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Biochemical changes in mango fruit varieties at different stages of growth and development under south Gujarat conditions

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Abstract : The experiment entitled "Biochemical characters of some mango (*Mangifera indica* L.) cultivars and hybrids at different stages of growth and development under south Gujarat conditions" was conducted at the Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). In this experiment six cultivars of mango *viz*., Alphonso, Dashehari, Kesar, Neelum, Rajapuri and Totapuri as well as three hybrids *viz*., Amrapalli, Mallika and Neelphonso were tested for their chemical properties. The experiment was laid out in completely randomized design (CRD) with nine treatments and three repetitions. Regarding chemical parameters, the maximum total soluble solids (TSS %) was recorded in Kesar at marble, mature and ripe stages and in Alphonso at pre-mature stage. The maximum total sugar (%) and reducing sugar (%) were recorded in Alphonso. The non reducing sugar (%) was observed maximum in Alphonso. Titrable acidity (%) was found minimum in Totapuri at marble, pre-mature and mature stages and in Alphonso at ripe stage. TSS: Acidity ratio was maximum in Totapuri at marble, pre-mature and mature stages and in Alphonso at ripe stage.

Key words : Mango varieties, Quality parameters, Stages of growth and development, Storage

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Mango (*Mangifera indica* L.) is the premier fruit of the world belongs to the family Anacardiaceae. It is grown in 111 countries around the world, but this fruit occupies a unique place amongst fruit crops grown for well over 4000 years in Indian subcontinent. Out of 69 species of mango, all the edible and commercial mango cultivars or varieties grown throughout the world belong to *Mangifera indica* L.

Owing to easy availability of this national fruit for a longer period, an excellent flavour and delicious taste with uniform blend of sweet and sour and nutritive value, it attains mass appeal and is called 'The King of the fruits'. Besides this fruit possesses a good source of vitamin-A, B-carotene, vitamin-B complex, vitamin-C, minerals, digestible sugars and trace elements.

In the past, fruit quality tests with regard to chemical parameters were studied only at ripe stage. However, changes in mango fruit were not studied so far for the different varieties at marble, per-mature, mature and ripe stages of growth. To understand the bio-chemical changes in mango fruits at different stages of growth and development, the investigation entitled studies on the changes in chemical properties of some mango cultivars and hybrids at different stages of growth and development under south Gujarat conditions was planned on the nine varieties of mango *viz*., Alphonso, Kesar, Dashehari, Rajapuri, Totapuri, Neelum, Neelphonso, Amrapalli and Mallika.

RESEARCH METHODS

The experiment was carried out at the Laboratory of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The

required quantity of mango fruits of nine varieties were collected from the orchard of Instructional farm of the college, at different four stages of growth and development *i.e.*, marble, pre-mature, mature and ripe stage during the year of 2009. The experiment was laid out in a completely randomized design (CRD) with three repeatitions. Fruits of cultivars. Alphonso, Dashehari, Kesar, Neelum, Rajapuri and Totapuri as well as three hybrids, Amrapalli, Mallika and Neelphonso were tested for their chemical characteristics. Ten fruits from different cultivars and hybrids at marble, pre-mature and mature stage were used on the same day for recording necessary observations in the laboratory. Simultaneously, more ten mature fruits were taken to the laboratory in CFB boxes for ripening process *i.e.* under storage condition. Observations on chemical characters *viz.*, TSS (%), total sugar (%), reducing sugar (%), non-reducing sugar (%), acidity (%) and TSS: Acidity ratio were recorded. The data recorded on various characters during the period of investigation were statistically analyzed by appropriate procedure to completely randomized design as per the method described by Panse and Sukhatme (1967).

RESEARCH FINDINGS AND DISCUSSION

The research results emerged from the investigation are summarized under following heads:

Chemical characteristics:

Total soluble solids (%):

The total soluble solids of different mango cultivars and hybrids recorded gradual increase from marble to ripe stage. Maximum TSS was recorded in Kesar at ripe stage (20.83). Alphanso at premature stage (10.07%) and at ripe stage (20.57%). Totapuri recorded minimum TSS (13.37 %) at ripe stage (Table 1). The increase in TSS from marble to ripe stage might be due to accumulation of more sugars in the fruit as a result of hydrolysis of starch *vis-a-vis* other components. While working with fruits, Tondon and Kalra (1983), Verma *et al.* (1986) and Aree (1987) also found similar results and supported the present findings.

