CHAPTER 29

RAMBUTAN

(*Nephelium lapspaceum*)

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CONTENTS

1. INTRODUCTION

Rambutan, the hairy litchi (*Nephelium lappaceum*) (Zee, 1993) is a medium sized evergreen tree growing up to 12-15 m height. It is native to the Malaysian-Indonesian region. Fruit resembles like litchi but because of long, thick, soft hairs or spines on its surface the synonymous name hairy litchi is ascertained (in Malay 'rambut' stands for hair). It produces ellipsoidal fruits in clusters of 15-20 fruits. The hairy outgrowth has red and yellow colours and it imparts an exotic appearance to its fruits (Chadha, 2003). They are grown generally for fruits in which the white, juicy, translucent, sub-acid – sweet flavoured aril is the edible. It can also be canned or made into jam but loses its flavor after heating. The aril of rambutan is very nutritive and rich in sugar, vitamin and mineral content as reported by Nath *et al*., (2009). The thin, leathery fruit skin is easily peeled away, revealing a pearly white, gelatinous, juicy pulp (aril) surrounding a large seed. The pulp tends to be attached to the seed in some varieties. In others, it can readily separate. Due to difference in latitudes and growing environment, sugar and vitamin C content of fruits and quality in terms flavour and taste is affected. The volatile compound of fruits of the

red-skinned cultivars of rambutan (cv. Jitlee, from sangapore), were extracted. The 20 most potent odourants included a –damascenone, (E)-4, 5-epoxy-(E)-2-decenal, vanillin (E)-2nonenal, phenylacetdice acid, cinnamicacid acid, unknown 1 (sweaty), ethayl 2-meathylbutyrate and delta-decalactone. On the basis of calculated odour activity values, B-damascenone, ethyl 2-methylbutyrate, 2, 6-nonadienal, (E)-2-nonenal and nonanal were determine to be the main contributor to the fruits aroma (Ong *et al*., 1998).

The aril of rambutan (per 100 g of edible potion) contain water 82% , protein 0.9 g, fat o.1g, carbohydrate 14.5 g, acid 0.3-1.5 g, fibre 1.1 g mineral: C a 3 mg, P 6 mg Fe 1.8 mg and vitamin A (carotene) 4 I.U, B_1 (thiamine) 0.4 mg B_2 (riboflavin) 0.05 mg , B_5 (niacin) 0.6 mg C (ascorbic acid) 31 mg. The above data shows that the nutritive value of rambutan is high in sugar (carbohydrate) and also high in vitamin C as well as Ca and P contain. The composition of edible portion of rambutan as described by Lam (1987) and it is mainly used as a fresh or a dessert mixture with other fruits or is used for canning or made into fruit syrup**.**

Table 1: Composition of rambutan fruits per 100 g edible portion

constituent	Content (g)	Constituent	Content (g)
Water	82.1	Niacin	0.5
Protein	0.9	Carotene	0
Fat	0.3	Phosphorus	0
Ash	0.3	Calcium	15
Glucose	2.8	Iron	0.1-2.5
Fructose	3.0	Vitamin C	70
Sucrose	9.9	Riboflavin	0.7
Starch	2.8	potassium	140
Dietary fibre	0.05	Sodium	2
Malic acid	0.31	Magnesium	10
Citric acid	297KJ	Thiamine	0.01
Energy			

Source: Lam (1987)

Rambutan is mostly used as fresh fruits or as desert mixed or is used for processed products like canning or fruits syrup. Peeled fruits canned in syrup can be store at the room temperature for 8-9 month (Ortiz and Corbero, 1984). Oil extracted from seed is used for soap industry. The amino acid profile of the seed protein indicated the superior quality of its protein (Augustin and Chua, 1988). The roots and leaves have certain medicinal values. Dyes can be prepared from the leaves (Johnson, 2013). De and Bhattacharjee (2008) reported that the root extract is used to treat fever and bark extract is for tongue diseases. The root decoction is administered against febrifuge and vermifuge. The whole tree has its aesthetic beauty owing to its beautiful leaves, flower and colorful

fruits and can be used in landscape. The pulp can be preserved in syrup or used in several conserves (Chadha, 2003). Boiled or roasted seeds are used to prepare a cocoa like beverage. Dried seed kernals are rich in fat and used in soap making.

