Studies on the physico- chemical characteristics of some mango germplasm

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Abstract: Twelve mango germplasm viz., MI-001, MI-002, MI-004, MI-006, MI-009, MI-016, MI-023, MI-024, MI-025, MI-026, MI-027 and MI-028 were studied for their physio-morphological and physico-chemical characteristics under the ecological conditions of Mymensingh. The germplasm MI-028 was the best in respect of external appearance. Wide variations were observed among the germplasm in different quantitative characteristics like fruit and stone size and weight. MI-009, MI-027, MI-024 and MI-016 were found to have higher edible portion compared to other germplasm. Peel to pulp ratio as well as pulp to stone ratio was also determined and maximum ratios were observed in MI-027 and MI-023, respectively. Mango fruits were analyzed to observe the chemical compositions. MI-002 possessed maximum moisture and ash contents whereas MI-027 had the highest titratable acidity. The germplasm MI-001 stood first in respect of pH, TSS, total sugar as well as reducing sugar. In contrast, the maximum non-reducing sugar and sugar/acidity ratio were noted in MI-028. Moreover, in terms of vitamin C content MI-025 was the best one among the germplasm studied. Correlation matrix computed for the relationships among the 17 physico-chemical characters showed a wide range of variability in both positive and negative directions with significant and non-significant values.

Introduction

Mango has got a unique position in respect of nutritional quality, taste, consumer's preference etc., among the fifty different fruits grown in Bangladesh (Ahmad, 1985). It has medium calorific and high nutritional values. The fruit has really of immense value in respect of money and prosperity. With the rapid increase in population, the nutritional as well as economic problems are getting worse parallely. To overcome these problems, development of mango variety(ies) by evaluation at different agroclimatic regions may be a programme of immediate importance. The fruit grows in almost all parts of the country. But the commercial and good quality grafted mangoes with known varietal identity are mostly confined in the North-Western districts. The general impression is that elite mango varieties do not perform well when grown in the eastern areas. So, the need exists for finding out the qualitative performance of elite varieties grown in the eastern areas. Unfortunately, information regarding the physio-morphological and physico-chemical characteristics of mango varieties growing under different regions of Bangladesh is scanty. So, an attempt was made to study the phusico-chemical characteristics of 12 mango germplasm under Mymensingh condition.

Materials and Method

The present experiment was conducted at the Germplasm (GP) Center of Fruit Tree Improvement Project (FTIP), Department of Horticulture and the laboratory of the Dept. of Bio-chemistry, Bangladesh Agricultural University, Mymensingh during October, 2000 to September, 2001. The experiment was conducted on ten years old mango plants of 12 germplasm namely MI-001 (Rad) , MI-002 (Farooquebhog), MI-004 (Neelumbori), MI-006 (Neelumboti), MI-009 (Mallika), MI-016 (Tommy Atkin), MI-023 (Gopalbhog), MI-024 (Fazli), MI-025 (Langra), MI-026 (Khirsapat), MI-027 (Ashwina) and MI-028 (Amrapali) . The experiment was laid out in a RCBD with three replications, where a single uniform tree constituted the unit of replication. Both the distances between plant-to-plant and row-to-row were 6m. Similar intercultural operations were done as and when necessary. For this study, the mature fruits were collected randomly from the selected plants. Ten fruits from each of the selected germplasm were taken in the laboratory for recording their physical characteristics like shape of fruit, external appearance, skin colour at ripe stage, peeling quality, skin thickness, pulp colour, fruit weight, fruit size, edible portion, non-edible portion, peel to pulp ratio, stone weight, stone size and pulp to stone ratio. Chemical parameters of mangoes were studied immediately after harvest. Ash content was determined by oven-dried samples placed in a muffle furnace at 600^0 C. The total soluble solid (TSS) content of mango pulp was estimated by using Abbe Refreactometer whereas, pH by pH meter. Total sugar was measured by anthrone method (Jayaraman, 1981). Reducing sugar content of mango pulp was determined by dinitrosalicylic acid method (Miller, 1972). Ascorbic acid content and titratable acidity were determined by visual titration method (Ranganna, 1979).

