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IDENTIFICATION AND DESCRIPTION OF INDIGENOUS MANGO (*MANGIFERA INDICA* L.) CULTIVARS OF COASTAL DISTRICTS IN ANDHRA PRADESH, INDIA BY MORPHOLOGICAL, BIOCHEMICAL AND MOLECULAR MARKERS

A. Himabindu[1]*, D. Srihari[2], M. Rajasekhar[2], V. Sudhavani[2], P. Subbarammamma[2] and K. Uma Krishna[2]

[1]College of Horticulture, Seetharampuram, Parvathipuram,
Manyam (Dist.) - 535 502, Dr. Y.S.R. Horticultural University, Andhra Pradesh, India.
[2]Horticultural Research Station, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari - 534 101, A.P., India.
*Corresponding author E-mail : himabindu291188@gmail.com
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ABSTRACT

Mango (*Mangifera indica*), one of the most significant tropical fruits, presents a remarkable diversity in its cultivars, each exhibiting unique morphological, biochemical and molecular properties. Characterization of mango cultivars has been successfully used for selection of improved cultivars for breeding programs. The study was conducted at Horticultural research station, Venkataramannagudem for evaluating the variability of mango cultivars to conserve the elite ones and to identify the superior genotypes based on fruit characters for future crop improvement. Thirty four mango cultivars were characterized using morphological, biochemical and molecular fruit characters to know the genetic diversity in mango. The morphological characteristics, including fruit shape, shape of fruit apex, depth of fruit stalk cavity, fruit sinus type, fruit skin surface texture, slope of fruit ventral shoulder, fruit beak type, skin color of ripe fruit, pulp color of ripe fruit, quantity of fiber in pulp, quantity of fiber on stone, veins on stone, pattern of stone venation and embryo shape were evaluated noting that these attributes significantly influence consumer appeal and marketability. The biochemical analysis focused on total soluble solids, titratable acidity, total sugars, reducing sugars, non-reducing sugars, ascorbic acid, β- carotene and total phenols were analyzed. Molecular characterization using RAPD and SSR primers were carried out and cultivar specific fragments were amplified. In response, the potential of breeding programmes and genetic modification efforts in developing improved traits were discussed. The future research directions were mapped, emphasizing the exploration of underutilized indigenous cultivars to broaden the genetic base of mango cultivars.

Key words : Characterization, Mango, Molecular, Morphological, Biochemical.

Introduction

Mango (*Mangifera indica* L.) is an important member of the family Anacardiaceae in the order Sapindales and is the most important fruit crop in India having a great cultural, socio-economic and religious significance since ancient times. It is said to be originated in the Indo-Burma (Myanmar) region (De-Candolle, 1904). By virtue of its excellent flavor, delicious taste, attractive color, delicious fruit quality with richness in vitamins and minerals, accessibility to common man, liking by the masses, mango has been assigned the status of the 'King of the fruits' in the tropical world and it is the 'National Fruit of India'. In India mango ranks first in terms of area with 2.25 million ha, first in respect of production with 21.82 million tonnes and with a productivity of 9.7 million tones /ha, while Andhra Pradesh ranks first in terms of area with 0.36 million ha, second in respect to production of 4.37 million tonnes and with a productivity of 12.05 million tones/ha (NHB, 2021). Andhra Pradesh is considered as a center of diversity for mango with a rich diversity of named local cultivars and unnamed local land races. Mango is considered to

be an allopolyploid, most probably amphidiploid and out breeding species having chromosome number 2n=40 (Mukherjee, 1950). It is highly heterozygous as performance varies with the climate which resulted in a high level of genetic diversity. Further, confusion exists in the nomenclature of mangoes due to different local names for the same variety. Knowledge of the magnitude of genetic variation among the land races of fruit characteristics is important for development of new varieties of mango with improved quality is the engine of market demand. As fruit is the most important classification and portrayal character, the objective of the study was to evaluate morphological, biochemical and molecular fruit characters of mango cultivars and to isolate and identify the superior genotypes for future breeding programmes.

