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Short communication

Studies on fruit and yield traits in indigenous coloured varieties of mango (*Mangifera indica* L.) in South Gujarat, India

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ABSTRACT

An investigation on fruit descriptors and yield in twelve mango varieties was conducted under South Gujarat conditions. Maximum fruit length was recorded in cv. Totapuri (16.23cm). Vanraj showed the highest values for fruit width (11.67cm), fruit circumference (37.37cm), fruit weight (729g), fruit volume (575.59cm^3) and fruit pulp (78.93%). Maximum TSS (21.20%), acidity (0.42%) and fruit firmness (7.00 rating) was observed in cvs. Deshi-1, Deshi-3 and Makaram, respectively. 'Totapuri' had maximum total shelf-life (21.33 days), number of fruits per tree (383.00) and fruit yield (236.80kg/tree). The varieties had green to yellow ground-colour of peel. All the varieties had red-blush peel colour, excepting cvs. Dadamio, Makaram and Swarnarekha which were purplish-red. Similarly, pulp colour ranged from light yellow to light orange. Based on overall performance, cvs. Alphonso, Deshi-1, Deshi-2, Kesar, Khandesi Borasio, Totapuri and Vanraj proved to be superior to the other varieties.

Key words: Colour, indigenous, varieties, mango

Mango (*Mangifera indica* L.) belongs to the family Anacardiacea, and is native to the Indo-Myanmar region (Mukherjee, 1953). In India, there exist hundreds of mango cultivars (Chadha and Pal, 1986), and Gujarat figures in the mango belt of the country. In particular, the southern part of Gujarat is well-suited for mango cultivation and is home to several indigenous coloured varieties, owing to a favourable tropical climate. Today, there is a good demand in international markets for varieties with attractive peel colour. Although numerous studies have been conducted on mango in the region, there is dearth of information on coloured mango varieties. These are distinct from each other in terms of gradation, intensity of colour and other attributes (Pleguezuelo *et al*, 2012). In view of the popularity and importance of coloured mango varieties globally, the aim of the present study was to assess physico-chemical and other characteristics of coloured mango fruits, especially, locally grown varieties in South Gujarat. This study will help identify suitable parents and potential mango varieties for further evaluation, conservation and utilization in crop improvement programmes. In the long run, this could prove important to guage consumer preference and emerging market-expectations.

The present study was carried out at Germplasm Evaluation Block, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, NAU, Navsari, during the fruiting season in year 2012. Varieties selected for this study were: Alphonso, Batli, Dadamio, Deshi-1, Deshi-2, Deshi-3, Kesar, Khandesi Borasio, Makaram, Swarnarekha, Totapuri and Vanraj. Age of the trees used in this experiment was 20-30 years. Plants were maintained under uniform conditions as per the recommended package of practices of Navsari Agricultural University. Fully mature mango fruits were harvested and collected randomly (as and when the fruits matured on the tree). After uniform ripening at room temperature, 15 fruits per variety were used in the study. Fruit description, viz., fruit length, fruit width, fruit circumference, fruit weight and fruit volume were recorded as per standard methods at ready-to-eat, ripe stage. Fruit pulp percentage was calculated as per Peter *et al* (2007). Total shelf-life was noted under room temperature for both pre- and post-ripening period in fruits starting with the day of harvest. Physiological loss in fruit weight was determined at 3-day intervals using standard formulae and was expressed in percentage (AOAC, 1994). Fruit firmness was rated as per DUS, with rating of low firmness (3), medium (5) and high firmness (7) (DUS, 2008). Fibre attachment to stone was observed and different ratings were given (DUS, 2008). A panel of five judges scored each variety, and the average score was taken as the final rating for the variety. Number of fruits per tree was recorded at

harvest. Fruit yield in term of kg per tree was obtained by multiplying average fruit-weight with number of fruits per tree. Total soluble solids (TSS) were determined with a digital hand-refractometer (HI 96801) at three different points on the fruit, i.e., shoulder, middle and distal end of the fruit, after thorough mixing. The values were expressed as percentage (Ranganna, 1986). Titratable acidity was estimated as per Ranganna (1986). Fruit parameters, viz., peel and pulp colour, pulp fibre, lenticel density and nature, depth of sinus, fruit shape, fruit apex and depth of fruit-stalk cavity, were determined by five judges who used DUS guidelines (DUS, 2008). The experiment was laid out in Randomised Block Design (RBD), with three replications, with three trees per replication. Data on various parameters were analyzed using Analysis of Variance (ANOVA) employing Statistical Package for Agricultural Workers (STAT OP Sheoran). Differences among individual means were tested using Least Significant Difference (LSD) test at $P< 0.05$ level.

