often in swampy areas and open forest slopes, near riversides and also along the streams. Whereas the edible cultivated bananas were mainly cultivated in the tropics with moist organic soil.

Cytology: Mostly diploids - 2n=2x=22 (Wilson, 1946; Simmonds & Dodds, 1949; Shepherd, 1964). But in cultivated bananas diploids, triploids and tetraploids are common.

Pollination: By bats, bees, birds, ants, squirrels, etc. (Liu *et al*., 2002). But almost all the cultivated bananas are seedless and may be due to the absence of fertile pollen grains. Most of the cultivated bananas are triploids or allopolyploids, hence sterile.

Uses: The leaves are used as fodder and also as a wrapping material. The buds in the emerging stage and also the inner core of the pseudostem of some species are used by the tribals for making various dishes and chutneys. Some wild forms like 'Calcutta 4' (*M. kattuvazhana*) is widely used for breeding purposes. Leaves of several species are harvested for dining plates and for offerings in temples and some are often cultivated exclusively for this purpose (e.g. *Musa balbisiana* Colla var. *elavazhai* A.Joe, Sreejith & M.Sabu). Some species with bright coloured bracts are potential ornamentals.

Many banana cultivars are also used for different proposes like fruit crop, vegetable, medicine and cosmetics (Frison & Sharrock, 1999; Amnuaysin *et al.,* 2012). Almost all parts of banana contain many nutritive compliments including minerals and fibers, and were used making many types of food items (Fingolo *et al.*, 2012). Banana is the second largest fruit crop in India after mango and India forms one of the top banana producing countries of the world, with 15% of the total production (Nayar, 2010). Some fruits like *Kunnan* are widely used as a baby food especially in Kerala, and almost all ripened fruits are also given to the children as an easily digestive and nutritional food. A number of dishes are made using different parts of banana and some are very famous also. Besides as a food crop, almost all parts of the plant are used for one or other purposes and thus it is also known as "*Kalpatharu*" in Malayalam.

Variations: According to Joe (2015) the size of the plant, number of flowers and fruits, etc. varies highly with the habitat and also with the taxa to an extent.

The genus consists of wild seeded forms and the cultivated seedless edible bananas generally referred as cultivated bananas or *Musa* cultivars. And the present study includes only the latter group – i.e., *Musa* cultivars, of South India.

According to the widely accepted theories (Kurz, 1867; Cheesman, 1947; 1948; Simmonds & Shepherd, 1955; etc.), the present day cultivated bananas were derived from the natural hybridization of two wild species – *Musa acuminata* Colla and *M. balbisiana* Colla; and they are considered as the 'Adam' and 'Eve' of present day bananas.

This chapter deals with the taxonomic treatment of these progenitors of the cultivated bananas (i.e., *Musa acuminata* & *M. balbisiana*), key to the *Musa* cultivars in South India and a detailed treatment of each cultivar.

I. ***Musa acuminata*** Colla**,** Mem. Reale Accad. Sci. Torino 25: 394. 1820; A.Spreng., Syst. Veg. (ed. 16) 1: 833. 1825; Baker, Ann. Bot. 7: 215. 1893; K.Schum. in Engl., Pflanzenr. 4(45): 21. 1900; Fawc., Banana 264. 1913; Simmonds, Kew Bull. 14(2): 203. 1960; Karthik. *et al.,* Fl. Ind. Enum. Monocot. 4: 104. 1989; Hore *et al*., J. Econ. Taxon. Bot. 16(2): 450. 1992; B.K.Sinha, Fl. Great Nicobar Island 451. 1999; T.L.Wu & W.J.Kress, in C.Y.Wu & P.H.Raven, Fl. China 24: 299. 2000; W.J.Kress, *et al*., Checklist Pl. Myanmar 45: 63. 2003; Hakkinen & Vare, Adansonia 30(1): 65. 2008; Giri *et al*., Materials Fl. Arunachal Pradesh 3: 184. 2009;

Hakkinen, Taxon 62(4): 810. 2013. A.Joe , Tax. Rev. family Musaceae India 157. 2015. **Fig. 04**

Iconotype: Icon in Rumph., Herb. Amb. 5: t. 61, fig. 1. 1747. (Lectotype, designated by Hakkinen & Vare, 2008c).

M. simiarum '*Pissang Jacki*' Rumph., Herb. Amb. 5: 138. 1747.

Musa corniculata Rumph. *ex* Kurz, J. Agri. Hort. Soc. India 14: 166, t. 2–3. 1878 *non.* Lour., 1790.

Plants slender; suckers 2–5, vertical. Mature pseudostem 1.2–2.5 m high, 28–35 cm circumference at base, green with small blackish-brown blotches or dots or green with pink or slight purple pigmentation and covered with grayish sheaths, glaucous, more glaucous towards apex, glaucous nature prominent at young stages; underlying colour light green; sap watery. Leaf habit intermediate, laminae 120–180 × 45–52 cm, oblong but oblanceolate at young condition or seedling stage, upper surface dull, green, lower surface medium green, glabrous, apex truncate; bases asymmetric, both sides rounded; midrib dorsally light green, ventrally yellowish green with slight pinkish tinge. Petioles 35–65 cm long, green or yellowish green, slightly glaucous or highly glaucous, petiole open with margins spreading or rarely erect; blotches present at base, black; petiole bases winged, with smooth margins and clasping the pseudostem. Inflorescences horizontal; peduncle 8–46 cm long, 4–5 cm diameter, green, glabrous with or without grooves. Sterile bracts 1–2, 32–45 × 9.3–14 cm, lanceolate, abaxially brown-purple with yellowish green lines; apex leafy, slightly glaucous, adaxially pink-purple with creamy tinge, apex yellow or creamy yellow, shiny, deciduous or persistent. Female bud lanceolate, tip convolute. Female bracts lanceolate, 24–36 × 8.5–14 cm, abaxially dark red-purple or brown-purple with yellow-green lines, base red-purple, apex green, leafy or not, slightly glaucous, adaxially red-purple, apex yellow, shiny, acute; lifting 1–2 bracts at a time, reflexed and revolute before falling, sometimes persistent, basal 3–7 bunches female. Female flowers 6–16 per bract in two rows, 8–10.3 cm long, creamy orange or orange. Compound tepal 3.6–4.9 × 1.2–1.7 cm, creamy orange, ribbed at dorsal angles, lobes 5, orange, outer lobes much longer than inner, marginal two lobes with small horns. Free tepal 1.9–2.4 × 1.8–2.6 cm, translucent cream or white, boat-shaped, apex corrugated with a short acumen, 0.4–0.5 cm long. Staminodes 5, 1.6–2 cm long, cream with slightly brown apex. Ovary 4.7–6.1 cm long, light green to yellowish green, glabrous, straight, with ovules in 2 rows per locule; style 3.2–3.5 cm long, cream, straight, inserted; stigma globose, greyish brown to dull white, sticky. Male bud lanceolate, convolute at apex, rachis falling vertically, green, glabrous. Male bracts lanceolate, 10.5–25 × 5.3–12.5 cm, abaxially red-purple or brown-purple with yellow apex, slightly glaucous; adaxially pink-purple, glabrous, shiny, apex yellow or cream with pink tinge, acute; lifting 1–2 bracts at a time, reflexed and revolute before falling, bract scars prominent. Male flowers 12–18 per bract in two rows, 4.3–6.8 cm long, falling with the bracts. Compound tepal 3.2–5.5 × 1.3–1.9 cm, creamy orange, apex curved backwards, ribbed at dorsal angles, lobes 5, orange, outer lobes much longer than inner, marginal two lobes with small horns. Free tepal 1.5–2.5 × 1.6–1.9 cm, cream or white, translucent, boat-shaped, corrugated at apex, with a short acumen. Stamens 5, 3.6–5.8 cm long, exserted; filaments 1.9–2.7 cm long, cream; anther 1.5–2.7 cm long, white or red, apex curved backwards. Ovary 1–1.5 cm long, rudiment, creamy white or dull yellow, straight; style 2–4.2 cm long, glabrous, straight, cream; stigma yellow, globose. Fruit bunch lax, with 3–7 hands and 6–16 fruits per hand, in two rows. Fruits 9–10.5 cm long, pointed upwards on nearly horizontal axis, straight or curved, slightly ridged, pedicel 1–1.5 cm long, glabrous, apex pointed without any floral relicts, fruit peel green at maturity, greenish yellow or pale yellow or dull yellow with some red to brown dots when ripen, pulp cream. Seeds 30–150 per fruit, 0.3–0.5 × 0.4–0.6 cm, warty, round to angled, black.

Flowering & Fruiting: Throughout the year.

Distribution: China, India (North-eastern States), Java, Malaya, Myanmar and Thailand.

Ecology: It is mainly seen in moist ravines under forest shades and also in grass lands.

Notes: All present day edible bananas were derived from this species, either pure lines or hybridization with *M. balbisiana.* Hence this species is considered as the closest and commonest wild relative of all cultivated bananas. The species exhibits high range of variation especially in the size and colour of both the vegetative and reproductive parts. The taxonomy and the variability of this species were well discussed by various authors (Cheesman, 1948; Simmonds, 1957; Joe, 2015; etc.).

Specimens Examined: INDIA, **Meghalaya:** Garo Hills, Tura peak, N25°30.447′ E090°13.792′, 500 m, 27 May 2013, *A.Joe & Ashfak 121774* (CALI); Garo Hills, Tura peak, N25°30.453′ E090°13.953′, 546 m, 27 May 2013, *A.Joe & Ashfak 121781* (CALI); Garo Hills, Balpakram National Park, N25°11.024′ E090°51.541′, 281 m, 29 May 2013, *A.Joe & Ashfak 121786* (CALI); Jaintia Hills, Way to Dawki from Jowai (between Amlarem & Dawki), N25°15.027′ E092°05.966′, 856 m, 31 May 2011, *A.Joe & Sreejith 116174* (CALI); Jaintia Hills, Sokha village, way to Dawki from Jowai, N25°12.721′ E092°02.402′, 525 m, 31 May 2011, *A.Joe & Sreejith 116175* (CALI); Khasi Hills, Mahadev Village, Lower Cherapunjee, N25°12.674′ E091°44.620′, 760 m, 28 May 2011, *A.Joe & Sreejith 130751* (CALI); **Mizoram:** Darlawn Dist., Darlawn, N24°02.021′ E092°58.094′, 141 m, 17 March 2012, *A.Joe & Sreejith 130823* (CALI).

II. *Musa balbisiana* Colla, Mem. Reale Accad. Sci. Torino 25: 384. 1820; Horan., Prodr. Monogr. Scitam. 42. 1862; Cheesman, Kew Bull. 3(1): 11. 1948; Simmonds, Kew Bull. 14(2): 203. 1960; Backer & Bakh.f., Fl. Java 3: 38. 1968; Argent, Notes Roy. Bot. Gard. Edinburgh 35: 80. 1976; B.D.Sharma & N.P.Singh, Fl. Karnataka 281. 1984; Karthik. *et al.,* Fl. Ind.

Enum. Monocot. 4: 104. 1989; T.L.Wu & W.J.Kress, in C.Y.Wu & P.H.Raven, Fl. China 24: 300. 2000; Hakkinen & Vare, Adansonia 30(1): 67. 2008; Vare & Hakkinen, Taxon 58(3): 1010. 2009; Giri *et al*., Materials Fl. Arunachal Pradesh, 3: 184. 2009; Hakkinen, Taxon 62(4): 810. 2013. A.Joe, Tax. Rev. family Musaceae India 182. 2015 (Thesis) *nom. cons*. **Fig. 05**

Musa '*Pisang Batu seu pisang bidji*' Rumph., Herb. Amb. 5: 132, t.60 fig. f. 1747.

Type: India orientalis, ex. Hort. Ripul. 1820, *s.n.* (TO image!, lectotype designated by Hakkinen & Vare, 2008c); Syntype: Icon in Rumph., Herb. Amb. 5: t. 60, fig. f. 1747. (Syntype, designated by Hakkinen & Vare, 2008c).

Musa rosacea Jacq., Pl. Rar. Hort. Schoenbr. 4: 22, t.445. 1804, Frag. Bot. 83, t. 132(4). 1809

Musa sapientum L. subsp. *seminifera* Lour. form *pruinosa* King *ex* Baker, Ann. Bot. 7: 214. 1893.

Musa paradisiaca subsp. *seminifera* var. *pruinosa* King *ex* K.Schum., in Engl., Pflanzenr. 4(45): 21. 1900.

Musa pruinosa (King *ex* Baker) Burkill, Rec. Bot. Surv. India 10: 384 1925.

Musa sapientum var. *pruinosa* (King *ex* Baker.) A.M.Cowan & Cowan, Trees North Bengal 135. 1929.

Musa shankarii Subba Rao & Kumari, Fl. Visakhapatnam Distr. (Andhra Pradesh) 2: 266. 2008.

Musa sapientum ('the wild sort') *auct. mult.* Roxb., Hort. Beng. 19. 1814 *nom. nud*.

Plants tall and stout, suckers 3–5, vertical. Mature pseudostem 3.8–4.5 m high, 50–60 cm circumference at the base, olive green, waxy, glaucous, more glaucous on young plants; underlying colour light green or yellowish green, shiny; sap watery. Leaf habit intermediate; laminae 150–240 × 60–86 cm, oblong, upper surface green, dull; lower surface medium green, glaucous; leaf bases asymmetric, both sides auriculated, truncate at apex, midrib adaxially yellowish green, abaxially pale yellow. Petioles 35–65 cm long, green or yellowish green, slightly glaucous; petiole canal margins curved inwards or overlapping or rarely open with erect margins; petiole base without prominent blotches or rarely with scattered blackish blotches, not winged and clasping the pseudostem. Inflorescence sub-horizontal/ oblique; peduncle 76–82 cm long, green to yellowish green, glabrous. Sterile bracts 1–2, lanceolate, 30–32 × 15–17 cm, abaxially ochreous yellow with pink-purple margin and base, apex green, slightly glaucous; adaxially dark red-purple with yellow apex, shiny, sometimes apex with leafy appendage, deciduous or persistent. Female bud lanceolate, tip convolute. Female bracts lanceolate, 24–29 × 14–18 cm; abaxially pink-purple with green apex, slightly glaucous; adaxially red-purple with green apex, shiny, apex truncate, lifting 1–2 bracts at a time, persistent for 2–3 days giving an appearance of bracts lifting 4–5 at a time, open and reflexed before falling, not revolute, sometimes persistent. Basal 3–10 bunches female. Female flowers 12–23 per bract in two rows, 9–11 cm long. Compound tepal 3.6–4 × 2–2.1 cm, creamy with slight pink flush and yellow base and apex or pink, ribbed at dorsal angles, divided only to the apex; lobes 5, orange-yellow, outer lobes much longer than inner, marginal two lobes with small horns. Free tepal 2.3–2.9 × 2.1–2.5 cm, boat-shaped, cream with pink tinge towards apex or fully pink or purple, apex not corrugated without a prominent acumen. Staminodes 5, 0.9–1.3 cm long, cream or dull yellow. Ovary 5.7–7.2 cm long, straight, light green to yellowish green, glabrous, with ovules in 4 rows per locule; style 2.7–3.2 cm long, straight, cream, inserted; stigma globose, grey-brown, sticky. Male bud lanceolate, convolute or sometimes slightly imbricate at apex, rachis falling vertically, green, glabrous. Male bracts lanceolate or in advanced blooming ovoid, 14.5–16 × 11–12.5 cm, abaxially pink-purple with yellow apex, slightly glaucous; adaxially blood red with greenish yellow apex, glabrous, shiny, apex almost truncate or round, lifting 1–2 bracts at a time, open and reflexed before falling, not revolute, sometimes persistent; bract scars prominent. Male flowers 12–16 per bract in two rows, 5.3–5.5 cm long, falling with the bract. Compound tepal 4.1–4.4 × 1.1–1.2 cm, cream with pink flush, apex curved backwards, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 1.1–1.2 cm long, marginal two lobes with small horn. Free tepal 2.1–2.2 × 1–1.1 cm, creamy white, translucent, boat-shaped, apex not corrugated with a short acumen or looking like trilobed apex. Stamens 5, 4.4–4.5 cm long; filaments 2.5–2.7 cm long, cream; anther 1.8–1.9 cm long, creamy yellow, curved backwards. Ovary rudiment, 1.4–1.5 cm long, straight, creamy white; style 3.4–3.5 cm long, straight or curved under stigma, cream, inserted; stigma brown, globose. Fruit bunch compact, with 3–10 hands and 12–23 fruits per hand, in two rows, fingers pointed upwards on the sub-horizontal axis, i.e. negatively geotropic. Fruits straight or curved, 8.7–11 cm long, circumference 6–12 cm, pronouncedly ridged, 4-angled; pedicel 1.8–3.7 cm long, slightly glaucous; apex slightly pointed without any floral relicts, 0.5–0.7 cm long; fruit peel green at maturity, yellow with slight powdery appearance when ripen, pulp cream. Seeds many, 187–220 per fruits, warty, black, across 0.6–0.7 cm, height 0.3–0.5 cm.

Flowering & Fruiting: Throughout the year.

Distribution: Widely distributed in South and South-East Asia. In India it is common in North-eastern States and Eastern Ghats.

Ecology: Unlike other *Musa* spp., *M. balbisiana* can withstand even in most dried areas and also get flowered even in the extreme drought conditions.

Notes: It is the commonest and most widely distributed *Musa* species in India. The diversity and distribution of this species is studied by various authors using various methods and came to the conclusion that the species is widely distributed in different parts of India, but shows remarkable variations and thus could be treated as distinct varieties within the species (Simmonds, 1962, 1966; Singh & Uma, 2000; Uma *et al.*, 2005a, 2006; Nayar, 2010; Joe, 2015). Since the species is widely distributed and a wide range of infraspecific variation existed within the species it was highly misidentified by various workers, and the correct identity of the typical *M. balbisiana* is given by Joe (2015).

Specimens Examined: INDIA, **Andhra Pradesh:** Arakku Valley, Mallidongur Hills, N18°22.956′ E082°53.068′, 1083m, 11 December 2011, *A.Joe & Sreejith 130746* (CALI). **Arunachal Pradesh:** Kanubari Reserve Forest, N27°01.281′ E095°13.298′, 336 m, 10 August 2011, *A.Joe & Sreejith 130703* (CALI). **Nagaland:** Mokokchung Dist. Settsu, N26°14.062′ E094°28.849′, 847 m, 20 August 2011, *A.Joe & Sreejith 130719* (CALI). **Odisha:** Kandhamal Dist., Guduguda, Thumudibandha, N19°56.365′ E083°39.907′, 759 m, 07 October 2011, *A.Joe & Sreejith 130742* (CALI).

Present study identified 24 *Musa* cultivars (Bananas) from South India. All of them were collected, planted in the Calicut University Botanical Garden (CUBG) and morpho-taxonomic characterizations were made based on Descriptors of Banana (*Musa* spp.). The identified cultivars include diploids and triploids with the genomic constitution of AA, AB, AAA, AAB and ABB.

List of *Musa* cultivars in South India

1. *Musa acuminata* Colla (AA) ‘Kadali’
2. *Musa acuminata* Colla (AA) ‘Karivazhai’
3. *Musa acuminata* Colla (AA) ‘Pisang lilin’
4. *Musa acuminata* Colla (AAA) ‘Dwarf cavendish’
5. *Musa acuminata* Colla (AAA) ‘Grand naine’
6. *Musa acuminata* Colla (AAA) ‘Red’

7. *Musa acuminata* Colla (AAA) ‘Robusta’
8. *Musa* × *paradisiaca* L. (AB) ‘Kunnan’
9. *Musa* × *paradisiaca* L. (AB) ‘Matti’
10. *Musa* × *paradisiaca* L. (AB) ‘Neypoovan’
11. *Musa* × *paradisiaca* L. (AB) ‘Thaenkunnan’
12. *Musa* × *paradisiaca* L. (AAB) ‘Namarai’
13. *Musa* × *paradisiaca* L. (AAB) ‘Nendran’
14. *Musa* × *paradisiaca* L. (AAB) ‘Pachanadan’
15. *Musa* × *paradisiaca* L. (AAB) ‘Poovan’
16. *Musa* × *paradisiaca* L. (AAB) ‘Rasthali’
17. *Musa* × *paradisiaca* L. (AAB) ‘Sirumalai’
18. *Musa* × *paradisiaca* L. (AAB) ‘Vannan’
19. *Musa* × *paradisiaca* L. (AAB) ‘Virupakshi’
20. *Musa* × *paradisiaca* L. (ABB) ‘Kachkol’
21. *Musa* × *paradisiaca* L. (ABB) ‘Karpuravalli’
22. *Musa* × *paradisiaca* L. (ABB) ‘Kuribontha’
23. *Musa* × *paradisiaca* L. (ABB) ‘Monthan’
24. *Musa* × *paradisiaca* L. (ABB) ‘Peyan’

Key to *Musa* cultivars in South India

1. Petiole canal margin overlapping; ovules in 4 rows per locule .... **(2)**

1. Petiole canal margin not overlapping; ovules in 2 rows per locule .... **(6)**

2. Fruit bunch sub-horizontal or oblique; peduncle short, < 55 cm with short internodes .... 22. ***Kuribontha***

2. Fruit bunch pendulous; peduncle long, > 55 cm with long internodes.... **(3)**

3. Ripened fruit golden yellow with brownish blotches, circumference > 15 cm; tip rounded or blunt-tipped .... 20. ***Kachkol***

3. Ripened fruit greenish yellow, circumference < 15 cm; tip pointed or bottle-necked .... **(4)**

4. Fruit bilaterally flattened; apex pointed .... 23. ***Monthan***

4. Fruit rounded; apex lengthily pointed or bottle-necked .... **(5)**

5. Male flower prominently purplish maroon, style straight; mature fruit not lean, ≥ 13 cm circumference .... 21. ***Karpuravalli***

5. Male flower prominently cream, style curved at base; mature fruit very lean < 13 cm circumference .... 24. ***Peyan***

6. Male bract internal surface homozygous, no sign of colour fadings towards base .... **(7)**

6. Male bract internal surface heterozygous, colour fades towards base..**(16)**

7. Petiole canal wide with erect margins .... **(8)**

7. Petiole canal straight with curved inwards margins .... **(11)**

8. Fruit bunch horizontal .... **(9)**

8. Fruit bunch sub-horizontal or oblique .... **(10)**

9. Peduncle long, > 50 cm; male flower style curved at base, stigma dull yellow .... 17. ***Sirumalai***

9. Peduncle short, ≤ 45 cm; male flower style straight, stigma yellow .... 19. ***Virupakshi***

10. Peduncle dark green without pigmentation; anther white or creamy white with brownish violet thecae.. 12. ***Namarai***

10. Peduncle dark green with purplish maroon pigmentation; anther black or creamy white with black or rusty brown thecae .... 14. ***Pachanadan***

11. Mature fruit bunch pendulous .... **(12)**

11. Mature fruit bunch sub-horizontal or oblique .... **(14)**

12. Fruit bunch very compact; fruits cylidrical or slightly ridged, apex bottle-necked; ripened fruit with sour taste .... 15. ***Poovan***

12. Fruit bunch lax; fruits pronouncedely ridged, apex lengthily pointed; ripened fruit with out sour taste .... **(13)**

13. Petiole canal margins curved inwards; rachis present with persistent male bracts and flowers; fruits very long, > 19 cm; ripened fruit pulp creamy yellow .... 13. ***Nendran***

13. Petiole canal straight with erect margins; rachis absent or if present, without male bracts or flowers or bare; fruits short, < 18 cm; ripened fruit pulp white .... 11. ***Thaenkunnan***

14. Leaf habit intermediate to drooping, leaf base asymmetric, one round and other pointed; fruit bunch lax ....10. ***Neypoovan***

14. Leaf habit erect, leaf base symmetric, both rounded; fruit bunch compact .... **(15)**

15. Petiole canal margins curved inwards; fruits straight, perpendicular to axis, cylindrical; pedicel short, ≤ 2 cm .... 8. ***Kunnan***

15. Petiole canal straight with erect margins; fruits curved back to pedicel, slightly ridged; pedicel long, > 2.2 cm..9. ***Matti***

16. Petiole canal straight or wide with erect margins .... **(17)**

16. Petiole canal open with spreading margins .... **(18)**

17. Male bud convolute; fruit bunch compact; fruits double curved or ‘S’ shaped, negatively geotropic, apex bottle-necked ....3. ***Pisang lilin***

17. Male bud imbricate; fruit bunch lax; fruits straight in the distal part, slightly curved towards axis, apex blunt-tipped .... 16. ***Rasthali***

18. Mature fruit bunch sub-horizontal or oblique .... **(19)**

18. Mature fruit bunch pendulous .... **(21)**

19. Petiole long, ≥ 45 cm, petiole margin gray; pedicel long, > 2 cm; fruits long, > 11 cm, apex bottle-necked .... 18. ***Vannan***

19. Petiole short, < 45 cm, petiole margin purple maroon; pedicel short, < 1.5 cm; fruits short, ≤ 10 cm, apex pointed or lengthily pointed .... **(20)**

20. Pseudostem whitish green with purple or rose pigmentation, male bract imbricate; fruits cylindrical ....1. ***Kadali***

20. Pseudostem dark green with large black colouration, male bract convolute; fruits pronouncedly ridged ....2. ***Karivazhai***

21. Plants tall, > 2.5 m; mature fruit purple with or without greenish tinge, become purple in ripening, apex blunt-tipped ....6. ***Red***

21. Plants short, < 2.5 m; mature fruit dark green, become yellowish green or remains green in ripening, apex pointed or lengthily pointed .... **(22)**

22. Rachis position falling vertically without curve, persistent male flowers and bracts .... 4. ***Dwarf cavendish***

22. Rachis position falling with a curve, bare .... **(23)**

23. Fruit dark green changes to yellow with or without slight greenish tinge at ripening; pedicel long, ≥ 2.5 cm .... 5. ***Grand naine***

23. Fruit dark green remains green at ripening; pedicel short, < 2.3 cm ....

.... 7. ***Robusta***

1. *Musa acuminata* Colla (AA) 'Kadali' **Fig. 06**

Standard Specimen: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 02 September 2011, *Sreejith 123214* (CALI).

Musa sapidisiaca K.C.Jacob var. *kadaliana* K.C.Jacob, Madras Bananas Monogr. pp. 52. 1952. ***syn. nov.***

Local names: (Kerala) *Deva Kadali, Kadali*; (Tamil Nadu) *Ney Kadali, Neyvedykadali, Narkadali, Poovan Kadali, Vellakadali.*

Plants slender, suckers 2–4, very close to parent plant, 10–20 cm away, vertical. Mature pseudostem 1.5–2.5 m high, 42–58 cm circumference at the base, whitish green with purple and rose pigmentation and covered with grayish yellow dried sheaths, with large black patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color yellowish white with purple patches, shiny; sap watery. Leaf habit intermediate, lamina 100–117 × 30–42 cm, oblong-lanceolate, apex rounded to obliquely truncate, with tendril-like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy; leaf bases asymmetric, one round and one pointed; midrib dorsally pale green, ventrally greenish white, glaucous. Petiole 35–44 cm long, waxy, more waxy towards base, with black large and extensive blotches, petiole canal open with spreading; margins, purplish maroon, petiole bases winged and not clasping the pseudostem. Inflorescence first horizontal and become sub-horizontal or oblique at maturity; peduncle 25–37 cm long, green with dark markings, densely hairy. Sterile bract 1, dorsally purple with yellowish green fading, sometimes with slight maroon tinge, glaucous, ventrally yellowish green with purple margins, not much grooved with green rudimentary leafy appendage at the apex, deciduous. Female bud linear-lanceolate, tip convolute or slightly imbricate. Female bracts lanceolate, 18–25 × 8–12 cm, not grooved, abaxially blackish maroon with yellowish striation, glaucous; adaxially purple with cream base, colour fades to cream towards base, shining, apex obtuse not split, lifting 1–2 bracts at a time, open reflexed and revolute. Basal 4–7 bunches female. Female flowers 5–12 per bract in two rows, 8.2–10.3 cm long. Compound tepal 3.8–4.4 × 1.8–2.1 cm, cream or creamy white with rusty black spots at the tip, slightly ribbed at dorsal angles, lobes 5, creamy yellow, outer lobes much longer than inner and the middle lobe is much broader than others. Free tepal 2.4–2.7 × 1.6–2 cm, obovate with a prominent acumen, cream, translucent, apex slightly corrugated, acumen 0.3–0.5 cm long. Staminodes 5, 2–4 cm long, white, base slightly greenish yellow. Ovary 4.5–6 cm long, yellowish green, ovules in 2 regular rows per locule; style 3.5–4 cm long, straight, exserted; stigma globose, grayish yellow, sticky. Male bud lanceolate to intermediate and become top-shaped at advanced blooming, apex slightly imbricate, sometimes aborted at fruit maturity; basal male flowers sometimes persistent, rachis horizontal, green, 20–33 cm at fruit maturity. Male bracts lanceolate to intermediate, 13.6–17.4 × 7.5–8.3 cm, not much grooved, abaxially dark purplish maroon with yellow patches, slightly glaucous; adaxially dull purple which fade to yellow towards base, fades towards base, apex intermediate to slightly obtuse, sometimes split; lifting 1–2 bracts at a time, open reflexed and revoluted, deciduous; bract scars scarcely prominent. Male flowers on average 12–14 per bract in two rows, 5.5–7 cm long, sometimes persistent or deciduous. Compound tepal 4.2–4.8 × 1.7–1.9 cm, apex lobed, curved backwards, cream, minutely ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 0.4–0.7 cm long. Free tepal 2.2–2.6 × 1.2–1.7 cm, white, translucent, obovate, apex smooth or slightly corrugated, with prominent, broad, truncate acumen, 0.2–0.4 cm long. Stamens 5, 3.5–4.2 cm long, filament 1.4–1.9cm long, white; anther 1.3–1.8 cm long, cream with white thecae. Ovary rudiment, straight, 1.4–2.3 cm long, white or cream without pigmentation; style straight, exserted, 3.9–4.3 cm long, white, stigma yellow. Fruit bunch lax, with 4–7 hands and 5–12 fruits per hand, in two rows; fingers pedicelled, pedicel small, 0.5–1.2 cm long, slightly fused at base. Fruits on mid hand 6.5–9 cm long, circumference 9–13 cm, straight, circular in cross section, apex pointed, with persistent floral relicts, immature peel colour dark green, become greenish yellow on ripening, peel very thin and become papery on ripening; immature fruit pulp creamy white, becoming cream on ripening, the ripened pulp when pressed at the tip splits in to three longitudinal parts, very sweet with excellent flavour. Seeds normally absent or sometimes 1–4 per fruit, black and warty.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a small, slender and a very rare cultivar mainly found in stray cultivation in the Malabar Coast. Its cultivation is restricted to Kerala and Tamil Nadu.

Cytology: Diploid (AA) – 2n = 2x = 22 (Morpho-taxonomic scoring = 15 – see APPENDIX II).

Notes: It takes around 15–17 months to mature from planting to harvest. The fruits are largely used for offering in Hindu temples. The Sanskrit name '*Kela*' for banana has been derived from the name *Kadali*. The fruit in ripened stage has a very sweet with excellent flavour so it is also used as an ingredient in many dishes like *payasam, prathaman*, etc. The ripened pulp when pressed at the tip splits in to three longitudinal parts. Since the bunches and fruits are very small and the plant is not largely grown, this has a great demand in markets and may cost □ 5–8 per fruit. Agarwal (1988) also reported that the male flowers produces high quality of fertile pollen grains.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Chevayur (Cultivated), 07 April 2011, *Sreejith 123208* (CALI); Mukkam, (Cultivated at Pantherankavu), 22 October 2014, *Sreejith 123271* (CALI).

2. *Musa acuminata* Colla (AA) 'Karivazhai' Fig. 07

Standard Specimen: INDIA. **Tamil Nadu:** Kolli Hills, Elangium Patty Village, Gundur Nadu (Cultivated), 01 Januay 2014, *Sreejith & A. Kabeer 123257* (CALI).

Musa sapidisiaca K.C.Jacob var. *karivazhaiana* K.C.Jacob, Madras Bananas Monogr. pp. 66. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *karivazhaiana* K.C.Jacob ecotype *manoranjithamiana* K.C.Jacob, Madras Bananas Monogr. pp. 67. 1952. ***syn. nov.***

Local names: (Tamil Nadu) *Karivazhai, Karuvazhai, Krishna vazhai, Manoranjitham.*

Plants slender; suckers 4–7, very close to parent plant, 5–14 cm away, vertical. Mature pseudostem 2.5–2.9 m high, 43–47 cm circumference at the base, dark green with large black blotches and covered with grayish black dried sheaths, with large black patches, shiny, not much glaucous; underlying color yellowish green with black coloration, shiny; sap watery. Leaf habit intermediate to drooping, lamina 204–217 × 42–46 cm, linear-lanceolate, apex obliquely truncate, with tendril like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy; leaf bases asymmetric, one round and one pointed; midrib dorsally pale green, ventrally yellowish green, shiny, not glaucous. Petiole 37–41 cm long, not waxy, petiole canal open with spreading, margins green with a purplish maroon coloration; petiole bases with black large and extensive blotches, winged and not clasping the pseudostem. Inflorescence sub-horizontal or oblique. Peduncle 50–53 cm long, 10 cm girth, green, densely hairy. Sterile bract 2, dorsally purplish maroon with yellowish green strands, not glaucous, ventrally purplish maroon with yellowish upper part, not much grooved and with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip convolute and pointed. Female bracts lanceolate, 24–28 × 8.8–11 cm, not grooved, abaxially blackish or dark purplish maroon, not glaucous; adaxially purplish maroon with yellowish strands and cream base, colour fades to cream towards base, shining, apex intermediate to obtuse not split; lifting 1–2 bracts at a time, open reflexed and revolute before falling. Basal 3–5 bunches female. Female flowers 7–10 per bract in two rows, 10–10.8 cm long. Compound tepal 3.7–4.1 × 1.6–1.8 cm, cream or creamy white with rusty black spots at the tip, ribbed at dorsal angles; lobes 5, creamy yellow, outer lobes much longer than inner and the middle lobe much broader than others. Free tepal 2.7–2.9 × 2.2–2.3 cm, ovate-obovate, cream, translucent, apex slightly corrugated with small and pointed acumen, 0.2–0.3 cm long. Staminodes 5, 1.5–2 cm long, greenish yellow, tip white. Ovary 6.7–7.1 cm long, yellowish green, ovules in 2 regular rows per locule; style 3.2–3.4 cm long, straight, inserted, white with dark maroon dots just beneath stigma; stigma globose, grayish yellow, sticky. Male bud intermediate become obovate and top-shaped at advanced blooming, apex convolute, sometimes aborted at fruit maturity; basal male flowers deciduous; rachis falling vertically, dark green, 48–50 cm at fruit maturity. Male bracts intermediate to top-shaped, 15–17 × 9.5–11 cm, slightly grooved, abaxially dark purple, slightly glaucous; adaxially reddish maroon fade to yellow towards base, shiny, apex highly pointed, not split; generally lifting one or rarely two bracts at a time, open reflexed and revoluted before falling, deciduous; bract scars prominent. Male flowers on average 10–12 per bract in two rows, 5.5–6 cm long, deciduous. Compound tepal 4.2–4.5 × 1.5–1.7 cm, cream with yellow lobes, slightly grooved at the dorsal side; lobes 5, almost equal, 0.4–0.5 cm long, curved back, yellow. Free tepal 2.3–2.5 × 2.3–2.5 cm, white, partially opaque, rounded or cordate, smooth with very small pointed acumen at tip, 0.2–0.4 cm long. Stamens 5, 4.3–4.6 cm long; filament 2.2–2.5 cm long, white with slight yellowish base; anther 2–2.1 cm long, cream with purplish violet thecae. Ovary rudiment, straight or slightly curved, 1.5–1.7 cm long, cream without pigmentation; style straight, exserted, 3.7–3.9 cm long, white with yellow upper part, stigma yellow. Fruit bunch lax, 3–5 hands and 7–10 fruits per hand in two rows, fingers pedicelled; pedicel very small, 0.5–1 cm long, fused at base. Fruits on mid hand 8–10 cm long, circumference 9–13 cm, straight or slightly curved, pronouncedly ridged in cross section, apex lengthily pointed, without any floral relicts, immature peel colour dark green, become yellow with slight greenish tinge at tip on ripening, peel very thick; immature fruit pulp creamy white, becoming cream on ripening, the ripened pulp when pressed at the tip splits in to three longitudinal parts, very sweet with excellent characteristic flavour and taste. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a very rare critically endangered hill banana, endemic to Kolli Hills of Tamil Nadu (noticed only five plants grown in five separate families). It is growing under special care and respect in that area due to its ritual and sacred uses.

Cytology: Diploid (AA) – 2n = 2x = 22 (Morpho-taxonomic scoring = 19 – see APPENDIX II)

Notes: It takes around 13 to 14 months to mature from planting to harvest. This cultivar got high sacred value and the fruit is used for offering to '*Konglaiamman*', the God of Kolli Hills of Tamil Nadu. The name *Karivazhai* is came from its black pseudostem (*Kari* in Malayalam = black) and the fruit in ripened stage has a very sweet and excellent characteristic flavour, hence got the name '*Manoranjitham*'. The fruits are very small and easily fall off from the bunch. The fruit has great demand and generally rate more than ten rupees per fruit.

Conservation aspects: Some conservation aspects and propagation techniques were started in the native places itself. The agricultural bodies started some macro-propagation techniques but it is not successful to this cultivar. The plant conserved in the Calicut University Botanical Garden and is also growing well.

3. *Musa acuminata* Colla (AA) 'Pisang lilin' Fig. 08

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Calicut University Campus (Cultivated), 21 December 2010, *Sreejith & A. Joe 123201* (CALI).

Local names: (Kerala) *Kavery, Mankompu, Mezhikuthiri pazham, Mezhukuthiri vazha, Dayana, Sugandhi, Sundari kadali, Sundari poovan*; (Tamil Nadu) *Kavery*. (Malaysia) *Pisang Lilin, Lidi, Pisang Lidi, Pisang Empat Puluh Hari, Pisang Lemak Manis Terenganu, Pisang Lemak Manis Kelantan, Pisang Mas Sagura*; (Indonesia) *Pisang Lilin, Pisang Muli*; (Philippines) *Mama-on*; (Thailand) *Kluai Lep Mu Nang, Kluai Thong Ki Maew, Kluai Thong Kap Dam*; (Vietnam) *Chuoi Tien*.

Plants slender, suckers 2–5, very close to parent plant, 2–15 cm away, vertical. Mature pseudostem 1.4–2.8 m high, 28–33 cm circumference at base, light green with blackish brown pigmentation and covered with grayish yellow dried sheaths, with large black patches, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color light green with very light pinkish pigmentation, shiny; sap watery. Leaf habit erect, lamina 120–173 × 45–56 cm, oblong, apex truncate, with tendril like appendage when young, upper surface dark green, shiny; lower surface dull green, waxy; leaf bases asymmetric, one round and one pointed, midrib dorsally pale green with slight pinkish pigmentation, ventrally greenish white, glaucous. Petiole 58–68 cm long, waxy, more waxy towards base; petiole canal straight with erect, margins purplish maroon, petiole bases with black large and extensive blotches, winged and not clasping pseudostem. Inflorescence first horizontal and become sub-horizontal or oblique; peduncle

27–42 cm long, green with dark markings, slightly pubescent. Sterile bract 1, dorsally greenish yellow with purple fadings, sometimes with slight maroon tinge, glaucous; ventrally purple with yellowish green base and margins, not much grooved, green rudimentary leafy appendage at the apex, deciduous. Female bud linear-lanceolate, tip convolute. Female bracts lanceolate, 22–31 × 11–12.5 cm, smooth and not grooved, abaxially purplish maroon with or without yellowish striation, slightly glaucous; adaxially purplish maroon fades to cream towards base and margins, shining, apex slightly pointed to intermediate, not split, usually lifting one bract at a time, open reflexed and revolute. Basal 4–8 bunches female. Female flowers 11–18 per bract in two rows, 8.5–11.5 cm long. Compound tepal 4–4.6 × 1.5–2.1 cm, cream or creamy white, slightly ribbed at dorsal angles, lobes 5, yellow, outer and central lobes much longer than others and central lobe much broader than others, outer lobes with beak-like projection. Free tepal 2–2.6 × 1.4–2.1 cm, ovate to obovate with prominent acumen, cream or creamy white, translucent, apex slightly corrugated, acumen pointed, 0.2–0.5 cm long. Staminodes 5, unequal, 1.4–2.9 cm long, creamy white or white with cream base. Ovary 6.2–7.5 cm long, yellowish green without pigmentation, curved or twisted, ovules in 2 regular rows per locule; style 2.7–3.8 cm long, straight, exserted, white with pinkish pigmentation and cream or grayish yellow stigma, stigma globose, sticky. Male bud slightly lanceolate to intermediate and become top-shaped at advanced blooming, apex convolute; rachis horizontal, green, 35–51 cm at fruit maturity. Male bracts lanceolate to intermediate, 16–19 × 8.5–10 cm, minutely grooved; abaxially dark purplish red to pinkish maroon without pigmentation, slightly glaucous; adaxially reddish maroon which fade to cream towards base, shiny, apex intermediate to obtuse, not split; lifting 1–2 bracts at a time, open reflexed and revoluted, deciduous; bract scars scarcely prominent. Male flowers on average 14–20 per bract in two rows, 6–6.6 cm long, deciduous. Compound tepal 4.4–5 × 1.3–1.4 cm, apex lobed, curved backwards, cream or creamy white, minutely ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 0.4–0.7 cm long. Free tepal 2–2.2

× 1–1.2 cm, white, translucent, obovate, apex smooth or slightly corrugated with a prominent acumen, narrow, 0.2–0.3 cm long. Stamens 5, 4–4.4 cm long; filament 1.6–1.8 cm long, white with cream base; anther 2.3–2.5 cm long, cream with whitish gray thecae. Ovary rudiment, straight, 1.4–1.6 cm long, creamy white without pigmentation; style straight, inserted, 4.1–4.4 cm long, white with yellow stigma. Fruit bunch compact, with 4–8 hands and 11–18 fruits per hand, in two rows; fingers pedicelled, pedicel 0.8–2 cm long, no sign of fusion of pedicel. Fruits on mid hand 13–19 cm long, circumference 8–12 cm; curved and 'S'-shaped, circular or slightly ridged in cross section, apex bottle-necked, without any floral relicts, immature peel colour dark green, become bright yellow on ripening, without any markings, peel up to 4 mm thick; immature fruit pulp white, becoming cream on ripening, sweet with a little sour taste and a characteristic flavour. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a Malaysian cultivar widely cultivated in Malaysia, Indonesia, Philippines, Thailand and Vietnam, and is introduced to Karnataka then to Kerala and Tamil Nadu. It is a small, slender and a rare cultivar found in stray cultivation in the Malabar area and also in and around Thiruvananthapuram district of Kerala, where it is commonly called as *Kavery*, *Sundari kadali, Sundari poovan* and *Sugandhi*.

Cytology: Diploid (AA) – 2n = 2x = 22 (Morpho-taxonomic scoring = 23 – see APPENDIX II)

Notes: It takes around 6–10 months to mature from planting to harvest and needs less manure compared to other native cultivars. Due to its specific characteristics of its fruit, it got different names such as '*Sugandhi'* (flavour), '*Mezhukuthiri pazham'* (lean and slender nature), *'Mankompu'* (curved and twisted fruit - like the horn of Deer), *Sundari poovan* and *Sundari kadali* (beautiful plant and fruit). According to the farmers view, its cultivation is highly economic and due to its short size and lifecycle, it needs less care and can produces up to 7 bunches within two years from the same clump. It is also good for diabetic patients as it contains lesser sugar content.

Specimens Examined: INDIA. **Kerala:** Malappuram Dist., Calicut University Campus (Cultivated), 13 January 2011, *Sreejith & A. Joe 123205* (CALI); 04 April 2011, *Sreejith & A. Joe 12327* (CALI); Kozhikode Dist., Cherukulathoor (Cultivated), 12 September 2011, *Sreejith 123215* (CALI); Thiruvananthapuram Dist. (Cultivated), 17 November 2011, *Sreejith 123217* (CALI).

4. *Musa acuminata* Colla (AAA) 'Dwarf cavendish' Fig. 09

Standard Specimen: INDIA. **Tamil Nadu:** Coimbatore, TNAU campus (Cultivated at NABI, Mohali, Punjab), 06 May 2013, *Siddharth Tiwari 123243* (CALI).

Musa sapidisiaca K.C.Jacob var. *cavendishii* (Lamb.) K.C.Jacob, Madras Bananas Monogr. pp. 37. 1952. ***syn. nov.***

Musa cavendishii Lambert ex Paxton, *Mag. Bot. iii.* pp. 51 – 52. 1837. ***syn. nov.***

Musa chinensis Sweet Hort. Brit. in Sweet (ed.), **2.** pp. 596. 1830. ***syn. nov.***

Musa acuminata Colla (AAA Group) 'Dwarf Cavendish' *Fruits 3*. pp. 502. 2012. ***syn. nov.***

Local names: (Kerala) *Dwarf cavendish, Khuzhi vazha, Kullan, Morris*; (Karnataka) *Guja bale, Gujali bale, Kabul bale, Pacha bale, Chukke bale*; (Tamil Nadu) *Kooli vazhai, Kooni cazhai, Khuzhi vazhai, Kullan, Kuttuvazhai, Morris vazhai, Tharai Matti vazhai, Pacha vazhai*; (Andhra Pradesh) *Potti pacha arati, Potti bhusawle, Cheetakali*; (Maharashtra) *Vamanakeli, Chines, Dwarf cavendish, Shedurni, bhusawali, Chittedar, Singpuri, Jahaji, Kabuli, Mauritus, Ardhapuri, Basarai*; (Arabia) *Maouz Shiny*; (Burma) *Wet ma lut*; (Italy) *Banana cavendish*; (Malaysia) *Pisang* *serendah*; (Thailand) *Klue Hom Khieo Khom*; (Vietnam) *Chou dun, Chou Tieu Lun*; (Indonesia) *Pisang Badak*; (Philippines) *Sulay Baguio*.

Plants robust, suckers 6–8, very close to parent plant, 8–18 cm away, vertical. Mature pseudostem 1.5–1.8 m high, 55–63 cm circumference at base, yellowish green with maroon pigmentation, covered with ochreous yellow dried sheaths, with large black patches, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color maroon with light yellow patches, shiny; sap watery. Leaf habit erect, lamina 135–163 × 65–84 cm, elliptic, broader towards base, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy, leaf bases symmetric, both auriculated and rounded, midrib dorsally green, waxy; ventrally whitish green glaucous. Petiole short and stout, 20–27 cm long, waxy, more waxy towards base, with black large and extensive blotches; petiole canal open with spreading, highly winged, margins purple; petiole bases winged and not clasping the pseudostem. Inflorescence pendulous; peduncle 30–50 cm long, green, hairy. Sterile bract one, dorsally green with yellowish green fadings, sometimes with slight maroon tinge, glaucous, ventrally yellowish green, not much grooved with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip convolute. Female bracts lanceolate, 35–55 × 16–24 cm, slightly grooved, abaxially maroon with yellow or greenish yellow patches, glaucous; adaxially orange-red fades to cream towards base and more orange tip, shining, apex obtuse and split, lifting 1–2 or sometimes 3 bracts at a time, open and reflexed but not revolute back. Basal 7–11 bunches female. Female flowers 12–18 per bract in two rows, 13–15 cm long. Compound tepal 3.6–4.1 × 1.8–2.2 cm, cream, ribbed at dorsal angles, lobes 5, creamy yellow, outer lobes much longer than inner and middle lobe is much broader than others. Free tepal 2.8–3 × 2–2.4 cm, ovate with an abruptly pointed acumen, cream, partially opaque, apex highly corrugated; acumen 0.4–0.6 cm long. Staminodes 5, 1.9–2.5 cm long, white with light greenish base. Ovary 10.3–11.5 cm long, greenish yellow, ovules in 2 regular rows per locule; style 3.3–

3.6 cm long, straight, inserted, white with reddish maroon dots just below stigma; stigma globose, cream, sticky. Male bud lanceolate to intermediate, apex convolute, basal male flowers persistent, tightly arranged without much space between the adjacent male hands, rachis falling vertically, green, 35–43 cm at fruit maturity. Male bracts intermediate to lanceolate, 20–26.5 × 11.2–12.5 cm, slightly grooved, abaxially purplish maroon with yellow patches, glaucous, adaxially orange-red with more yellow towards base and more red towards tip, shiny, colour fades towards base, brittle, apex obtuse and split; lifting 2–3 bracts at a time, just open or slightly reflexed, not revolute, lower bracts persistent, upper scars prominent. Male flowers on average 16–18 per bract in two rows, 5–6.4 cm long, persistent. Compound tepal 3.5–4.2 × 1.1–1.7 cm, apex lobed, curved backwards, cream, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 0.6–1 cm long. Free tepal 2.2–2.4 × 1.2–1.7 cm, white, translucent, oblong, apex highly corrugated, truncate with a prominent acumen, narrow, 0.2–0.3 cm. Stamens 5, 3.7–4.6 cm long; filament 1.2–1.8 cm long, white with light green base; anther 1.9–2.5 cm long, creamy white with white thecae. Ovary rudiment, straight or slightly curved, 1.8–2.3 cm long, creamy white with slight greenish tinge; style straight, inserted, 3.5–3.8 cm long, white with yellow stigma. Fruit bunch compact, with 7–11 hands and 12–18 fruits per hand, in two rows, fingers pedicelled; pedicel 1.5–2.6 cm long with no sign of fusion of pedicel. Fruits on mid hand 12–18 cm long, circumference 14–20 cm, curved back to peduncle, prominently ridged in cross section, apex lengthily pointed, with persistent style base, immature peel colour dark green, fruit on ripening remains green or sometimes slightly yellowish green or during hot weather becomes yellow tinge; immature fruit pulp creamy white, becoming cream on ripening. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is an introduced cultivar and is common in most of the Pacific Islands. In South India, it is common in Kerala and Tamil Nadu, but for the commercial purpose it is widely cultivated in Tiruchirappalli area of Tamil Nadu. It is generally cultivated as a pure crop. Its fruit had a great demand in many places especially in the city areas. K.C. Jacob (1952) reported that this variety is largely grown in the Canary Islands and from where the fruits are exported to Europe.

Cytology: Triploid (AAA) – 2n = 3x = 33 (Morpho-taxonomic scoring = 21 – see APPENDIX II)

Notes: The plants are too short with closely arranged, broad and erect leaves. It takes around 13 months to mature from planting to harvest. It produces heavy bunch of fruits almost touching the ground. Due to its dwarf structure, it is generally planted on bits of about 0.5–0.7 m high. The fruits are harvested during cold weather remain nearly green even when ripe whereas those harvested during hot weather become yellow tinge when ripe. The fruit in ripened stage is slightly spicy with agreeable flavour. It is not used as vegetable for cooking purpose.

5. *Musa acuminata* Colla (AAA) 'Grand naine' Fig. 10

Standard Specimen: INDIA. **Tamil Nadu:** Coimbatore, TNAU campus (Cultivated at NABI, Mohali, Punjab), 06 May 2013, *Siddharth Tiwari 123241* (CALI).

Local names: (Kerala) *G-nine, Grand naine, High gate*; (Tamil Nadu) *G-nine, Grand naine*; (N.E. India) *Harichal, Jahaji, Jahaji kol*; (England) *Grand naine*; (Indonesia) *Pisang ambon jepang*; (Vietnam) *Chuoi va huong*.

Plants robust, suckers 4–8, very close to parent plant, 5–17 cm away, vertical. Mature pseudostem 2–2.4 m high, 58–65 cm circumference at base, yellowish green with reddish maroon pigmentation and with large black patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color yellowish green with reddish maroon patches, shiny; sap watery. Leaf habit intermediate to drooping, lamina 195–215 × 84–89 cm, elliptic, broader at middle and tapering towards base and apex, apex obliquely truncate with tendril like appendage when young; upper surface dark green, shiny; lower surface dull green, waxy; leaf bases asymmetric, one rounded and other pointed or in some cases, both rounded, midrib dorsally dull green shiny; ventrally yellowish green glaucous. Petiole short, 35–39 cm long, waxy, more waxy towards base, with large and extensive brown blotches; petiole canal open with spreading, highly winged, margins purple; petiole bases winged, not clasping pseudostem. Inflorescence pendulous, peduncle 60–80 cm long, dark green with blackish pigmentation, hairy. Sterile bract 1, dorsally greenish yellow, margins maroon, glaucous, ventrally cream with maroon pigmentation, tip green, slightly grooved with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip convolute. Female bracts lanceolate, 32–50 × 13.5–20 cm, minutely grooved, abaxially purplish maroon with yellow green lines; adaxially cream with orange upper part, colour fades to cream towards base, shining; apex obtuse and split; lifting 2–3 bracts at a time, open and reflexed but not revolute back. Basal 9–13 bunches female. Female flowers 18–30 per bract in two rows, 11.3–15 cm long. Compound tepal 3.7–4.1 × 2.1–2.5 cm, cream with rusty brown or black upper part, ribbed at dorsal angles, lobes 5, rusty brown or black and dried. Free tepal 2.7–3 × 2–2.4 cm, obovate, boat-shaped, white or creamy white with more cream upper part, apex highly corrugated with a tapering acumen; acumen 0.4–0.6 cm long. Staminodes 5, 1.4–2.1 cm long, white with light greenish base. Ovary 8.3–10 cm long, pale green with yellow tinge, ovules in 2 regular rows per locule; style 3–3.5 cm long, straight, inserted, white with reddish maroon dots just below stigma; stigma globose, cream, sticky. Male bud lanceolate to intermediate, apex convolute, aborted before fruit maturity, basal 2–5 hand male flowers persistent, rachis falling with a curve, bare, green, 65–83 cm at fruit maturity. Male bracts intermediate to lanceolate, 20–25 × 11.2–13 cm, grooved, abaxially purplish maroon with yellow patches, slightly glaucous, adaxially orange-red with cream base and margins and more red towards tip, shiny, colour fades towards base, brittle, apex obtuse, sometimes split; lifting 2–3 bracts at a time, just open or slightly reflexed, not revolute, deciduous; scars prominent, compact. Male flowers on average 16–19 per bract in two rows, 5.8–6.3 cm long, deciduous. Compound tepal 3.8–4.2 × 1.3–1.8 cm, apex lobed, curved backwards, cream, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 0.5–0.8 cm long. Free tepal 2–2.2 × 1.7–1.9 cm, white or creamy white, translucent, oblong, apex highly corrugated with prominent acumen, narrow, pointed, 0.4–0.6 cm long. Stamens 5, 3.4–3.6 cm long; filament 1.5–1.6 cm long, white with light green base; anther 1.9–2.1 cm long, creamy white with white thecae. Ovary rudiment, straight or slightly curved, 2.1–2.5 cm long, white with slight yellowish green tip; style straight, inserted, 3.4–3.6 cm long, white; stigma dull yellow, falsely 3-lobed. Fruit bunch compact, with 9–13 hands and 18–30 fruits per hand, in two rows, fingers pedicelled; pedicel 2.5–3 cm long with no sign of fusion of pedicel. Fruits on mid hand 15–23 cm long, circumference 14–20 cm, curved back to peduncle, slightly ridged in cross section, apex lengthily pointed, with persistent floral relicts; immature peel colour dark green, become yellow on ripening; immature fruit pulp creamy white, becoming cream on ripening. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is an introduced cultivar and in India it is found in stray cultivation in North East India and also in some part of Kerala, Andhra Pradesh and Tamil Nadu.

Cytology: Triploid (AAA) – 2n = 3x = 33 (Morpho-taxonomic scoring = 24 – see APPENDIX II).

Notes: It is a medium sized plant with close set of drooping leaves. It takes around 13–15 months to mature from planting to harvest. '*Grand naine*' in French means "large-dwarf" and is true to its name in the sense that this plant is not very tall but produces bunches that is almost three-fourth its size with each having more than 200 fruits. The rachis generally falls vertically with a characteristic bend. The fruit on plant closely resemble to *Robusta* but on ripening, they turn yellow and moreover it has much longer shelf life than that of Robusta. While the latter tend to drop from the bunch in two to three days after ripening, the former stay intact on the bunch for more than two weeks after ripening, maintaining their peculiar aroma and taste. This quality of the *Grand naine* which has made them appealing to farmers, markets and consumers.

Specimens Examined: INDIA. **Tamil Nadu:** Pollachi, (Cultivated), 27 April 2014, *K.P. Vimal 123266* (CALI); 27 April 2014, *K.P. Vimal 123267* (CALI);

6. *Musa acuminata* Colla. (AAA) 'Red' Fig. 11

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Calicut University Botanical Garden (Cultivated), 17 November 2011, *Sreejith 123217* (CALI).

Musa sapidisiaca K.C.Jacob var. *rubra* (Feminger) Jacob, Madras Bananas Monogr. pp. 68. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *rubra* forma *venkadaliana* Jacob, Madras Bananas Monogr. pp. 68. 1952. ***syn. nov.***

Local names: (Kerala) *Chenkadali, Kappa vazha, Chorakadali, Chorapoovan, Chuvanna kappa, Chuvanna chevvazha, Kappa, Malam poovan, Raktha kadali*; (Karnataka) *Chandra bale, Chontha bale, Kenpu bale, Kunkuma bale, Sakkalathi bale*; (Tamil Nadu) *Pattu vazhai, Senthuzhuvan, Chevvazhai, Chenkadali*; (Andhra Pradesh) *Yerra arati, Lal mowze, Yerra chakkarakeli*; (Maharashtra) *Lalkela, Velchi, Chenkadali, Chandrabale*; (Odisha) *Lalkadali, Beet java*; (W.B. & North-East) *Therek marang, Agniswar, Tulsi manohar, Terekanchi, Lalkela, Ampan*; (Burma) *Shwe Nget Pyaw*; (China) *Hong Guo Jiao, Rode Banana, Cuba*; (England) *Jamaica red banana*; (France) *Figue rose*; (German) *Weinrote banana, Kuba banana*; (Italy) *Banana rosa, Banana di cuba*; (Malaysia) *Pisang raja udang*;

(Netherland) *Banana, rod banana, Red dacca, Claret banana*; (Srilanka) *Rathambala*; (Thailand) *Klue bat.*

Tall and stout plant, suckers 5–10, close to parent plant, 8–20 cm away, vertical or slightly angled. Mature pseudostem 2.9–4 m high, 60–75 cm circumference at base, brownish purple, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color purplish maroon, shiny; sap milky white. Leaf habit intermediate to drooping; lamina 270–390 × 80–92 cm, oblong-lanceolate, apex truncate or obliquely truncate, with tendril like appendage when young; upper surface dark green, dull; lower surface dull green with purplish tinge, waxy; leaf bases slightly asymmetric, both auriculated and rounded; midrib dorsally greenish purple, shiny; ventrally purplish maroon, glaucous. Petiole 65–80 cm long, waxy, more waxy towards base; petiole canal open with spreading, margins purple; petiole bases with large prominent black blotches, winged and clasping the pseudostem. Inflorescence pendulous; peduncle 75–86 cm long, dark brownish purple, hairy. Sterile bracts 2, dorsally dark brownish purple with greenish yellow patches, glaucous; ventrally dark brownish purple with leafy appendage at apex, deciduous. Female bud lanceolate, slightly imbricating at the tip. Female bracts highly brittle, lanceolate, 40–48 × 17–25 cm, minutely grooved, abaxially brownish purple with light yellowish fading towards base and margins, shiny; adaxially reddish purple which fades towards base, shiny, apex obtuse and split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 4–10 bunches female. Female flowers 10–18 per bract in two rows, 13–17 cm long. Compound tepal 5.8–6.6 × 2.3–2.6 cm, creamy white with purplish maroon patches at base and more yellowish upper part, ribbed at dorsal angles; lobes 5, yellow with blackish patches, outer lobes much longer than inner. Free tepal 3.7–4.2 × 2.7–3 cm, lanceolate, boat-shaped with a prominent midrib-like central ridge, translucent cream or white, apex highly corrugated and truncate with prominent acumen, acumen 0.4–0.6 cm. Staminodes 5, 2.6–3.8 cm long, white or creamy white with light green base. Ovary 8.5–10 cm long, straight, whitish to yellowish green with purple tip, ovules in 2 regular rows per locule; style 4.7–5.3 cm long, straight, inserted, white or creamy white; stigma globose, cream, sticky. Male bud top-shaped to intermediate, apex convolute; rachis falling vertically, 90–110 cm at fruit maturity, blackish brown. Male bracts lanceolate to intermediate, 20–25 × 15–17.5 cm, slightly grooved, abaxially dark purplish maroon with violet tinge, glaucous; adaxially reddish maroon, fades to cream towards base, shiny, apex slightly pointed; lifting 1–2 bracts at a time, revolute before falling; bract scars prominent, male bud in advanced blooming top shaped, convolute. Male flowers on average 13–17 per bract in two rows, 7.8–8.2 cm long, normally fall with bract or sometimes persistent. Compound tepal 5.8–6.5 × 2–2.5 cm, apex curved backwards, creamy white with maroon base and black pigmentation on the upper part, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.8–1.2 cm long. Free tepal 3.8–4.2 × 2.4–2.8 cm, white or creamy white, translucent, lanceolate, boat-shaped, apex highly corrugated with prominent acumen; acumen 0.5–0.7 cm long. Stamens 5, 5.5–6 cm long; filament 3–3.3 cm long, white or creamy white; anther 2.5–2.7 cm long, white or creamy white with brownish thecae or completely cream. Ovary rudiment, straight or slightly curved, 2.3–2.5 cm long, creamy white with reddish maroon flesh on the upper part; style straight, inserted, 5.1–5.3 cm long, creamy white with yellow upper part and stigma. Fruit bunch compact, with 4–10 hands and 10–18 fruits per hand, in two rows; fingers shortly pedicelled; pedicel 0.8–2 cm long, fused at the base, bend towards the peduncle. Fruits 14–17 cm long, circumference 14–21 cm, cylindrical without prominent ridges; apex blunt-tipped, with persistent floral relicts, immature peel colour greenish purple, become purple at ripening; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is not generally grown as pure stand, but few plants are cultivated along with other cultivars, especially in hilly areas. The fruits are in great demand in Tamil Nadu, Karnataka and some parts of

Kerala. The cultivation is much more in Tamil Nadu compared to other parts of South India.

Cytology: Triploid (AAA) – 2n = 3x = 33 (Morpho-taxonomic scoring = 20 – see APPENDIX II).

Notes: It is a long duration crope and takes about 18 months to mature from the time of planting to harvest. It requires heavy doses of manure for successful growth so it also exhausts the soil rather quickly. It is generally known in world wide as 'Red banana', hence the name *Red* is accepted here. The intensity of the colour of stem, petiole, midrib and fruit may found slightly varied with altitude and soil type. But taste and flavour of the ripe fruit remains constant.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 04 May 2011, *Sreejith 123277* (CALI).

7. *Musa acuminata* Colla (AAA) 'Robusta' Fig. 12

Standard Specimen: INDIA. **Tamil Nadu:** Coimbatore, TNAU campus (Cultivated), 06 April 2011, *Siddharth Tiwari 123246* (CALI).

Musa sapidisiaca K.C.Jacob var. *padapachchaaratiana* K.C.Jacob, Madras Bananas Monogr. pp. 40. 1952. ***syn. nov.***

Local names: (Kerala) *Anamalu, Robusta, Monsmarie, Sapumal;* (Karnataka) *Pacha bale, Chukke bale, Yenteedi bale*; (Tamil Nadu) *Robusta, Pacha vazhai*; (Andhra Pradesh) *Pada pacha aratti, Pedda bhusaval, Mdras pacha aratti*; (Maharashtra) *Harichal, Bombay green, Peda pacha arati*; (Odisha) *Malbhog*; (N.E. India) *Bongile Jahaji, Jahaji, Borjahali*; (Indonesia) *Pisang ambon putin*; (Italy) *Banana poyo*; (Malaysia) *Pisang buai*; (Netherland) *Poyo bananaan*; (Philippines) *Tudok*; (Vietnam) *Chuoi T ieu vanh.*

Plants robust, suckers 4–8, very close to parent plant, 5–15 cm away, vertical. Mature pseudostem 1.8–2.4 m high, 48–55 cm circumference at base, maroon with grayish yellow tinge and with large brown patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color yellowish green with reddish maroon pigmentation, shiny; sap watery. Leaf habit drooping, lamina 182–198 × 66–74 cm, elliptic, broader at middle and tapering towards base and apex, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, shiny; lower surface dull green, waxy; leaf bases asymmetric, both sides pointed, midrib dorsally dull green, shiny; ventrally yellowish green glaucous. Petiole very short, 17–25 cm long, waxy, more waxy towards base, with large and extensive brown blotches; petiole canal open with margins spreading, highly winged, margins purple; petiole bases winged and not clasping the pseudostem. Inflorescence pendulous; peduncle 45–54 cm long, dark green with blackish pigmentation, hairy. Sterile bracts 2, dorsally greenish yellow with orange tinge and maroon margins, glaucous; ventrally greenish yellow with maroon pigmentation and green tip, not much grooved with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip slightly imbricating. Female bracts lanceolate, 32–39 × 12–15 cm, not much grooved, abaxially greenish yellow with purplish maroon base; adaxially yellowish orange with reddish orange upper part and cream base, colour fades to cream towards base, shining, apex obtuse and split, lifting 2–3 bracts at a time, just open or rarely reflexed but not revolute back. Basal 7–10 bunches female. Female flowers 12–22 per bract in two rows, 12–13 cm long. Compound tepal 3.8–4.2 × 1.8–2.2 cm, cream with yellow upper parts, ribbed at dorsal angles; lobes 5, bright yellow, outer lobes much longer than inner and middle lobe much broader than the others. Free tepal 2.2–2.4 × 1.8–2 cm, ovate-oblong, white or creamy white, apex highly corrugated with a broad acumen, 0.4–0.6 cm long. Staminodes 5, 1.7–2.2 cm long, white with greenish yellow base. Ovary 7.8–8.8 cm long, yellowish green or pale green, ovules in 2 regular rows per locule; style 3.3–3.8 cm long, straight, inserted, white with purplish violet dots; stigma globose, creamy white, sticky. Male bud lanceolate to intermediate, apex slightly imbricating; rachis falling vertically with a curve, dark green, bare, 45–56 cm at fruit maturity. Male bracts intermediate to lanceolate, 20–23 × 9–11 cm, minutely grooved, abaxially purplish maroon, slightly glaucous; adaxially orange-red fades to cream towards base and margins and more red towards tip, shiny, apex obtuse and split; lifting 2–3 bracts at a time, just open or slightly reflexed, not revolute, deciduous along with male flowers; scars prominent. Male flowers on average 12–16 per bract in two rows, 5.3–5.6 cm long, deciduous. Compound tepal 3.4–3.7 × 1.3–1.6 cm, apex lobed, curved backwards, cream, ribbed at dorsal angles, lobes 5, cream or yellow, outer lobes much longer than inner, 0.5–0.9 cm long and middle lobe much broader than others. Free tepal 2.2–2.4 × 1.4–1.6 cm, creamy white, translucent, oblong, apex slightly corrugated with a prominent acumen; acumen narrow, pointed, 0.4–0.6 cm long. Stamens 5, 3.4–3.6 cm long; filament 1.6–1.7 cm long, white with light greenish base; anther 1.9–2.1 cm long, creamy white with grayish thecae. Ovary rudiment, straight or slightly curved, 1.7–2 cm long, cream; style straight, inserted, 3.6–3.8 cm long, white with purple dots; stigma yellow, falsely 3-lobed. Fruit bunch compact, with 7–10 hands and 12–22 fruits per hand, in two rows, fingers pedicelled; pedicel 1.5–2.2 cm long with no sign of fusion of pedicel. Fruits on mid hand 14–22 cm long, circumference 13–18 cm, curved back to peduncle, slightly ridged in cross section, apex pointed, with persistent floral relicts, immature peel colour dark green, which remains on ripening also; immature fruit pulp creamy white, becoming cream on ripening. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is widely cultivated in Tamil Nadu and is also common in other states like Andhra, Telangana, Karnataka, Kerala, etc. It is generally cultivated as a pure crop. Its fruit had a great demand in many places especially in the city areas and is one of the most economic crops in Tamil Nadu. It is very widely produced by tissue culture techniques and is commonly available in Nurseries and is also supplied to the farmers through local bodies like *Krishi Bhavan,* etc.

Cytology: Triploid (AAA) – 2n = 3x = 33 (Morpho-taxonomic scoring = 23 – see APPENDIX II).

Notes: It is a medium sized plant with close set of drooping leaves. It takes around 12–15 months to mature from planting to harvest. The name 'Robusta' comes from its robust appearance of the pseudostem. Many breeding experiments were done on this cultivar and produces many improved cultivars like '*Dwarf cavendish*', '*Grand naine*' etc. The fruit on plant closely resemble to the '*Grand naine*' and '*Dwarf cavendish'* but it remains the green colour even after ripening and moreover it has much lesser shelf life than the *Grand naine*. The fruit also has a characteristic aroma.

Specimens Examined: INDIA. **Kerala:** Kozhikode, Poovattuparamba (Cultivated), 03 May 2015, *Sreejith 123274* (CALI).

8. *Musa* × *paradisiaca* L. (AB) 'Kunnan' Fig. 13

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Panambra, Elampilasseri (Cultivated), 16 November 2012, *Sreejith & A. Joe 123236* (CALI).