Materials and Methods

The present study was conducted to evaluate the performance of mango cultivars of coastal districts in Andhra Pradesh at Horticultural Research Station, Venkataramannagudem. A well-planned germplasm collection survey based on diversity richness was conducted in coastal districts of Andhra Pradesh, which includes Horticultural Research Station and private owned mango orchards. Random sampling strategy was followed for collection of samples. Three plants in each cultivar were taken as sample size. The experimental material consists of 34 indigenous mango cultivars and variants within them obtained from the coastal districts of Andhra Pradesh. Five fruits of each cultivar were taken per replication for evaluating fruit morphological and biochemical characters. All the morphological observations like fruit shape, fruit apex, depth of fruit stalk cavity, fruit sinus, skin color of fruit, surface texture, slope of shoulders, fruit beak, fruit attractiveness, pulp color, quantity of fiber in pulp, pattern of stone venation, veins on stone, quantity of fiber on stone and embryo shape etc., were taken as per the IPGRI descriptor for mango (IPGRI, 2006).

Longitudinal slices of fruit pulp were used to extract juice with the help of standard commercial juicer. The juice was extracted from each sample and homogenized to study the biochemical parameters like total soluble solids and β-carotene. The data recorded on fruit biochemical characters of mango were subjected to statistical analysis.

To carry out RAPD and SSR analysis, leaves from each of the 34 germplasm were collected randomly. Total genomic DNA was extracted by using the modified CTAB (Cetyl Trimethyl Ammonium Bromide) method (Murray and Thompson, 1980). Finally, the DNA samples were stored at -20ºC. The concentration and quality of DNA were estimated by using NanoDrop spectrophotometer at 260 nm and verified by running a sample on 0.8 percent agarose gel. DNA amplification was done using fifteen RAPD arbitrary decamer primers (Operon Technologies, Inc., Alameda, California, USA OPA-02,03,05,10,18,20, OPB-18, OPG-02,03,10, 11,13 and OPX-04,06,12) adopting the procedure of Williams *et al*. (1990) with some modifications. Twenty SSR primers SSR-8, SSR-15, SSR-16, SSR-20, SSR-39, SSR-46, SSR-52, SSR-61, SSR-82, MiIIHR- 13, MiIIHR- 15, MiIIHR-17, MiIIHR-18, MiIIHR-19, MiIIHR- 23, MiIIHR-24, MiIIHR-30, MiIIHR-31, MngSSR-14 and MngSSR-24 were used for amplification. PCR reactions were performed on each DNA sample in an oil-free thermal cycler (Thermal Cycler, Eppendorf). The amplified products were separated electrophoretically and the scores obtained using all the primers were then pooled to create a single data matrix and used to construct a UPGMA (Unweighted Pair Group Method of Arithmetic Means) dendrogram among germplasm using a computer program, the NTSYS-pc software package version 2.02 (Rohlf, 2000). The primary objective of studying the morphological, biochemical and molecular fruit characters of mango cultivars is to explore and compare the various mango cultivars for selection of improved cultivars in breeding programs.

Results and Discussion

The present study revealed that morphological characters are useful tools for identifying assorted mango germplasm. Fruit shape was identified as key distinguishing morphological marker. The cultivars Chinna Suvarnarekha, Suvarnarekha and Banglora-2 could be used as source for red skin color in breeding programmes (Table 1), as the external appearance could get special advantage in fresh fruit market, especially in export trade. The results were in accordance with Simi (2006) in mango.

Results from the experiment reviled that, significant variation related to fruit TSS was observed among mango cultivars and it was varied from 15.58 to 25.44ºBrix (Table 1). The cultivars having TSS 20ºBrix or even more, which is a desirable character, and they had less acidity and high sugar: acid ratio can be used as good donors in future hybridization programme to evolve superior varieties and hybrids. It was stated that smaller sized mango fruits recorded higher ascorbic acid content than larger sized fruits (Rathor, 2005). Fruit carotenoid is one of the most important parameters attributing yellow to orange color

Table 1 : Characterization of mango cultivars using morphological, biochemical and molecular markers.

