INDIAN JOURNAL OF
ARID HORTICULTURE
Vol.9 (1-2): 96-99

SHORT COMMUNICATION

Changes in chemical parameters of bael [*Aegle marmelos*(L.) Correa] fruits of different cultivars during growth and development

Sanjay Kumar and Bhagwan Deen
Department of Horticulture
N.D. University of Agriculture & Technology, Kumarganj, Faizabad-224229
(Received : 29.09.2014; Accepted: 20.11.2014)

Bael fruit [*Aegle marmelos* (L.) Correa] is known in India from pre-historic time, Hiuen Tsiang, the Chinese Buddhist pilgrim who came to India in 1629 A.D. noted the presence of this tree along with other trees in this region (Sambamurthy and Subrahmanyam, 1989). Bael is a very hardy tree and can be also grown well in swampy, alkaline or stony soils having p^H range from 5 to 8 and up to an altitude of 1200 meters (Orwa *et al.*,2009). It is grown in almost all the states of India. Utilization of bael in day-to-day life has great nutritional, environmental as well as commercial importance. It has been in use from time immemorial in traditional systems of medicine for relieving constipation, diarrhoea, dysentery, peptic ulcer and respiratory infections. The fruits have a pleasant aroma which is not destroyed even during processing. There is a lot of potential for processing bael fruits into various products like preserve, squash, dehydrated slices, toffee, R.T.S. and bael powder etc. which can be very easily popularized in domestic as well as International markets. The dried bael fruit is used for the preparation of 'No Caffeine Tea' in Thailand. Therefore, the present studies were carried out to know the seasonal changes in biochemical constituents in different cultivars during growth and development of bael fruits. These study have been decided the maximum nutritive value and as per need fruits could be harvested.

The studies were carried out on 20 year old uniform and healthy trees growing at N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) The branches were tagged on four sides of the tree and experiment was laid out in C.R.D. with three replications. First sampling was done on July, 2011 and subsequent samples were taken at 30 days interval in NB-4, NB-5, NB-7 and NB-9 after fruit set up to maturity of fruits. The T.S.S. was estimated at ambient temperature by ERMA made Refractometer (0-32) and these values expressed as per cent T.S.S. The acidity, ascorbic acid and sugars were estimated by methods as described by Ranganna (2010). Total carotenoids content was determined by method as suggested by Sagar and Samuel (2008). The total phenols was estimated by the method described by Singhleton and Rossi, 1965 and Singhleton *et al.*, 1999.

The data on changes in T.S.S. content of bael fruits are presented in Table 1. Data show that T.S.S. content of fruits was increase up to 60 DAFS and then started decreasing up to 120 DAFS thereafter T.S.S. content was started increasing again in all the cultivars up to maturity of fruits. The T.S.S. content was maximum (29.10%) in NB-4 followed by NB-9 (27.20%). The increasing, followed by decreasing and again increasing trend in T.S.S. content during growth and development of bael fruits probably due to difference in rate of accumulation of food materials and hydrolysis of polysaccharides into sugars. Kaushik *et al*. (2002) and Roy and Singh (1978) reported that T.S.S. of bael fruits increased continuously with growth and development which are contradictory to the present finding in which increasing followed decreasing followed by increasing in T.S.S. content was observed in bael fruits.

The per cent acidity content was showed decreasing trend in all the cultivars during growth and development of fruits Table 2. The minimum acidity content was recorded in NB-9 cultivars followed NB-4 during entire period of growth and development. NB-7 was significantly higher in acidity content among all cultivars. The acidity content was minimum on 240 DAFS as compare to 30 DAFS in all the cultivars of bael. The decreasing trend in acidity content might be due to rapid utilization of organic acids and conversion of organic acids into their salts and sugars (Ruffner *et al*., 1975). Significantly variation in acidity content among cultivars could be due to cultivar effects. The findings is supported by other workers who have reported that titrable acidity of fruits was decreased with growth in bael (Kaushik *et al*., 2002) and (Nidhi and Gehlot, 2007).