Result showed that physico-chemical characteristics of the fruit were highly significant ($P< 0.05$) for differences among varieties (Table 1). Maximum fruit length was observed in cv. Totapuri (16.23cm), while this was minimum in Deshi-3 (9.43cm). 'Vanraj' recorded maximum fruit-width (11.67cm), while, cv. Makaram recorded the least (7.00cm). Fruit circumference was highest in 'Vanraj' (37.37cm), and lowest in Makaram (23.20cm). Several workers have reported mango cultivars to differ in fruit length and width, according to their genetic make-up (Jilani *et al*, 2010).

Highest fruit-weight was recorded in cv. Vanraj (729.03g). In contrast, 'Makaram' had lowest fruit-weight (235.73g). The remaining varieties had fruits ranging in weight from 300 to 363g. Maximum fruit volume was noted in 'Vanraj' (739.33cm^3), while, the minimum was recorded in 'Makaram' (240.00cm^3). Sarkar *et al* (2001) also reported variation in fruit-weight among different mango cultivars, which could be due to genetic or physiological factors (Uddin *et al*, 2006).

A distinct variation was observed in pulp content in different varieties (Table 1). Maximum pulp percentage was obtained in 'Vanraj' (78.93). This is in accordance with Kulkarni and Rameshwar (1981) among varieties evaluated by them. Similarly, pulp colour ranged from light-yellow to light-orange. These findings fall in the range reported by several researchers in mango (Sarkar *et al*, 2001; Jilani *et al*, 2010).

Fruit-firmness, as indicated in Table 2, rated maximum in 'Makaram' (7.00) and minimum (3.00) in 'Alphonso'. TSS content and acidity are also considered as a measure of fruit quality (Shafique *et al*, 2006). TSS recorded maximum in cv. Deshi-1 (21.20%), and minimum in cv. Totapuri (15.63%). Highest acidity was recorded in 'Totapuri' (0.42%), and least in 'Deshi-1' (0.24%) and Kesar (0.25%). Variation in chemical constituents among varieties too has been reported by researchers earlier (Syed, 2009).

Data on ripening behaviour in various mango varieties showed highly significant differences (Table 2). Maximum

Table 1. Fruit and yield descriptors in mango

Variety	Pulp colour	Fruit shape	Fruit length (cm)	Fruit width (cm)	Fruit circum-ference (cm)	Fruit weight (g)	Fruit volume (cm^3)	Fruit pulp (%)	TSS (%)	Acidity (%)	Number of fruits per tree	Yield (kg/tree)
Alphonso	Medium yellow	Ovate oblique	10.53	8.30	26.77	331.34	351.00	77.18	19.67	0.27	307.67	113.22
Batli	Light yellow	Ovate oblong	13.43	7.83	24.60	363.10	378.00	69.12	18.50	0.36	187.67	112.99
Dadamio	Light yellow	Ovate	10.30	8.70	26.73	358.23	372.67	66.29	17.63	0.38	210.33	124.52
Deshi-1	Medium yellow	Ovate	10.93	8.77	24.27	315.90	335.67	76.15	21.20	0.24	329.33	106.07
Deshi-2	Medium yellow	Ovate	10.50	8.47	23.70	301.23	312.00	71.43	20.40	0.28	292.33	95.61
Deshi-3	Light orange	Ovate	9.43	7.83	24.17	236.27	241.00	64.46	17.50	0.42	108.33	44.78
Kesar	Medium yellow	Oblong	12.13	7.97	24.80	319.67	326.33	72.23	18.80	0.25	273.33	97.80
Khandesi Borasio	Light orange	Ovate oblong	9.80	7.60	24.23	302.83	340.00	76.30	20.70	0.35	311.67	113.67
Makaram	Medium yellow	Oblong	12.60	7.00	23.20	235.73	240.00	60.14	16.70	0.37	119.33	45.95
Swarnarekha	Light orange	Ovate oblong	12.90	9.20	24.77	424.27	458.33	75.36	17.67	0.30	262.67	163.40
Totapuri	Medium yellow	Oblong with pointed tip	16.23	9.10	24.53	618.77	630.67	67.91	15.63	0.42	383.00	330.27
Vanraj	Medium yellow	Ovate oblique	15.07	11.67	37.37	729.03	739.33	78.93	17.23	0.33	172.67	399.39
CV	-	-	4.51	3.94	4.14	41.21	34.66	3.49	1.61	11.73	6.06	3.86
± SEM	-	-	0.32	0.19	0.62	13.96	11.74	1.18	17.00	0.20	3.06	2.03
CD (P=0.05)	-	-	0.93	0.57	1.82	6.39	5.15	2.87	0.01	0.07	8.15	5.27