Musa sapidisiaca K.C.Jacob var. *kunnaniana* K.C.Jacob, Madras Bananas Monogr. pp. 94. 1952. ***syn. nov.***

Local names: (Kerala) *Adukkan, Amirthapani, Annaan, Kannan, Kunnan, Nadan kunnan, Valia kunnan, Adukvan, Adukku poovan, Kulamelkula*; (Karnataka) *Chitti bale, Firige bale*; (Tamil Nadu) *Poong kadali, Vella kadali, Nar kadali*; (Andhra Pradesh) *Amirthpani, Chakkara keli, Chinna sugantham, Ginni, Karpura chakkara keli, Madras aratti, Neechu, Sanna aakulu chettu, Sugantha*; (Odisha) *Patti mokiri, Sudha.*

Plants slender, suckers 4–7, not much close to parent plant, 13–22 cm away, vertical or slightly angled. Mature pseudostem 2.1–2.4 m high, 35–50 cm circumference at base; yellowish green with maroon pigmentation and covered with white dried sheaths, with blackish patches, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color greenish white with slight purplish maroon fadings, shiny; sap watery. Leaf habit erect; lamina 145–155 × 50–60 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy, leaf bases symmetric, both rounded; midrib dorsally green waxy; ventrally whitish green glaucous. Petiole 42–50 cm long, waxy, more waxy towards base, with black scattered blotches; petiole canal slightly curved inwards, purple; petiole bases not winged and clasping the pseudostem. Inflorescence sub-horizontal or oblique, peduncle 30–45 cm long, green with black dots, glabrous, glaucous. Sterile bracts 2, dorsally yellowish green with dark maroon fadings, much more in the second one and sometimes maroon with yellowish fading, glaucous, ventrally maroon with yellow or greenish yellow patches towards base and margins, not much grooved with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, imbricate at tip. Female bracts lanceolate, 25–30 × 10–12 cm, slightly grooved, abaxially dark blackish maroon, with yellowish patches, glaucous; adaxially dark reddish maroon, colour slightly fades towards base, shining, apex obtuse and split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 5–9 hands female. Female flowers 9–14 per bract in two rows, 9.5–12.2 cm long. Compound tepal 4–4.4 × 1.5–2 cm, cream with maroon patches and more yellowish lobes, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner. Free tepal 2.4–3 × 1.5–2 cm, obovat, cream, translucent, apex highly corrugated with a prominent and broadly truncate acumen, 0.4–0.6 cm long. Staminodes 5, 1.2–1.7 cm long, white with light greenish base. Ovary 6.5–7.8 cm long, dull yellowish green, ovules in 2 regular rows per locule; style 3.8–4.5 cm long, straight, inserted, white with reddish maroon dots just below stigma; stigma globose, cream or greyish yellow, sticky. Male bud lanceolate to intermediate, highly imbricate at apex, rachis falling at an angle, blackish brown, bare, 65–85 cm long at fruit maturity. Male bracts intermediate to lanceolate, 15–19 × 8.1–10 cm, not grooved, abaxially dark purplish maroon with slight blackish markings, glaucous; adaxially dark reddish maroon, shiny, no mark of colour fading, apex intermediate to obtuse, not split; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 14–18 per bract in two rows, 5–6 cm long, fall with the bract. Compound tepal 3.3–4.1 × 1–2.2 cm, apex lobed, curved backwards, cream with maroon patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.4–0.6 cm long. Free tepal 1.8–3 × 1.2–1.8 cm, white or cream, translucent, oblong, boat-shaped, apex highly corrugated with a prominent acumen, narrow, 0.4–0.6 cm long. Stamens 5, 3.2–4 cm long; filament 1.9–2.2 cm long, cream; anther 1.3–2 cm long, cream with purplish maroon thecae. Ovary rudiment, straight, 1.5–2.1 cm long, cream or creamy white with slight maroon patches; style curved at base, exserted 3.7–4.1 cm long, white or creamy white; stigma dull yellow. Fruit bunch compact, with 5–9 hands and 9–14 fruits per hand, in two rows, fingers pedicelled; pedicel 1.5–2 cm long with no sign of fusion of pedicel. Fruits on mid hand 8.5–11.5 cm long, strait, circumference 8–12 cm, rounded in cross section; apex bottle-necked, with persistent floral relicts, immature peel colour dark green, become bright yellow with black dots at maturity; immature fruit pulp white, becoming creamy white with little bit hard at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a medium sized plant found in stray cultivation throughout South India especially in the backyards. Since this produces much small and lesser number of fruits compared with other common cultivars such as *Poovan,* etc., it is not grown as pure stand anywhere.

Cytology: Diploid (AB) – 2n = 2x = 22 (Morpho-taxonomic scoring = 48 – see APPENDIX II).

Notes: It takes around 15 to 16 months to mature from planting to harvest. It is a medium sized plant with small, narrow and erect leaves. The unripe fruits are used for culinary purpose and the dried fruit powder is used as a baby-food, especially in the rural areas of Kerala. The ripened fruits are also consumed as raw.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Chevayur (Cultivated), 06 April 2011, *Sreejith 123251* (CALI); Pantheerankavu, Athaani (Cultivated), 03 May 2015, *Sreejith 123276* (CALI); Malappuram Dist., Kondotty (Cultivated) *Ahmadul Kabeer 123249* (CALI); Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123229* (CALI).

9. *Musa* × *paradisiaca* L. (AB) 'Matti' Fig. 14

Standard Specimen: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123231* (CALI).

Musa sapidisiaca K.C.Jacob var. *mattiana* K.C.Jacob, Madras Bananas Monogr. pp. 55. 1952. ***syn. nov.***

Local names: (Kerala) *Matti, Mattippazham, Mattippoovan*; (Tamil Nadu) *Kunnan Matti, Mattippoovan.*

Plants slender, suckers 4–8, not much close to parent plant, 10–20 cm away, vertical or slightly angled. Mature pseudostem 2.3–2.8 m high, 40–53 cm circumference at base; yellowish green with maroon pigmentation and covered with white dried sheaths, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color greenish white with slight purplish maroon patches, shiny; sap watery. Leaf habit erect; lamina 150–175 × 50–64 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy, leaf bases symmetric, both rounded; midrib dorsally green waxy; ventrally dull green glaucous. Petiole 46–65 cm long, waxy, more waxy towards base, with large and extensive black blotches; petiole canal straight or sometimes slightly curved inwards, purple; petiole bases not winged and clasping the pseudostem. Inflorescence sub-horizontal or oblique, peduncle 40–50 cm long, light or yellowish green with slight maroon tinge and black dots, glabrous, glaucous. Sterile bracts 2, dorsally yellowish green with maroon shades, much more in the second one and sometimes maroon with yellowish fading, glaucous, ventrally maroon with yellow or greenish yellow patches towards base and margins, not much grooved with green rudimentary leafy appendage at apex, deciduous. Female bud linear-lanceolate, imbricate at tip. Female bracts lanceolate, 27–32 × 10.5–16 cm, slightly grooved, abaxially dark blackish maroon with purple tinge, highly glaucous; adaxially reddish maroon with slight purplish tinge, no sign of colour fadings towards base, shining, apex intermediate and sometimes split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 5–10 hands female. Female flowers 10–15 per bract in two rows, 9.5–12.5 cm long. Compound tepal 4.1–4.4 × 1.5–2.1 cm, cream with maroon patches and more yellowish lobes, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner, 0.5–0.6 cm long. Free tepal 2.5–3 × 1.5–2 cm, obovate, cream, translucent, apex highly corrugated and broadly truncate acumen, 0.5–0.6 cm long. Staminodes 5, 1.3–2.2 cm long, white with light greenish base. Ovary 6.6–8 cm long, dull yellow with or without greenish tinge, ovules in 2 regular rows per locule; style 3.9–4.3 cm long, straight, inserted, white with reddish maroon dots just below stigma; stigma globose, cream or greyish yellow, sticky. Male bud lanceolate to intermediate, highly imbricate at apex; rachis falling at an angle, blackish brown, bare, 62–95 cm long at fruit maturity. Male bracts intermediate to lanceolate, 16–22 × 8.1–12.2 cm, not grooved, abaxially purplish maroon, glaucous; adaxially reddish maroon, shiny, no mark of colour fading, apex intermediate to obtuse, not split; lifting

1–2 bracts at a time or sometimes 3, revolute just before falling; bract scars prominent. Male flowers on average 14–18 per bract in two rows, 5–7 cm long, fall with the bract. Compound tepal 3.8–4.7 × 0.9–2.2 cm, apex lobed, curved backwards, cream with maroon patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.4–0.6 cm long. Free tepal 2–3 × 1.5–1.8 cm, cream, translucent, oblong, boat-shaped, apex highly corrugated with a prominent narrow acumen, 0.6–1 cm long. Stamens 5, 3.2–4.3 cm long; filament 1.7–2.2 cm long, cream; anther 1.4–2 cm long, cream with pinkish purple thecae. Ovary rudiment, straight, 1.6–2.5 cm long, cream or creamy white with slight maroon patches; style curved at base or in some cases straight, exserted 3.7–4.5 cm long, white or creamy white with or without reddish dots just below stigma; stigma dull yellow. Fruit bunch compact, with 5–10 hands and 10–15 fruits per hand, in two rows, fingers pedicelled; pedicel 2.3–3 cm long with no sign of fusion of pedicel. Fruits on mid hand 8–11 cm long, curved, circumference 8–12 cm, rounded or slightly ridged in cross section; apex bottle-necked, with persistent floral relicts, immature peel colour dark green, become bright yellow with black dots at maturity; immature fruit pulp white, becoming creamy white at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is rare plant and there is no commercial/ large scale production anywhere except in some small areas nearby Nagarcoil in Tamil Nadu district and very rarely in some backyards of farmer’s house in Kerala.

Cytology: Diploid (AB) – 2n = 2x = 22 (Morpho-taxonomic scoring = 47 – see APPENDIX II).

Notes: It takes around 14 to 15 months to mature from planting to harvest. It is a medium sized plant with small, narrow and erect leaves. Since it helps for easy digestion, this fruit is widely given to the 3–12 month old babies.

Specimens Examined: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123229* (CALI). **Tamil Nadu:** Kanyakumari Dist., Nagarcoil, 30 October 2015, *Drisya & T. Kottekkattu 123284* (CALI).

10. *Musa* × *paradisiaca* L. (AB) 'Neypoovan' **Fig. 15**

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 06 April 2011, *Sreejith 123208* (CALI).

Musa sapidisiaca K.C.Jacob var. *neypoovaniana* Jacob, Madras Bananas Monogr. pp. 76. 1952. ***syn. nov.***

Local names: (Kerala) *Adakka poovan, Ari poovan, Kadali poovan, Kunnan poovan-kadali, Kunnan poovan, Madhura annan, Ney kadali, Neypoovan, Nhali poovan, Nhani poovan, Thekkan kadali, Tirunelli poovan, Thulunaattu kadali, Vadakkan kadali, Rani poovan*; (Karnataka) *Deva bale, Hoo bale, Elakkie bale, Puttu sugantha, Poo bale, Mitga bale, Mitli*; (Tamil Nadu) *Mysore rasthali, Rasakadali, Elarasi, Poonkadali, Pacharasi*; (Andhra Pradesh) *Mysore rasthali, Karpura aratti, Rasadala*; (Maharashtra) *Safed velchi*; (Odisha & W.B.) *Chini champa, Kanthali champa*; (North-East) *Somai.*

Plants slender, suckers 2–5, not much close to parent plant, 9–17 cm away, vertical or slightly angled. Mature pseudostem 2.5–3.5 m high, 50–58 cm circumference at base, yellowish green, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color whitish green with some purplish blotches, shiny, sap milky white. Leaf habit intermediate to drooping; lamina 165–215 × 53–65 cm, oblong-lanceolate, obliquely truncate or truncate at apex, with tendril like appendage when young, upper surface dark green, dull; lower surface light green, waxy; leaf bases asymmetric, both rounded or one side rounded and other pointed; midrib dorsally yellow-green, glaucous, ventrally dark green. Petiole 60–75 cm long, waxy, more waxy towards base; petiole canal margins curved inwards, purple; petiole bases winged and clasping the pseudostem, with black or black-brown scattered blotches. Inflorescence horizontal and become sub-horizontal or oblique; peduncle 32–46 cm long, light green with maroon pigmentation, slightly pubescent. Sterile bracts 2, dorsally yellowish green with maroon fading, ventrally maroon with green leafy appendage at the apex, deciduous. Female bud lanceolate, convolute or slightly imbricate at tip. Female bracts lanceolate, 27–36 × 14–20 cm, moderately grooved, abaxially dark maroon with or without light yellow patches, glaucous; adaxially reddish maroon, shiny, no sign of colour fadings; apex obtuse and sometimes split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 6–10 bunches female. Female flowers 10–18 per bract in two rows, 11.3–15 cm long. Compound tepal 4.5–5.7 × 1.9–2.9 cm, creamy white with maroon tinge, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner. Free tepal 3.1–3.4 × 1.7–2.2 cm, lanceolate, boat-shaped, translucent cream or white with slight purple tinge, apex highly corrugated and truncate without a prominent acumen. Staminodes 5, 1.7–3.8 cm long, white or creamy white with light green base. Ovary 7.3–10.2 cm long, straight, pale green with or without a purple patches at the base and tip, ovules in 2 regular rows per locule; style 4.4–5.1 cm long, straight, inserted, white with reddish maroon dots just beneath stigma, stigma globose, cream or grey, sticky. Male bud lanceolate to intermediate, highly imbricate at apex; rachis falling at an angle, dark brown or blackish brown, 78–86 cm long at fruit maturity. Male bracts lanceolate to intermediate, 14–20.3 × 8.3–13.5 cm, slightly grooved; abaxially dark purplish maroon, glaucous; adaxially maroon, shiny, no sign of colour fadings; apex obtuse and sometimes split; lifting 1–2 bracts at a time, revolute before falling; bract scars prominent; male bud in advanced blooming top shaped, almost convolute. Male flowers on average 13–19 per bract in two rows, 6.3–7.8 cm long, fall with bract. Compound tepal 4.8–5.8 × 1.3–1.9 cm, apex curved backwards, creamy white with purplish strands, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.5–0.8 cm long. Free tepal 2.6–3 × 1.3–1.9 cm, lanceolate, creamy white with purple coloration, translucent, boat-shaped, apex highly corrugated with a prominent acumen 0.4–0.6 cm long. Stamens 5, 4.8–5.5 cm long; filament 2.5–3.5 cm long, creamy white; anther 2–3 cm long, creamy white with brownish thecae or completely cream. Ovary rudiment, straight, 1.5–2.1 cm long, creamy white with or without a purplish base; style straight, inserted, 4.5–5.2 cm long, creamy white with purple dots towards tip, stigma pale yellow. Fruit bunch lax, with 6–10 hands and 10–18 fruits per hand, in two rows, fingers pedicelled, bend towards the peduncle; pedicel 1.8–2.5 cm long, base with no sign of fusion;. Fruits 7–11.5 cm long, circumference 8–11 cm, slightly ridged, apex bottle-necked, with persistent floral relicts, immature peel colour dark green, become bright yellow and very thin at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is widely cultivated throughout South India, especially in Malabar area where the plants are grown in the backyards of almost all houses for leaves as well as fruits.

Cytology: Diploid (AB) – 2n = 2x = 22 (Morpho-taxonomic scoring = 47 – see APPENDIX II).

Notes: It takes around 13 months to mature from planting to harvest. It does not need any special care and hence commonly cultivated in home gardens. It is not grown as pure stand anywhere and is not a chief commercial variety. The fruit has a tendency to crack if irrigation be continued even after the fruits are ¾ fill. It is largely grown as a rain-fed crop on the Malabar area and the fruits are highly delicious.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 12 September 2011, *Sreejith 123215* (CALI); Pantheerankavu, Athaani (Cultivated), 03 May 2015, *Sreejith 123275* (CALI); Malappuram Dist., Calicut University Botanical Garden (Cultivated),17 November 2011, *Sreejith 123217* (CALI); *ibid.,* 17 November 2011, *Sreejith 123223* (CALI); Thrissur Dist., Palakkuzhi (Cultivated), April 2012, *A. Joe 130747* (CALI).

11. *Musa × paradisiaca* L. (AB) 'Thaenkunnan' **Fig. 16**

Standard Specimen: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 06 April 2011, *Sreejith 123210* (CALI).

Musa sapidisiaca K.C.Jacob var. *thaenkunnaniana* K.C.Jacob, Madras Bananas Monogr. pp. 99. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *thaenkunnaniana* forma *thattillakunnaniana* K.C.Jacob, Madras Bananas Monogr. pp. 100. 1952. ***syn. nov.***

Local names: (Kerala) *Chundilla kunnan, Chundillan, Kodapilla kunnan, Koombilla annan, Koombilla chingan, Koombilla kannan, Koombilla poovan, Mambilla kunnan, Maniyilla kunnan, Kunnan, Taen kunnan, Thattilla kunnan*; (Tamil Nadu) *Poo vazhai, Poola chundan, Poong kadali, Poovilla vazhai*; (Karnataka) *Kaththe bale, Mambilla, Rundu bale*; (Andhra Pradesh) *Benda atratti, Chitrachalam, Godavari keli*; (Ceylon) *Suwandel.*

Plants medium stout, suckers 1–5, not much close to parent plant, 10–25 cm away, vertical or slightly angled. Mature pseudostem 2.7–3.5 m high, 46–65 cm circumference at base, slightly yellowish green with black and brownish purple patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color yellowish green with maroon pigmentation, shiny; sap watery. Leaf habit intermediate to erect, lamina 215–268 × 63–77 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, lower surface dull green, waxy; leaf bases slightly asymmetric, both rounded; midrib dorsally green; ventrally dull green with slight yellowish tinge, glaucous. Petiole 45–51 cm long, waxy, more waxy towards base; petiole canal margins straight with erect and purplish maroon margins; petiole bases not winged and clasping pseudostem, with black and maroon sparse blotches along base.

Inflorescence pendulous; peduncle 50–73 cm long, dark green without any pigmentation, not pubescent, glaucous. Sterile bracts 2, dorsally purplish maroon with greenish yellow patches, glaucous; ventrally maroon with greenish yellow patches towards base and margins, not much grooved with a little but not much developed green leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip minutely imbricate. Female bracts lanceolate, 23.7–37 × 7–13 cm, slightly grooved, abaxially dark blackish maroon with yellowish green tip, glaucous; adaxially reddish maroon which fades towards base and tip, shining, apex pointed to obtuse and split, lifting 2–4 bract at a time, open reflexed and slightly revolute at tip just before falling. All bunches female (6–14) or in some cases first 5–7 hands female then produces 6–11 hands hermaphrodite or male and again female; but with less manure and water stress conditions, especially in hot summer, it produces 4–7 hands of female followed by male flowers as in the other cultivars. Female flowers 8–16 per bract in two rows, 10–13.8 cm long. Compound tepal 4.3–5.6 × 1.5–2.2 cm, creamy white with maroon patches and more yellow lobes, ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes longer than inner. Free tepal 2.5–3 × 1.5–2.3 cm, ovoid to lanceolate, cream, apex highly corrugated with a pointed acumen, 0.4–0.6 cm long. Staminodes 5, 2–3.5 cm long, white with yellowish green base. Ovary 6.5–8.5 cm long, pale green, ovules in 2 regular rows per locule, style 3.7–4.4 cm long, straight, white without pigmentation, stigma globose, cream, sticky. Normally male bud and male flowers completely absent and the last bunch develop in to fruits. But in some cases it also produces male bud and flowers; male bud lanceolate, imbricate at apex; rachis falling vertically, dark green, 45–53 cm at fruit maturity. Male bracts lanceolate, 20–22 × 8–8.8 cm, grooved; abaxially dark blackish purple, glaucous, adaxially reddish maroon, shiny, no sign of colour fading, apex obtuse and split; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars scarcely prominent. Male flowers on average 8–12 per bract in two rows, 7.5–7.8 cm long, fall with the bract or sometimes upper 3–4 bunches of rudimentary ovary persistent even up to fruit maturity. Compound tepal 5.4–5.8 × 1.3–1.6 cm, apex curved backwards, cream with maroon patches and yellow lobes, slightly ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes much longer than inner, 0.4–0.6 cm long. Free tepal 2.4–2.7 × 1.8–2 cm, creamy white with maroon tinge, opaque, oblong-ovate, boat-shaped; apex highly corrugated with prominent pointed acumen, 0.4–0.6 cm long. Stamens 5, 4–4.5 cm long; filament 2–2.8 cm long, cream, anther 1.8–2.2 cm long, creamy white with brownish violet thecae. Ovary rudiment, straight, 2.2–2.3 cm long, creamy white without pigmentation; style straight, inserted 4.5–4.7 cm long, white without pigmentation, stigma dull yellow; stigma globose, sometimes bifid, dull yellow. Fruit bunch lax, with a curve. Peduncle 55–65 cm long, 20–25 cm girth; 5–14 hands and 8–16 fruits per mid-hand, in two rows, fingers pedicelled; pedicel long, 4–6 cm. Fruits on mid hand 12.5–16 cm long, circumference 11–15 cm, curved, pronouncedly ridged in cross section, apex lengthily pointed, with persistent style base, immature peel colour dark green, become yellow with greenish tinge and some black markings at ripening, yellow at over-ripened stage and easily falloff; immature fruit pulp pure white, which retains even after ripening and very sweet at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is very rare cultivar found in stray cultivation in Kerala and some part of Tamil Nadu and also in some part Andhra and Karnataka.

Cytology: Diploid (AB) – 2n = 2x = 22 (Morpho-taxonomic scoring = 47 – see APPENDIX II).

Notes: It takes around 16–18 months to mature from planting to harvest. The fruits very sweet and that is how it got the name *Thaenkunnan* (in Malayalam, *Thaen* means Honey). It is a medium size plant with medium sized leaves and bunch with pronouncedly ridged and lengthily pointed fruits. Normally it produces only pistillate flowers (female only) and all develops in to fruits or in some cases, it may produce 4–7 hands of pistillate flowers and then some hermaphrodite or male flowers followed by female flowers, so that the mature bunch has fruits from base to tip or at the basal and the tip portions with a naked middle rachis. But during hot summer, it produces normal bunches of 4–6 female flowers followed by male. K.C. Jacob (1952) treated the later one under the variety *M. sapidisiaca* var. *thaenkunnaniana* and the former forma *thattillakunnaniana* under the variety. But both the conditions were seen in the same clump. The fruit is very sweet and pure white in colour, but it has very short shelf life and it falloff very easily.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 20 April 2015, *Sreejith 123272* (CALI); Malappuram Dist., Kuttippuram, (Cultivated), 03 January 2015, *Sreejith & C. Pramod 123210* (CALI).

12. *Musa × paradisiaca* L. (AAB) 'Namarai' Fig. 17

Standard Specimen: INDIA. **Tamil Nadu:** Kolli Hills Koochakarai Paatty (Cultivated), 01 January 2014, *Sreejith & A. Kabeer123252* (CALI).

Musa sapidisiaca K.C.Jacob var. *namaraiana* K.C.Jacob, Madras Bananas Monogr. pp. 56. 1952. ***syn. nov.***

Local names: (Tamil Nadu) *Mala vazhai, Mala vazha, Namarai, Nimaran.*

Plants normal; suckers 4–6, close to parent plant, 6–15 cm away, vertical. Mature pseudostem 2.7–3.2 m high, 46–55 cm circumference at base, yellowish green with black or blackish brown patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color whitish yellow with slight maroon pigmentation, shiny; sap watery. Leaf habit intermediate to drooping, lamina 215–245 × 63–67 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, lower surface dull green, waxy; leaf bases symmetric, both auriculated and rounded; midrib dorsally yellowish green, ventrally dull green with slight yellowish tinge, glaucous. Petiole 45–51 cm long, waxy, more waxy towards base; petiole canal margins wide with erect, margins blackish brown; petiole bases slightly winged and clasping pseudostem, base with scattered blackish blotches. Inflorescence horizontal become sub-horizontal or oblique at fruit maturity; peduncle 60–70 cm long, dark green without any pigmentation, glabrous, glaucous. Sterile bracts 2, dorsally greenish yellow with maroon patches, much more in the second one, ventrally maroon with greenish yellow patches towards base and margins, slightly grooved with a little but not much developed green leafy appendage at the apex, deciduous. Female bud linear-lanceolate, tip imbricate. Female bracts lanceolate, 28–35 × 15–18.5 cm, slightly grooved, abaxially dark blackish maroon with or without yellowish green patches and with red tip, glaucous; adaxially reddish maroon with orange tinge, no sign of colour fading, shining, apex obtuse and sometimes split, lifting one bract at a time or rarely two, reflexed and revolute before falling. Basal 5–7 bunches female. Female flowers 10–16 per bract in two rows, 11–12.5 cm long. Compound tepal 4–4.3 × 1–1.5 cm, creamy white with reddish maroon base, which fades towards tip, ribbed at dorsal angles; lobes 5, yellow, outer lobes slightly longer than inner and curved back. Free tepal 2.7–2.9 × 2.1–2.3 cm, ovoid, cream; apex corrugated with pointed acumen, 0.5–0.6 cm long. Staminodes 5, 1.9–2.7 cm long, white with yellowish green base. Ovary 7.8–8.3 cm long, light yellowish green, ovules in 2 regular rows per locule; style 3.9–4.2 cm long, straight, inserted, white with purplish violet middle part; stigma globose, cream, sticky. Male bud intermediate to top-shaped, imbricate at apex; rachis falling vertically, blackish brown, 75–83 cm at fruit maturity. Male bracts lanceolate to intermediate, 17.5–20 × 12–13.5 cm, grooved, abaxially dark brownish purple, glaucous; adaxially reddish maroon, shiny, no sign of colour fading, apex intermediate–obtuse and sometimes split; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 12–14 per bract in two rows, 5.7–6.1 cm long, normally fall with bract or sometimes upper 3–4 bunches persistent. Compound tepal 4.5–4.8 × 1.5–1.9 cm, apex curved backwards, cream with maroon patches and yellow lobes, ribbed at dorsal angles; lobes 5, yellow, outer lobes and middle lobe much longer than inner, 0.5–0.7 cm long. Free tepal 2.3–2.5 × 1.7–2 cm, white, opaque, oblong-ovate, boat-shaped; apex corrugated with a prominent pointed acumen, 0.3–0.4 cm long. Stamens 5, 4.2–4.5 cm long; filament 2.1–2.3 cm long, white or creamy white; anther 1.8–2.1 cm long, white or creamy white with brownish violet thecae. Ovary rudiment, straight, 1.8–2 cm long, cream with purple fleshy patches; style curved at base, inserted 4–4.5 cm long, white with purple dots and dull yellow stigma. Fruit bunch lax, with 5–7 hands and 10–16 fruits per hand, in two rows, fingers pedicelled; pedicel 1.9–2.2 cm long. Fruits on mid hand 13.5–15 cm long, straight in the distal part, circumference 10–14 cm, pronouncedly ridged in cross section, apex pointed, with persistent style base, immature peel colour dark green, become yellow with some black markings at maturity; immature fruit pulp white, becoming cream soft and very sweet at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is rare hill banana grown as scattered units along with other cultivars in the hilly areas of Tamil Nadu. The main cultivation is restricted to Palani, Kolli and Sirumalai hills of Tamil Nadu. It can also thrive in the plains of Tamil Nadu and also produces much larger bunches than in its natural habitat.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 44 – see APPENDIX II).

Notes: It takes around 13 months to mature from planting to harvest. It is a slender plant with medium sized leaves and bunch with smaller and easily falling fruits. The fruit is widely exported to Palani temple for the preparation of "*Panchamritham*". For this purpose only it is cultivated in some hilly areas and now become one of the major economic crops of the local peoples in these areas. Recently many local dailies reported that this variety is to be extinct because of the issues of the land from where it is cultivated. The fruit is very juicy, sweet and with a good flavour but the major defect is that it has short shelf life and falloff soon after maturity.

13. *Musa* × *paradisiaca* L. (AAB) 'Nendran' Fig. 18

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Panambra (Cultivated), 24 January 2012, *Sreejith 123218* (CALI).

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob, Madras Bananas Monogr. pp. 42. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob forma *kaalieththaniana* K.C.Jacob, Madras Bananas Monogr. pp. 43. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob forma *eleriana* K.C.Jacob, Madras Bananas Monogr. pp. 44. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob forma *kaleththaniana* K.C.Jacob, Madras Bananas Monogr. pp. 44. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob forma *velaththaniana* K.C.Jacob, Madras Bananas Monogr. pp. 44. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *plantaniana* K.C.Jacob forma *myndoliana* K.C.Jacob, Madras Bananas Monogr. pp. 45. 1952. ***syn. nov.***

Musa sapidisiaca K.C.Jacob var. *corniculata* (Rumph.) K.C.Jacob, Madras Bananas Monogr. pp. 43. 1952. ***syn. nov.***

Local names: (Kerala) *Attu nendran, Chengalikodan, Chengazhikodan, Eththakka, French plantain, Giant plantain, Horn plantain, Kal eththan, Malai ethan, Manjeri Moongil, Mysore Ethan, Nendran, Nana nendran, Nedu nendran, Nendran, Neockon, Ottamoongil, Pindi eththan, Randupadala,* *Thiruvonan, Zanzibar*; (Tamil Nadu) *Attu nendran, Eleri, Eththakka, Giant plantain, Horn plantain, Kal eththan, Moongil, Nana nendran, Nedu nendran, Nendran, Otta moongil, Pindi eththan, Zanzibar*; (Karnataka) *Nana nendran, Nendran*; (Maharashtra) *Rejeli*; (Odisha) *Gajabantal, Saja bantal, Singa bantal, Singapuri*; (Denmark) *Hooru plantain*; (England) *African plantain, French plantain, Giant plantain, Horn plantain, Horse plantain*; (France) *Banana Corne, Banana cent livres*; (Germany) *Hornfeermige, Pisang Feige*; (Indonesia) *Pisang candi*; (Malaysia) *Pisang lang, Pisang nangka, Pisang ton dok, Pisang tun dok*; (Philippines) *Bhangoaisan*; (Thailand) *Kluai nga chang*.

Plants normal; suckers 3–8, close to parent plant, 8–17 cm away, vertical or slightly angled. Mature pseudostem 2.6–3.3 m high, 45–65 cm circumference at base, green to yellowish green, with blackish patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color whitish green with some purplish blotches, shiny; sap watery. Leaf habit drooping; lamina 190–220 × 65–70 cm, oblong, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, shiny; lower surface dull green, waxy; bases asymmetric, one rounded and one pointed; midrib dorsally dull green, ventrally whitish green with slight yellowish tinge, glaucous. Younger leaves with some brownish purple patches at the lower surface. Petiole 35–57 cm long, waxy, more waxy towards base; petiole canal margins pinkish purple to red, curved inwards; petiole bases not winged and clasping the pseudostem, without blotches or if present, very small scattered brownish dots. Inflorescence pendulous; peduncle 45–60 cm long, dull green without any pigmentation, glabrous, glaucous. Sterile bracts 2, dorsally yellowish green with maroon tinge, much more in the second one; ventrally maroon with yellowish green margins, slightly grooved without much developed green leafy appendage at apex, deciduous. Female bud linear-lanceolate, slightly imbricate at tip. Female bracts lanceolate, 28–38 × 13–18 cm, not much grooved, abaxially dark blackish purple with greenish yellow patches, glaucous; adaxially reddish maroon with yellowish patches towards margins, no sign of colour fading, shining, apex obtuse and split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 5–8 bunches female. Female flowers 8–10 per bract in two rows, 16–19 cm long. Compound tepal 4.4–4.7 × 2.2–2.5 cm, cream with orange-yellow lobes, ribbed at dorsal angles; lobes 5, orange-yellow, outer lobes much longer than inner. Free tepal 3.2–3.5 × 2.2–2.4 cm, ovate, white with yellow patches, apex highly corrugated and truncate with a broad acumen, 0.6–0.9 cm long. Staminodes 5, 3.1–3.9 cm long, white with light green base and grayish tip. Ovary 13.5–14 cm long, light yellowish green with slightly purplish pedicel, ovules in 2 regular rows per locule; style 3.9–4.2 cm long, straight, inserted, white; stigma globose, cream or greyish yellow, sticky. Male bud lanceolate, highly imbricate at apex; rachis falling vertically, blackish brown, with persistent male flowers and bracts, 48–64 cm at fruit maturity. Male bracts lanceolate, 24–29 × 13–14.8 cm, not much grooved; abaxially purplish maroon, slightly glaucous; adaxially reddish maroon, no sign of colour fading towards base, shiny, colour uniform, apex obtuse and split; lifting 1–3 bracts at a time, reflexed and revolute; male bud in advanced blooming slightly top-shaped, mostly male bract and male flowers persistent up to fruit maturity; if falls, then bract scars prominent. Male flowers on average 9–12 per bract in two rows, 8–9.3 cm long, mostly persistent along with the bract. Compound tepal 5.2–5.8 × 1.5–1.8 cm, apex curved backwards, cream, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.5–0.9 cm long. Free tepal 3–3.3 × 2.6–2.8 cm, white or creamy white, partially opaque, ovate-oblong, apex highly corrugated with a prominent acumen, 0.6–0.9 cm long. Stamens 5, 4.6–5 cm long; filament 2.4–2.7 cm long, white or creamy white; anther 2.4–2.7 cm long, cream or light yellow with white thecae. Ovary rudiment, straight, 3–3.3 cm long, white or creamy white with light greenish tinge; style straight, inserted 4.8–5.3 cm long, white with reddish dots just below stigma; stigma yellow. Fruit bunch lax, with 5–8 hands and 8–10 fruits per hand, in two rows, fingers pedicelled; pedicel 3.7–4.3 cm long, no sign of fusion of pedicel. Fruits on mid hand 20–27 cm long, straight in the distal part, circumference 14–18 cm, pronouncedly ridged in cross section, apex lengthily pointed, with floral relicts, immature peel colour dark green, become brownish yellow with black marks at maturity; immature fruit pulp grayish white, becoming creamy yellow and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is extensively cultivated as a rain-fed crop especially in the Western Coasts of South India. It is one of the major economic crops in many rural areas.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 38 – see APPENDIX II).

Notes: It has been under cultivation on the Malabar Coast from time immemorial. It is largely grown as pure stand crop. It takes about 11 months to mature from the time of planting to the harvest stage. It is planted year after year from fresh suckers. This fruit is a major ingredient in various dishes in Malabar cuisine and is an essential element at the banquets of the Malayali population during their festivities. Ripe fruits are ordinarily consumed after steaming. Banana figs and halva made with ripe fruits are popular and delicious. The porridge made from ripened fruits form an integral part of Sadhya during Onam and other festive occasions. The unripe fruit is used for culinary purpose and serves as a side-dish for a meal of rice. Banana chips are another popular one and are made by frying the sliced fruits in coconut oil, which can be kept well for 2–3 months and are even exported to Baghdad in exchange for dates from that region. The flour obtained from the unripe banana is also utilized as food.

In addition to the normal cultivar some ecotypes were also identified. It includes *Chengalikodan* and *Moongil.*

***Chengalikodan*:** It is very rare but cultivated in some parts of Thrissur District of Kerala especially in Kechery and Kalparambu area. Very recently it got the rank of Geographical indication (GI) status from the Geographical Identification Registry, Chennai (under the Geographical Identification of Goods Act 1999). Since its cultivation was restricted to the Chengazhikode village of Thrissur, it got the name as Chengalikodan.

It is similar to cv. *Nendran* in all aspects except the characters of fruit bunch especially in visual appeal, quality and taste. It produces much heavier bunch of 7–10 hands which bear 20–25 fruits and which weigh up to one quintal. The hands are arranged in a cyclic manner with golden yellow colored fruits. The fruits are reported to have very tasty with 26–30 percent sugar, 0.31–0.6 percent acidity and a shelf life of 7–9 days.

Normally it is planted in the month of October and has a great demand during the festival season like Onam as it is often offered as '*Kazhchakula*' to the presiding deity at various temples including Guruvayur Sree Krishna Temple, across the state. There is no fixed rate for this banana and is determined by the visual appeal and quality.

***Moongil*:** It is another ecotype of Nendran restricted to some hilly areas of Kerala. It is also very peculiar in its fruit as it produces only one or rarely two hands with 3–7 fruits; but the length of fruit may go up 50–70 cm and has a characteristic curve. It is very rare and is cultivated by the tribal peoples. Since it has a special taste, in ancient times it was used to present to Kings. Since it produces only one hand, it is also called as *Ottamoongi.*

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Cherukulathoor (Cultivated), 12 September 2011, *Sreejith 123215* (CALI); Mundakkal (Cultivated), 03 May 2015, *Sreejith 123273* (CALI).

14. *Musa* × *paradisiaca* L. (AAB) 'Pachanadan' Fig. 19

Standard specimen: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123226* (CALI).

Musa sapidisiaca K.C.Jacob var. *pachanaadaniana* K.C.Jacob, Madras Bananas Monogr. pp. 85. 1952. ***syn. nov.***

Local names: (Kerala) *Cheruvannan, Erodan, Ethappadatti, Mannan, Padathi, Thekkan mannan, Thodan, Vannan, Vella paadan*; (Karnataka) *Belli baja, Cheena bale, Huli bale, Guli bale, Mara bale, Pacha bale, Kari bale, Bargi bale, Naga bale*; (Tamil Nadu) *Erode nadan, Kadali, Kaali, Kal kadali, Korangu laadan, Ladan, Ladda, Nadan, Nattu chingan, Pachanadan, Pachanala, Pacha vazhai*; (Andhra Pradesh) *Bengala, Chakkarakeli, Konda aratti, Malabar, Pacha aratti, Pacha ladan*.

Plants normal; suckers 4–6, close to parent plant, 6–15 cm away, vertical. Mature pseudostem 2.6–3.2 m high, 58–65 cm circumference at base, yellowish green with maroon pigmentation, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color greenish yellow with slight maroon pigmentation, shiny; sap watery. Leaf habit intermediate; lamina 175–240 × 75–80 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green; lower surface dull green, waxy; leaf bases symmetric, both rounded; midrib dorsally yellowish green, glaucous; ventrally dull green with slight yellowish tinge. Petiole 45–52 cm long, waxy, more waxy towards base; petiole canal margins wide with erect, margin green with gray tinge; petiole bases with blackish brown sparse blotches along the margins, not winged and clasping the pseudostem. Inflorescence horizontal become sub-horizontal or oblique at fruit maturity; peduncle 65–74 cm long, dark green with purplish maroon pigmentation, glabrous, glaucous. Sterile bracts 2, dorsally yellowish green with maroon margins, much more in the second one, glaucous; ventrally dark maroon with greenish yellow tinge towards margins and tip, slightly grooved with a little but not much developed green leafy appendage at the apex, deciduous. Female bud lanceolate, tip imbricate. Female bracts lanceolate, 31–39.5 × 18–20 cm, moderately grooved; abaxially maroon with greenish yellow patches, glaucous; adaxially reddish maroon with yellowish orange fading towards tip, shining; apex obtuse and sometimes split; lifting one bract at a time or rarely 2, reflexed and revolute before falling. Basal 7–8 bunches female. Female flowers 12–16 per bract in two rows, 11.7–14 cm long. Compound tepal 4–4.7 × 2–2.2 cm, creamy white with or without maroon pigmentation at base, ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes slightly longer than inner and curved back. Free tepal 2.7–3 × 2.4–2.6 cm, ovoid, cup-shaped, cream, apex corrugated with a broadly pointed acumen, 0.4–0.7 cm long. Staminodes 5, 2–2.7 cm long, white with yellowish green base and grayish white tip. Ovary 7–9.2 cm long, light yellowish green; ovules in 2 regular rows per locule; style 3.8–4.3 cm long, straight, inserted, white with maroon dots or pigmentation at the middle part; stigma globose, grayish yellow, sticky. Male bud intermediate to top-shaped, imbricate at apex; rachis falling vertically, dark green with blackish brown bract scars, 57–63 cm long at fruit maturity. Male bud sometimes aborted before fruit maturity. Male bracts intermediate to top-shaped, 15.3–20 × 10.8–13.1 cm, grooved, abaxially dark purplish maroon, glaucous; adaxially reddish maroon, shiny, no sign of colour fading, apex intermediate to slightly pointed; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 10–15 per bract in two rows, 5.3–6.5 cm long, normally fall with bract. Compound tepal 3.9–4.4 × 1.5–1.6 cm, apex curved backwards, cream with slight purplish maroon tinge, minutely ribbed at dorsal angles, lobes 5, yellow, outer and middle lobes much larger than inner, 0.5–0.8 cm long. Free tepal 2.2–2.7 × 1.5–1.8 cm, creamy white, translucent, oblong-ovate, boat-shaped; apex corrugated with prominent pointed acumen, 0.3–0.4 cm long. Stamens 5, 2.7–4.5 cm long; filament 1.3–2.5 cm long, white or creamy white; anther 1.5–2.3 cm long, mostly aborted, rudimentary and rusty brown or if developed, cream with grayish thecae, sterile. Ovary rudiment, straight, 1.4–1.8 cm long, cream with purplish maroon pigmentation; style straight, inserted 4–4.3 cm long, white with yellow stigma. Fruit bunch lax, with 7–8 hands and 12–16 fruits per hand, in two rows; fingers pedicelled, straight or slightly curved, erect or perpendicular to the peduncle; pedicel 1.5–2 cm long, no sign of fusion at base. Fruits on mid hand 11–15 cm long, circumference 12–16 cm, slightly ridged in cross section, apex pointed or lengthily pointed, with persistent style base, immature peel colour dark green, become yellow or greenish yellow, rarely with some black markings; immature fruit pulp white, becoming cream, not much juicy but very sweet at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is one of the commercial cultivar of Tamil Nadu especially in Coimbatore and Tiruchirappalli districts and is also cultivated in other states of South India. Even though the large size of the bunch and fruits along with the sweet taste made it popular among farmers. However, the erect nature of fruit and the shorter shelf-life become a barrier in transportation.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 39 – see APPENDIX II).

Notes: It takes around 15 months to mature from planting to harvest. It is a large plant with medium sized leaves and large bunch with big and easily falling fruits. The fruit is not so juicy but sweet and with a medium flavour. The major defect is the smaller shelf-life and so it fall off very easily.

Specimens Examined: INDIA. **Kerala:** Malappuram Dist., Panambra, Elampilasseri (Cultivated), 16 November 2012, *Sreejith & A. Joe 123237*; Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123237* (CALI).

15. ***Musa*** **× *paradisiaca* L. (AAB) 'Poovan'** **Fig. 20**

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Mundakkal (Cultivated), 13 October 2011, *Sreejith 123216* (CALI).

Musa sapidisiaca K.C.Jacob var. *poovaniana* K.C.Jacob, Madras Bananas Monogr. pp. 77. 1952. ***syn. nov.***

Local names: (Kerala) *Cheru kai, Mysore poovan, Palayangodan*; (Karnataka) *Cheena bale, Huli bale, Kari bale, Kari goddi, Mysoor kadali, Nanjangud bale, Othuasa bale, Vilayathi bale, Mysoor mitli, Mitli, Mituga chandan, Terabun*; (Tamil Nadu) *Adukku namarai, Dorai vazhai, Erode poovan, Kadali, Kallattu vazhai, Kari vazhai, Poovan, Poovazhai, Palichan kadali, Navarai, Pulippu kai, Mysore kadali, Kotta vazhai*; (Andhra Pradesh) *Ginni aratti, Bengala aratti, Karpurachakkarakeli, Rasthali, Salem chakkarakeli, Sugandam, Vasana chettu, Yerra aratti, Yerra sugandam*; (Maharashtra) *Lalvelchi, Champa, Mysore, Sour velchi*; (West Bengal) *Champa, Champa kela, Alpon*; (North-East) *Cheni champa, Champakol, Alpon, Ladiyachampa, Garomoina, Dasaman, Kawrmut, Lang bhal-al, Bai bhal-al-their, Heijao*; (Arabia) *Moz sobaoel sitt*; (Burma) *Nget pyaw chin*; (England) *Mysore banana, Champa banana*; (Indonesia) *Pisang kelung*; (Malaysia) *Pisang keling*; (Philippines) *Inagel*; (Srilanka) *Hondera wale*; (Thailand) *Kluai khai farang, Kluai kai farang, Kluai lanka*; (Vietnam) *Chouicom chua.*

Plants normal; suckers 3–8, close to parent plant, 6–17 cm away, vertical or slightly angled. Mature pseudostem 2.4–3.2 m high, 47–69 cm circumference at base, purplish maroon to yellowish green, with or without blackish patches, waxy, slightly glaucous towards apex, more glaucous on young plants; young plants dark maroon; underlying color yellowish green with some purplish blotches, shiny; sap watery. Leaf habit intermediate to drooping; lamina 176–230 × 68–85 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, dull; lower surface dull green, waxy; leaf bases asymmetric, both auriculated and rounded or in some cases the auriculation is restricted to one side; midrib dorsally green with some maroon tinge; ventrally maroon or green with maroon strands, glaucous. Petiole 45–73 cm long, waxy, more waxy towards base; petiole canal margins straight with erect or sometimes slightly curved inwards, purplish maroon; petiole bases with black large blotches, sometimes extended, not winged and clasping pseudostem. Inflorescence first sub-horizontal or oblique and become pendulous at fruit maturity; peduncle 45–55 cm long, dark green with or without maroon pigmentation, slightly pubescent. Sterile bracts 2, dorsally yellowish green with maroon fading, much more in second one; ventrally maroon, highly grooved with green leafy appendage at apex, deciduous. Female bud obovate-lanceolate, tip imbricate. Female bracts obovate-lanceolate, 25–36 × 15–24 cm, highly grooved, abaxially dark maroon with or without light yellow patches, glaucous; adaxially brownish maroon, with or without yellowish patches, no sign of colour fading towards base, dull, apex obtuse and sometimes split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 7–15 bunches female. Female flowers 12–19 per bract in two rows, 10–12.5 cm long. Compound tepal 3.9–4.9 × 1.9–2.5 cm, creamy white with maroon fleshy patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner. Free tepal 2.4–3 × 2–2.6 cm, ovate-obovate, cup-shaped, translucent cream or white, apex highly corrugated with truncate and broadly pointed acumen, 0.4–0.6 cm long. Staminodes 5, 1.4–2.2 cm long, white or creamy white with light green base. Ovary 7.4–9 cm long, straight, yellowish green; ovules in two regular rows per locule; style 3.4–4.2 cm long, straight, inserted, creamy white with maroon pigmentation; stigma globose, cream or grey, sticky. Male bud lanceolate to intermediate, apex convolute or minutely imbricate; rachis falling vertically, blackish brown, 64–76 cm long at fruit maturity. Male bracts lanceolate to intermediate, 15–20.5 × 9–12.5 cm, grooved, abaxially dark blackish maroon, glaucous; adaxially reddish maroon, no sign of colour fadings towards base, shiny; apex intermediate to obtuse, not split; lifting 1–2 bracts at a time, reflexed and revolute just before falling; bract scars prominent, male bud in advanced blooming top-shaped, convolute. Male flowers on average 13–18 per bract in two rows, 5.7–6.8 cm long, fall with bract. Compound tepal 4.8–5.2 × 1.1–1.5 cm, apex curved backwards, creamy white with or without maroon patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.5–0.7 cm long. Free tepal 2.1–2.7 × 1.4–1.9 cm, white or creamy white, translucent or opaque, lanceolate, boat-shaped; apex slightly corrugated with or without acumen, if present, less than 0.3 cm long. Stamens 5, 3.9–4.6 cm long; filament 1.6–2.5 cm long, white or creamy white; anther 1.9–2.5 cm long, creamy white with yellowish thecae or completely cream. Ovary rudiment, straight, 1.4–1.7 cm long, creamy white with or without a purplish fading; style curved at base, inserted, 4.5–5.2 cm long, creamy white with yellow stigma. Fruit bunch very compact, with 7–15 hands and 12–19 fruits per hand, in two rows, fingers pedicelled; pedicel 1.9–2.4 cm long, fused at base. Fruits on mid hand 9–13.5 cm long, straight or straight in the distal part, circumference 9–11 cm, slightly ridged in cross section; apex bottle-necked, without any floral relicts, immature peel colour dark green, become bright yellow at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is the commonest commercial variety cultivated throughout South India. It is hardy and thrives well up to an elevation of 5000 ft. The taste and flavour vary considerably with the treatment given and the altitude where it is grown. It is actually an introduced one to South India. This factor is clear from the various local names coming the places where from it was introduced, *viz. Bengala, Salem, Mysore, Palayamkodan* and other names.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 35 – see APPENDIX II).

Notes: It takes around 13 months to mature from planting to harvest. It is very tall and stout with large leaves and heavy bunch of fruits. Bunches with a maximum of 350 fruits are common. It has good keeping quality and so can be exported to other states. There is a great scope for this variety to be cultivated extensively for the purpose of international trade. The fruit has a tendency to become sub-acidic when grown under irrigation and this sub-acidic taste is liked by some Indians, especially Telugus. The unripe fruits are used for culinary purpose, especially in Kerala. The fruits produced under rain-fed condition (mainly in the slopes of the Nilgiris and the Palni hills and throughout the Malabar Coast) are free from sour taste and favor to foreigners. They are good for making 'banana figs'.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Cheruculathoor (Cultivated at CUBG), 30 January 2012, *Sreejith 123222* (CALI); Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123230* (CALI).

16. *Musa* × *paradisiaca* L. (AAB) 'Rasthali' Fig. 21

Standard Specimen: INDIA. **Kerala:** Kozhikode Dist., Mukkam (cultivated at Pantheerankavu) 03 October 2013, *Sreejith 123250* (CALI).

Musa sapidisiaca K.C.Jacob var. *champa* (Hort.) K.C.Jacob, Madras Bananas Monogr. pp. 72. 1952. ***syn. nov.***

Local names: (Kerala) *Anna poovan, Ari poovan, Nattu poovan, Nattu thuluvan, Poovan, Thuluvan*; (Tamil Nadu) *Karkandu vazhai, Kozhikodu, Nattu poovan, Ullur poovan, Tholluvan, Vellai tholluvan*; (Andhra Pradesh) *Amrithapani, Mokiri, Bengala Desi, Karpura chakkarakeli, Pallu, Pedda sugandan, Poo sugandhi, Sugantha, Thella Mokkiri*; (Gujarat) *Soniyal, Ambeli, Sakkal nagpur, Sakkar chayna*; (Maharashtra) *Mutheli, Silk fig, Apple banana*; (Odisha) *Patkapura, buttam, Pot kapura, Sonkel, Ellaichi, Jalakonda mokri, Kothia*; (North-East & W.B.) *Martman, Malbhog, Sabri, Digjowa, Amritman, Kulpait*; (Burma) *Htaw bat*; (England) *Silk banana, Apple banana,* *Sugar banana, Silk fig*; (France) *Figue pomme*; (Indonesia) *Pisang rajah sereh*; (Malaysia) *Pisang rastali, Pisang rajah sereh*; (Philippines) *Latundan*; (Portugal) *Banana de cuba, Banana maca*; (Srilanka) *Kolikkud*; (Thailand) *Kluai nam*; (Vietnam) *Chuoi goong.*

Plants normal; suckers 1–4, not much close to parent plant, 12–23 cm away, oblique. Mature pseudostem 1.7–2 m high, 45–63 cm circumference at base, green to yellowish green, with or without blackish patches, waxy, slightly glaucous towards apex, more glaucous on young plants, underlying color whitish green with some purplish blotches, shiny; sap watery. Leaf habit intermediate to drooping, lamina 156–240 × 42–68 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, dull; lower surface dull green, waxy; leaf bases asymmetric, one rounded and one pointed; midrib dorsally dull green, ventrally dull green with slight yellowish tinge, glaucous. Petiole 45–67 cm long, waxy, more waxy towards base, petiole canal margins straight with erect or sometimes slightly curved inwards, margins green with light maroon endings; petiole bases without blotches or with sparse blackish markings at the margins, margins not winged and clasping the pseudostem. Inflorescence sub-horizontal or oblique; peduncle 47–58 cm long at fruit maturity, dull green without any pigmentation, slightly pubescent. Sterile bracts 2, dorsally dark maroon with yellowish green patches, much more in second one, ventrally dark maroon with greenish yellow patches towards base, slightly grooved without much developed green leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip imbricate. Female bracts lanceolate, 28–38 × 13–18 cm, not much grooved, abaxially dark blackish maroon with or without yellowish green patches, glaucous; adaxially reddish maroon with yellowish patches towards margins, colour fades towards base, shining; apex obtuse and sometimes split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 5–8 bunches female. Female flowers 5–12 per bract in two rows, 7–10 cm long. Compound tepal 4.8–5.5 × 2.3–2.7 cm, creamy white with more yellowish lobes and with or without slight pinkish striations, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner. Free tepal 3.2–3.6 × 2.1–2.7 cm, oblong-lanceolate, boat-shaped, white or creamy white, apex highly corrugated with truncate acumen 0.7–0.9 cm long. Staminodes 5, 1.3–3.2 cm long, white or creamy white with light green base. Ovary 7.3–8.3 cm long, light yellowish green, ovules in 2 regular rows per locule; style 3.5–4.6 cm long, straight, inserted, white with red dots below stigma; stigma globose, cream or greyish yellow, sticky. Male bud lanceolate, apex highly imbricate; rachis falling vertically, bare, blackish brown, 75–85 cm long at fruit maturity. Male bracts lanceolate, 18–23 × 11.5–13.5 cm, grooved, abaxially dark maroon with black patches, glaucous, adaxially reddish maroon, shiny, colour slightly fades towards extreme base, apex slightly pointed, sometimes split; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 10–16 per bract in two rows, 7.2–8 cm long, fall with bract. Compound tepal 5.2–5.8 × 1.5–2 cm, apex curved backwards, creamy white with maroon patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.5–0.8 cm long. Free tepal 2.7–3.2 × 1.9–2.2 cm, white or creamy white, opaque, linear-lanceolate, boat-shaped, apex highly corrugated with prominent acumen, 0.3–0.4 cm long. Stamens 5, 4.3–5 cm long; filament 2–2.5 cm long, white or creamy white; anther 2.2–2.5 cm long, creamy white with brownish thecae or in some completely black and aborted. Ovary rudiment, straight, 2–2.3 cm long, white or creamy white without pigmentation; style straight, inserted 5–5.5 cm long, white with reddish dots just below stigma; stigma brownish yellow. Fruit bunch lax, with 5–8 hands, 5–12 fruits per hand, in two rows, fingers pedicelled; pedicel 1.3–2 cm long, fused at the base. Fruits on mid hand 9–15 cm long, straight or straight in the distal part, circumference 9–12.5 cm, rounded in cross section, apex blunt-shaped or slightly pointed, without floral relicts or sometimes with persistent style base, immature peel colour dark green, become bright yellow (without any marks) at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is the commonest commercial cultivar found in almost all states of India and also in other banana growing countries in the world such as Malaysia, Philippines, Burma, England, France, Thailand, etc. Since this plant has a very good root system, it can be grown even in places affected with stormy wind. Due to its wide range of cultivation, it has various local names.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 31 – see APPENDIX II).

Notes: It takes around 15–16 months to mature from planting to harvest. It has a very shining and sweet fruit and is considered as one of the most delicious of bananas throughout the world. Generally it is used as a fruit crop and the unripe fruits are also used for culinary purpose. Normally *Rasthali* produces medium bunch and fruit with very sweet taste but in the heavy manure condition, it produces large bunches with big fruits and may lose the natural taste and flavor.

Specimens Examined: INDIA. **Kerala:** Malappuram Dist., Calicut University Botanical Garden (Cultivated), 17 November 2011, *Sreejith & A. Joe 116103* (CALI); *ibid.,* 22 January 2012, *Sreejith 123223* (CALI). **Tamil Nadu:** Coimbatore, TNAU campus (Cultivated at NABI, Mohali, Punjab), 06 May 2013, *Siddharth Tiwari 123245* (CALI).

17. *Musa* × *paradisiaca* L. (AAB) 'Sirumalai' **Fig. 22**

Standard Specimen: INDIA. **Tamil Nadu:** Sirumalai, Puthur (Cultivated), 22 February 2014, *Sreejith & A. Kabeer123262* (CALI).

Musa sapidisiaca K.C.Jacob var. *vannaniana* K.C.Jacob eco-type *sirumalaiensis*, Madras Bananas Monogr. pp. 90. 1952. ***syn. nov.***

Local names: (Tamil Nadu) *Cheruvannan, Mala vazhai, Mala vazha pazham, Sirumalai, Sirumalai pazham, Udiran vazhai, Vannan, Vannan kali, Vella vazhai, Virupachi, Virupakshi.*

Plants normal; suckers 2–4, close to parent plant, 6–15 cm away, vertical. Mature pseudostem 2.7–3.2 m high, 45–55 cm circumference at base, yellowish green with slight purple tinge, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color whitish to yellowish green with slight maroon pigmentation, shiny; sap watery. Leaf habit intermediate to drooping; lamina 210–225 × 65–70 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface green; lower surface dull green, highly waxy; leaf bases asymmetric, both rounded and slightly auriculated; midrib dorsally green, ventrally dull green with slight yellowish tinge, glaucous. Petiole 45–51 cm long, waxy, more waxy towards base, petiole canal margins wide with erect, with pinkish purple margins; petiole bases with black blotches, not winged and clasping pseudostem. Inflorescence horizontal; peduncle 52–62 cm long at fruit maturity, dark green with black dots, glabrous, glaucous. Sterile bracts 2, dorsally dull maroon with greenish yellow patches, much less in second one; ventrally dark purplish maroon with greenish yellow patches towards margins, not much grooved with a little but not much developed green leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip imbricate. Female bracts obovate-lanceolate, 25–35 × 15–22 cm, slightly grooved, abaxially dark blackish maroon with greenish yellow patches and yellow tip, glaucous; adaxially reddish maroon with yellow tinge towards tip, no sign of colour fading towards base, shining, apex obtuse and split, lifting 1–2 bract at a time, reflexed and revolute before falling. Basal 5–7 bunches female. Female flowers 10–14 per bract in two rows, 11–13.5 cm long. Compound tepal 4.2–5.2 × 2–2.3 cm, creamy white with maroon tinge, ribbed at dorsal angles; lobes 5, yellow, outer lobes slightly longer than inner and with a hone-like projection 0.7–1 cm long, curved back. Free tepal 2.7–3.2 × 2–2.3 cm, ovate-obovate, cream, apex corrugated with a pointed acumen, 0.3–0.4 cm long. Staminodes 5, 2–3.3 cm long, white with yellowish green base and with or without purple patches at tip. Ovary 7.5–8.5 cm long, yellowish green with purplish violet pedicel, ovules in two regular rows per locule; style 3.9–4.2 cm long, straight, inserted, white or creamy white with purplish violet dots; stigma globose, grayish to cream, sticky. Male bud top-shaped, tip imbricate, almost aborted at fruit maturity but not completely; rachis falling vertically, dark green, 75–81 cm long at fruit maturity. Male bracts top-shaped, 17–20 × 12–15 cm, grooved; abaxially dark blackish maroon, glaucous, adaxially reddish maroon, shiny, no sign of colour fading, apex intermediate to obtuse, not split; lifting 2–3 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 12–14 per bract in two rows, 5.5–7.3 cm long, fall with bract. Compound tepal 4.5–5 × 1.5–1.9 cm, apex curved backwards, cream with purplish maroon patches, ribbed at dorsal angles, lobes 5, yellow, outer and middle lobes much longer than inner, 0.5–0.7 cm long. Free tepal 2.3–2.5 × 1.7–2 cm, white or cream, translucent, ovate, apex minutely corrugated with a prominent pointed acumen, 0.2–0.3 cm long. Stamens 5, 4–5.1 cm long; filament 1.7–3 cm long, white; anther 2–2.2 cm long, cream with brownish violet thecae, sometimes anthers black and aborted. Ovary rudiment, straight, 1.7–1.9 cm long, cream with purple fleshy pigmentation; style curved at base, inserted 4.1–4.5 cm long, creamy white with dull yellow stigma. Fruit bunch lax, with 5–7 hands and 10–14 fruits per hand, in two rows; fingers pedicelled; pedicel 1.5–2 cm long, no sign of fusion at base. Fruits on mid hand 9–11 cm long, straight, perpendicular to the axis, circumference 9–10 cm, pronouncedly ridged in cross section, apex lengthily pointed without any floral relicts. Immature peel colour dark green with black dots, become yellow with green tinge and some black markings at maturity, turns dark on overripe; immature fruit pulp white, becoming cream, soft and very sweet at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a very rare hill banana grows only in hilly areas of Tamil Nadu at an elevation of 1000 to 5000 ft. Now the cultivation is restricted to some hill villages of Dindigul district of Tamil Nadu such as Sirumalai, Thenkadu, Thavittukadai and Velanpannai. It is cultivated along with Coffee, Pepper also as a multi-tier system. The area of cultivation is reducing year by year due to high crop loss due to frequent diseases like bunchy top and stem borer.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 43 – see APPENDIX II).

Notes: It is similar to the cultivar *'Vannan'* and Jacob (1952) treated this as an ecotype under the variety *vannaniana* (= *Vannan*). It differs from *Vannan* with the characters of fruit like, high shelf life and also in the colour of the ripened fruits. It takes around 13–18 months to mature from planting to harvest. It is a medium to tall and stout plant with medium sized leaves and bunch with very small fruits. It is one of the hill crops in the Sirumalai regions of Tamil Nadu, thus earn the name "Sirumalai pazham". It is growing widely in this area and is believed to have some medicinal properties and thus always priced higher than all other bananas. Even though it is unique to state of Tamil Nadu and is known for their special flavour and long shelf life. It is highly susceptible to *Banana bunchy top virus* (BBTV) and Stem borer, which leads to high rate of reduction of cultivation from 18000 ha to 2000 ha within a period of 7–9 years. The production of exotic hill bananas, considered superior to the native cultivars in nutrition and taste along with the difficulties in marketing our native one by the intervening of middlemen, dwindling the production. The normal market rate may go up to 5–10 rupees per fruit.

18. *Musa* × *paradisiaca* L. (AAB) 'Vannan' **Fig. 23**

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Calicut University Botanical Garden (Cultivated), 16 March 2011, *Sreejith 123202* (CALI).

Musa sapidisiaca K.C.Jacob var. *vannaniana* K.C.Jacob, Madras Bananas Monogr. pp. 88. 1952. ***syn. nov.***

Local names: (Kerala) *Cheru vannan, Kaali, Kaalithodan, Monthan, Mundilapadan, Mundi vella paadan, Padalu, Valia thodan, Vannan, Vannan eradan, Vannan kali, Vellappadan*; (Karnataka) *Kaadu bale*; (Tamil Nadu) *Ethara vazhai, Ethana vazhai, Kaali vazhai, Katta kaali, Korangu naadan, Korangu pachalaadan, Kozhikkootu vazhai, Ladan, Mala vazhai, Mundi vellapaadan, Mundilapaadan, Padalu, Pacha ladan, Sirumalai cheru vannan, Thenkasi mala vazhai, Udiri, Valiathodan, Vannan, Vannan kaali*; (Andhra Pradesh) *Sugandham*; (Orissa) *Dacca martaban*; (Ceylon) *Embulhondarawala, Poo valai, Puvalu, Watupalu.*

Plants tall, suckers 3–7, close to parent plant, 8–17 cm away, vertical. Mature pseudostem 2.8–3.9 m high, 51–75 cm circumference at base, yellowish green with brown patches, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color whitish green with some pinkish blotches, shiny; sap milky white. Leaf habit erect to intermediate; lamina 180–230 × 55–77 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, lower surface dull green, waxy; leaf bases asymmetric, one rounded one pointed, midrib dorsally green, ventrally light green with or without slight pinkish pigmentation, glaucous. Petiole 45–73 cm long, waxy, more waxy towards base; petiole canal margins open with spreading, margins gray, with rare brownish black blotches, petiole bases not winged and clasping the pseudostem. Inflorescence sub-horizontal or oblique; peduncle 43–55 cm long at fruit maturity, dark green with or without black pigmentation, slightly pubescent. Sterile bracts 2, dorsally whitish green with maroon fading, much more in the second one, ventrally maroon with green patches, highly grooved with green leafy appendage at the apex, deciduous. Female bud obovate-lanceolate, imbricate at the tip. Female bracts obovate-lanceolate, 27–35 × 19–24 cm, moderately grooved; abaxially dark maroon, glaucous; adaxially maroon, without yellow patches, no sign of colour fading, shiny, apex intermediate to obtuse, not split, lifting 1–2 bracts at a time, reflexed and revolute before falling. Basal 7–10 bunches female. Female flowers 8–15 per bract in two rows, 13–15 cm long. Compound tepal 4–4.9 × 1.9–2.2 cm, creamy white with slight maroon patches, ribbed at dorsal angles, lobes 5, yellow, outer lobes much longer than inner. Free tepal 2.4–2.8 × 1.9–2.2 cm, oblanceolate, cup-shaped, translucent white, apex highly corrugated and truncate with a broadly pointed acumen, 0.3–0.5 cm long. Staminodes 5, 2.1–2.5 cm long, white or creamy white with light green base. Ovary 8–9.5 cm long, straight or sometimes twisted, yellowish green, ovules in 2 regular rows per locule; style 4–5 cm long, straight, inserted, white with purple pigmentation; stigma globose, yellow, sticky. Male bud top-shaped to intermediate, apex slightly imbricate; rachis falling vertically, bare, blackish brown, 61–75 cm long at fruit maturity. Male bracts intermediate to obovate, 16–20 × 10–13 cm, grooved; abaxially dark maroon, glaucous; adaxially reddish maroon, shiny, colour fades towards base, apex intermediate to obtuse, not split; lifting 1–2 bracts at a time, reflexed and revolute before falling; bract scars prominent. Male flowers on average 15–18 per bract in two rows, 5.5–7.2 cm long, fall with bract. Compound tepal 4.7–5.2 × 1.1–1.5 cm, apex curved backwards, cream without any patches, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.5–0.7 cm long. Free tepal 2.5–3 × 1.8–2.1 cm, ovate, white with light yellow base, partially opaque, apex slightly corrugated with a pointed acumen; acumen 0.3–0.4 cm long,. Stamens 5, 4.5–4.9 cm long; filament 2.5–2.8 cm long, white with cream base; anther 2–2.3 cm long, creamy white with yellowish brown thecae. Ovary rudiment, straight, 1.7–2.1 cm long, creamy white with purplish fading towards tip; style straight, inserted, 4.3–4.7 cm long, creamy white with yellow stigma. Fruit bunch compact, with 7–10 hands and 8–15 fruits per hand, in two regular rows, fingers pedicelled; pedicel 2.3–3.5 cm long, fused at base. Fruits on mid hand 12–15 cm long, straight or straight in the distal part, perpendicular to the axis, circumference 10–14 cm, pronouncedly ridged, apex bottle-necked, without any floral relicts, immature peel dark green, become greenish yellow at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is found as stray cultivation in Tamil Nadu and Kerala. The taste, flavour and the keeping quality of the fruit varies with the altitude. Even though the fruits are very sweet and tasty, normally it has no commercial importance due to its short shelf life and the difficulties in the transportation due to the erect nature of fruit.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 33 – see APPENDIX II).

Notes: It takes around 13–14 months to mature from planting to harvest. It is a tall and stout cultivar with large leaves and medium bunch with 70–90 fruits. It has a very bad keeping quality and fall off easily. The ripened fruit is sweet and tasty and the unripe fruits are also used for culinary purpose.

Specimens Examined: INDIA. **Kerala:** Malappuram Dist., Calicut University Botanical Garden (Cultivated), 24 June 2011, *Sreejith 123204* (CALI).

19. *Musa* × *paradisiaca* L. (AAB) ‘Virupakshi’ Fig. 24

Standard Specimen: INDIA. **Tamil Nadu:** Palani Hills, Pachalur (Cultivated), 24 February 2014, *Sreejith & A. Kabeer123264* (CALI).

Musa sapidisiaca K.C.Jacob var. *vannaniana* K.C.Jacob eco-type *virupakshiensis*, Madras Bananas Monogr. pp. 89. 1952. ***syn. nov.***

Local names: (Tamil Nadu) *Cheru vannan, Ethara vazhai, Kaali vazhai, Kaali thodan, Kattu kali, Korangu nadan, Korangu pachaladan, Kozhikottu vazhai, Ladan, Malai kali, Malai vazhai, Mundila paadan, Mundi vellapaadan, Pachaladan, Padalu, Tenkasi malavazhai, Sirumalai, Udiran vazhai, Vannan, Vella vazhai, Valiathodan, Virupachi, Virupakshi.*

Plants normal, suckers 2–4, close to parent plant, 6–18 cm away, vertical. Mature pseudostem 2.5–2.7 m high, 42–54 cm circumference at base, greenish yellow with slight purplish maroon tinge, waxy, slightly glaucous towards apex, more glaucous on young plants; underlying color greenish yellow with slight maroon pigmentation, shiny; sap watery. Leaf habit intermediate to drooping; lamina 180–190 × 55–60 cm, linear-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green; lower surface dull green, highly waxy; leaf bases symmetric, both rounded and slightly auriculated; midrib whitish dorsally green with slight yellow tinge, ventrally greenish yellow, glaucous. Petiole 47–51 cm long, waxy, more waxy towards base; petiole canal margins wide with erect, with pinkish purple margins; petiole bases with sparse blackish brown blotches, not winged and clasping pseudostem. Inflorescence horizontal, peduncle 34–45 cm long, green with slight yellow tinge and black dots at fruit maturity, glabrous, glaucous. Sterile bracts 2, dorsally dull maroon with yellowish tinge, much less in second one, ventrally maroon with slight yellow fading, not much grooved with a little but not much developed green leafy appendage at apex, deciduous. Female bud linear-lanceolate, tip imbricate. Female bracts obovate-lanceolate, 25–33 × 13–18 cm, slightly grooved, abaxially purplish maroon with greenish yellow patches, glaucous; adaxially orange red with greenish yellow tinge towards tip, no sign of colour fading towards base, shining, apex obtuse and split, lifting 1–2 bract at a time, reflexed and revolute before falling. Basal 5–9 bunches female. Female flowers 8–12 per bract in two rows, 10.4–11.7 cm long. Compound tepal 3.8–4.2 × 1.8–2.3 cm, cream with purplish maroon fleshy tinge at the base which fades towards tip, ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes slightly longer than inner, 0.5–0.8 cm long, curved back. Free tepal 2.7–2.9 × 2–2.3 cm, ovate-obovate, cream, apex corrugated with a pointed acumen, 0.3–0.4 cm long. Staminodes 5, sub-equal, 2.2–2.6 cm long, cream with white tip and yellowish green base. Ovary 7–7.8 cm long, green with yellow fading and purplish maroon colour at pedicel, ovules in 2 regular rows per locule; style 3.8–4 cm long, straight, exserted, purplish violet; stigma globose, grayish to cream, sticky. Male bud intermediate to top-shaped, tip imbricate, almost aborted at fruit maturity but not completely; rachis falling vertically, bare, dark green, 55–65 cm long at fruit maturity. Male bracts lanceolate to intermediate, 17–20 × 11–13 cm, grooved, abaxially purplish maroon, glaucous; adaxially reddish maroon, shiny, no sign of colour fading, apex intermediate to obtuse, not split; lifting 2–3 bracts at a time, reflexed and revoluted before falling; bract scars prominent. Male flowers on average 12–14 per bract in two rows, 5.9–6.7 cm long, fall with bract. Compound tepal 4.3–4.6 × 1.4–1.7 cm, apex curved backwards, cream with purple fleshy coloration, ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes much longer than the inner, 0.5–0.8 cm long. Free tepal 2.3–2.6 × 1.9–2 cm, white or cream, translucent, obovate, apex highly corrugated with a prominent tapering acumen, 0.2–0.3 cm long. Stamens 5, 3.8–4.2 cm long; filament 1.8–2.1 cm long, cream; anther 2–2.2 cm long, cream with brown thecae. Ovary rudiment, straight, 1.9–2.1 cm long, cream with purplish maroon fleshy coloration; style straight, inserted 4.1–4.4 cm long, cream with purple dots and yellow stigma. Fruit bunch lax, with 5–9 hands and 8–14 fruits per hand, in two rows; fingers pedicelled; pedicel 1.3–2 cm long. Fruits on mid hand 8–11 cm long, straight, perpendicular to axis, circumference 9–12.5 cm, pronouncedly ridged in cross section, apex lengthily pointed with persistent style base. Immature peel colour dark green with black dots, become yellow with slight green tinge and some black markings at maturity and turns dark on overripe; immature fruit pulp white, becoming cream soft and very sweet at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a very rare hill banana grows only in hilly areas of Tamil Nadu at an elevation of 2000 to 5000 ft. The cultivation is restricted to lower Palni, Sirumalai and Kolli hills of Tamil Nadu. Like *Sirumalai*, it is also cultivated along with Coffee, Pepper as a multitier system. The area of cultivation is reducing year by year due to high crop loss due to frequent diseases like bunchy top and stem borer.