Data show that reducing sugars, non-reducing and total sugars content was increased in all the cultivars during with the growth and development of fruits (Table 3). The maximum reducing sugars, non-reducing and total sugars content was recorded in NB-9 followed by NB-4 during entire period of observation in comparison to other cultivars. After 240 DAFS, NB-9 was significantly observed to be higher in reducing sugars content in comparison to other cultivars. There was no significant difference in total sugars content among the cultivars on 210 and 240 DAFS. The increase in reducing sugars content of fruits might be due to conversion of starch into sugars during growth and development of fruits. The tendency of increment in non-reducing sugars during growth and development might be due to availability of starch amount to hydrolyze into sugars and the increase in total sugars might be because of increase in reducing and non-reducing sugars resulting from the conversion of starch into sugars and variation may account for the cultivars The results are in line with the findings of Roy and Singh (1978) and Mukhopadhyay *et al*. (2002) in bael fruits,

The data recorded on changes in ascorbic acid content during growth and development of fruits in bael cultivars are presented in Table 4. Data show the significant difference in ascorbic acid content between NB-9 and NB-7. The maximum ascorbic acid was recorded in NB-9 (21.75mg/100g) followed by NB-4 (19.90mg/100g) on 240 DAFS. Overall ascorbic acid content increased in all four cultivars of bael with the growth and development of their fruits up to 240 DAFS. The gradual increase in ascorbic acid content could be associated with the greater synthesis of glucose-6-phosphate, which served as a precursor for its synthesis in fruits (Mapson, 1970). The results are confirmed by Selvaraj *et al*. (1999) who reported that ascorbic acid content increased during fruit maturation and ripening of Guava, similar results are also accordance with the findings of Singh *et al*. (1998) in Kinnow mandarin.

The data on changes in total carotenoids content during growth and development of bael fruits are presented in Table 5. Data show continuous increase in total carotenoids content in all the cultivars during the growth and development of fruits. On 240th DAFS, the total carotenoids content was higher in all the cultivars than initial day of observation; however, NB-9 was significantly higher in comparison to others on 240 DAFS. Increase in total carotenoids might have taken place because of the unmasking of these pigments and conversion of chlorophyll into carotenoids as the fruits approached to maturity. The results are similar to Kaushik and Yamdagni (1999) who reported more than 4 fold increase in carotenoids during fruit maturation in bael fruits. The findings is also supported by similar reports of Singh *et al*. (1998) in Kinnow Mandarin.

Data furnished in Table 6 show that total phenol content was continuously decreased during growth and development of fruits in all cultivars. The maximum total phenol content was observed in NB-9 followed by NB-5 during entire period of growth and development. Total phenol content was higher on 30th DAFS in all the cultivars of bael which was decreased when fruits proceeded towards maturity. The possible reason of decrease in total phenols in fruits might be due to reduction in tannins begun with increase in sugar synthesis and the original acrid taste of fruit diminished. The finding is supported by other workers who have also reported that during growth and development total phenol content decreased in bael fruits Roy and Singh, (1980), Kaushik *et al.* (2000) and in papaya (Abu-Gaukh *et al.*, 2010).

Table 1. Changes in total soluble solids content (%) during growth and development of fruits

Cultivars	T.S.S. at different intervals (days)							
	30	60	90	120	150	180	210	240
NB-4	28.10	32.10	22.10	19.20	22.10	23.10	27.10	29.10
NB-5	25.10	26.10	20.20	16.20	19.20	20.00	21.20	26.20
NB-7	22.20	28.10	19.20	18.20	20.10	21.00	22.10	24.10
NB-9	30.10	31.20	21.10	14.10	19.00	20.20	22.10	27.20
SEm$\pm$	0.574	0.663	0.455	0.341	0.449	0.480	0.507	0.486
C.D. at 5%	1.872	2.162	1.483	1.111	1.464	1.565	1.655	1.585