S. no.	Name of the cultivar	Morphological markers	Biochemical Markers	Molecular Markers
1	Banganapalli -1(Syn: Chapta, Safeda, Baneshan)	Fruit large (450.86 g), roundish, dotted on surface, ventral shoulder rising and then rounded, obtuse apex, beak is perceptible, sinus shallow with yellow skin color. Pulp golden yellow and fibreless. Stone venation is forked and in level with surface with reniform embryo shape.	Fruit quality excellent with sweet taste (TSS 21.27°Brix), highest reducing sugars (6.44%), maximum TSS: acid ratio of 155.95 and β-carotene content (1670.15 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPX 06 at 600 bp.
2	Banganapalli -2	Fruit is large (452.23 g), roundish, smooth, ventral shoulder rising and then rounded, obtuse apex; beak is perceptible, sinus shallow with yellow skin color. Pulp light yellow and fibreless. Stone venation is parallel and in level with surface with reniform embryo shape.	Fruit quality excellent with TSS of 17.15°Brix and β-carotene content (916.83 µg/100g).	Banganapalli-2 was closely related to Banganapalli-1 and formed a sub cluster in RAPD and SSR primers and also in combined dendrogram.
3	Banganapalli -3	Fruit is light (228.63 g) in weight, roundish, ventral shoulder rising and then rounded, obtuse apex, beak is perceptible, sinus shallow with yellow skin color. Pulp golden yellow and fibreless. Stone venation is parallel and in level with surface with reniform embryo shape.	Fruit quality excellent with sweet taste (TSS 20.36°Brix) and β-carotene content (1006.44 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPX 04 at 1500 bp.
4	Banglora -1(Syn: Totapuri, Collector, Kallamai, Selam, Sundersha, Thevadiyamuthi, Burmodilla, Killi Mukku, Gilli Mukka Kili Chundan)	Fruit is heavy (723.98 g) in weight, oblong shape, ventral shoulder sloping abruptly, obtuse apex, beak pointed, deep sinus with greenish yellow skin color. Pulp yellow orange with low fiber. Stone venation is parallel and elevated than surface with oblong embryo shape.	Fruit quality excellent with TSS of 16.61°Brix and β-carotene content (1217.51 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPG 11 at 730bp and with SSR primer MiIIHR 24 at 260bp.
5	Banglora -2	Fruit is light (131.43 g) in weight, oblong shape, ventral shoulder sloping abruptly, obtuse apex, beak pointed, sinus shallow with green with red blush color. Pulp light yellow with low fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 15.69°Brix and β-carotene content (752.05 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 02 at 200bp and OPB 18 with 1000bp.
6	Baramasi	Fruit is light (231.87 g) in weight, roundish, ventral shoulder ending in a long curve, obtuse apex, beak perceptible, sinus shallow with greenish yellow skin color. Pulp light yellow with high quantity of fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 21.04 °Brix, highest ascorbic acid content of (88.40%), titrable acidity of 0.73% and β-carotene content (703.24 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPB 18 at 200bp.

Table 1 continued...

Table 1 continued...

7	Cherukurasam	Fruit medium (382.42 g), oblong shape, ventral shoulder ending in a long curve, obtuse apex, beak perceptible, sinus absent with golden yellow skin color. Pulp yellow orange with low fiber. Stone venation is parallel and elevated than surface with reniform embryo shape.	Fruit quality excellent with highest TSS of 25.44°Brix and total sugars (21.51%) and β-carotene content (1307.79 µg/100g).	Cherukurasam was closely related to Banglora-1 in RAPD and combined RAPD and SSR dendrogram.
8	Chinnarasam	Fruit medium (361.48 g), oblong shape, ventral shoulder rising and then rounded, obtuse apex, beak perceptible, sinus shallow with greenish yellow skin color. Pulp dark orange with low fiber. Stone venation is parallel and depressed than surface with reniform embryo shape.	Fruit quality excellent with TSS of 17.88°Brix and maximum β-carotene content (1679.89 µg/100g).	Cultivar specific fragment was amplified with SSR primer MiIIHR 31 at 200bp.
9	Chinna Suvarnarekha	Fruit is light (221.53 g) in weight, oblong shape, ventral shoulder ending in long curve, obtuse apex, beak prominent, deep sinus and skin color is green with red blush. Pulp light yellow and fibreless. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 16.33°Brix and β-carotene content (765.85 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 03 at 500bp.
10	Elamandala	Fruit is heavy (792.15 g) in weight, roundish, ventral shoulder rising and then rounded, round apex, beak perceptible, sinus absent and skin color is greenish yellow. Pulp light yellow and high quantity of fiber. Stone venation is parallel and elevated than surface with reniform embryo shape.	Fruit quality excellent with sweet taste (TSS 23.55°Brix) and β-carotene content (811.32 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 10 at 1400 bp (Fig 1).
11	Hyder	Fruit medium (271 g), oblong shape, ventral shoulder ending in a long curve, obtuse apex, beak prominent, sinus shallow and skin color is yellow. Pulp dark orange with high quantity of fiber. Stone venation is parallel and level with surface with reniform embryo shape.	Fruit quality excellent with TSS of 18.16°Brix and β-carotene content (1668.49 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 18 at 1050bp and OPG 11 at 1000bp.
12	Imam Pasand	Fruit heavy (493.77 g) in weight, roundish, ventral shoulder rising and then rounded, round apex, beak pointed, sinus absent and skin color is greenish yellow. Pulp light yellow and fibreless. Stone venation is parallel and elevated than surface with reniform embryo shape.	Fruit quality excellent with TSS of 18.39°Brix and β-carotene content (867.87 µg/100g).	Cultivar specific fragment was amplified with SSR primer SSR 20 at 280bp.
13	Jalal	Fruit heavy (635.64 g) in weight, oblong shape, ventral shoulder ending in a long curve, obtuse apex, beak perceptible, sinus shallow and skin color is greenish yellow. Pulp yellow orange and fibreless. Stone venation is parallel and elevated than surface with oblong embryo shape.	Fruit quality excellent with TSS of 16.45°Brix β-carotene content (1151.35 µg/100g).	Jalal was closely related to Sora mamidi and Tella Rasalu in RAPD and combined marker analysis.