Cytology: Triploid (AAB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 36 – see APPENDIX II)

Notes: It is similar to the cultivars ‘Vannan’ and ‘Sirumalai’. Jacob (1952) treated this as an ecotype under the variety *vannaniana* (= *Vannan*). It differs from *Vannan* in the fruit characters such as the colour of the ripe fruits yellow with a green tinge and the high shelf life of fruits. It takes around 13–18 months to mature from planting to harvest. It is a medium to tall and stout plant with medium sized leaves and bunch with very small fruits. It is one of the hill crops in the Palani regions of Tamil Nadu, and is one of the major ingredients of *Panchamritham*. It is growing widely in this area and due to the high natural preservative quality of the dry pulp, this *prasadam* can be retained for a year. Even though it is unique to state of Tamil Nadu and is known for their special flavour and long shelf life, it is highly susceptible to *Banana bunchy top virus* (BBTV) and Stem borer, which leads to high rate of reduction of cultivation.

In order to preserve these hill banana cultivars and also to preserve the interest of the farmers, an organization named ‘Tamil Nadu Hill Banana Growers Federation’ has been formed. The major objective is the maintenance of a disease free banana gardens and the major achievement of this federation is the obtaining Geographical Indication registration for both the Virupakshi and Sirumalai hill banana cultivars.

20. ***Musa* × *paradisiaca* L. (ABB) 'Kachkol'** **Fig. 25**

Standard Specimen: INDIA. **Tamil Nadu:** Kolli Hills, Koochakarai Paatty (Cultivated), 01 January 2014, *Sreejith & A. Kabeer 123254* (CALI).

Local names: (Tamil Nadu) *Monthan vazai, Monthan*; (Kerala) *Mondan vazha, Mondan*; (NE) *Kachkol, Kacha kol, Kacha kela.*

Tall and robust plants with suckers 4–8, close to parent plant, 7–20 cm away, oblique. Mature pseudostem 3–3.3 m high, 48–55 cm circumference at base, yellowish green covered with grayish yellow dried sheaths, waxy, glaucous, more glaucous on young plants; underlying color light yellowish green with very light maroon pigmentation, shiny; sap watery. Leaf habit drooping; lamina 170–185 × 50–60 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, shiny; lower surface dull green, waxy, glaucous; leaf bases symmetric, both rounded and slightly auriculated; midrib dorsally green, shiny; ventrally yellowish green and glaucous. Petiole 52–58 cm long, waxy, more waxy towards base; petiole canal margins whitish green, overlapping; petiole bases not winged and clasping pseudostem, without prominent blotches. Inflorescence pendulous; peduncle long, 60–83 cm long, light green, glaucous, glabrous with long internodes. Sterile bracts 2, dorsally yellowish green with maroon fading towards margins, much more in second one; ventrally dark maroon with yellowish green tip, slightly grooved with green leafy appendage at apex, deciduous. Female bud lanceolate, tip imbricate. Female bracts intermediate to lanceolate, 26–35 × 15–21 cm, minutely grooved, abaxially maroon with greenish yellow patches towards tip, glaucous; adaxially dark reddish maroon with yellowish green patches towards tip, shining, no sign of colour fading towards base; apex obtuse and split; lifting 1–2 bracts at a time, reflexed and sometimes revolute just before falling. Basal 5–11 bunches female. Female flowers 9–13 per bract in two rows, 10–14.8 cm long. Compound tepal 4.2–5.1 × 1.9–2.7 cm, cream with pinkish maroon tinge, maroon fleshy coloration at ventral side, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner with a horn like appendage and middle one is much broader than others. Free tepal 3.1–4 × 2.2–3.4 cm, ovate-obovate, cup-shaped, partially opaque, cream with purplish maroon pigmentation, apex highly corrugated with a prominent acumen, 0.4–0.6 cm long. Staminodes 5, unequal, 2–3.6 cm long, cream with white tip. Ovary 8.3–11 cm long, straight, pale yellowish green with purplish maroon patches at tip; ovules in 4 regular rows per locule; style 3.4–3.9 cm long, straight, exserted, white or creamy white with or without purple tinge; stigma globose, grey or cream, sticky. Male bud lanceolate to top-shaped, tip highly imbricate; rachis falling vertically, bare, dark green, 53–67 cm long at fruit maturity. Male bracts obovate-oblong to intermediate, 13.6–22 × 9–15.8 cm, minutely grooved; abaxially purplish maroon, glaucous; adaxially reddish maroon with or without yellow colour at extreme tip, no sign of colour fading towards tip, shiny; apex intermediate, not split; lifting 1–2 bracts at a time, revolute just before falling; bract scars prominent; male bud in advanced blooming top-shaped, imbricate. Male flowers on average 14–20 per bract in two rows, 5.5–8.3 cm long, fall with the bract. Compound tepal 4.3–5.6 × 1.1–1.5 cm, apex curved backwards, purplish violet with cream margins, minutely ribbed; lobes 5, yellow, outer and middle lobes much longer than inner, 0.3–0.4 cm long. Free tepal 2.5–3.3 × 1.7–3 cm, obovate, opaque, purplish violet with cream base and tip, boat-shaped, apex minutely corrugated with a small acumen, 0.2–0.4 cm long. Stamens 5, 3.9–5.2 cm long; filament 1.9–2.6 cm long, creamy white with purplish maroon towards upper part; anther 2–2.7 cm long, cream with creamy white thecae. Ovary rudiment, straight, 1.6–2.7 cm long, cream with a purplish pigmentation; style straight, inserted, 4–5.3 cm long, white or creamy white with or without maroon fading and dull yellow stigma. Fruit bunch lax, with 5–11 hands and 9–13 fruits per mid hand, in two rows, fingers pedicelled, 3–4 cm long, no sign of fusion at the base. Fruits on mid hand 14–19 cm long, straight in the distal part, negatively geotropic, circumference 15.5–21 cm, pronouncedly ridged; apex blunt-tipped or rounded, with persistent floral relicts, immature peel colour dark green, become yellow or golden yellow with brown blotches and brownish black coloration at the tip; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a very rare cultivar of South India, only found in stray cultivation in some parts of Tamil Nadu and in some parts of Kerala, but it is a very common cultivar in north and north-east India. It is mainly used for the culinary purposes and normally not consumed in raw form or as ripened fruit.

Cytology: Triploid (ABB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 64 – see APPENDIX II).

Notes: It takes around 14–15 months to mature from planting to harvest. The fruit is large and shows some similarity with *Nendran* but is highly peculiar with a rounded and brownish apex. The rind is very thick and is used for culinary purposes. Its name 'Kachkol' (Kacha = green & Kol = banana) due to its usage as green vegetables in North-Eastern states, where it is largely grown.

Specimens Examined: INDIA. **Arunachal Pradesh:** Chimpoo (Cultivated), 01 January 2014, *Sreejith & A. Joe 116109* (CALI); **Kerala:** Malappuram Dist., Chenakkal (Cultivated), 06 March 2013, *Sreejith & A. Joe 123239* (CALI); **Tripura:** Mohanpur (Cultivated), 01 January 2014, *Sreejith & A. Joe 116167* (CALI); **Chhattisgarh:** Bhilai (Cultivated), 01 January 2014, *Sreejith & A. Joe 130756* (CALI).

21. *Musa* × *paradisiaca* L. (ABB) 'Karpuravalli' **Fig. 26**

Standard Specimen: INDIA. **Kerala:** Malappuram Dist., Panambra, Elampilasseri (Cultivated), 16 November 2012, *Sreejith & A. Joe 123235* (CALI).

Musa sapidisiaca K.C.Jacob var. *venneettukunnaniana* K.C.Jacob, Madras Bananas Monogr. pp. 113. 1952. ***syn. nov.***

Local names: (Kerala) *Chara Kaali, Charappadatti, Karpuravalli, Kudumbavazha, Vellapalayankodan, Venneettu Kunnan, Vennettu Mannan, Venneettu Vannan, Venner Kunnan*; (Karnataka) *Banria, Baku Plata, Boothi Bale, Boothi Javari, Govakkai, Kostha Bontha, Manohar, Poombidiyan, Sakara Bale, Shahil Baig, Burkel*; (Tamil Nadu) *Ashy Ney Mannan, Karpura Vazhai, Karpuravalli, Kudumbavazhai, Navaral, Nellore Amrithapani, Pannai Vazhai, Peyan, Peykunnan, Poombidiyan, Rajavazhai, Samba Vazhai, Sambrani Vazhai, Thean Vazhai*; (Andhra Pradesh) *Batheesa Arati, Bharatha Ratnavali, Boodithi, Bukkisa Arati, Kostha Bontha, Nellore Arithapani*; (Bihar) *Kanthali*; (Gujarat) *Calanaul*; (Odisha) *Baku Plata*; (West Bengal) *Chinia*; (North East) *Bangla Kola Geda, Banria, Gera, Deshikadali, Manohar, Manuva Kola, Sail Kola, Shalil Kela*; (Burma) *Yak Hine*; (England) *Thai Cooking Banana*, *Ducgsse Banana*; (Malaysia) *Pisang Awak, Pisang Siem, Pisang Klotok*; (Philippines) *Katali*; (Thailand) *Kluai Nam Wa*.

Plants tall and stout, suckers 3–7, close to parent plant, 6–19 cm away, vertical or slightly angled. Mature pseudostem 2.5–3.2 m high, 46–59 cm circumference at the base, yellowish green, without pigmentation, waxy, glaucous, more glaucous on young plants; underlying color light green, shiny; sap watery. Leaf habit intermediate to drooping; lamina 176–190 × 60–70 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, shiny, lower surface whitish green, waxy, glaucous; leaf bases asymmetric, both auriculated and rounded or in some cases the auriculation is restricted to one side; midrib both sides yellowish green, glaucous. Petiole 42–55 cm long, waxy, more waxy towards base; petiole canal margins overlapping; petiole bases without prominent blotches, not winged and clasping the pseudostem. Inflorescence pendulous; peduncle very long, 60–90 cm long at fruit maturity, light green glaucous, pubescent with long internodes, *c.* 27 cm. Sterile bracts 2, dorsally pink with greenish yellow fading, much more in the second one; ventrally dark maroon, highly grooved with green leafy appendage at the apex, deciduous. Female bud obovate-lanceolate, highly imbricate at the tip. Female bracts ovate-obovate, 20–28 × 14–19 cm, highly grooved; abaxially purplish maroon with greenish yellow patches, glaucous; adaxially reddish maroon, shining, no sign of colour fading towards base; apex obtuse and sometimes split, lifting 1–2 bracts at a time, reflexed and sometimes revolute just before falling. Basal 5–9 bunches female. Female flowers 10–18 per bract in two rows, 9–13 cm long. Compound tepal 3.6–4.3 × 1.7–2.3 cm, cream with pinkish maroon flesh, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner and the outermost lobes have a horn-like appendage. Free tepal 2.8–3.3 × 2.5–3 cm, ovate-obovate, cup-shaped, translucent cream or white with purplish maroon pigmentation, apex highly corrugated and truncate with a broadly pointed acumen, 0.3–0.4 cm long. Staminodes 5, 1.3–2.3 cm long, white or creamy white with light green base. Ovary 7.1–9 cm long, straight, yellowish green with purple patches at the tip, ovules in 4 regular rows per locule; style 3.3–4 cm long, straight, exserted, white or rarely creamy white without any pigmentation; stigma globose, grey or cream, sticky. Male bud lanceolate to intermediate, highly imbricate at apex; rachis falling vertically, bare, blackish brown, 60–105 cm at fruit maturity. Male bracts obovate-oblong to intermediate, 17–22.3 × 12.4–15.2 cm, not grooved; abaxially purplish maroon with yellowish green patches and yellow tip, highly glaucous; adaxially reddish maroon with yellow tip, shiny, apex obtuse, not split; lifting 1–2 bracts at a time, revolute just before falling; bract scars prominent, male bud in advanced blooming obovate, imbricate. Male flowers on average 18–20 per bract in two rows, 6.3–7.1 cm long, fall with the bract.

Compound tepal 4.5–5.4 × 1.1–1.9 cm, apex curved backwards, cream with purplish maroon pigmentation and yellow tip, slightly ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.4–0.6 cm long. Free tepal 3–3.6 × 2–2.6 cm, obovate, boat-shaped, translucent white with purplish maroon pigmentation, apex slightly corrugated with a small acumen, 0.2–0.3 cm long. Stamens 5, 4–4.7 cm long; filament 1.6–2.1 cm long, white with some maroon tinge; anther 2.2–2.9 cm long, cream with whitish thecae. Ovary rudiment, straight, 1.8–2 cm long, cream with a purplish fading; style straight, inserted, 4.3–4.8 cm long, white with creamy white or dull yellow stigma. Fruit bunch lax, with 5–9 hands and 10–18 fruits per hand in two rows; fingers pedicelled; pedicel 2.8–3.2 cm long, fused at base. Fruits on mid hand 11–14.5 cm long, negatively geotropic, straight in the distal part, circumference 13–15 cm, pronouncedly ridged, apex pointed or bottle-necked, with persistent floral relicts, immature peel colour dull green, glaucous, with or without markings, become greenish yellow with or without rusty black at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a common cultivar in Tamil Nadu and some part of Kerala especially in the Palakkad area and also in stray cultivation.

Cytology: Triploid (ABB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 59 – see APPENDIX II).

Notes: It is a medium to very high, stout plants with heavy bunches of fruit with conspicuous ashy coating. It takes about 14 to 15 months to mature from the planting to harvest. The fruits are used both for the culinary as well as ripened fruit. It has good keeping quality and stands transport well. The plant is highly susceptible to wind and cannot be cultivated in high wind circulating areas.

National Research Centre for Banana (NRCB) develops a hybrid cultivar from *Karpuravalli* and named as '*Udayam'*. It is much robust in nature and which can withstand strong winds. It is also tolerant to low temperature and produces big bunches of about 18 hands and 17–18 fingers per hand, which may weigh up to 37–45 kg. It only takes about 13–14 months to mature from planting to harvest and has a greater shelf life of 12–15 days after harvest. But it also susceptible to *Fusarium* wilts.

Specimens Examined: INDIA. **Kerala:** Kozhikode Dist., Near Railway Station, 26 January 2012, *Sreejith 123221* (CALI); **Tamil Nadu:** Coimbatore, TNAU campus (Cultivated at NABI, Mohali, Punjab), 06 May 2013, *Siddharth Tiwari 123242* (CALI); Kolli Hills, Koochakarai Paatty (Cultivated), 01 January 2014, *Sreejith & A. Kabeer123256* (CALI); Sirumalai, Tenmalai (Cultivated), 22 February 2014, *Sreejith & A. Kabeer123261* (CALI).

22. *Musa* × *paradisiaca* L. (ABB) 'Kuribontha' Fig. 27

Standard Specimen: INDIA. **Andhra Pradesh:** Araku, Jangarguda Village, (Cultivated), 14 January 2013, *Sreejith & A. Joe 123206* (CALI).

Musa sapidisiaca K.C.Jacob var. *kuribonthana* K.C.Jacob, Madras Bananas Monogr. pp. 125. 1952. ***syn. nov.***

Local names: (Tamil Nadu) *Katha bontha, Pidi bontha, Pidimonthan*; (Andhra Pradesh) *Kuribontha.*

Medium sized plants with suckers 3–6, away from parent plant, 13–25 cm away, slightly angled. Mature pseudostem 2–3.2 m high, 44–53 cm circumference at base, yellowish green, without pigmentation, waxy, glaucous, more glaucous on young plants, underlying color light green, shiny; sap watery. Leaf habit intermediate to drooping; lamina 172–190 × 60–72 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young, upper surface dark green, shiny, lower surface dull green, waxy, glaucous; leaf bases symmetric, both auriculated and rounded; midrib both sides greenish yellow with slight pink coloration, ventrally glaucous. Petiole 44–60 cm long, waxy, more waxy towards base; petiole canal margins pink purple, overlapping; petiole bases not winged and clasping pseudostem, no prominent blotches. Inflorescence sub-horizontal or oblique, peduncle very short, 34–50 cm long, dark green glaucous, glabrous with short internodes. Sterile bracts 2, dorsally pink with greenish yellow fading, much more in second one, ventrally dark maroon, highly grooved with green leafy appendage at apex, deciduous. Female bud obovate-lanceolate, tip highly imbricate. Female bracts obovate-lanceolate, 24–27 × 15–17 cm, moderately grooved, abaxially purplish maroon with greenish yellow patches towards tip, glaucous; adaxially dark reddish maroon with yellowish green tip, shining, no sign of colour fading towards base, apex obtuse and split; lifting 1–2 bracts at a time, reflexed and sometimes revolute just before falling. Basal 4–8 bunches female. Female flowers 6–12 per bract in two rows, 9.5–12 cm long. Compound tepal 3.5–3.7 × 2.2–2.5 cm, cream with pinkish maroon fleshy coloration at inner side, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner. Free tepal 3.1–3.3 × 2.8–3 cm, ovate-obovate, cup-shaped, partially opaque, cream or white with purplish maroon pigmentation, apex highly corrugated with a broad acumen, 0.2–0.3 cm long. Staminodes 5, unequal, 1.5–2.3 cm long, white with light green base. Ovary 7.5–8.4 cm long, straight, pale yellowish green with purplish maroon patches at pedicel and tip; ovules in 4 regular rows per locule; style 3.2–3.5 cm long, straight, exserted, white without any pigmentation; stigma globose, grey or cream, sticky. Male bud intermediate to top-shaped, tip highly imbricate; rachis falling vertically, bare, blackish brown, 55–65 cm long at fruit maturity. Male bracts obovate-oblong to intermediate, 16.3–17.5 × 11.4–12.2 cm, moderately grooved; abaxially dark brownish maroon without pigmentation, highly glaucous; adaxially reddish maroon with yellow colour at extreme tip, shiny, no sign of colour fadings towards base; apex obtuse, not split; lifting 1–2 bracts at a time, revolute just before falling; bract scars prominent; male bud in advanced blooming top-shaped, imbricate. Male flowers on average 16–18 per bract in two rows, 5.7–6.3 cm long, fall with bract. Compound tepal 4.2–4.6 × 1.1–1.3 cm, apex curved backwards, purplish violet with cream margins, not ribbed; lobes 5, yellow, outer and middle lobes much longer than inner, 0.3–0.4 cm long. Free tepal 2–2.3 × 1.8–2 cm, oblong-ovate, opaque, purplish violet with cream base and tip, boat-shaped, apex minutely corrugated with a broadly truncate acumen, 0.2–0.4 cm long. Stamens 5, 4–4.4 cm long; filament 1.8–2.1 cm long, cream with purplish maroon towards tip; anther 1.8–2.2 cm long, cream with creamy white thecae. Ovary rudiment, straight, 1.5–1.8 cm long, cream with purplish violet pigmentation; style straight, inserted, 4–4.3 cm long, white with creamy white or dull yellow stigma. Fruit bunch lax, with 5–8 hands and 10–12 fruits per mid hand, in two rows, fingers pedicelled; pedicel 2.3–3.2 cm long. Fruits on mid hand 8–14 cm long, straight, negatively geotropic, circumference 12–14 cm, pronouncedly ridged, apex pointed, with persistent floral relicts, immature peel colour dark green, become yellow with brownish red lines on ripening; immature fruit pulp white, remains white and become soft even ripening. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a very rare cultivar only found in stray cultivation in some parts of Andhra and Tamil Nadu and is not grown as pure stand anywhere. The unripe fruits are used mainly for culinary purpose and the ripe fruits may occasionally be consumed in the places where they are grown.

Cytology: Triploid (ABB) – $2n = 3x = 33$ (Morpho-taxonomic scoring = 64 – see APPENDIX II).

Notes: It takes around 15–16 months to mature from planting to harvest. It shows some similarity with ‘Monthan’ but differs in the small size of fruit and much lax nature of hands. Since it is highly attached to the pedicel even after ripening it can be transported easily. The fruit peel/ rind is very thick and is also used for culinary purposes.

23. *Musa* × *paradisiaca* L. (ABB) 'Monthan' **Fig. 28**

Standard Specimen: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated), 17 May 2011, *Sreejith 123224* (CALI).

Musa sapidisiaca K.C.Jacob var. *monthaniana* K.C.Jacob, Madras Bananas Monogr. pp. 144. 1952. ***syn. nov.***

Local names: (Kerala) *Chetti kai, Erachi vazha, Kuppakaali, Malavannan, Ponnan, Ponthan, Sodari, Thenali, Thezhuthani*; (Karnataka) *Akku bale, Aunda bale, Banga bale, Budhu bale, Deva bale, Kalyana bale, Kari bale, Kilandi, Konga bale, Manga bale, Mara bale, Mathuranga bale, Shan bale, Silanti*; (Tamil Nadu) *Erode bonthan, Erode monthan, Erode vazhai, Kondai monthan, Kondaikai, Maanaathu monthan, Malai monthan, Monthan vazhai, Naathangi monthan, Nattu monthan, Nielh bontha, Nirbontha, Thoppul vazhai, Yendra monthan, Yenthala monthan, Thrichirapalli monthan, Trichynopoly monthan*; (Andhra Pradesh) *Basthi bontha, Muchika bontha, Yenugu bontha, Yenugu monthan*; (Maharashtra & Odisha) *Bainsa, Bankel, Bankela, Bhaingu, Bhainsa kela, Kachkela, Kanchikela*; (North East) *Dakshinsagar, Kachkel, Kashkel, Sabjikela, There haw*; (Malaysia) *Pisang nangka*; (Philippines) *Madhuranga*; (Thailand) *Kluai Nom Mi*; (Vietnam) *Chuoi Ngop Cau.*

Plants normal; suckers 3–7, not much close to parent plant, 12–21 cm away, vertical or slightly angled. Mature pseudostem 2.5–3.1 m high, 46–55 cm circumference at base; yellowish green, without pigmentation, waxy, glaucous, more glaucous on young plants; underlying color light green, shiny; sap watery. Leaf habit intermediate to drooping; lamina 176–190 × 60–70 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, shiny; lower surface whitish green, waxy, glaucous; leaf bases asymmetric, both auriculated and rounded or in some cases auriculation is restricted to one side; midrib both sides yellowish green, glaucous. Petiole 42–55 cm long, waxy, more waxy towards base; petiole canal margins grayish, overlapping; petiole bases without prominent blotches, not winged and clasping the pseudostem. Inflorescence pendulous; peduncle long, 65–75 cm long at fruit maturity, light green glaucous, pubescent with long internodes, *c.* 27 cm long. Sterile bracts 2, dorsally pink with greenish yellow fading, much more in second one; ventrally dark maroon, highly grooved with green leafy appendage at apex, deciduous. Female bud obovate-lanceolate, tip highly imbricate. Female bracts ovate-obovate, 20–28 × 14–19 cm, highly grooved, abaxially purplish maroon with greenish yellow patches, glaucous; adaxially reddish maroon, shining, no sign of colour fading towards base, apex obtuse and sometimes split; lifting 1–2 bracts at a time, reflexed and sometimes revolute just before falling. Basal 5–9 bunches female. Female flowers 10–16 per bract in two rows, 9–13 cm long. Compound tepal 3.6–4.3 × 1.7–2.3 cm, cream with pinkish maroon flesh, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner and outermost lobes have a horn-like appendage. Free tepal 2.8–3.3 × 2.5–3 cm, ovate-obovate, cup-shaped, translucent cream or white with purplish maroon pigmentation, apex highly corrugated and truncate with a broadly pointed acumen, 0.3–0.4 cm long. Staminodes 5, 1.3–2.3 cm long, white or creamy white with light green base. Ovary 7.1–9 cm long, straight, yellowish green with purple patches at tip, ovules in 4 regular rows per locule; style 3.3–4 cm long, straight, exserted, white or rarely creamy white without any pigmentation; stigma globose, grey or cream, sticky. Male bud lanceolate to intermediate, tip highly imbricate; rachis falling vertically, bare, blackish brown, 50–60 cm long at fruit maturity. Male bracts obovate-oblong to intermediate, 17–22.3 × 12.4–15.2 cm, not grooved, abaxially purplish maroon with yellowish greenish yellow tip, highly glaucous; adaxially reddish maroon with yellow tip, shiny, no sign of colour fadings towards base, apex obtuse, not split; lifting 1–2 bracts at a time, revolute just before falling; bract scars prominent; male bud in advanced blooming obovate, imbricate. Male flowers on average 18–20 per bract in two rows, 6.3–7.1 cm long, fall with the bract. Compound tepal 4.5–5.4 × 1.1–1.9 cm, apex curved backwards, cream with purplish maroon pigmentation and yellow tip, slightly ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner, 0.4–0.6 cm long. Free tepal 3–3.6 × 2–2.6 cm, obovate, translucent white with purplish maroon pigmentation, boat-shaped, apex moderately corrugated with a broadly truncate acumen, 0.2–0.3 cm long. Stamens 5, 4–4.7 cm long; filament 1.6–2.1 cm long, white with some maroon tinge; anther 2.2–2.9 cm long, cream with whitish thecae. Ovary rudiment, straight, 1.8–2 cm long, cream with purplish fading; style straight, inserted, 4.3–4.8 cm long, white with creamy white or dull yellow stigma. Fruit bunch lax, with 5–9 hands and 10–16 fruits per hand, in two rows; fingers pedicelled, 2.8–3.2 cm long, no sign of fusion at base. Fruits on mid hand 11–14.5 cm long, straight, circumference 13–15 cm, pronouncedly ridged, negatively geotropic; apex pointed, with persistent floral relicts, immature peel colour dull green with or without markings, become greenish yellow with or without rusty black markings at maturity; immature fruit pulp white, becoming creamy white and soft at maturity. Seeds completely absent.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is a common cultivar growing in almost all states in South India. Since it is widely used for the culinary purposes, it has a great demand in the vegetable market and there is a large trade in the unripe fruit.

Cytology: Triploid (ABB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 64 – see APPENDIX II).

Notes: It takes around 13–14 months to mature from planting to harvest. It is fairly a tall and stout variety with a medium size bunch of around 50–70 fruits per bunch. There is a great trade in the vegetable market. The unripe fruit is widely used to prepare '*bhagi*', chips and also for other culinary usages. The ripened fruits are also consumed rarely.

Specimens Examined: INDIA. **Kerala:** Thrissur, Parappur, Keeripalam (Cultivated), 14 February 2011, *Alfred Joe 123206* (CALI); **Tamil Nadu:** Dindigul Dist., Authupatty, 165 m. (Cultivated), 23 February 2014, *Sreejith & A. Kabeer 123263* (CALI).

24. *Musa* × *paradisiaca* L. (ABB) 'Peyan' Fig. 29

Standard Speimen: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123232* (CALI).

Musa sapidisiaca K.C.Jacob var. *peyaniana* K.C.Jacob, Madras Bananas Monogr. pp. 101. 1952. ***syn. nov.***

Local names: (Kerala) *Ney vannan, Ney vazha, Peyan*; (Tamil Nadu) *Kallu vazhai, Kotta vazhai, Madavazhai, Peyan, Savargundy*; (Andhra Pradesh) *Booditha aratti, Nokala bontha, Palakola bontha, Sapota bontha, Rasthali*.

Plants tall, stout; suckers 4–9, very close to parent plant, 4–18 cm away, vertical. Mature pseudostem 3.5–4.1 m high, 57–72 cm circumference at base, yellowish green with maroon pigmentation covered with grayish white old sheath, waxy, glaucous, more glaucous on young plants; underlying color whitish green, shiny; sap watery. Leaf habit drooping; lamina 206–220 × 60–67 cm, oblong-lanceolate, obliquely truncate at apex, with tendril like appendage when young; upper surface dark green, shiny; lower surface whitish green, waxy, glaucous; leaf bases asymmetric, both auriculated and rounded; midrib both sides yellowish green, glaucous. Petiole 64–70 cm long, waxy, more waxy towards base; petiole canal margins gray, overlapping; petiole bases with sparse black blotches, not winged and clasping pseudostem. Inflorescence pendulous; peduncle long, 65–90 cm long, light green glaucous, glabrous with long internodes, 22–43 cm long. Sterile bracts 2, dorsally greenish yellow with maroon fading, much more in second one; ventrally dark maroon, highly grooved with green leafy appendage at apex, deciduous. Female bud obovate-lanceolate, tip highly imbricate. Female bracts intermediate to ovate-obovate, 28–32 × 19–20 cm, slightly grooved; abaxially purplish maroon with greenish yellow patches, glaucous; adaxially reddish maroon, shining, no sign of colour fading towards base, apex obtuse and split; lifting 1–2 bracts at a time, reflexed, sometimes revolute just before falling. Basal 7–10 bunches female. Female flowers on mid-hand 12–16 per bract in two rows, 11.4–13.5 cm long. Compound tepal 3.9–4.3 × 1.8–2.1 cm, cream with pinkish maroon flesh, ribbed at dorsal angles; lobes 5, yellow, outer lobes much longer than inner and the outermost lobes have a horn-like appendage. Free tepal 3–3.3 × 2.5–2.7 cm, obovate-lanceolate, boat-shaped, translucent white without pigmentation, apex highly corrugated with truncate and broadly pointed acumen, 0.3–0.4 cm long. Staminodes 5, 1.3–1.6 cm long, white with light green base. Ovary 7.7–8.5 cm long, straight, yellowish green with purple patches at tip, ovules in 4 regular rows per locule; style 3.9–4.1 cm long, straight, inserted, white without any pigmentation; stigma globose, grey or cream, sticky. Male bud intermediate to top-shaped, tip imbricate, sometimes aborted at fruit maturity; rachis falling vertically, bare, green with blackish brown tinge, 65–105 cm long at fruit maturity. Male bracts intermediate, 20–23.5 × 12–13.5 cm, not grooved; abaxially purplish maroon with yellowish green margins and yellow tip, highly glaucous; adaxially reddish maroon with yellow tip, shiny, no sign of colour fading towards base, apex obtuse, not split; lifting 1–2 bracts at a time, revolute just before falling; bract scars prominent; male bud in advanced blooming top-shaped, imbricate. Male flowers on average 18–22 per bract in two rows, 7–7.5 cm long, predominantly cream, fall with the bract. Compound tepal 4.9–5.2 × 1.2–1.4 cm, apex curved backwards, cream with slight purplish maroon pigmentation and yellow tip, ribbed at dorsal angles; lobes 5, yellow, outer and middle lobes much longer than inner, 0.4–0.6 cm long, outermost lobes with a horn-like appendage. Free tepal 2.4–2.7 × 1.5–1.7 cm, translucent white without pigmentation, oblanceolate, boat-shaped, apex highly corrugated with a small, narrow, pointed acumen, 0.1–0.2 cm long. Stamens 5, 3.7–4 cm long; filament 1.6–1.7 cm long, cream; anther 2.1–2.3 cm long, creamy yellow with white or creamy white thecae. Ovary rudiment, straight, 2–2.2 cm long, cream without pigmentation; style curved at base, inserted, 5–5.5 cm long, white with dull yellow stigma. Fruit bunch lax, with 7–10 hands and 12–16 fruits per hand, in two rows; fingers pedicelled, 2.3–2.5 cm long, fused at base. Fruits on mid hand 9–11 cm long, straight, negatively geotropic, circumference 9–12 cm, slightly ridged; apex bottle-necked, with persistent style base; immature peel colour dull green, become dull yellow with glaucous on ripening; immature fruit pulp white, becoming cream and soft at maturity. Seeds completely absent or in some cases when planted along with wild species may produces 3–8 seeds at the fruit tip; seeds black, bilaterally flattened, warty.

Flowering & Fruiting: Throughout the year.

Distribution/ Cultivation: It is not much common, but cultivated in the backyards of some houses especially in Tamil Nadu and some areas of Kerala especially in Thiruvananthapuram.

Cytology: Triploid (ABB) – 2n = 3x = 33 (Morpho-taxonomic scoring = 63 – see APPENDIX II).

Notes: It takes about 14–15 months to mature from the time of planting to harvest. Plant is very tall, stout and produces large leaves. It produces numerous suckers up to 4–9 and can easily spread. Fruits are very small, angled, pointed upwards and are very closely arranged in the hand but the hands are much lax in the long bunch. The fruit is reported to have laxative properties.

Specimens Examined: INDIA. **Kerala:** Thiruvananthapuram Dist. (Cultivated at Malabar Botanical Garden, Olavanna), 17 May 2012, *Sreejith 123224* (CALI).

COMPARATIVE MORPHOLOGY

The genus *Musa* is characterized by rhizomatous perennial unbranched monocotyledonous arborescent herbs, commonly cultivated in almost all tropics and sub-tropics for fruit and leaves. Since all cultivated bananas were originated by the natural hybridization of two wild species *M. acuminata* and *M. balbisiana*, they exhibit a vast morphologic variation from one to other and in different ploidy levels (diploid, triploid and tetraploid). The morpho-taxonomic scoring system developed by Simmonds and Shepherd (1955) using fifteen qualitative/quantitative characters form the backbone of the present day classification of cultivated bananas.

The habitat where it is grown along with the availability of manure and water are the main parameters, which determines the growth and development of banana plant. The morphology of the plant varies highly by means of colour, length and width of parts, number of flowers, fruits, etc. So in order to study the morpho-taxonomic variations of South Indian bananas, every efforts have been made to collect live specimens of all taxa from the study area, and maintained a live germplasm at CUBG. These plants were used for the detailed study and comparison at different stages of growth, flowering, fruiting, etc. The height, blotches at the base, leaf habit, inflorescence and bud nature and fruit characters like number of hands, number of fruits per hand, its size, shape, nature, apex nature, peel, etc. are the most variable characters in cultivated bananas.

Habit

Plants are rhizomatous unbranched herbs with a tuft of terminal leaves. The erect unbranched areal trunk generally called pseudostem and is formed by the close arrangement of leaf sheaths with a tuft of leaves at the apex. Based on the overall appearance of the pseudostem, three types of habits were recognized, *viz.*, slender, normal and robust. The slender habit is found in cultivars with genomic group AA, like *Kadali, Karivazhai* and *Pisang lilin* and also in some AB group like *Kunnan.* While almost all AAA group exhibits a robust habit due to the short and stout nature of the pseudostem along with tightly arranged leaves, as in *Dwarf cavendish, Grand naine* and *Robusta.* Whereas the cultivar *Red* even though had a tall nature exhibits a robust appearance due to its large girth. All others, *viz., Thaenkunnan* (AB), *Namarai, Nendran, Pachanadan, Poovan, Rasthali, Sirumalai, Vannan, Virupakshi* (AAB)*, Kachkol*, *Karpuravalli, Kuribontha, Monthan* and *Peyan* (ABB) have a normal habit. But some ABB groups (e.g. *Kachkol, Karpuravalli,* etc.) may show some stout nature. Since the size of the pseudostem varies with the habitat and the availability of manure and water, it cannot be considered as a liable character. Pseudostem colour also varies within the range of green; *i.e.*, yellowish green to dark green and also to black (in *Karivazhai*) and reddish maroon (in *Red*). But pigmentation in the underlying pseudostem and the blotches in the upper part along the petiole margins are found more specific to the groups and can be considered as a good key character for the identification of taxa. Large and extensive blotches are found in *M. acuminata* but is completely absent in *M. balbisiana.* So cultivars with more 'A' genome and comparatively more affinities with *M. acuminata* have large and extensive black or brown blotches (*Kadali, Karivazhai, Pisang lilin, Dwarf cavendish, Grand naine, Red* and *Robusta*) and it decreases while coming to AB and AAB group; but some cultivars like *Poovan* and *Vannan* shows large extensive blotches. It is almost absent in ABB group with some exemption as in *Peyan* (shows some scattered blackish dots). *Poovan* is very common in South India and is cultivated both in the plains as well as in hilly areas; but it shows some variation depending on the altitude, where it is cultivated; especially in the colour of pseudostem and petiole. In the hilly areas it has a blackish pseudostem with greenish petiole whereas in the plains, it has a purplish maroon pseudostem with some yellowish green tinge.

Rhizome (suckers)

Rhizome is the underground stem with short nodes and internodes and small scale leaves. The meristem of the apical bud first produces leaves and later it starts to grow through the pseudostem and emerges out at the tip as inflorescence. Its size and colour may vary with the cultivar, but in all banana cultivars the rhizome is stoloniferous and produces lateral suckers. Since the cultivated bananas will not produce seeds, it is the only way of propagation; *i.e.,* by means of suckers.

Roots/root system

Root system is similar to other monocotyledons. They are small, non-tuberous and fibrous, and are produced directly from the main rhizome. The length and girth of the roots may vary with the habitat were it grows and also with the cultivar. Normally the cultivars like *Red, Dwarf cavendish, Robusta,* etc. produces more robust and thick roots and the number and compactness are also high in these cultivars, when compared to others.

Leaves

The banana leaves are large, simple, obovate to linear lanceolate and petiolate and are arranged as terminal tuft with a distinct midrib and with penni-parallel veins. A single plant may bear leaves with different size and nature; and for the uniformity, the third leaf from the top after the emergence of the inflorescence is noticed. The cultivated bananas shows three types of leaf habit such as erect (e.g. *Dwarf cavendish, Kunnan, Pisang lilin, Thaenkunnan* and *Vannan*), intermediate (e.g. *Kadali, Karivazhai, Namarai, Neypoovan, Pachanadan* and *Sirumalai*) and drooping (e.g. *Grand naine, Kachkol, Karpuravalli, Kuribontha, Monthan, Nendran, Peyan, Poovan, Rasthali, Red, Robusta* and *Virupakshi*). The petiole length ranges from 17–80 cm. Shortest petiole is noticed in *Robusta* (17 cm) and the longest in *Red* (80 cm). Petiole margins may be winged and not clasping the pseudostem (e.g. *Dwarf cavendish, Kadali, Kunnan, Karivazhai, Robusta,* etc.) or winged and clasping the pseudostem (e.g. *Neypoovan, Red,* etc.) or may be not winged and clasping the pseudostem (e.g. *Nendran, Poovan, Rasthali, Thaenkunnan,* etc.). Petiole margin is another key character to distinguish the two species *M. acuminata* and *M. balbisiana* and in the former the petiole margin is found open with margins spreading whereas in the latter, the margins are overlapped. The cultivars exhibit a wide range of variation depending on the genomic status and can be grouped in to five; *viz.,* open with margins spreading (e.g. *Dwarf cavendish, Grand naine, Kadali, Karivazhai, Robusta,* etc.), wide with erect margins (e.g. *Namarai, Pachanadan, Sirumalai, Virupakshi,* etc.), straight with erect margins (e.g. *Kunnan, Thaenkunnan, Poovan, Rasthali,* etc.), margins curved inwards (e.g. *Nendran, Neypoovan,* etc.) and margins overlapping (e.g. *Kachkol, Karpuravalli, Kuribontha, Monthan,* etc.) (**Fig. 30**). Petiole margin may also have different colours, which are also specific to a particular cultivar/group to an extent. Mature lamina shape varies from elliptic (e.g. *Dwarf cavendish, Robusta,* etc.) to linear lanceolate (e.g. *Karivazhai, Rasthali, Sirumalai,* etc.). Lamina size varies with the habitat and the availability of water and manure; whereas base of the lamina is almost consistent and can be considered as a key character. Three types of leaf bases were noticed in South Indian bananas, *viz.,* both sides rounded (e.g. *Kunnan, Thaenkunnan, Pachanadan,* etc.), one side rounded and one pointed (e.g. *Kadali, Karivazhai, Grand naine, Neypoovan,* etc.), both sides auriculated and rounded (e.g. *Kachkol, Karpuravalli, Kuribontha, Monthan,* etc.) (**Fig. 31**). The leaf margin is entire and wavy. The colour of the lamina is another character. It is specific to some cultivars and by experience, these can be identified even in the vegetative phase. Generally ABB groups have dull coloured lamina when compared to others, but in some cases its intensity also varies with the environment also. *Poovan* has a dark leaf lamina but those growing in a highly fertile soil and under shade conditions have very dark green leaves with prominent veins.

Inflorescence

After a standard period of vegetative growth (varies with the cultivar), the shoot meristem on the underground rhizome started to elongate up through the centre of the pseudostem and transforms in to the inflorescence and merged out from the tip. The immature inflorescence is enclosed inside the bract as a compound spike – looks like a large bud. Inflorescence arises and merged out in horizontal plane in almost all cultivated bananas; but in later advanced stages, it may be horizontal (as in *Sirumalai, Virupakshi,* etc.) or become sub-horizontal or oblique (as in *Kadali, Karivazhai, Kunnan, Neypoovan,* etc.) or pendulous (as in *Dwarf cavendish, Karpuravalli, Red, Robusta,* etc.). The peduncle may be densely hairy (as in *Kadali, Karivazhai, Robusta,* etc.) or slightly pubescent (as in *Neypoovan, Pisang lilin, Poovan, Rasthali,* etc.) or may be glabrous (as in *Nendran, Pachanadan, Thaenkunnan,* etc); light green (as in *Karpuravalli, Monthan, Vannan*, etc.) or dark green with or without blackish markings. Some cultivars like *Poovan* shows a characteristic bend on the peduncle in advanced stage. The length of the peduncle may also vary with the cultivars. Normally the ABB groups have a long peduncle (e.g. *Karpuravalli, Monthan,* etc.) and the smallest one is noticed in *Kunnan.*

Female bud

In banana, normally the initial 2–8 hands are female flowers, which later developed in to fruits and these were enclosed inside the bract generally referred as female bud. In the emerging stage, the female bud is completely covered by 1–2 sterile bracts. The female bud is normally linear-lanceolate (e.g. *Kadali, Karivazhai, Grand naine, Kunnan, Nendran, Rasthali,* etc.) but is ovate to obovate-lanceolate in *Poovan, Vannan, Kachkol, Karpuravalli, Monthan, etc.* The female bracts are either convolute (e.g. *Kadali, Pisang lilin, Dwarf cavendish,* etc.) or imbricate (e.g. *Kunnan, Neypoovan, Namarai, Poovan, Vannan, Kachkol,* etc.).

Female bract

In the genus *Musa* the bracts and flowers were independent and has no attachment at the base. Female bracts may be lanceolate as in *M. acuminata* (e.g. *Kadali, Karivazhai, Robusta,* etc.) to ovate-obovate as in *M. balbisiana* (e.g. *Karpuravalli, Monthan, Peyan,* etc.), brightly colored and deciduous. The size and colour varies with habitat and growing condition. Normally the abaxial surface is glaucous and adaxially glabrous and shiny. The bracts may be just open and slightly reflexed back as in *M. balbisiana* or may be open, reflexed and revoluted back before falling with apex pointed to obtuse and split as in *M. acuminata*. Normally female bracts have a blackish maroon to purple abaxial surface with or without yellow or yellowish green tinge and adaxially reddish maroon to yellowish purple with or without colour fadings. But some cultivars like *Karivazhai* and *Pachanadan* had a blackish maroon upper surface and *Dwarf cavendish* shows an orange to orange-red inner surface.

Flowers

The family Musaceae is considered as the least specialized family in the order Zingiberales due to the least advanced flower structure. The flowers are incomplete, cyclic, unisexual, epigynous, monochlamydeous, irregular, zygomorphic and trimerous. The three sepals and the two lateral petals are united to form a tubular sheath – called 'compound tepal' which encloses the fertile stamen and style. The median upper tepal is free 'free tepal' which form a dome over the nectar gate. In the genus *Musa* out of the six stamens, five are well developed and the upper sixth one is much reduced or completely aborted. Gynoecium with inferior, tricarpellery, syncarpus, tri-locular ovary with axile placentation and a single long style and globose stigma. There are two types of flowers, the basal sets are functionally female, which develops in to fruit and the others are functionally male with aborted ovary and much developed androecium. In cultivated bananas, the flowers are generally arranged in two layers.

Female flowers

In *Musa* cultivars, the first formed few hands of flowers are functionally female and which later develop into fruits. The number of hands and the flowers per single hand may vary with the cultivar and is also changed with the growing conditions. The compound tepal colour may be either white or cream with or without purple or purplish maroon coloration. The free tepal tip is either corrugated or smooth with or without a prominent acumen. Normally five staminodes are present inside the compound tepal and its length increases and much developed from basal hands towards tip. The ovary is inferior, glaucous, normally green or with different shades of green, tricarpellery syncarpous trilocular with many ovules in axile placentation. The number of rows of ovules per locule may be two in *M. acuminata* and four in *M. balbisiana*; and that is why it is two in all AA, AAA, AB and AAB groups, but four in ABB group (since it has more affinity towards B). The ovary colour normally green, but its intensity may vary from light yellowish green to the dark green with or without pigmentation. The length of the ovary also varies with the cultivars, and those with larger fruits have long ovary (e.g. *Nendran, Robusta,* etc.) and short fruited have a small ovary (e.g. *Kadali, Karivazhai,* etc.). Style is straight with or without pigmentation. Stigma is globose or dorsiventrally flattened with sticky surfaces (**Fig. 32**).

Rachis

Rachis position, nature, length and the bract scars on the rachis may vary with cultivars and can be used as a key character for the identification of cultivar to some extent. Its position may be falling vertically (as in *Karivazhai, Dwarf cavendish, Red, Namarai, Nendran, Poovan, Karpuravalli,* etc.), at an angle (as in *Neypoovan, Kunnan,* etc.), with a curve (as in *Grand naine, Robusta, Thaenkunnan,* etc.) or horizontal (as in *Kadali, Pisang lilin,* etc.). An erect rachis is also seen in some wild species. Most common cultivars like *Neypoovan, Kunnan, Poovan, Robusta, Red, Rasthali,* etc. exhibit a completely naked rachis without any remnants of male flowers and bracts; whereas in some others like *Nendran, Dwarf cavendish,* etc. shows persistent male flowers and bracts throughout the rachis. But in some cultivars like *Red, Namarai,* etc. shows few hands of persistent male flowers near the fruit bunch and leaving the remaining portion naked.

Male bud

Male buds are generally lanceolate in shape, but in advanced stage, it becomes top-shaped in some cultivars. The male bud is linear-lanceolate in *Dwarf cavendish, Grand naine, Robusta, Kunnan, Namarai, Nendran, Rasthali,* etc.; intermediate in *Karivazhai, Pachanadan, Poovan, Red,* etc. and top-shaped in *Namarai, Sirumalai* and *Peyan*. In *Thaenkunnan,* normally the male bud and flowers are completely absent and all flowers are female, which develops in to fruits. But in the summer season, or in the water scarce habitat, it produces male flowers in linear-lanceolate male bud.

Male bract

Mostly the male bracts are deciduous as in *Kadali, Neypoovan, Poovan, Rasthali, Pachanadan, Monthan, Karpuravalli,* etc. In some cultivars like *Nendran* it may be persistent throughout the rachis. Male bract shows diversity in shape, size, colour and nature. Mostly the male bracts are lanceolate (e.g. *Kadali, Pisang lilin, Grand naine, Red, Neypoovan, Thaenkunnan, Nendran, Poovan, Rasthali, Virupakshi,* etc.) or intermediate (e.g. *Karivazhai, Robusta, Kunnan, Namarai, Pachanadan, Vannan,* etc.) or obovate-oblong (e.g. *Kachkol, Karpuravalli, Kuribontha, Monthan* etc.) or rarely top-shaped as in *Sirumalai* cultivar. Abaxially purple with or without reddish maroon tinge. Adaxially it may be orange red (e.g. *Dwarf cavendish, Grand naine, Robusta,* etc.) or red (e.g. *Pisang lilin, Red, Thaenkunnan, Namarai, Nendran, Poovan, Rasthali, Sirumalai, Vannan,* etc.) or purple (e.g. *Kadali*) or purple brown/ maroon (e.g. *Karivazhai, Kunnan, Neypoovan, Kachkol, Kuribontha,* etc.). Internal colour fading towards base is also noticed as a reliable character in *Musa* taxonomy. In some cultivars like *Kadali,* *Karivazhai, Pisang lilin, Dwarf cavendish, Grand naine, Red, Robusta,* etc. the internal bract colour fades to cream towards base whereas in others like *Neypoovan, Kunnan, Thaenkunnan, Namarai, Nendran, Karpuravalli, Monthan,* etc. there is no sign of colour fadings towards base. The bracts may be just open (as in *Dwarf cavendish, Grand naine, Robusta,* etc.) or reflexed and revoluted before falling (as in *Kadali, Karivazhai, Pisang lilin, Red, Kunnan, Neypoovan, Thaenkunnan, Namarai, Nendran, Pachanadan, Poovan, Vannan, Karpuravalli, Peyan,* etc.). Tip may be convolute (as in *Karivazhai, Pisang lilin, Dwarf cavendish, Grand naine, Red,* etc.) or slightly imbricate (as in *Thaenkunnan, Namarai, Poovan,* etc.) or highly imbricate (as in *Kadali, Robusta, Kunnan, Neypoovan, Nendran, Rasthali, Vannan, Karpuravalli, Kachkol,* etc.) (**Fig. 33**).

Male flowers

Normally in *Musa* cultivars the male flowers are produced just below the female flowers. The male bud sometimes continued to grow even after fruit maturity or in some cases may be aborted before fruit maturation. The male flowers have more developed anthers with rudimentary ovary, style and stigma and these flowers never develop in to fruits. The characters of tepal are almost similar to that in the female flowers. Cultivars with more affinities with 'A' genome (e.g. *Kadali, Karivazhai, Dwarf cavendish, Grand naine, Robusta, Rasthali, Thaenkunnan, Nendran,* etc.) has cream or yellow colored male flowers whereas the balbisiana lines (e.g. *Kachkol, Karpuravalli, Kuribontha, Monthan, Peyan,* etc.) have male flowers with predominant purplish violet coloration. Some AB (e.g. *Neypoovan*) and AAB (e.g. *Namarai, Poovan, Sirumalai,* etc.) groups have cream male flowers with some purplish fleshy coloration. Male flowers have five developed stamens with dithecous and parallel anthers which dehisce throughout their length. The filament is elongated with almost the same length of the anther and cream or white in colour with light greenish tinge at the base. Anthers are generally cream or white with the thecae/ pollen sac colour white (as in *Kadali, Dwarf* *cavendish, Grand naine, Kachkol, Karpuravalli, Kuribontha, Monthan,* etc.) or cream (as in *Thaenkunnan, Namarai, Nendran, Sirumalai, Vannan, Virupakshi, Peyan,* etc.) or yellow (as in *Poovan*) or brown/rusty brown (as in *Red, Neypoovan, Pachanadan, Rasthali,* etc.) or pink/pink-purple/purplish violet (as in *Karivazhai, Kunnan,* etc.). Ovary is generally cream or greenish yellow with or without purplish or maroon fleshy coloration. The style may be straight (as in *Kadali, Pisang lilin, Dwarf cavendish, Red, Robusta, Neypoovan, Nendran, Pachanadan, Virupakshi, Karpuravalli, Monthan,* etc.) or curved at the base (as in *Kunnan, Namarai, Poovan, Sirumalai, Peyan,* etc.). Normally stigma is yellow (e.g. *Kadali, Karivazhai, Red, Pachanadan, Poovan, Vannan,* etc.) but it may vary from dull yellow (as in *Grand naine, Neypoovan, Thaenkunnan, Namarai, Sirumalai, Karpuravalli, Kuribontha, Peyan,* etc.) to brownish yellow (e.g. *Rasthali*) (**Fig. 34**). The male flowers usually fall along with the bract or in some cases the rudimentary ovary may be persistent even at fruit maturity.

Fruit bunch

Fruit and bunch characters are the most striking differences among the banana cultivars and it exhibits diversity in bunch appearance, nature, number of hands and the fruit characters like number of fruits per hand, their length, appearance, base and apex nature, colour, taste, etc. The bunch position may be hanging vertically (as in *Dwarf cavendish, Grand naine, Red, Robusta, Thaenkunnan, Nendran, Poovan, Kachkol, Karpuravalli, Monthan, Peyan,* etc.) or sub-horizontal/oblique (as in *Kadali, Karivazhai, Pisang lilin, Kunnan, Neypoovan, Namarai, Pachanadan, Vannan, Kuribontha,* etc.) or horizontal (as in *Sirumalai, Virupakshi,* etc.) in the cultivated forms, but erect bunches are also seen in some wild species. Bunch-shape may also vary with cultivars and five types were recognized such as cylindrical (e.g. *Grand naine, Red,* etc.), truncate (e.g. *Dwarf cavendish, Kachkol, Nendran, Poovan, Robusta,* etc.), asymmetric (e.g. *Karpuravalli, Monthan, Neypoovan, Peyan, Pisang lilin,* etc.), with a curve in the bunch axis (e.g. *Thaenkunnan*), and cylindrical (e.g. *Kadali, Kunnan, Kuribontha, Karivazhai, Namarai, Rasthali, Sirumalai, Vannan,* etc.). The number of hands may vary largely with cultivars and also with the habitat. It may vary from 3 to 14 or 16. But a single fruit is found in ecotype '*Moongil*'. Based on the distance between adjacent hands, the fruit bunch can be categorized in to three; such as lax – one can easily place his hand between the fruit hands (e.g. *Kadali, Karivazhai, Neypoovan, Thaenkunnan, Namarai, Nendran, Pachanadan, Rasthali, Sirumalai, Virupakshi, Kachkol, Karpuravalli, Kuribontha, Monthan, Peyan,* etc.), compact – one can easily place his fingers between the hands of fruit (e.g. *Pisang lilin, Dwarf cavendish, Grand naine, Red, Robusta, Kunnan, Vannan,* etc.) and very compact – one cannot place his figure between the hands of fruit (e.g. *Poovan*) (**Fig. 35 & 36**).

Fruits

In the cultivated edible banana, fruits are parthenocarpic fleshy berry without seeds. According to Simmonds (1966) the edible fruit pulp develops from the inner surface of the locule and also by the swelling of the septa and the axis. Within the fruit hand, the fruits vary in their arrangement, position, number per hand, size, shape, fusion of pedicel, apex nature, etc. (**Fig. 37**). The absolute number of fruits per hand is variable; however the number on the second hand/mid hand is comparatively stable in a particular cultivar. Fruit length may also found as a key character to some cultivars like *Nendran*, *Kachkol, Pisang lilin,* etc.; but in most cases it comes in the range of 6–15 cm long. Fruits nature may be either curved back to axis (e.g. *Dwarf cavendish, Grand naine, Neypoovan, Rasthali, Robusta, Thaenkunnan,* etc.) or negatively geotropic (e.g. *Pisang lilin, Red, Kachkol, Karpuravalli, Monthan, Peyan,* etc.) or perpendicular to the axis (e.g. *Kadali, Karivazhai, Kunnan, Namarai, Nendran, Pachanadan, Poovan, Sirumalai, Vannan, Virupakshi, Kuribontha,* etc.). Based on the shape, it may be straight/slightly curved (e.g. *Kadali, Karivazhai, Kunnan, Namarai, Pachanadan, Poovan, Sirumalai, Vannan, Kuribontha, Peyan,* etc.) or straight in the distal part (e.g. *Nendran, Rasthali,* *Virupakshi, Kachkol, Karpuravalli,* etc.) or curved (e.g. *Dwarf cavendish, Grand naine, Robusta, Neypoovan, Thaenkunnan,* etc.) or curved in 'S' shaped/double curved (e.g. *Pisang lilin*). In some cultivars like *Karivazhai, Dwarf cavendish, Kachkol, Karpuravalli,* etc. the fruits have 3–4 prominent ridges whereas cultivars *Kadali, Pisang lilin, Red,* etc. have smooth and cylindrical fruits and some others (e.g. *Dwarf cavendish, Poovan, Robusta,* etc.) have fruits with slight ridges.

The banana fruit is attached to the axis by means of a basal stalk – the pedicel. Very long pedicel (4–6 cm long) is noticed in cultivars like *Nendran, Kachkol* and *Thaenkunnan* and the shortest in *Kadali* and *Karivazhai* (0.5–1 cm). The basal fusion of pedicel is another variant character in *Musa* cultivars. It may be highly fused as in *Thaenkunnan, Peyan,* etc. or slightly fused as in *Kadali, Poovan, Rasthali,* etc. or without any sign of fusion (e.g. *Pisang lilin, Dwarf cavendish, Grand naine, Kunnan,* etc.). Banana fruit apex is another very striking character and may be pointed (as in *Kadali, Robusta, Namarai,* etc.) or lengthily pointed (as in *Karivazhai, Dwarf cavendish, Thaenkunnan, Nendran, Karpuravalli, Peyan,* etc.) or blunt-tipped (as in *Red, Rasthali,* etc.) or bottle-necked (as in *Pisang lilin, Kunnan, Neypoovan,* etc.). The reminisce of floral relicts at the banana tip is another significant character for the identification of some cultivars. It may be persistent as in *Kadali, Grand naine, Red, Kunnan, Neypoovan, Kachkol, Karpuravalli,* etc. or completely absent as in cultivars like *Karivazhai, Pisang lilin, Poovan, Rasthali, Vannan,* etc. But in some others (e.g. *Dwarf cavendish, Thaenkunnan, Namarai, Pachanadan,* etc.) only the base of the style is persistent (**Fig. 38**).

Banana fruit is covered with a thin covering – the peel; and is generally photosynthetic and green with some exceptions (greenish purple in *Red*) till fruit maturity. The colour intensity may be varied with cultivars; from pale green, glaucous (e.g. *Karpuravalli*) to dark green (e.g. *Poovan*). On ripening it generally changes to yellow. It may be greenish yellow as in *Kadali, Monthan,* etc. and bright yellow as in *Pisang lilin, Rasthali,* etc.

Seeds

In the genus *Musa,* numerous arillate seeds were packed closely inside the fruit and are surrounded by mucilaginous covering; but are completely absent in cultivars or rarely 1–10 seeds may be present in few cultivars. In general, the ABB group has more tendencies to settle seeds than others.

Table 03. Comparison of characters of *Musa* cultivars in South India

No.	Attributes		1. *Kadali*	2. *Karivazhai*	3. *Pisang lilin*
1	Habit		Slender	Slender	Slender
2	Pseudostem	Height (cm)	150–250	250–290	140–280
3		Circumference at base (cm)	42–58	43–47	28–33
4		Colour	Whitish green with purple & rose pigmantation	Dark green with large black bloches	Light green with blackish brown pigmentation
5		Underlying colour	Yellowish white with purple patches	Yellowish green with black coloration	Light green with light pinkish pigmentation
6		Blotches at the tip	Large & extensive (black)	Large & extensive (black)	Large & extensive (black)
7	Sap Colour		Watery	Watery	Watery
8	Leaf habit		Intermediate	Intermediate to drooping	Erect
9	Lamina	Size (cm)	100–117 × 30–42	204–217 × 42–46	120–173 × 45–56
10		Shape	Oblanceolate	Linear-lanceolate	Oblong
11		Base	One rounded and one pointed	One rounded and one pointed	One rounded and one pointed
12		Symmetry	Asymmetric	Asymmetric	Asymmetric
13	Petiole	Length (cm)	35–44	37–41	58–68
14		Base	Winged & not clasping	Winged & not clasping	Winged & not clasping
15		Canal	Open with spreading	Open with spreading	Straight with erect
16		Margin colour	Purplish maroon	Purplish maroon	Purplish maroon
17	Inflorescence (at advanced stage)		Sub-horizontal	Sub-horizontal	Sub-horizontal
18	Peduncle	Length	25–37	50–53	27–42
19		Nature	Densely hairy	Densely hairy	Slightly pubescent
20		Colour	Green with dark markings	Green	Green with dark markings
21	Female bud	Shape	Linear-lanceolate	Linear-lanceolate	Linear-lanceolate
22		Nature	Convolute	Convolute	Convolute
23	Female bract	Size (cm)	18–25 × 8–12	24–28 × 8.8–11	22–31 × 11–12.5
24		Shape	Lanceolate	Lanceolate	Lanceolate
25		Colour-abaxial	Blackish maroon with yellow strands	Dark purplish maroon	Purplish maroon with or without yellow strands
26		Colour-adaxial	Purple with cream base	Purplish maroon with yellowish strands & cream base	Purplish maroon fades to cream towards base & margin
27		Colour fading	Fades towards base	Fades towards base	Fades towards base
28		Apex	Obtuse	Intermediate to obtuse	Slightly pointed to intermediate
29		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
30	Female flower length (cm)		8.2–10.3	10–10.8	8.5–11.5

31	Compound tepal	Size (cm)	3.8–4.4 × 1.8–2.1	3.7–4.1 × 1.6–1.8	4–4.6 × 1.5–2.1
32		Colour	Cream creamy white with rusty black spots at the tip	Cream or creamy white with rusty black spots at the tip	Cream or creamy white
33		Lobe colour	Creamy yellow	Creamy yellow	Yellow
34	Free tepal	Size (cm)	2.4–2.7 × 1.6–2	2.7–2.9 × 2.2–2.3	2–2.6 × 1.4–2.1
35		Shape	Obovate	Ovate-obovate	Ovate-obovate
36		Colour	Cream	Cream	Cream or creamy white
37		Apex	Slightly corrugated	Slightly corrugated	Corrugated
38		Acumen (cm)	0.3–0.5	0.2–0.3	0.2–0.5
39	Staminode	Size (cm)	2–4	1.5–2	1.4–2.9
40	Ovary	Length (cm)	4.5–6	6.7–7.1	6.2–7.5
41		Colour	Yellowish green	Yellowish green	Yellowish green
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Horizontal	Falling vertically	Horizontal
44		Nature	Bare	Bare	Bare
45		Length @ fruit maturity (cm)	20–33	48–50	35–51
46		Bract scars	Scarcely prominent	Prominent	Scarcely prominent
47	Male bud	Shape	Lanceolate	Intermediate	Lanceolate
48		Nature	Slightly imbricate	Convolute	Convolute
49	Male bract	Size (cm)	13.6–17.4 × 7.5–8.3	15–17 × 9.5–11	16–19 × 8.5–10
50		Surface nature	Not grooved	Slightly grooved	Minutely grooved
51		Shape	Lanceolate to intermediate	Intermediate to top shaped	Lanceolate to intermediate
52		Colour-abaxial	Dark purplish maroon with yellow patches	Dark purple	Dark purplish red to pinkish maroon
53		Colour-adaxial	Dull purple fades to yellow towards base	Reddish maroon fade to yellow towards base	Reddish maroon fades to cream towards base
54		Colour fading	Fades towards base	Fades towards base	Fades towards base
55		Apex	Intermediate to slightly obtuse	Pointed	Intermediate to obtuse
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	12–14	10–12	14–20
59		Predominant colour	Cream	Cream	Cream
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	4.2–4.8 × 1.7–1.9	4.2–4.5 × 1.5–1.7	4.4–5 × 1.3–1.4
62		Colour	Cream	Cream	Cream
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.2–2.6 × 1.2–1.7	2.3–2.5 × 2.3–2.5	2–2.2 × 1–1.2

65		Shape	Obovate	Rounded or cordate	Obovate
66		Colour	White	White	White
67		Apex	Highly corrugated	Smooth	Smooth
68		Acumen (cm)	0.2–0.4	0.2–0.4	0.2–0.3
69	Stamen	Length (cm)	3.5–4.2	4.3–4.6	4–4.4
70		Filament length (cm)	1.4–1.9	2.2–2.5	1.6–1.8
71		Filament colour	White	White with pale yellow base	White with cream base
72		Anther length (cm)	1.3–1.8	2–2.1	2.3–2.5
73		Anther colour	Cream	Cream	Cream
74		Thecae colour	White	Purplish violet	Whitish gray
75	Ovary pigmentation		Absent	Absent	Absent
76	Style nature		Straight	Straight	Straight
77	Stigma colour		Yellow	Yellow	Yellow
78	Fruit bunch	Appearance	Lax	Lax	Compact
79		Number of hands	4–7	3–5	4–8
80		Axis	Sub-horizontal	Sub-horizontal	Sub-horizontal
81	Fruits	Number on mid hand	5–12	7–10	11–18
82		Pedicel length	0.5–1.2	0.5–1	0.8–2
83		Base	Slightly fused	Fused at base	No sign of fusion
84		Fruit length (cm)	6.5–9	8–10	13–19
85		Circumference (cm)	9–13	9–13	8–12
86		Shape	Straight	Straight or slightly curved	Curved & ‘S’ shaped
87		Nature	Perpendicular to axis	Perpendicular to axis	Negatively geotropic
88		C.S.	Circular	Pronouncedly ridged	Circular
89		Apex nature	Pointed	Lengthily pointed	Bottle-necked
90		Floral relicts	Persistent	Absent	Absent
91		Mature peel colour	Dark green	Dark green	Dark green
92		Ripened peel colour	Greenish yellow	Yellow	Bright yellow

No.	Attributes		4. *Dwarf cavendish*	5. *Grand naine*	6. *Red*
1	Habit		Robust	Robust	Tall & stout
2	Pseudostem	Height (cm)	150–180	200–240	290–400
3		Circumference at base (cm)	55–63	58–65	60–75
4		Colour	Yellowish green with maroon pigmentation	Yellowish green with reddish maroon pigmentation	Brown-purple
5		Underlying colour	Maroon with light yellow patches	Yellowish green	Purplish maroon
6		Blotches at the tip	Large & extensive (black)	Large & extensive (brown)	Large & extensive (black)
7	Sap Colour		Watery	Watery	Milky white
8	Leaf habit		Erect	Drooping	Drooping
9	Lamina	Size (cm)	135–163 × 65–84	195–215 × 84–89	270–390 × 80–92
10		Shape	Elliptic	Elliptic	Oblanceolate
11		Base	Both auriculated & rounded	One rounded and one pointed	Both auriculated & rounded
12		Symmetry	Symmetric	Asymmetric	Asymmetric
13	Petiole	Length (cm)	20–27	35–39	65–80
14		Base	Winged & not clasping	Winged & not clasping	Winged & clasping
15		Canal	Open with spreading	Open with spreading	Open with spreading
16		Margin colour	Purple	Purple	Purple
17	Inflorescence (at advanced stage)		Pendulous	Pendulous	Pendulous
18	Peduncle	Length	30–50	60–80	75–86
19		Nature	Hairy	Hairy	Hairy
20		Colour	Green	Dark green with black pigmentation	Dark brownish purple
21	Female bud	Shape	Linear-lanceolate	Linear-lanceolate	Lanceolate
22		Nature	Convolute	Convolute	Slightly imbricate
23	Female bract	Size (cm)	35–55 × 16–24	32–50 × 13.5–20	40–48 × 17–25
24		Shape	Lanceolate	Lanceolate	Lanceolate

25		Colour-abaxial	Maroon with yellow or greenish yellow patches	Purplish maroon with yellow green lines	Brownish purple with light yellowish fading towards base & margins
26		Colour-adaxial	Orange-red fades to cream towards base	Cream with orange upper part	Reddish purple fades towads base
27		Colour fading	Fades towards base	Fades towards base	Fades towards base
28		Apex	Obtuse & split	Obtuse & split	Obtuse & split
29		Bract behavior	Reflexed but not revolute	Reflexed but not revolute	Reflexed & revoluted
30	Female flower length (cm)		13–15	11.3–15	13–17
31	Compound tepal	Size (cm)	3.6–4.1 × 1.8–2.2	3.7–4.1 × 2.1–2.5	5.8–6.6 × 2.3–2.6
32		Colour	Cream	Cream with rusty brown upper part	Cream white with purplish maroon patches at base
33		Lobe colour	Creamy yellow	Rusty brown	Yellow with black patches
34	Free tepal	Size (cm)	2.8–3 × 2–2.4	2.7–3 × 2–2.4	3.7–4.2 × 2.7–3
35		Shape	Ovate	Obovate	Lanceolate
36		Colour	Cream	White	Cream or white
37		Apex	Highly corrugated	Highly corrugated	Highly corrugated
38		Acumen (cm)	0.4–0.6	0.4–0.6	0.4–0.6
39	Staminode	Size (cm)	1.9–2.5	1.4–2.1	2.6–3.8
40	Ovary	Length (cm)	10.3–11.5	8.3–10	8.5–10
41		Colour	Greenish yellow	Pale green with yellow tinge	Yellowish green with purple tip
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Falling vertically	Falling with a curve	Falling vertically
44		Nature	Bracts & flowers persistent on entire stalk	Bare	Few hands of persistent neutral flowers near fruit & rest bare
45		Length @ fruit maturity (cm)	35–43	65–83	90–110
46		Bract scars	Persistent bracts	Prominent	Prominent
47	Male bud	Shape	Lanceolate to intermediate	Lanceolate to intermediate	Top-shaped to intermediate