Total sugar (%):

It is evident from the data presented in Table 1 that the total sugar of different cultivars and hybrids of mango increased throughout the growth and development of fuit. Alphonso possessed highest total sugar (13.77 %) at ripe stage. Which was at par with Kesar recording 13.50 % total sugar. In case hybrids, total sugar of Neelphanso and Amarpali was 12.80 and 12.50 per cent, respectively and remained at par with each other. An increased concentration of sugars from marble to ripe stage of fruit development could be attributed to strong source (leaf) and sink (fruit) relationship as well as conversion of starch into sugars during biochemical changes under ripening process which might have resulted into sweetness. In over ripe fruits, total sugar content decreased because of consumption of reducing sugars for respiration and for other energy consuming ripening processes (Fuchs *et al.,* 1980). An increase in total sugar from marble stage to ripe stage was reported by Tondon and Kalra (1983), Aree (1987) and Sharaf *et al.* (1989) which are in conformity with the present investigation.

Reducing sugar (%):

The reducing sugar increased throughout the growth period of mango fruits. It was maximum (5.37 %) in Alphonso at ripe stage, which was at par with Kesar (5.17) (Table 1). This might be due to biochemical changes in sugars leading into increase or decrease in sugar. During ripening, starch content decreased up to some extent resulting into an increase in the reducing sugars (Fuchs *et al.,* 1980). The similar results were also observed by Tondon and Kalra (1983) and Aree (1987) which are in support of the present findings.

Non-reducing sugar (%):

With the development of fruit, the non-reducing sugar increased from marble stage to ripe stage. The data preented in Table 1 showed that non-reducing sugar was significantly higher in Alphonso (8.40 %) followed by Kesar (8.33 %) and Neelum (8.27 %) at ripe stage. During ripening, there was decrease in starch content and an increase in the non-reducing sugars. Similar trend was reported by Fuchs *et al.* (1980) and Verma *et al.* (1986).

Acidity (%) (Titrable):

Titrable Acidity showed the decreasing trend throughout the different stages of growth and development of different varieties and hybrids of mango tested under study. The acidity was maximum in Rajapuri at marble (0.88%), premature, (0.65%) and mature stages (0.57 %). However, it drastically reduced at ripe stage up to 0.17 per cent (Table 1). The decrease in acidity could be due to conversion of acids into sugars and then utilization as respiratory substrate during ripening and later on. The titrable acidity increased continuously and reached the highest level at maturity. The rate of increase was slow in the beginning but, it was very high during the maturation period. The above findings are in accordance with Verma *et al.* (1986), Aree (1987), Aclantara and Mendoza (1991)

Table 1 : Chemical changes in fruits of nine mango varieties, at different stages of develop (Average values)

Character	Varieties / Stages	Alphonso	Dashehari	Kesar	Neelum	Rajapuri	Totapuri	Neelphonso	Amrapalli	Mallika	S.E.	C.D. (P=0.05)	C.V. %
Total	Marble	6.73	6.33	7.13	5.53	6.47	6.47	6.93	7.07	6.67	0.068	0.206	1.318
soluble	Pre mature	10.07	8.47	9.13	8.67	8.20	8.60	8.77	9.77	9.97	0.070	0.210	1.846
solids (%)	Mature	10.20	8.67	11.27	8.87	8.47	8.73	9.27	9.97	10.07	0.096	0.288	1.813
	Ripe	20.57	15.87	20.83	15.70	15.73	13.37	19.03	18.73	17.83	0.208	0.625	2.025
Total	Marble	3.64	2.27	3.34	2.92	2.94	2.48	2.52	3.08	3.48	0.098	0.295	5.758
sugar (%)	Pre mature	3.70	2.38	3.39	2.96	2.92	2.53	2.67	3.09	3.52	0.134	0.404	7.734
	Mature	4.53	3.20	4.29	3.89	3.80	3.82	3.79	4.08	4.18	0.087	0.261	3.816
	Ripe	13.77	11.60	13.50	11.35	11.50	11.23	12.80	12.50	11.77	0.114	0.343	1.623
Reducing	Marble	3.04	2.03	2.80	2.50	2.50	2.20	2.20	2.60	2.90	0.098	0.296	6.773
sugar (%)	Pre mature	3.10	2.10	2.83	2.53	2.55	2.25	2.33	2.60	2.93	0.138	0.413	9.294
	Mature	3.73	2.60	3.53	3.24	3.17	3.03	3.12	3.35	3.40	0.080	0.242	4.325
	Ripe	5.37	4.23	5.17	3.08	4.43	3.53	5.03	5.07	4.73	0.083	0.250	3.200
Non	Marble	0.60	0.23	0.54	0.42	0.44	0.28	0.32	0.48	0.58	0.016	0.050	6.798
reducing	Pre mature	0.60	0.28	0.55	0.43	0.46	0.28	0.33	0.49	0.59	0.016	0.049	6.461
sugar (%)	Mature	0.80	0.60	0.75	0.65	0.63	0.79	0.68	0.73	0.78	0.014	0.042	3.461
	Ripe	8.40	7.17	8.33	8.27	7.27	7.70	7.77	7.43	7.03	0.113	0.339	2.547
Acidity	Marble	0.68	0.70	0.72	0.78	0.88	0.63	0.72	0.82	0.80	0.012	0.038	2.969
(%)	Pre mature	0.48	0.49	0.51	0.55	0.65	0.34	0.42	0.60	0.58	0.011	0.034	3.870
	Mature	0.34	0.34	0.38	0.42	0.57	0.23	0.30	0.53	0.46	0.011	0.033	4.838
	Ripe	0.08	0.18	0.12	0.23	0.17	0.20	0.10	0.14	0.16	0.009	0.027	10.660
TSS:	Marble	9.90	9.04	9.90	7.09	7.35	10.27	9.62	8.62	8.34	1.083	3.25	7.63
Acidity	Pre mature	20.98	17.28	17.90	15.76	12.61	25.29	20.89	16.28	17.19	0.508	1.53	6.62
ratio	Mature	30.00	25.50	29.66	18.74	14.86	37.96	30.90	16.36	21.89	0.272	0.82	3.80
	Ripe	257.12	88.17	173.50	68.26	110.17	66.85	190.30	133.79	114.44	15.783	47.32	18.42