Table 1 continued...

Table 1 continued...

14	Jehangir (Syn: Umdra)	Fruit heavy (694.77 g) in weight, roundish, ventral shoulder ending in a long curve, round apex, pointed beak, sinus absent and skin color is yellow. Pulp light yellow and fibreless. Stone venation is forked and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 15.83°Brix and β-carotene content (805.11 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 20 at 1300bp.
15	Kolanka Goa	Fruit heavy (421.97 g) in weight, oblong shape, ventral shoulder rising and the rounded, obtuse apex, prominent beak, shallow sinus and skin color is greenish yellow. Pulp golden yellow with low fiber. Stone venation is parallel and elevated than surface with oblong embryo shape.	Fruit quality excellent with TSS of 17.05°Brix and β-carotene content (1044.26 µg/100g).	Kolanka Goa was closely related to Chinna Suvarnarekha, Elamandala and Imam Pasand in RAPD and combined marker analysis.
16	Kottapalli Kobbari	Fruit medium (221.45 g) in weight, oblong shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, shallow sinus and skin color is greenish yellow. Pulp light orange with high quantity of fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 17.58°Brix and β-carotene content (1561.94 µg/100g).	Kottapalli Kobbari formed a sub cluster with Hyder in RAPD and combined marker analysis.
17	Kowsuri Pasand	Fruit is heavy (1068.30 g) in weight, oblong shape, ventral shoulder ending in a long curve, round apex, pointed beak, sinus absent and skin color is greenish yellow. Pulp light orange with high quantity of fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 15.58°Brix and β-carotene content (1532.42 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPX 04 at 2500bp.
18	Nalla Andrews	Fruit is heavy (412.72 g) in weight, roundish shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus absent and skin color is greenish yellow. Pulp white and fiberless. Stone venation is parallel and elevated than surface with oblong embryo shape.	Fruit quality excellent with TSS of 17.98°Brix and β-carotene content (623.71 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 10 (Fig 1) at 1230bp and OPG 11 at 700bp.
19	Nalla Rasalu	Fruit medium (359.42 g) in weight, oblong shape, ventral shoulder rising and then rounded, obtuse apex, perceptible beak, sinus shallow, skin color is greenish yellow. Pulp yellow orange with medium quantity of fiber. Stone venation is parallel and level with surface with reniform embryo shape.	Fruit quality excellent with TSS of 16.28°Brix and β-carotene content (1284.07 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPG 03 at 200bp.
20	Navaneetham	Fruit medium (343.47 g) in weight, ovoid shape, ventral	Fruit quality excellent with TSS of 15.31°Brix	Cultivar specific fragment was

Table 1 continued...

