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Gahane KD
M.Sc. Student, Department of Horticulture, College of Horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Patil SR
Associate Professor, College of Horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Tayade SA
M.Sc. Student, Department of Horticulture, College of Horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Raut HS
M.Sc. Student, Department of Horticulture, College of Horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Correspondence
Gahane KD
M.Sc. Student, Department of Horticulture, College of Horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Morphological and physicochemical variability studies in local mango genotypes for pickle purpose

Gahane KD, Patil SR, Tayade SA and Raut HS

Abstract
The experiment entitled, "Morphological and Physicochemical Variability Studies in Local Mango Genotypes for Pickle Purpose" was carried out during 2015-2016 on the basis of morphological and physical parameter of fruits. A survey, collection and screening of mango genotypes in Akola, Amravati and Washim districts known of mining of pickle was undertaken for pickle preparation, in order to identify suitable local variety for preparation of quality pickle commercially on adhoc basis. The 50 mango genotypes were collected and evaluated for distinct pickle characters. These genotypes revealed wide variability in physic-chemical parameters of fruit *viz*., Average fruit weight (40.8 to 270.70 g), pulp weight (23.83 to 197.4 g), pulp percentage (25.17 to 87.77%), peel weight (11.2 to 71.5 g), peel percentage (11.53 to 34.76%), stone weight (14 to 61.7 g), stone percentage (18.07 to 48.31%), pulp: stone ratio (0.52 to 3.74), pulp: peel ratio (0.97 to 3.68), pulp thickness (13.2 to 28.6 mm), peel thickness (0.1 to 3.0 mm). considering unripe fruit should be too acidic for pickle as G-42 recorded (6.71) higher acidity, however it appears inferior for most of rest characters. From overall performance in respect of higher fruit weight, peel per cent, pulp thickness, pulp weight, pulp per cent, stone per cent and pulp: stone ratio. whitish to golden yellow pulp colour, beak type, fruit shape, fruit shoulder, twenty mango genotypes *viz*., G-18, G-01, G-42, G-40, G-38, G-29, G-31, G-22, G-39, G-41, G-21, G-04, G-9, G-16, G-44, G-50, G-24, G-26, G-32 and G-36 were identified as promising genotypes.

Keywords: Mango, variability, morphological, physicochemical, genotypes, pickle

Introduction
Mango (*Mangifera indica* L.) is one of the member of the family Anacardiaceae in order Sapindales. It is one of the important fruit crop among the tropical and subtropical fruits grown in more than 110 countries of the world. Mango fruit is closely associated with the history of Indian Agriculture and enjoys a royal status in the country. Cultivation of mango in India is very ancient, about 4000 years old. The mango is presumed to be the most commonly eaten fresh fruit worldwide. Mango is second most important fruit crop contributes 35.80 per cent in area and 22.1 per cent in production, in total fruit crops grown in India. It is being cultivated in India on 2500 lakh hectares area with an annual production of 18002.4 lakh tones along with productivity 7.2 lakh tones/ha. Maharashtra has the highest mango production occupying 482 lakh hectares area with 633 lakh tones production along with 1.3 lakh tones/ha productivity (Tiwari *et al.* 2013) [13]. Pickle, in addition to use of the green mangoes pickles, should provide an excellent outlet for the economic utilization of fallen marketable surplus of green mangoes. Pickle is also prepared on large scale in Akola, Amravati and Washim district of Maharashtra. Local mango genotypes are used for pickle preparation. Invariably, under ripe and wind-fallen seedling or country mangoes are utilized for the manufacture of pickle. No particular varieties are in demand for this purpose.
Therefore, considering the need of time and future thrust, it is necessary to screen the suitable mango genotypes for preparation of pickle from raw green mangoes. Till date, nobody has tried to screen local mango genotypes and standardize suitable mango variety for pickle preparation. It is need of time to explore possibility of identification and utilization of available genetic pool of different mango varieties available in Western Vidarbha region of Maharashtra.