2. DOMESTICATION

Natural distribution of rambutan is observed in humid tropical Southeast Asian countries. From these places rambutan was spread in different parts of the world. It was introduced in Mexico during 1950s (Fraire, 2001). During 1980s rambutan was brought in Northern territory of Australia (Lim and Diczbalis, 1998). In 1990, rambutan was first introduced into West Africa by the French, into Taiwan, china during 1915-1922 and into Hainan, china during 1950-1960. In 1987, it has been estimated about 10,000 rambutan tree in southern Hainan. The third place to have rambutan production in china is Xishangbana, a tropical area in Yunnan province (Bose *et al*., 2002). Chadha, (2003) also revealed that it is mainly confined in South-East Asia especially Indonesia, Malaysia and Thailand. In the recent past, the fruit has spread to other humid tropical regions of the world including India. De and Bhattacharjee (2008) reported that it is grown in Thailand, Malaysia, Indonesia, Phillipines, Australia, Sri Lanka, Vietnam, Hawaii, Central America and Africa. In India, it is cultivated in Nilgiris hills.

3. TAXONOMY

Rambutan (*Nephelium lappaceum*) belongs to the family soapberry family (sapindaceae) and order sapindales. The family Sapindaceae which includes fruit tree of about 37 genera and 72 species, but a few species are important. Twenty species of *Nephelium* are found in Malaysia out of which 10 species are reported to be endemic in this country. The endemic species of Malaysia are *N. aculeatum, N. compressum, N. costatum, N. daedaleum, N. hamulatum, N. havilandii, N. macrophyllum, N. meduseum, N. papillatum and N. reticulatum*. The most important economic species in the genus *Nephelium* is rambutan (*N. lappaceum*). However, pulasan (*N. ramboutan-ake*) and kalambuko (*N. cuspidatum*) are also cultivated for fruits in Malaysia. Some other species like *kalas* (*N. daedaleum*), *geringgong* (*N. laurinum*), *buah sungkit* (*N. maingayi*) and *mertapang* (*N. melanomiscum*) produce edible but sour fruits (Martin *et al.*, 1987).

4. CENTERS OF ORIGIN/CENTERS OF DIVERSITY

Rambutan is native to Malaysia and Indonesia. It is grown in entire Southeast Asia (The Philippines, Singapore, Thailand and Vietnam) (Laksmi *et al.*, 1987; Tindall, 1994). To some extent cultivation is also reported from India, Bangladesh (Alam *et al*., 2008), Australia (Lim and Diczbalis, 1998), South Africa (Tindall, 1994) and Mexico (Fraire, 2001.). The countries like Thailand and Malaysia are cultivated rambutan for export purpose. From Malaysia, the center of production, it spread westward to the countries,

such as Thailand, Myanmar, Sri lanka, India and eastward to Vietnam, Philippines, Indonesia and Hawaii.

5. OBJECTIVE OF IMPROVEMENT

The selection criteria of rambutan during any improvement prorgamme should consider some plant and fruit characters. These are as follows:

Table 2: Selection criteria of rambutan (Sarip, 2012; Landrigan *et al.*, 1996; Kader, 2009).

Plant part	Desirable characters
Tree characteristics	1. Dwarfness
	2. Offseason fruiting
	3. Heavy bearing
	4. Resistance to pests and diseases
	5. Precocity
	6. Ease of vegetative propagation
Fruit characters	1. Fruit weight (30g)
	2. Number of fruits per panicle
	3. Appearance of fruits (hairs < 1.00 cm)
	4. Detachable aril
	5. TSS (16-18 °Brix.)
	6. Aril recovery
	7. Aril texture

5.1. Major objectives of Rambutan improvement programme should be as follows

i. Development of high yielding cultivar having wider adaptability and suitable for processing purpose.

ii. Selection of promising types having large fruit size and more fruits per panicle.

iii. Development of red skinned cultivar having small and soft hairs, small seed with non-sticky aril.

6. CYTOGENETICS

Rambutan is a diploid species in the genus *Nephelium*. The chromosome number is reported as $2n = 2x = 22$.

7. INHERITANCE PATTERN

No attempt has been made to study the genetics of the crop or inheritance pattern of economically important traits. Hybridization programmes in Malaysia (MADRI), Australia and Mexico has been under progress. These centres could provide some valuable information regarding the inheritance pattern of this crop.