Results and Discussion

Morpho-physiological characteristics of fruits

The shape of MI-004 and MI-006 were oblong oval but MI-002 and MI-024 were oblongish oval. MI-001 was ellipsoid and MI-26 was almost roundish(Table 1). The shape of MI-009 was oblong whereas, MI-023 and MI-025 were oblique oblong and ovalish oblong, respectively. The germplasm MI-028 was oblong oblique whereas MI-027 and MI-016 were obliquely oval. Good appearance of mango has the highest phenotypic acceptability for consumption. Among the 12-mango germplasm appearance of MI-028 was very good while MI-002, MI-004 and MI-023 were good. On the contrary, MI-009, MI-016 and MI-027 were in poor appearance. The skin colour of ripe fruits of MI-001, MI-006, MI-023, MI-026 and MI-028 were yellowish green while MI-004 had greenish yellow. Ripe fruits of MI-024 and MI-025 were light green while that of MI-016 and MI-027 were green. MI-002 and MI-009 had yellow coloured fruits. Peeling was easy in MI-001, MI-002, MI-004, MI-009, MI-024, MI-025 and MI-028(Table 1). But it was difficult in the remaining germplasm. The fruit skin was thin in MI-001, MI-025 and MI-028 while it was medium in MI-002, MI-004, MI-009, MI-023 and MI-024. Fruits were thick skinned in the remaining cultivars. The pulp colour of the fruits were orange in MI-001, MI-004, MI-006, MI-023 and MI-028; yellow in MI-002, MI-009, MI-025, MI-026 and cream yellow in MI-016, MI-024 and MI-027.

Table 1. Morpho-physiological characteristics of 12 mango germplasm cultivated in the GP center

Germplasm	Shape of fruit	External appearance	Skin colour at ripe stage	Peeling quality	Skin thickness	Pulp colour
MI-001	Ellipsoid	Medium	Yellowish green	Easy	Thin	Orange
MI-002	Oblongish oval	Good	Yellow	Easy	Medium	Yellow
MI-004	Oblong oval	Good	Greenish yellow	Easy	Medium	Orange
MI-006	Oblong oval	Medium	Yellowish green	Difficult	Thick	Orange
MI-009	Oblong	Poor	Yellow	Easy	Medium	Yellow
MI-016	Obliquely oval	Poor	Green	Difficult	Thick	Cream yellow
MI-023	Oblique oblong	Good	Yellowish green	Difficult	Medium	Orange
MI-024	Oblongish oval	Medium	Light green	Easy	Medium	Cream yellow
MI-025	Ovalish oblong	Medium	Light green	Easy	Thin	Yellow
MI-026	Almost roundish	Medium	Yellowish green	Difficult	Thick	Yellow
MI-027	Obliquely oval	Poor	Green	Difficult	Thick	Cream yellow
MI-028	Oblong oblique	Very good	Yellowish green	Easy	Thin	Orange

Table 2. Quantitative characteristics of 12 mango germplasm

Germplasm	Fruit weight (g)	Fruit size (cm)			Edible portion (%)	Non-edible portion (%)			Peel to pulp ratio
		Length	Breadth	Thickness		Peel	Stone	Total	
MI-001	216.62	11.71	6.08	5.60	76.41	13.84	9.75	23.59	5.53
MI-002	276.07	9.50	7.36	6.63	72.58	11.92	15.50	27.42	6.15
MI-004	273.23	9.26	7.32	7.25	69.22	15.85	14.93	30.78	4.37
MI-006	232.11	8.93	6.92	6.30	64.07	17.66	18.27	35.93	3.60
MI-009	394.74	11.73	7.88	7.01	79.05	10.23	10.72	20.95	7.73
MI-016	706.67	12.88	9.71	8.71	77.21	12.53	10.26	22.79	6.17
MI-023	172.33	8.15	6.32	6.03	61.97	16.53	21.50	38.03	3.75
MI-024	453.39	11.80	8.41	7.68	77.34	10.00	12.66	22.66	7.74
MI-025	215.03	8.38	6.50	5.89	68.46	16.49	15.05	31.54	4.15
MI-026	246.38	8.59	7.21	6.28	66.14	17.64	16.22	33.86	3.75
MI-027	415.80	12.03	8.37	7.15	78.64	10.39	10.97	21.36	7.76
MI-028	169.31	8.62	5.91	5.46	68.65	15.25	16.09	31.34	4.52
LSD at 1%	17.12	0.392	0.282	0.272	1.668	1.233	1.356	1.666	0.626
Level of significance	**	**	**	**	**	**	**	**	**