Table 2. Changes in acidity content (%) during growth and development of fruits

Cultivars	Acidity content at different intervals (days)							
	30	60	90	120	150	180	210	240
NB-4	0.54	0.51	0.50	0.48	0.46	0.43	0.38	0.35
NB-5	0.58	0.55	0.53	0.51	0.48	0.44	0.39	0.36
NB-7	0.61	0.57	0.54	0.52	0.49	0.45	0.42	0.37
NB-9	0.52	0.50	0.48	0.44	0.42	0.41	0.37	0.33
SEm$\pm$	0.013	0.012	0.012	0.008	0.010	0.008	0.009	0.006
C.D. at 5%	0.043	0.039	0.038	0.025	0.032	0.025	0.028	0.020

Table 3. Changes in sugars content (%) during growth and development of fruits

Treatments	Sugars content at different intervals (days)											
	30			60			90			120		
	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total
T1 (NB-4)	3.10	6.65	9.75	3.75	7.60	11.35	4.00	8.55	12.55	4.65	8.40	13.05
T2 (NB-5)	2.05	6.65	8.70	3.15	6.75	9.90	3.70	7.90	11.60	4.00	7.65	11.65
T3 (NB-7)	2.20	5.70	7.90	3.25	6.60	9.85	3.80	6.65	10.45	4.10	7.20	11.30
T4 (NB-9)	3.15	6.65	9.80	4.00	8.50	12.50	4.20	8.65	12.85	4.90	8.70	13.60
SEM ±	0.060	0.146	0.206	0.070	0.162	0.239	0.096	0.155	0.197	0.101	0.182	0.247
C.D. at 5%	0.196	0.475	0.672	0.229	0.530	0.779	0.312	0.504	0.642	0.330	0.592	0.807
Treatments	Sugars content (%)											
	150			180			210			240		
	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total	Reducing	Non-Reducing	Total
T1 (NB-4)	4.75	8.55	13.30	4.95	8.65	13.60	5.05	9.00	14.05	5.05	9.20	14.25
T2 (NB-5)	4.45	8.25	12.70	4.75	8.40	13.15	4.85	8.80	13.65	4.90	8.95	13.85
T3 (NB-7)	4.55	8.00	12.55	4.80	8.15	12.95	4.90	8.30	13.20	4.95	8.55	13.50
T4 (NB-9)	5.00	8.80	13.80	5.10	8.90	14.00	5.15	9.25	14.40	5.20	9.50	14.70
SEM ±	0.103	0.168	0.264	0.076	0.158	0.193	0.062	0.156	0.241	0.061	0.182	0.219
C.D. at 5%	0.335	0.547	0.861	0.249	0.514	0.629	0.202	0.508	0.787	0.199	0.593	0.713

Table 4. Changes in ascorbic acid content (mg/100g) during growth and development of fruits

Cultivars	Ascorbic acid at different intervals (days)							
	30	60	90	120	150	180	210	240
NB-4	10.50	11.00	11.50	12.70	14.65	15.89	18.05	19.90
NB-5	9.70	9.85	10.25	12.05	13.80	15.30	16.90	18.50
NB-7	9.30	9.55	10.10	11.70	13.10	14.00	16.15	17.25
NB-9	11.00	11.20	12.70	13.30	15.00	17.65	19.20	21.75
SEm±	0.203	0.255	0.258	0.272	0.319	0.314	0.388	0.447
C.D. at 5%	0.662	0.831	0.840	0.888	1.041	1.023	1.264	1.457

Table 5. Changes in total carotenoids content (μg/100g) during growth and development of fruits

Cultivars	Total carotenoids at different intervals (days)							
	30	60	90	120	150	180	210	240
NB-4	14.20	14.50	14.90	17.00	20.90	23.10	26.20	30.75
NB-5	14.50	14.80	15.20	18.60	21.10	24.50	29.30	32.50
NB-7	13.00	13.10	13.55	15.20	18.08	20.04	23.90	27.10
NB-9	15.40	16.20	17.50	20.10	24.50	29.20	33.80	37.30
SEm±	0.309	0.280	0.352	0.384	0.498	0.426	0.685	0.742
C.D. at 5%	0.009	0.914	1.147	1.253	1.625	1.390	2.234	2.420