8. PROBLEMS OF BREEDING

i. The limited area of natural distribution indicates low genepool of this perennial fruit species.

ii. Some clones have viable (dehisceble) anthers in their hermaphrodite flowers. But, emasculation of anthers virtually damaged the minute flowers. Therefore, utmost care has to be taken during emasculation.

iii. Only 0.2-0.3% of the pollinated flowers develops into fruits (De and Bhattacharjee, 2008).

9. BOTANICAL DESCRIPTION

Rambutan is an evergreen tree and reaches about a height of 10 to 12 m. The leaves are pinnately compound without end-leaflet (Van Welzen *et al.*, 1988). On the lower surface of each leaflet some small crater-like hills (domatia) are located in the axils between the mid and secondary veins. However, the function of the domatia is unknown. Minute (less than 3 mm) greenish colour flowers are borne on terminal or axillary panicles. The male and hermaphrodite flowers are appeared in different trees (i.e., androdioecious) (Lim, 1984; Chin and Phoon, 1982). Flowering and fruiting starts 3-5 years after planting. The fruits are ovoid, usually covered with red colour pericarp and soft spine-like protuberances (spinterns) on fruit surface. Some clones also have distinct yellow colour pericarp. The colour of spines also varies from green, yellow and red (Nakasone and Paull, 1998). The edible part of fruit consists of white to translucent, sweet to sub-acidic juicy aril which clings to the testa of seed. Fruit weight ranges from 20-35 g. Fruits are mature during May-August depending upon genotypes and agro-ecological conditions.

10. FLORAL BIOLOGY

10.1. Flowering

Normally rambutan flowers once in a year. However, depending upon genotypes, soil and agro-climatic conditions flowering may be observed in two distinct seasons and it is a common phenomenon in Malay Peninsula (Lim, 1984). The first flowering season appears during April and second one in mid-August. Each flower opens acropetally approximately three weeks after emergence of the panicles. The flowering period lasts for about 2-3 weeks. The main flowering period in rambutan occurs during the dry season. The healthy

and well develop inflorescences on vigorous shoot show good fruit set and retention (Valmayor *et al*, 1970). Its inflorescence consists of a much branched panicle developing from terminal buds of the previous season's growth. Each panicle has numerous male, female and hermaphrodite flowers. After insect pollination of the last two kinds of flowers, fruit set is occurred.

10.2. Flower

Flowers are apetalus greenish white in colour with about 2 mm diameter. The calyx has four to six pubescent lobes. The male flower with hairy filaments has five to seven stamens which arise from the disc between the lobes of the nectarines. Each stamen has a whitish to mentose filament with a yellowish bilobed anther. The anther lobes split along a longitudinal line to release large amount of pollen. At a center of the male flower, the abortive ovary is present which is highly pubescent and not able to produce fruits. The gynoecium in this type of flower is small and rudimentary. While in hermaphrodite flowers, the ovary is well developed (2-3 locules) and flowers have 6-7 undehiscent anthers. Thus bisexual flowers act as functionally female flower. However, some hermaphrodite trees of some clones are able to produce functionally male flower with viable pollens. Nevertheless this clones exhibited a low level of self-pollination (Sarip, 2012). Therefore, emasculation of flowers during breeding programmes is not necessary.

Trees are dioecious; flowers are hermaphrodite, protandry or protogyny hinders self pollination. Chin and Phoon (1982) reported that rambutan is an androdioecious with separate male and hermaphrodite tree. The male is seldom found since now a day rambutan is usually rise by the vegetative propagated sampling from male mother plant. The hermaphrodite tree is obtained referred to as the female because it bears fruits. The hermaphrodite flower has six to seven stamens but the anther does not dehisce to release the well-developed pollen grain inside. Functionally, it serves as a female flower. The ovary is two or three –lobed and bears a bifid or trifid stigma. The outer surface of the ovary and stigma are pubescent while the stigma surface is highly papillose. The pollen grain is sticky and barrel- shaped. The exine is finely patterned with minute fusiform depression.