** Significant at 1% level

Quantitative characteristics of fruits

Highly significant variation was found in the fruit weight of different mango germplasm (Table 2). The heaviest fruit (706.67 g) was recorded in MI-016, whereas the lightest fruit was obtained from MI-028 (169.31 g), which was statistically similar to MI-023 (172.33g). A wide range of variation was observed among the germplasm in respect of fruit length. MI-016 produced the longest fruit (12.88 cm) whereas MI-023 produced the shortest fruit (8.15 cm).The average breadth of different mango germplasm was found to vary from 5.91 to 9.71 cm . The thickest fruit (8.71 cm) was in MI-016, whereas MI-024 occupied second position

(7.68 cm). Per cent edible portion of fruits is an important character for selecting quality fruits and in this study it is significantly varied from 61.97 to 79.05% (Table 2). Per cent peel of different mango germplasm ranged from 10.00 to 17.66 (Table 2). The result revealed that the per cent stone weight of the germplasm significantly varied from 9.75 to 21.50%. MI-023 contained proportionately the heaviest stone (21.50%) among the studied varieties. The lightest stone was found in MI-001 (9.75%) closely proceeded by MI-016 (10.26%) and MI-009 (10.72%). The highest percentage of non-edible portion (38.03) was obtained from MI-023 whereas the germplasm MI-009 had the lowest percentage of non-edible portion (20.95). Peel to pulp ratio varied from 3.60 to 7.76 among different mango germplasm (Table 2). The highest ratio (7.76) was observed in MI-027. Saha *et al.* (1995) and Bhuyan and Guha (1995) observed wide range of variability in respect of different physico-chemical characteristics of mango fruits.

Stone characteristics

The stone characteristics in respect of weight, length, breadth, thickness and pulp to stone ratio were studied and the results pertaining to these are reported in Table 3. The mango germplasm under investigation showed highly significant differences in stone weight (Table 3). MI-016 produced the heaviest stone (72.53 g). The lightest stone was observed in MI-001 (21.14 g). MI-016 had the longest stone (11.17 cm) and was significantly different from rest of the germplasm. MI-001 occupied second position (10.77 cm). MI-023 Produced the smallest stone (6.47 cm) closely proceeded by MI-026 (6.97 cm) and MI-004 (7.07 cm). The widest stone (5.13 cm) was also noted in MI-016, which was statistically similar to MI-024 (4.90 cm). The stone thickness of different mango germplasm varied from 1.21 to 2.35 cm. The germplasm MI-001 produced the thinnest stone (1.21), which was significantly different in comparison to other germplasm. Stone characteristics like length, breadth and thickness were studied by Haque *et al.* (1993) and Sardar *et al.* (1998). They observed that the different varieties maintained distinctive stone characteristics of their own. Marked variation in pulp to stone ratio was also observed in the present study among the different mango germplasm. Maximum pulp to stone ratio (0.35) was found in MI-023 followed by MI-006 (0.29) and MI-026 (0.25).