48		Nature	Convolute	Convolute	Convolute
49	Male bract	Size (cm)	20–26.5 × 11.2–12.5	20–25 × 11.2–13	20–25 × 15–17.5
50		Surface nature	Slightly grooved	Grooved	Slightly grooved
51		Shape	Intermediate to lanceolate	Intermediate to lanceolate	Lanceolate to intermediate
52		Colour-abaxial	Purplish maroon with yellow patches	Purplish maroon with yellow patches	Dark purplish maroon with violet tinge
53		Colour-adaxial	Orange-red with yellow base & red tip	Orange-red with cream base & base and red tip	Reddish maroon with cream base
54		Colour fading	Fades towards base	Fades towards base	Fades towards base
55		Apex	Obtuse & split	Obtuse & split	Slightly pointed
56		Bract behavior	Just open	Just open	Reflexed & revolute
57		Nature	Persistent	Deciduous	Deciduous
58	Male flowers	Numbers/bract	16–18	16–19	13–17
59		Predominant colour	Cream	Cream	Cream with purple fleshy
60		Nature	Persistent	Deciduous	Deciduous
61	Compound tepal	Size (cm)	3.5–4.2 × 1.1–1.7	3.8–4.2 × 1.3–1.8	5.8–6.5 × 2–2.5
62		Colour	Cream	Cream	Cream with purple fleshy and black pigmentation on the upper part
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.2–2.4 × 1.2–1.7	2–2.2 × 1.7–1.9	3.8–4.2 × 2.4–2.8
65		Shape	Oblong	Oblong	Lanceolate
66		Colour	White	White	White or creamy white
67		Apex	Highly corrugated	Highly corrugated	Highly corrugated
68		Acumen (cm)	0.2–0.3	0.4–0.6	0.5–0.7
69	Stamen	Length (cm)	3.7–4.6	3.4–3.6	5.5–6
70		Filament length (cm)	1.2–1.8	1.5–1.6	3–3.3
71		Filament colour	White	White	White
72		Anther length (cm)	1.9–2.5	1.9–2.1	2.5–2.7

73		Anther colour	Creamy white	Creamy white	White or creamy white
74		Thecae colour	White	White	Brown
75	Ovary pigmentation		Absent	Absent	Reddish maroon
76	Style nature		Straight	Straight	Straight
77	Stigma colour		Yellow	Dull yellow	Yellow
78	Fruit bunch	Appearance	Compact	Compact	Compact
79		Number of hands	7–11	9–13	4–10
80		Axis	Pendulous	Pendulous	Pendulous
81	Fruits	Number on mid hand	12–18	18–30	10–18
82		Pedicel length	1.5–2.6	2.5–3	0.8–2
83		Base	No sign of fusion	No sign of fusion	Fused at the base
84		Fruit length (cm)	12–18	15–23	14–17
85		Circumference (cm)	14–20	14–20	14–21
86		Shape	Curved	Curved	Curved
87		Nature	Curved back to axis	Curved back to axis	Curved back to axis
88		C.S.	Pronouncedly ridged	Slightly ridged	Circular
89		Apex nature	Lengthily pointed	Lengthily pointed	Blunt-tipped
90		Floral relicts	Persistent style base	Persistent floral relicts	Persistent floral relicts
91		Mature peel colour	Dark green	Dark green	Greenish purple
92		Ripened peel colour	Green with slight yellow	Yellow	Purple

No.	Attributes		7. *Robusta*	8. *Kunnan*	9. *Matti*
1	Habit		Robust	Slender	Slender
2	Pseudostem	Height (cm)	180–240	210–240	230–280
3		Circumference at base (cm)	48–55	35–50	40–53
4		Colour	Maroon with greyish yellow tinge	Yellowish green with maroon pigmentation	Yellowish green with maroon pigmentation
5		Underlying colour	Yellowish green with reddish maroon pigmentation	Greenish white with slight purplish maroon fadings	Greenish white with slight purplish maroon patches
6		Blotches at the tip	Large & extensive (brown)	Scattered blotches (black)	Large & extensive (black)
7	Sap Colour		Watery	Watery	Watery
8	Leaf habit		Drooping	Erect	Erect
9	Lamina	Size (cm)	182–198 × 66–74	145–155 × 50–60	150–175 × 50–64
10		Shape	Elliptic	Linear-lanceolate	Linear-lanceolate
11		Base	Both pointed	Both rounded	Both rounded
12		Symmetry	Asymmetric	Symmetric	Symmetric
13	Petiole	Length (cm)	17–25	42–50	46–65
14		Base	Winged & not clasping	Not winged & clasping	Not winged & clasping
15		Canal	Open with spreading	Slightly curved inwards	Straight
16		Margin colour	Purple	Purple	Purple
17	Inflorescence (at advanced stage)		Pendulous	Sub-horizontal	Sub-horizontal
18	Peduncle	Length (cm)	45–54	30–45	40–50
19		Nature	Hairy	Glabrous	Glabrous
20		Colour	Dark green with blackish pigmentation	Green with black dots	Yellowish green with slight maroon tinge
21	Female bud	Shape	Linear-lanceolate	Linear-lanceolate	Linear-lanceolate
22		Nature	Slightly imbricate	Imbricate	Imbricate
23	Female bract	Size (cm)	32–39 × 12–15	25–30 × 10–12	27–32 × 10.5–16
24		Shape	Lanceolate	Lanceolate	Lanceolate

25		Colour-abaxial	Greenish yellow with purplish maroon base	Blackish maroon with yellow patches	Blackish maroon with purple tinge
26		Colour-adaxial	Yellowish orange with reddish orange upper part and cream base	Reddish maroon	Reddish maroon with slight purplish tinge
27		Colour fading	Fades towards base	Slightly fades towards base	No sign of colour fadings towards base
28		Apex	Obtuse & split	Obtuse & split	Intermediate
29		Bract behavior	Just open, not reflexed	Reflexed & revolute	Reflexed & revolute
30	Female flower length (cm)		12–13	9.5–12.2	9.5–12.5
31	Compound tepal	Size (cm)	3.8–4.2 × 1.8–2.2	4–4.4 × 1.5–2	4.1–4.4 × 1.5–2.1
32		Colour	Cream	Cream with maroon patches	Cream with maroon patches
33		Lobe colour	Yellow	Yellow	Yellow
34	Free tepal	Size (cm)	2.2–2.4 × 1.8–2	2.4–3 × 1.5–2	2.5–3 × 1.5–2
35		Shape	Ovate-oblong	Obovate	Obovate
36		Colour	White or creamy white	Cream	Cream
37		Apex	Highly corrugated	Highly corrugated	Highly corrugated
38		Acumen (cm)	0.4–0.6	0.4–0.6	0.5–0.6
39	Staminode	Size (cm)	1.7–2.2	1.2–1.7	1.3–2.2
40	Ovary	Length (cm)	7.8–8.8	6.5–7.8	6.6–8
41		Colour	Pale green	Dull yellowish green	Dull yellow
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Falling vertically with a curve	Falling at an angle	Falling at an angle
44		Nature	Bare	Bare	Bare
45		Length @ fruit maturity (cm)	45–56	65–85	62–95
46		Bract scars	Prominent	Prominent	Prominent
47	Male bud	Shape	Lanceolate	Lanceolate to intermediate	Lanceolate
48		Nature	Slightly imbricate	Highly imbricate	Highly imbricate
49	Male bract	Size (cm)	20–23 × 9–13	15–19 × 8.1–10	16–22 × 8.1–12.2

50		Surface nature	Minutely grooved	Smooth	Smooth
51		Shape	Intermediate to lanceolate	Intermediate to lanceolate	Intermediate to lanceolate
52		Colour-abaxial	Purplish maroon	Dark purplish maroon with slight black markings	Purplish maroon
53		Colour-adaxial	Orange-red fades to cream towads base & margins and red tip	Dark reddish maroon	Reddish maroon
54		Colour fading	Fades towards base	No sign of colour fading	No sign of colour fading
55		Apex	Obtuse & split	Intermediate to obtuse	Intermediate
56		Bract behavior	Just open	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	12–16	14–18	14–18
59		Predominant colour	Cream	Cream	Cream with slight maroon tinge
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	3.4–3.7 × 1.3–1.6	3.3–4.1 × 1–2.2	3.8–4.7 × 0.9–2.2
62		Colour	Cream	Cream with maroon patches	Cream with maroon patches
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.2–2.4 × 1.4–1.6	1.8–3 × 1.2–1.8	2–3 × 1.5–1.8
65		Shape	Oblong	Oblong	Oblong
66		Colour	Creamy white	White or cream	Cream
67		Apex	Slightly corrugated	Highly corrugated	Highly corrugated
68		Acumen (cm)	0.4–0.6	0.4–0.6	0.6–1
69	Stamen	Length (cm)	3.4–3.6	3.2–4	3.2–4.3
70		Filament length (cm)	1.6–1.7	1.9–2.2	1.7–2.2
71		Filament colour	White	Cream	Cream
72		Anther length (cm)	1.9–2.1	1.3–2	1.4–2
73		Anther colour	Cream	Cream	Cream
74		Thecae colour	Gray	Purplish maroon	Pinkish purple

75	Ovary pigmentation		Absent	Slight maroon	Slight maroon
76	Style nature		Straight	Curved at base	Curved at base
77	Stigma colour		Yellow	Dull yellow	Dull yellow
78	Fruit bunch	Appearance	Compact	Compact	Compact
79		Number of hands	7–10	5–9	5–10
80		Axis	Pendulous	Sub-horizontal	Sub-horizontal
81	Fruits	Number on mid hand	12–22	9–14	10–15
82		Pedicel length	1.5–2.2	1.5–2	2.3–3
83		Base	No sign of fusion	No sign of fusion	No sign of fusion
84		Fruit length (cm)	14–22	8.5–11.5	8–11
85		Circumference (cm)	13–18	8–12	8–12
86		Shape	Curved	Straight	Curved
87		Nature	Curved back to axis	Perpendicular to axis	Curved back to axis
88		C.S.	Slightly ridged	Circular	Slightly ridged
89		Apex nature	Pointed	Bottle-necked	Bottle-necked
90		Floral relicts	Persistent floral relicts	Persistent floral relicts	Persistent floral relicts
91		Mature peel colour	Dark green	Dark green	Dark green
92		Ripened peel colour	Dark green	Dark yellow	Bright yellow

No.	Attributes		10. *Neypoovan*	11. *Thaenkunnan*	12. *Namarai*
1	Habit		Slender	Medium stout	Normal
2	Pseudostem	Height (cm)	250–350	270–350	270–320
3		Circumference at base (cm)	50–58	46–65	46–55
4		Colour	Yellowish green	Yellowish green with black patches	Yellowish green with black patches
5		Underlying colour	Whitish green with slight purlish blotches	Yellowish green with maroon pigmentation	Whitish yellow with slight maroon tinge
6		Blotches at the tip	Scattered (black/ blackish brown)	Sparse blotches (blackish maroon)	Scattered blotches (black)
7	Sap Colour		Milky white	Watery	Watery
8	Leaf habit		Intermediate	Erect	Intermediate
9	Lamina	Size (cm)	165–215 × 53–65	215–268 × 63–77	215–245 × 63–67
10		Shape	Oblanceolate	Linear-lanceolate	Linear-lanceolate
11		Base	One rounded & other pointed	Both rounded	Both auriculated & rounded
12		Symmetry	Asymmetric	Asymmetric	Symmetric
13	Petiole	Length (cm)	60–75	45–51	45–51
14		Base	Winged & clasping	Not winged & clasping	slightly winged & clasping
15		Canal	Curved inwards	Straight with erect	Wide with erect
16		Margin colour	Purple	Purplish maroon	Blackish brown
17	Inflorescence (at advanced stage)		Sub-horizontal	Pendulous	Sub-horizontal
18	Peduncle	Length (cm)	32–46	50–73	60–70
19		Nature	Slightly pubescent	Glabrous	Glabrous
20		Colour	Light green with maroon pigmentation	Dark green	Dark green
21	Female bud	Shape	Lanceolate	Linear-lanceolate	Linear-lanceolate
22		Nature	Slightly imbricate	Minutely imbricate	Imbricate
23	Female bract	Size (cm)	27–36 × 14–20	23.7–37 × 7–13	28–35 × 15–18.5
24		Shape	Lanceolate	Lanceolate	Lanceolate

25		Colour-abaxial	Dark maroon with or without light yellow patches	Blackish maroon with yellowish green tip	Blackish maroon with or without yellowish green patches and red tip
26		Colour-adaxial	Reddish maroon	Reddish maroon	Reddish maroon with orange tinge
27		Colour fading	No sign of colour fadings	Fades towards base	No sign of colour fadings
28		Apex	Obtuse & split	Pointed & split	Obtuse
29		Bract behavior	Reflexed & revoluted	Reflexed & revolute	Reflexed & revolute
30	Female flower length (cm)		11.3–15	10–13.8	11–12.5
31	Compound tepal	Size (cm)	4.5–5.7 × 1.9–2.9	4.3–5.6 × 1.5–2.2	4–4.3 × 1–1.5
32		Colour	Creamy white with maroon tinge	Cream with maroon patches	Cream with reddish maroon base
33		Lobe colour	Yellow	Yellow	Yellow
34	Free tepal	Size (cm)	3.1–3.4 × 1.7–2.2	2.5–3 × 1.5–2.3	2.7–2.9 × 2.1–2.3
35		Shape	Lanceolate	Ovoid-lanceolate	Ovoid
36		Colour	White with purplish tinge	Cream	Cream
37		Apex	Highly corrugated	Highly corrugated	Highly corrugated
38		Acumen (cm)	Not prominent	0.4–0.6	0.5–0.6
39	Staminode	Size (cm)	1.7–3.8	2–3.5	1.9–2.7
40	Ovary	Length (cm)	7.3–10.2	6.5–8.5	7.8–8.3
41		Colour	Pale green with or without purple patches at base & tip	Pale green	Yellowish green
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Falling at an angle	Falling vertically	Falling vertically
44		Nature	Bare	Bare	Few hands of persistent neutral flowers near fruit & rest bare
45		Length @ fruit maturity (cm)	78–86	45–53	75–83
46		Bract scars	Prominent	Scarcely prominent	Prominent

47	Male bud	Shape	Lanceolate	Lanceolate	Intermediate to top-shaped
48		Nature	Highly imbricate	Imbricate	Imbricate
49	Male bract	Size (cm)	14–20.3 × 8.3–13.5	20–22 × 8–8.8	17.5–20 × 12–13.5
50		Surface nature	Slightly grooved	Grooved	Grooved
51		Shape	Lanceolate	Lanceolate	Intermediate
52		Colour-abaxial	Dark purplish maroon	Blackish purple	Dark brownish purple
53		Colour-adaxial	Maroon	Reddish maroon	Reddish maroon
54		Colour fading	No sign of colour fadings	No sign of colour fading	No sign of colour fading
55		Apex	Obtuse	Obtuse & split	Intermediate to obtuse
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	13–19	8–12	12–14
59		Predominant colour	Cream with purple fleshy	Cream	Cream with purple fleshy
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	4.8–5.8 × 1.3–1.9	5.4–5.8 × 1.3–1.6	4.5–4.8 × 1.5–1.9
62		Colour	Cream with purple fleshy	Cream with maroon patches	Cream with maroon patches
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.6–3 × 1.3–1.9	2.4–2.7 × 1.8–2	2.3–2.5 × 1.7–2
65		Shape	Lanceolate	Oblong-ovate	Oblong-ovate
66		Colour	Cream with purple tinge	Creamy white with maroon tinge	White
67		Apex	Highly corrugated	Highly corrugated	Corrugated
68		Acumen (cm)	0.4–0.6	0.4–0.6	0.3–0.4
69	Stamen	Length (cm)	4.8–5.5	4–4.5	4.2–4.5
70		Filament length (cm)	2.5–3.5	2–2.8	2.1–2.3
71		Filament colour	Creamy white	Cream	White
72		Anther length (cm)	2–3	1.8–2.2	1.8–2.1
73		Anther colour	Cream	Creamy white	White or creamy white
74		Thecae colour	Brown or cream	Brownish violet	Brownish violet
75	Ovary pigmentation		Purple	Absent	Purple fleshy

76	Style nature		Straight	Straight	Curved at base
77	Stigma colour		Pale yellow	Dull yellow	Dull yellow
78	Fruit bunch	Appearance	Lax	Lax	Lax
79		Number of hands	6–10	5–14	5–7
80		Axis	Sub-horizontal	Pendulous	Sub-horizontal
81	Fruits	Number on mid hand	10–18	8–16	10–16
82		Pedicel length (cm)	1.8–2.5	4–6	1.9–2.2
83		Base	No sign of fusion	Completely fused at the base	No sign of fusion
84		Fruit length (cm)	7–11.5	12.5–16	13.5–15
85		Circumference (cm)	8–11	11–15	10–14
86		Shape	Curved	Curved	Straight
87		Nature	Curved back to axis	Curved back to axis	Perpendicular to axis
88		C.S.	Slightly ridged	Pronouncedly ridged	Pronouncedly ridged
89		Apex nature	Bottle-necked	Lengthily pointed	Pointed
90		Floral relicts	Persistent floral relicts	Persistent style base	Persistent style base
91		Mature peel colour	Dark green	Dark green	Dark green
92		Ripened peel colour	Bright yellow	Yellow with green tinge and black markings	Yellow with black markings

No.	Attributes		13. *Nendran*	14. *Pachanadan*	15. *Poovan*
1	Habit		Normal	Normal	Normal
2	Pseudostem	Height (cm)	260–330	260–320	240–320
3		Circumference at base (cm)	45–65	58–65	47–69
4		Colour	Yellowish green with black patches	Yellowish green with maroon pigmentation	Purplish maroon with yellowish green tinge
5		Underlying colour	Whitish green with purple blotches	Greenish yellow with slight maroon tinge	Yellowish green with purple tinge
6		Blotches at the tip	Scattered dots (brown)	Sparse blotches (blackish brown)	Large & extensive blotches (black)
7	Sap Colour		Watery	Watery	Watery
8	Leaf habit		Drooping	Intermediate	Drooping
9	Lamina	Size (cm)	190–220 × 65–70	175–240 × 75–80	176–230 × 68–85
10		Shape	Oblong	Linear-lanceolate	Oblong-lanceolate
11		Base	One rounded & other pointed	Both rounded	Both auriculated & rounded
12		Symmetry	Asymmetric	Symmetric	Asymmetric
13	Petiole	Length (cm)	35–57	45–52	45–73
14		Base	Not winged & clasping	Not winged & clasping	Not winged & clasping
15		Canal	Curved inwards	Wide with erect	Straight with erect
16		Margin colour	Pinkish purple/red	Green with gray tinge	Purplish maroon
17	Inflorescence (at advanced stage)		Pendulous	Sub-horizontal	Pendulous
18	Peduncle	Length (cm)	45–60	65–74	45–55
19		Nature	Glabrous	Glabrous	Slightly pubescent
20		Colour	Dull green	Dark green with purplish maroon pigmentation	Dark green with or withot maroon pigmentation
21	Female bud	Shape	Linear-lanceolate	Lanceolate	Obovate-lanceolate
22		Nature	Slightly imbricate	Imbricate	Imbricate
23	Female bract	Size (cm)	28–38 × 13–18	31–39.5 × 18–20	25–36 × 15–24
24		Shape	Lanceolate	Lanceolate	Obovate-lanceolate

25		Colour-abaxial	Dark blackish purple with greenish yellow patches	Maroon with greenish yellow patches	Dark maroon with or without light yellow patches
26		Colour-adaxial	Reddish maroon with yellowish patches towards margins	Reddish maroon with yellowish orange tip	brownish maroon with or without light yellow patches
27		Colour fading	No sign of colour fadings	Fades towards base	No sign of colour fadings
28		Apex	Obtuse & split	Obtuse	Obtuse
29		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
30	Female flower length (cm)		16–19	11.7–14	10–12.5
31	Compound tepal	Size (cm)	4.4–4.7 × 2.2–2.5	4–4.7 × 2–2.2	3.9–4.9 × 1.9–2.5
32		Colour	Cream	Creamy white with or without maroon pigmentation	Cream with maroon fleshy patches
33		Lobe colour	Yellowish orange	Yellow	Yellow
34	Free tepal	Size (cm)	3.2–3.5 × 2.2–2.4	2.7–3 × 2.4–2.6	2.4–3 × 2–2.6
35		Shape	Ovate	Ovoid	Ovate-obovate
36		Colour	White with yellow patches	Cream	Cream
37		Apex	Highly corrugated	Corrugated	Highly corrugated
38		Acumen (cm)	0.6–0.9	0.4–0.7	0.4–0.6
39	Staminode	Size (cm)	3.1–3.9	2–2.7	1.4–2.2
40	Ovary	Length (cm)	13.5–14	7–9.2	7.4–9
41		Colour	Pale green with slight purplish pedicel	Light yellowish green	Yellowish green
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Falling vertically	Falling vertically	Falling vertically
44		Nature	Persistent male flowers & bracts	Bare	Bare
45		Length @ fruit maturity (cm)	48–64	57–63	64–76
46		Bract scars	Prominent	Prominent	Prominent
47	Male bud	Shape	Lanceolate	Intermediate to top shaped	Lanceolate to intermediate
48		Nature	Highly imbricate	Imbricate	Minutely imbricate

49	Male bract	Size (cm)	24–29 × 13–14.8	15.3–20 × 10.8–13.1	15–20.5 × 9–12.5
50		Surface nature	Grooved	Grooved	Grooved
51		Shape	Lanceolate	Intermediate to top-shaped	Lanceolate to intermediate
52		Colour-abaxial	Purplish maroon	Dark purplish maroon	Dark blackish maroon
53		Colour-adaxial	Reddish maroon	Reddish maroon	Reddish maroon
54		Colour fading	No sign of colour fadings	No sign of colour fading	No sign of colour fading
55		Apex	Obtuse & split	Intermediate	Intermediate to obtuse
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Persistent	Deciduous	Deciduous
58	Male flowers	Numbers/bract	9–12	10–15	13–18
59		Predominant colour	Cream	Cream	Cream
60		Nature	Persistent	Deciduous	Deciduous
61	Compound tepal	Size (cm)	5.2–5.8 × 1.5–1.8	3.9–4.4 × 1.5–1.6	4.8–5.2 × 1.1–1.5
62		Colour	Cream	Cream with slight purplish maroon tinge	Creamy white with or without maroon patches
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	3–3.3 × 2.6–2.8	2.2–2.7 × 1.5–1.8	2.1–2.7 × 1.4–1.9
65		Shape	Ovate-oblong	Oblong-ovate	Lanceolate
66		Colour	Cream	Cream	White or creamy white
67		Apex	Highly corrugated	Corrugated	Slightly corrugated
68		Acumen (cm)	0.6–0.9	0.3–0.4	0.1–0.3
69	Stamen	Length (cm)	4.6–5	2.7–4.5	3.9–4.6
70		Filament length (cm)	2.4–2.7	1.3–2.5	1.6–2.5
71		Filament colour	Cream	White or creamy white	White or creamy white
72		Anther length (cm)	2.4–2.7	1.5–2.3	1.9–2.5
73		Anther colour	Cream	Rusty brown	Cream
74		Thecae colour	White	Rusty brown	Yellow or cream
75	Ovary pigmentation		Absent	Purplish maroon	Cream / purple
76	Style nature		Straight	Straight	Curved at base
77	Stigma colour		Yellow	Yellow	Yellow
78	Fruit bunch	Appearance	Lax	Lax	Very compact

79		Number of hands	5–8	7–8	7–15
80		Axis	Pendulous	Sub-horizontal	Pendulous
81	Fruits	Number on mid hand	8–10	12–16	12–19
82		Pedicel length (cm)	3.7–4.3	1.5–2	1.9–2.4
83		Base	No sign of fusion	No sign of fusion	Fused at base
84		Fruit length (cm)	20–27	11–15	9–13.5
85		Circumference (cm)	14–18	12–16	9–11
86		Shape	Straight in the distal part	Straight	Straight
87		Nature	Perpendicular to axis	erpendicular to axis	Perpendicular to axis
88		C.S.	Pronouncedly ridged	Slightly ridged	Slightly ridged
89		Apex nature	Lengthily pointed	Pointed	Bottle-necked
90		Floral relicts	Persistent floral relicts	Persistent style base	Absent
91		Mature peel colour	Dark green	Dark green	Dark green
92		Ripened peel colour	Brownish yellow with black markings	Greenish yellow	Bright yellow

No.	Attributes		16. *Rasthali*	17. *Sirumalai*	18. *Vannan*
1	Habit		Normal	Normal	Tall
2	Pseudostem	Height (cm)	170–200	270–320	280–390
3		Circumference at base (cm)	45–63	45–55	51–75
4		Colour	Green to yellowish green with or without blackish patches	Yellowish green with purple pigmentation	yellowish green with brown patches
5		Underlying colour	Whitish green with purple blotches	Whitish to yellowish green with slight maroon pigmentation	Green with pink tinge
6		Blotches at the tip	Sparse blotches (brown)	Sparse blotches (blackish brown)	Large & extensive blotches (black)
7	Sap Colour		Watery	Watery	Milky white
8	Leaf habit		Intermediate to drooping	Intermediate	Erect
9	Lamina	Size (cm)	156–240 × 42–68	210–225 × 65–70	180–230 × 55–77
10		Shape	Linear-lanceolate	Linear-lanceolate	Oblong-lanceolate
11		Base	One rounded & other pointed	Both rounded	One rounded & other pointed
12		Symmetry	Asymmetric	Asymmetric	Asymmetric
13	Petiole	Length (cm)	45–67	45–51	45–73
14		Base	Not winged & clasping	Not winged & clasping	Not winged & clasping
15		Canal	Straight with erect	Wide with erect	Open with spreading
16		Margin colour	Light maroon	Pink purple	Gray
17	Inflorescence (at advanced stage)		Sub-horizontal	Horizontal	Sub-horizontal
18	Peduncle	Length (cm)	47–58	52–62	43–55
19		Nature	Slightly pubescent	Glabrous	Slightly pubescent
20		Colour	Dull green	Dark green with black dots	Dark green
21	Female bud	Shape	Linear-lanceolate	Linear-lanceolate	Obovate-lanceolate
22		Nature	Imbricate	Imbricate	Imbricate
23	Female bract	Size (cm)	28–38 × 13–18	25–35 × 15–22	27–35 × 19–24
24		Shape	Lanceolate	Obovate-lanceolate	Obovate-lanceolate

25		Colour-abaxial	Dark blackish maroon with or without yellowish green patches	Blackish maroon with greenish yellow patches and yellow tip	Dark maroon
26		Colour-adaxial	Reddish maroon with yellowish patches towards margin	Reddish maroon with yellow tip	Maroon
27		Colour fading	Fades towards base	No sign of colour fadings	No sign of colour fadings
28		Apex	Obtuse	Obtuse & split	Intermediate to obtuse
29		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
30	Female flower length (cm)		7–10	11–13.5	13–15
31	Compound tepal	Size (cm)	4.8–5.5 × 2.3–2.7	4.2–5.2 × 2–2.3	4–4.9 × 1.9–2.2
32		Colour	Creamy white with or without slight pink strands	Cream with maroon tinge	Cream with light maroon pigmentation
33		Lobe colour	Yellow	Yellow	Yellow
34	Free tepal	Size (cm)	3.2–3.6 × 2.1–2.7	2.7–3.2 × 2–2.3	2.4–2.8 × 1.9–2.2
35		Shape	Oblong-lanceolate	Ovate-obovate	Oblanceolate
36		Colour	White or creamy white	Cream	White
37		Apex	Highly corrugated	Corrugated	Highly corrugated
38		Acumen (cm)	0.7–0.9	0.3–0.4	0.3–0.5
39	Staminode	Size (cm)	1.3–3.2	2–3.3	2.1–2.5
40	Ovary	Length (cm)	7.3–8.3	7.5–8.5	8–9.5
41		Colour	Light yellowish green	Yellowish green	Yellowish green
42		Number of rows of ovules per locule	Two	Two	Two
43	Rachis	Position	Falling vertically	Falling vertically	Falling vertically
44		Nature	Bare	Bare	Bare
45		Length @ fruit maturity (cm)	75–85	75–81	61–75
46		Bract scars	Prominent	Prominent	Prominent
47	Male bud	Shape	Lanceolate	Top-shaped	Top-shaped to intermediate
48		Nature	Highly imbricate	Imbricate	Slightly imbricate

49	Male bract	Size (cm)	18–23 × 11.5–13.5	17–20 × 12–15	16–20 × 10–13
50		Surface nature	Grooved	Grooved	Grooved
51		Shape	Lanceolate	Top-shaped	Intermediate to obovate
52		Colour-abaxial	Blackish maroon with black patches	Dark blackish maroon	Dark maroon
53		Colour-adaxial	Reddish maroon	Reddish maroon	Reddish maroon
54		Colour fading	Fades towards base	No sign of colour fading	Fades towards base
55		Apex	Slightly pointed	Intermediate	Intermediate to obtude
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	10–16	12–14	15–18
59		Predominant colour	Cream	Cream with purple tinge	Cream
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	5.2–5.8 × 1.5–2	4.5–5 × 1.5–1.9	4.7–5.2 × 1.1–1.5
62		Colour	Creamy white with maroon patches	Cream with slight purplish maroon tinge	Cream
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.7–3.2 × 1.9–2.2	2.3–2.5 × 1.7–2	2.5–3 × 1.8–2.1
65		Shape	Linear-lanceolate	Ovate	Ovate
66		Colour	White or creamy white	White or cream	White with light yellow base
67		Apex	Highly corrugated	Minutely corrugated	Slightly corrugated
68		Acumen (cm)	0.3–0.4	0.2–0.3	0.3–0.4
69	Stamen	Length (cm)	4.3–5	4–5.1	4.5–4.9
70		Filament length (cm)	2–2.5	1.7–3	2.5–2.8
71		Filament colour	White	White	White
72		Anther length (cm)	2.2–2.5	2–2.2	2–2.3
73		Anther colour	Creamy white	Cream	Creamy white
74		Thecae colour	Brown / black	Brownish violet	Yellowish brown
75	Ovary pigmentation		Absent	Purple fleshy	Purple fadings
76	Style nature		Straight	Curved at base	Straight

77	Stigma colour		Brownish yellow	Dull yellow	Yellow
78	Fruit bunch	Appearance	Lax	Lax	Compact
79		Number of hands	5–8	5–7	7–10
80		Axis	Sub-horizontal	Horizontal	Sub-horizontal
81	Fruits	Number on mid hand	5–12	10–14	8–15
82		Pedicel length (cm)	1.3–2	1.5–2	2.3–3.5
83		Base	Fused at base	No sign of fusion	Fused at base
84		Fruit length (cm)	9–15	9–11	12–15
85		Circumference (cm)	9–12.5	9–10	10–14
86		Shape	Straight in the distal part	Straight	Straight
87		Nature	Slightly curved towards axis	Perpendicular to axis	Perpendicular to axis
88		C.S.	Rounded	Pronouncedly ridged	Pronouncedly ridged
89		Apex nature	Blunt-tipped	Lengthily pointed	Bottle-necked
90		Floral relicts	Absent	Absent	Absent
91		Mature peel colour	Dark green	Dark green	Dark green
92		Ripened peel colour	Bright yellow	Yellow with green tinge	Greenish yellow

No.	Attributes		19. *Virupakshi*	20. *Kachkol*	21. *Karpuravalli*
1	Habit		Normal	Tall & robust	Tall & stout
2	Pseudostem	Height (cm)	250–270	300–330	250–320
3		Circumference at base (cm)	42–54	48–55	46–59
4		Colour	Greenish yellow with purplish tinge	Yellowish green	yellowish green
5		Underlying colour	Greenish yellow with purple tinge	Light yellowish green	Light green
6		Blotches at the tip	Sparse blotches (blackish brown)	Absent	Absent
7	Sap Colour		Watery	Watery	Watery
8	Leaf habit		Intermediate to drooping	Drooping	Drooping
9	Lamina	Size (cm)	180–190 × 55–60	170–185 × 50–60	176–190 × 60–70
10		Shape	Linear-lanceolate	Oblong-lanceolate	Oblong-lanceolate
11		Base	Both rounded	Both auriculated & rounded	Both auriculated & rounded
12		Symmetry	Symmetric	Symmetric	Asymmetric
13	Petiole	Length (cm)	47–51	52–58	42–55
14		Base	Not winged & clasping	Not winged & clasping	Not winged & clasping
15		Canal	Wide with erect	Overlapping	Overlapping
16		Margin colour	Pinkish purple	Whitish green	Gray
17	Inflorescence (at advanced stage)		Horizontal	Pendulous	Pendulous
18	Peduncle	Length (cm)	34–45	60–83	60–90
19		Nature	Glabrous	Glabrous	Pubescent
20		Colour	Yellowish green	Light green	Light green
21	Female bud	Shape	Linear-lanceolate	Lanceolate	Obovate-lanceolate
22		Nature	Imbricate	Imbricate	Highly imbricate
23	Female bract	Size (cm)	25–33 × 13–18	26–35 × 15–21	20–28 × 14–19
24		Shape	Obovate-lanceolate	Intermediate to lanceolate	Ovate-obovate
25		Colour-abaxial	Purplish maroon with greenish yellow patches	Maroon with greenish yellow patches	Purplish maroon with greenish yellow tinge
26		Colour-adaxial	Orange red with greenish yellow tip	Dark reddish maroon with yellowish tip	Reddish maroon

27		Colour fading	No sign of colour fadings	No sign of colour fadings	No sign of colour fadings
28		Apex	Obtuse & split	Obtuse & split	Obtuse
29		Bract behavior	Reflexed & revolute	Reflexed but not revolute	Reflexed but not revolute
30	Female flower length (cm)		10.4–11.7	10–14.8	9–13
31	Compound tepal	Size (cm)	3.8–4.2 × 1.8–2.3	4.2–5.1 × 1.9–2.7	3.6–4.3 × 1.7–2.3
32		Colour	Cream with purple fleshy tinge	Cream with pinkish maroon tinge	Cream with pinkish maroon flesh
33		Lobe colour	Yellow	Yellow	Yellow
34	Free tepal	Size (cm)	2.7–2.9 × 2–2.3	3.1–4 × 2.2–3.4	2.8–3.3 × 2.5–3
35		Shape	Ovate-obovate	Ovate-obovate	Ovate-obovate
36		Colour	Cream	Cream with purplish maroon pigmentation	Cream with purplish maroon pigmentation
37		Apex	Corrugated	Highly corrugated	Highly corrugated
38		Acumen (cm)	0.3–0.4	0.4–0.6	0.3–0.4
39	Staminode	Size (cm)	2.2–2.6	2–3.6	1.3–2.3
40	Ovary	Length (cm)	7–7.8	8.3–11	7.1–9
41		Colour	Light yellowish green	Yellowish green with purplish patches at tip	Yellowish green with purple patches at tip
42		Number of rows of ovules per locule	Two	Four	Four
43	Rachis	Position	Falling vertically	Falling vertically	Falling vertically
44		Nature	Bare	Bare	Bare
45		Length @ fruit maturity (cm)	55–65	53–67	60–105
46		Bract scars	Prominent	Prominent	Prominent
47	Male bud	Shape	Intermediate to top-shaped	Lanceolate to top-shaped	Lanceolate to intermediate
48		Nature	Imbricate	Highly imbricate	Highly imbricate
49	Male bract	Size (cm)	17–20 × 11–13	13.6–22 × 9–15.8	17–22.3 × 12.4–15.2
50		Surface nature	Grooved	Minutely grooved	Smooth
51		Shape	Lanceolate-intermediate	Obovate-oblong	Oblong
52		Colour-abaxial	Purplish maroon	Purplish maroon	Purplish maroon with yellowish green patches &

					yellow tip
53		Colour-adaxial	Reddish maroon	Reddish maroon with or without yellow tip	Reddish maroon with yellow tip
54		Colour fading	No sign of colour fading	No sign of colour fading	Fades towards base
55		Apex	Intermediate	Intermediate	Intermediate
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	12–14	14–20	18–20
59		Predominant colour	Purplish maroon	Purplish violet	Purplish maroon
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	4.3–4.6 × 1.4–1.7	4.3–5.6 × 1.1–1.5	4.5–5.4 × 1.1–1.9
62		Colour	Cream with purple fleshy coloration	Purplish violet with cream margins	Cream with purplish maroon coloration
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2.3–2.6 × 1.9–2	2.5–3.3 × 1.7–3	3–3.6 × 2–2.6
65		Shape	Obovate	Obovate	Obovate
66		Colour	White or cream	Purplish violet	White with purplish maroon pigmentation
67		Apex	Highly corrugated	Minutely corrugated	Slightly corrugated
68		Acumen (cm)	0.2–0.3	0.2–0.4	0.2–0.3
69	Stamen	Length (cm)	3.8–4.2	3.9–5.2	4–4.7
70		Filament length (cm)	1.8–2.1	1.9–2.6	1.6–2.1
71		Filament colour	Cream	Cream with purple tinge	White with slight maroon tinge
72		Anther length (cm)	2–2.2	2–2.7	2.2–2.9
73		Anther colour	Cream	Cream	Cream
74		Thecae colour	Brown	Creamy white	White
75	Ovary pigmentation		Purple fleshy	Purple fleshy	Purple fadings
76	Style nature		Straight	Straight	Straight
77	Stigma colour		Yellow	Dull yellow	Dull yellow
78	Fruit bunch	Appearance	Lax	Lax	Lax
79		Number of hands	5–9	5–11	5–9

80		Axis	Horizontal	Pendulous	Pendulous
81	Fruits	Number on mid hand	8–14	9–13	10–18
82		Pedicel length (cm)	1.3–2	3–4	2.8–3.2
83		Base	Fused at base	No sign of fusion	Fused at base
84		Fruit length (cm)	8–11	14–19	11–14.5
85		Circumference (cm)	9–12.5	15.5–21	13–15
86		Shape	Straight	Straight in the distal part	Straight in the distal part
87		Nature	Perpendicular to axis	Negatively geotropic	Negatively geotropic
88		C.S.	Pronouncedly ridged	Pronouncedly ridged	Pronouncedly ridged
89		Apex nature	Lengthily pointed	Blunt-tipped	Pointed or bottle-necked
90		Floral relicts	Persistent style base	Persistent	Persistent
91		Mature peel colour	Dark green	Dark green	Dull green
92		Ripened peel colour	Yellow with slight green tinge	Golden yellow with brown blotches	Greenish yellow

No.	Attributes		22. *Kuribontha*	23. *Monthan*	24. *Peyan*
1	Habit		Medium	Normal	Tall
2	Pseudostem	Height (cm)	200–320	250–310	350–410
3		Circumference at base (cm)	44–53	46–55	57–72
4		Colour	Yellowish green	Yellowish green	Yellowish green with maroon pigmentation
5		Underlying colour	Light green	Light green	Whitish green
6		Blotches at the tip	Absent	Absent	Very sparse (black)
7	Sap Colour		Watery	Watery	Watery
8	Leaf habit		Drooping	Drooping	Drooping
9	Lamina	Size (cm)	172–190 × 60–72	176–190 × 60–70	206–220 × 60–67
10		Shape	Oblong-lanceolate	Oblong-lanceolate	Oblong-lanceolate
11		Base	Both auriculated rounded	Both auriculated & rounded	Both auriculated & rounded
12		Symmetry	Symmetric	Asymmetric	Asymmetric
13	Petiole	Length (cm)	44–60	42–55	64–70
14		Base	Not winged & clasping	Not winged & clasping	Not winged & clasping
15		Canal	Overlapping	Overlapping	Overlapping
16		Margin colour	Pinkish purple	Gray	Gray
17	Inflorescence (at advanced stage)		Sub-horizontal	Pendulous	Pendulous
18	Peduncle	Length (cm)	34–50	65–75	65–90
19		Nature	Glabrous	Pubescent	Glabrous
20		Colour	Dark green	Light green	Light green
21	Female bud	Shape	Ovate-lanceolate	Obovate-lanceolate	Obovate-lanceolate
22		Nature	Highly imbricate	Highly imbricate	Highly imbricate
23	Female bract	Size (cm)	24–27 × 15–17	20–28 × 14–19	28–32 × 19–20
24		Shape	Obovate-lanceolate	Ovate-obovate	Ovate-obovate
25		Colour-abaxial	Purplish maroon with greenish yellow tinge	Purplish maroon with greenish yellow tinge	Purplish maroon with greenish yellow tinge
26		Colour-adaxial	Dark reddish maroon with yellowish green tip	Reddish maroon	Reddish maroon
27		Colour fading	No sign of colour fadings	No sign of colour fadings	No sign of colour fadings
28		Apex	Obtuse & split	Obtuse & split	Obtuse & split
29		Bract behavior	Reflexed & revolute	Reflexed & rarely revolute	Reflexed & rarely revolute
30	Female flower length (cm)		9.5–12	9–13	11.4–13.5
31	Compound tepal	Size (cm)	3.5–3.7 × 2.2–2.5	3.6–4.3 × 1.7–2.3	3.9–4.3 × 1.8–2.1
32		Colour	Cream with pinkish maroon tinge	Cream with pinkish maroon tinge	Cream with pinkish maroon flesh

33		Lobe colour	Yellow	Yellow	Yellow
34	Free tepal	Size (cm)	3.1–3.3 × 2.8–3	2.8–3.3 × 2.5–3	3–3.3 × 2.5–2.7
35		Shape	Ovate-obovate	Ovate-obovate	Obovate-lanceolate
36		Colour	Cream with purplish maroon pigmentation	White with purplish maroon pigmentation	White
37		Apex	Highly corrugated	Highly corrugated	Highly corrugated
38		Acumen (cm)	0.2–0.3	0.3–0.4	0.3–0.4
39	Staminode	Size (cm)	1.5–2.3	1.3–2.3	1.3–1.6
40	Ovary	Length (cm)	7.5–8.4	7.1–9	7.7–8.5
41		Colour	Yellowish green with purplish patches at tip	Yellowish green with purplish patches at tip	Yellowish green with purple patches at tip
42		Number of rows of ovules per locule	Four	Four	Four
43	Rachis	Position	Falling vertically	Falling vertically	Falling vertically
44		Nature	Bare	Bare	Bare
45		Length @ fruit maturity (cm)	55–65	50–60	65–105
46		Bract scars	Prominent	Prominent	Prominent
47	Male bud	Shape	Intermediate	Lanceolate	Intermediate to top-shaped
48		Nature	Highly imbricate	Highly imbricate	Imbricate
49	Male bract	Size (cm)	16.3–17.5 × 11.4–12.2	17–22.3 × 12.4–15.2	20–23.5 × 12–13.5
50		Surface nature	Moderately grooved	Smooth	Smooth
51		Shape	Obovate-oblong to intermediate	Obovate-oblong	Intermediate
52		Colour-abaxial	Dark brownish maroon	Purplish maroon with yellowish green	Purplish maroon with yellowish green margin & tip
53		Colour-adaxial	Reddish maroon with yellow tip	Reddish maroon with yellow tip	Reddish maroon with yellow tip
54		Colour fading	No sign of colour fading	No sign of colour fading	No sign of colour fading
55		Apex	Obtuse	Obtuse but not split	Obtuse but not split
56		Bract behavior	Reflexed & revolute	Reflexed & revolute	Reflexed & revolute
57		Nature	Deciduous	Deciduous	Deciduous
58	Male flowers	Numbers/bract	16–18	18–20	18–22
59		Predominant colour	Purplish violet	Purplish maroon	Cream
60		Nature	Deciduous	Deciduous	Deciduous
61	Compound tepal	Size (cm)	4.2–4.6 × 1.1–1.3	4.5–5.4 × 1.1–1.9	4.9–5.2 × 1.2–1.4
62		Colour	Purplish violet with cream	Cream with purplish maroon	Cream with slight purplish maroon

			margins	pigmentation	tinge
63		Lobe colour	Yellow	Yellow	Yellow
64	Free tepal	Size (cm)	2–2.3 × 1.8–2	3–3.6 × 2–2.6	2.4–2.7 × 1.5–1.7
65		Shape	Oblong-ovate	Obovate	Oblanceolate
66		Colour	Purplish violet with cream base and tip	Cream with purplish maroon pigmentation	White
67		Apex	Minutely corrugated	Moderately corrugated	Highly corrugated
68		Acumen (cm)	0.2–0.4	0.2–0.3	0.1–0.2
69	Stamen	Length (cm)	4–4.4	4–4.7	3.7–4
70		Filament length (cm)	1.8–2.1	1.6–2.1	1.6–1.7
71		Filament colour	Cream with purplish maroon base & tip	White with maroon tinge	Cream
72		Anther length (cm)	1.8–2.2	2.2–2.9	2.1–2.3
73		Anther colour	Cream	Cream	Creamy yellow
74		Thecae colour	Cremy white	White	White or cream
75	Ovary pigmentation		Purplish violet	Purple fadings	Absent
76	Style nature		Straight	Straight	Curved at base
77	Stigma colour		Dull yellow	Dull yellow	Dull yellow
78	Fruit bunch	Appearance	Lax	Lax	Lax
79		Number of hands	5–8	5–9	7–10
80		Axis	Sub-horizontal	Pendulous	Pendulous
81	Fruits	Number on mid hand	10–12	10–16	12–16
82		Pedicel length (cm)	2.3–3.2	2.8–3.2	2.3–2.5
83		Base	Fused at base	No sign of fusion	Fused at base
84		Fruit length (cm)	8–14	11–14.5	9–11
85		Circumference (cm)	12–14	13–15	9–12
86		Shape	Straight	Straight	Straight
87		Nature	Perpendicular to axis	Negatively geotropic	Negatively geotropic
88		C.S.	Pronouncedly ridged	Pronouncedly ridged	Slightly ridged
89		Apex nature	Pointed	Pointed	Bottle-necked
90		Floral relicts	Persistent	Persistent	Persistent style base
91		Mature peel colour	Dark green	Dull green	Dull green
92		Ripened peel colour	Yellow with brownish red lines	Greenish yellow	Dull yellow

PHENETICS

Phenetics is the systems of classification based on overall similarity. This covers the general methods carried out in different phases of the study and it includes selection of accessions, selection and scoring of characters and analysis of data. All 24 taxa of cultivated banana of South India (Operational Taxonomic Units/OTU) were subjected to numerical analysis. Morpho-taxonomic characters were selected based on Descriptors for Banana (*Musa* spp.) (IPGRI-INIBAP/CIRAD, 1996) with some modifications. The taxa were grouped according to the character state and the characters were selected based on Sneath and Sokal (1973). The qualitative characters were directly converted to numerical code using different codes for different character states. The twenty four cultivars selected for the study are given in the **Table 04.**

Table 04: *Musa* cultivars (OTUs) selected for the study

Sl. No.	Name of Taxa (OTU)	Genomic group
1	*Musa acuminata* Colla 'Kadali'	AA
2	*Musa acuminata* Colla 'Karivazhai'	
3	*Musa acuminata* Colla 'Pisang lilin'	
4	*Musa acuminata* Colla 'Dwarf cavendish'	AAA
5	*Musa acuminata* Colla 'Grand naine'	
6	*Musa acuminata* Colla 'Red'	
7	*Musa acuminata* Colla 'Robusta'	
8	*Musa × paradisiaca* L. 'Kunnan'	AB
9	*Musa × paradisiaca* L. 'Matti'	
10	*Musa × paradisiaca* L. 'Neypoovan'	
11	*Musa × paradisiaca* L. 'Thaenkunnan'	
12	*Musa × paradisiaca* L. 'Namarai'	AAB
13	*Musa × paradisiaca* L. 'Nendran'	
14	*Musa × paradisiaca* L. 'Pachanadan'	
15	*Musa × paradisiaca* L. 'Poovan'	
16	*Musa × paradisiaca* L. 'Rasthali'	
17	*Musa × paradisiaca* L. 'Sirumalai'	
18	*Musa × paradisiaca* L. 'Vannan'	
19	*Musa × paradisiaca* L. 'Virupakshi'	
20	*Musa × paradisiaca* L. 'Kachkol'	ABB
21	*Musa × paradisiaca* L. 'Karpuravalli'	
22	*Musa × paradisiaca* L. 'Kuribontha'	
23	*Musa × paradisiaca* L. 'Monthan'	
24	*Musa × paradisiaca* L. 'Peyan'	

Character selection and scoring

According to Heywood (1967), a character is a feature of an organism, that can be measured, counted or accessed. A good classification will largely depends on the characters selected, how varied they are, whether they are discontinuous and also why they are treated (Pankhurst, 1991). All characters may not be having equal weightage for the purpose of comparison and should be easily observable, available, reliable, heritable and useful for classification/identification.

Since a phenetic classification needs as many characters available, we had selected 50 reliable and useful characters coming from almost all parts of the plant in both vegetative and reproductive phase.

Characters scored and methods of scoring

Fifty characters including those used by Simmonds (1959, 1962, 1966), Stover and Simmonds (1987), Shepherd (1959) and IPGRI-INIBAP/CIRAD (1996) were selected for the study (**Table 05**). This includes forty four qualitative and six quantitative characters. Thirteen characters were derived from vegetative part, sixteen from female inflorescence (bunch & fruits) and twenty one from the male inflorescence (**Table 06**). Simple two-state characters were coded as binary and ordered and unordered multistate by means of discrete states.

Table 05: Characters and characteristic states used for the numerical analysis

Sl. No.	Character	Characteristic states	Remarks
	Vegetative structures		
1.	Pseudostem height (m)	1. ≤2 2. 2.1 to 2.9 3. ≥3	Recorded from the base of the pseudostem to the emerging point of the peduncle
2.	Pseudostem aspect	1. Slender 2. Normal 3. Robust	
3.	Blotches at the petiole base	1. Sparse blotching 2. Small blotches 3. Large blotches 4. Extensive pigmentation 5. Without pigmentation	
4.	Predominant underlying colour of the pseudostem	1. Watery green 2. Light green 3. Green 4. Cream 5. Pink-purple 6. Red-purple 7. Purple 8. Other	Remove the outermost sheath from the pseudostem. Record the main colour of the exposed surface of the underlying pseudostem (do not take into account the pigmentation
5.	Pigmentation of the underlying pseudostem	1. Pink-purple 2. Red 3. Purple 4. Other	
6.	Sap colour	1. Watery 2. Milky 3. Red-purple 4. Other	Cut the external sheath of pseudostem and record the characteristics of the sap.
7.	Petiole canal of the third leaf	1. Open with margins spreading 2. Wide with erect margins 3. Straight with erect margins 4. Margins curved inward 5. Margins overlapping	Leaf III is the third leaf counted from the last leaf produced before bunch emergence. Cut the petiole halfway between the pseudostem and the leaf blade and examine the cross section
8.	Petiole margins	1. Winged and undulating 2. Winged and not clasping the pseudostem 3. Winged and clasping the pseudostem 4. Not winged and clasping the pseudostem 5. Not winged and not clasping the pseudostem	Observation should be made on the neck, where the petiole and pseudostem meet

9.	Petiole margin colour	1. Green 2. Pink/purple to red 3. Purple to blue 4. Other	Record the colour of the margin
10.	Appearance of the leaf upper surface	1. Dull 2. Shiny	
11.	Insertion point of lamina on petiole	1. Symmetric 2. Asymmetric	
12.	Shape of lamina base	1. Both sides rounded 2. One side rounded and one pointed 3. Both sides pointed 4. Both sides auriculated and rounded	
13.	Colour of midrib ventral surface	1. Yellow 2. Light green 3. Green 4. Pink-purple 5. Red-purple 6. Purple to blue 7. Others	
	Female inflorescence structure (bunch & fruit)		
14.	Peduncle length	1. ≤ 30 cm 2. 31-60 cm 3. ≥ 61 cm	Measured from the point of emergence from the pseudostem to first hand
15.	Peduncle hairiness (nature)	1. Hairless (glabrous) 2. Slightly hairy (hairy) 3. Very hairy, short hairs (puberulent) 4. Very hairy, long hairy (> 2 mm) (pubescent)	
16.	Arrangement of ovules per locule	1. Two rowed 2. Four rowed	
17.	Bunch position	1. Hanging vertically 2. Slightly angled 3. Hanging at a 45° angle 4. Horizontal 5. Erect	Angle between the axis of the bunch and the vertical
18.	Bunch shape	1. Cylindrical (length of bunch more than twice its width) 2. Truncate cone shaped 3. Asymmetric 4. With a curve in the bunch axis 5. Spiral (all fruit are attached to a unique crown coiled around the stalk) 6. Cylindrical (length of bunch less than twice its width)	Notice at the time of harvest

19.	Bunch appearance	1. Lax (one can easily place one's hand b/w the hands of fruit) 2. Compact (one can easily place one's finger b/w the hands of fruit) 3. Very compact (one cannot place one's finger b/w the hands of fruit)	
20.	Fruit position	1. Curved towards stalk 2. Parallel to the stalk 3. Curved upward (obliquely, at a 45º angle upward) 4. Perpendicular to the stalk 5. Pendent	
21.	Number of fruit on mid-hand	1. ≤ 12 2. 13–16 3. ≥ 17	
22.	Fruit pedicel length (mm)	1. ≤10 mm 2. 11 to 20 mm 3 .≥21 mm	
23.	Fusion of pedicels (before they join the crown)	1. No visible sign of fusion 2. Partially fused 3. Totally fused	
24.	Fruit shape (longitudinal curvature)	1. Straight (or slightly curved) 2. Straight in the distal part 3. Curved (sharp curve) 4. Curved in 'S' shape (double curvature) 5. Other	
25.	Fruit length	1. ≤ 15 cm 2. 16–20 cm 3. 21–25 cm 4. 26–30 cm 5. ≥ 31 cm	
26.	C.S. of fruit	1. Pronounced ridge 2. Slightly ridged 3. Rounded	
27.	Fruit apex	1. Pointed 2. Lengthily pointed 3. Blunt-tipped 4. Bottle-necked 5. Rounded	
28.	Remains of flower relicts at fruit apex	1. Without any floral relicts 2. Persistent flower relicts 3. Only base of the style persists	
29.	Mature fruit peel colour	1. Yellow 2. Bright yellow 3. Orange 4. Grey spots	

		5. Brown / rusty brown 6. Orange red, red or pink/pink purple 7. Red purple 8. Black 9. Other	
	Male inflorescence structure		
30.	Rachis position	1. Falling vertically 2. At an angle 3. With a curve 4. Horizontal or supra-horizontal 5. Erect	
31.	Rachis appearance	1. Bare 2. Neutral flowers on one to few hands only at proximal end near the bunch (rest of stalk is bare) 3. Male flowers/bracts at distal end, above the male bud (rest of stalk is bare) 4. Neutral/male flowers and presence of withered bracts on the entire stalk 5. Neutral/male flowers on the whole stalk without persistent bracts 6. Small bunch of neutral/hermaphrodite flowers just above the male bud 7. Others	
32.	Male bud shape	1. Like a top (low shoulder, thin and short) 2. Lanceolate (narrowly elliptical) 3. Intermediate 4. Ovoid (low shoulder, wide and pointed) 5. Rounded (wide with obtuse tip) 6. Oblong (high shoulder, fairly straight sides, tapered tip) 7. Heart shaped (high shoulder, wide and short) 8. Others	High shouldered means that the largest width of the bud is within the first third of the length. Low shouldered means it is the largest at mid-length
33.	Bract imbrication	1. Convolute 2. Moderately imbricate 3. Deeply imbricate	
34.	Colour of the bract external face	1. Yellow 2. Green	

		3. Red 4. Red-purple 5. Purple-brown 6. Purple 7. Blue 8. Pink-purple 9. Orange-red 10. Others	
35.	Colour of the bract internal face	1. Whitish 2. Yellow or green 3. Orange red 4. Red 5. Purple 6. Purple brown 7. Pink-purple 8. Others	
36.	Colour fading on bracts	1. Colour discontinuing towards base 2. Colour homozygous	
37.	Bract apex shape	1. Lengthily pointed 2. Slightly pointed 3. Intermediate 4. Obtuse 5. Obtuse and split	
38.	Bract behaviour before falling	1. Revolute 2. Not revolute	Recorded as the bract has lifted up to the horizontal
39.	Presence of grooves on the bract	1. Few grooves or not grooved 2. Moderately grooved 3. Strongly grooved	
40.	Dominant colour of male flower	1. White 2. Cream 3. Yellow 4. Pink 5. Red-purple 6. Others	
41.	Compound tepal basic colour	1. White 2. Cream 3. Yellow 4. Orange 5. Pink/pink-purple 6. Others	
42.	Compound tepal pigmentation	1. Very few or no visible sign of pigmentation 2. Rust-coloured spots 3. Presence of pink	
43.	Lobe colour of compound tepal	1. Cream 2. Yellow 3. Orange 4. Green 5. Others	

44.	Free tepal appearance	1. Smooth 2. Slightly corrugated 3. Highly corrugated	
45.	Anther colour	1. White 2. Cream 3. Yellow 4. Grey 5. Brown/rusty brown 6. Pink/pink-purple 7. Black (anthers aborted) 8. Others	Noticed in fresh
46.	Pollen sac colour	1. White 2. Cream 3. Yellow 4. Brown/rusty brown 5. Pink/pink-purple 6. Red-purple 7. Others	
47.	Style nature	1. Straight 2. Curved under stigma 3. Curved at the base 4. Curved twice 5. Other	
48.	Style basic colour	1. White 2. Cream 3. Red-purple 4. Others	
49.	Pigmentation on style	1. Without pigmentation 2. Purple	
50.	Stigma colour	1. Cream 2. Yellow 3. Pink/pink-purple 4. Bright yellow 5. Orange 6. Others	

Table 06: Types of characters used in the analysis

Type of characters	Vegetative structures	Bunch & fruit	Male bud	Total
Quantitative	1	5	0	6
Qualitative	12	11	21	44
Binary	2	1	3	6
Multistate	11	15	18	44
Distinguish genome group	2	3	8	13
Total	28	35	50	113

Analysis and discussion

The tabulated data were used to generate phenograme using PAUP* 4.0b 10[beta] version and which follows the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) method (optimality criterion = distance; Branch swapping algorithm – Tree Bisection Reconnection (TBR); Bootstrap = 100). **Fig. 39**

Phenetic analyses of the present study of twenty four *Musa* cultivars were segregated in to two distinct groups. All the taxa were separated at a distance of 100 bootstraps. Group 1 includes seven taxa of pure *M. acuminata* lines (both AA & AAA) and are, *Kadali, Karivazhai, Pisang lilin, Red, Dwarf cavendish, Grand naine* and *Robusta.* Group 1 is further divided in to 1a and 1b. Group 1a includes all AA cultivars (*i.e., Kadali, Karivazhai* & *Pisang lilin*) and *Red* (AAA). *Kadali* and *Karivazhai* shows more similarity and both of them are more allied to *Pisang lilin.* Group 1b includes all the dwarf and robust plants of AAA group (*i.e., Dwarf cavendish, Grand naine* & *Robusta*). Here *Dwarf cavendish* and *Grand naine* shows more similarity than *Robusta.* The characters like plant height, male flower and bract characters separated the *Red* from other AAA groups (*i.e.,* Group 1b). More over, many authors placed it under AA group and here it can be interpreted as a connection link between AA and AAA.

Group 2 consists of all hybrids of AB, AAB and ABB groups of cultivated bananas. Group 2 is further divided in to two groups Group 2a and Group 2b. In Group 2a, *Nendran* (AAB) shows some specific characters especially in infructascence and fruits, hence separated from other 11 cultivars. *Matti, Kunnan* and *Neypoovan,* being AB group shows both the characters of A and B, become separated. Although, *Thaenkunnan* is coming under AB group, it shows some specific characters, especially of male bud and male flowers, it got separated from the other AB cultivars (*Matti, Kunnan* & *Neypoovan*) and the fruit characters are more similar to that of AAB groups and thus found intermingled with them or form an intermediate or a connecting link. All others were also separated one by one. The hill bananas *Virupakshi, Sirumalai* and *Namarai* were separated at the final stage and also in which *Virupakshi* and *Sirumalai* are more similar.

Group 2b includes all ABB groups (5 cultivars) and these shows some characters allied to *M. balbisiana,* especially in the characters like pseudostem nature, blotches at the leaf bases and also in the male flower and bract characters. Hence can be easily separated from others. Here *Kachkol* is more allied to *Monthan,* and *Karpuravalli* to *Peyan;* but *Kuribontha* forms an out group to these.

Conclusion

Phenetic analyses of the present study of twenty four *Musa* cultivars revealed that two groups exist in the South Indian cultivated bananas and this well support the genomic classification. 1 pure lines of *M. acuminata* (AA & AAA). 2 all hybrid cultivars (AB, AAB & ABB). The genetic interrelation ship is highly reflected in the phenogram and are highly reliable (100 bootstraps).

DATABASE AND CONSERVATION

A database with all relevant updated informations of all *Musa* cultivars in South India was prepared for easy identification of different taxa. The home page include Introduction, Acknowledgements, Add data, Edit data, Delete data, Search and close options on the menu bar as well as on the main window of the software. A click on any of these options will lead to the respective pages. Add data button is used for incorporating all data including photographs. If any data is to be edited, go to the edit page and necessary changes like additions or modifications can be made. There is a general search option in the main window. A click on the search button will give the options for searching cultivar name, genomic group, synonyms, habit, local names, endemic status and altitude. For searching the details of a particular cultivar, click on the button, and then the details such as cultivar name, citations, description, habit, distribution, local names, endemic status, altitude and photographs will appear on the window. Desired photographs can be seen in an enlarged view by clicking on the photograph. Each taxon can also be searched by valid name, synonyms and common names. The close button should be used for closing a window. The database was developed by using the software Visual FoxPro (Version 6) with the help of a computer programmer (**Fig. 40**).

All taxa under study were conserved at Calicut University Botanical Garden Germplasm Conservatory for cultivated bananas (*Musa* garden) for further studies (**Fig. 41**). The traditional banana cultivation practices were followed for the conservation and all are growing well in the garden. It includes 72 accessios and are labelled using standard metallic ‘T’ labels (15 × 5 cm) indicating the details such as collection number, name of cultivar and collection locality.