10.3. Anthesis

The anthesis of flowers occurs at 09.00 hr-11.00hr. The anthesis in male flower is indicated by parting of the calyx whereas, in hermaphrodite flowers indicated by the recurving of the bifid-trifid stigma. The stigma comes under receptive condition at the time of anthesis and remains so for a day after anthesis. The greenish white stigma become receptive at anthesis and remains far a day after which it turns brown (Nath *et al*., 2009). Anther dehiscence in the male flower begins at about 08: 30 hours onwards (Chin and Phoon, 1982). Pollination is entomophillus and carried out by *Trigona spp*., *Apis spp*., *Companatus spp*. and *Scolia spp*. mainly between 9.00 am to 10.00 am. (Sarip *et al*., 1996).

10.4. Fruit

Fruit is single seeded nut and edible part is aril.

11. IMPROVEMENT IN FLOWERING AND FRUIT SETTING

Subhrabandhu and Shoda (1997) reported that spray of thiourea (500mg/L) and hydrogen cyanamide (550 and 1500mg/L) showed significant effect on inducing flower emergence in rambutan cv. Rougrien, while potassium nitrate had no effect. Nath *et al*., (2009) found that the application of NAA at panicle emergence stage has been found to improve male flower in Thailand which enhance pollination process.

12. DIFFERENT SPECIES

Twenty two *Nephelium* species have been recorded, including in Myanmar, Thailand and Indo- China, 13 in peninsular Malaysia, 16 in Borneo, four in the Philippines, and three in western Java (Tindall, 1994). The other *Nephelium* species other than rambutan are *Nephelium chryseum*, mountain rambutan growing wild; *Nephelium topengii*, Hainan rambutan growing wild locally in Hainan*; Nephelium malaiense*, the Malay longan; *Nephelium obovatum* , the vin longan; *Nephelium bassocense*; *Nephelium eriopetalum; Nephelium glabruam, Nephelium hypoleucum* , the white under- leaf rambutam of Thailand; *Nephelium rimosum; Nephelium xerospermoides*.

The other popular edible *Nephelium* species

***N. ramboutan-ake* (Labill.) Leenh.:** (Pulasan) The botanical synonym is *N. mutabile* Blume. The fruits are opened through twisting of two hands together. The common name pulasan was derived from Malay word *"Pulas"* meaning "twist". The edible part is aril and the fruit surface has short spiny projections. The peel colour is red.

***N. cuspidatum* Blume:** (Kalambuko) The botanical synonym is *N. robustum* Radlk. It is relatively large tree than rambutan. This species is native to Burma, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (throughout the island) and The Philippines.

13. CROP IMPROVEMENT METHODS

13.1. Introduction

The introduction of rambutan varieties throughout world has been carried out from Southeast Asia. It was introduced in Hawaii. Mexico has introduced rambutan during 1950s (Fraire, 2001). At least 50 introduced varieties of rambutan have been grown in Australia (Lim and Diczbalis, 1998).

13.2. Selection

Rambutan is a cross-pollinated crop and therefore large genetic variation has occurred in nature. Most of them can be distinguished by spine length, fruit wall colour, aril thickness, aroma, adherence of aril to the seed, vitamin C content and fruit set. Most of the commercial cultivars of rambutan are developed through selections from seedling populations grown in different agro-ecological situations in Southeastern countries and Mexico. Attempt has been made in Mexico to screen out superior export quality rambutan varieties from some Asiatic cultivars. The genotypes RT-01 and RT-05 exhibited the best attributes of fruit weight, total soluble solids and titratable acidity, desirable traits for export fruit. While the selections RT-01, RT-03 and RT-05 showed excellent fruit qualities (Fraire, 2001). In India, two popular rambutan varieties have been selected at Central Horticultural Experiment Station (CHES; IIHR), Chettalli, Coorg, Karnataka, India. They are named as Arka Coorg Arun and Arka Coorg Patib (http://www.iihr.res.in/content/new-rambutan-varieties-identified).

Rongrein and Chompu are most popular varieties in Thailand. Bingjai, Lebak Bulus and Rapiah are important varieties of Indonesia, which have sweet, sub-acid and very sweet pulp respectively (Chadha, 2003). R-3, R-134, R-156, R-167, Binjai, Jitlee, Rongrien, Seematjan, Rohng-Rian, Boting Rambutan No.1 are the important varieties of rambutan as reported by De and Bhattacharjee, (2008). Nath *et al.*, (2009) further reported that out of the wide genepool in the variability region, some important cultivars of rambutan have been developed. There are many cultivars of rambutan in the South East Asian tropical region where rambutan is popularly grown.