Materials and Methods
The experiment entitled "Morphological and Physicochemical Variability Studies in Local Mango Genotypes for Pickle Purpose" was carried out by survey and collection of different mango genotypes in Akola, Amravati and Washim districts of Maharashtra and study their morphological and physical characters of fruits in analytical laboratory of Horticulture section, Department of Horticulture, Dr. P.D.K.V., Akola during the year 2015-2016.

a. Experiment details: While screening of local mango genotypes for preparation of pickle, mango fruits were collected during the harvesting season of mango in 2015. Fully developed, mature but unripe fruits were collected as suggested by Wagh (1995) [14]. 5-6 kg (25 No.) of mango fruits per treatment was taken.

b. Treatment details: Different fifty local mango genotypes were collected from various locations of Akola, Amravati and Washim districts for morphological, morphological and physical characters of fruits.

Results and Discussion

During the course of investigation conducted to explore and evaluate the suitable local mango genotypes for preparing pickle. These are studied in relation to the morphological and physical characters of fruits. The results are presented below under appropriate headings

1 **Fruit shape:** From the Table 1, it is observed that, a wide variability was observed in fruit shapes of mango genotypes. Fruit shape of these 50 mango genotypes categorized as Roundish, Oblong Elliptical, Ovoid, Ablong and Abovid. Out of these 50 genotypes 18 is roundish with percentage 32 per cent, 11 are oblong elliptical with percentage 22 per cent, 1 are Ovoid with percentage 2 per cent, 8 are oblong with percentage 16 per cent, remaining 12 is Abovid fruit shape with percentage 24 per cent. However, there is no specificity about fruit shape of mango for pickle but regular even shape fruits proved most convenient while preparing pickle through pulp slices. These results are close agreement with Anila and Radha (2003) [1] who worked on five mango cultivars under Kerala condition and found oblong fruit shape in most of the cultivars.

2 **Beak type:** From the Table 1, it is observed that, a wide variability was observed in beak type of mango genotypes. Beak type of these 50 mango genotypes categorized as Perceptible, Mommiform, Pointed and Prominent. Out of these 50 genotypes 29 is perceptible with percentage 58 per cent, 10 are Mommiform with percentage 20 per cent, 7 are pointed with percentage 14 per cent remaining 4 is prominent beak type with percentage 8 per cent.

3 **Pulp color:** From the Table 1, it is observed that, a wide variability was observed in pulp color of mango genotypes. Pulp color of these 50 mango genotypes categorized as Yellowish green, Dark yellow, Whitish yellow, Light yellow, Pale yellow, Whitish and Golden yellow. Out of these 50 genotypes 1 is yellowish green with percentage 2 per cent, 12 is dark yellow with percentage 24 per cent, 12 are whitish yellow with percentage 24 per cent, 10 are light yellow with percentage 20 per cent, 6 are pale yellow with percentage 12 per cent, 4 are whitish with percentage 8 per cent remaining 5 is golden yellow pulp colour with percentage 10 per cent. The pulp color is also deciding factor while selection of fruits for pickle preparation. Thus, if white flesh color is there it is said to be very good and if the dark yellow color is there considered not suitable.

4 **Fruit shoulder:** From the Table 1, it is observed that, a wide variability was observed in fruit shoulder of mango genotypes. Fruit shoulder of these 50 mango genotypes categorized as Long curve type, Slopping abruptly, and Rising in then rounded. Out of these 50 genotypes 25 is long curve type with percentage 50 per cent, 16 are slopping abruptly with percentage 32 per cent, remaining 8 is rising in then rounded fruit shoulder with percentage 16 per cent.

Table 1: Classification of local mango genotypes on the basis of fruit shape, beak type pulp color and fruit shoulder