Table 1 continued...

		shoulder ending in a long curve, round apex, pointed beak, sinus shallow and skin color is greenish yellow. Pulp light yellow with low amount of fiber. Stone venation is parallel and level with surface with reniform embryo shape.	and β-carotene content (870.49 µg/100g).	amplified with RAPD primer OPA 03 at 800bp.
21	Nuzividu Tiyya Mamidi	Fruit light (148.75 g) in weight, roundish, ventral shoulder ending in a long curve, round apex, perceptible beak, sinus absent and skin color is greenish yellow. Pulp light yellow with low amount of fiber. Stone venation is parallel and level with surface with reniform embryo shape.	Fruit quality excellent with TSS of 17.37°Brix and β-carotene content (890.46 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPX 04 at 180 and 380bp.
22	Nuzividu Rasalu	Fruit medium (314.22 g) in weight, oblong shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus absent and skin color is greenish yellow. Pulp golden yellow with low amount of fiber. Stone venation is forked and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 16.07°Brix and β-carotene content (1093.26 µg/100g).	Nuzividu Rasalu was closely related to Nuzividu Tiyya Mamidi in both RAPD and combined marker analysis.
23	Panchadara Kalasa	Fruit medium to heavy (368.32 g) in weight, roundish, ventral shoulder ending in a long curve, round apex, perceptible beak, sinus absent and skin color is green. Pulpcolor is light yellow with medium amount of fiber. Stone venation is forked and level with surface with reniform embryo shape.	Fruit quality excellent with sweet taste (TSS 20.04°Brix) and β-carotene content (944.65 µg/100g).	Cultivar specific fragment was amplified with SSR primer MiIIHR 19 at 100bp (Fig 2).
24	Pandurivari Mamidi	Fruit light (151.75 g) in weight, roundish, ventral shoulder ending in a long curve, round apex, perceptible beak, sinus absent and skin color is greenish yellow. Pulp yellow orange with medium amount of fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 18.94°Brix and β-carotene content (1226.60 µg/100g).	Pandurivari Mamidi formed a sub cluster with Panchadara Kalasa in RAPD and combined marker analysis.
25	Paparao Goa	Fruit medium to heavy (388.97 g) in weight, roundish, ventral shoulder rising and then rounded, obtuse apex, mammiform beak, sinus shallow and skin color is green with red blush. Pulp light yellow and fiberless. Stone venation is forked and depressed with reniform embryo shape.	Fruit quality excellent with TSS of 19.02°Brix, maximum total phenol content (98.04 mg/ 100g) and β-carotene content (917.99 µg/ 100g).	Paparao Goa formed a sub cluster with Peddarasam in RAPD, SSR and combined marker analysis.
26	Peddarasam	Fruit heavy (490.05 g) in weight, oblong shape, ventral shoulder rising and then rounded, obtuse apex,	Fruit quality excellent with TSS of 19.71°Brix and β-carotene content (955.65 µg/100g).	Peddarasam was closely related to Paparao Goa and formed a sub

Table 1 continued...

Table 1 continued...

		perceptible beak, sinus absent and skin color is greenish yellow. Pulp light yellow with high quantity of fiber. Stone venation is parallel and depressed with reniform embryo shape.		cluster in RAPD, SSR and combined marker analysis.
27	Panukula Mamidi	Fruit medium (265.87 g), roundish, ventral shoulder rising and then rounded, round apex, pointed beak, sinus absent and skin color is greenish yellow. Pulp golden yellow with medium amount of fiber. Stone venation is forked and depressed with oblong embryo shape.	Fruit quality excellent with TSS of 20.32°Brix and β-carotene content (1230.05 µg/100g).	Panukula Mamidi formed a sub cluster with Jalal, Sora Mamidi, Tella Rasalu and Rajamamidi in RAPD and combined marker analysis.
28	Royal Special (Syn: Bobbili Punasa, Bobbili Pedda, Chirutapudi Goa)	Fruit light (150.49 g) in weight, roundish shape, ventral shoulder ending in a long curve, round apex, perceptible beak, sinus absent and skin color is yellow. Pulp light yellow with high quantity of fiber. Stone venation is parallel and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 20.68°Brix, highest titrable acidity of 1.19% and β-carotene content (915.79 µg/100g).	Cultivar specific fragment was amplified with SSR primer SSR 15 at 270bp.
29	Rajamanu (Syn: Safeda)	Fruit light (147.53 g) in weight, ovoid shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus shallow and skin color is greenish yellow. Pulp yellow orange and fiberless. Stone venation is forked and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 17.83°Brix and β-carotene content (1313.38 µg/100g).	Cultivar specific fragment was amplified with RAPD primer OPA 10 at 980bp (Fig 1).
30	Sora Mamidi	Fruit heavy (1395.45 g) in weight, oblong shape, ventral shoulder rising and then rounded, obtuse apex, pointed beak, deep sinus, and skin color is yellow. Pulp per cent is 84% with light yellow color and fiberless. Stone venation is parallel and elevated than surface with reniform embryo shape.	Fruit quality excellent with TSS of 15.05°Brix and β-carotene content (1232.73 µg/100g).	The cultivar Sora Mamidi and Tella Rasalu was closely related and formed a sub cluster at extreme end of the dendrogram in RAPD, SSR and combined marker analysis.
31	Suvarnarekha(Syn: Sundri, Lal Sundri)	Fruit medium (333.97 g) in weight, oblong shape, ventral shoulder ending in a long curve, obtuse apex, pointed beak, sinus shallow and skin color is green with red blush. Pulp yellow orange and fiberless. Stone venation is forked and level with surface with oblong embryo shape.	Fruit quality excellent with TSS of 20.16°Brix and β-carotene content (1361.64 µg/100g).	The cultivar Suvarnarekha was closely related to Tella Gulabi and formed a sub cluster in RAPD, SSR and combined marker analysis.
32	Tella Gulabi	Fruit light (140.77 g) in weight, roundish, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus shallow and skin color is greenish yelllow. Pulp yellow orange and fiberless. Stone venation is forked	Fruit quality excellent with TSS of 18.20°Brix and β-carotene content (1446.21 µg/100g).	The cultivar Tella Gulabi was closely related to Suvarnarekha and formed a sub cluster in RAPD, SSR and combined marker analysis.