NAMES AND SYNONYMS OF *MUSA* CULTIVARS IN SOUTH INDIA

Table 07: List of *Musa* cultivars and synonyms

Group	Name	Synonyms	State/ locality
AA	***Musa acuminata* Colla (AA) 'Kadali'**	*Deva kadali* *Kadali*	Kerala
		Ney kadali *Neyvedykadali* *Narkadali* *Poovan kadali* *Vellakadali*	Tamil Nadu
AA	***Musa acuminata* Colla (AA) 'Karivazhai'**	*Karivazhai* *Karuvazhai* *Krishna vazhai* *Manoranjitham*	Tamil Nadu
AA	***Musa acuminata* Colla (AA) 'Pisang lilin'**	*Dayana* *Kavery* *Mankompu* *Mezhikuthiri pazham* *Mezhukuthiri vazha* *Sugandhi* *Sundari kadali* *Sundari poovan*	Kerala
		Kavery	Tamil Nadu
		Lidi *Manis terenganu* *Pisang empat puluh hari* *Pisang lemak* *Pisang lemak manis Kelantan* *Pisang lidi* *Pisang lilin* *Pisang mas sagura*	Malaysia
		Pisang muli	Indonesia
		Mama-on	Philippines
		Kluai lep mu nang *Kluai thong ki maew* *Kluai thong kap dam*	Thailand

		Chuoi tien	Vietnam
AAA	***Musa acuminata* Colla (AAA) 'Dwarf cavendish'**	*Dwarf cavendish* *Khuzhi vazha* *Kullan* *Morris*	Kerala
		Guja bale *Gujali bale* *Kabul bale* *Pacha bale* *Chukke bale*	Karnataka
		Kooli vazhai *Kooni cazhai* *Khuzhi vazhai* *Kullan* *Kuttuvazhai* *Morris vazhai* *Tharai Matti vazhai* *Pacha vazhai*	Tamil Nadu
		Potti pacha arati *Potti bhusawle* *Cheetakali*	Andhra Pradesh
		Vamanakeli *Chines* *Dwarf cavendish* *Shedurni* *bhusawali* *Chittedar* *Singpuri* *Jahaji* *Kabuli* *Mauritus* *Ardhapuri* *Basarai*	Maharashtra
		Maouz shiny	Arabia
		Wet ma lut	Burma
		Banana cavendish	Italy
		Pisang serendah	Malaysia
		Klue hom khieo khom	Thailand
		Chou dun *Chou tieu lun*	Vietnam

		Pisang badak	Indonesia
		Sulay baguio	Philippines
AAA	***Musa acuminata* Colla (AAA) 'Grand naine'**	*G-nine* *Grand naine* *High gate*	Kerala
		G-nine *Grand naine*	Tamil Nadu
		Harichal *Jahaji* *Jahaji kol*	N.E. India
		Grand naine	England
		Pisang ambon jepang	Indonesia
		Chuoi va huong	Vietnam
AAA	***Musa acuminata* Colla (AAA) 'Red'**	*Chandra bale* *Chenkadali* *Chontha bale* *Chorakadali* *Chorapoovan chuvanna kappa* *Chuvanna chevvazha* *Kappa* *Kappa vazha* *Malam poovan* *Raktha kadali*	Kerala
		Kenpu bale *Kunkuma bale* *Sakkalathi bale*	Karnataka
		Chenkadali *Chevvazhai* *Pattu vazhai* *Senthuzhuvan*	Tamil Nadu
		Lal mowze *Yerra arati* *Yerra chakkarakeli*	Andhra Pradesh
		Chenkadali chandrabale *Lalkela* *Velchi*	Maharashtra
		Beet java *Lalkadali*	Odisha
		Agniswar *Ampan*	W.B. & North-East

		Lalkela *Terekanchi* *Therek marang* *Tulsi manohar*	
		Shwe Nget Pyaw	Burma
		Cuba *Hong Guo Jiao* *Rode Banana*	China
		Jamaica red banana	England
		Figue rose	France
		Kuba banana *Weinrote banana*	German
		Banana di cuba *Banana rosa*	Italy
		Pisang raja udang	Malaysia
		Banana *Claret banana* *Red dacca* *Rod banana*	Netherland
		Rathambala	Srilanka
		Klue bat	Thailand
AAA	***Musa acuminata* Colla (AAA) 'Robusta'**	*Anamalu* *Monsmarie* *Robusta* *Sapumal*	Kerala
		Pacha bale *Chukke bale* *Yenteedi bale*	Karnataka
		Pacha vazhai *Robusta*	Tamil Nadu
		Mdras pacha aratti *Pada pacha aratti* *Pedda bhusaval*	Andhra Pradesh
		Bombay green *Harichal* *Peda pacha arati*	Maharashtra
		Malbhog	Odisha
		Bongile jahaji *Borjahali* *Jahaji*	N.E. India

		Pisang ambon putin	Indonesia
		Banana poyo	Italy
		Pisang buai	Malaysia
		Poyo bananaan	Netherland
		Tudok	Philippines
		Chuoi T ieu vanh	Vietnam
AB	***Musa* × *paradisiaca* L. (AB) 'Kunnan'**	*Adukkan* *Adukku poovan* *Adukvan* *Amirthapani* *Annaan* *Kannan* *Kulamelkula* *Kunnan* *Nadan kunnan* *Valia kunnan*	Kerala
		Chitti bale *Firige bale*	Karnataka
		Nar kadali *Poong kadali* *Vella Kadali*	Tamil Nadu
		Amirthpani *Chakkara keli* *Chinna sugantham* *Ginni* *Karpura chakkara keli* *Madras aratti* *Neechu* *Sanna aakulu chettu* *Sugantha*	Andhra Pradesh
		Patti mokiri *Sudha*	Odisha
AB	***Musa* × *paradisiaca* L. (AB) 'Matti'**	*Matti* *Mattippazham* *Mattippoovan*	Kerala
		Kunnan Matti *Mattippoovan*	Tamil Nadu
		Matti	Andhra
AB	***Musa* × *paradisiaca* L. (AB) 'Neypoovan'**	*Adakka poovan* *Ari poovan*	Kerala

		Kadali poovan *Kunnan poovan-kadali* *Kunnan poovan* *Madhura annan* *Ney Kadali* *Neypoovan* *Nhali poovan* *Nhani poovan* *Thekkan Kadali* *Tirunelli poovan* *Thulunaattu kadali* *Vadakkan kadali* *Rani poovan*	
		Deva bale *Elakkie bale* *Hoo bale* *Mitga bale* *Mitli* *Poo bale* *Puttu sugantha*	Karnataka
		Elarasi *Mysore rasthali* *Pacharasi* *Poonkadali* *Rasakadali*	Tamil Nadu
		Mysore rasthali *Karpura aratti* *Rasadala*	Andhra Pradesh
		Safed velchi	Maharashtra
		Chini champa *Kanthali champa*	Odisha & W.B.
		Somai	North-East
AB	***Musa* × *paradisiaca* L. (AB) 'Thaenkunnan'**	*Chundilla kunnan* *Chundillan* *Kodapilla Kunnan* *Koombilla annan* *Koombilla chingan* *Koombilla kannan* *Koombilla poovan* *Kunnan* *Mambilla kunnan*	Kerala

		Maniyilla kunnan *Taen kunnan* *Thattilla kunnan*	
		Poo vazhai *Poola chundan* *Poong kadali* *Poovilla vazhai*	Tamil Nadu
		Kaththe bale *Mambilla* *Rundu bale*	Karnataka
		Benda atratti *Chitrachalam* *Godavari keli*	Andhra Pradesh
		Suwandel	Ceylon
AAB	***Musa* × *paradisiaca* L. (AAB) 'Namarai'**	*Mala vazhai* *Mala vazha* *Namarai* *Nimaran*	Tamil Nadu
AAB	***Musa* × *paradisiaca* L. (AAB) 'Nendran'**	*Attu nendran* *Chengalikodan* *Chengazhikoda* *Eththakka* *French plantain* *Giant plantain* *Horn plantain* *Kal eththan* *Malai ethan* *Manjeri moongil* *Mysore ethan* *Nendran* *Nana nendran* *Nedu nendran* *Nendran* *Neockon* *Ottamoongil* *Pindi eththan* *Randupadala* *Thiruvonan* *Zanzibar*	Kerala
		Anaikomban *Attunendran* *Eleri*	Tamil Nadu

		Eththakka *Giant plantain* *Horn plantain* *Kal eththan* *Moongil* *Nana nendran* *Nedu nendran* *Nendran* *Otta moongil* *Pindi eththan* *Zanzibar*	
		Nana nendran *Nendran*	Karnataka
		Rejeli	Maharashtra
		Gajabantal *Saja bantal* *Singa bantal* *Singapuri*	Odisha
		Hooru plantain	Denmark
		African plantain *French plantain* *Giant plantain* *Horn plantain* *Horse plantain*	England
		Banana corne *Banana cent livres*	France
		Hornfeermige *Pisang feige*	Germany
		Pisang candi	Indonesia
		Pisang lang *Pisang nangka* *Pisang ton dok* *Pisang tun dok*	Malaysia
		Bhangoaisan	Philippines
		Kluai nga chang	Thailand
AAB	***Musa* × *paradisiaca* L. (AAB) 'Pachanadan'**	*Cheruvannan* *Erodan* *Ethappadatti* *Mannan* *Padathi* *Thekkan mannan*	Kerala

		Thodan *Vannan* *Vella paadan*	
		Bargi bale *Belli baja* *Cheena bale* *Guli bale* *Huli bale* *Kari bale* *Mara bale* *Naga bale* *Pacha bale*	Karnataka
		Erode nadan *Kadali* *Kaali* *Kal kadali* *Korangu laadan* *Ladan* *Ladda* *Nadan* *Nattu chingan* *Pachanadan* *Pachanala* *Pacha vazhai*	Tamil Nadu
		Bengala *Chakkarakeli* *Konda aratti* *Malabar* *Pacha aratti* *Pacha ladan*	Andhra Pradesh
AAB	***Musa* × *paradisiaca* L. (AAB) 'Poovan'**	*Cheru kai* *Mysore poovan* *Palayangodan*	Kerala
		Cheena bale *Huli bale* *Kari bale* *Kari goddi* *Mysoor kadali* *Nanjangud bale* *Othuasa bale* *Vilayathi bale* *Mysoor mitli*	Karnataka

		Mitli *Mituga chandan* *Terabun*	
		Adukku namarai *Dorai vazhai* *Erode poovan* *Kadali* *Kallattu vazhai* *Kari vazhai* *Kotta vazhai* *Mysore Kadali* *Navarai* *Palichan Kadali* *Poovan* *Poovazhai* *Pulippu kai*	Tamil Nadu
		Bengala aratti *Ginni aratti* *Karpurachakkarakeli* *Rasthali* *Salem chakkarakeli* *Sugandam* *Vasana chettu* *Yerra aratti* *Yerra sugandam*	Andhra Pradesh
		Champa *Lalvelchi* *Mysore* *Sour velchi*	Maharashtra
		Champa *Champa kela alpon*	West Bengal
		Alpon *Bai bhal-al-their* *Champakol* *Cheni champa* *Dasaman* *Garomoina* *Heijao* *Kawrmut* *Ladiyachampa* *Lang bhal-al*	North-East
		Moz sobaoel sitt	Arabia

		Nget pyaw chin	Burma
		Mysore banana *Champa banana*	England
		Pisang kelung	Indonesia
		Pisang keling	Malaysia
		Inagel	Philippines
		Hondera wale	Srilanka
		Kluai khai farang *Kluai kai farang* *Kluai lanka*	Thailand
		Chouicom chua	Vietnam
AAB	***Musa* × *paradisiaca* L. (AAB) 'Rasthali'**	*Anna poovan* *Ari poovan* *Nattu poovan* *Nattu thuluvan* *Poovan* *Thuluvan*	Kerala
		Karkandu vazhai *Kozhikodu* *Nattu poovan* *Ullur poovan* *Tholluvan* *Vellai tholluvan*	Tamil Nadu
		Amrithapani *Bengala desi* *Karpura chakkarakeli* *Mokiri* *Pallu* *Pedda sugandan* *Poo sugandhi* *Sugantha* *Thella mokkiri*	Andhra Pradesh
		Ambeli *Sakkal nagpur* *Sakkar chayna* *Soniyal*	Gujarat
		Apple banana *Mutheli* *Silk fig*	Maharashtra
		Buttam	Odisha

		Ellaichi *Jalakonda mokri* *Kothia* *Patkapura* *Pot kapura* *Sonkel*	
		Amritman *Digjowa* *Kulpait* *Malbhog* *Martman* *Sabri*	N.E & W.B.
		Htaw bat	Burma
		Apple banana *Silk banana* *Silk fig* *Sugar banana*	England
		Figue pomme	France
		Pisang rajah sereh	Indonesia
		Pisang rastali *Pisang rajah sereh*	Malaysia
		Latundan	Philippines
		Banana de cuba *Banana maca*	Portugal
		Kolikkud	Srilanka
		Kluai nam	Thailand
		Chuoi goong	Vietnam
AAB	***Musa* × *paradisiaca* L. (AAB) 'Sirumalai'**	*Cheruvannan* *Mala vazhai* *Mala vazha pazham* *Sirumalai* *Sirumalai pazham* *Udiran vazhai* *Vannan* *Vannan kali* *Vella vazhai* *Virupachi* *Virupakshi*	Tamil Nadu
AAB	***Musa* × *paradisiaca* L. (AAB) 'Vannan'**	*Cheru vannan* *Kaali*	Kerala

		Kaalithodan *Monthan* *Mundilapadan* *Mundi vella paadan* *Padalu* *Valia thodan* *Vannan* *Vannan eradan* *Vannan kali* *Vellappadan*	
		Kaadu bale	Karnataka
		Ethana vazhai *Ethara vazhai* *Kaali vazhai* *Katta kaali* *Korangu naadan* *Korangu pachalaadan* *Kozhikkootu vazhai* *Ladan* *Mala vazhai* *Mundi vellapaadan* *Mundilapaadan* *Pacha ladan* *Padalu* *Sirumalai cheru vannan* *Thenkasi mala vazhai* *Udiri* *Valiathodan* *Vannan* *Vannan kaali*	Tamil Nadu
		Sugandham	Andhra Pradesh
		Dacca martaban	Orissa
		Embulhondarawala *Poo valai* *Puvalu* *Watupalu*	Ceylon
AAB	***Musa* × *paradisiaca* L. (AAB) 'Virupakshi'**	*Cheru vannan* *Ethara vazhai* *Kaali vazhai* *Kaali thodan* *Kattu kali* *Korangu nadan*	Tamil Nadu

		Korangu pachaladan *Kozhikottu vazhai* *Ladan* *Malai kali* *Malai vazhai* *Mundila paadan* *Mundi vellapaadan* *Pachaladan* *Padalu* *Tenkasi malavazhai* *Sirumalai* *Udiran vazhai* *Vannan* *Vella vazhai* *Valiathodan* *Virupachi* *Virupakshi*	
ABB	***Musa* × *paradisiaca* L. (ABB) 'Kachkol'**	*Monthan vazai* *Monthan*	Kerala
		Mondan vazha *Mondan*	Tamil Nadu
		Kachkol *Kacha kol* *Kacha kela*	N. E.
ABB	***Musa* × *paradisiaca* L. (ABB) 'Karpuravalli'**	*Chara kaali* *Charappadatti* *Karpuravalli* *Kudumbavazha* *Vellapalayankodan* *Venneettu kunnan* *Vennettu mannan* *Venneettu vannan* *Venner kunnan*	Kerala
		Banria *Baku plata* *Boothi bale* *Boothi javari* *Govakkai* *Kostha bontha* *Manohar* *Poombidiyan* *Sakara bale*	Karnataka

		Shahil baig *Burkel*	
		Ashy ney mannan *Karpura vazhai* *Karpuravalli* *Kudumbavazhai* *Navaral* *Nellore amrithapani* *Pannai vazhai* *Peyan* *Peykunnan* *Poombidiyan* *Rajavazhai* *Samba vazhai* *Sambrani vazhai* *Thean vazhai*	Tamil Nadu
		Batheesa arati *Bharatha ratnavali* *Boodithi* *Bukkisa arati* *Kostha bontha* *Nellore arithapani*	Andhra Pradesh
		Kanthali	Bihar
		Calanaul	Gujarat
		Baku plata	Odisha
		Chinia	West Bengal
		Bangla kola geda *Banria* *Gera* *Deshikadali* *Manohar* *Manuva kola* *Sail kola* *Shalil kela*	N. E.
		Yak hine	Burma
		Thai cooking banana *Ducgsse banana*	England
		Pisang awak *Pisang siem* *Pisang klotok*	Malaysia
		Katali	Philippines

		Kluai nam wa	Thailand
ABB	***Musa* × *paradisiaca* L. (ABB) ‘Kuribontha’**	*Katha bontha* *Pidi bontha* *Pidimonthan*	Tamil Nadu
		Kuribontha	Andhra Pradesh
ABB	***Musa* × *paradisiaca* L. (ABB) ‘Monthan’**	*Chetti kai* *Erachi vazha* *Kuppakaali* *Malavannan* *Ponnan* *Ponthan* *Sodari* *Thenali* *Thezhuthani*	Kerala
		Akku bale *Aunda bale* *Banga bale* *Budhu bale* *Deva bale* *Kalyana bale* *Kari bale* *Kilandi* *Konga bale* *Manga bale* *Mara bale* *Mathuranga bale* *Shan bale* *Silanti*	Karnataka
		Erode bonthan *Erode monthan* *Erode vazhai* *Kondai monthan* *Kondaikai* *Maanaathu monthan* *Malai monthan* *Monthan vazhai* *Naathangi monthan* *Nattu monthan* *Nielh bontha*	Tamil Nadu

		Nirbontha *Thoppul vazhai* *Thrichirapalli monthan* *Trichynopoly monthan* *Yendra monthan* *Yenthala monthan*	
		Basthi bontha *Muchika bontha* *Yenugu bontha* *Yenugu monthan*	Andhra Pradesh
		Bainsa *Bankel* *Bankela* *Bhaingu* *Bhainsa kela* *Kachkela* *Kanchikela*	Maharashtra & Odisha
		Dakshinsagar *Kachkel* *Kashkel* *Sabjikela* *There haw*	N. E.
		Pisang nangka	Malaysia
		Madhuranga	Philippines
		Kluai nom mi	Thailand
		Chuoi ngop cau	Vietnam
ABB	***Musa* × *paradisiaca* L. (ABB) 'Peyan'**	*Ney vannan* *Ney vazha* *Peyan*	Kerala
		Kallu vazhai *Kotta vazhai* *Madavazhai* *Peyan* *Savargundy*	Tamil Nadu
		Booditha aratti *Nokala bontha* *Palakola bontha* *Sapota bontha* *Rasthali*	Andhra Pradesh

PHYTOCHEMISTRY

India is well known for the use of folklore medicinal plants to cure various diseases, and Indian medicinal plants have been studied for various pharmacological and pharmacognostic activities. They are considered as the potential sources of bioactive compounds and are useful to maintain the normal health of human and animals.

Chemical substances derived from the plants – generally considered as secondary metabolites, have been used to human diseases since long. Currently, the health care based on natural products is still the mainstay of about 75–80% of the whole world population, and majority of traditional therapy and treatment involve the use of plants and plant extracts.

According to Doymaz (2010) bananas are rich in nutrients, starch, sugar and vitamins A and C, potassium, calcium, sodium and magnesium. Banana is also used for the treatment of many disorders in traditional systems of medicine. Banana leaves can be used in the treatment of cough and bronchitis. Roots are used to arrest hemoptysis, as anthelmintic, etc. The banana fruit is traditionally used tp cure diarrhoea, dysentery, intestinal lesions in ulcerative colitis, diabetes (unripe), uremia, nephritis, gout, hypertension, cardiac disease (ripened), etc. It contains antioxidizer and counteracts the noxious effects of the free radicals. It is also used as an antidote for snake bite, asthma, burns, diabetes, fever, gangrene, gout, head ache, hemorrhage, inflammation, insomnia, intestinal parasites, sores, syphilis, tuberculosis, ulcers and warts. It is also used to cure stomach aches, lack of appetite, maintaining bones healthy, gastric ulcer, strengthening the immune system, reducing the risk of hypertension. Flowers are used in dysentery and menorrhagia. Stem juice of fruited plant is used for treating diarrhoea, dysentery, cholera, otalgia, hemoptysis and blood disorders and venereal diseases. The plant is also used in inflammation, pain and snake bite.

Simmonds (1959) first noticed that there are a number of significant biological differences between the various groups of bananas and suggested that it can also be used as a tool to differentiate *M. acuminata* and *M. balbisiana* derivatives. The fruits of *M. balbisiana* lines are found more starchy, more acidic, less aromatic, contain more vitamin C and are less liable to phenolic browning. In this scence it can be better used as a good tool in banana taxonomy.

Many authors reported different biological activities in different parts of banana plant such as leaves (Yakubu *et al.,* 2007), roots (Mallick *et al.,* 2007), fruits (Ojewole & Adewunmi, 2003), stem (Kailash & Varalakshmi, 1992; Kailash *et al.,* 1993) and seeds (Mallick *et al.* 2006).

The *in vitro* bioactivity and phytochemical screening of methanolic extract of *M. acuminata* flower by Sumathy *et al.* (2011) revealed that it is a very good antioxidant source like butylated hydroxytoluene (BHT) and also confirmed the presence of glycosides, tannins, saponnins, phenols, steroids and flavonoids.

The preliminary metabolic constituents of the bract of *M. acuminata* was investigated by Gunavathy *et al.* (2014) and it revealed the presence of alkaloids, flavonoids, terpenoids, coumarins, phenols, tannins, glycosides, steroids and saponins in different solvents.

Sreejith *et al.* (2016) conducted the GC-MS analysis of the fruit pulp extracts of two hill bananas (*Karivazhai* and *sirumalai*) and reported 22 fatty acids and volatile compounds from the fruit (15 in *Karivazhai* and 10 in *Sirumalai*).

The chemotaxonomy had proven very significant role in the taxonomy of banana since back. Simmonds (1954a, 1954b), Horry and Jay (1988a, 1988b), etc. also worked on the chemical profile of cultivated banana and proved that some pigments like anthocyanin and their distribution among different banana cultivars gave good support for the banana taxonomy.

Subsequently Javed *et al.* (2001) described the relationship between the different wild Malaysian bananas based on the distribution of anthocyanins. The chemical constituents of the *Musa* pseudostem were evaluated by various authors (Akpabio *et al.,* 2012; Apriasari *et al.,* 2014).

In the present study, the methanolic extract of fruit pulps of thirteen banana cultivars were subjected to GC-MS analysis for the identification of fatty acids and volatile compounds present in them and the data is presented below.

Observations

The unripe fruit pulp of 13 common South Indian banana cultivars (**Table 08**) from different ploidy levels (AA, AB, AAB & ABB) were subjected to extraction with methanol using Soxhlet apparatus. The solvent was recovered under reduced pressure in Rotary evaporator at 54ºC and was subjected to GC-MS analysis to study the chemical composition.

Table 08. List of *Musa* cultivars used for the GC-MS analysis.

Sl. No.	Name of Taxa	Genomic group
1	*Musa acuminata* Colla 'Kadali'	AA
2	*Musa acuminata* Colla 'Karivazhai'	
3	*Musa acuminata* Colla 'Pisang lilin'	
4	*Musa* × *paradisiaca* L. 'Kunnan'	AB
5	*Musa* × *paradisiaca* L. 'Neypoovan'	
6	*Musa* × *paradisiaca* L. 'Thaenkunnan'	
7	*Musa* × *paradisiaca* L. 'Nendran'	AAB
8	*Musa* × *paradisiaca* L. 'Pachanadan'	
9	*Musa* × *paradisiaca* L. 'Poovan'	
10	*Musa* × *paradisiaca* L. 'Sirumalai'	
11	*Musa* × *paradisiaca* L. 'Kachkol'	ABB
12	*Musa* × *paradisiaca* L. 'Karpuravalli'	
13	*Musa* × *paradisiaca* L. 'Monthan'	

A total of 140 fatty acids and volatile compounds were identified by the GC-MS analysis of thirteen South Indian *Musa* cultivars studied with their chemical formula, molecular mass, retention time and area percentage in each cultivar (APPENDIX III). Out of which 105 compounds have much higher concentration (area percentage below 1% were not considered) and the area percentage of these major compounds in each cultivar is given below:

1. ***Musa acuminata* (AA) 'Kadali':** Out of twenty one compounds identified the following seventeen compounds have higher concentration (*i.e.* $\leq$ 1%) and are, 1,2,3-Propanetriol (36.17), 1,2,3-Butanetriol (12.28), c-Hexadecanoic acid (9.52), 2-(4-morpholinylsulfanyl)-1,3-benzothiazole (9.20), Diphenyl sulfone (6.22), bis(2-sulfhydrylethyl)-Disulfide (4.75), Malic acid (4.56), 1-Pentyl-2,2-D2 Acetate (1.99), [S-R*,R*)]-1,2,3,4-Butanetetrol (1.77), cis,cis,cis-7,10,13-Hexadecatrienal (1.53), 1-azido-4-(methylthio)- Butane (1.49), (Z,Z)-9,12-Octadecadienoic acid (1.40), N,N-Dimethyl-O-(1-methyl-butyl) Hydroxilamine (1.28), 1,2-Benzenedicarboxylic acid, 1,2-bis(2-ethylhexyl) ester (1.25), Benzothiazole (1.24), 4-hexyl-2,5-dihydro-2,5-dioxo-3-Furanacetic acid (1.14) and Hexadecanoic acid, methyl ester (1.00) **Fig. 42**

2. ***Musa acuminata* (AA) 'Karivazhai':** Out of nineteen compounds identified the following fourteen compounds have higher concentration (*i.e.* $\leq$ 1%) and are, 1-Heptatriacotanol (56.48%), Diphenyl sulfone (8.61%), n-Propyl 9,12,15-octadecatrienoate (5.32%), 1,2,3-Propanetriol (3.89%), 5-Hydrxymethylperfural (2.92%), Allopregnane-3beta.,7alpha.,11alpha.-triol-20-one (2.81%), Trilinolein (2.58%), 19,21-Tetracontadiyne (2.50%), (3-beta.)-9,19-Cyclolanostan-3-ol-acetate (2.28%), Dihydro-neotigogenin dibenzoate (1.73%), 1H-Pymole-2,4-dicarboxylic acid, 3,5-dimethyl-,diethyl ester (1.69%), n-Hexadecanoic acid (1.49%), Bicyclo[9,3,1]pentadecane-1-carbonitrile, 12-hydroxy-15-oxo- (1.22%) and Decaborane(14) (1.20%). **Fig. 43**

3. ***Musa acuminata*** **(AA) 'Pisang lilin':** Out of twenty seven compounds identified the following sixteen compounds have higher concentration (*i.e.* ≤ 1%) and are, 3-Deoxy-d-mannoic lactone (35.05%), 5-Hydrxymethylperfural (10.76%), 3-(2-methoxy-1-methylethoxy)- 1-Propanamine (7.19%), Diphenyl sulfone (6.73%), n-Hexadecanoic acid (6.03%), Xanthosine (5.54%), 1,2,3-benzenetriol (4.21%), 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (3.20%), (3-beta.)-9,19-Cyclolanostan-3-ol-acetate (2.96%), (Z,Z)-9,12-Octadecadienoic acid (2.76%), cis,cis,cis-7,10,13-Hexadecatrienal (2.20%), 1,2-Cyclopentanedione (2.01%), Dodecanoic acid (1.40%), 1-Heptatriacotanol (1.21%), N-ethyl-N-nitroso-Ethanamine (1.06%) and Palmitoleic acid (1.03%). **Fig. 44**

4. ***Musa* × *paradisiaca*** **(AB) 'Kunnan':** Out of twenty compounds identified the following eleven compounds have higher concentration (*i.e.* ≤ 1%) and are, E,E,Z-1,2,12-Nonadecatriene-5,14-diol (42.16%), 1-Heptatriacotanol (26.18%), (3-beta.)-9,19-Cyclolanostan-3-ol-acetate (5.56%), (E,E,E)-9-Octadecanoic acid, 1,2,3-propanetriyl ester (5.28%), 4,4'-((p-Phenylene)disopropylidene)diphenol (4.13%), 1-Dimethyl (octyl) sililoxypropane (2.41%), Cholest-4-en-3ol, (3.alpha.)- (2.33%), E,Z-1,3,12-Nonadecatriene (2.13%), Diphenyl sulfone (1.25%), 2-Hydroxy-4-methoxy-7-methyl-7,8,9, 10,11,12,13,14-octahydro-6-oxab (1.11%) and 3-ethoxy-Benzaldehyde (1.04%). **Fig. 45**

5. ***Musa* × *paradisiaca*** **(AB) 'Neypoovan':** Out of fourteen compounds identified the following ten compounds have higher concentration (*i.e.* ≤ 1%) and are, (3-beta.)-9,19-Cyclolanostan-3-ol-acetate (35.75%), 1-Heptatriacotanol (34.71%), Trichloroacetic acid, tridec-2-ynl ester (9.78%), Butyl 6,9,12,15-octadecatetraenoete (6.11%), 7-Methyl-13-oxatricyclo [6.4.2.0(1,6)]tetraec-11-en-14-one (3.62%), Trideuteriomethyl-10-epoxy-7-ethyl-3,11-dimethyltrid (3.04%), 3-Isopropyltricyclo[4.3.1.1(2,5)]undec-3-en-10-ol (2.28%), 3-Deoxy-d-

mannoic lactone (1.41%), Diphenyl sulfone (1.33%) and 11-Hydroxy-11-methyl-tricyclo[3.4.1.1(2,5)]undecan-10-one (1.20%). **Fig. 46**

6. ***Musa* × *paradisiaca* (AB) 'Thaenkunnan':** Out of twenty three compounds identified the following sixteen compounds have higher concentration (*i.e.* ≤ 1%) and are, 1,2,3-Propanetriol (29.14%); n-Hexadecanoic acid (18.22%); Diphenyl sulfone (8.76%); 5-methyl-2,4(1H,3H)-Pyrimidinedione (6.90%); (Z)-7-Tetradecenal (5.27%); 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (4.72%); 4,4'-((p-Phenylene)disopropylidene)diphenol (3.22%); (Z,Z)-9,12-Octadecadienoic acid (2.87%); 5-Hydrxymethylperfural (2.72%); (E)- 9-Octadecenoic acid, methyl ester (2.71%); Hexadecanoic acid, methyl ester (2.53%); 1,2-dihydro-2,2,4-trimethyl- Quinoline (2.35%); 9,12-Octadecadienoic acid(Z,Z)-methyl ester (1.71%); Diglycolic acid (1.70%); Methyl triethylsilyl ether (1.19%) and 4-(3,4-dihydro-2,2,4-trimethyl-2H-1-benzopyran-4-yl)- Phenol (1.01%). **Fig. 47**

7. ***Musa* × *paradisiaca* (AAB) 'Nendran':** Out of twenty three compounds identified the following seventeen compounds have higher concentration (*i.e.* ≤ 1%) and are, 1,2,3-Propanetriol (23.25%); Erythritol (17.24%); 1-(+)-ascorbic acid, 2,6-dihexadecanoate (7.69%); 2-(4-morpholinylsulfanyl)-1,3-benzothiazole (7.15%); 3-Deoxy-d-mannoic lactone (6.96%); 1,2-Cyclopentanedione (5.84%); Diphenyl sulfone (5.27%); 5-(hydroxymethyl)- 2-Furaldehyde (3.88%); 2-isopropenyl-2-methyl-Butanedioic acid (3.16%); (Z,Z)-9,12-Octadecadienoic acid (2.60%); E,E,Z-1,3,12-Nonadecatriene-5,14-diol (2.54%); .delta.1,alpha-cyclohexaneacetic acid (2.38%); 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (1.71%); Hexadecanoic acid, methyl ester (1.57%); Urea-N15 (1.36%); 3-Furanacetic acid, 4-hexyl-2,5-dihydro-2,5-dioxo- (1.24%) and N,N-diethyl-beta.-Alanine (1.10%). **Fig. 48**

8. ***Musa* × *paradisiaca* (AAB) 'Pachanadan':** Out of sixteen compounds identified the following eleven compounds have higher concentration (*i.e.* ≤ 1%) and are, 9,12-octadeca-dienoic acid(Z,Z)- 2,3-dihydroxy-propyl ester (27.31%); (Z,Z)-9,12-octadeca-dienoic acid, 2,3-dihydroxy-propyl ester (16.54%); DL-Arabinitol (14.57%); (1S,2E,4S,5R,7E,11E)-Cembra-2,7,11-trien-4,5-diol (11.07%); 1,2,3-Propanetriol (7.38%); Butyl 9,12-octadecadieonate (7.23%); E,Z-1,3,12-Nonadecatriene (6.63%); Isophthalic acid, 2-propylphenyl tridecyl ester (1.87%); Diphenyl sulfone (1.65%); 3-(1-hydroxy-2-isopropyl-5-methylcyclohexyl)- Propiolic acid (1.55%) and 3,4,5,6,7, 8,9,10-octahydro-12-hydr-1H-2-Benzoxacyclododecin-1-one (1.02%). **Fig. 49**

9. ***Musa* × *paradisiaca* (AAB) 'Poovan':** Out of twenty six compounds identified the following twenty two compounds have higher concentration (*i.e.* ≤ 1%) and are, Butyl 9,12-octadecadieonate (13.85%); 1-(+)-ascorbic acid, 2,6-dihexadecanoate (12.58%); 2-(methylamino)-2-thioxo-Acetamide (10.66%); 5-(hydroxymethyl)- 2-Furaldehyde (7.87%); E,Z-1,3,12-Nonadecatriene (5.29%); Diphenyl sulfone (4.02%); 3-Deoxy-d-mannoic lactone (3.96%); .beta. –Sitosterol (3.91%); Butyl 9,12,15-octadecatrienoate (3.71%); (Z,Z)-9,12-Octadecadienoic acid (3.27%); (7R,8R)-cis-anti-cis-Tricyclo[7.3.0.0(2,6)]dodecan-7,8-diol (3.21%); 4,4'-((p-Phenylene)disopropylidene)diphenol (3.18%); N,N-dimethyl-5.alpha.-Cholestan-6.beta.-amine (3.12%); 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (2.80%); 5-(Hydroxymethyl)-2-(dimethoxymethyl)furan (2.48%); (Z,Z,Z)-9,12,15-Octadecadienoic acid (2.38%); Maltol (2.33%); (1.alpha.,3a.alpha.,4.beta.,7.alpha.,8a.beta)-octahydro-1,4,9,9-tetram- (2.29%); 9,12-octadeca-dienoic acid(Z,Z)- 2,3-dihydroxy-propyl ester (2.26%); Hexadecanoic acid, methyl ester (1.62%); Oleic acid (1.19%) and 9,12-Octadecadienoic acid(Z,Z)-methyl ester (1.04%). **Fig. 50**

10. ***Musa × paradisiaca* (AAB) 'Sirumalai':** All the ten compounds identified have morethan 1% concentration and they include 1,2,3-Propanetriol (39.21%); Diphenyl sulfone (30.54%); 5-Hydrxymethylperfural (7.67%); Dimethyl ester of tartronic acid (5.06%); 1,2-dihydro-2,2,4-trimethyl- Quinoline (5.00%); (E,E)-2,4-Decadienal (3.26%); (E,E)-2,4-Heptadienal (2.88%); Hexanoic acid (2.26%); 1- (2-furanyl)-2-Butanone (2.25%) and 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (1.87%). **Fig. 51**

11. ***Musa × paradisiaca* (ABB) 'Kachkol':** All the seven compounds identified have morethan 1% concentration and they include, E,E,Z-1,3,12-Nonadecatriene-5,14-diol (76.07%); 19,21-Tetracontadiyne (5.73%); Propyleneglycol monoleate (5.5%); 12-hydroxy-15-oxo-Bicyclo[9,3,1]pentadecane-1-carbonitrile (5.27%); 2,6,10,10-tetramethyl-Tricyclo[7.2.0.0(2,6)]undecan-5-ol (4.39%); (phenylsulfonyl) Benzene (1.69%) and 2-(4-morpholinylsulfanyl)-1,3-benzothiazole (1.35%).

Fig. 52

12. ***Musa × paradisiaca* (ABB) 'Karpuravalli':** Out of twenty six compounds identified the following seventeen compounds have higher concentration (*i.e.* ≤ 1%) and are, 1-(+)-ascorbic acid, 2,6-dihexadecanoate (36.93%); Diphenyl sulfone (8.99%); (Z,Z)-9,12-Octadecadienoic acid (8.04%); Hexadecanoic acid, methyl ester (5.96%); Dichloroacetic acid, tridec-2-ynyl ester (5.80%); 5-(hydroxymethyl)- 2-Furaldehyde (5.64%); 4-t-Butyl-2-(4-methoxy-phenyl)-6-p-tolyl-pyridine (4.72%); (E)- 9-Octadecenoic acid (4.56%); 9,12-Octadecadienoic acid(Z,Z)-methyl ester (2.65%); 9-Octadecenoic acid(Z), methyl ester (1.91%); Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester (1.85%); 2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one (1.80%); 1,2-dihydro-2,2,4-trimethyl- Quinoline (1.70%); 5-(Hydroxymethyl)-2-(dimethoxymethyl)furan (1.32%); Malonic acid, 2,4-dimethylpent-3yl ethyl ester (1.11%); Phthalic acid, di(6-methylhept-2-yl) ester (1.05%) and Phthilic acid, butyl undecyl ester (1.01%). **Fig. 53**

13. ***Musa* × *paradisiaca* (ABB) 'Monthan':** Out of nine compounds identified the following six compounds have higher concentration (*i.e.* ≤ 1%) and are, Diphenyl sulfone (61.53%); (3.beta, 22E)-Stigmasta-5,22-dien-3-ol (16.15%); Atriplexinol (7.17%); Hexadecanoic acid, methyl ester (6.35%); 4,4'-((p-Phenylene)disopropylidene)diphenol (4.52%) and Heptadecenoic acid, 16-methyl-methyl ester (2.24%). **Fig. 54**

Discussion

Out of thirteen methanolic extracts of the unripe fruit pulps of banana cultivars, the maximum number of compounds (22) occur in *Poovan* fruit followed by *Nendran* (17), *Kadali* (17), *Karpuravalli* (17), *Pisang lilin* (16) and Thaenkunnan (16) and minimum in *Monthan* (6).

The GC-MS data also showed that most of the compounds in cultivars like *Kadali*, *Pisang lilin*, *Thaenkunnan*, *Nendran* and *Sirumalai* were elucidated in the first half where as in the extracts of *Monthan* and *Kachkol* the compounds elucidated only after 30 minutes and hence the number of compounds were also very little (*ie,* 6 or 7).

The chemical profile of the banana fruit pulp with respect to the major constituents is very specific to each cultivar studied (about 73% of total compounds reported), this indicate the chemical uniqueness of the cultivar. Thus these components can be considered as chemical markers of banana cultivars (**Table 09**). A higher concentration of E,E,Z-1,2,12-Nonadecatriene-5,14-diol (42.16%) and a combination of (E,E,E)-9-octadecanoic acid, 1,2,3-propanetriyl ester (5.28), 1-dimethyl(octyl)sililoxypropane (2.41%), (3α)-cholest-4-en-3ol (2.33%), E,Z-1,3,12-Npnadecatriene (2.13%), 2-hydroxy-4-methoxy-7-methyl-7,8,9,10,11,12,13,14-octahydro-6-oxab (1.11%) and 3-ethoxy-Benzaldehyde (1.04%) makes *Kunnan* distinct from other banana cultivars in South India. Similarly, a combination of (3β, 22E)-Stigmasta-5,22-dien-3-ol (16.15%), Atriplexinol (7.17%) and Heptadecenoic acid, 16-methyl-methyl ester (2.24%) is characteristic of *Monthan.* Erythritol

(17.24%), 2-isopropyl-2-methyl-butanedioic acid (3.16%), delta.1, alpha-cyclohexaneacetic acid (2.38%) is unique for *Nendran* and 2-(methylamino)-2-thioxo-acetamide (10.66%), β-sitosterol (3.91%), Butyl 9,12,15-octadecatrienoate (3.71%), N,N-dimethyl-5α-cholastan-6β-amine (3.12%), (Z,Z,Z)-9,12,15-octadecadienoic acid (2.38%) and Maltol (2.33%) for *Poovan*. The presence of 1,2,3-Bitanetriol (12.28%), c-hexadecanoic acid (9.52%), Malic acid (4.56%), bis(2-sulfhydrylethyl)-disulfide (4.75%) and 1-Pentyl-2,2-D2 acetate (1.99%) in 'Kadali'; (Z,Z)-9,12-octadeca-dienoic acid-2,3-dihydroxy-propyl ester (16.54%), DL-Arabinitol (14.17%), (1S,2E,4S,5R,7E,11E)-cembra-2,7,11-trien-4,5-diol (11.07%), Isophthalic acid, 2-propylphenyl tridecyl ester (1.87%), 3-(1-hydroxy-2-isopropyl-5-methylcyclohexyl)-Ppropiolic acid (1.55%) and 3,4,5,6,7,8,9,10-octahydro-12hydr-1H-2-benzoxacyclododecin-1-one (1.02%) in *Pachanadan* make it distinct from others.

3-(2-methoxy-1-methyethoxy)-1-propanamine (6.81%), Xanthosine (5.25%), Dodecanoic acid (1.33%) and N-ethyl-N-nitroso-ethanamine (1.01%) are specific to *Pisang lilin*. Similarly, Trichloroacetic acid, tridec-2-ynlester (9.78%), Butyl 6,9,12,15-octadecatetraenoete (6.11%) 7-methyl-13-oxatricyclo[6.4.2.0(1,6)]tetraec-11en-14-one (3.62%), Trideuteriomethyl-10-epoxy-7-ethyl-3,11-dimethyltrid (3.04%), 3-isopropyltricyclo-[4.3.1.1(2,5)]undec-3-en10-ol (2.28%) and 11-hydroxy-11-methyl-tricyclo[3.4.1.1(2,5)]undecan-10-one (1.20) in *Neypoovan*; 5-methyl-2,4(1H,3H)-pyrimidinedione (6.90%), (Z)-7-tetradecenal (5.27%), (E)-9-octadecenoic acid, methyl ester (2.71%), Diglycolic acid (1.70%),Methyl triethylsilylether (1.19%) and 4-(3,4-dihydro-2,2,4-trimethyl-2H-1-benzopyran-4-yl)-phenol (1.01%) in *Thaenkunnan* and Allopregnane-3β-7α.11α-triol-20-one (2.81%), Dihydro-neotigogenin dibenzoate (1.73%), 1H-pymole-2,4-dicarboxylic acid, 3,5-dimethyl-diethyl ester (1.69) in *Karivazhai* are also unique. Dimethyl ester of tartronic acid (5.06%), (E,E)-2,4-decadienal (3.26%), (E,E)-2,4-heptadienal (2.88%), Hexanoic acid (2.26%), 1-(2-furanyl)-2-butanone (2.25%) is characteristic of *Sirumalai*;

Dichloroacetic acid, tridec-2-ynyl ester (5.80%), 4-t-butyl-2-(4-methoxy-phenyl)-6-p-tolyl-pyridine (4.72%), (E)-9-octadecenoic acid (4.56%), 9-octadecenoic acid(Z), methyl ester (1.91%), Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester (1.85%), Malonic acid, 2,4-dimethylpent-3yl ethyl ester (1.11%) and Phthilic acid, Pthalic acid, di(6-methylhept-2-yl) ester (1.05%) and butyl undecyl ester (1.01%) in *Karpuravalli* and 2,6,10,10-tetramethyl-trycyclo[7.2.0.0(2,6)]undecan-5-ol (4.36%) and Propyleneglycol monoleate (5.50%) in *Kachkol* were also found specific in the extract tested.

Table 09: Specific compounds in the methanolic extracts of South Indian banana pulps.

Sl. No.	Cultivar	Total No. of comp.	Specific compounds noticed	Chemical formula	Mol. wt.	Area percentage (%)
1	'Kadali'	21	1,2,3-Butanetriol	$C_6H_{10}O_3$	106.12	12.28
			c-hexadecanoic acid	$C_{16}H_{32}O_2$	256.43	9.52
			Malic acid	$C_4H_6O_5$	134.0874	4.56
			bis(2-sulfhydrylethyl)-disulfide	$C_4H_{10}S_4$	186	4.75
			2,2'-thiobis- Butane	$C_8H_{18}S$	146.294	0.64
			Dibutyl phthalate	$C_{16}H_{22}O_4$	278.34	0.83
			Benzothiazole	C_7H_5NS	135.1863	1.24
			N,N-Dimethyl-O-(1-methyl-butyl) Hydroxilamine	$C_7H_{17}NO$	131.216	1.28
			1-azido-4-(methylthio)- Butane	$C_5H_{11}N_3S$	145.23	1.49
			[S-R*,R*)]-1,2,3,4-Butanetetrol	$C_4H_{10}O_4$	122.1998	1.77
			1-Pentyl-2,2-D2 Acetate	$C_7H_{14}O_2$	130.1849	1.99
			1,2-Benzenedicarboxylic acid, 1,2-bis(2-ethylhexyl) ester	$C_{24}H_{38}O_4$	390.5561	1.25
			1-Pentyl-2,2-D2 acetate	$C_7H_{12}D_2O_2$	132.197	1.99
2	'Karivazhai'	19	Allopregnane-3β-7α.11α-triol-20-one	$C_{21}H_{34}O_4$	350.49	2.81
			Methyl 16-oxo-cleroda-3,13(14)-E-dien-15-oate	$C_{21}H_{32}O_3$	332.477	0.23
			1,2-Epoxy-5,9-cyclododecadiene	$C_{12}H_{18}O$	178.2707	0.42
			URS-12-en-20-oic acid methyl ester			0.50

			o-Mentha-1(7),8-dien-3-ol	$C_{10}H_{16}O$	152.2334	0.72
			Decaborane(14)	B_{10}	108.11	1.20
			Trilinolein	$C_{57}H_{98}O_6$	879.3844	2.58
			n-Propyl 9,12,15-octadecatrienoate	$C_{21}H_{36}$	320.509	5.32
			Dihydro-neotigogenin dibenzoate	$C_{41}H_{54}O_5$	626.86	1.73
			1H-pymole-2,4-dicarboxylic acid, 3,5-dimethyl-diethyl ester	$C_{12}H_{17}NO_4$	239.2677	1.69
3	'Pisang lilin'	27	3-(2-methoxy-1-methylethoxy)-1-propanamine	$C_7H_{17}NO_2$	147.2154	7.19
			2-Furanmethanol	$C_5H_6O_2$	98.100	0.25
			p-Dioxane-2,3-diol	$C_4H_8O_4$	120.104	0.42
			7,10-Octadecadienoic acid, methyl ester	$C_{19}H_{34}$	294.472	0.45
			1,2-Benzenediol	$C_6H_6O_2$	110.111	0.98
			1,2,3-benzenetriol	$C_6H_6O_3$	126.110	4.21
			Palmitoleic acid	$C_{16}H_{30}$	254.408	1.03
			Dodecanoic acid	$C_{12}H_{24}O_2$	200.32	1.40
			N-ethyl-N-nitroso-ethanamine	$C_4H_{10}N_2O$	102.1350	1.06
4.	'Kunnan'	20	E,E,Z-1,2,12-Nonadecatriene-5,14-diol	$C_{19}H_{34}O_2$	294.2	42.16
			1-dimethyl(octyl)siliIoxypropane	$C_{13}H_3OOS$	230	2.41
			(3α)-cholest-4-en-3ol	$C_{27}H_{46}O$	386.6535	2.33
			L-Arabinitol	$C_5H_{12}O$	152.146	0.81
			(Z)-9-Tetradecenal	$C_{14}H_{26}$	210.356	0.39
			(2E)-4,5-dimethyl-2-undecene	$C_{13}H_{26}$	182.346	0.27
			3-ethoxy-Benzaldehyde	$C_9H_{10}O_2$	150.1745	1.04
5	'Neypoovan'	14	Trichloroacetic acid, tridec-2-ynlester	$C_{15}H_{23}Cl_3O_2$	341.701	9.78
			Butyl 6,9,12,15-octadecatetraenoate	$C_{22}H_{36}$	332.520	6.11
			7-methyl-13-oxatricyclo [6.4.2.0(1,6)]tetradec-11en-14-one			3.62
			Trideuteriomethyl-10-epoxy-7-ethyl-3,11-dimethyltrid			3.04
			3-isopropyltricyclo-[4.3.1.1(2,5)]undec-3-en10-ol	$C_{14}H_{22}O$	206.32	2.28
			2,3-epoxy-1-propanol	$C_3H_6O_2$	74.078	0.54
6	'Thaenkunnan'	23	5-methyl-2,4(1H,3H)-pyrimidinedione	$C_5H_6N_2O_2$	126.11	6.90
			(Z)-7-tetradecenal	$C_{14}H_{26}O$	210.35	5.27
			(E)-9-octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296.48	2.71

			Diglycolic acid	$C_4H_6O_5$	134.089	1.70
			2,6-dichloro-1,1'-biphenyl	$C_{12}H_8Cl_2$	223.098	0.93
			2.alpha.-isopropyl-5.Alpha.-Estran-3-one	$C_{21}H_{34}O$	302.4941	0.85
			Benzo(a)azulene	$C_{14}H_{10}$	178.2292	0.51
			4-(3,4-dihydro-2,2,4-trimethyl-2H-1-benzopyran-4-yl)-phenol	$C_{18}H_{20}O_2$	268.35	1.01
7	'Nendran'	23	Erythritol	$C_4H_{10}O_4$	122.12	17.24
			2-isopropyl-2-methyl-butanedioic acid	$C_{16}H_{28}O_8$	348.389	3.16
			Phthalic acid, di(2-propylpentyl) ester	$C_{24}H_{38}O_4$	390.5561	0.94
			9,12-Octadecadienoic acid(Z)-methyl ester	$C_{19}H_{34}O_2$	294.4721	0.93
			Caprolactam	$C_6H_{11}NO$	113.16	0.80
			1,3-dipalmitic trimethylsilyl ether	$C_{38}H_{76}O_5Si$	641.0925	0.90
			delta.1, alpha-cyclohexaneacetic acid	$C_8H_{12}O_2$	140.1797	2.38
8	'Pachanadan'	16	(Z,Z)-9,12-octadeca-dienoic acid-2,3-dihydroxy-propyl ester	$C_{21}H_{38}O_4$	354.52	16.54
			DL-Arabinitol	$C_6H_{10}O_5$	152.15	14.17
			(1S,2E,4S,5R,7E,11E)-cembra-2,7,11-trien-4,5-diol	$C_{20}H_{34}O_2$	306.48	11.07
			Isophthalic acid, 2-propylphenyl tridecyl ester	$C_{30}H_{42}O_4$	466.65	1.87
			3-(1-hydroxy-2-isopropyl-5-methylcyclohexyl)-Ppropiolic acid	$C_{13}H_{20}O_3$	224	1.55
9	'Poovan'	26	2-(methylamino)-2-thioxo-acetamide			10.66
			β-sitosterol	$C_{29}H_{50}O$	414.706	3.91
			Butyl 9,12,15-octadecatrienoate	$C_{22}H_{38}O_2$	334.536	3.71
			(7R,8R)-cis-anti-cis-Tricyclo[7.3.0.0(2,6)]dodecan-7,8-diol	$C_{12}H_{20}O_2$	196.286	3.21
			N,N-dimethyl-5α-cholestan-6β-amine	$C_{29}H_{53}$	415.738	3.12
			(Z,Z,Z)-9,12,15-octadecadienoic acid	$C_{18}H_{36}O_2$	278.42	2.38
			(1.alpha.,3a.alpha.,4.beta.,7.alpha.,8a.beta)-octahydro-1,4,9,9-tetram-	$C_{15}H_{24}$	204.3511	2.29
			Oleic acid	$C_{18}H_{34}O_2$	282.4614	1.19
			Maltol	$C_6H_6O_3$	1.35	2.33
10	'Sirumalai'	10	Dimethyl ester of tartronic acid	$C_{15}H_{22}O_5Si$	310.4177	5.06
			(E,E)-2,4-decadienal	$C_{10}H_{16}O$	152.24	3.26
			(E,E)-2,4-heptadienal	$C_7H_{10}O$	110.1537	2.88
			1-(2-furanyl)-2-butanone	$C_8H_{10}O_2$	138.1638	2.25

11	'Kachkol'	7	2,6,10,10-tetramethyl-trycyclo[7.2.0.0(2,6)]undecan-5-ol	$C_{15}H_{26}O$	222.366	4.36
			Propyleneglycol monoleate	$C_{21}H_{40}O_3$	340.54	5.50
12	'Karpuravalli'	26	Dichloroacetic acid, tridec-2-ynyl ester	$C_{15}H_{24}Cl_2O_2$	307.256	5.80
			4-t-butyl-2-(4-methoxy-phenyl)-6-p-tolyl-pyridine	$C_{23}H_{25}NO$	331.4507	4.72
			9-octadecenoic acid(Z), methyl ester	$C_{19}H_{36}O_2$	296.48	1.91
			Phenanthrene	$C_{14}H_{10}$	178.2292	0.64
			2,2',3-Trichloro-1,1'-biphenyl	$C_{12}H_7Cl_3$	257.5430	0.48
			2,3-dichloro-1,1'-biphenyl	$C_{12}H_8Cl_2$	223.098	0.46
			Methyl stearate	$C_{19}H_{38}O_2$	298.5038	0.43
			Phthilic acid, Pthalic acid, di(6-methylhept-2-yl) ester	$C_{24}H_{38}O_4$	390.55	1.05
			butyl undecyl ester	$C_{23}H_{36}O_4$	376	1.01
13	'Monthan'	9	(3β, 22E)-Stigmasta-5,22-dien-3-ol	$C_{58}H_{98}O_2$	827.398	16.15
			Cyclohexanecarboxylic acid, dodec-9-ynyl ester	$C_{19}H_{32}O_2$	292.4562	0.78
			Atriplexinol	C_30H_{48} O_5	488.6991	7.17
			Heptadecenoic acid, 16-methyl-methyl ester	$C_{19}H_{38}O_2$	298.5	2.24

Diphenyl sulfone ($C_{12}H_{11}O_2S$) was found in all cultivars but its concentration is very low in *Kadali*, *Neypoovan*, *Monthan* and *Kachkol*; and is much high in *Monthan* (61.53) followed by *Sirumalai* (30.54%). It was already reported in other plants such as *Gnidia glauca, Dioscorea bulbifera* (Ghosh *et al.,* 2013), *Myriactis humilis* (Chen *et al.,* 2005) etc.

Some other compounds are present in more than one cultivar and it shows its interrelationship between them. Glycerol is present in 6 cultivars (*Kadali*, *Karivazhai*, *Thaenkunnan*, *Nendran*, *Pachanadan* and *Sirumalai*) and is very high in *Sirumalai* (39.21%), *Kadali* (36.17%) and *Thaenkunnan* (29.14%). *Pisang lilin*, *Thaenkunnan*, *Nendran*, *Poovan*, *Sirumalai* and *Karpuravalli* contains 2,3-Dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one, Hexadecanoic acid, methyl ester are present in *Kadali*, *Thaenkunnan*, *Nendran*, *Poovan*, *Karpuravalli* and *Monthan* and (Z,Z)-9,12-Octadecadienoic acid in *Kadali*, *Pisang lilin*, *Thaenkunnan*, *Nendran*, *Poovan* and *Karpuravalli*.

By using the data obtained from the GC-MS analysis of methanolic extract of the pulp of these thirteen South Indian banana cultivars, it was imposible to separate the genomic groups of cultivated bananas but the uniqueness of each cultivar is vivid through the chemical profile of the fatty acids and the volatile compounds.

Some of the cultivars have some compounds in abundance which has significant role in contributing to the fruit quality (**Fig. 55**). The graph shows that the 1,2,3-Propanetriol (*i.e.,* glycerine) is the major compound in *Kadali* (36.17%), *Thaenkunnan* (29.14%), *Nendran* (23.25%), *Sirumalai* (39.21%) and *Monthan* (61.53). However, it varies in other cultivars. 1-Heptatriacotanol is found abundant in *Karivazhai* (56.48%), is an alcoholic compound, which showed antimicrobial activity (Kalaiarasan *et al.*, 2011). The presence of 3-Deoxy-d-mannoic lactone in *Pisang lilin* (35.05%), E,E,Z-1,2,12-Nonadecatriene-5,14-diol in *Kunnan* (42.16%), (3-beta.)-9,19-Cyclolanostan-3-ol-acetate in *Neypoovan* (35.75%), 9,12-octadeca-dienoic acid(Z,Z)-2,3-dihydroxy-propyl ester in *Pachanadan* (27.31%), Butyl 9,12-octadecadieonate in *Poovan* (13.85%), E,E,Z-1,3,12-Nonadecatriene-5,14-diol in *Kachkol* (76.07%) and 1-(+)-ascorbic acid, 2,6-dihexadecanoate in *Karpuravalli* (36.93%) are found abundant.

Some other interesting compounds with reported antioxidants, antifungal, antimicrobial or other such activities were also found in some pulp extracts tested. The presence of 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one in *Thaenkunnan* (4.72%), *Pisang lilin* (3.03%), *Poovan* (2.80%), *Sirumalai* (1.87%), *Karpuravalli* (1.80%) and *Nendran* (1.71%) shows the antimicrobial and anti-inflammatory activity of these fruits. The anti-inflammatory compound n-Hexadecanoic acid is also present in *Thaenkunnan*

(18.22%), *Pisang lilin* (5.71%) and *Karivazhai* (1.49%) fruits. Dodecanoic acid is present in the fruits of *Pisang lilin* (1.33%); and is a saturated fatty acid with antifungal and antimicrobial activity.

Monthan pulp extract contains Atriplexinol (7.17%); which is a pentacyclic triterpenoid with antifungal activity and was first isolated from *Atriplex stocksii* by Siddiqui *et al.* (1994). Such a higher concentration of this compound indicates its antifungal activity of this fruit. The presence of maltol in 'Poovan' (2.33%) and (E,E)-2,4-Decadienal in 'Sirumalai' (3.26%) also indicates their antioxidant and nematicidal activity.

Urea is present in the ethanolic extract of the fruit pulp of cultivar 'Nendran' (1.36%). Since it is cultivated widely for the commercial propose and urea may be widely used as fertilizer, the possible source of this urea is from the manure. This shows that the chemicals applied in the soil is absorbed by the plant and is stored in the fruit, which may result in the bioaccumulation of the toxic compounds.

Conclusion

The chemical profiling of fatty acids and the volatile compounds of methanolic extracts of the fruit pulps of 13 *Musa* cultivars in South India were done using GC-MS analysis. The study indicates these are very distinct, in support of the distinct morphological features. In Chemotaxonomic point of view, rather than the closeness of relationship between allied cultivars, the uniqueness of each cultivar is vivid through the chemical profile of the fatty acids and the volatile compounds. The study also throws some light towards the presence of some important chemical compounds and such compounds are important based on their biological and pharmacognostic activities. The present study is also very significant since it is the first time attempt in most of the cultivars.

SUMMARY

Musaceae, the banana family, are considered as the most ancient family in the order Zingiberales with three genera – *Musa, Ensete* and *Musella* (Kress, 1990). The genus *Musa* includes several seeded wild forms and a number of seedless edible cultivars. It is generally considered as one of the taxonomically difficult group, primarily due to its bulkiness and high range of variation (Joe, 2015). The genus consists of plants with large rhizomatous perennial habit with well developed areal shoots, developed by the folded leaf sheaths – the pseudostem and a terminal tuft of leaves. Inflorescence is terminal, developed by the elongation of apical bud and penetrated through the pseudostem. Flowers are epigynous and usually unisexual (bisexual flowers are also seen in some wild species). The fruits are very large and are edible or not. Present study deals with the taxonomy of banana cultivars in South Indian and their phytochemistry.

Banana has been recognized as one of the major fruit crop in India and it ranks second in area of production and first in production (29.19% of global production). Even though the cultivated banana attracts a good deal of research in many aspects, most of them lack a botanical identity and almost all banana cultivars were treated as a single species – either *M. paradisiaca* or *M. sapientum.*

The plants were collected from all parts of South India, notes down the special characters, local names, uses, and all other details available from the farmers itself. The photographs were also taken from the field. The rhizomes were collected and brought to the Calicut University Botanical Garden to develop a live germplasm of South Indian *Musa* cultivars. Herbarium specimens including voucher specimen and standard specimens of all cultivars were prepared and deposited in the Calicut University Herbarium (CALI).

During the present study, 24 *Musa* cultivars were identified from South India with synonyms, and a detailed description, colour photographs and a dichotomous key to all taxa were provided for the easy identification. The genomic constitution of each cultivar was identified using morpho-taxonomic scoring method developed by Simmonds and Shepherd (1955) and compared with the modified score card of Singh and Uma (2000). These include diploids and triploids with the genomic constitutions of AA, AAA, AB, AAB or ABB. There are no tetraploids and pure *M. balbisiana* lines so far found in South India.

Nomenclature

All cultivars were named in accordance with the latest Code of nomenclature - ICN (McNeill *et al.*, 2012) and ICNCP (Brickell *et al.*, 2009). For the naming of cultivated bananas, a modified three-tier system, originally proposed by Simmonds and Shepherd (1955), was followed. Instead of only the generic name the binomial (parent name in the case of pure lines and for hybrids *Musa* × *paradisiaca* was used), followed by the letter combination indicating the ploidy and genomic set in paranthesis and then the cultivar epithet in single inverted comas. In most cases cultivar names are extracted from Jacob (1952) and those, which are not included in this monograph, the mostly used common name is used.

New synonyms

All the previous authors except Jacob (1952) treated the *Musa* cultivars under a single name (either *M. paradisiaca* or *M. sapientum*) and it cannot identify the correct in all these cases. Jacob (1952) treated all the banana cultivars in Madras provinces under a new species *M. sapidisiaca* and gave the varietal status to all. But the species itself is found invalid due the lack of diagnosis and he only mentioned the new species as a combination of two Linnaean species (*i.e., M. paradisiaca* and *M. sapientum*); hence all these varieties are also invalid. In the present work, these all varieties were treated as synonyms under the respective cultivar. Some cultivars shows high range of continuous variation and Jacob (1952) treated some of them as distinct varieties, hence these all such varieties are also treated here as a single cultivar and synonymised.

Endemism

Present study revealed that four hill bananas, *viz., Musa acuminata* Colla (AA) 'Karivazhai'; *Musa* × *paradisiaca* L. (AAB) 'Namarai'; *Musa* × *paradisiaca* L. (AAB) 'Sirumalai'; *Musa* × *paradisiaca* L. (AAB) 'Virupakshi', are endemic to some hilly areas of Tamil Nadu and one cultivar (*Musa* × *paradisiaca* L. (AB) 'Matti') is found endemic to Andhra.

Germplasm conservation

An attempt has been made to conserve all South Indian Banana cultivars in the Calicut University Botanical Garden (CUBG). The fresh rhizomes collected from various localities in South India were collected and planted in the *Musa* garden at CUBG. A collection of 72 accessions of 24 cultivars are surviving in the conservatory. Some of these cultivars are endemic to some hilly areas and some are highly endangered and may be lost in the coming future. So this conservatory may help for further research and can also be made useful for the breeding experiments for the production of improved cultivars.

It is noticed that the hill banana *Musa acuminata* Colla (AA) 'Karivazhai' is very difficult to grow in the plains and the other hill bananas also faces some stresses here. Some banana cultivars like *Musa acuminata* Colla (AAA) 'Grand naine', *Musa* × *paradisiaca* L. (AAB) 'Nendran', *Musa* × *paradisiaca* L. (AAB) 'Rasthali', etc. needs special care and it needs to replant in every year. The cultivar *Red* needs double manure and water for its growth where as the cultivars like *Neypoovan, Poovan, Vannan,* etc. can grow for years in the same clump even without any care. Some shows variation in colour of pseudostem and leaf parts and in the taste with variation in altitude.

Musa × *paradisiaca* L. (AB) 'Thaenkunnan' generally produces only female flowers and all are developed in to fruits but in the extreme summer or in the severe drought condition, it has a tendency to produce male flowers towards the tip and thus may get normal infructescence.

Database of South Indian *Musa* cultivars

A database was prepared for the easy identification of different South Indian *Musa* cultivars. It provides all relevant updated information of all cultivars under study. The taxon can also be searched by valid name, synonyms, common names and endemic status. The close button should be used for closing a window. The database is developed by using the software Visual FoxPro (Version 6) with the help of a computer programmer.

Phenetic analysis

Phenetic analyses of twenty four *Musa* cultivars revealed that there are two groups exist in the South Indian cultivated bananas and this well support the genomic classification – I. pure lines of *M. acuminata* (AA & AAA). II. all hybrid cultivars (AB, AAB & ABB). The genetic interrelation ship is highly reflected in the phenogram and are highly reliable (100 bootstraps).

Phytochemical analysis

The chemical profiling of fatty acids and the volatile compounds of methanolic extracts of the fruit pulps of thirteen *Musa* cultivars in South India were done using GC-MS analysis. A total of 140 fatty acids and volatile compounds were identified from thirteen banana cultivars with their chemical formula, molecular mass, retention time and area percentage in each cultivar (APPENDIX III). Out of which 105 compounds have much higher concentration (*i.e.,* area percentage is higher than 1%).

The study indicates these are very distinct, in support of the distinct morphological features. In Chemotaxonomic point of view, rather than the closeness of relationship between allied cultivars, the uniqueness of each cultivar is vivid through the chemical profile of the fatty acids and the volatile compounds. The study also throws some light towards the presence of some important chemical compounds such as 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one, n-Hexadecanoic acid, Dodecanoic acid, Atriplexinol, maltol, (E,E)-2,4-Decadienal, etc. Such compounds are important with their biological and pharmacognostic activities. The present study is also very significant since it is the first time attempt in most of the cultivars done.

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INDEX TO SCIENTIFIC NAMES

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INDEX TO VERNACULAR NAMES

APPENDIX I

MUSACEAE

PLANT DESCRIPTION

Name: ……………………………………………… Coll. no. : …………...……

Habitat:…………...………; Locality:.……………………..……..………………..

Collector: ...……………………………….; Date: ……………………………….

Vernacular name: ………………………………………………………………

PSEUDOSTEM:

Height: …………………...……; Aspect (circumference) :……………………….

Colour: ……………………………………….…….. ; Appearance : (dull / waxy)

Pigmentation of the underlying pseudostem: …………………………………......

Sap colour :……………………………; Number of suckers : …………………....

Notes :.……………………………………………………..…………………….……

……………………………………………………………………………………...

LEAF:

Leaf habit: (erect/ intermediate/ drooping); Notes : …...………………………………

Petiole:

Blotches at the base: (present / absent); Blotch colour:…….…………………………...

Petiole canal: (open with spreading/wide with erect/straight with erect/curved inward/overlapping)

Notes: ………………………………………………………..…………………….

Lamina :

Length: ………………………….; Breadth :………….…………….…………….

Dorsal surface:……………….……….….….; Ventral surface:…..…………….……

Base: (both sides pointed/one round & one pointed/both rounded/both auriculated & rounded)

Midrib colour (dorsal): …………………………; (ventral): ……….………..……….

Flag leaf colour (dorsal): ……………………….……… ; (ventral): ………..………..…...

Flag leaf length: ……….……..............; Breadth :…………………….……….

Cigar leaf colour: …………………………; Notes: …………………...……………

…………………………………………………………………………...……

INFLORESCENCE:

Bunch orientation : (pendulous / sub horizontal (oblique) / horizontal / erect)

Peduncle colour: ………………..………………; Length: ………………………..

Notes: ………………………………………………………………...……………

……………………………………………………………………………...…

STERILE BRACTS (SPATHE):

Numbers:………………..; Length: …………..…………; Breadth : ……….......

Colour: (upper): ……………………..………..; (lower): …..…………………….…

Notes: ………………………………………………………………..…..

FEMALE BUNCH / BISEXUAL:

Bracts :

Length: ………………; Breadth: …..……........; Cincinnus:……….……flowered

Colour: (dorsal): ……………………..……. (ventral): ………………………………

Curling : (just open / open & reflexed / reflexed & revolute)

Shape : (top-shaped / lanceolate / intermediate / ovoid / rounded)

Apex : (pointed / slightly pointed / intermediate / obtuse / obtuse & split)

Notes: ……………………………………………….…………….……………..

Female flowers: Number: ………………; Length: ………………..……….

Notes: …………………………………..……………………………………..

Compound tepal: Length: …………………….; Breadth: ……………..…......

Number of lobes: ………………….; Colour: ……………………………………

Notes: ………………………………….…………………………………………

Free tepal: Length: …………; Breadth: …..............; Colour: ……………........

Notes:.……………………………..……………………………………………

Staminodes:

Number: ……….…...…; Length: ….………………..…; Breadth: …………………

Colour: ………..……..; Notes: …..…………..……………………………………

Stamen:

Number: ……….…...; Length: ……………….…; Breadth: ….…………………….

Colour: …………..…….; Notes: …………………….………………………

Pistil :

Ovary length: ……………………; Basic colour: …………………….…..…………

Style length: ……………………; Colour: …………….……………………………..

Style shape: (straight / curved under stigma / curved at the base /curved twice)

Stigma shape: ……………………….; Colour: ……………….…………………..

Notes: ..……………………………………………………………………………….

MALE BUNCH :

Rachis position : (falling vertically / at an angle / with a curve / horizontal / erect)

Bract scars : (prominent / scarcely prominent / absent)

Male bud shape: (top shaped / lanceolate / intermediate / ovoid / rounded)

Notes: ……………………..................……………………………………………….

Bracts: Length: ….…………; Breadth: ……….........; Cincinnus:…..…..flowered

Colour: (upper): ……………………...…………….; (lower): ..………………………….

Curling : (just open / open & reflexed / reflexed & revolute)

Shape : (top-shaped / lanceolate / intermediate / ovoid / rounded)

Bract apex : (pointed / slightly pointed / intermediate / obtuse / obtuse & split)

Notes: ……………………………………………………………………………….

Male flowers :

Number: ……………….…; Length : ………….…...……………….…………….…

Notes: ……………………….……………………………….……………………..

Compound tepal: Length : …………….……; Breadth: …….…………….....

Number of lobes: ……………..; Colour: ……………..…………………………..

Notes: ………………………………………..……………………………………..

Free tepal: Length: …………….; Breadth: …............. ; Colour: ……………....

Notes: ……………………………………………………………………………..…..

Stamens: Number: ……….………; Length: ……………………………………

Filament length: ……………………...…..; Colour: ……………….……….........…

Anther size: ……..…..; colour: ……………..…….; Shape: …………….………

Notes: …………………………………..…...…………………………………...

Pistil: Ovary length:………………; Basic colour: ..……………………………

Style length: ……………………….; Colour: ………………..…………………

Style shape : (straight / curved under stigma / curved at the base /curved twice)

Stigma shape: ………………....; Colour: …………………..……………………

Notes: ………………………………….................……………………………

FRUIT :

Number of fruits (on the mid hand): ……………..; Length: …………..……………..

Shape: (straight / straight in the distal part / curved / 'S'- shaped)

Apex: (pointed /lengthily pointed / blunt-tipped / bottle-necked / rounded)

Remains of flower relicts at the fruit apex: (absent/persistent/base of the style prominent)

T.S. of the fruit: (pronounced ridged / slightly ridged / rounded)

Fruit peel colour (at maturity): ………………………..………………..……….

Pulp colour (at maturity): ……………………….………; Notes : ……..………

…………………………………………………………………………...…………

SEEDS :

Number: …………….; Shape: …..…..….…………..; Size: ………...………….

Surface: ……………………………….……...; Colour: ……………..……………

Notes: …………………………………………………………………….……….

……………………………………………………………………………......