Sr. No.	Parameter	States	Genotype	No. of type	(%)
1.	Fruit shape	Roundish	G-01, G-02, G-03, G-05, G-06, G-10, G-13, G-15, G-16, G-22, G--25, G-28, G-34, G-35, G-36, G-41, G-47 and G-48	18	36
		Oblong Elliptical	G-04, G-18, G-21, G-23, G-27, G-29, G-32, G-38, G-40, G-43 and G-49	11	22
		Ovoid	G-07	1	2
		Ablong	G-09, G-11, G-14, G19, G-33, G-37, G-45 and G-46	8	16
		Abovid	G-8, G-12, G-17, G-20, G-24, G-26, G-30, G-31, G-39, G-42, G-44 and G-50	12	24
	Total			**50**	**100**
2.	Beak type	Perceptible	G-1, G-2, G-3, G-4, G-5, G-6, G-7, G-8, G-10, G-12, G-17, G-18, G-19, G-21, G-23, G-26, G-27, G-31, G-32,G-33, G-36, G-40, G-41, G-43, G-44, G-46, G-47, G-48 and G-49	29	58
		Mommiform	G-9, G-13, G-14, G-22, G-34, G-35, G-37, G-39, G-45 and G-50	10	20
		Pointed	G-11, G-15, G-24, G-28, G-29, G-38 and G-42.	7	14
		Prominent	G-16, G-20, G-25 and G-30	4	8
	Total			**50**	**100**
3.	Pulp color	Yellowish green.	G-45	1	2
		Dark yellow	G-01, G-04, G-07, G-14, G-19, G-27, G29, G-37, G-39, G-42, G-43 and G-46.	12	24
		Whitish yellow	G-03, G-12, G-13, G-17, G-22, G-23, G-31, G-35, G-40, G-44 and G-49.	12	24
		Light yellow	G-02, G-05, G-09 G-15, G-24, G-28, G-30 G-32, G-38 and G-49	10	20
		Pale yellow	G-20, G-24, G-34, G-36, G-47 and G-50	6	12
		Whitish	G-8, G-10, G-18 and G-33	4	8
		Golden yellow	G-06, G-11, G-16, G-21 and G-25	5	10
	Total			**50**	**100**
4.	fruit shoulder	Ending in the long curve type	G-1,G-2, G-3, G5, G-6, G-7, G-13, G-16, G-17, 18, G-19, G-20, G-21, G-28, G-29, G-31, G-32, G-33, G-36, G-39, G-40, G-44, G-45, G-46 and G-47	25	50
		Slopping abruptly	G-4, G-8, G-9, G-10, G-11, G-12, G-14, G-25, G-26, G-27, G-38, G-41, G-43, G-48, G-49 and G-50.	16	32
		rising in then rounded type	G-15, G-22, G-23, G-24, G-30, G-34, G-35, and G-42.	8	16
	Total			**50**	**100**

5 **Average fruit weight:** The data on average fruit weight of all genotypes is presented in Table 2. A wide variability observed in average fruit weight of and it varied from 40.08 to 270.70 g with 121.94 as population mean. Among the selected 50 mango genotypes, mango genotype G-42 had highest fruit weight (270.70 g), followed by mango genotypes G-29, G-39, G-40, G-41, G-42 and G-44. All of these are superior mango genotype fruits in average weight parameter of fruits (above 200 g). These genotypes appear to be suitable for pickle preparation. Similar results of this character *viz*., average fruit weight for pickling reported by Bhuyan and Kobra (2007) [3] found maximum fruit weight in 'Maldah' (407.00 g). Ali *et al*. (1992) studied 32 varieties of mango and observed heaviest fruit in cultivar 'Fazli' (465.0 g), followed by 'Samar Bahisht Chausa' (389.0 g). Kaur *et al*. (2014) [5] recorded average fruit weight of the evaluated germplasm which was ranged from 80.63 to 301.33 gm.

6 **Pulp weight:** The data in respect to pulp weight presented in table 2 indicated a marked variation. The pulp weight varied from 23.83 g to 133.63 g with 61.72 as population mean. The genotype G-11 had highest pulp weight (133.63 g), whereas the lowest (23.83 g) was in genotype G-4. The mango genotypes are having higher pulp weight, which is very good character for preparation of pickle. This might be due to genetic makeup of individual genotypes (Gurmani, 1989) [4].

7 **Pulp percentage:** The data of pulp percentage presented in Table 2 showed wide variation from 25.17 to 96.44 per cent with 54.92 as population mean. The genotype G-43 recorded highest pulp percentage (96.44%), while the lowest (25.17%) was recorded by the genotypes G-16. These results are in close conformity with Kulkarni and Rameshwar (1981) [6] studied 22 cultivars of mango and found maximum pulp (81.0%) and minimum peel (6.8%) in Vanraj', smallest stone (9.4%) in 'Fazli'.