13.3. Hybridization

The world's first rambutan breeding programme was started in Malaysia during 1981. In order to achieve the goals, as many as 16 popular rambutan cultivars (R 3, R4, R7, R9, R99, R 134, R 137, R 139, R 153, R 156, R 157, R 160, R 161, R 162, R 168 and R 170) have been planted at MADRI Research Station, Bukit Ridan in 1991. Two plants *viz*. R 99 and R 134 were selected from the above population as a parental line. Huge variations in respect of size, TSS, fruit weight and percent flesh recovery have been identified in F_1 hybrids resulted between the cross of above two the maternal plants (Sarip, 1998; Sarip, 2012). Intergeneric hybridization between rambutan and longan was failed (Tindall, 2010). However, seedless pulasan (*N. mutabile*) varieties could be used to develop new types of rambutan. The hybrids between *N. mutabile* and rambutan (*Nephelium lappaceum*) could also be used as a source of resistant rootstocks of rambutan.

13.4. Biotechnology

13.4.1. *Micropropagation*

An efficient micropropagation protocol was developed for *in vitro* storage and cryopreservation through shoot tips of *Nephelium lappaceum* Linn. Woody plant medium supplemented with activated charcoal and 1.00 ppm GA_3 was found to be best for survival of shoot tips, elongation and less browning of medium (Chew *et al*., 2008).

13.4.2. *Molecular Markers*

Randomly amplified polymorphic DNA (RAPD) markers were successfully employed to reveal genetic diversity and genetic relatedness among 211 rambutan accessions planted at the MARDI-IPGRI rambutan field genebank, Kemaman, Terengganu, Malaysia (Chew *et al*., 2005). Morphological and molecular characterization of several rambutan collections has been carried out by fAFLP molecular in Brazil (Andrade *et al*., 2011). In Malaysia, PCR-ISSR method was used to study the applicability of ISSR markers in determining the male parent for selected F_1 progenies derived from hybridization programmes. The assessment of genetic diversity through ISSR markers were also carried out in Malaysia (Sarip, 2012).

Aradhya *et al.* (1996) evaluated sixty four accessions involving 6 taxa (4 species and 2 taxonomic varieties) of Nephelium were fingerprinted, classified and evaluated for intraspecifc genetic diversity using isoenzyme polymorphism. Multivariate analyses of the isoenzyme data revealed 5 district clusters representing the 5 taxa including the study. Isoenzyme data suggest that *N. hypoleucum* is the closest relative of *N. lappaceum* var. *lappaceum*. Interestingly, the N. *lappaceum* var. *pallens* exhibits closer association with *N. rambutan* – ake (*N.mutabile*) than its sipling taxon *N. lappaceum* var. *lappaceum*. The isoenzyme result dispute the taxonomic relationship in Nephelium.

Imelda *et al*. (1999) reported that the cultured anthers from 6 plant type at the uninucleate stage of microspore development in MS and Nitsch & Nitsch (NN) media with 2,4-D, NAA and kinetin added at various concentration. Only anthers from functional male Binjai and Babat plant produces callus and only on NN medium with NAA or 2, 4-D and kinetin. The callus produce was compact. Kinetin was needed for callus formation, but at concentration above 1 mg / L provide inhibitory. De and Bhattacharjee (2008) also reported that tissue culture protocol is available to raise plantlet using vegetative tissue of mature plants.

14. DIFFERENT CULTIVARS

14.1. Seematjan

It is the common cultivar grown in the tropics. The tree has an open crown with long, spreading branches. The fruits at full ripe stage became dark red in colour with soft and curved spines (2cm in length) covering the whole rind. This cultivar has two strains, *i.e.* 'Besar' with its more juicy and sweeter aril firmly adhered to the seed coat and 'Koombang' with smaller fruits having thinner rind and sparsely arranged spines. Its aril is rather soft but less sweet than the Besar.

14.2. Lebakbulus

This cultivar is grown in Indonesia. Fruit size is large and round in shape. This is considered one of the best cultivar having characteristics of good blend sugar and acid in the aril.

The aril does not cling to the seed. The tree is large with a broad crown. The fruits is also dark red with shorter spines (1.5 cm in length) widely spaced on the rind. The whitish aril, 0.5 cm thick, adheres firmly to the seed coat.