Table 2 : Post harvest changes in chemical parameters during storage of mango fruits (Av. values)

Characters	Varieties Stages	Alphonso	Dashehari	Kesar	Neelum	Rajapuri	Totapuri	Neelphonso	Amrapalli	Mallika	S.E.	C.D. (P=0.05)	C.V. %
Total soluble solids (%)	1st day	10.20	8.67	11.27	7.87	8.47	8.73	9.27	8.67	10.07	0.096	0.288	1.813
	3rd day	13.57	11.83	12.50	10.30	9.47	10.83	11.33	14.20	12.47	0.10	0.31	1.52
	6th day	20.57	15.87	18.70	15.70	13.20	13.37	17.73	18.73	17.83	0.11	0.33	1.05
	9th day	19.97	15.90	20.83	16.70	15.73	13.60	19.03	20.60	18.87	0.12	0.37	1.17
	12th day	19.97	16.00	20.83	16.80	15.87	13.80	17.83	20.70	18.97	0.12	0.37	1.16
	15th day	19.97	16.00	21.00	16.80	15.87	13.80	17.83	20.70	18.97	0.13	0.38	1.20
Total sugar (%)	1st day	4.53	3.20	4.29	3.89	3.80	3.82	3.79	4.08	4.18	0.087	0.261	3.816
	3rd day	7.63	5.52	7.42	6.42	6.21	7.57	6.47	7.90	6.43	0.04	0.11	0.92
	6th day	13.77	11.60	11.20	11.35	8.41	11.23	9.30	12.50	11.77	0.05	0.14	0.72
	9th day	13.63	11.42	13.50	11.32	11.70	11.34	12.80	12.46	11.83	0.06	0.18	0.85
	12th day	13.54	11.28	13.45	11.25	11.63	11.24	12.73	12.44	11.79	0.07	0.20	0.94
	15th day	13.16	11.26	13.27	11.22	11.53	11.16	12.68	12.42	11.71	0.07	0.20	0.90
Reducing sugar (%)	1st day	3.73	2.60	3.53	3.24	3.17	3.03	3.12	3.35	3.40	0.080	0.242	4.325
	3rd day	4.83	3.23	4.07	3.19	3.63	3.24	4.25	4.42	6.27	0.04	0.11	1.52
	6th day	5.37	4.23	4.75	3.08	3.88	3.53	4.62	5.07	4.73	0.03	0.08	1.10
	9th day	5.53	4.33	5.17	3.14	4.43	3.72	5.03	5.12	4.91	0.05	0.14	1.73
	12th day	5.74	4.42	5.33	3.13	4.63	3.62	5.14	5.14	4.97	0.02	0.07	0.81
	15th day	5.76	4.46	5.21	3.10	4.40	3.54	5.18	5.12	4.89	0.02	0.07	0.92
Non reducing sugar (%)	1st day	0.80	0.60	0.75	0.65	0.63	0.79	0.68	0.79	0.78	0.087	0.261	3.816
	3rd day	2.80	2.28	3.36	3.23	2.58	4.33	2.22	3.48	3.17	0.05	0.15	3.28
	6th day	8.40	7.17	6.45	8.27	4.53	7.70	4.68	7.43	7.03	0.06	0.17	1.44
	9th day	8.10	7.09	8.33	8.18	7.27	7.62	7.77	7.34	6.92	0.09	0.26	1.92
	12th day	7.80	6.86	8.12	8.12	7.00	7.62	7.59	7.30	6.82	0.07	0.20	1.46
	15th day	7.40	6.80	8.06	8.12	7.13	7.62	7.50	7.30	6.82	0.08	0.23	1.70
Acidity (%)	1st day	0.34	0.34	0.38	0.42	0.57	0.23	0.30	0.53	0.46	0.011	0.033	4.838
	3rd day	0.28	0.25	0.26	0.36	0.50	0.21	0.27	0.28	0.35	0.01	0.02	3.52
	6th day	0.23	0.17	0.21	0.23	0.47	0.12	0.22	0.14	0.17	0.00	0.01	4.59
	9th day	0.23	0.17	0.17	0.23	0.42	0.08	0.20	0.14	0.17	0.01	0.02	8.46
	12th day	0.23	0.17	0.17	0.23	0.42	0.08	0.20	0.14	0.17	0.01	0.02	8.81
	15th day	0.23	0.17	0.17	0.23	0.42	0.08	0.20	0.14	0.17	0.00	0.01	7.01