Table 6. Changes in total phenols content (mg/100g) during growth and development of fruit

Cultivars	Total phenols at different intervals (days)							
	30	60	90	120	150	180	210	240
NB-4	71.50	70.00	62.50	57.30	46.70	40.00	35.20	30.80
NB-5	72.60	71.20	63.40	58.00	47.10	42.80	36.00	31.50
NB-7	69.80	65.40	61.00	55.80	42.30	38.00	34.10	28.60
NB-9	74.50	72.50	66.60	59.00	48.60	43.20	38.90	32.40
SEm±	0.706	1.131	1.128	0.605	1.057	0.718	0.813	0.626
C.D. at 5%	2.302	3.687	3.678	1.972	3.448	2.340	2.653	0.042

References

Abu-Goukh, A.B.A., Shattir, A.E.T. and Mahdi, E.F.M. 2010. Physico-chemical changes during growth and development of papaya fruit (chemical changes). *Agric. and Biol. J. North America*, **1** (5): 871-877.

Kaushik, R.A. and Yamdagni, R. 1999. Changes in bio-chemical constituents of bael fruit during growth and development. *J. Med. Arom.Pl. Sci*., 21 (1): 26-28.

Kaushik, R.A., Yamdagni, R. and Dhawan, S.S. 2000. Physico-chemical characteristics Seasonal changes of bael (*Aegle marmelos* Correa) fruit at green and ripe stage of maturity. *Haryana J. Hort., Sci*., 29 (1/2): 44-45.

Kaushik, R.A., Yamdagni, R. and Dhawan, S.S. 2002. Seasonal changes during growth and development of bael (*Aegle marmelos* Correa) fruit. *Haryana J. Hort. Sci*., 31 (1/2): 32-34.

Mapson, L.W. 1970. Vitamins in fruits. In " biochemistry of fruits and their products". Ed. A.C. Hulme Vol. 1, Academic Press, London and New York. pp 369.

Mukhopadhyay, P., Gongopadhyay, D. and Mazumdar, B.C. 2002. Further studies on qualitative constituents of bael (*Aegle marmelos* Correa) fruits grown in the Sunderbans area of West Bengal. *Indian Agricult.*, 46 (1/2): 97-102.

Nidhi, and Gehlot, R. 2007. Studies on physico-chemical character tics of fresh bael and guava fruits. *Research on Crops*, 8 (1): 189-190.

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Simons, A. 2009. Agro-forestry data base, 4.0.

Ranganna, S. 2010. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill, New Delhi.

Roy, S. K. and Singh, R.N. 1980. Studies on changes during development and ripening of bael fruit. *Punjab Horticultural Journal.*, 20 (3/4): 190-197.

Ruffner, H.P., Koblet, W. and Rast, D. 1975. Galacogenesis in the ripening berries of grapes (*Vitis vinifera*). *Vitis*, 13 (4): 319-328.

Sagar, V.R. and Samuel, D.V.K. 2008. Laboratory Manual on Analysis of Fruit and Vegetable Products. Discipline of Post Harvest Technology, IARI, New Delhi.

Sambamurthy, A.V.S.S. and Subrahmanyam, N.S. 1989. Fruits and Nuts, A text Book of Economic Botany, Wiley Eastern Limited, New Delhi, pp.697-698.

Selvaraj, Y., Pal, D.K., Raja, M.E. and Rawal, R.D. 1999. Changes in chemical composition of guava fruits during growth and development. *Indian J. Hort.*, 56 (1): 10-18.

Singh, H.K., Singh, O.P., Dutt, S.N. and Dutt, A.S. 1998. Studies on fruit growth and development in kinnow. *Indian J. Hort*., 55 (3): 177-182.

Singleton, V.L. and Rossi, J.A. Jr. 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungtic acid reagent. *American Journal of Ecology and Viticulture*, 16: 144-158.

Singleton, V.L., Orthofer, R. and Lamuela-Raventos, R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteau reagent. *Methods in Enzymology*, 299 : 152-178.