APPENDIX - II

Morpho-taxonomic scoring system for genomic classification of cultivated banana

Sl. No.	Taxa	Score																Genome
		Pseudostem colour	Petiole canal	Peduncle	Pedicel	Ovules	Bract curling	Bract shape	Bract apex	Bract shoulder	Bract colour	Colour fading	Bract scars	Free tepal of male flower	Male flower colour	Stigma colour	Total	
1	*Kadali*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15	AA/~~AAA~~
2	*Karivazhai*	1	1	1	1	1	1	2	1	1	2	1	1	3	1	1	19	AA/~~AAA~~
3	*Pisang lilin*	1	2	1	2	1	1	1	2	1	2	1	2	5	1	1	23	AA/~~AAA~~
4	*Dwarf cavendish*	1	1	1	2	1	5	1	2	1	1	1	1	1	1	1	21	~~AA~~/AAA
5	*Grand naine*	1	1	1	3	1	5	1	2	1	1	1	1	1	1	3	24	~~AA~~/AAA
6	*Red*	1	2	1	1	1	1	1	2	1	1	1	1	1	4	1	20	~~AA~~/AAA
7	*Robusta*	1	1	1	2	1	5	1	3	1	1	1	1	2	1	1	23	~~AA~~/AAA
8	*Kunnan*	4	4	5	3	1	1	3	5	4	3	5	1	1	3	5	48	AB
9	*Matti*	4	3	5	3	1	1	3	4	4	4	5	1	1	3	5	47	AB
10	*Neypoovan*	4	4	3	2	1	1	1	4	3	4	5	5	1	4	5	47	AB
11	*Thaenkunnan*	4	3	5	5	1	1	1	5	2	4	5	4	1	1	5	47	AB
12	*Namarai*	3	2	5	2	1	1	2	3	2	3	5	5	3	3	4	44	AAB

Sl. No.	Taxa	Score																Genome
		Pseudostem colour	Petiole canal	Peduncle	Pedicel	Ovules	Bract curling	Bract shape	Bract apex	Bract shoulder	Bract colour	Colour fading	Bract scars	Free tepal of male flower	Male flower colour	Stigma colour	Total	
13	*Nendran*	3	4	5	5	1	1	1	5	1	2	5	1	1	1	1	38	AAB
14	*Pachanadan*	2	3	5	3	1	1	2	4	2	3	5	1	2	4	1	39	AAB
15	*Poovan*	1	3	3	4	1	1	2	4	2	3	5	1	1	3	1	35	AAB
16	*Rasthali*	2	4	3	2	1	1	1	2	3	3	2	1	1	1	4	31	AAB
17	*Sirumalai*	2	3	5	2	1	1	4	3	2	3	5	1	4	5	2	43	AAB
18	*Vannan*	1	1	4	4	1	1	3	3	3	3	2	1	3	2	1	33	AAB
19	*Virupakshi*	2	3	5	2	1	1	2	2	3	3	5	1	1	4	1	36	AAB
20	*Kachkol*	5	5	5	5	5	2	5	3	5	4	5	2	4	5	4	64	ABB
21	*Karpuravalli*	5	5	4	4	5	2	4	4	5	4	3	2	3	4	5	59	ABB
22	*Kuribontha*	5	5	5	4	5	1	5	5	5	4	5	3	4	4	4	64	ABB
23	*Monthan*	5	5	3	4	5	2	5	5	5	5	5	3	3	4	5	64	ABB
24	*Peyan*	4	5	5	4	5	2	4	5	4	5	5	3	4	3	5	63	ABB

APPENDIX III

GC-MS profile (fatty acids and volatile compounds) of methanolic extracts of thirteen *Musa* cultivar fruit pulps

Ret. Time	Compound	Peak area percentage (%)												
		Kadali	*Karivazhai*	*Pisang lilin*	*Kunnan*	*Neypoovan*	*Thaenkunnan*	*Nendran*	*Pachanadan*	*Poovan*	*Sirumalai*	*Kachkol*	*Karpuravalli*	*Monthan*
4.156	2-Furanmethanol	-	-	0.25	-	-	-	-	-	-	-	-	-	-
4.203	p-Dioxane-2,3-diol	-	-	0.42	-	-	-	-	-	-	-	-	-	-
5.638	1,2-Cyclopentanedione	-	-	2.01	-	-	-	5.84	-	0.97	-	-	-	-
6.851	Hexanoic acid	-	-	-	-	-	-	-	-	-	2.26	-	0.69	-
7.064	1-Dimethyl(octyl)sililoxypropane	-	-	-	2.41	-	-	-	-	-	-	-	-	-
7.140	1,2,3-Propanetriol	36.17	3.89	-	0.69	-	29.14	23.25	7.38	-	39.21	-	-	-
7.228	2-(methylamino)-2-thioxo- Acetamide	-	-	-	-	-	-	-	-	10.66	-	-	-	-
7.245	2,3-epoxy-1-propanol	-	-	-	-	0.54	-	-	-	-	-	-	-	-
7.246	1- (2-furanyl)-2-Butanone	-	-	-	-	-	-	-	-	-	2.25	-	-	-
7.271	3-(2-methoxy-1-methylethoxy)- 1-Propanamine	-	-	7.19	-	-	-	-	-	-	-	-	-	-
7.798	(E,E)-2,4-Heptadienal	-	-	-	-	-	-	-	-	-	2.88	-	-	-
7.864	Dimethyl ester of tartronic acid	-	-	-	-	-	-	-	-	-	5.06	-	-	-

8.560	1-Pentyl-2,2-D2 Acetate	1.99		-	-	-	-	-	-	-	-	-	-	-
8.624	2,2'-thiobis- Butane	0.64	-	-	-	-	-	-	-	-	-	-	-	-
8.700	[S-R*,R*)]-1,2,3,4-Butanetetrol	1.77	-	-	-	-	-	-	-	-	-	-	-	-
8.760	1,2,3-Butanetriol	12.28	-	-	-	-	-	-	-	-	-	-	-	-
9.165	N,N-Dimethyl-O-(1-methyl-butyl) Hydroxilamine	1.28	-	-	-	-	-	-	-	-	-	-	-	-
9.254	Malic acid	4.56	-	-	-	-	-	-	-	-	-	-	-	-
9.280	1-azido-4-(methylthio)- Butane	1.49	-	-	-	-	-	-	-	-	-	-	-	-
9.440	Urea-N15	-	-	-	-	-	-	1.36	-	-	-	-	-	-
9.495	Diglycolic acid	-	-	-	-	-	1.70	-	-	-	-	-	-	-
9.587	bis(2-sulfhydrylethyl)-Disulfide	4.75	-	-	-	-	-	-	-	-	-	-	-	-
9.607	5-methyl-2,4(1H,3H)-Pyrimidinedione	-	-	-	-		6.90	-	-	-	-	-	-	-
9.610	Maltol	-	-	-	-	-	-	-	-	2.33	-	-	-	-
11.185	N-ethyl-N-nitroso-Ethanamine	-	-	1.06	-	-	-	-	-	-	-	-	-	-
11.325	Malonic acid, 2,4-dimethylpent-3yl ethyl ester	-	-	0.82	-	-	-	-	-	0.87	-	-	1.11	-
11.492	2,3-Dihydro-3,5-dihydroxy-6methyl-4H-pyran-4-one	0.89	-	3.20	-	-	4.72	1.71	-	2.80	1.87	-	1.80	-
11.742	Methyl triethylsilyl ether	-	-	-	0.38	-	1.19	-	-	-	-	-	-	-
11.882	5,6-dihydro-4-methyl-2H-Pyran-2-one	-	-	-	0.16	-	-	-	0.35	-	-	-	-	-
13.016	1,2-Benzenediol	-	-	0.98	-	-	-	-	-	-	-	-	-	-
13.802	5-Hydrxymethylperfural	-	2.92	10.76	-	-	2.72	3.88	-	7.87	7.67	-	5.64	-
13.877	Benzothiazole	1.24	-	-	-	-	-	-	-	-	-	-	-	-
14.672	Caprolactam	-	-	-	-	-	-	0.80	-	-	-	-	-	-

15.635	5-(Hydroxymethyl)-2-(dimethoxymethyl) furan	-	-	0.78	-	-	0.38	-	-	2.48	-	-	1.32	-
16.403	(E,E)-2,4-Decadienal	-	-	-	-	-	-	-	-	-	3.26	-	-	-
16.796	Erythritol	-	-	-	-	-	-	17.24	-	-	-	-	-	-
16.896	(2E)-4,5-dimethyl-2-undecene	-	-	-	0.27	-	-	-	-	-	-	-	-	-
18.180	1,2,3-benzenetriol	-	-	4.21	-	-	-	-	-	-	-	-	-	-
19.623	1,2-dihydro-2,2,4-trimethyl-Quinoline	-	-	-	-	-	2.35	-	-	0.46	5.00	-	1.70	0.96
19.961	Xanthosine	-	-	5.54	-	0.63	-	-	-	-	-	-	-	-
20.494	4-hexyl-2,5-dihydro-2,5-dioxo-3-Furanacetic acid	1.14	-	-	-	-	-	1.24	-	-	-	-	-	-
21.110	Tetrahydro-4-hydroxy-6-pentyl-2H-Pyran-2-one	-	-	-	0.34	-	-	-	0.70	-	-	-	-	-
22.551	Dodecanoic acid	-	-	1.40	-	-	-	-	-	-	-	-	-	-
23.837	2,2’-dichloro-1,1’-biphenyl	-	-	-	-	-	0.64	-	-	-	-	-	0.48	-
23.960	3-Deoxy-d-mannoic lactone	-	-	35.05	-	1.41	-	6.96	-	3.96	-	-	-	-
24.503	DL-Arabinitol	-	-	-	-	-	-	-	14.57	-	-	-	-	-
25.523	.delta.1,alpha-cyclohexaneacetic acid	-	-	-	-	-	-	2.38	-	-	-	-	-	-
25.736	2,3-dichloro-1,1’-biphenyl	-	-	-	-	-	-	-	-	-	-	-	0.46	-
25.750	2,6-dichloro-1,1’-biphenyl	-	-	-	-	-	0.93	-	-	-	-	-	-	-
25.893	2,2’,5,5’-Tetramethyl-1,1’-biphenyl	-	-	-	-	-	0.82	-	-	-	-	-	0.52	-
26.126	3-ethoxy-Benzaldehyde	-	-	-	1.04	-	-	-	-	-	-	-	-	-
26.511	L-Arabinitol	-	-	-	0.81	-	-	-	-	-	-	-	-	-
27.026	Myristic acid	-	-	0.48	-	-	-	-	-	-	-	-	0.42	-

27.301	2-isopropenyl-2-methyl- Butanedioic acid	-	-	-	-	-	-	3.16	-	-	-	-	-	-
27.485	2,2’,3-Trichloro-1,1’-biphenyl	-	-	-	-	-	-	-	-	-	-	-	0.48	-
27.507	1,1’-biphenyl, 2,2’,5-trichloro-	-	-	-	-	-	0.85	-	-	-	-	-	-	-
27.570	Phenanthrene	-	-	-	-	-	-	-	-	-	-	-	0.64	-
27.584	Benzo(a)azulene	-	-	-	-	-	0.51	-	-	-	-	-	-	-
29.126	Phthilic acid, butyl undecyl ester	-	-	-	-	-	-	-	-	-	-	-	1.01	-
29.746	N,N-diethyl-.beta.-Alanine	0.85	-	-	-	-	-	1.10	-	-	-	-	-	-
30.357	Diphenyl sulfone	6.22	8.61	6.73	1.25	1.33	8.76	5.27	1.65	4.02	30.54	1.69	8.99	61.53
30.488	Hexadecanoic acid, methyl ester	1.00	0.65	0.37	-	-	2.53	1.57	-	1.62	-	-	5.96	6.35
30.789	Palmitoleic acid	-	-	1.03	-	-	-	-	-	-	-	-	-	-
30.792	(E)- 9-Octadecenoic acid	-	-	0.48	-	-	-	-	-	-	-	-	4.56	-
30.812	Oleic acid	-	-	-	-	-	-	-	-	1.19	-	-	-	-
30.855	(Z,Z)-9,12-Octadecadienoic acid	1.40	-	2.76	0.40	-	2.87	2.60	0.36	3.27	-	-	8.04	-
30.971	1-(+)-ascorbic acid, 2,6-dihexadecanoate	-	-	-	-	-	-	7.69	0.79	12.58	-	-	36.93	-
31.105	Dibutyl phthalate	0.83	-	-	-	-	-	-	-	-	-	-	-	-
31.257	n-Hexadecanoic acid	-	1.49	6.03	0.99	-	18.22	-	-	-	-	-	-	-
31.309	c-Hexadecanoic acid	9.52	-	-	-	-	-	-	-	-	-	-	-	-
32.659	2-(4-morpholinylsulfanyl)-1,3-benzothiazole	9.20	-	-	-	-	-	7.15	-	-	-	1.35	-	-
34.579	9,12-Octadecadienoic acid(Z,Z)-methyl ester	-	-	-	-	-	1.71	0.78	-	1.04	-	-	2.65	-
34.766	9-Octadecenoic acid(Z), methyl ester	-	-	-	-	-	-	-	-	-	-	-	1.91	-

34.768	9,12-Octadecadienoic acid(Z)-methyl ester	-	-	-	-	-	-	0.93	-	-	-	-	-	-
34.789	(E)-9-Octadecenoic acid, methyl ester	-	-	-	-	-	2.71	-	-	-	-	-	-	-
35.485	Methyl stearate	-	-	-	-	-	-	-	-	-	-	-	0.43	-
35.495	Heptadecenoic acid, 16-methyl-methyl ester	-	-	-	-	-	-	-	-	-	-	-	-	2.24
35.720	cis,cis,cis-7,10,13-Hexadecatrienal	1.53	-	2.20	-	-	-	-	-	-	-	-	-	-
35.736	E,E,Z-1,3,12-Nonadecatriene-5,14-diol	-	-	-	-	-	-	2.54	-	-	-	76.07	-	-
35.748	Dichloraacetic acid, tridec-2-ynyl ester	-	-	-	-	-	-	-	-	-	-	-	5.80	-
35.754	(Z,Z,Z)-9,12,15-Octadecadienoic acid	-	-	-	-	-	-	-	-	2.38	-	-	-	-
35.756	(Z)-9-Tetradecenal	-	-	-	0.39	-	-	-	-	-	-	-	-	-
35.814	(Z)-7-Tetradecenal	-	-	-	-	-	5.27	-	-	-	-	-	-	-
36.290	4-(3,4-dihydro-2,2,4-trimethyl-2H-1-benzopyran-4-yl)- Phenol	-	-	-	-	-	1.01	-	-	-	-	-	-	-
36.395	1-Heptadecanecarboxylic acid	-	-	-	-	-	-	0.71	-	-	-	-	0.84	-
39.760	1-Heptatriacotanol	-	56.48	1.21	26.18	34.71	-	-	-	-	-	-	-	-
41.554	(3-beta.)-9,19-Cyclolanostan-3-ol-acetate	-	2.28	2.96	5.56	35.75	-	-	-	-	-	-	-	-
42.560	17-(1,5-Dimethylhexyl)-10,13-dimethyl -1,7,8,9,10,11,12,13,14,15,16,17	-	-	-	-	0.10	-	-	-	-	-	-	-	-
42.670	3-(5-Methoxy-1-cyclohexenyl)-1-(1-methylcyclopropyl)-1-propanol	-	-	-	-	0.12	-	-	-	-	-	-	-	-
42.725	Methyl 16-oxo-cleroda-3,13(14)-E-dien-15-oate	-	0.23	-	-	-	-	-	-	-	-	-	-	-
42.759	E,E,Z-1,2,12-Nonadecatriene-5,14-diol	-	-	-	42.16	-	-	-	-	-	-	-	-	-
43.113	Butyl 9,12-octadecadieonate	-	-	-	-	-	-	-	7.23	13.85	-	-	-	-

43.365	11-Hydroxy-11-methyl-tricyclo[3.4.1.1(2,5)]undecan-10-one	-	-	-	-	1.20	-	-	-	-	-	-	-	-
43.369	3,4,5,6,7,8,9,10-octahydro-12-hydr-1H-2-Benzoxacyclododecin-1-one	-	-	-	-	-	-	-	1.02	-	-	-	-	-
43.385	2-Hydroxy-4-methoxy-7-methyl-7,8,9,10,11,12,13,14-octahydro-6-oxab	-	-	-	1.11	-	-	-	-	-	-	-	-	-
44.290	(1S,2E,4S,5R,7E,11E)-Cembra-2,7,11-trien-4,5-diol	-	-	-	-	-	-	-	11.07	-	-	-	-	-
44.291	(E,E,E)-9-Octadecanoic acid, 1,2,3-propanetriyl ester	-	-	0.77	5.28	-	-	-	-	-	-	-	-	-
44.301	.beta. –Sitosterol	-	-	-	-	-	-	-	-	3.91	-	-	-	-
44.350	2,6,10,10-tetramethyl-Tricyclo[7.2.0.0(2,6)]undecan-5-ol	-	-	-	-	-	-	-	-	-	-	4.39	-	-
44.440	1H-Pymole-2,4-dicarboxylic acid, 3,5-dimethyl-,diethyl ester	-	1.69	-	-	-	-	-	-	-	-	-	-	-
44.503	(Z,Z)-9,12-octadeca-dienoic acid, 2,3-dihydroxy-propyl ester	-	-	-	-	-	-	-	16.54	-	-	-	-	-
44.556	Trichloroacetic acid, tridec-2-ynl ester	-	-	-	-	9.78	-	-	-	-	-	-	-	-
44.682	1,3-dipalmitic trimethylsilyl ether	-	-	-	-	-	-	0.90	-	-	-	-	-	-
44.682	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	-	-	0.69	-	-	-	-	-	0.68	-	-	1.85	-
44.850	18-Noradietane	-	-	-	-	-	-	-	0.98	-	-	-	-	-
45.080	Phthalic acid, di(6-methylhept-2-yl) ester	-	-	-	-	-	-	-	-	-	-	-	1.05	-
45.081	Phthalic acid, di(2-propylpentyl) ester	-	-	-	-	-	-	0.94	-	-	-	-	-	-
45.098	1,2-Benzenedicarboxylic acid, 1,2-bis(2-ethylhexyl) ester	1.25	-	-	-	-	-	-	-	-	-	-	-	-
45.200	E,Z-1,3,12-Nonadecatriene	-	-	-	2.13	-	-	-	6.63	5.29	-	-	-	-
45.673	Benz(e)azulen-3(3aH)-one, 4,6a,7,8,9,10,10a,10b-octahydro-3a,8,10a	-	-	-	-	-	-	-	-	-	-	-	-	0.25

45.740	Bicyclo[9,3,1]pentadecane-1-carbonitrile, 12-hydroxy-15-oxo-	-	1.22	-	-	-	-	-	-	-	-	5.27	-	-
45.915	19,21-Tetracontadiyne	-	2.50	-	-	-	-	-	-	-	-	5.73	-	-
46.369	9,12-octadeca-dienoic acid(Z,Z)- 2,3-dihydroxy-propyl ester								27.31	2.26	-	-	-	-
46.965	Dihydro-neotigogenin dibenzoate	-	1.73	-	-	-	-	-	-	-	-	-	-	-
47.105	Allopregnane-3beta.,7alpha.,11alpha.-triol-20-one	-	2.81	-	-	-	-	-	-	-	-	-	-	-
47.120	3-(1-hydroxy-2-isopropyl-5-methylcyclohexyl)- Ppropiolic acid	-	-	-	-	-	-	-	1.55	-	-	-	-	-
47.190	n-Propyl 9,12,15-octadecatrienoate	-	5.32	-	-	-	-	-	-	-	-	-	-	-
47.390	Cyclohexanecarboxylic acid, dodec-9-ynyl ester	-	-	-	-	-	-	-	-	-	-	-	-	0.78
47.448	Isophthalic acid, 2-propylphenyl tridecyl ester	-	-	-	-	-	-	-	1.87	-	-	-	-	-
47.470	4,4'-((p-Phenylene)disopropylidene)diphenol	-	-	-	4.13	-	3.22	-	-	3.18	-	-	-	4.52
47.471	4-t-Butyl-2-(4-methoxy-phenyl)-6-p-tolyl-pyridine	-	-	-	-	-	-	-	-	-	-	-	4.72	-
47.488	3-Isopropyltricyclo[4.3.1.1(2,5)]undec-3-en-10-ol	-	-	-	-	2.28	-	-	-	-	-	-	-	-
47.920	(1.alpha.,3a.alpha.,4.beta.,7.alpha.,8a.beta)-octahydro-1,4,9,9-tetram-	-	-	-	-	-	-	-	-	2.29	-	-	-	-
48.458	7,10-Octadecadienoic acid, methyl ester	-	-	0.45	-	-	-	-	-	-	-	-	-	-
48.515	Propyleneglycol monoleate	-	-	-	-	-	-	-	-	-	-	5.50	-	-
48.640	Trideuteriomethyl-10-epoxy-7-ethyl-3,11-dimethyltrid	-	-	-	-	3.04	-	-	-	-	-	-	-	-
48.650	Butyl 9,12,15-octadecatrienoate	-	-	-	-	-	-	-	-	3.71	-	-	-	-
48.920	Trilinolein	-	2.58	-	-	-	-	-	-	-	-	-	-	-

48.980	1,2-Epoxy-5,9-cyclododecadiene	-	0.42	-	-	-	-	-	-	-	-	-	-	-
49.190	N,N-dimethyl-5.alpha.-Cholestan-6.beta.-amine	-	-	-	-	-	-	-	-	3.12	-	-	-	-
49.280	Decaborane(14)	-	1.20	-	-	-	-	-	-	-	-	-	-	-
49.415	7-Methyl-13-oxatricyclo [6.4.2.0(1,6)]tetraec-11-en-14-one	-	-	-	-	3.62	-	-	-	-	-	-	-	-
49.485	(7R,8R)-cis-anti-cis-Tricyclo[7.3.0.0(2,6)]dodecan-7,8-diol	-	-	-	-	-	-	-	-	3.21	-	-	-	-
49.500	Cholest-4-en-3ol, (3.alpha.)-	-	-	-	2.33	-	-	-	-	-	-	-	-	-
49.843	Butyl 6,9,12,15-octadecatetraenoete	-	-	-	-	6.11	-	-	-	-	-	-	-	-
49.920	o-Mentha-1(7),8-dien-3-ol	-	0.72	-	-	-	-	-	-	-	-	-	-	-
50.125	2.alpha.-isopropyl-5.Alpha.-Estran-3-one	-	-	-	-	-	0.85	-	-	-	-	-	-	-
50.505	Atriplexinol	-	-	-	-	-	-	-	-	-	-	-	-	7.17
50.685	(3.beta, 22E)-Stigmasta-5,22-dien-3-ol	-	-	-	-	-	-	-	-	-	-	-	-	16.15
50.925	URS-12-en-20-oic acid methyl ester	-	0.50	-	-	-	-	-	-	-	-	-	-	-

APPENDIX IV

PUBLICATIONS

List of papers published

1. **Sreejith, P.E.**, Linu N.K., Sasikumar P., Radhakrishnan K.V. & M. Sabu 2016. Phytochemical studies of an endemic and critically endangered hill banana, *Musa acuminata* Colla (AA) 'Karivazhai' fruit by GC-MS. *J. Chem. Pharmceut. Res.* **8(5):** 164–168.

2. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2016. A new variety of *Musa sikkimensis* Kurz and notes on the taxonomic identity and history of *Musa sikkimensis* (Musaceae) from North-East India. *Webbia* **71(1):** 53–59. DOI:10.1080/00837792.2015.1113721.

3. Sabu, M., Alfred Joe & **P.E. Sreejith** 2016. Brief overview of diversity of wild Indian Musaceae. *Acta Hortic.* **1114:** 75–80. DOI 10.17660/ActaHortic.2016.1114.10

4. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2016. Notes on *Musa rubra* Kurz (Musaceae) and reduction of *M. laterita* Cheesman as conspecific. *Taiwania* **61(1):** 34–40.

5. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2014. *Musa cylindrica,* a new species of *Musa* (Musaceae) from North-East India. *Phytotaxa* **172(2):** 137–140. DOI:10.11646/phytotaxa.172.2.11. **(Impact Factor: 1.32).**

6. Alfred Joe, **Sreejith, P.E.**, Ashfak, O.A. & M. Sabu 2014. Regarding the identity, rediscovery and taxonomic history of *Musa nagensium* (Musaceae) from India. *Rheedea* **24(1):** 5–11.

7. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2014. A new variety of *Musa balbisiana* Colla (Musaceae) from South India. *Phytotaxa* **175(2):** 113–116. DOI:10.11646/phytotaxa.175.2.6. **(Impact Factor: 1.32).**

8. Alfred Joe, **Sreejith P.E.** & M. Sabu 2014. On the rediscovery and extended distribution of *Musa cheesmanii* (Musaceae) from North-East India. *Int. J. Pl. Anim. Env. Sci.* **4(1):** 1–4.

9. Alfred Joe, Sabu, M. & **P.E. Sreejith** 2014**.** A new variety of *Musa velutina* H. Wendl. & Drude (Musaceae) from Assam, North-East India. *Pl. Syst. Evol.* **300(1):** 13–17. **(Impact Factor: 1.42).**

10. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2014. Notes on the rediscovery, taxonomic history and conservation of *Musa mannii* H. Wendl. ex Baker (Musaceae). *Webbia* **69(1):** 115–120. DOI:10.1080/00837792.2014.893603

11. Alfred Joe, **Sreejith, P.E.** & M. Sabu 2013. Notes on the Rediscovery and Taxonomic Status of *M. flaviflora* NW Simmonds & *M. thomsonii* (King ex Schumann) AM Cowan & Cowan (Musaceae) from India. *Ann. Pl. Sci.* **2(8):** 260–267.

12. Alfred Joe, M. Sabu & **P.E. Sreejith** 2013. On the Rediscovery of *Musa ochracea* K.Sheph. (Musaceae) from North-East India. *Taiwania* **58(4):** 321–325.

13. **Sreejith, P.E.**, Alfred Joe & M. Sabu 2013. *Musa arunachalensis*: A new species of *Musa* section *Rhodochlamys* (Musaceae) from Arunachal Pradesh, northeastern India. *Phytotaxa* **134(1):** 49–54. **(Impact Factor: 1.32).**

14. Alfred Joe, M. Sabu, A. Ashfak & **P.E. Sreejith** 2014. *Musa laterita* Cheesman (Musaceae): A new record for India from the wild, with a key

to *Musa* (Section *Rhodochlamys*) in India. *Folia Malaysiana* **14(1):** 37–44.

15. Sabu, M, Alfred Joe & **P.E. Sreejith** 2013. *Musa chunii* Häkkinen (Musaceae): An addition to the wild banana flora of India and notes on conservation of a Critically Endangered species. *Ann. Pl. Sci.* **2(5):** 260–267.

16. Alfred Joe, **Sreejith P.E.** & M. Sabu 2013. Notes on the Rediscovery and Taxonomic Status of *M. flaviflora N.W.Simmonds* and *M. thomsonii* (King ex Schumann) A.M.Cowan & Cowan (Musaceae) From India. *Ann. Pl. Sci.* **2(8):** 260–267.

17. Sabu, M., Alfred Joe & **P.E. Sreejith** 2013. *Musa velutina* subsp. *markkuana* (Musaceae): a new subspecies from northeastern India. *Phytotaxa* **92(2):** 49–54. **(Impact Factor: 1.32).**

18. **Sreejith, P.E.,** M. Sabu & Alfred Joe 2013. On the Identity and Typification of *Phrynium nicobaricum* (Marantaceae) from Andaman and Nicobar Islands, India. *Taiwania* **59(1):** 71–75.

APPENDIX V

PRESENTATIONS

Papers presented in International & National Seminars/Symposia

1. **Sreejith, P.E**., Linu, N.K., Sasikumar, P., Radhakrishnan, K.V. & M. Sabu – *Bioprospecting of two endemic hill banana fruits by GC-MS analysis.* International Symposium on Phytochemistry and Prof. Dr. A. Hisham Endowment Award Ceremony-2016. 27 Feb. 2016.

2. **Sreejith, P.E**., Linu, N.K., Aswathi, P., Sasikumar, P., Radhakrishnan, K.V. & M. Sabu – *Classification of South Indian cultivated bananas: A chemo-taxonomic approach.* Silver jubilee Conference of IAAT and Council Meeting of IAPT & International Seminar on Advancements in Angiosperm Systematics and Conservation. 19 – 21 Nov. 2015.

3. **Sreejith, P.E**., M. Sabu & Alfred Joe – *Studies on Musa cultivars in South India: A Taxonomic approach.* XXIV Annual Conference of IAAT & International Seminar on Trends in Plant Systematics (TIPS). 31 Oct. – 2 Nov., 2014. (Bagged **Prof. K.S. Manilal Award for Best Paper in Floristics**).

4. **Sreejith P.E.**, Alfred Joe & M. Sabu – *Taxonomic studies on Musa L. cultivars (Musaceae) in Kerala.* XXIII Annual conference of IAAT and National seminar on ‘Resent advances in Plant Taxonomy Research’. 27 – 29 Dec. 2013.

5. **Sreejith P.E**., M. Sabu & Alfred Joe – *Taxonomic studies on selected Musa L. cultivars (Musaceae) in South India.* National Seminar on Biodiversity Conservation and Climate Change (BCCC-11). 02 – 04 Dec. 2011. (Bagged **Best Paper Presentation Award** in the technical section 14 of the symposium).

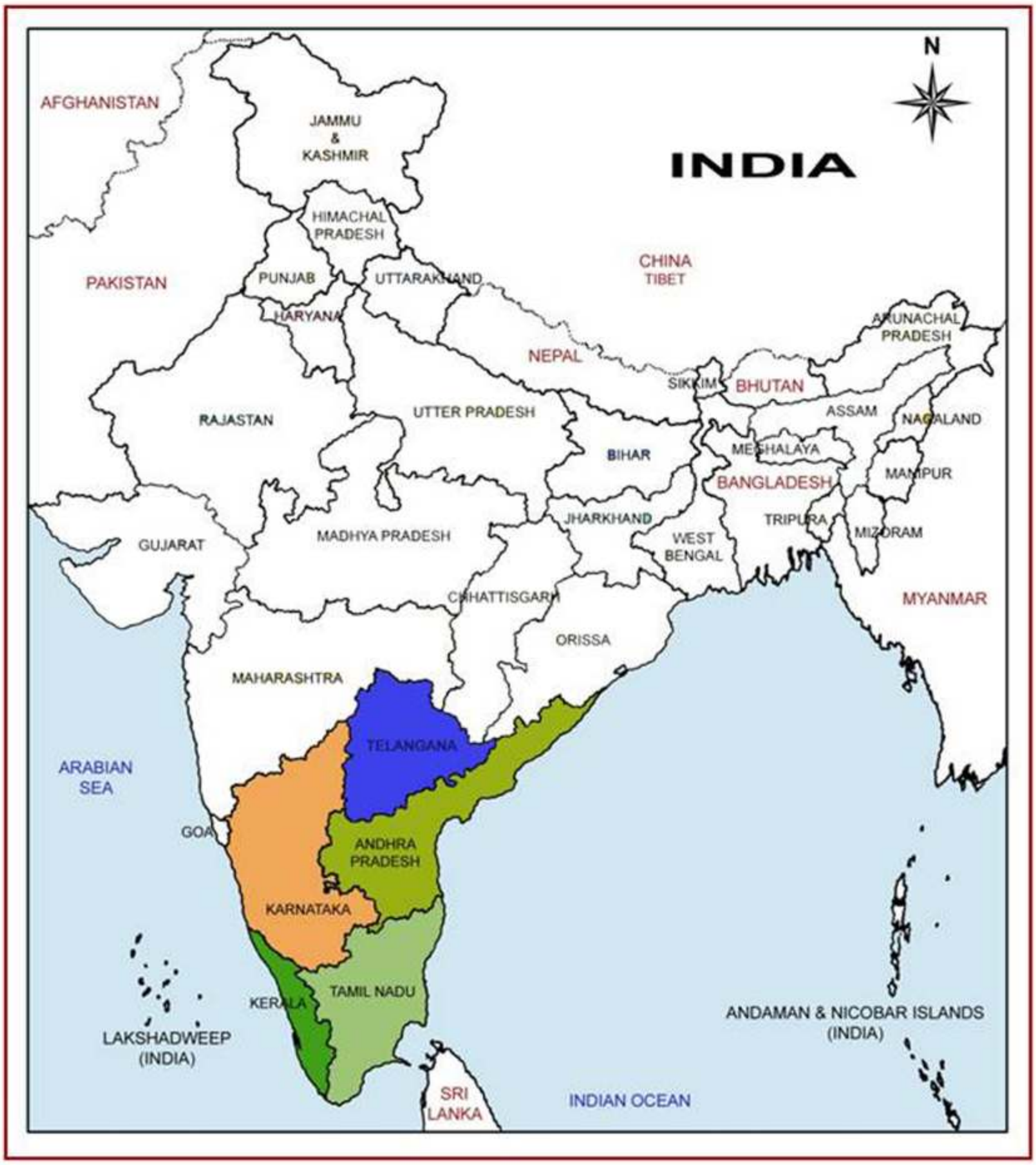

Fig. 02. **Map of South India** (Area of study)

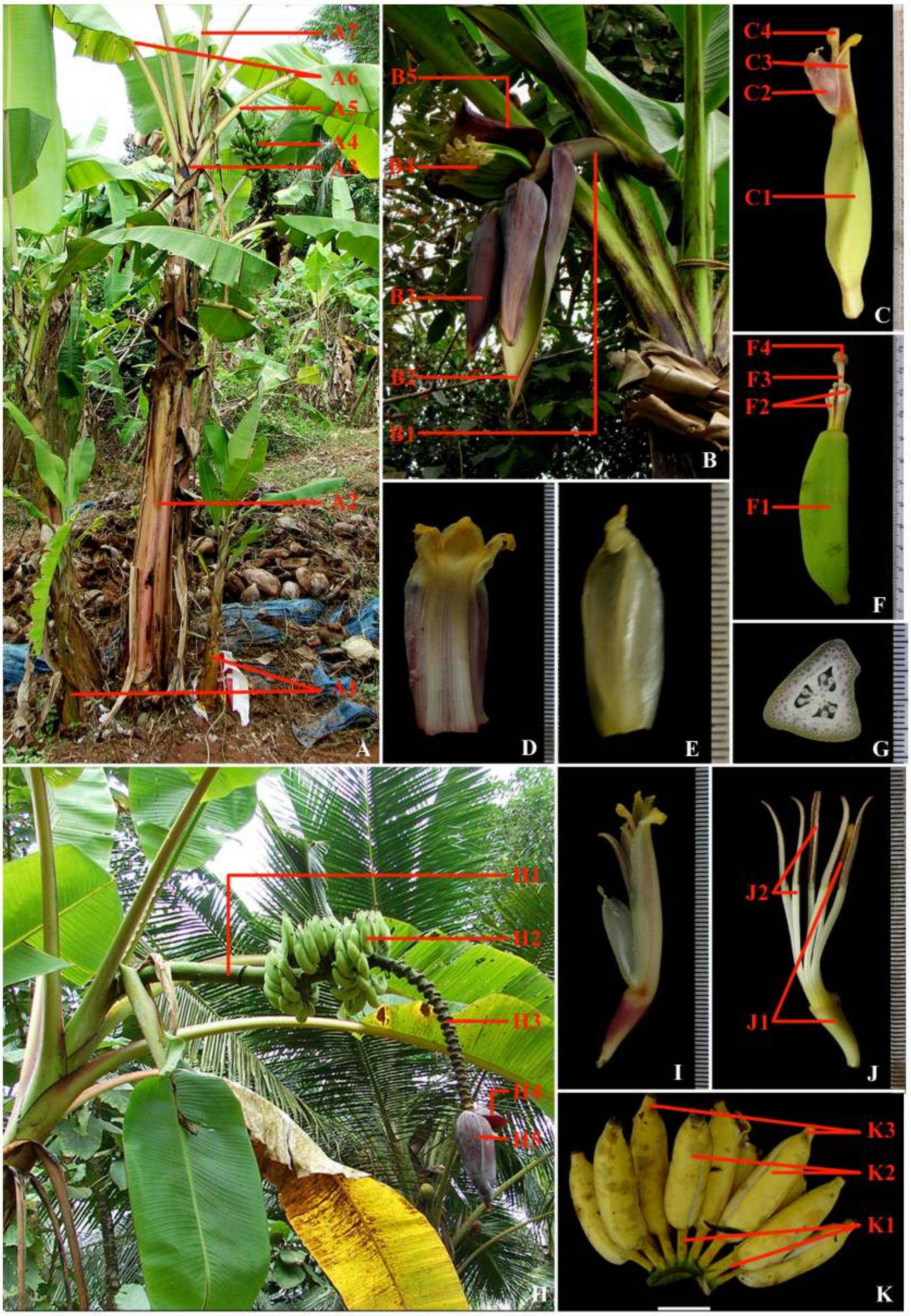

Fig. 03. **General morphology**: **A.** habit (**A1.** suckers; **A2.** pseudostem; **A3.** petiole base; **A4.** inflorescence; **A5.** petiole; **A6.** leaf base; **A7.** 3rd leaf); **B.** inflorescence at early stages (**B1.** peduncle; **B2.** sterile bract; **B3.** female bud; **B4.** female flowers; **B5.** female bract); **C.** female flower (**C1.** ovary; **C2.** free tepal; **C3.** compound tepal; **C4.** stigma); **D.** compound tepal; **E.** free tepal; **F.** pistil with staminodes (**F1.** ovary; **F2.** staminodes; **F3.** style; **F4.** stigma); **G.** c.s. of ovary); **H.** infructescence (**H1.** peduncle; **H2.** fruits; **H3.** rachis; **H4.** male bract; **H5.** male bud); **I.** male flower; **J.** rudimentary pistil with stamens (**J1.** rudimentary pistil; **J2.** stamens); **K.** fruit hand (**K1.** pedicel; **K2.** fruit; **K3.** fruit apex).

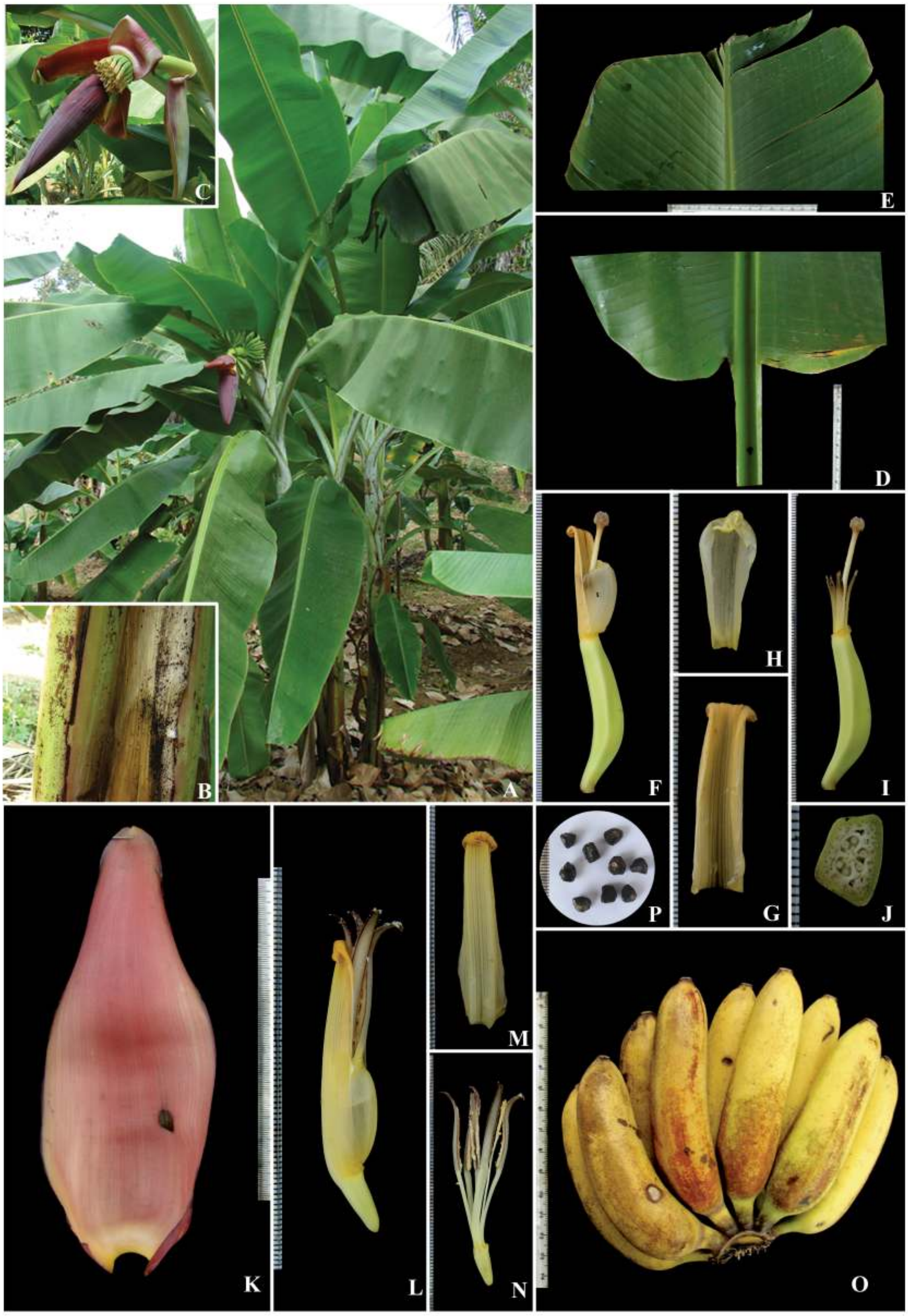

Fig. 04. ***Musa acuminata*** **Colla**: **A.** habit; **B.** pseudostem coloration; **C.** inflorescence at early stage; **D.** leaf base; **E.** leaf apex; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.**free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract abaxial surface; **L.** male flower; **M & N.** male flower parts - **M.** compound tepal; **N.** rudementary pistil with stamens; **O.** ripened fruit hand; **P.** seeds.

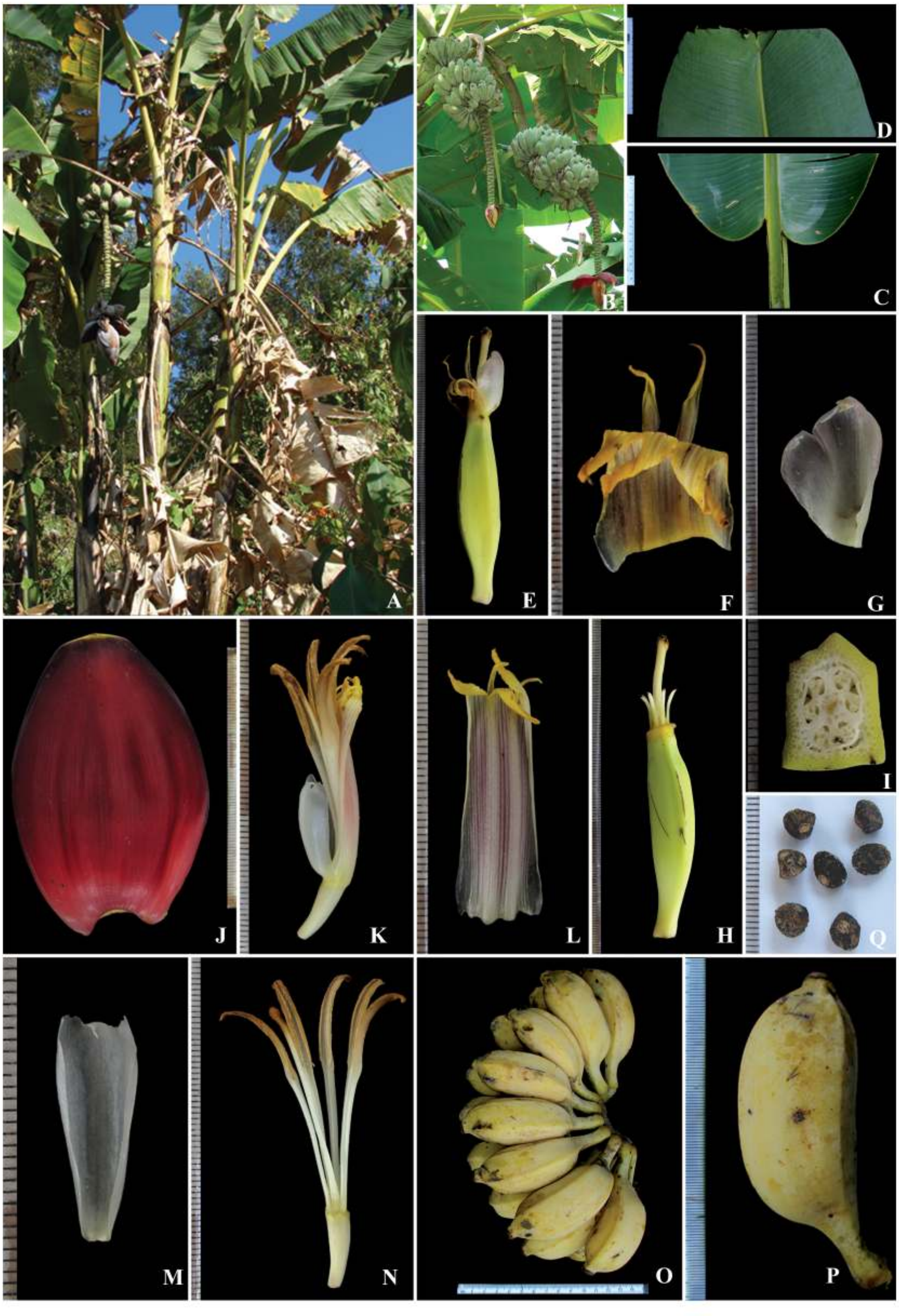

Fig. 05. ***Musa balbisiana* Colla**: **A.** habit; **B.** infructescences with advanced stage of male bud; **C.** leaf base; **D.** leaf apex; **E.** female flower; **F-I.** female flower parts - **F.** compound tepal; **G.** free tepal; **H.** pistil with staminodes; **I.** c.s. of ovary; **J.** male bract; **K.** female flower; **L-N.** male flower parts - **L.** compound tepal; **M.** free tepal; **N.** rudimentary pistil with stamen; **O.** ripened fruit hand; **P.** single fruit; **Q.** seeds.

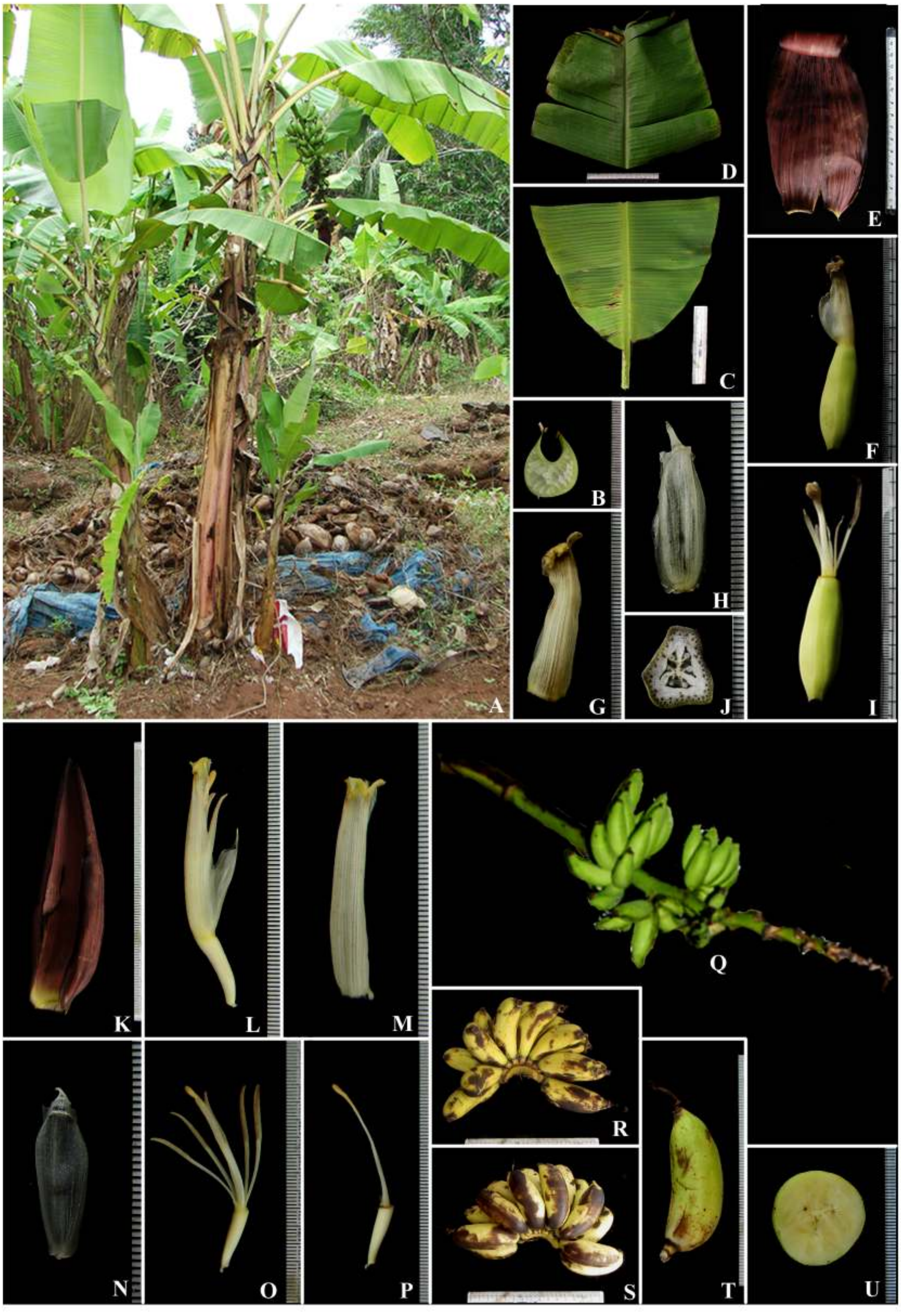

Fig. 06. ***Musa acuminata*** **Colla (AA) 'Kadali'**: **A.** habit; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence; **R-S.** fruit bunch; **T.** single fruit; **U.** c.s. of fruit.

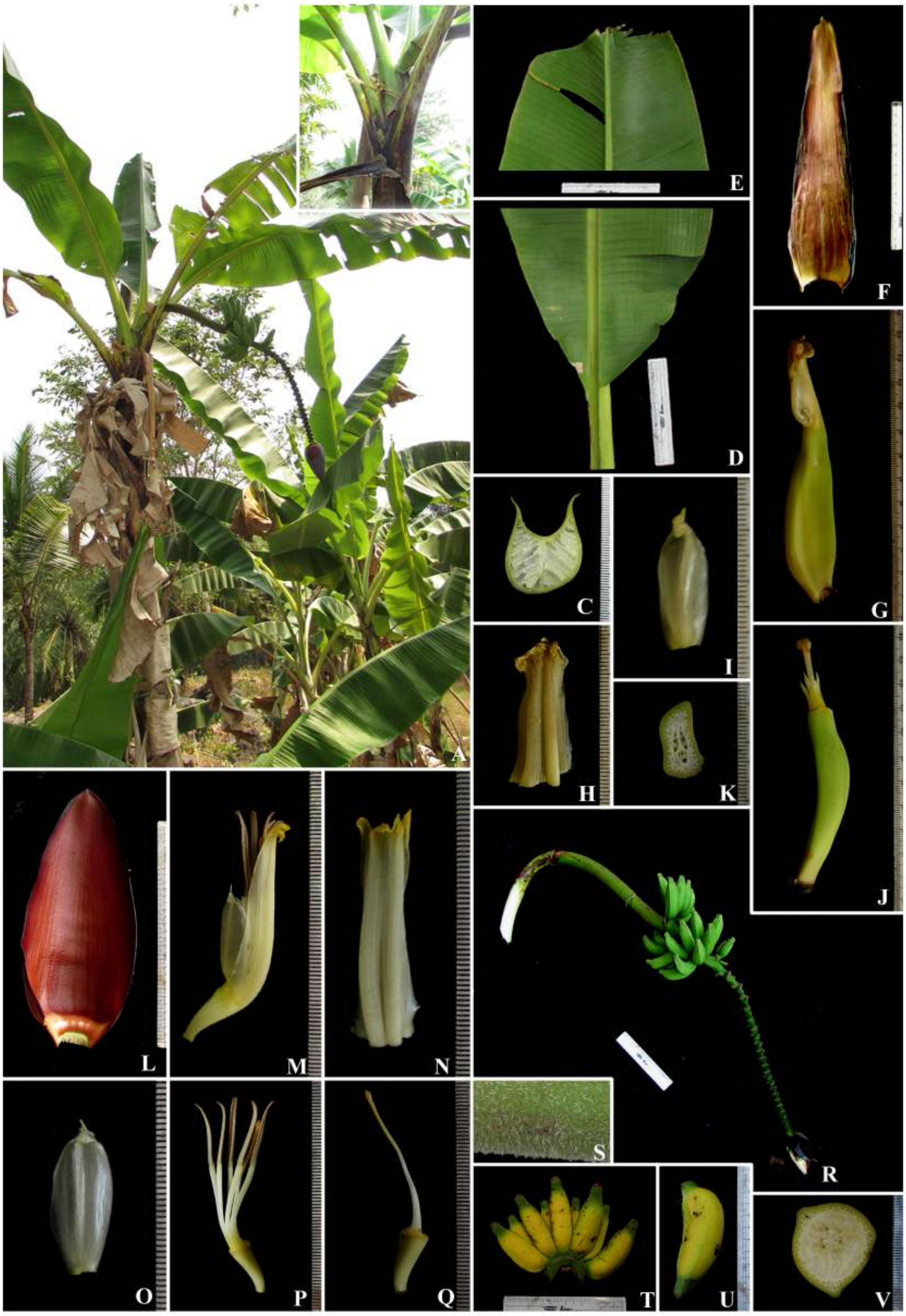

Fig. 07. ***Musa acuminata*** **Colla (AA) 'Karivazhai'**: **A.** habit; **B.** mature pseudostem showing blotches at the petiole base; **C.** c.s. of petiole; **D.** leaf base; **E.** leaf tip; **F.** female bract; **G.** female flower; **H-K.** female flower parts - **H.** compound tepal; **I.** free tepal; **J.** pistil with staminodes; **K.** c.s. of ovary; **L.** male bract; **M.** male flower; **N-Q.** male flower parts; **N.** compound tepal; **O.** free tepal; **P.** rudementary pistil with stamens; **Q.** rudementary pistil; **R.** mature infructescence with advanced stages of male bud; **S.** peduncle showing pubescent hairs; **T.** fruit bunch; **U.** single fruit; **V.** c.s of fruit.

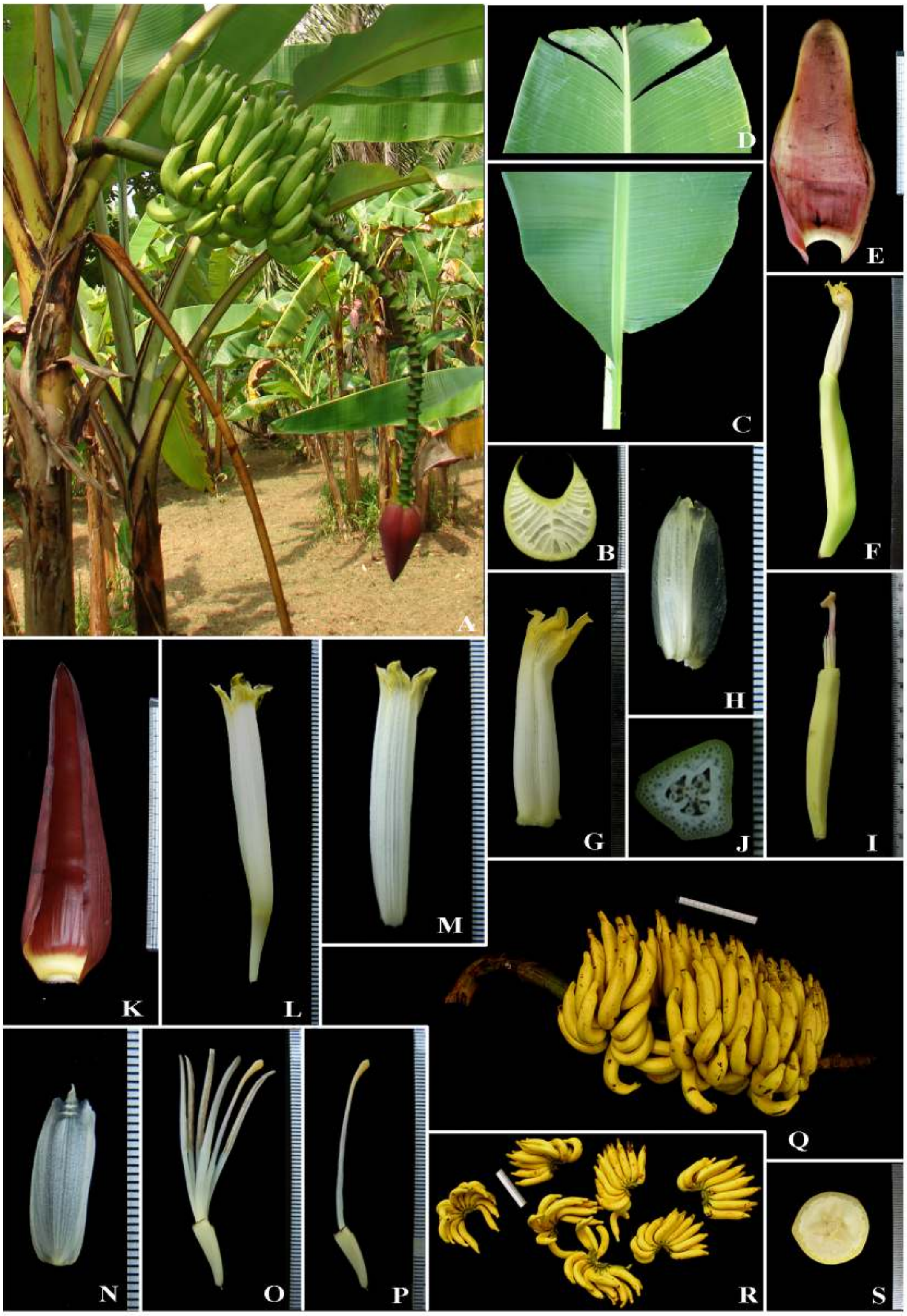

Fig. 08. ***Musa acuminata*** **Colla (AA) 'Pisang lilin'**: **A.** habit; **B.** c.s. petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-I.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with stamonodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence; **R.** fruit bunches showing different shapes of fruits; **S.** c.s of fruit.

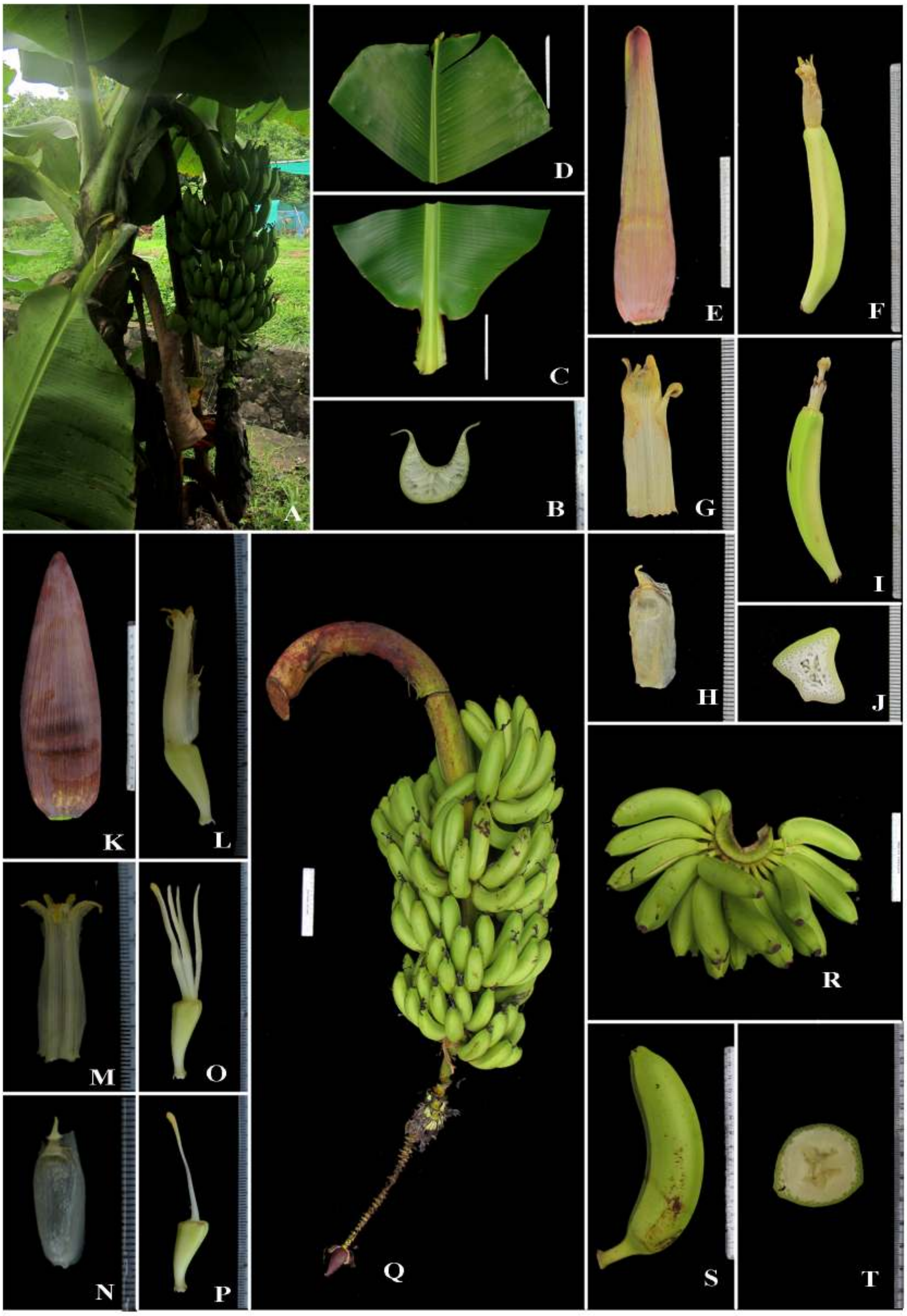

Fig. 09. ***Musa acuminata*** **Colla (AAA) 'Dwarf cavendish'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

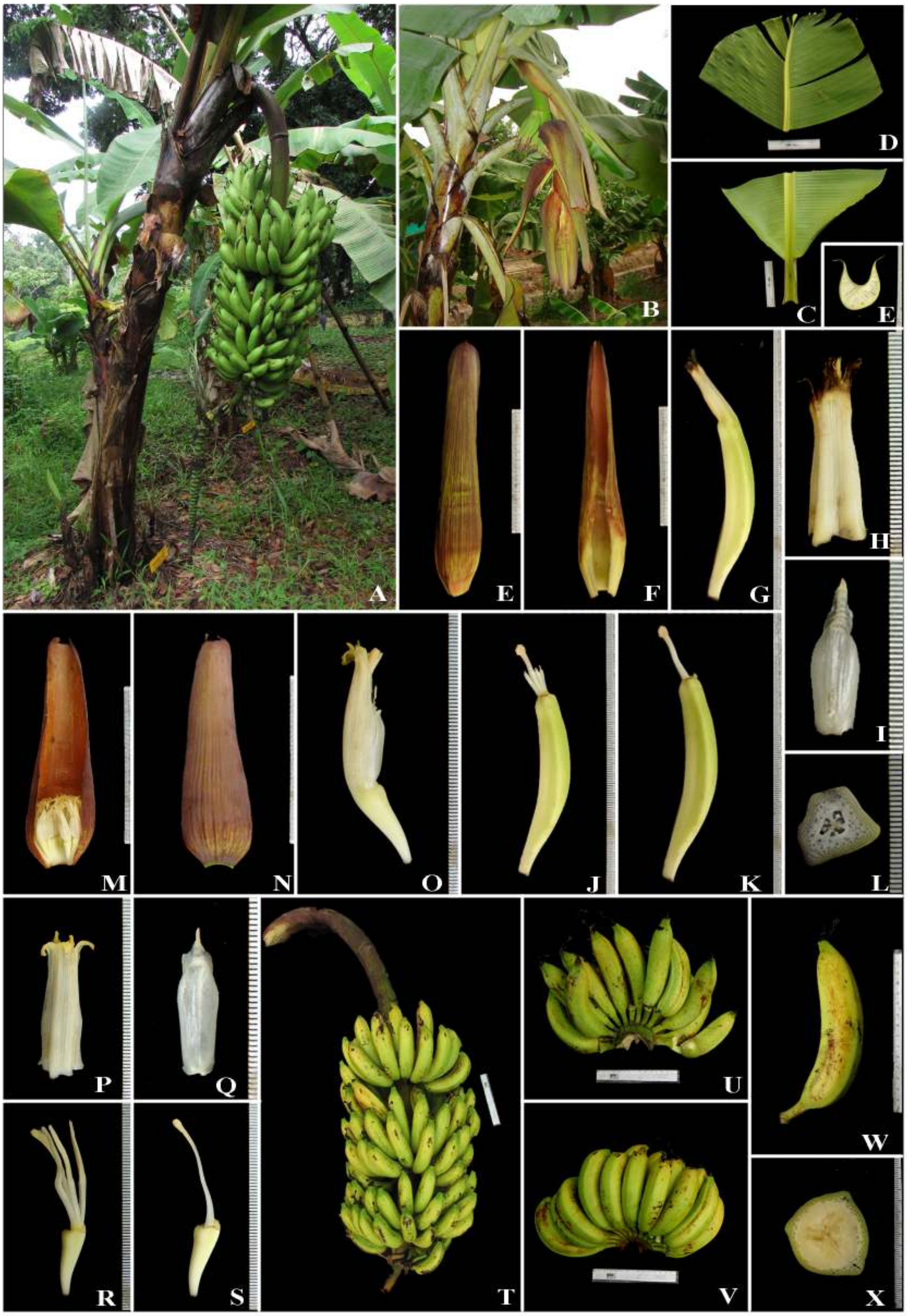

Plate 10. ***Musa acuminata* Colla (AAA) 'Grand nain '**: **A.** habit with mature fruit bunch; **B.** inflorescence at early stage; **C.** leaf base; **D.** leaf tip; **E.** c.s of petiole; **E & F.** female bract (dorsal & ventral views); **G.** female flower; **H-L.** female flower parts - **H.** compound tepal; **I.** free tepal; **J.** pistil with staminodes; **K.** pistil; **L.** c.s. of ovary; **M & N.** male bracts (dorsal & ventral views); **O.** male flower; **P-S.** male flower parts - **P.** compound tepal; **Q.** free tepal; **R.** rudementary pistil with stamens; **S.** rudementary pistil; **T.** infructescence with ripened fruits; **U & V.** fruit bunch; **W.** single fruit; **X.** c.s. of fruit.

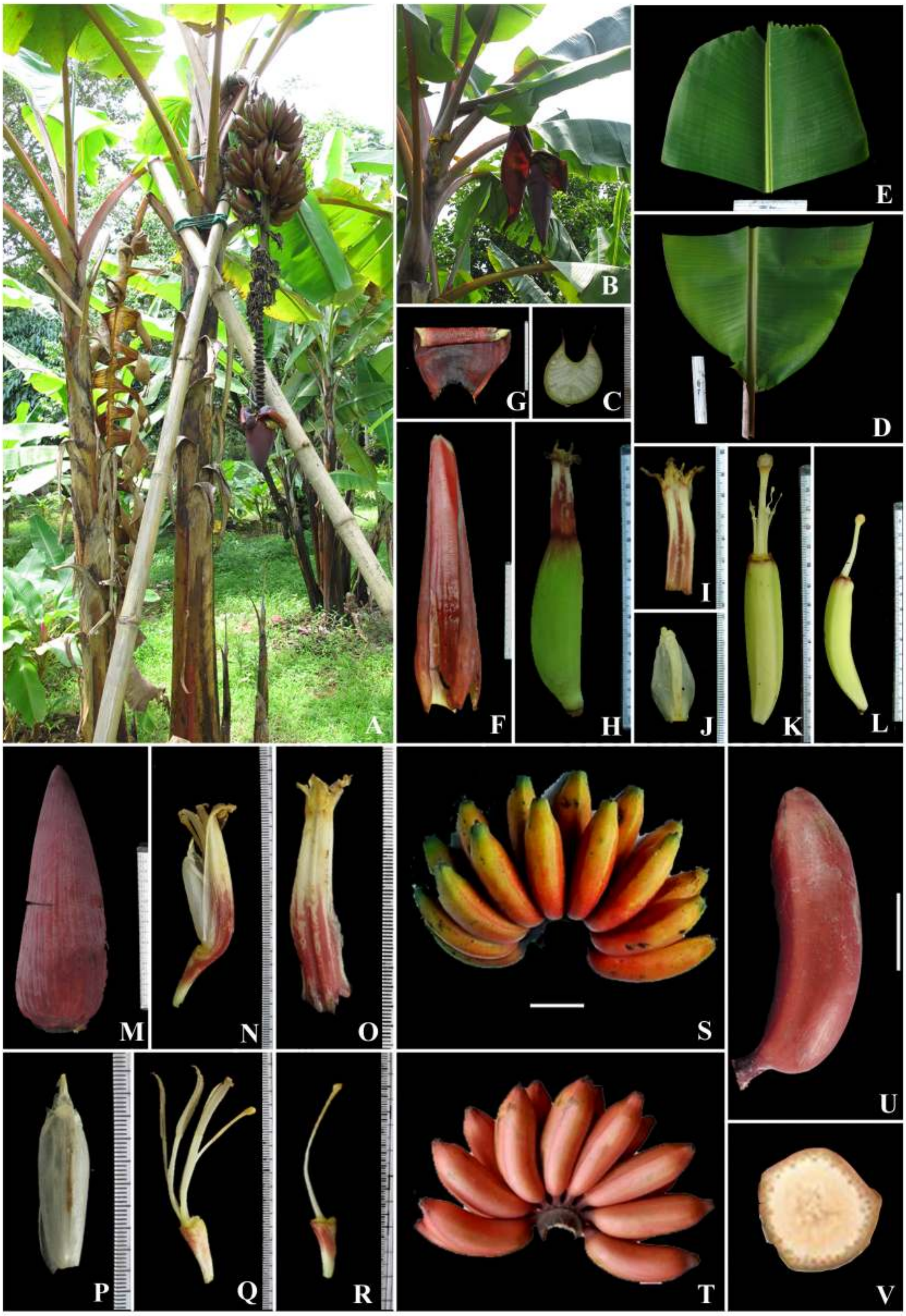

Fig. 11. ***Musa acuminata*** **Colla (AAA) 'Red'**: **A.** habit with mature fruit bunch; **B.** inflorescence at early stage; **C.** c.s. of petiole; **D.** leaf base; **E.** leaf tip; **F** & **G.** female bract; **H.** female flower; **I-L.** female flower parts - **I.** compound tepal; **J.** free tepal; **K.** pistil with staminodes; **L.** pistil; **M.** male bract; **N.** male flower; **O-R.** male flower parts; **O.** compound tepal; **P.** free tepal; **Q.** rudementary pistil with stamens; **R.** rudementary pistil; **S** & **T.** fruit hand; **U.** single fruit; **V.** c.s. of fruit.

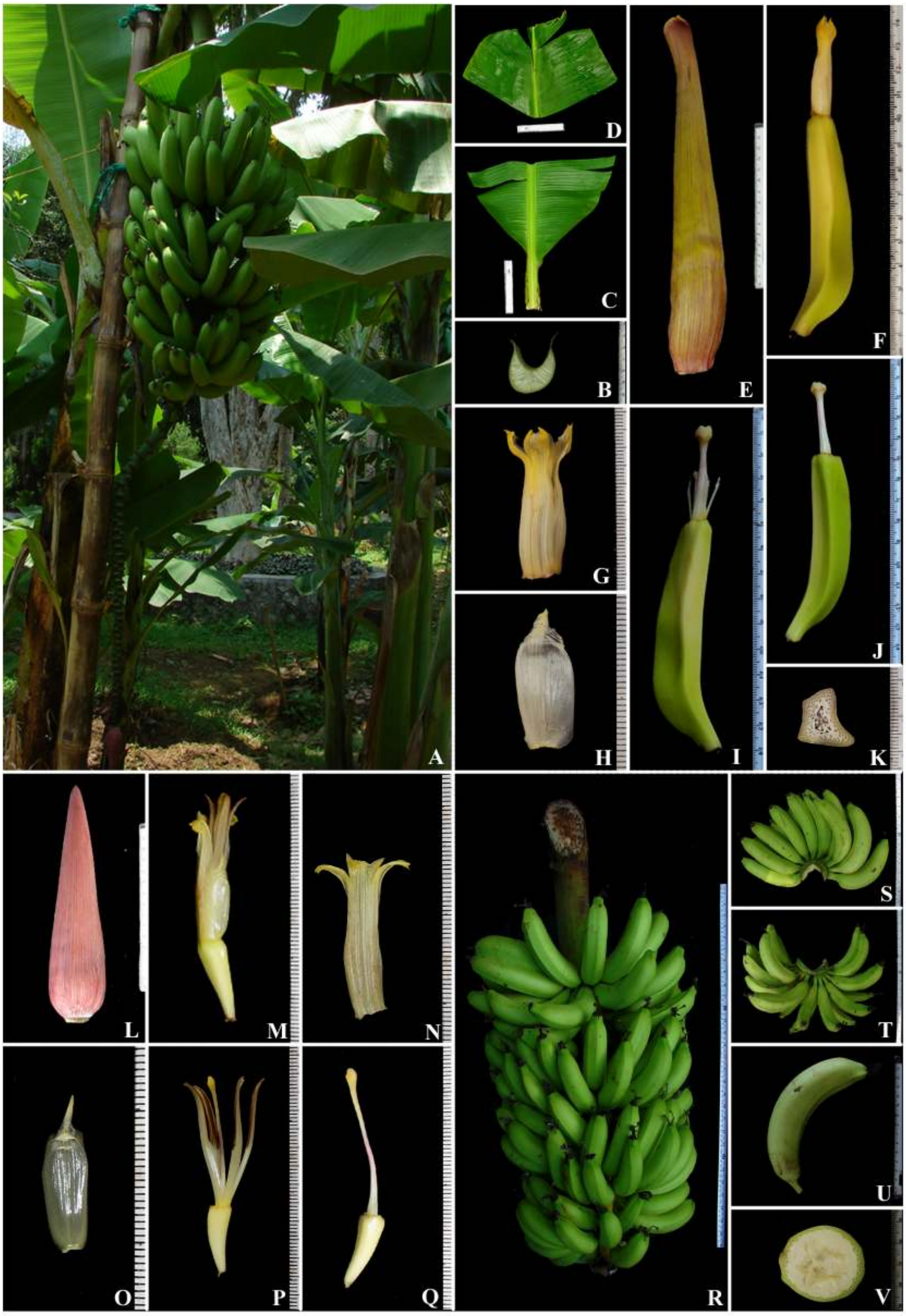

Fig. 12. ***Musa acuminata* Colla (AAA) 'Robusta'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-K.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** pistil; **K.** c.s. of ovary; **L.** male bract; **M.** male flower; **N-Q.** male flower parts - **N.** compound tepal; **O.** free tepal; **P.** rudementary pistil with stamens; **Q.** rudementary pistil; **R.** infructescence with ripened fruits; **S & T.** fruit hand; **U.** single fruit; **V.** c.s. of fruit.