and Mandal *et al.* (1993).

TSS : Acidity ratio:

TSS : Acidity ratio of different cultivars and hybrids were found significant at all stages of growth and development under study. The maximum ratio was noted in Totapuri at marble (10.27), premature (25.29) mature stage (37.96) and Alphonso at ripe stage (257.12). This might be due to accumulation of more sugars in the fruit due to hydrolysis of starch and reduction in organic acids at later stages. The results are in conformity with the findings of Aree (1987) and Kudachikar (2003).

Changes in chemical parameters during storage:

Total soluble solids (TSS) (%):

The total soluble solids (TSS) of different cultivars and hybrids of mango during storage was gradually increased with the advancement of storage period (Table 2). Total soluble solids content was significantly higher in Kesar at 1st, 9th, 12th and 15th day of storage while on 3rd day, it was higher in Amrapalli (T_8) and it was higher in Alphonso on the 6th day. The lowest total soluble solids content was noted in Rajapuri during storage period. The increase in total soluble solids content during storage might be due to the accumulation of more sugars and other components in the fruit as a result of hydrolytic activity by the enzymes. The above findings are similar to the reports of Katrodia *et al.* (1984), Medicott and Thompson (1985), Verma *et al.* (1986), Aclantara and Mendoza (1991), Rajput and Pandey (1997), Jadhao *et al.* (2000) and Patel *et al.* (2003).

Total sugar (%):

The data of Table 2 revealed that the total sugar content of fruit was gradually increased with increase in storage period. The total sugar content was significantly the highest in Alphonso at 1st, 6th, 9th and 12th day of storage while at 3rd day, it was highest in Amrapali and at 15th day it was highest in Kesar. During ripening conversion of complex food material into simple substances like sugar is possible because of enzymatic activities leading to improvement in quality. On the other hand, in over ripe fruits, total sugar content decreases because of the consumption of sugar for its respiration and other energy consuming ripening processes (Fuchs *et al.,* 1980). Simultaneously, the biochemical changes occurred amongst the sugar fraction and other constituents in pulp throughout the storage period. Similar results were also reported by Minhas *et al.* (1991), Hossain *et al.*(2001), and Anila and Radha (2003) which are in agreement with the present findings.

Reducing sugar (%):

The reducing sugar of different cultivars and hybrids of mango increased with an increased in storage period (Table 2). Reducing sugar content was significantly higher in Alphonso during storage it might be due to biochemical changes occurred amongst the sugar fractions with other constituents in fruit during storage. During ripening, there was a decrease in starch content and an increase in the reducing sugars. The reports of Katrodia *et al.* (1984) and Verma *et al.* (1986) confirmed the results of the present study.

Non-reducing sugar (%):

The non-reducing sugar content of mango fruits was gradually increased with an increase in storage period. Alphonso significantly recorded the highest non-reducing sugar during 1st and 6th day of storage; at 9th and 12th day it was highest in Kesar; while, at 3rd and 15th day, it was highest in Totapuri and Neelum, respectively (Table 2). During ripening, starch content decreased resulting into increase in the non-reducing sugars. The reports of Verma *et al.* (1986) and Chaudhari *et al.* (1998) supported the present findings.