Table 3. Stone characteristics of 12 mango germplasm under investigation

Germplasm	Stone weight (g)	Stone size (cm)			Pulp to stone ratio
		Length	Breadth	Thickness	
MI-001	21.14	10.77	2.97	1.21	0.12
MI-002	42.80	7.54	4.05	2.11	0.21
MI-004	40.80	7.07	4.12	2.16	0.22
MI-006	42.42	7.23	4.06	2.03	0.29
MI-009	45.62	9.10	4.42	2.00	0.14
MI-016	72.53	11.17	5.13	2.30	0.13
MI-023	37.05	6.47	3.61	2.16	0.35
MI-024	57.38	9.91	4.90	2.35	0.16
MI-025	32.37	7.10	3.94	1.85	0.22
MI-026	39.95	6.97	4.14	2.16	0.25
MI-027	45.60	9.47	4.79	2.13	0.14
MI-028	27.20	7.66	3.30	1.80	0.23
LSD at 1%	6.436	0.282	0.262	0.126	0.023
Level of significance	**	**	**	**	**

** Significant at 1% level

Bio-chemical characteristics

The moisture content of the fruit pulp of different mango germplasm under the study ranged from 77.11 to 86.45% (Table 4). MI-002 contained 86.45% moisture and the lowest moisture content (77.11%) was found in MI-001. The highest ash (0.88%) was noted in the fruit pulp of MI-002, whereas the lowest ash (0.42%) was recorded in the fruit pulp of MI-016. MI-001 contained the highest TSS (24.12%) followed by MI-028 (23.00%) and MI-023 (22.07%). The pH of the juice of different mango germplasm ranged from 4.03 to 5.31 (Table 4). It was the highest (5.31) in the fruit pulp of MI-001, whereas the lowest pH (4.03) was noted from the juice of MI-027. The mango germplasm showed wide variation in case of total sugar (Table 4). MI-001 was the highest (20.16%) followed by MI-028 (20.02%) and MI-023 (19.42%). The present results however differ much from the findings of Lodh *et al.* (1974) who obtained 7.35 to 13.20% total sugar in eight varieties of mango. This difference might be due to varietal difference as well as growing climate. Again, the maximum reducing sugar (7.34%) was

found in MI-001, which was significantly different from the rest of the germplasm. Chaudhari *et al.* (1997) reported 2.6 to 7.1% reducing sugar in 19 South Indian mango varieties. The non-reducing sugar content of the fruit pulp of mangoes varied from 9.90 to 14.60%. On the other hand, the highest titratable acidity (0.58%) was found in MI-027, which was closely preceded by MI-016 (0.55%) and MI-025 (0.52%). The ascorbic acid content of the fruits of different mango germplasm ranged from 5.33 to 31.08 mg%. The highest sugar/acidity ratio (79.88) was recorded in MI-028 and the lowest sugar/acidity ratio (22.08) was found in MI-027 (Table 4).

Table 4. Chemical composition of fruits in different mango germplasm

Germplasm	Moisture (%)	Ash (%)	TSS (%)	pH	Reducing sugar (%)	Non-reducing sugar (%)	Total Sugar	Titratable acidity (%)	Sugar/acidity ratio	Ascorbic acid (mg/100g pulp
MI-001	77.11	0.54	24.12	5.31	7.34	12.82	20.16	0.30	68.95	5.33
MI-002	86.45	0.88	17.75	4.23	3.22	11.55	14.77	0.44	33.74	14.37
MI-004	81.31	0.52	20.51	4.42	6.51	10.02	16.53	0.32	52.24	12.28
MI-006	80.59	0.55	20.58	4.48	4.80	12.54	17.34	0.26	67.77	10.31
MI-009	82.83	0.49	19.73	4.16	3.12	12.05	15.17	0.58	26.39	19.93
MI-016	85.37	0.42	17.91	4.10	3.32	10.60	13.92	0.55	25.82	19.46
MI-023	79.03	0.65	22.07	5.0	5.05	14.36	19.41	0.33	58.47	7.40
MI-024	81.18	0.46	18.98	4.50	3.68	11.44	15.12	0.23	59.30	17.82
MI-025	79.69	0.66	20.87	4.62	4.02	13.40	17.42	0.52	33.38	31.08
MI-026	80.05	0.72	21.21	4.98	4.93	13.53	18.46	0.36	44.98	9.51
MI-027	83.02	0.77	16.25	4.03	2.96	9.90	12.86	0.58	22.08	24.42
MI-028	78.75	0.55	23.00	5.08	5.42	14.60	20.02	0.25	79.88	25.42
LSD 1%	1.396	0.145	0.987	0.514	0.731	1.513	1.256	0.072	23.35	1.281
Level of significance	**	**	**	**	**	**	**	**	**	**