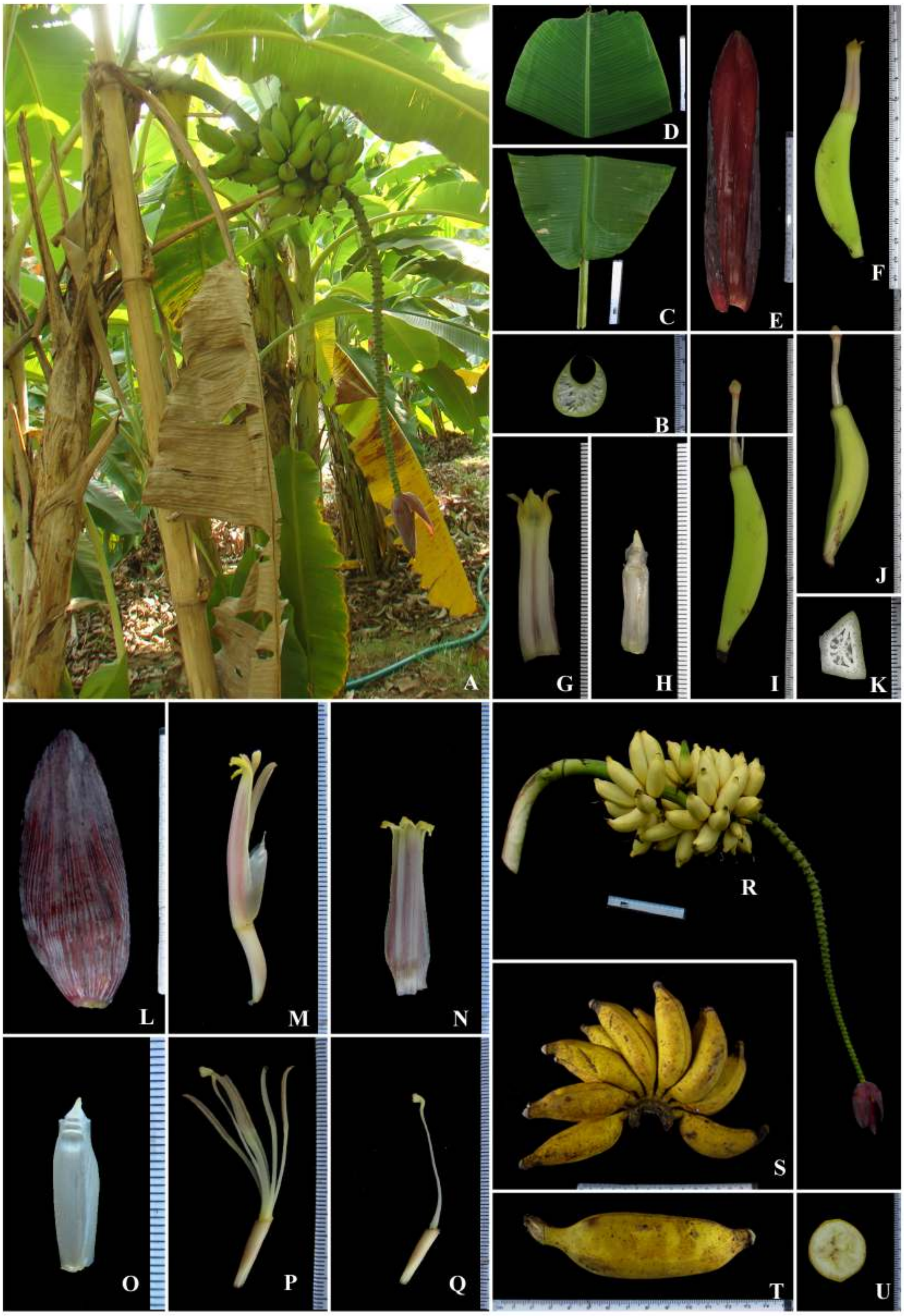

Fig. 13. ***Musa* × *paradisiaca* L. (AB) 'Kunnan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-K.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** pistil; **K.** c.s. of ovary; **L.** male bract; **M.** male flower; **N-Q.** male flower parts - **N.** compound tepal; **O.** free tepal; **P.** rudementary pistil with stamens; **Q.** rudementary pistil; **R.** infructescence with advanced stages of male bud; **S.** fruit hand; **T.** single fruit; **U.** c.s. of fruit.

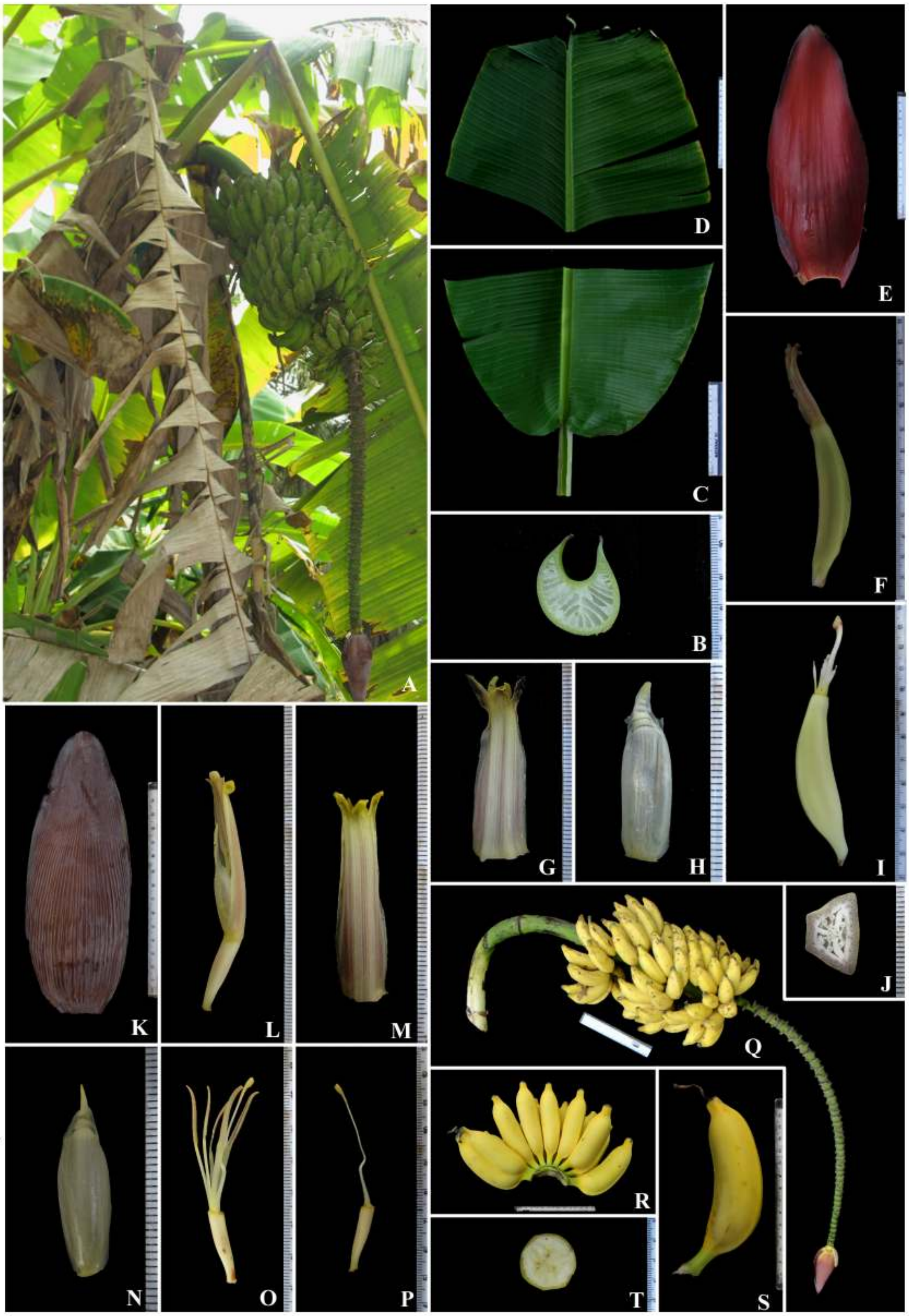

Fig. 14. ***Musa* × *paradisiaca* L. (AB) 'Matti'. A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit hand; **S.** single fruit; **T.** c.s. of fruit.

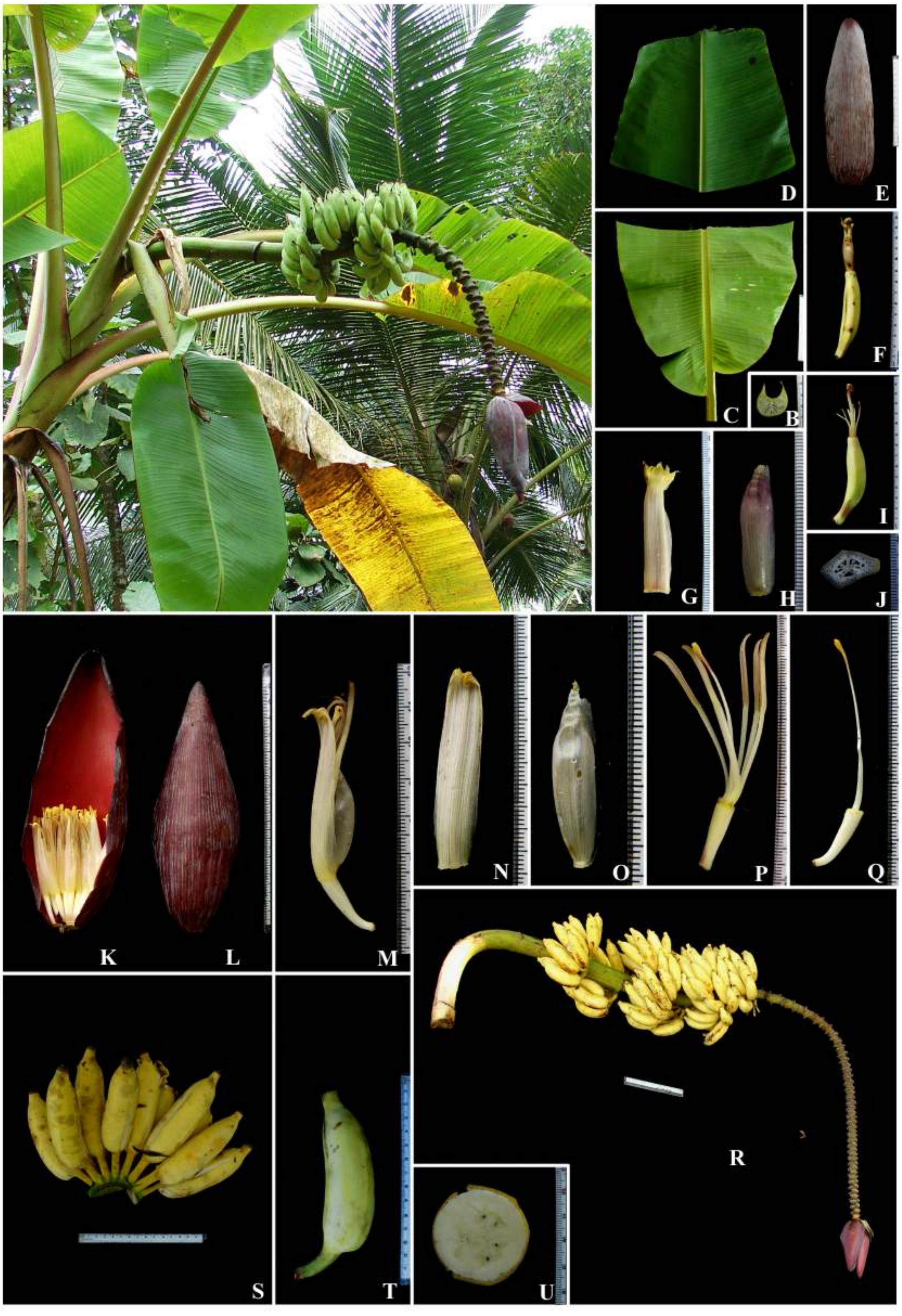

Fig. 15. ***Musa* × *paradisiaca* L. (AB) 'Neypoovan'**: **A.** habit with mature fruit bunch; **B.** c.s of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract with male flowers; **L.** male bract - dorsal view; **M.** male flower; **N-Q.** male flower parts - **N.** compound tepal; **O.** free tepal; **P.** rudementary pistil with stamens; **Q.** rudementary pistil; **R.** infructescence with advanced stages of male bud; **S.** fruit hand; **T.** single fruit; **U.** c.s. of fruit.

Fig. 16. ***Musa* × *paradisiaca* L. (AB) 'Thaenkunnan'**: **A.** habit with mature fruit bunch; **B.** mature bunch without male flowers and malebud; **C.** normal fruit bunch with male bud; **D.** c.s of petiole; **E.** leaf base; **F.** leaf tip; **G.** female bract; **H.** female flower; **I-L.** female flower parts - **I.** compound tepal; **J.** free tepal; **K.** pistil with staminodes; **L.** c.s. of ovary; **M.** male bract; **N.** male flower; **O-R.** male flower parts - **O.** compound tepal; **P.** free tepal; **Q.** stamens; **R.** rudementary pistil; **S.** infructescence; **T** & **U.** fruit bunch; **V.** single fruit.

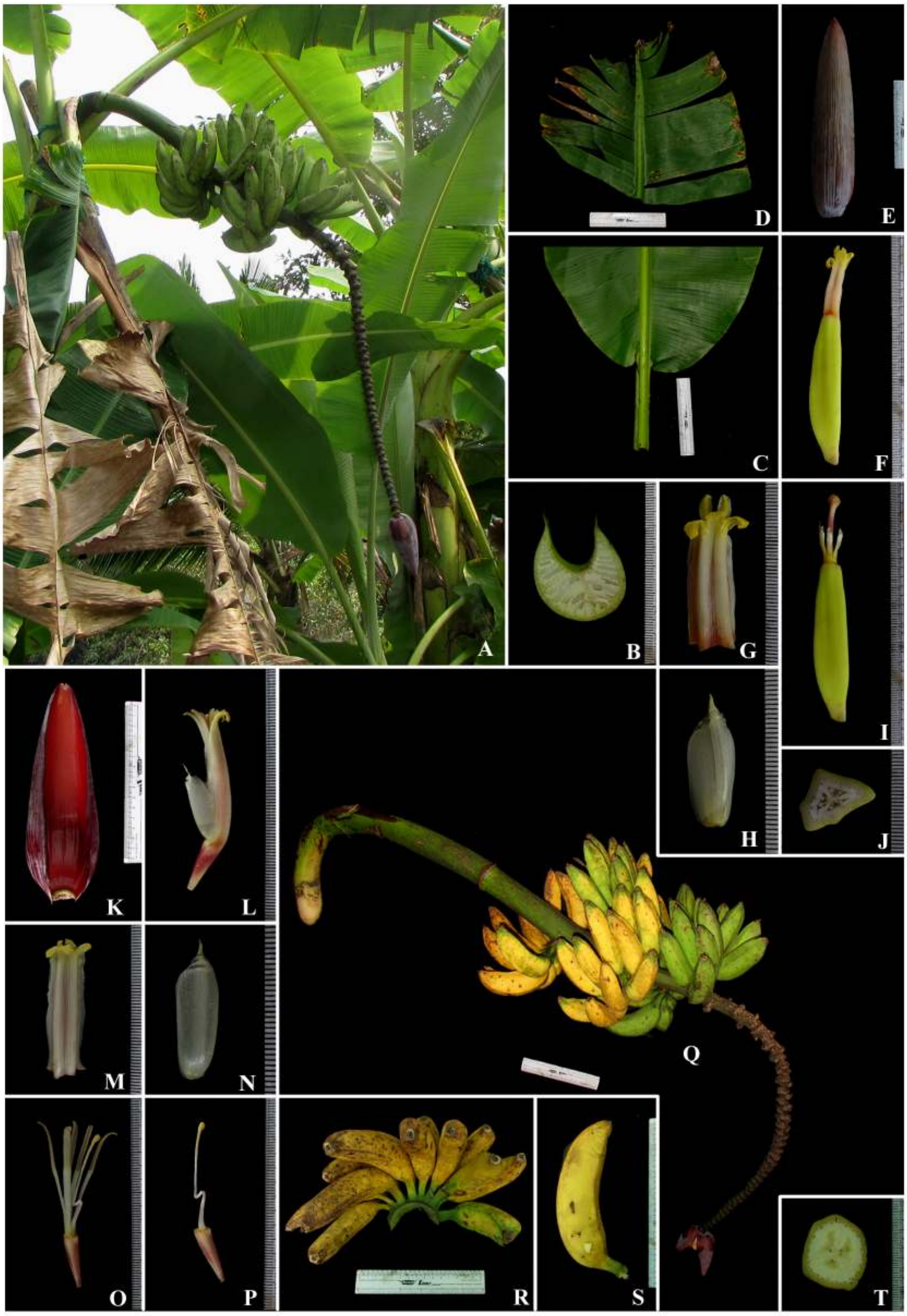

Fig. 17. ***Musa* × *paradisiaca* L. (AAB) 'Namarai'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit hand; **S.** single fruit; **T.** c.s. of fruit.

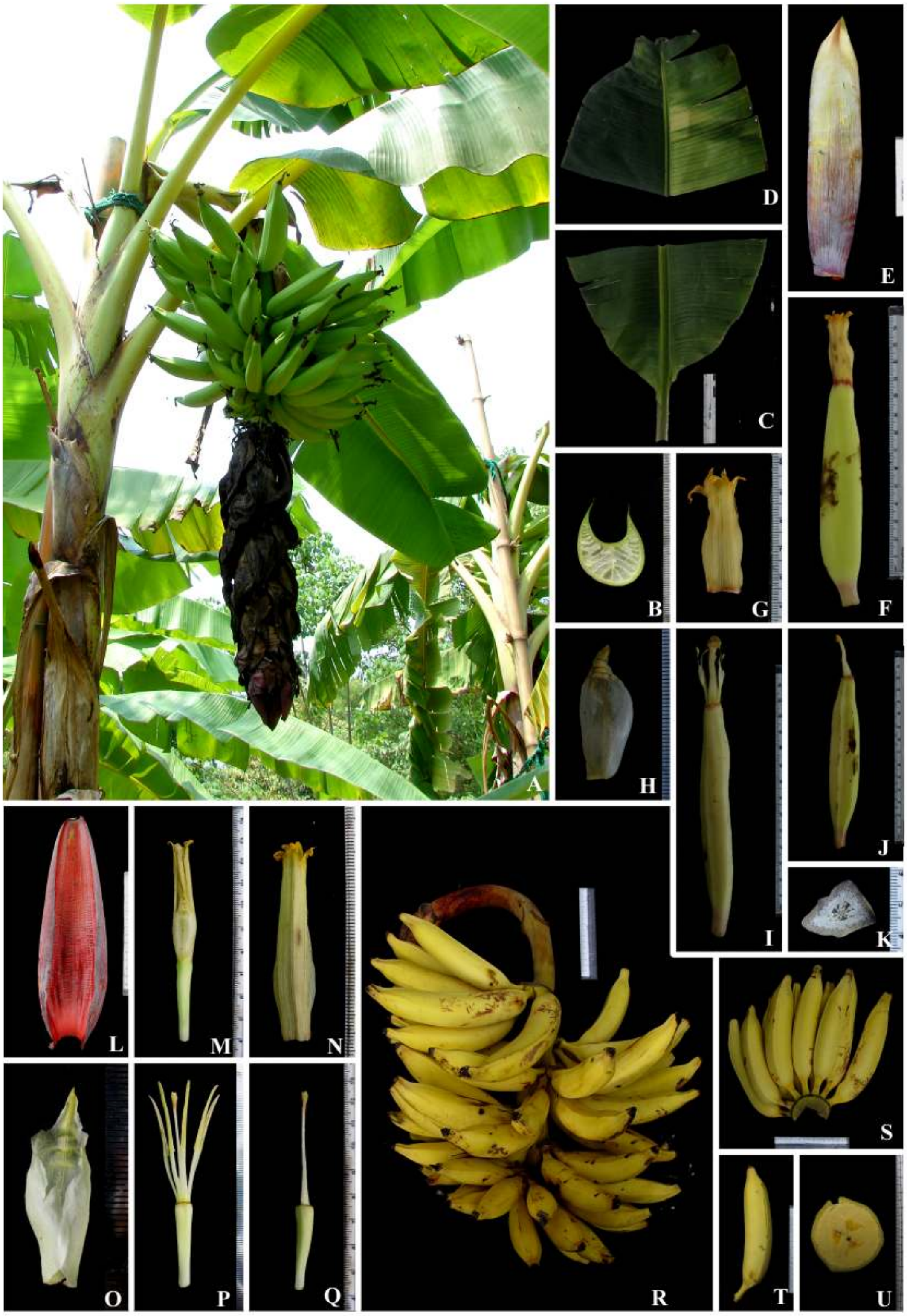

Fig. 18. ***Musa* × *paradisiaca* L. (AAB) 'Nendran'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-K.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** flower without tepals; **J.** pistil; **K.** c.s. of ovary; **L.** male bract; **M.** male flower; **N-Q.** male flower parts - **N.** compound tepal; **O.** free tepal; **P.** stamens; **Q.** rudementary pistil; **R.** infructescence with advanced stages of male bud; **S.** fruit bunch; **T.** single fruit; **U.** c.s. of fruit.

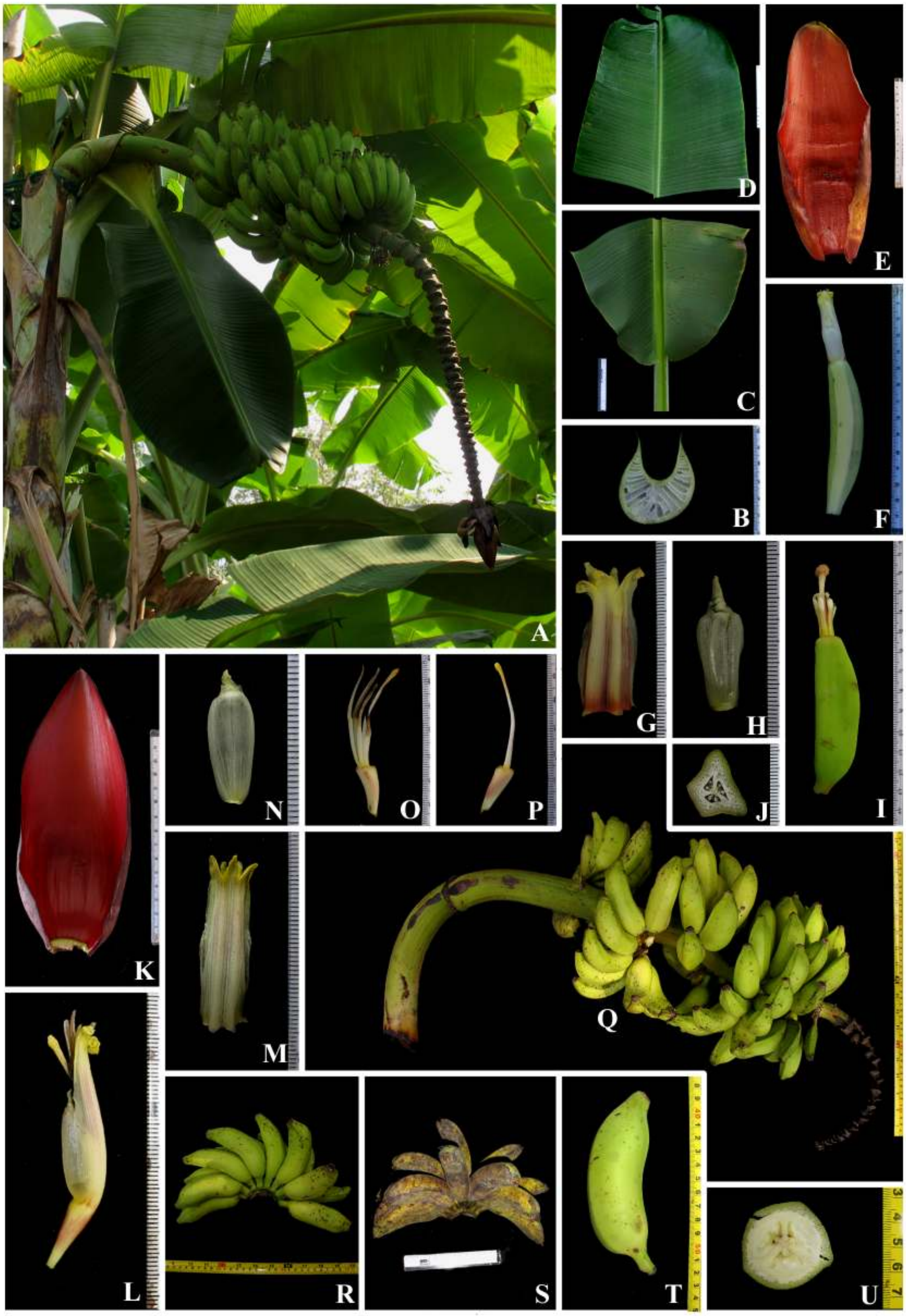

Fig. 19. ***Musa × paradisiaca* L. (AAB) 'Pachanadan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** flower without tepals; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** stamens; **P.** rudementary pistil; **Q.** infructescence; **R & S.** fruit bunch; **T.** single fruit; **U.** c.s. of fruit.

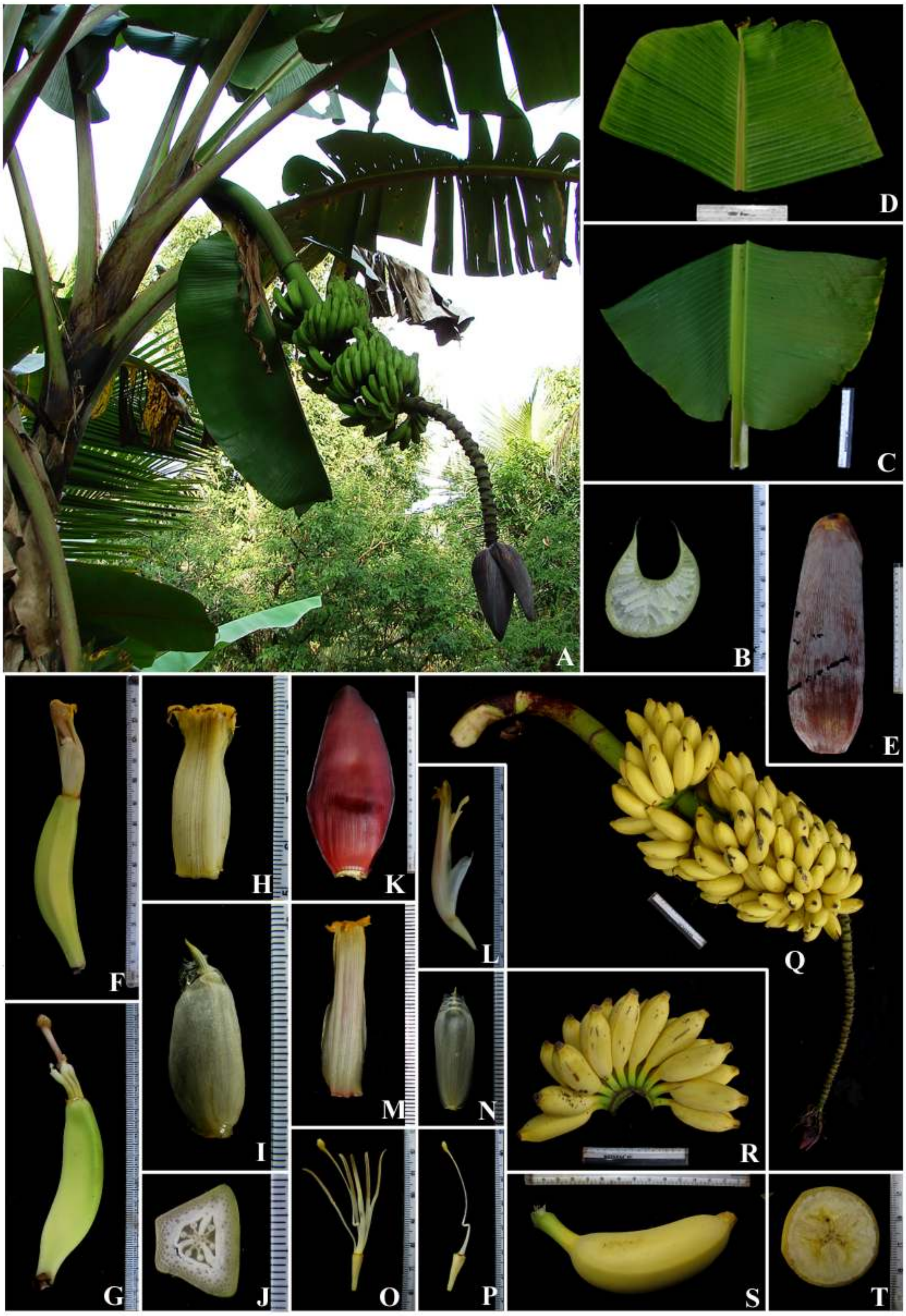

Fig. 20. ***Musa* × *paradisiaca* L. (AAB) 'Poovan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

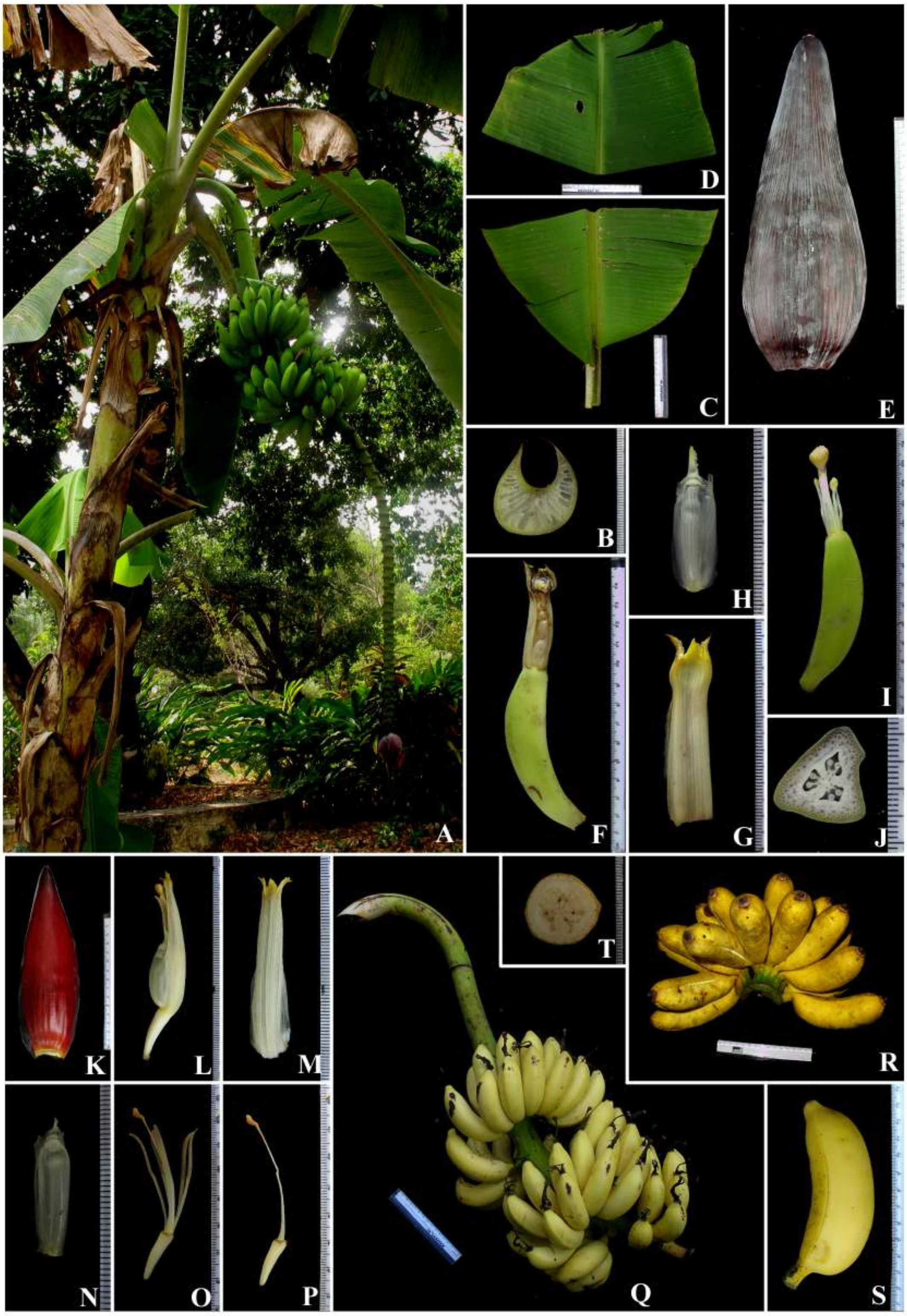

Fig. 21. ***Musa* × *paradisiaca* L. (AAB) 'Rasthali'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with ripened fruits; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

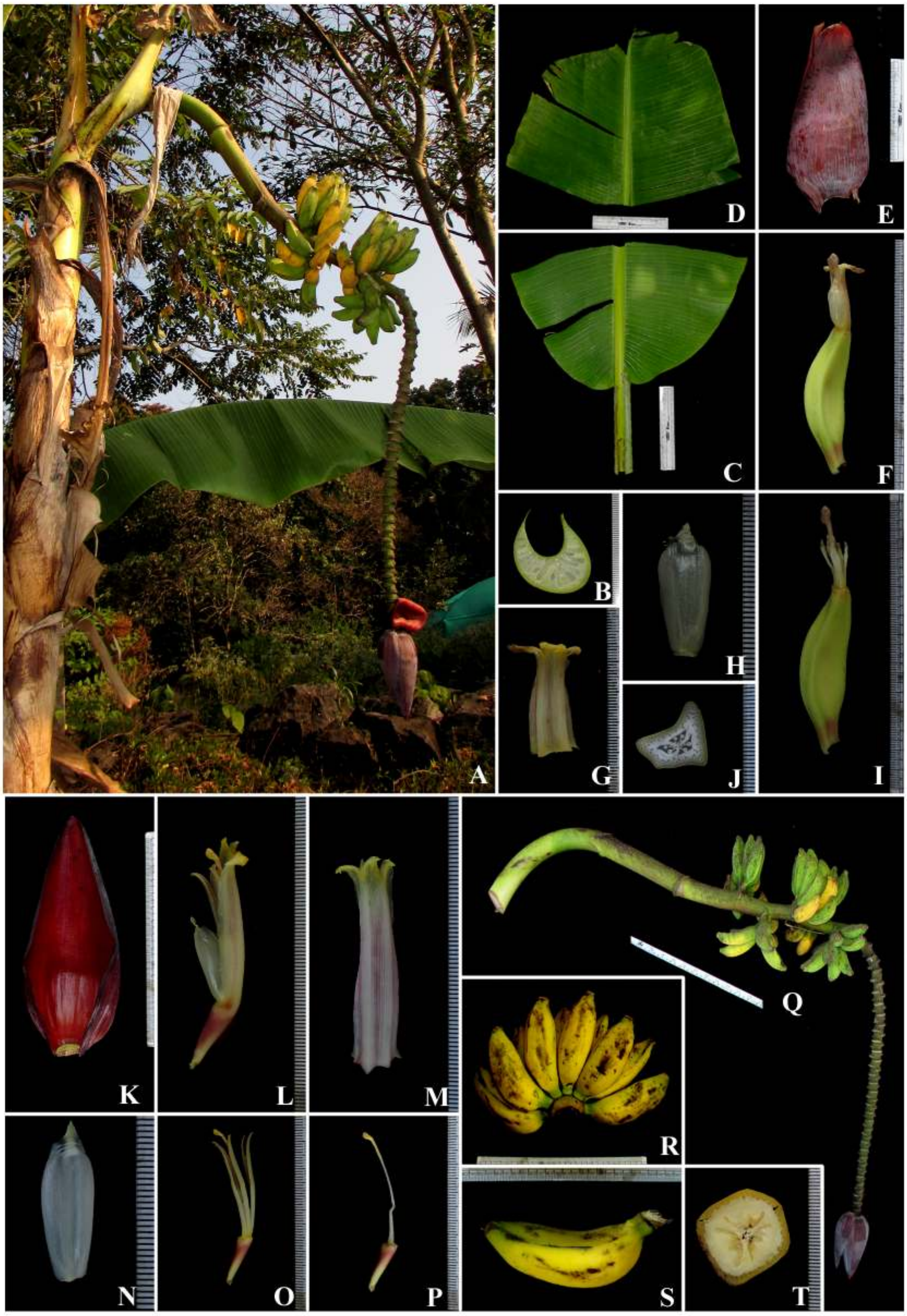

Fig. 22. ***Musa* × *paradisiaca* L. (AAB) 'Sirumalai'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

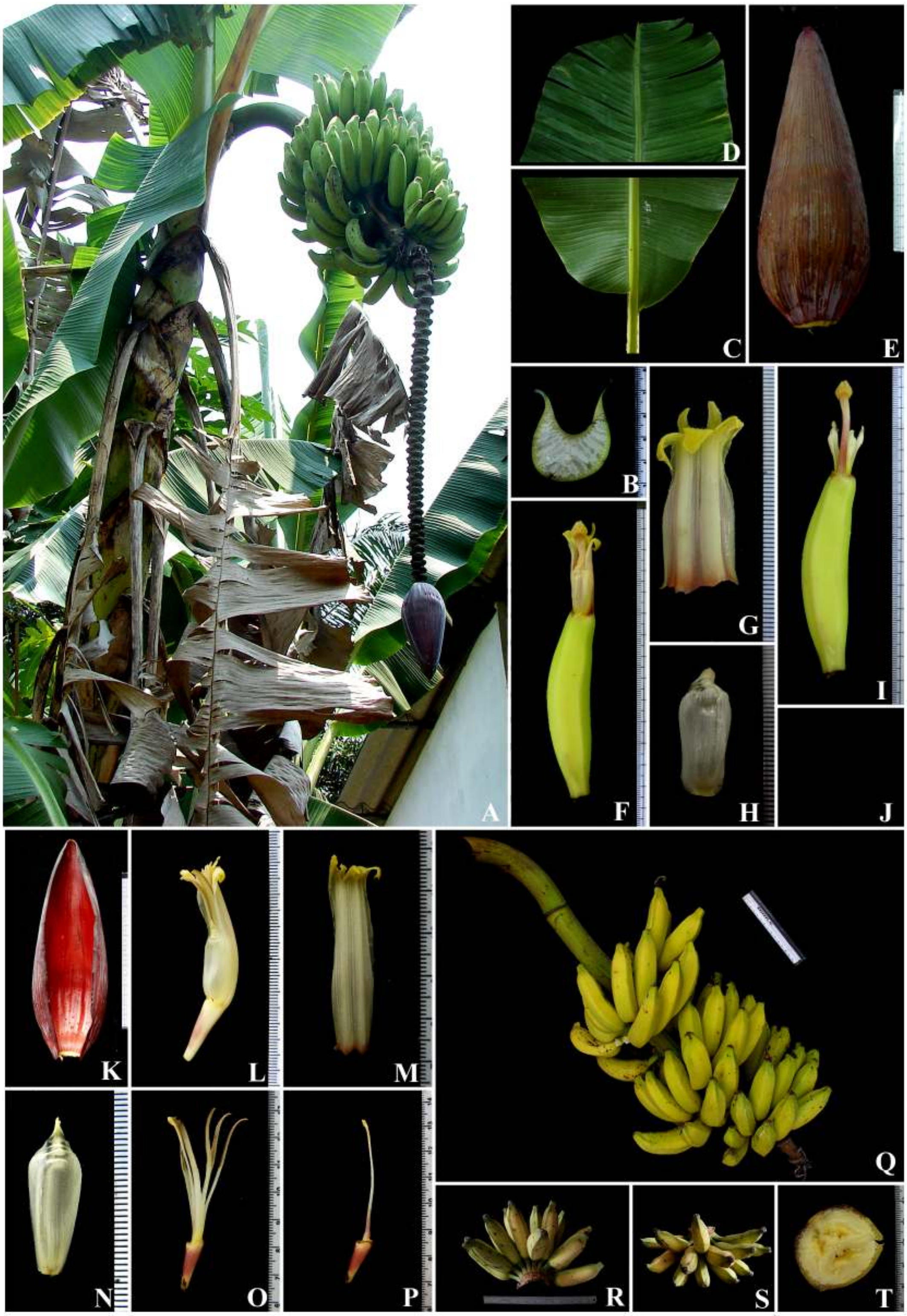

Fig. 23. ***Musa × paradisiaca* L. (AAB) 'Vannan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence; **R & S.** fruit bunch; **T.** c.s. of fruit.

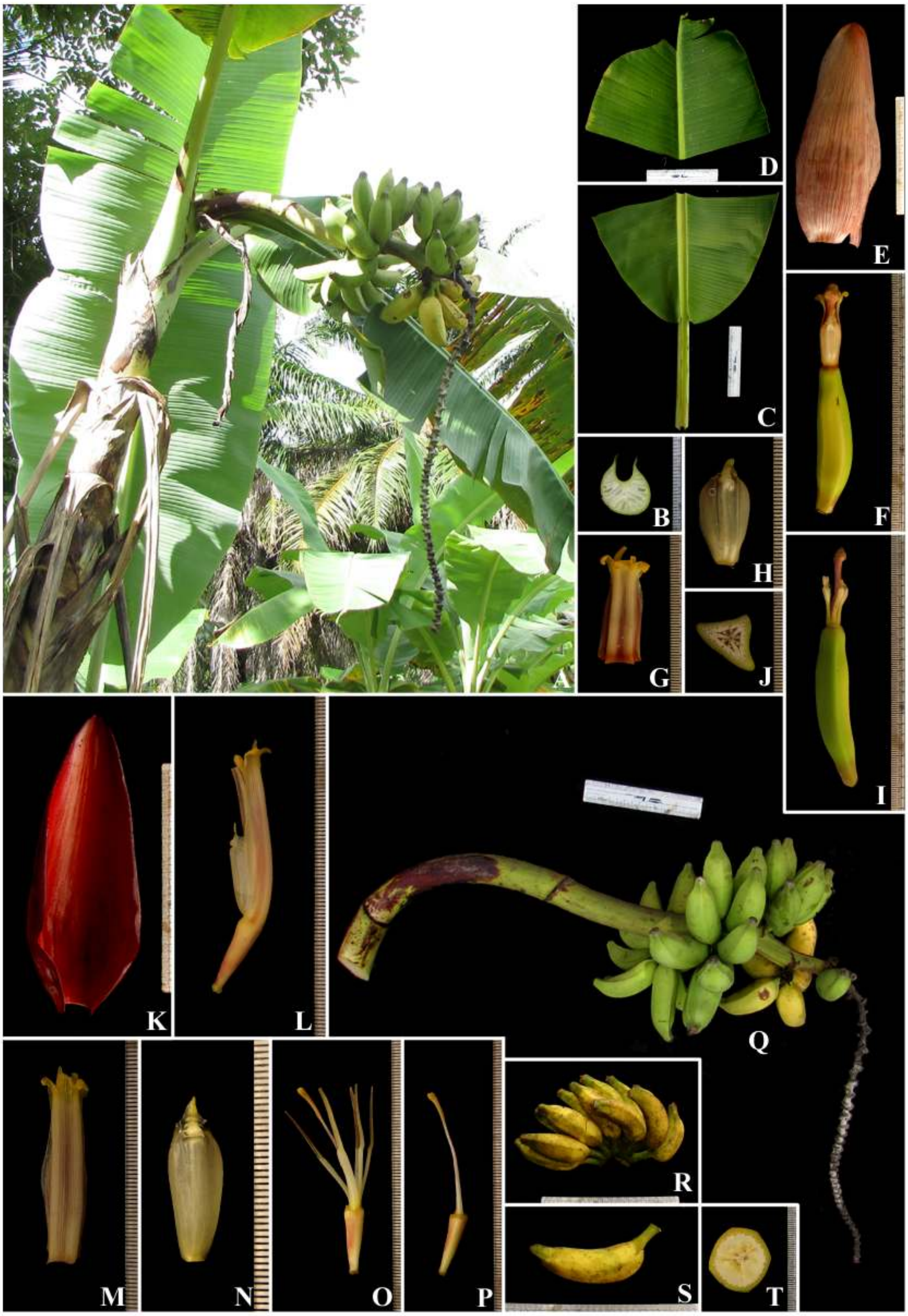

Fig. 24. ***Musa* × *paradisiaca* L. (AAB) 'Virupakshi'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

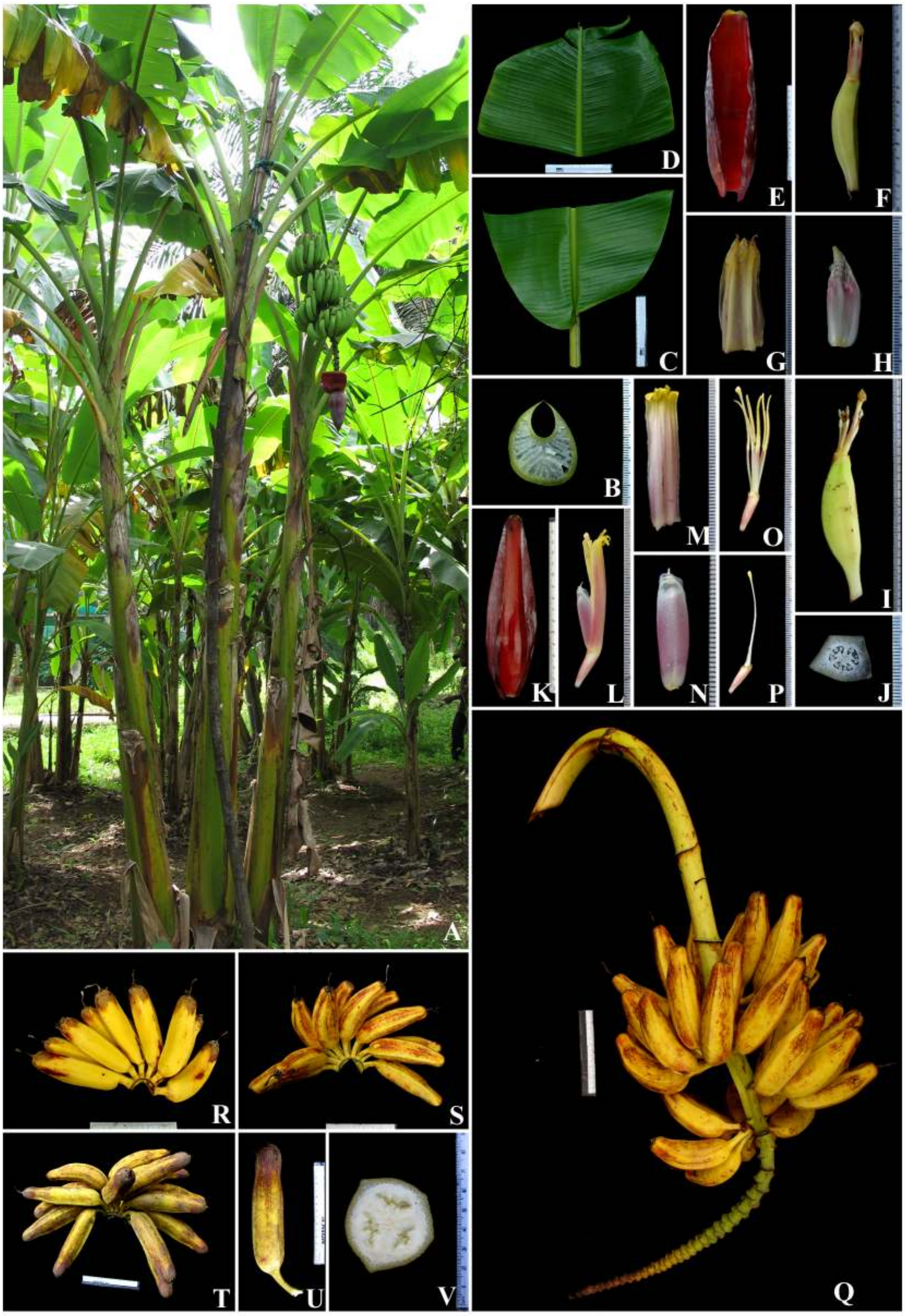

Fig. 25. ***Musa × paradisiaca* L. (ABB) 'Kachkol'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with ripened fruits; **R-T.** fruit bunch; **U.** single fruit; **V.** c.s. of fruit.

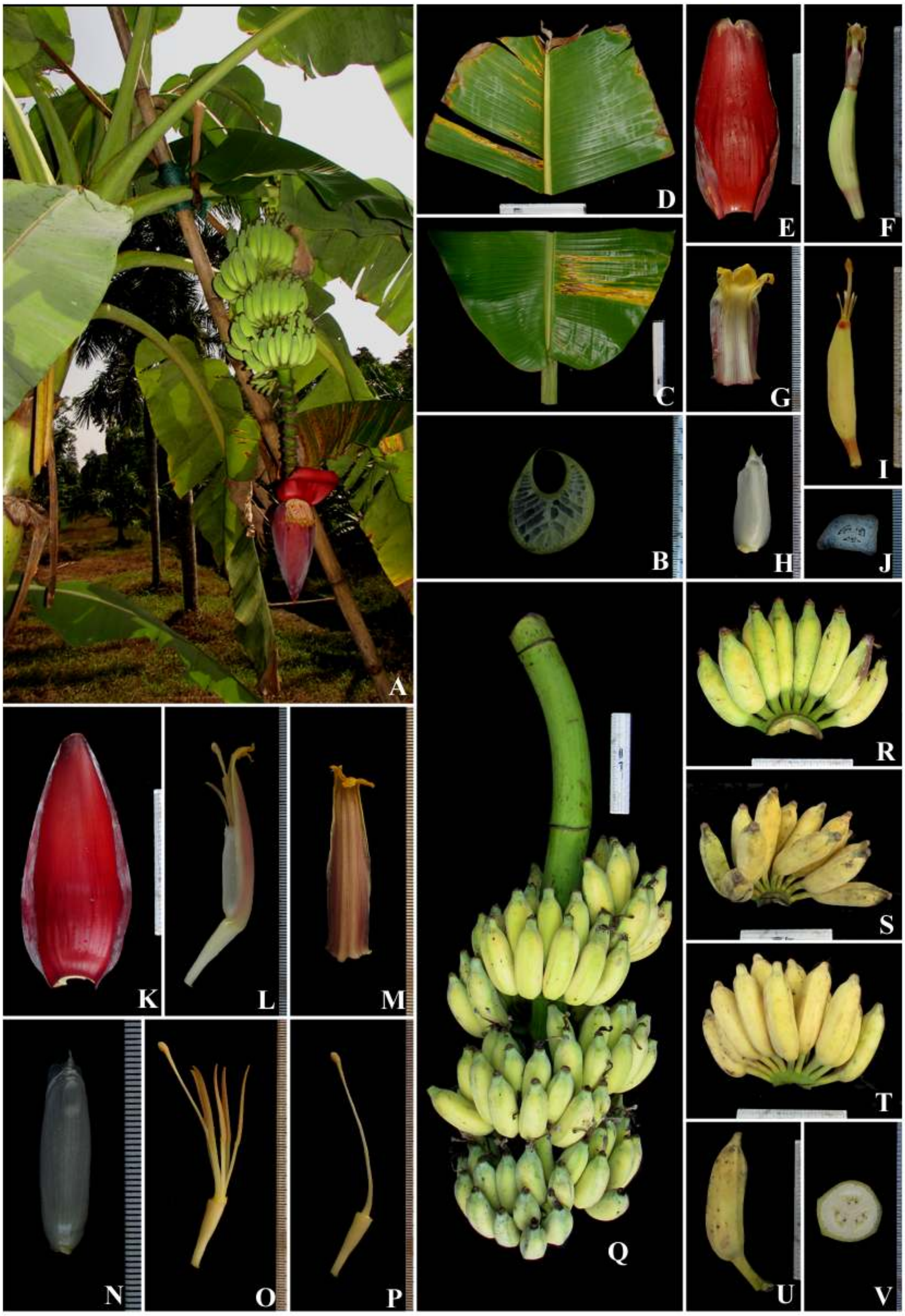

Fig. 26. ***Musa* × *paradisiaca* L. (ABB) 'Karpuravalli'**: **A.** habit with fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence; **R-T.** fruit bunch; **U.** single fruit; **V.** c.s. of fruit.

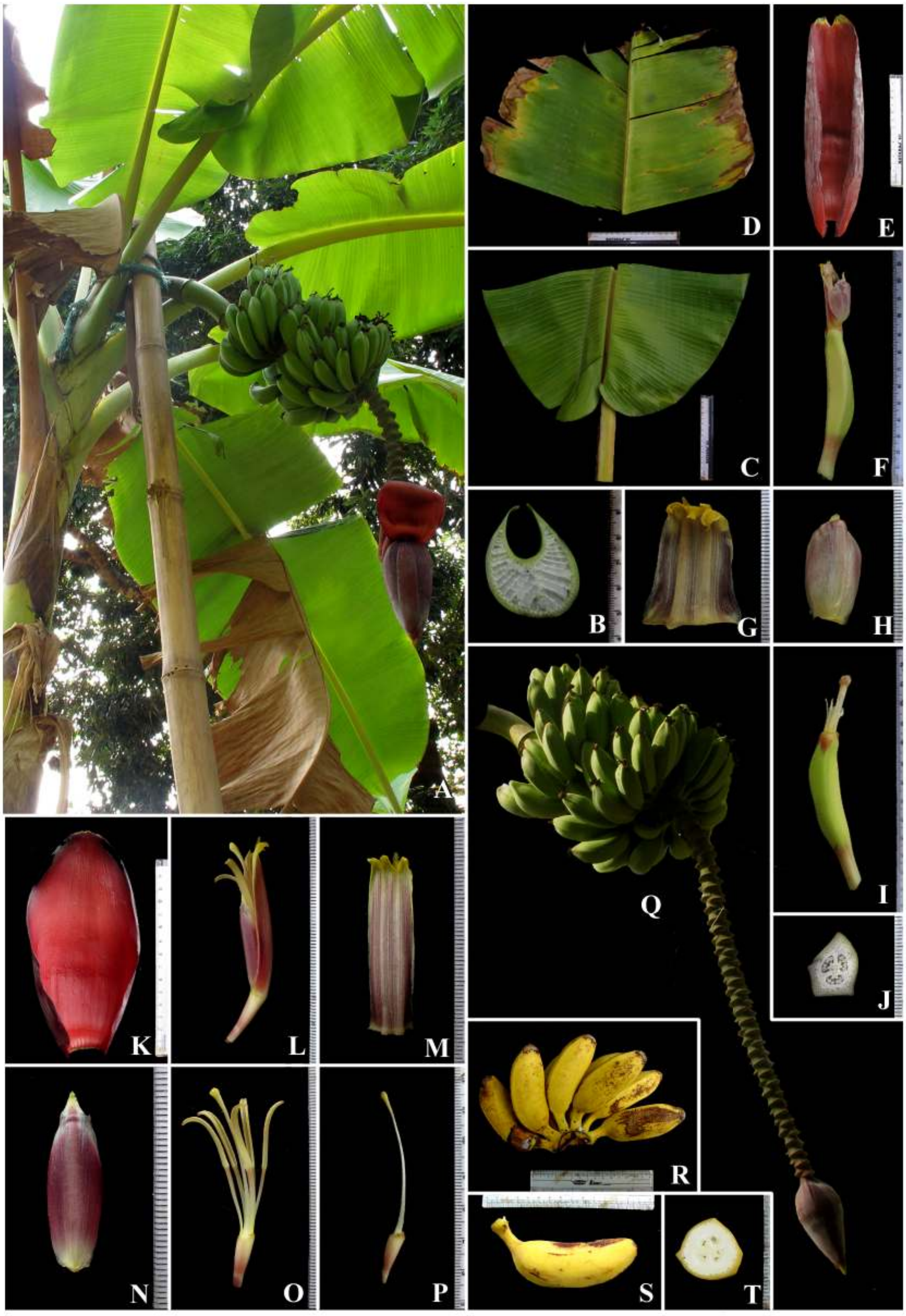

Fig. 27. ***Musa* × *paradisiaca* L. (ABB) 'Kuribontha'**: **A.** habit; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with advanced stages of male bud; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

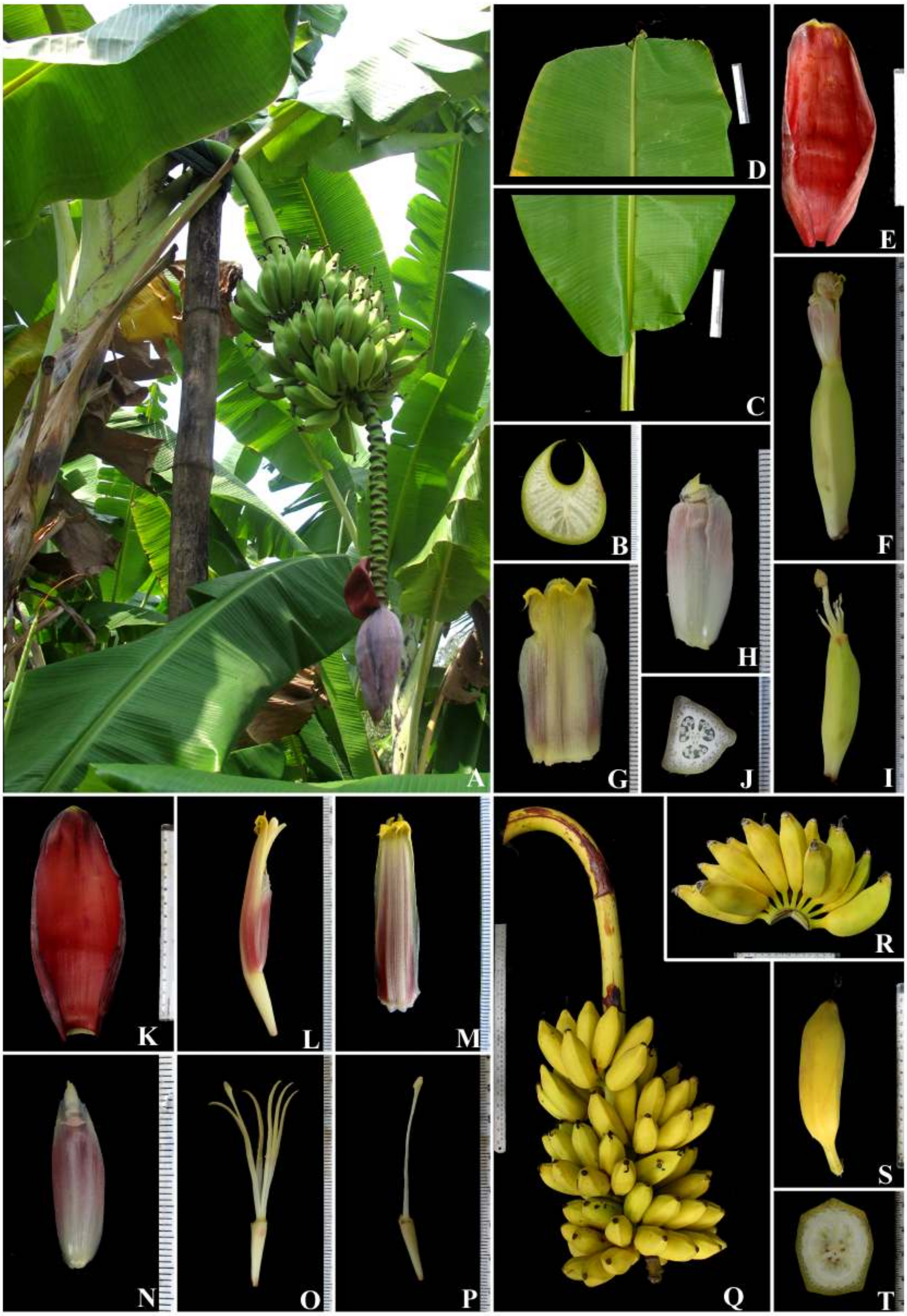

Fig. 28. ***Musa* × *paradisiaca* L. (ABB) 'Monthan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-J.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence with ripened fruits; **R.** fruit bunch; **S.** single fruit; **T.** c.s. of fruit.

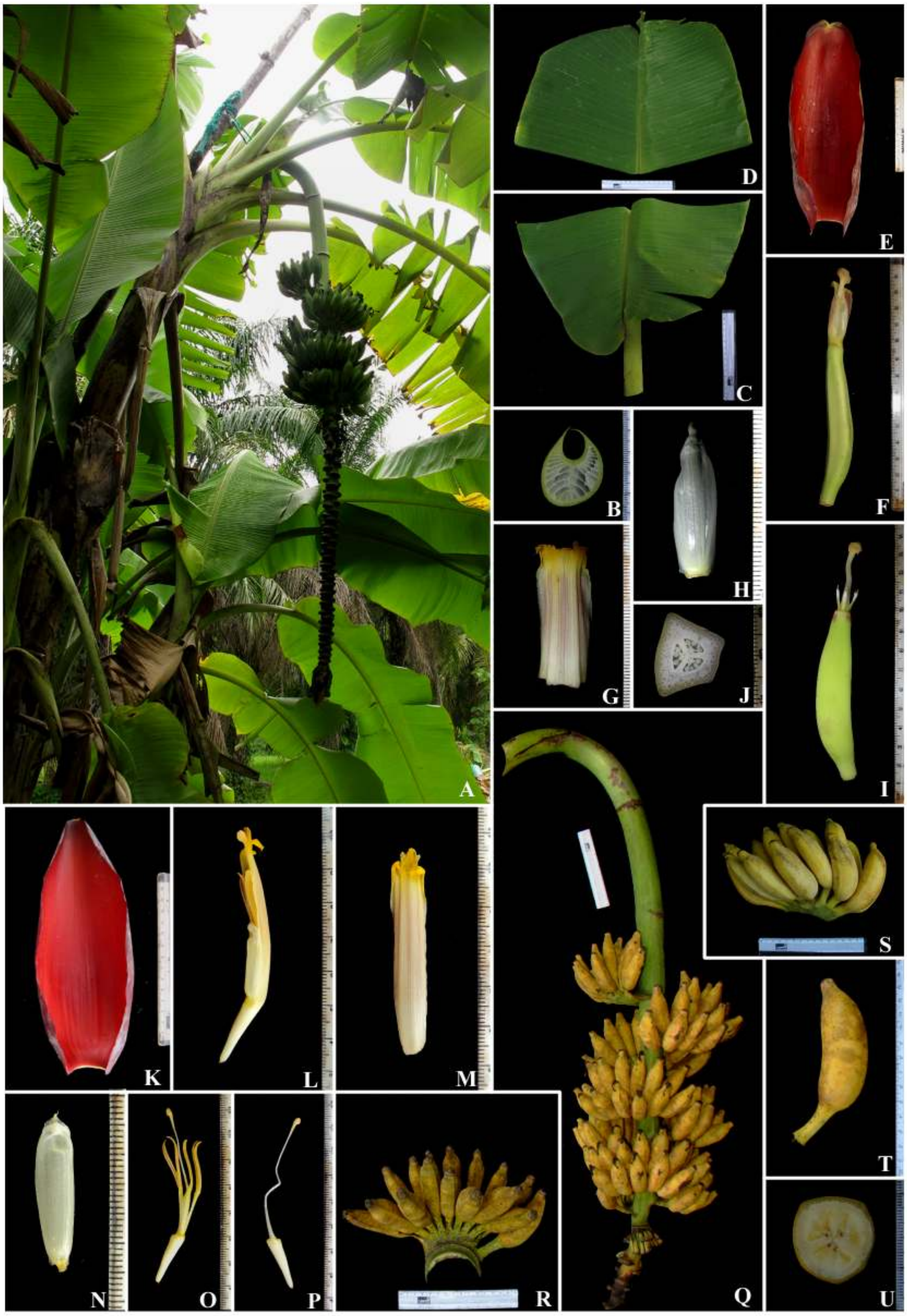

Fig. 29. ***Musa* × *paradisiaca* L. (ABB) 'Peyan'**: **A.** habit with mature fruit bunch; **B.** c.s. of petiole; **C.** leaf base; **D.** leaf tip; **E.** female bract; **F.** female flower; **G-I.** female flower parts - **G.** compound tepal; **H.** free tepal; **I.** pistil with staminodes; **J.** c.s. of ovary; **K.** male bract; **L.** male flower; **M-P.** male flower parts - **M.** compound tepal; **N.** free tepal; **O.** rudementary pistil with stamens; **P.** rudementary pistil; **Q.** infructescence ripened fruits; **R** & **S.** fruit hands; **T.** single fruit; **U.** c.s. of fruit.

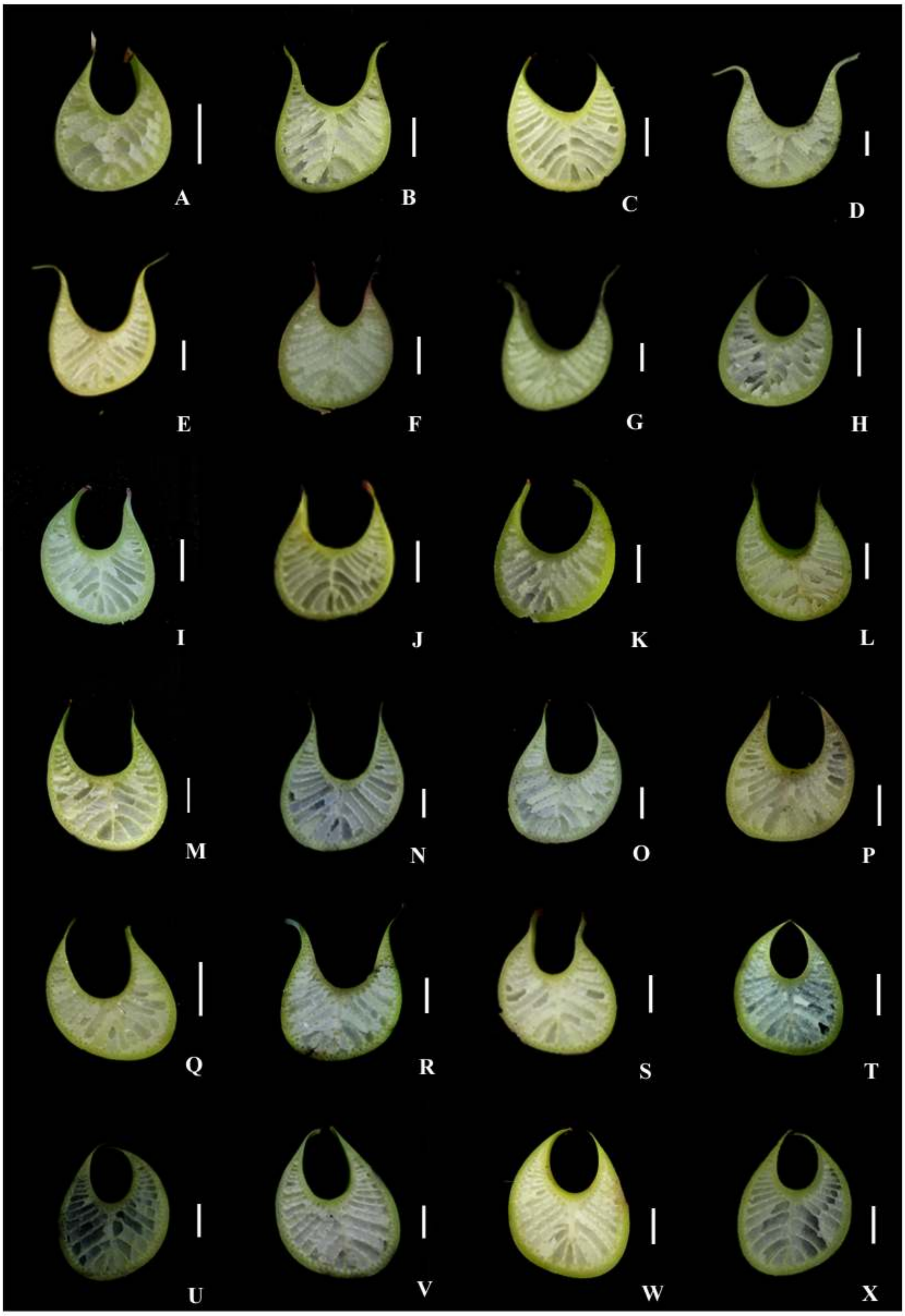

Fig. 30. **c.s. of Petiole (showing variation in petiole canal)**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 1 cm).

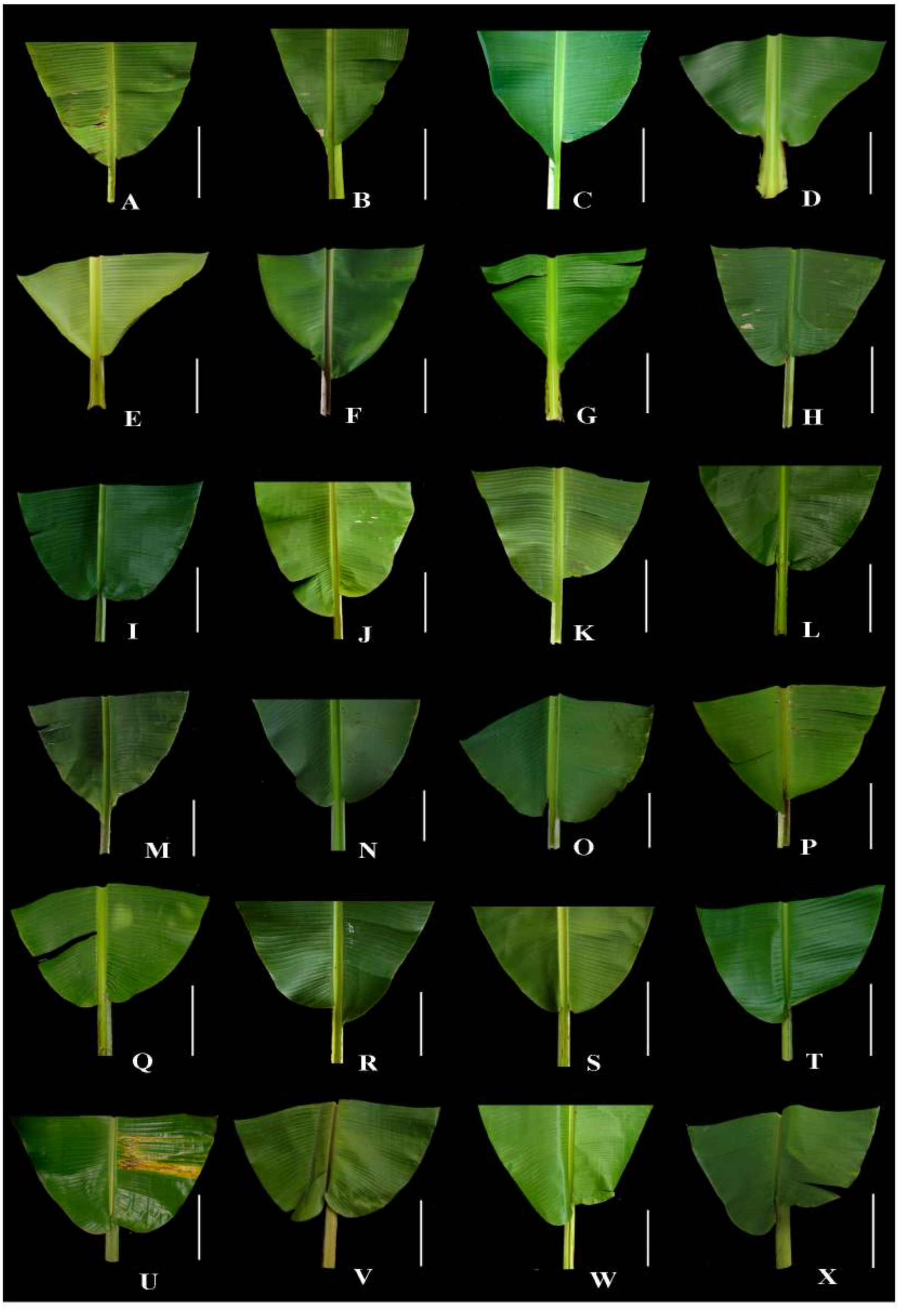

Fig. 31. **Leaf base**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 15 cm).