Table 1 continued...

Table 1 continued...

		and level with surface with oblong embryo shape.		
33	Tella Rasalu	Fruit medium (187.17 g) in weight, oblong shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus absent and skin color is greenish yellow. Pulp light yellow orange with low quantity of fiber. Stone venation is forked and level with surface with reniform embryo shape.	Fruit quality excellent with TSS of 18.20°Brix and β-carotene content (989.92 µg/100g).	The cultivar Tella Rasalu and Sora Mamidi was closely related and formed a sub cluster at extreme end of the dendrogram in RAPD, SSR and combined marker analysis.
34	Rajamamidi	Fruit light (242.70 g) in weight, elliptic shape, ventral shoulder ending in a long curve, obtuse apex, perceptible beak, sinus absent, and skin color is greenish yellow. Pulp light yellow with low quantity of fiber. Stone venation is parallel and level with surface with oblong embryo shape. Fruit quality excellent with TSS of 15.60°Brix.	Fruit quality excellent with TSS of 15.60°Brix and β-carotene content (1031.56 µg/100g).	Cultivar Rajamamidi formed a sub cluster with Jalal, Sora Mamidi, Tella Rasalu and Panukula Mamidi in RAPD and combined marker analysis.

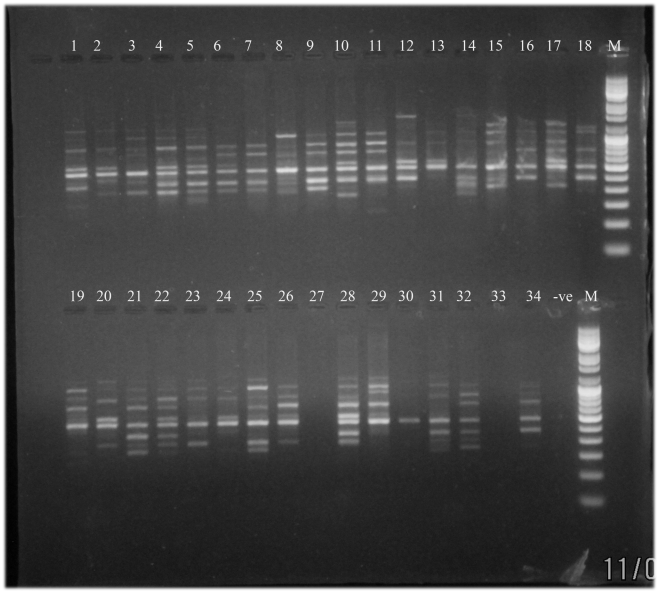

Fig. 1 : RAPD gel profiles of mango cultivars generated using primer OPA-10. PCR Product Size 280-1150bp