Table 2. Ripening and shelf-life in mango fruits after harvest

Variety	Time taken to ripening (days)	Post-ripening life (days)	Total post-harvest life (days)	Fruit firmness (rating)
Alphonso	7.67	8.67	16.33	3.00
Batli	6.67	7.67	14.33	4.33
Dadamio	6.00	6.33	12.33	5.00
Deshi-1	5.67	8.00	13.67	3.00
Deshi-2	6.67	7.67	14.33	3.67
Deshi-3	4.67	6.33	11.00	6.33
Kesar	7.33	7.67	15.00	3.00
Khandesi Borasio	5.33	6.00	11.33	3.00
Makaram	5.67	9.00	14.67	7.00
Swarnarekha	7.33	7.67	15.00	5.00
Totapuri	8.67	12.67	21.33	3.67
Vanraj	4.67	6.67	11.33	3.67
CV	11.74	11.38	7.16	2.14
± SEM	0.43	0.51	0.56	0.35
CD. (0.05)	1.27	1.52	1.67	1.06

Table 3. Physiological weight loss (%) in mango fruits at various intervals after harvest

Variety	3 DAH	6 DAH	9 DAH	12 DAH	15 DAH	18 DAH	21 DAH
Alphonso	5.87	10.17	14.83	17.03	19.14	-	-
Batli	5. 26	11.58	16.52	18.40	20.94	-	-
Dadamio	7.96	14.05	16.82	19.36	23.48	-	-
Deshi-1	6.07	11.35	15.15	19.50	21.17	-	-
Deshi-2	7.34	11.72	16.48	19.19	21.06	-	-
Deshi-3	7.03	15.63	19.06	23.86	25.63	-	-
Kesar	6.28	11.06	15.15	18.08	19.94	-	-
Khandesi Borasio	6.94	15.20	18.23	21.85	23.74	-	-
Makaram	5.63	11.67	15.03	17.72	19.57	-	-
Swarnarekha	6.00	11.38	15.33	17.27	20.13	-	-
Totapuri	5.66	9.66	13.27	16.07	18.05	18.63	20.05
Vanraj	6.47	12.69	18.26	21.72	23.86	-	-
CV	0.53	2.45	0.67	1.35	2.69	-	-
± SEM	0.02	0.17	0.06	0.15	0.33	-	-
C.D. (0.05)	0.06	0.5	0.19	0.44	0.98	-	-

DAH: Days after harvest; (-), not determined, as, 91.67% of varieties lost their post-harvest life, with exception of 'Totapuri'

number of days taken to ripen after harvest was observed in 'Totapuri' (8.67), while this was minimum in 'Vanraj' and 'Deshi-3' (4.67). Similarly, 'Totapuri' recorded longest post-ripening life (12.67 days), the shortest was observed in 'Dadamio' and 'Deshi-3' (6.33 days). Total post-harvest life significantly higher in 'Totapuri' (21.33 days), and lowest in 'Deshi-3' (11.00 days). These finding are in accordance with Herianus *et al* (2003). Variation in post-harvest life in mango varieties could be due to their unique genetic make-up.

The physiological weight-loss in fruits differed significantly with variety (Table 3). At three days after harvest (DAH), least physiological weight-loss was noticed in 'Batli' (5.26%), while maximum weight-loss was recorded in 'Dadamio' (7.96 %). However, 'Totapuri' recorded minimum physiological weight-loss. 'Deshi-3' showed maximum physiological weight-loss at all intervals of observation, with an exception at 3 DAH (7.03%). Reduction in weight is attributed to physiological loss in weight due to respiration, transpiration of water through the peel tissue and due to other biological changes occurring in the fruit (Rathore *et al*, 2007), depending upon the genetic constitution of variety (Rymbai *et al*, 2014).