14.3. Seenjonja

The tree is small and dwarf. The ovoid fruits are dark red, 4 cm long and 3 cm wide. The aril adheres firmly to the seed. The rind is covered by fine spines measuring about 1 cm long.

14.4. Seelengkeng

It is small dwarf tree. The fruits are small, 3 cm long and 2 cm in diameter and the rind is covered by fine, soft spines. The tough aril tastes sweeter and more like that of litchi.

14.5. Seetangkooweh

It is large tree with a broad crown. The fruits are ovoid but laterally compressed, 5 cm long and 4 cm wide with a thinner rind and short and fine spine (1 cm long). The yellowish white sweet aril adheres firmly to the seed- coat

14.6. Seekonto

The is large and has a broad crown, growing very fast. The fruits are big, ovoid in shape, 5 cm long, 4 cm in diameter with coarser and shorter spines. The aril adhering to the seed –coat comes of easily and tastes rather dry, coarse and sub-acide sweet.

14.7. Rogaine

It is the most popular cultivar of Thailand. The tree is of medium size. The fruits is bright red and ovate in shape; red spines. The aril is juicy and tough in texture, sweet, easily separates from seed.

14.8. See-chompoo

It is popular variety of Thailand. The tree is of medium size with a broad crown. It has smaller seed and thicker aril compared with cv.Rorgrien, the white aril is juicy, sweet and tough in texture. The aril is easily detached from seed. It is a mutant cultivar of rambutan from “Bangyeekhan”. The fruits are globose (28-35 g). The pericarp is pink to red and aril possesses a good flavour.

14.9. B-R-1 (Boting-Rambutan NO.1)

It is a new cultivar selected in Hainan, china. The tree is large , with profuse long branches forming a broad crown. The red fruit is big and ovate in shape, each weighing 30.2g on an average. There are about 350-461 spines (fine and dense). The seed is small, aril thick, juicy, crisp and sweet with 18.2-217^{o} Brix TSS.

14.10. B-R-2

Promising cultivar selected in Hainan, from plant introduce from south east Asia into china in 1960. The tree is medium size with comparatively fewer branches. The yellowish red fruit is round in shape with short fine spines covering the thin rind. The seed is small and white aril is thick with higher vitamin C content. The fruits quality is very good, tasting sweet, juicy and crisp but it lacks good keeping quality.

14.11. Arka Coorg Arun

The tree is semi-spreading with early maturing abilities. Flowering occurs during February-March. Skin colour of the fruits is dark red. Ripening of fruits takes place during September-October. Average fruit weight is 40-45 g. The aril is white, firm, sweet and not attached with testa. Yield : 750-1000 fruits/tree.

14.12. Arka Coorg Patib

This is also a high yielding semi spreading type cultivar. This selection can be classified as mid-season variety. Flowering occurs during February-March. The skin colour of fruits is yellow. Fruits can be harvested during October. The fruits are smaller (25-30 g) than Arka Coorg Arun. The aril is juicy, sweet and white in colour. Yield: 1200-1500 fruits/tree.

14.13. Rong Rien

This is probably the best rambutan cultivar grown in Thailand. It was developed through a seedling selection from the introduced Malaysian cultivars. Fruits are oval (40-50 g) in shape. Fruit bunch consists of 10-13 fruits. The skin colour is red. Aril is sweet with a good flavor.

14.14. Bangyeekhan

It is also cultivated in Thailand. The fruits are large in size but flat-elongated in shape. The short small spineterns are red or yellow at base, but remaining green at tip during maturity. The aril is strongly attached with the seed.

14.15. Binjai

It is also grown in Indonesia. It is a large sized cultivar. Fruits are oval in shape. The skin is deep red when ripe. The aril is crunchy and have good flavor.

14.16. Rapiah

Fruits are small to medium sized. The skin is very hard with short spineterns. During ripening fruit becomes an uneven, green, yellow or red colour. Aril can be easily separated from seeds.

14.17. Peng Th'ng Cheng

It is an important cultivar of Malaysia. The tree is vigourous. Fruits are medium in size (22-33 g). The pericarp is thick and red in colour. The aril is sweet.