Acidity (%):

The acidity content of different cultivars and hybrids of mango gradually decreased up to 6th day of storage and at 9th, 12th and 15th day, it remained similar. The acidity content was lowest in Totapuri during storage period (Table 2). The decrease in acidity could be due to conversion of organic acids into sugars and then utilization as respiratory substrate during storage period. The titrable acidity increased continuously and reached the highest level at maturity. The rate of increase was slow in the beginning but it was peak during the maturation period. Similar results were also reported by Aclantara and Mendoza (1991) as well as Minhas *et al.* (1991).

REFERENCES

Aclantara, E.F. and Mendoza, Jr. D. E. (1991). Developmental changes during growth and maturation of 'Pico' mango fruits. *Hort. Aust.,* **61** : 44-54.

Anila, R. and Radha, T. (2003). Physico-chemical analysis of mango varieties under Kerala condition. *J. Tropical Agric.,* **41** (1/2) : 20-22.

Aree, Jaipet (1987). Study on growth and development, biochemical changes and harvesting indices of mango (*Mangifera indica* L.) cv. NANG KLANGWUN. *Bangkok (Thailand)* 64 leaves.

Chaudhari, S. N., Desai, U. T. and Patil, B. T. (1998). Physico-chemical characters of 22 north Indian varieties along with two commercial varieties Alphonso and Kesar at Rahuri. *Recent Hort.* **4** : 1-5.

Fuchs, V., Edna, P. and Zauberman, G. (1980). Changes in amylase activity, starch and sugars contents in mango fruit pulp. *Scientia Hort.*, **13** : 155-160.

Hossain, M. M., Haque, M. A., Rahim, M. A. and Rahman, M. H. (2001). Physico-morphological and compositional variation in ripe fruit of three mango varieties. *J. Biol. Sci.* **1** (11) : 1101-1102.

Jadhao, B.J., Kulwal, L.V., Mahokar, V. K and Joshi, P. S. (2000). Physico-chemical characteristics of fruits of some mango cultivars grown under Akola conditions. *J. Soil & Crops,* **10** (1) : 54-56.

Katrodia, J. S., Bhuva, H. P. and Patel, G. L. (1984). Performance of 60 cvs. of mango for 9 years were recorded since the beginning of fruiting. *Acta Hort.,* **231** (1) : 121-124.

Kudachikar, V. B., Kulkarni, S.G., Aradhya, S.M., Prasad, B. A. and Ramana, K.V.R. (2003). Physico-chemical changes in mango (*Mangifera indica* L.) varieties 'Alphonso' and 'Raspuri' during fruit development and maturation. *J. Food Sci. & Tech.,* Mysore., **40** (3) : 285-289.

Mandal, U., Mandal, S.K. and Mazumdar, B.C. (1993). Comparative fruit development studies of two new mango varieties in the Western Lateritic Zone of West Bengal. *Indian Biol.,* **25** : 2, 69-71.

Meddicott, A. P. and Thompson, A. K. (1985). Analysis of sugars and organic acids in ripening mango fruit (*Mangifera indica* L. var. Keitt) by high performance liquid chromatography. *J. Sci. Food & Agric*., **36** : 561-566.

Minhas, P.P.S., Dhaliwal, G.S., Grewal, G.P.S. and Singh, M.P. (1991). Performance of cvs. of mango under Ludhiana conditions. *Prog. Hort.,* **23** (1-4) : 15-17.

Panse, V. G. and Sukhatme, P.V. (1967). *Statistical methods for agricultural workers*, ICAR, New Delhi.

Patel, R.M., Shah, R.R., Padhiar, B.V. and Patel, N.B. (2003). Physiological changes in different cultivars cvs. of mango. Paper presented in National Seminar on mango held at Junagadh on 14-15th June.

Rajput, S.S. and Pandey, S.D. (1997). Physico-chemical characteristics of some mango cultivars under Chhatisgarh region of Madhya Pradesh. *Hort. J*., **10** (1) : 9-14.

Sharaf, A., Ahmed, F.A. and El-Saadany, S.S. (1989). Bio-chemical changes in some fruits at different ripening stages. *Food Chem*., **31** (1) : 19-28.

Subramanyam, H., Gouri, S. and Krishnamurthy, S. (1976). Ripening behaviour of mango fruits graded on specific gravity basis. *J. Food Sci. Tech*., **13** : 84-86.

Tondon, D.K. and Kalra, S.K. (1983). Changes in sugars, starch and amylase activity during development of mango fruit cv. Dashehari. *J. Hort. Sci*., **58** (3) : 449-453.

Verma, R.A., Tripathi, M. P. and Srivastava, R.K. (1986). Studies on development of carotenoids ripening of mangoes (cv. DASHEHARI). *Prog. Hort*., **18** (1-2) : 39-44.

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