Good appearance of mango fruit has the highest phenotypic acceptability in consumers (Uddin *et al*, 2006). Among various varieties, green ground colour of mango peel was observed in cvs. Dadamio, Makaram and Swarnarekha, yellow colour in cvs. Alphonso, Batli, Deshi-1, Deshi-2, Deshi-3, Kesar and Totapuri, while, only 'Khandesi Borasio' showed greenish-yellow colour. All the varieties had red-blush peel colour, except cvs. Dadamio, Makaram and Swarnarekha, which showed purplish-red colour (Table 4). Pulp fibre was scarce in cvs. Alphonso, Deshi-1, Deshi-2, Kesar, Khandesi Borasio and Totapuri medium in cvs. Batli, Dadamio, Swarnarekha, and abundant in cvs. Deshi-3 and Makaram. Lenticel density ranged from sparse in cvs. Alphonso and Swarnarekha, to dense in cvs. Dadamio, Deshi-1, Deshi-2, Kesar, Khandesi Borasio and Totapuri. Cultivars Batli, Deshi-3 and Makaram had medium lenticels-density. Varieties Deshi-1, Deshi-2, Khandesi Borasio and Swarnarekha are the only ones with prominent lenticels. Sinus was absent in 'Deshi-3', very shallow in cvs. Batli and Dadamio, and shallow in all other varieties. Fruit in cv. Alphonso was ovate-oblique, Kesar and Makaram cvs. had oblong fruit, Batli, Khandesi Borasio and Swarnarekha had ovate-oblong fruits, Totapuri fruit was oblong with a pointed tip, and the rest were ovate. Fruit apex of all the varieties was obtuse, except in 'Dadamio' and 'Totapuri' where it was round and acute, respectively. Depth of fruit stalk cavity was shallow in cvs. Alphonso, Deshi-1, Deshi-2 and Swarnarekha, but the cavity was absent in all other varieties. Variation in external appearance among varieties may be attributed to genetic make-up, as, each genotype is unique.

Differences in fruit yield among varieties were highly significant (Table 1). Number of fruits per tree varied from as low as 108.33 in 'Deshi-3', to as high as 383.00 in 'Totapuri'. Eight of the 12 varieties studied had more than

Table 4. Secondary descriptors in mango fruits

Variety	Peel colour		Pulp fibre	Lenticel			Fruit apex	Depth of fruit-stalk cavity
	Ground	Blush		Density	Nature	Sinus		
Alphonso	Yellow	Red	Scarce	Sparse	Less prominent	Shallow	Obtuse	Shallow
Batli	Yellow	Red	Medium	Medium	Less prominent	Very shallow	Obtuse	Absent
Dadamio	Green	Purplish-red	Medium	Dense	Less prominent	Very shallow	Round	Absent
Deshi-1	Yellow	Red	Scarce	Dense	Prominent	Shallow	Obtuse	Shallow
Deshi-2	Yellow	Red	Scarce	Dense	Prominent	Shallow	Obtuse	Shallow
Deshi-3	Yellow	Red	Abundant	Medium	Less prominent	Absent	Obtuse	Absent
Kesar	Yellow	Red	Scarce	Dense	Less prominent	Shallow	Obtuse	Absent
Khandesi Borasio	Greenish-yellow	Red	Scarce	Dense	Prominent	Shallow	Obtuse	Absent
Makaram	Green	Purplish-red	Abundant	Medium	Less prominent	Shallow	Obtuse	Absent
Swarnarekha	Green	Purplish-red	Medium	Sparse	Prominent	Shallow	Obtuse	Shallow
Totapuri	Yellow	Red	Scarce	Dense	Less prominent	Shallow	Acute	Absent
Vanraj	Greenish Red	Red	Medium	Medium	Less prominent	Shallow	Obtuse	Shallow

200 fruits per tree. Similarly, highest fruit-yield (kg per tree) was recorded in 'Totapuri' (236.80kg/tree), while, 'Deshi-3' had the lowest yield (25.56 kg/tree). This is in line with findings of Sarkar *et al* (2001). Exceptional results obtained in 'Totapuri' may be attributed to unique genetic features of an individual variety.

The present investigation concludes that of the 12 mango varieties studied, fruits of Alphonso, Deshi-1, Deshi-2, Kesar, Khandesi Borasio, Totapuri and Vanraj were superior in various fruit parameters, as well as yield. Of these, cvs. Deshi-1 and Deshi-2 are promising, local genotypes. These varieties can be studied in-depth for further evaluation and use in mango breeding programmes, to help assess consumer preference and emerging market-expectations.

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