8 **Pulp Thickness:** Thickness of mango pulp of 50 genotypes is presented in Table 2. Thickness of pulp varied from 13.2 mm to 28.6 mm with population mean of 17.86. The highest pulp thickness was observed in genotype G-21 (28.6 mm), however the lowest was possess by the genotypes G-25 (13.2 mm). These results are in close conformity with Tidke (1994) [12] who reported, the thick pulp (more pulp thickness) character is suitable for pickling purpose. Higher pulp thickness is considered as to be good for stability of pickle preparation.

9 **Peel weight:** Observation pertaining to peel weight from 50 genotypes shown in Table 2. The variability was from 11.2 to 71.5 g with 31.16 gas population mean was observed. The highest peel weight fruit (71.5 g) was recorded by mango genotype G-41; however the lowest (11.2 g) was recorded from genotype G-6. These results are in close agreement of Pruthi and Bedekar (1963) [9] who reported high percentage of peel is the best for pickling mango. They had recorded 8.8 per cent peel in Pickling variety Amlet.

10 **Peel Percentage:** Observation pertaining to peel percentage from 50 genotypes shown in Table 3. The variability was from 11.53 to 34.76 per cent with 25.71 per cent as population mean was observed. The highest peel percentage (34.76%) was recorded by mango genotype G-50; however the lowest (11.53%) was recorded from genotype G-42. These results are in close agreement of Kulkarni and Rameshwar (1981) [6] studied 22 cultivars of mango and found maximum pulp (81.0%) and minimum peel (26.8%) in Vanraj', smallest stone (9.4%) in 'Fazli'.

11 **Pulp:** peel ratio It is evident from table 3 that, pulp to peel ratio among all 50 genotypes varied, between 0.97 to 3.68 with 2.20 as population mean was observed. The highest pulp to peel ratio (3.68) was recorded by mango genotype G-31; however the lowest pulp to peel ratio (0.97) was recorded from genotype G-41.

12 **Peel thickness:** The data in respect to peel thickness presented in Table 3 indicated a marked variation. The peel thickness varied from 1.0 mm to 3.0 mm with 1.62 as population mean. The genotype G-41 had highest peel thickness (3.0 mm), whereas the lowest (1.0 mm). Highest peel thickness is believed to be best for stability of pickle for long period. Therefore, these mango genotypes can be considered as suitable for preparation of pickle considering thin peel. These results are close similar with Tidke (1994) [12] reported that thick to semi-thick peel character is suitable for pickling purpose.

13 **Stone weight:** The stone weight of pickle type mango genotypes are shown in Table 3 indicated a marked variation. The stone weight varied from 14 g to 61.7 g with 30.70 as population mean. The genotype G-44 had highest stone weight (61.7 g), whereas the lowest (14.1 g) was in genotype G-3. These results are in close conformity with Sarkar *et al.* (2001) [11] who observed the different varieties maintained distinctive stone characteristics of their own.

14 **Stone percentage**: From the Table 3 it is observed that, stone percentage of pickle type mango also show wide variability which has ranged from 18.07% to 48.31% with 26.52 population mean. The fruits of genotypes G-16 had highest stone percentage (48.31%), lowest (18.07%) has recorded by genotype G-18. The pickling variety Amlet of Karnataka contains 13.9 per cent stone (Pruthi and Bedekar, 1963) [9]. The average stone percentage in the seedling type green mango was found to be 27.7 per cent by Teotia and Pruthi (1987).

15 **Pulp to stone ratio:** It is evident from Table 3 that, pulp: stone ratio among all 50 genotypes varied between 0.52 to 3.74 with 2.16 populations mean. The genotype G-43 recorded the highest pulp: stone (3.74) ratio, on the contrary lowest (0.52) was recorded by genotype G-16. These results are in congruence with Narayana (1976) who reported the flesh for pickling should be about four times of the weight of the stone. For preparation pickle pulp to stone ratio should also be high.