14.18. Kaw Tow

It is grown in Malaysia. The fruits are medium in size (32-37 g). The colour of aril is scarlet during ripening. The aril is sweet, juicy but adhering with the seed. The number of fruits per bunch varies from 6-22.

14.19. Lee Long

This cultivar is also grown in Malaysia. The average fruit weight is 34-36 g. Fruits are elongated in shape. The ripe fruits are orange to red in colour. The edible portion consists of almost 50 percent of fruit. The aril is firm, crispy and sweet but clings to the seed.

Characteristics of some important cultivars or selection of Rambutan has been presented in Table 2.

Table 2: Characteristic features of rambutan cultivars grown in south- eastern Asia

Cultivars or selection	Shape, fruit size	Colour of skin	Aril texture, crunchiness
Bangyeekhan	Large oval	Red	Above average
Binjai	Large oval	Red	Above average
Jitlee	Medium	Red	Above average
Lebakbakbulus	Large oval	Reddish orange	Average
Maharlika	Large	Red	Above average
Rapiah	Medium round	Greenish yellow	Above average
Rongrien	Large	Red	Above average
R3(Gula Batu)	Medium round	Red	Above average
R 134	Medium round	Red	Above average
R156(Muar gading)	Large	Round yellow	Average
R160 (Khaw Tow Bak)	Medium round	Red	Average
R161(Lee long)	Large oval	Red	Average
R162 (Daun Hijau)	Large oval	Orange – red	Above average
R163	Large oval	Yellow	Average
R170 (Deli Cheng0	Large oval	Red	Average
Seechompoo	Large	Pinkish red	Above average
Seenjonja	Small	Red	Average
Simacan (Indonesia)	Large round	Red	Average

Source: Aradhya *et al.* (1996)

15. FUTURE RESEARCH NEEDS

Though Rambutan is minor fruit crop in India but it occupies a good position in South-East Asian countries. There is an urgent need of research in this important crop on the following aspects:

i. Collection, conservation and evaluation of different cultivars suitable for different agro-climatic zones of India.

ii. The pollen of both litchi and longan though germinate on the stigma of rambutan but further developments are arrested in the embryo sac. Therefore, development of protocol for embryo-rescue technique for production of Rambutan hybrid with desirable traits would be important objective in future improvement programme.

iii. Standardization of agro-techniques for higher yield.

iv. Development of various value added products for utilization of surplus produce.

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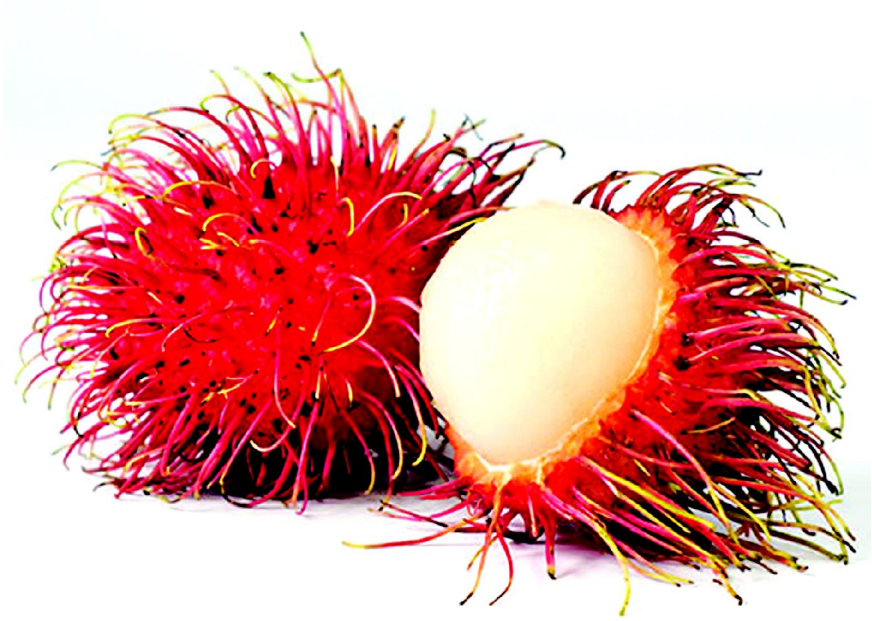
RAMBUTAN (*Nephelium lappaceum*)



Rambutan-Fruit

Rambutan bunchf