Fig. 32. **Female flower**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 2 cm).

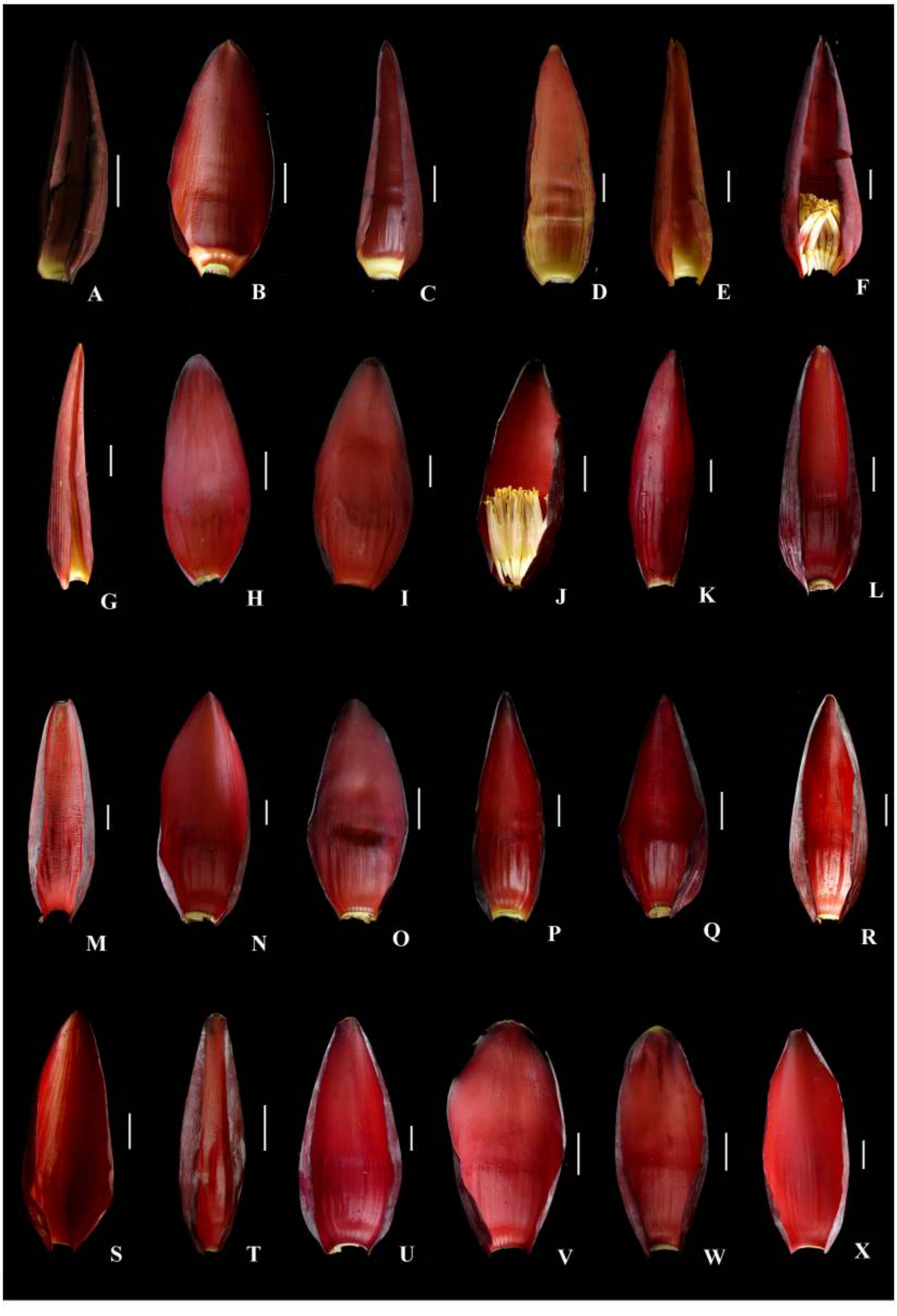

Fig. 33. **Male bract (ventral view): A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 3 cm).

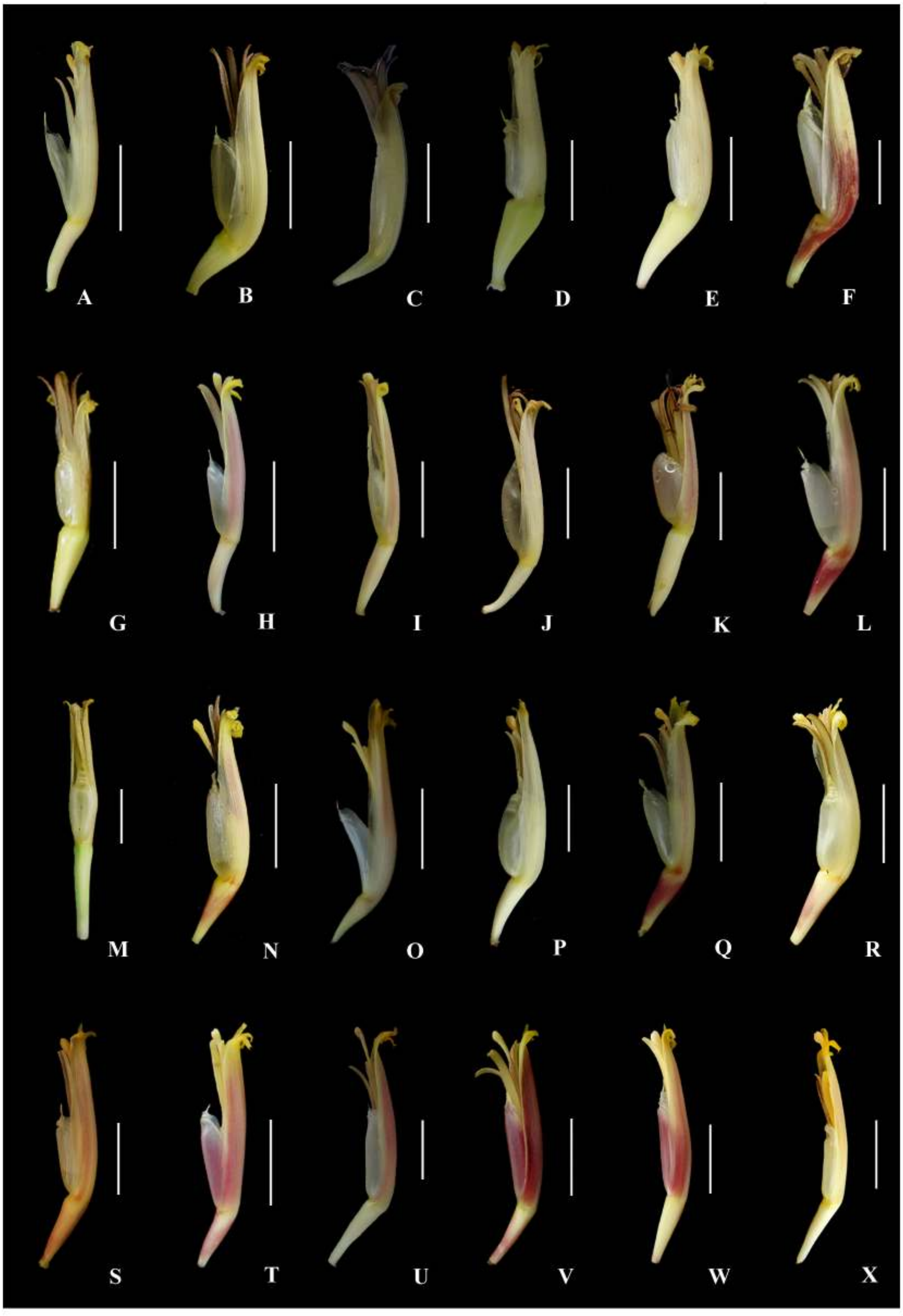

Fig. 34. **Male flower**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 2 cm).

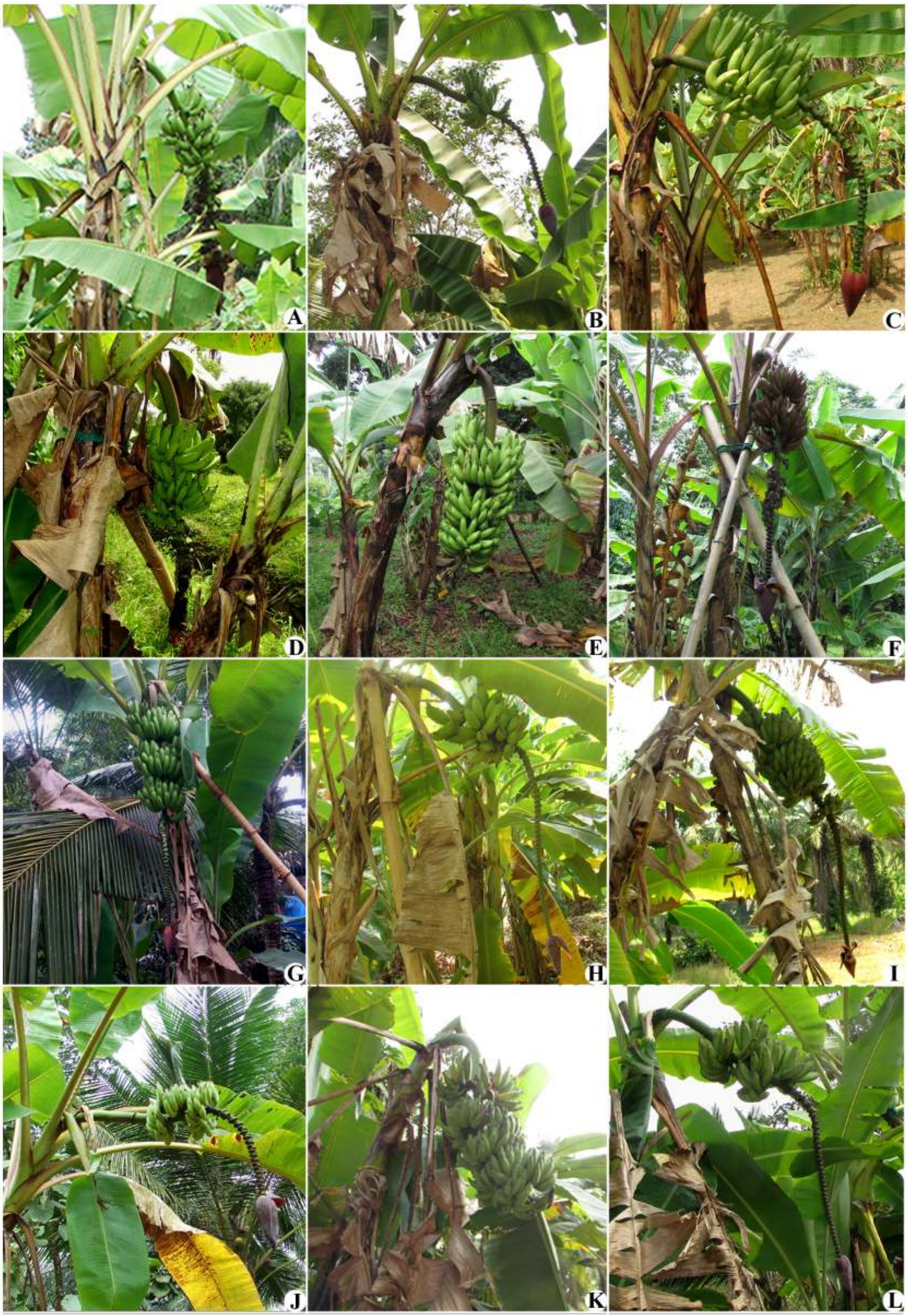

Fig. 35. **Fruit bunch**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*.

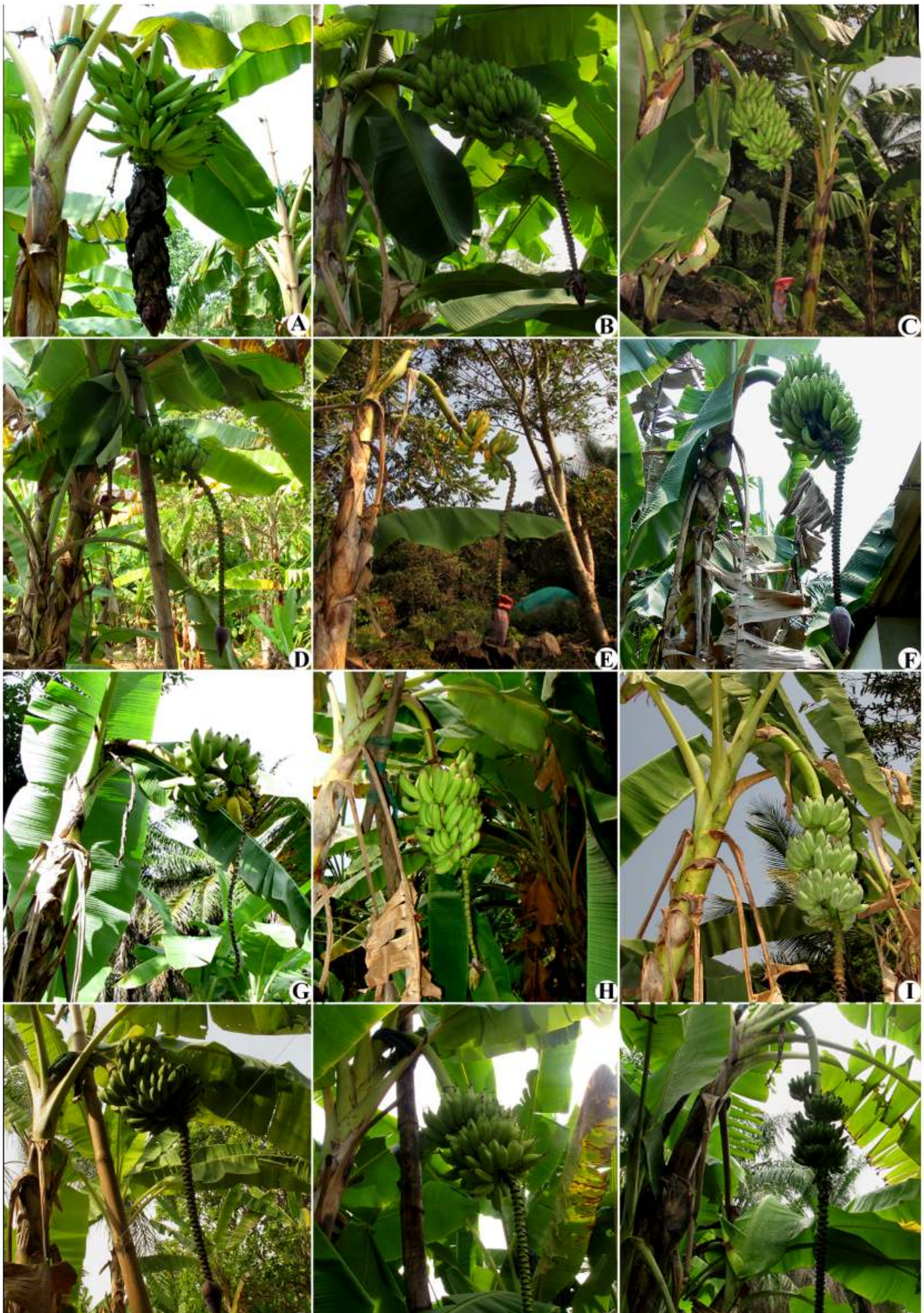

Fig. 36. **Fruit bunch**: **A.** *Nendran*; **B.** *Pachanadan*; **C.** *Poovan*; **D.** *Rasthali*; **E.** *Sirumalai*; **F.** *Vannan*; **G.** *Virupakshi*; **H.** *Kachkol*; **I.** *Karpuravalli*; **J.** *Kuribontha*; **K.** *Monthan*; **L.** *Peyan*.

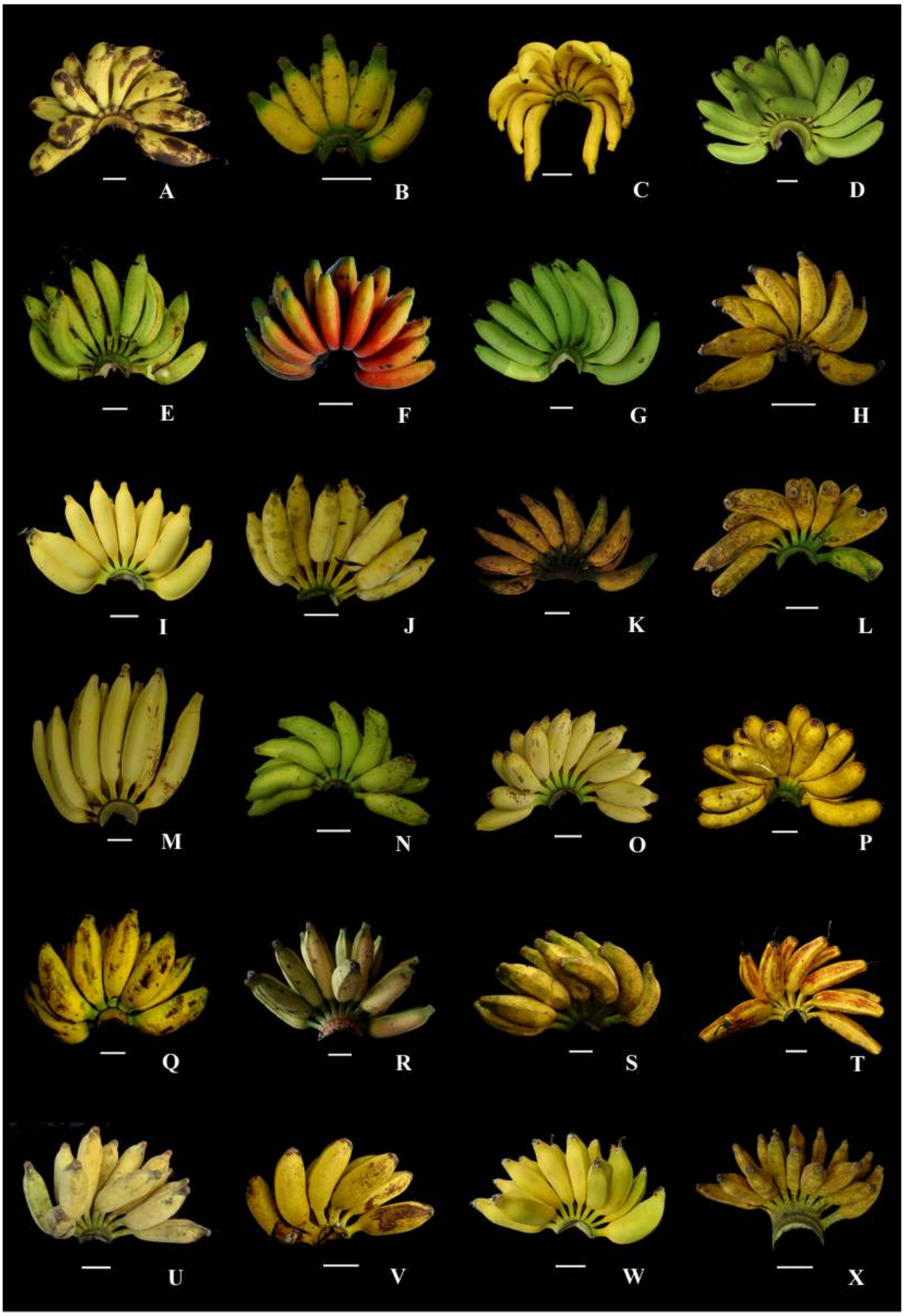

Fig. 37. **Ripened fruit hand**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 5 cm).

Fig. 38. **Ripened fruit**: **A.** *Kadali*; **B.** *Karivazhai*; **C.** *Pisang lilin*; **D.** *Dwarf cavendish*; **E.** *Grand naine*; **F.** *Red*; **G.** *Robusta*; **H.** *Kunnan*; **I.** *Matti*; **J.** *Neypoovan*; **K.** *Thaenkunnan*; **L.** *Namarai*; **M.** *Nendran*; **N.** *Pachanadan*; **O.** *Poovan*; **P.** *Rasthali*; **Q.** *Sirumalai*; **R.** *Vannan*; **S.** *Virupakshi*; **T.** *Kachkol*; **U.** *Karpuravalli*; **V.** *Kuribontha*; **W.** *Monthan*; **X.** *Peyan* (scale 3 cm).

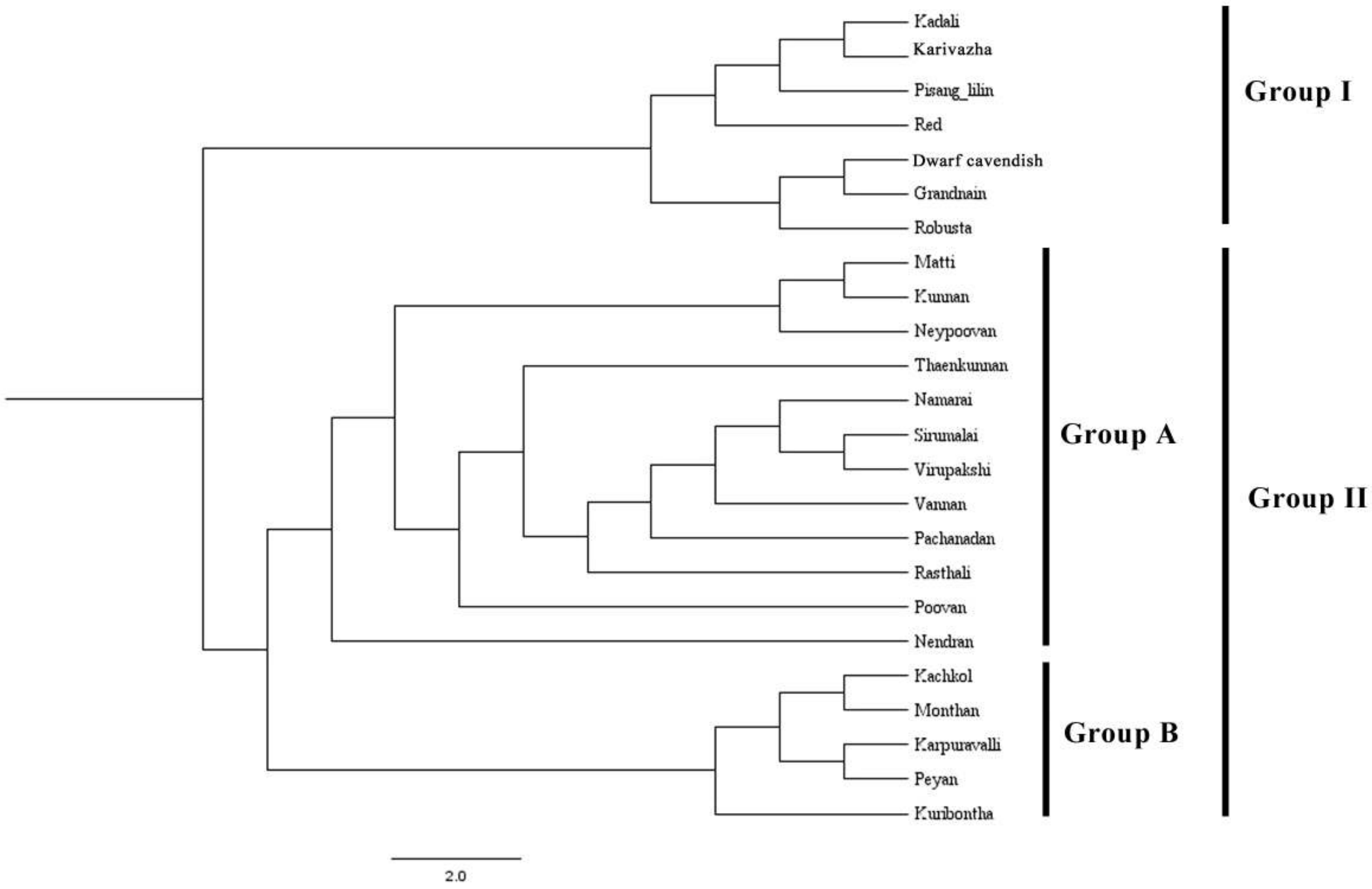

Fig. 39. Phenogram from UPGMA clustering of distance coefficients between 24 *Musa* cultivars in South India

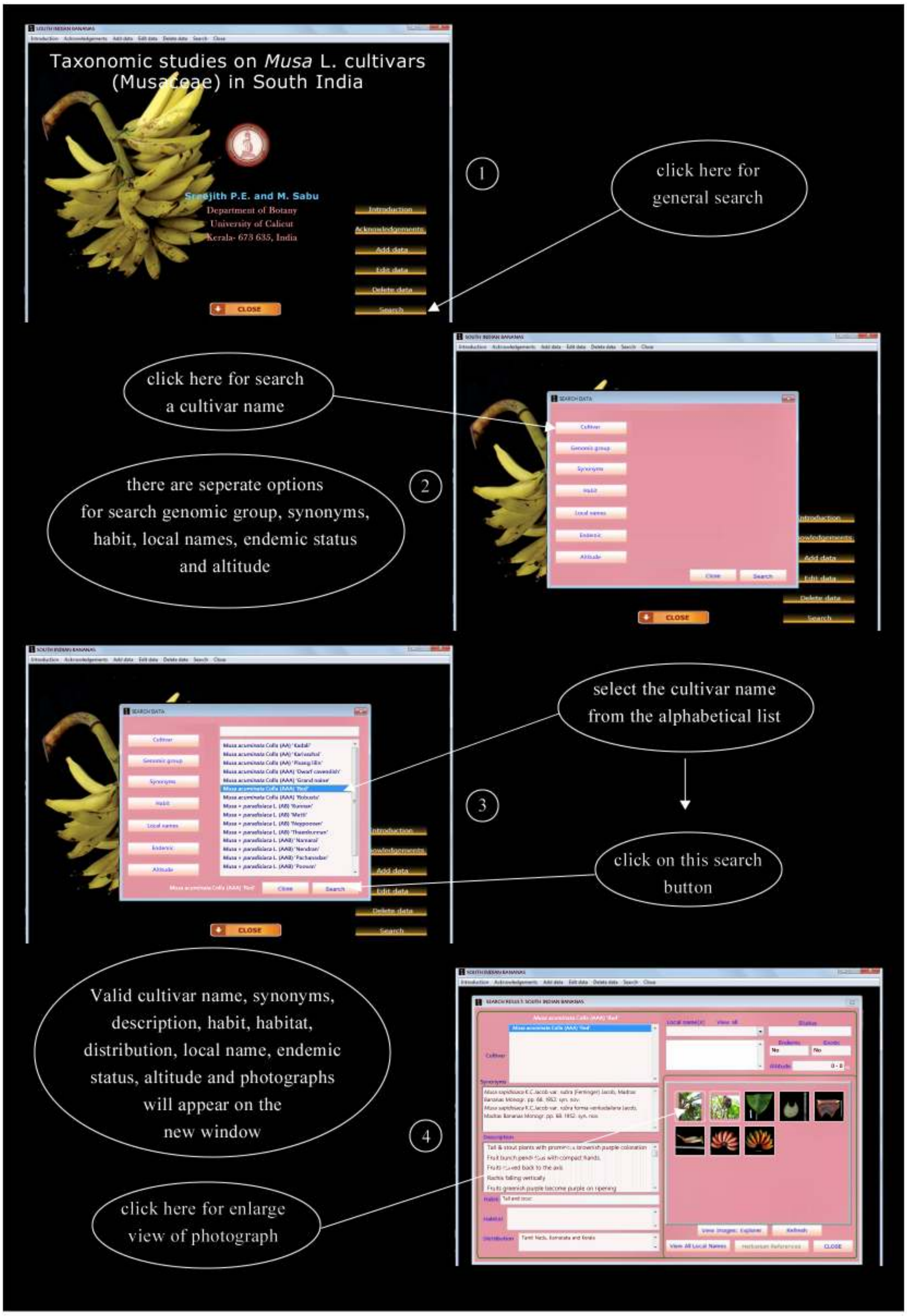

Fig. 40. **Database of South Indian bananas**: a schematic representation.

Fig. 41. **Conservation of South Indian *Musa* cultivars**: views from *Musa* garden of the Calicut University Botanical Garden

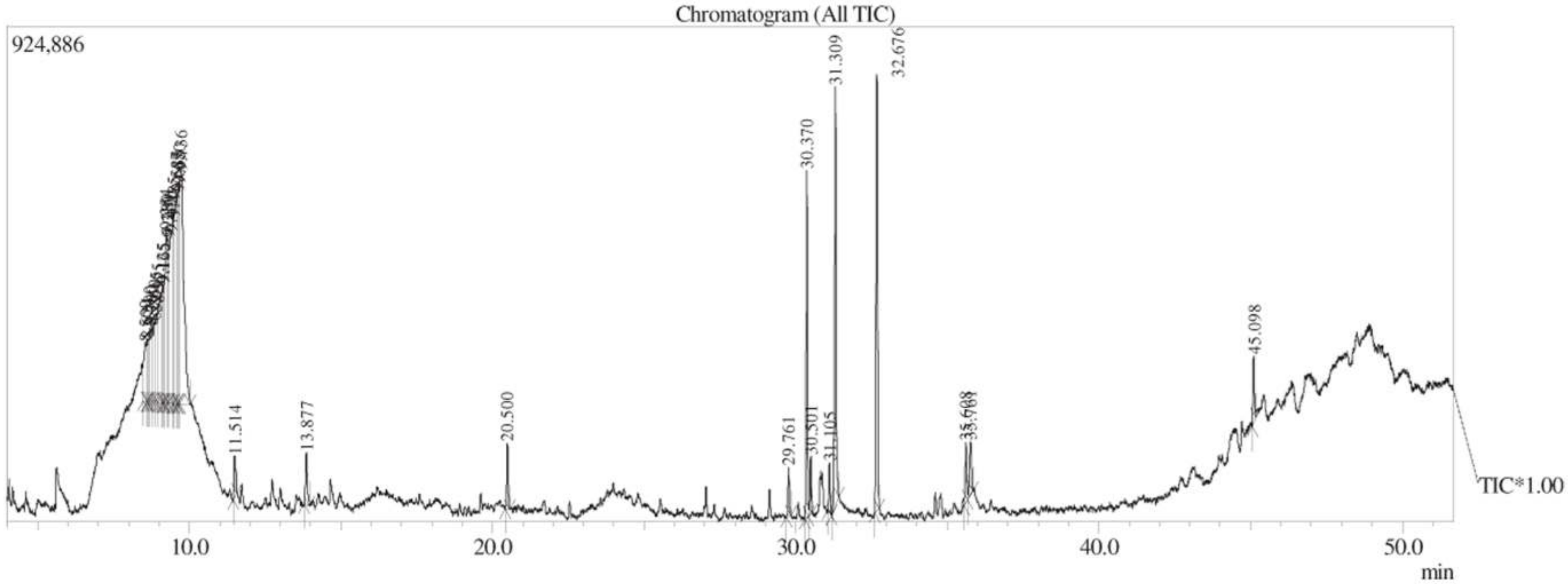

Fig. 42. Chromatogram of methanolic extract of *Musa acuminata* (AA) 'Kadali' fruit pulp

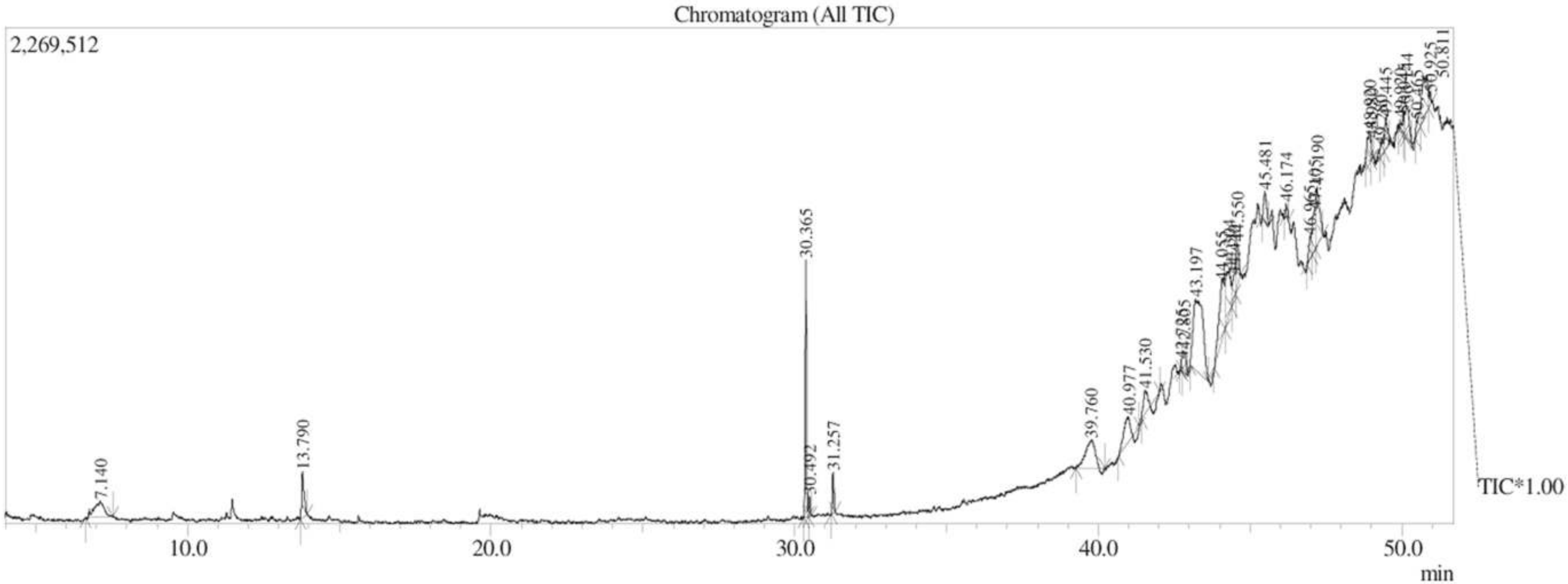

Fig. 43. Chromatogram of methanolic extract of *Musa acuminata* (AA) 'Karivazhai' fruit pulp

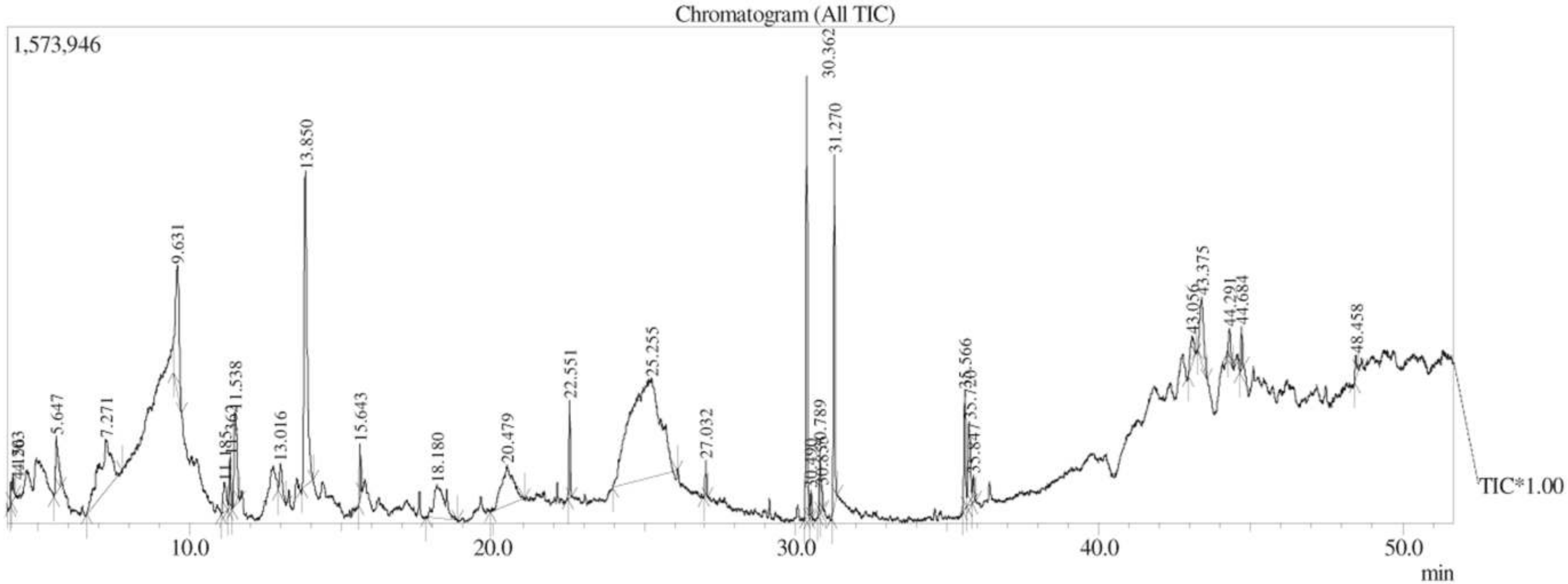

Fig. 44. Chromatogram of methanolic extract of *Musa acuminata* (AA) ‘Pisang lilin’ fruit pulp

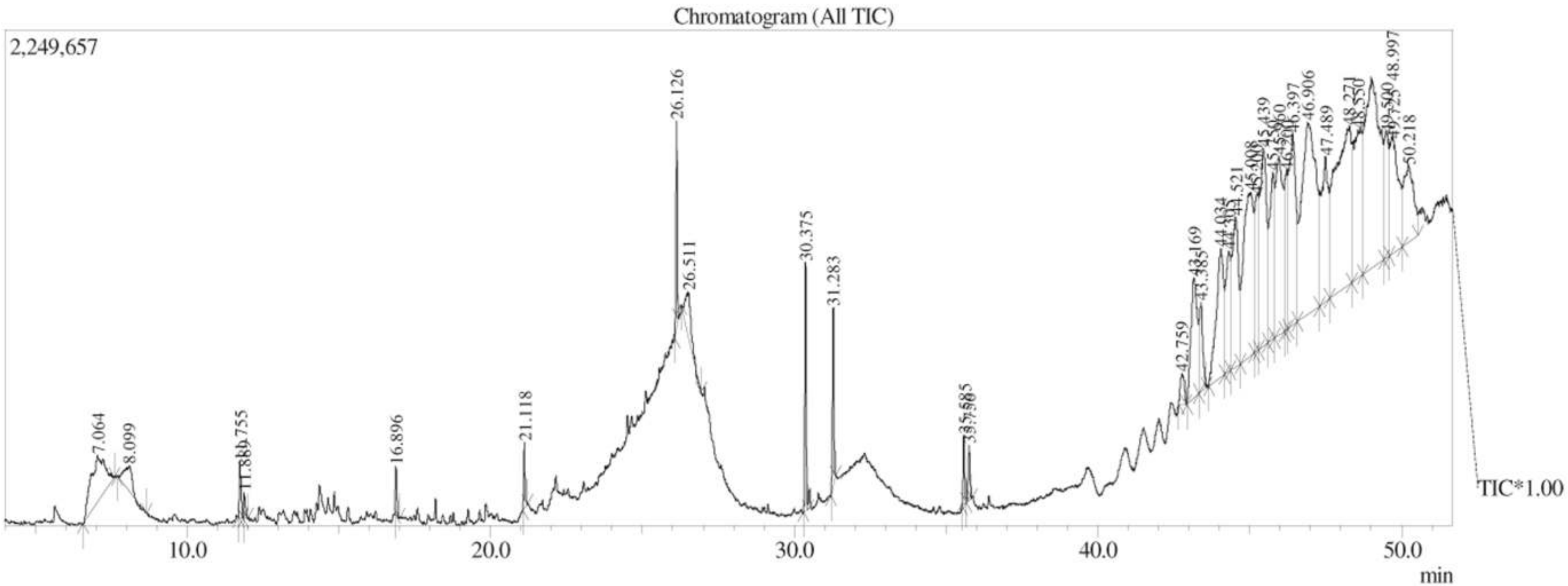

Fig. 45. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AB) ‘Kunnan’ fruit pulp.

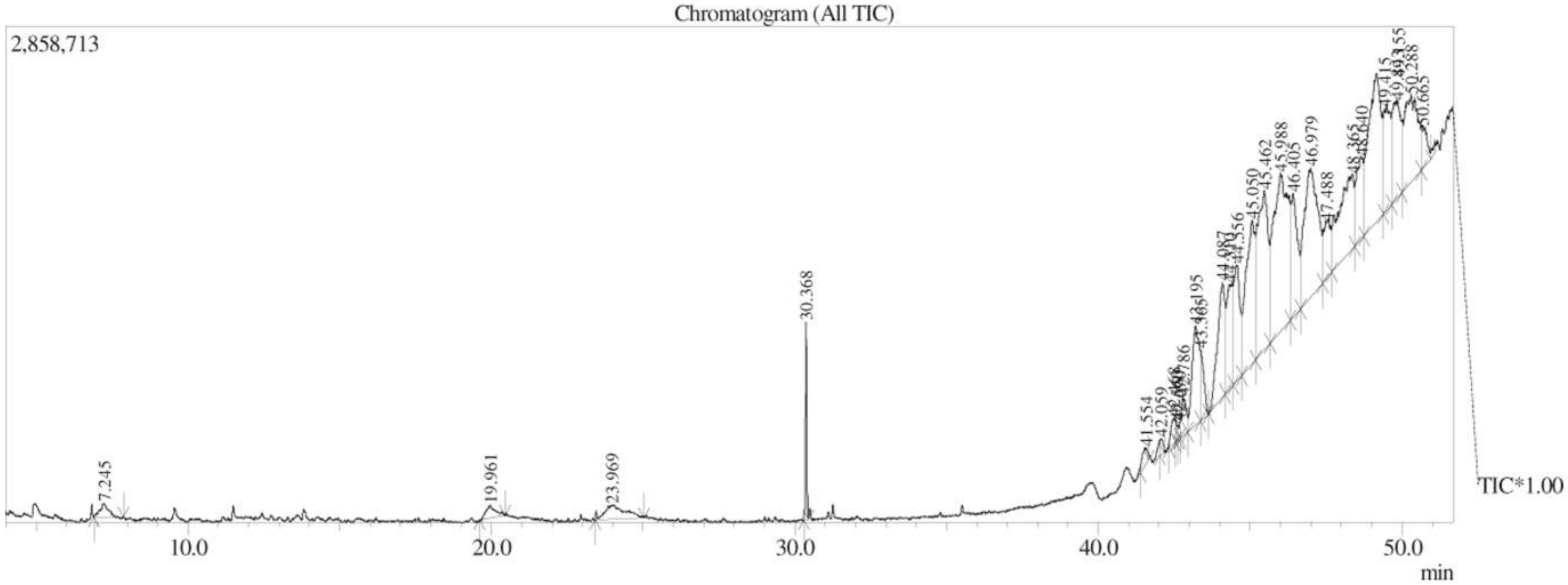

Fig. 46. Chromatogram of methanolic extract of *Musa × paradisiaca* (AB) 'Neypoovan' fruit pulp.

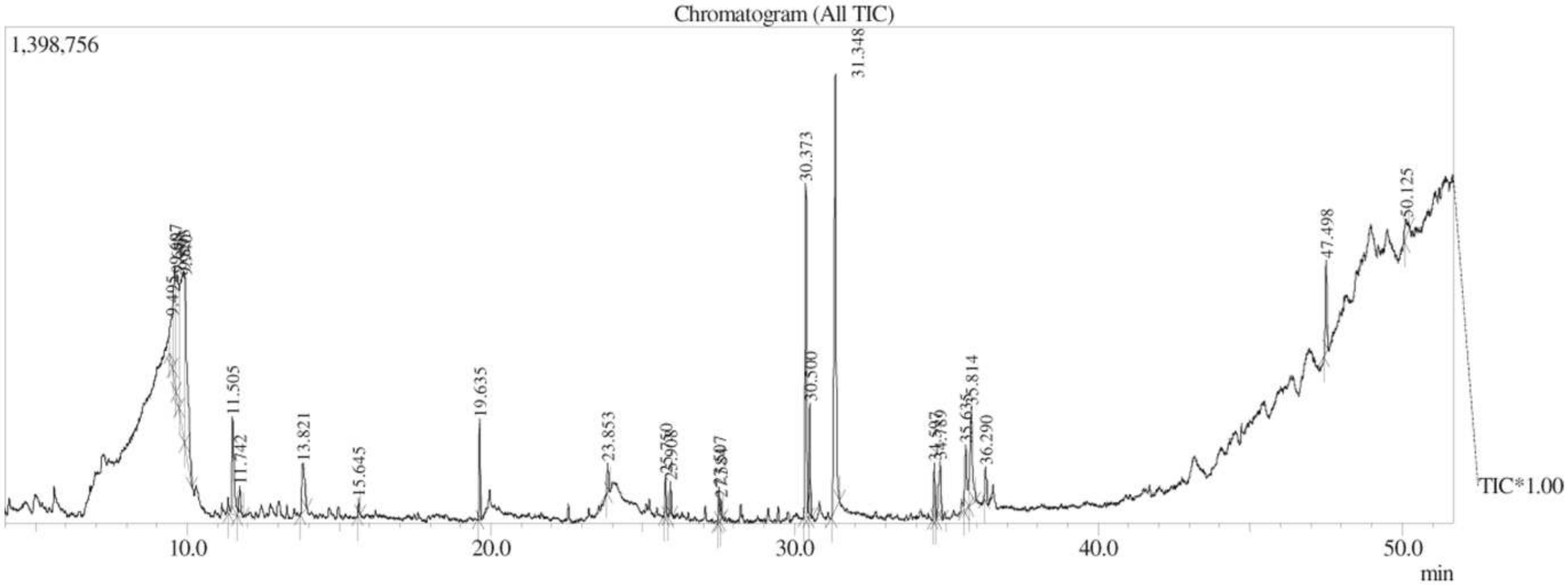

Fig. 47. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AB) ‘Thaenkunnan’ fruit pulp.

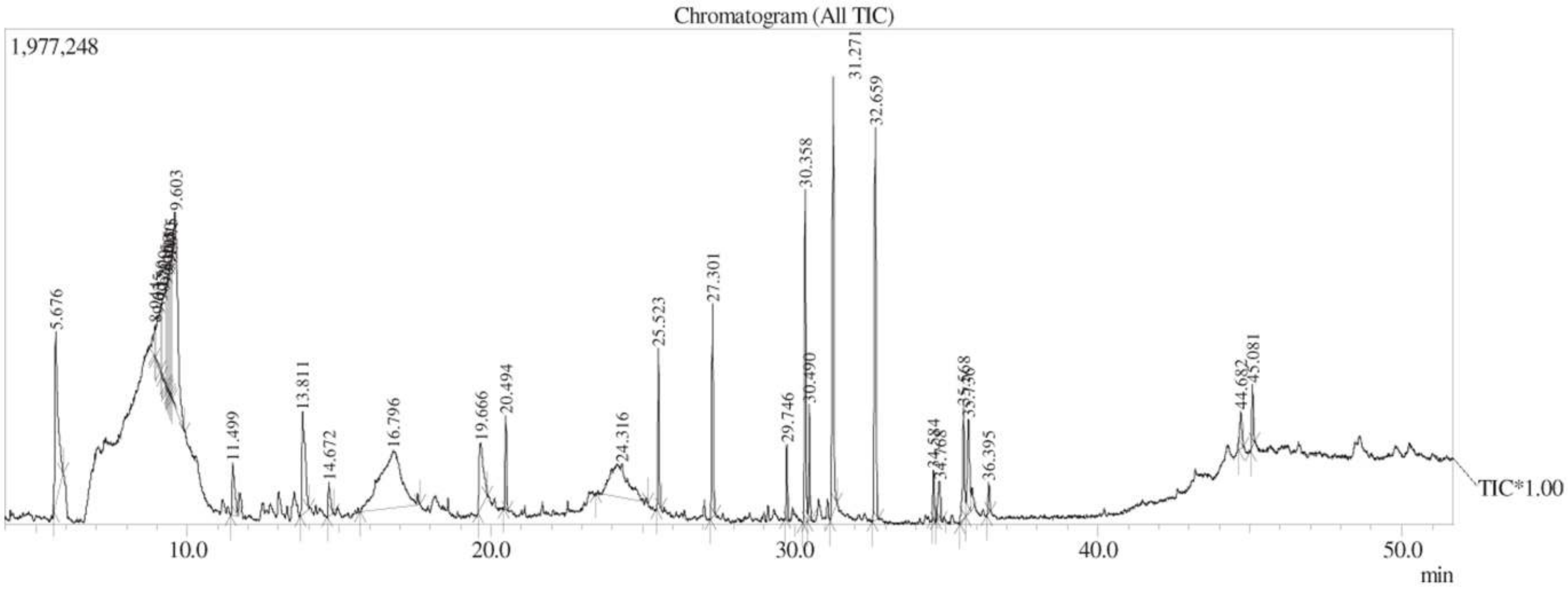

Fig. 48. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AAB) 'Nendran' fruit pulp.

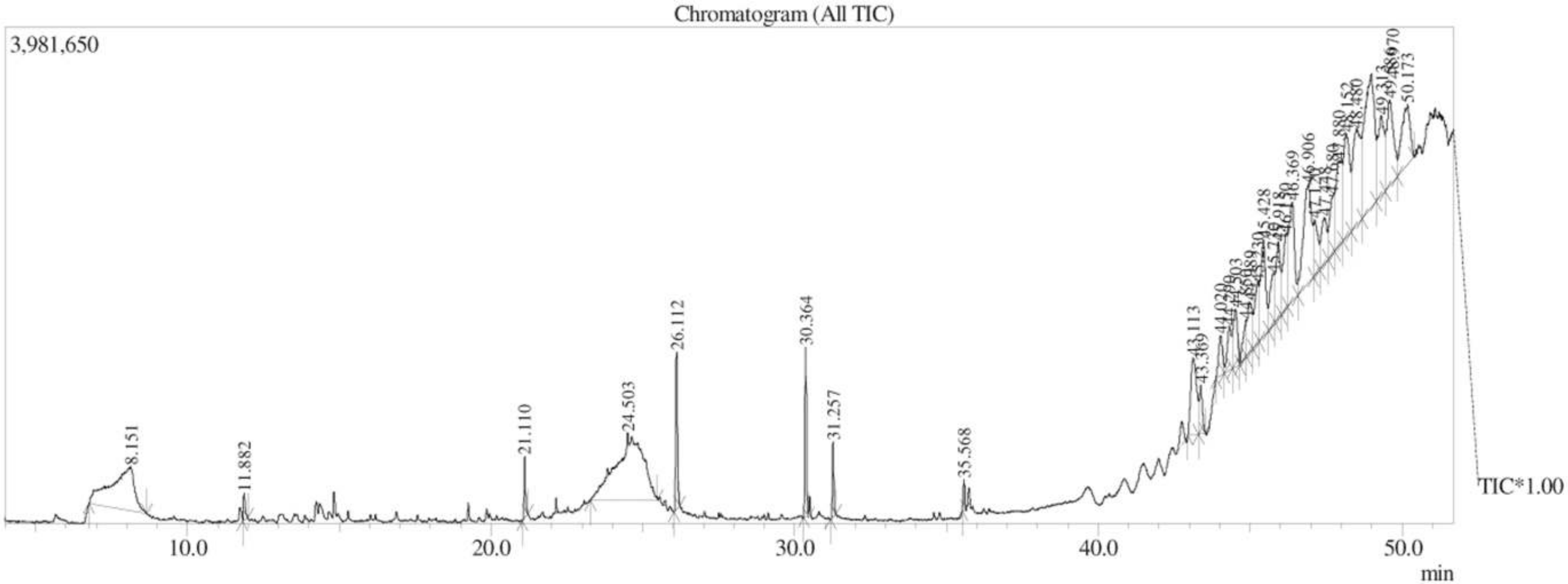

Fig. 49. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AAB) 'Pachanadan' fruit pulp.

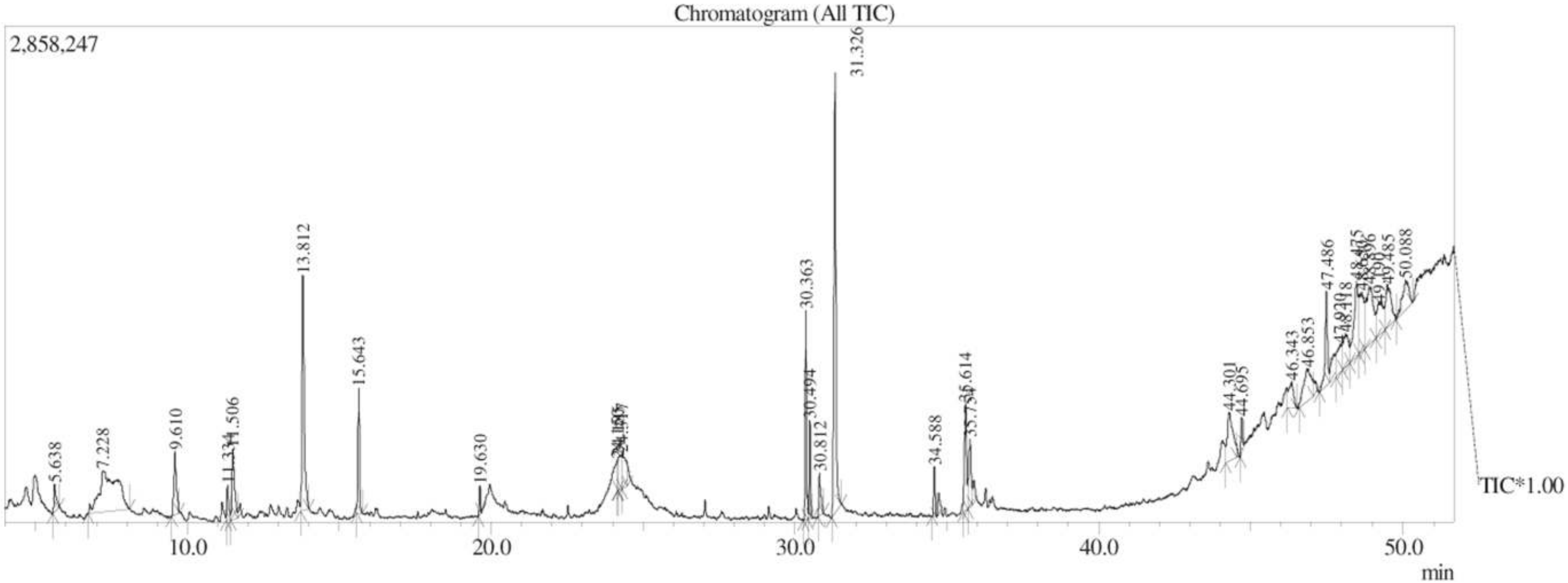

Fig. 50. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AAB) 'Poovan' fruit pulp.

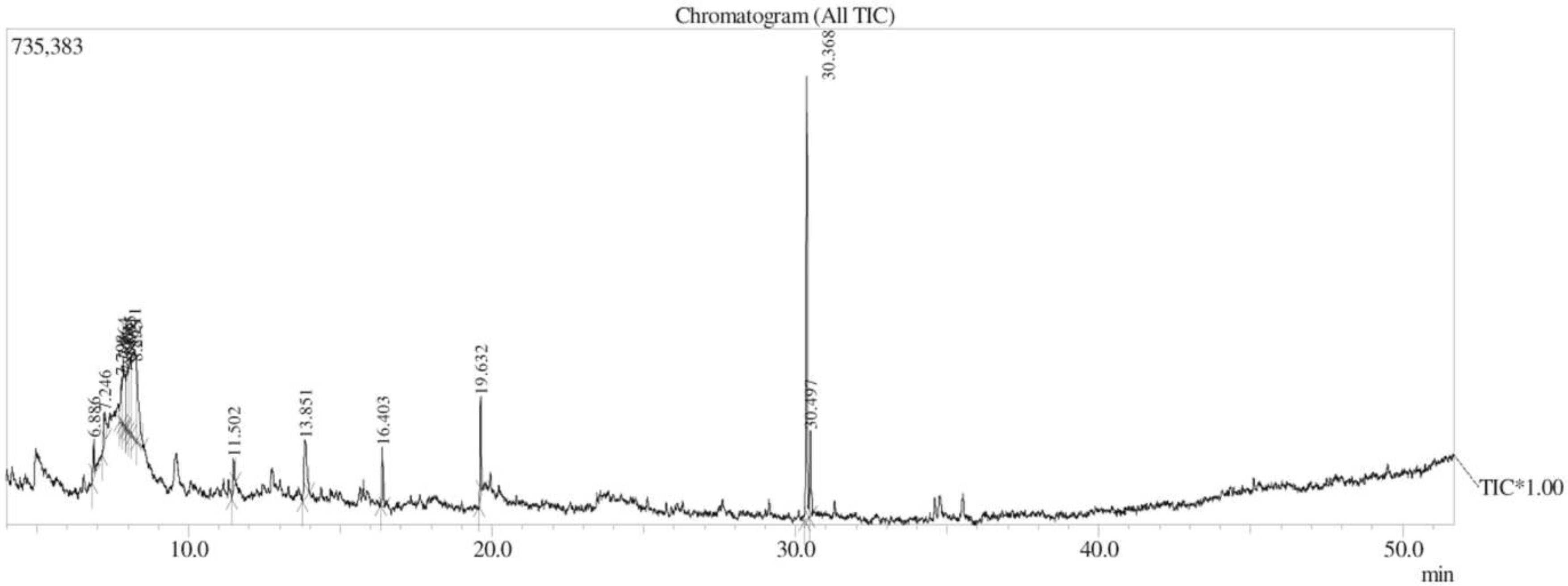

Fig. 51. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (AAB) ‘Sirumalai’ fruit pulp.

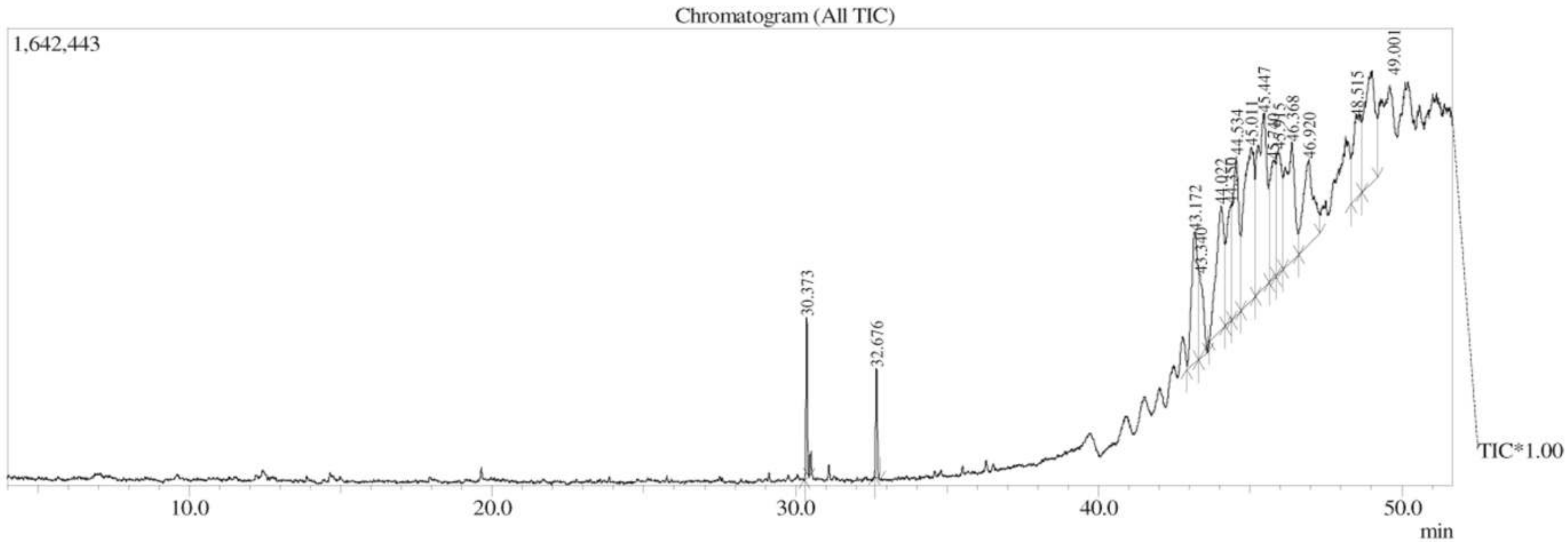

Fig. 52. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (ABB) 'Kachkol' fruit pulp.

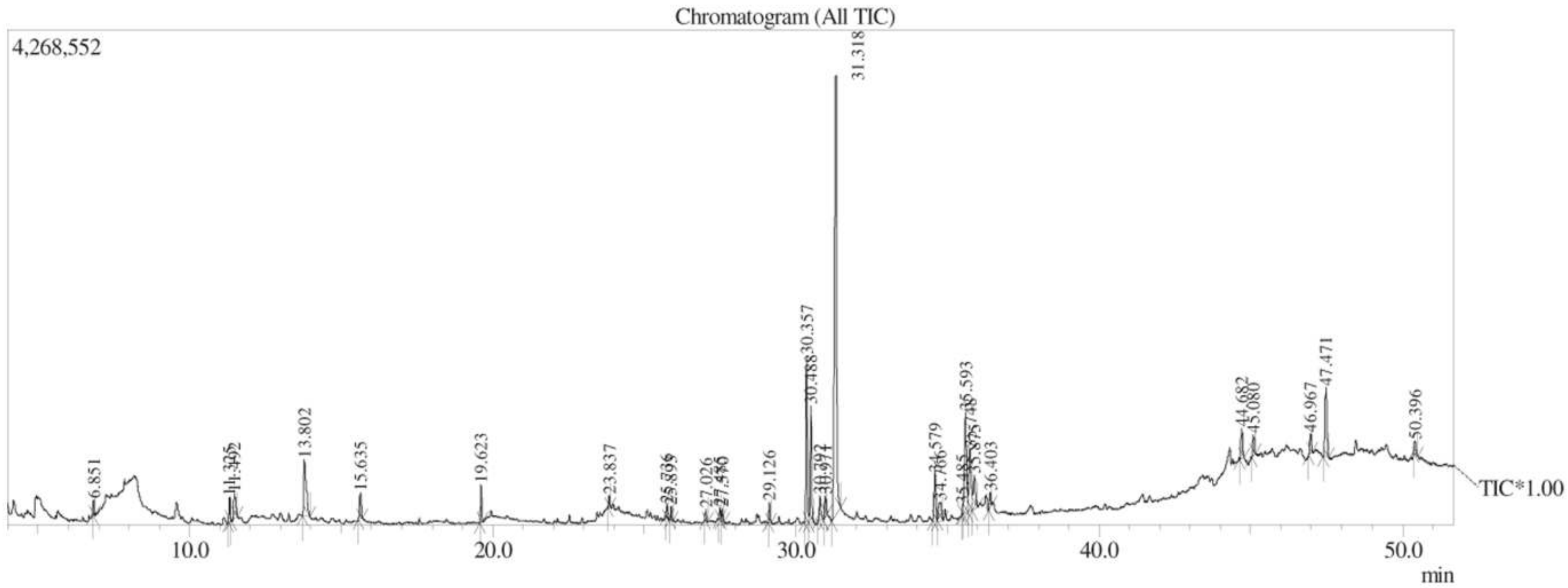

Fig. 53. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (ABB) 'Karpuravalli' fruit pulp.

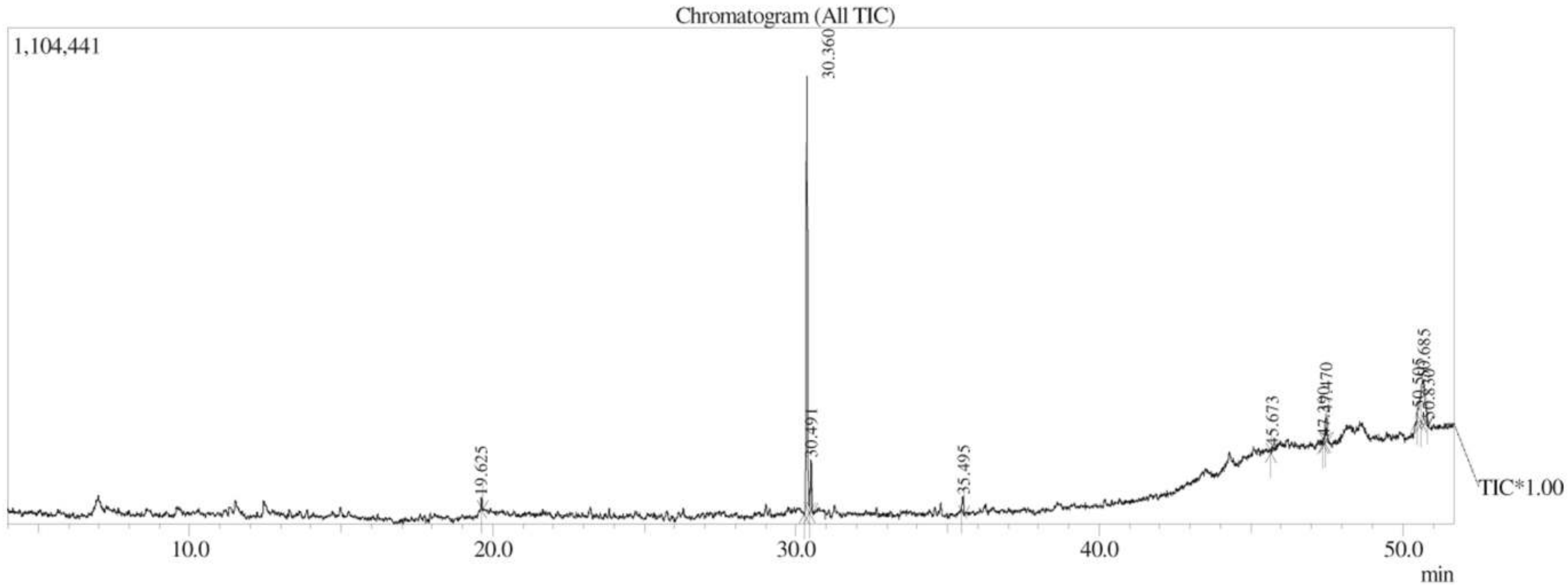

Fig. 54. Chromatogram of methanolic extract of *Musa* × *paradisiaca* (ABB) 'Monthan' fruit pulp.

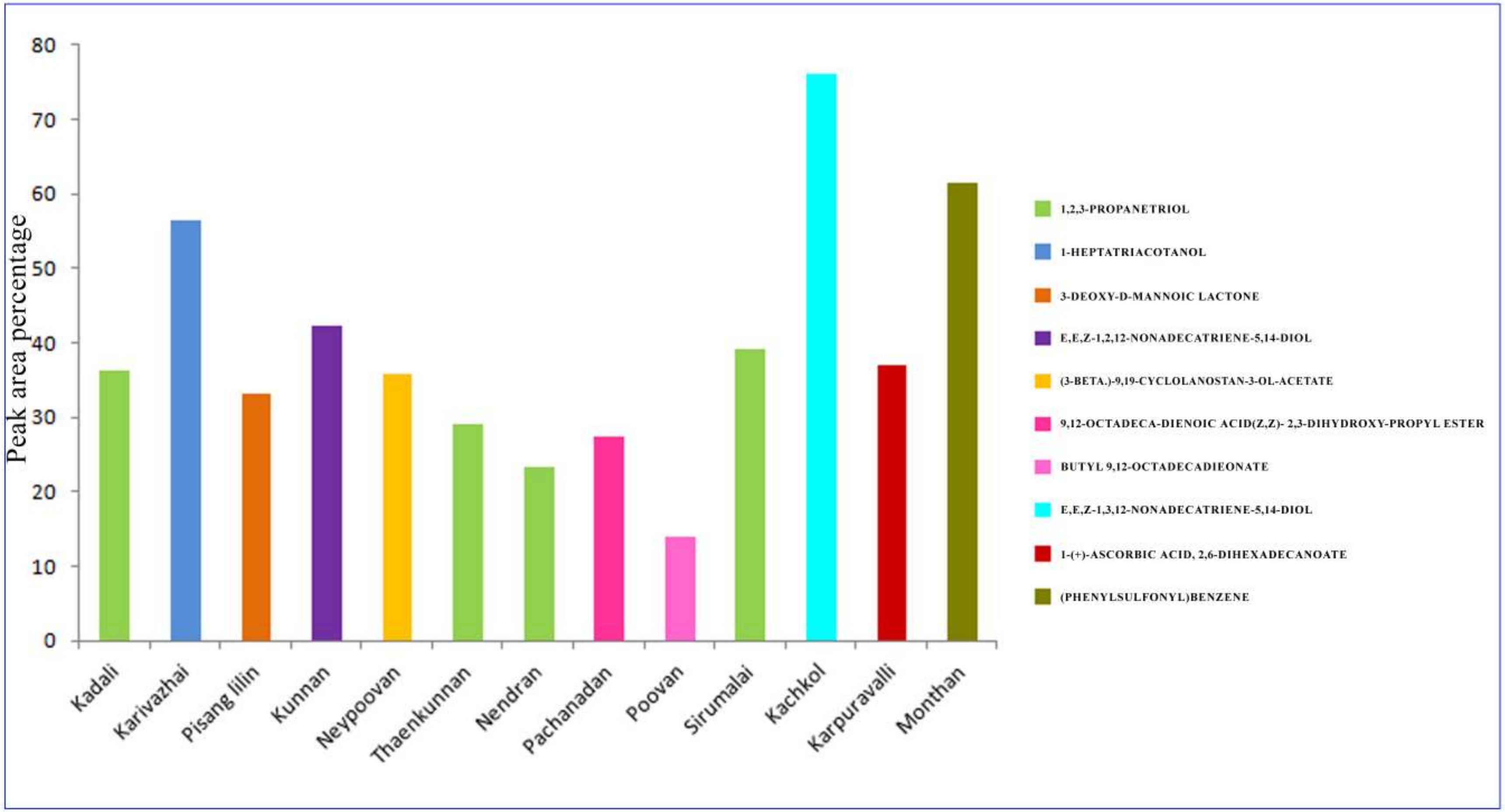

Fig. 55. Graphical representation showing the peak area percentage of major compound in the GC-MS profile of 13 *Musa* cultivars.

ANGIOSPERM TAXONOMY & FLORISTICS DIVISION
DEPARTMENT OF BOTANY
UNIVERSITY OF CALICUT
KERALA - 673 635

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