Lane 1 : Banganapalli- 1
Lane 2 : Banganapalli- 2
Lane 3 : Banganapalli- 3
Lane 4 : Banglora- 1
Lane 5 : Banglora- 2
Lane 6 : Baramasi
Lane 7 : Cherukurasam
Lane 8 : Chinnnarasam
Lane 9 : Chinna Suvarnarekha
Lane 10: Elamandala
Lane 11 : Hyder
Lane 12: Imam Pasand
Lane 13: Jalal
Lane 14: Jehangir
Lane 15: Kolanka Goa
Lane 16: Kottapalli Kobbari
Lane 17: Kowsuri Pasand
Lane 18: Nalla Andrews
Lane 19: Nalla Rasalu
Lane 20: Navaneetham
Lane 21: Nuzividu Tiyya Mamidi
Lane 22: Nuzividu Rasalu
Lane 23: Panchadara Kalasa
Lane 24: Pandurivari Mamidi
Lane 25: Paparao Goa
Lane 26: Peddarasam
Lane 27: Panukula Mamidi
Lane 28: Royal Special
Lane 29: Rajamanu
Lane 30: Sora Mamidi
Lane 31: Suvarnarekha
Lane 32: Tella Gulabi
Lane 33: Tella Rasalu
Lane 34: Rajamamidi
Lane -ve: Control
Lane M: Medium Range DNA Ruler

in pulp, the greater the carotenoids, the better the quality of the fruit. From the results, it was found that mango cultivars with yellow colored pulp were having maximum â-carotene content than mango cultivars with white colored pulp. More carotenoid content is known to result in dark orange coloured flesh, which is a feature of consumer's preference. Banganapalli-1, Banganapalli-3, Banglora-1, Cherukurasam, Chinnarasam, Hyder, Jalal, Kolanka Goa, Nalla Rasalu, Nuzividu Rasalu, Pandurivari Mamidi, Rajamanu, Suvarnarekha and Tella Gulabi had yellow colored pulp can be used as a source for having high vitamin A (Table 1). These genotypes may be considered promising as genitors for breeding programmes.

The fifteen RAPD primers generated 177 bands with sizes ranged from 100 - 5000 bp. The most important

function of a primer is to discriminate as many germplasm as possible, which could be exploited for DNA fingerprinting. The polymorphic fragments present in only one cultivar were considered to be unique fragments. Out of the total 177 polymorphic fragments, nineteen fragments were unique to particular germplasm (Table 1), which could be exploited for DNA fingerprinting of these germplasm by converting RAPD markers into STS (Sequence Tagged Site) markers, which would be useful for detecting mixes between germplasm (Himabindu and Rajasekhar, 2021).

Out of 20 SSR markers, eighteen microsatellites were amplified and produced sixty five alleles. The total number of alleles varied from 1 (MngSSR 14 and MiIIHR 18) to 9 (MiIIHR 23) with an average number (3.61) of alleles per locus. Out of the 65 polymorphic fragments, five fragments were unique to particular cultivars (Table 1). High level of polymorphism was observed with MiIIHR 19 primer *i.e.*, 9 alleles per locus. Further, null alleles were also observed among the mango cultivars with SSR primers (Himabindu *et al*., 2022). The variation in alleles might be due to template DNA concentration and purity, primer selection, primer design, amplicon size, PCR conditions and sensitivity of product detection. These DNA markers have the potential to be used in mango for Marker-Assisted Selection (MAS) and for cultivar identification.

Data were tabulated and visually represented where necessary to facilitate easy comparison and interpretation. The morphological, biochemical and molecular characters of each cultivar are described in Table 1.

Conclusion

The preference for certain mango varieties often hinges on these morphological and biochemical characteristics, influencing market demand and consequently, the economic prospects for farmers and traders as per the consumer point of view. Molecular characterization using RAPD and SSR primers were carried out and cultivar specific fragments were amplified. Understanding these variations is crucial for multiple aspects of mango production and utilization. In breeding programs, knowledge of specific cultivar traits is indispensable for developing improved varieties with desired qualities like enhanced sweetness, high nutritional specific varieties. For cultivation, it informs growers about cultivar-specific requirements and management practices, which are essential for optimal yield and quality. The results of the present study indicated that RAPD and SSR markers can be employed in fingerprinting, characterization of germplasm, assessment of molecular genetic divergence and relatedness among mango germplasm. This information could be used successfully for cultivar identification and for the assessment of genetic diversity among mango germplasm. This exploration not only diversifies mango production but also plays a crucial role in the conservation of genetic diversity, offering potential solutions to cultivation challenges and market demands. This study not only sheds light on the current state of mango diversity but also sets a foundation for future studies and initiatives aimed at optimizing the cultivation and utilization of this globally cherished fruit.

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