Table 2: Variability Studies in Local Mango Genotypes on the basis Physical Parameters

Genotypes	Fruit weight (g)	Pulp weight (g)	Pulp (%)	Pulp thickness (mm)	Peel weight (g)
G-01	105.2	68.06	64.70	14.23	25.3
G-02	53.9	34.2	63.45	13.2	15.3
G-03	56.2	36.93	65.71	16.8	13.3
G-04	54.34	43.2	79.50	15.2	17.3
G-05	64.92	38.93	59.97	18.3	21.3

G-06	40.8	24.31	59.58	12.3	11.2
G-07	88.92	61.2	68.83	19.4	27.5
G-08	112.96	63.5	56.21	18.3	32.6
G-09	155.3	117.5	75.66	20.1	43.4
G-10	62.4	50.1	80.29	15.3	21.2
G-11	199.12	133.63	67.11	21.2	53.2
G-12	151.06	86.06	56.97	20.3	39.4
G-13	67.9	55.9	82.33	17.4	23.2
G-14	95.9	62.3	64.96	16.9	21.5
G-15	114.7	61.4	53.53	16.2	35.7
G-16	112.4	83.3	74.11	26.2	27.4
G-17	115.4	84.2	72.96	21.4	36.8
G-18	96.3	63.4	65.84	19.2	23.8
G-19	116.6	81.23	69.67	14.2	19.8
G-20	108.8	67.9	62.41	24.3	22.6
G-21	116.82	79.86	68.36	28.6	29.4
G-22	83.2	62.3	74.88	18.3	17.5
G-23	91.1	57.4	63.01	19.3	18.7
G-24	109.8	61.3	55.83	16.3	24.6
G-25	95.7	53.9	56.32	13.2	21.3
G-26	137.3	94.3	68.68	18.3	32.5
G-27	140.5	97.5	69.40	13.2	38.4
G-28	92.4	63.2	68.40	19.7	24.8
G-29	240.4	178.32	74.18	21.5	65.7
G-30	129.4	89.6	69.24	23.1	34.7
G-31	71.8	49.3	68.66	18.7	13.4
G-32	146.4	112.4	76.78	16.5	31.9
G-33	70.2	43.4	61.82	14.2	12.5
G-34	85.1	47.9	56.29	19.2	17.8
G-35	95.5	55.4	58.01	21.3	23.7
G-36	87.6	65	74.20	17.2	21.5
G-37	139.3	113.2	81.26	19.4	37.2
G-38	179.3	123.6	68.93	17.2	41.4
G-39	240.4	171	71.13	14.2	64.21
G-40	234.5	163	69.51	13.7	69.4
G-41	214.7	159.3	74.20	14.3	71.5
G-42	270.7	197.4	72.92	16.2	31.2
G-43	121.1	88.4	73.00	17.4	34.2
G-44	213.4	187.3	87.77	13.2	54.7
G-45	72.3	49.4	68.33	17.2	16.5
G-46	164.7	97.8	59.38	18.5	36.7
G-47	95.4	63.4	66.46	19.2	24.9
G-48	118.4	71.4	60.30	14.2	29.4
G-49	98.7	59.3	60.08	19.4	28.4
G-50	168	112.4	66.90	20.3	58.4
Range	40.8 to 270.70	23.83 to 197.4	25.17 to 87.77	13.2 to 28.6	11.2 to 71.5
Mean	121.94	61.72	67.76	17.86	31.16
S.D.	54.55	42.28	7.77	3.44	15.18
Variance	2976.69	1787.57	60.31	11.86	230.44
S.E.+	7.71	5.98	1.10	0.49	2.15
C.V.	44.74	68.50	11.46	19.28	48.72

Table 3: Variability Studies in Local Mango Genotypes on the basis Physical Parameters