** Significant at 1% level

Correlation among different physico-chemical characters

Correlation matrix was also computed to investigate interrelationships among the different physico-chemical characters. It was observed that fruit weight showed highly significant and positive association with fruit and stone size, stone weight, edible portion, moisture content and titratable acidity (Table 5). Attri *et al.* (1999) reported that fruit weight was significantly correlated with fruit length, breadth, per cent edible portion and stone weight. But highly significant and negative correlation was observed with TSS, total sugar, reducing sugar, non reducing sugar, pH and ash. Again, TSS had highly significant and positive relation with total sugar, reducing sugar, non-reducing sugar and pH but it was negatively correlated with titratable acidity, vit. C and ash. Moreover, highly significant and negative correlation existed between the total sugar and titratable acidity. Sarker *et al.* (1979) worked on acid-sugar balance in mango and reported that at the ripe stage total sugar and acidity showed significant negative correlation.

Considering the overall performance of all the germplasm, it appears that MI-028 have a bright prospect for growing under the climatic conditions of Mymensingh. But the results obtained from a single year study is not sufficient to draw a valid conclusion for the performance of any biological entity. This is also very important for long duration tree fruits. So, the same experiment should be repeated under the same environment for further verification of the test results.

Table 5. Correlation matrix among different physico-chemical characters of mango

Characters	Fruit length	Fruit breadth	Fruit thickness	Stone length	Stone breadth	Stone thickness	Stone weight	Edible portion	Moistur	TSS	Vit. C	Total sugar	Reducing sugar	Non-reducin sugar	pH	Ash	Acidity
Fruit weigl	0.811**	0.957**	0.928**	0.727**	0.845**	0.491**	0.896**	0.676**	0.646**	-0.670*	0.24	-0.742*	-0.575**	-0.636**	-0.614*	-0.371	0.475**
Fruit length		0.723**	0.668**	0.949**	0.545**	0.035	0.547**	0.908**	0.391*	-0.455*	0.10	-0.592*	-0.319	-0.615**	-0.396	-0.369	0.386*
Fruit breadth			0.965**	0.573**	0.941**	0.656**	0.934**	0.606**	0.735**	-0.803*	0.20	-0.843*	-0.635**	-0.720**	-0.712*	-0.218	0.488**
Fruit thickness				0.520**	0.901**	0.685**	0.938**	0.533**	0.701**	-0.730*	0.13	-0.792*	-0.507**	-0.751**	-0.685*	-0.321	0.376*
Stone lengt					0.359*	-0.161	0.421**	0.847**	0.215	-0.24	0.07	-0.378*	-0.150	-0.438**	-0.198	-0.436*	0.251
Stone breadth						0.794**	0.912**	0.457**	0.689**	-0.841*	0.32	-0.858*	-0.724**	-0.665**	-0.719*	-0.13	0.459**
Stone thickness							0.773**	-0.057	0.576**	-0.667*	0.13	-0.595*	-0.596**	-0.380*	-0.530*	0.033	0.157
Stone weight								0.373*	0.706**	-0.717*	0.14	-0.734*	-0.619**	-0.569**	-0.644*	-0.29	0.339*
Edible portion									0.413**	-0.464*	0.30	-0.592*	-0.373*	-0.569**	-0.430*	-0.18	0.468**
Moisture										-0.846*	0.22	-0.818*	-0.700**	-0.627**	-0.759*	0.195	0.543**
TSS											-0.361	0.930**	0.807**	0.703**	0.830*	-0.25	-0.583**
Vit. C												-0.369*	-0.540**	-0.091	-0.360	-0.00	0.492**
Total sugar													0.771**	0.838**	0.822*	-0.101	-0.587**
Reducing sugar														0.299	0.688*	-0.231	-0.623**
Non-reducing suga															0.642*	0.048	-0.345*
pH																-0.01	-0.594**
Ash																	0.218

* Significant at 5% level
** Significant at 1% level

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