Genotypes	Peel (%)	Pulp: Peel ratio	Peel thickness (mm)	Stone weight (g)	Stone percentage (%)	Pulp: stone ratio
G-01	24.05	2.69	2.0	31.33	29.78	2.17
G-02	28.39	1.76	2.0	16	29.68	1.68
G-03	23.67	2.78	1.6	14	24.91	2.64
G-04	31.84	1.38	2.0	19.33	35.57	1.23
G-05	32.81	1.83	1.0	14.1	21.72	2.76
G-06	27.45	2.17	2.0	14.5	35.54	1.68
G-07	30.93	1.59	2.5	30.7	34.53	1.42
G-08	28.86	1.95	2.5	21.3	18.86	2.98
G-09	27.95	1.48	1.5	34.13	21.98	1.89
G-10	33.97	2.36	2.5	27.8	44.55	1.80
G-11	26.72	2.51	2.0	41.06	20.62	3.25
G-12	26.08	2.18	1.5	27.7	18.34	3.11
G-13	34.17	2.41	1.0	24.7	36.38	2.26
G-14	22.42	2.90	1.0	28.4	29.61	2.19

G-15	31.12	1.72	1.5	32.2	28.07	1.91
G-16	24.38	1.03	1.0	54.3	48.31	0.52
G-17	31.89	1.17	2.0	38.7	33.54	1.11
G-18	24.71	2.04	1.5	17.4	18.07	2.79
G-19	16.98	2.03	1.0	29.8	25.56	1.35
G-20	20.77	2.09	2.0	32.4	29.78	1.46
G-21	25.17	2.39	2.0	27.5	23.54	2.56
G-22	21.03	3.56	1.0	21.4	25.72	2.91
G-23	20.53	3.07	1.0	23.9	26.23	2.40
G-24	22.40	2.49	1.0	29.4	26.78	2.08
G-25	22.26	2.53	2.0	32.4	33.86	1.66
G-26	23.67	2.20	2.0	39.4	28.70	1.81
G-27	27.33	1.88	2.0	29.4	20.93	2.46
G-28	26.84	2.55	2.0	23.7	25.65	2.67
G-29	27.33	1.13	2.0	45.1	18.76	1.65
G-30	26.82	1.83	1.0	30.1	23.26	2.11
G-31	18.66	3.68	1.0	25.7	35.79	1.92
G-32	21.79	2.11	2.0	28.4	19.40	2.37
G-33	17.81	3.47	1.0	18.4	26.21	2.36
G-34	20.92	2.69	1.0	20.4	23.97	2.35
G-35	24.82	2.34	2.0	18.4	19.27	3.01
G-36	24.54	3.02	1.0	20.4	23.29	3.19
G-37	26.70	1.92	2.0	33.8	24.26	2.11
G-38	23.09	1.79	1.0	41.3	23.03	1.80
G-39	26.71	1.63	2.0	58.4	24.29	1.79
G-40	29.59	1.04	1.0	59.4	25.33	1.22
G-41	33.30	0.97	3.0	46.7	21.75	1.49
G-42	11.53	2.29	2.0	51.4	18.99	1.39
G-43	28.24	3.41	1.0	31.2	25.76	3.74
G-44	25.63	1.60	1.8	61.7	28.91	1.41
G-45	22.82	2.99	1.5	22.7	31.40	2.18
G-46	22.28	2.16	1.7	31.8	19.31	2.49
G-47	26.10	2.55	1.0	29.3	30.71	2.16
G-48	24.83	2.43	2.0	26.9	22.72	2.65
G-49	28.77	2.09	2.0	22.3	22.59	2.66
G-50	34.76	1.92	1.0	34.2	20.36	3.29
Range	11.53 to 34.76	0.97 to 3.68	0.1 to 3.0	14 to 61.7	18.07 to 48.31	0.52 to 3.74
Mean	25.71	2.20	1.62	30.70	26.52	2.16
S.D.	4.75	0.66	0.53	11.77	6.61	0.67
Variance	22.61	0.43	0.28	138.42	43.76	0.44
S.E.+	0.67	0.09	0.07	1.66	0.94	0.09
C.V.	18.50	29.93	33.12	38.32	24.94	30.79

Conclusions

From overall results, it can be concluded that, twenty selected mango genotypes *viz*. G-18, G-01, G-42, G-40, G-38, G-29, G-31, G-22, G-39, G-41, G-21, G-04, G-9, G-16, G-44, G-50, G-24, G-26, G-32, G-36, are promising amongst all those genotypes which were taken for studies for pickle. So, in all total 50 selected pickle mango genotypes only twenty genotypes are found most promising and could be recommend for pickle making on ad-hoc basis.

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