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Behavioral Pattern of Physicochemical Constituents of the Postharvest Mango (*Mangifera indica* L.) Influenced by Storage Stimuli

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Abstract: An investigation was carried at the laboratory of the Department of Biochemistry and Molecular Biology, University of Rajshahi, Bangladesh during the period from May, 2010 to September, 2011 to study the behavioral pattern of some physicochemical constituents of the mango pulp. The experiment was comprised of two popular mango cultivars in Bangladesh (viz., Langra and Khirshapat) and six storage stimuli, namely control, paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water (55±1°C) and low temperature (4±1°C). The two factors experiment was assigned in randomized complete block design with tree replicates. The varieties had profound variation in terms of most of the characters studied in the laboratory condition. Initially the Langra significantly enriched a greater amount of vitamin C (151.23 mg/100 g) and titratable acidity (4.31%) and these were decreased gradually with the progress of storage period. The Khirshapat showed higher pulp pH (5.83); produced enormous amount of TSS (18.00%) and sugar (TS = 17.62%, RS = 6.51% and NRS = 11.06%) content at 12th day of storage. The pH, TSS, sugar (TS, RS and NRS) content of mango pulp was rapidly increased, whereas vitamin C and titratable acidity decreased drastically from the untreated mangoes. On the other hand, low temperature retarded the changes. The Langra using low temperature (4±1°C) exhibited lower diminishing tendency in vitamin C and titratable acidity and also using no treatment slightly increased TSS; enriched enormous amount of sugar (TS, RS and NRS). Therefore, low temperature (4±1°C) was found satisfactory for delay ripening and postharvest changes of mango in storage condition.

Key words: Postharvest, mango, cultivars, storage stimuli, physicochemical constituents

INTRODUCTION

The mango (*Mangifera indica* L.) is being one of the most popular fruit crops grown in tropical and subtropical region of the world (Mukherjee, 1956). It is very important for its aromatic flavor, attractive color, delicious taste and nutritional values. Green and ripe mangoes are used for making-juice, chutney, pickles, jam, jelly etc. and recognized as the king of fruits in Bangladesh as well as in other South-East Asian countries (Shahjahan *et al*., 1994). Nutritionally, it contains enormous amount of appreciable β carotene, vitamin C, acidity and dietary fibre and soluble sugars which are used for good sources of human nutrition. It is capable to prevent many deficiency diseases and possesses antioxidant activities (Purohit, 1985). The postharvest loss of fresh mango fruit is one of the major problems because of its perishability in nature and climacteric pattern in respiration. There is a prominent evidence of postharvest loss which is calculated from 5-25% in developed countries and 20-50% in developing countries (Khader, 1985). The changes in physicochemical constituents of the postharvest mango can be considerably reduced by applying improved storage methods. Inducing of different postharvest stimuli viz., paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water and low temperature are very efficient barriers to the normal respiration of mango fruits. These stimuli strongly impede in ethylene synthesis that resulted in low respiration and delay changes (Tefera *et al.,* 2007; Benitez *et al*., 2006; Fawaz, 2006; Muy *et al.,* 2004). The postharvest change is a normal phenomenon which occurs naturally inside the mangoes and sometimes needs for human nutrition (Fonseca *et al.,* 2004). The behavior of the changes of constituents in the postharvest mango is needed for knowing the information regarding the stages in which essential composition remain at the maximum or minimum quantities. So, the study was undertaken from the point of view.

MATERIALS AND METHODS

Experimental materials and design: Mature but unripe green mango cultivars, namely the Langra and the Khirshapath were assembled from Kansart of Shibgonj Upazila of Chapai Nowabgonj district and the other materials used as storage stimuli viz., paraffin wax and polyethylene cover were taken from Royal scientific store at cooperative market of Rajshahi city. The experiment was comprised of two factors and laid out in Randomized Complete Block Design (RCBD) with three replicates. The cultivars [viz., Langra (V_1) and Khirshapat (V_2)] were treated with control = T_0, Paraffin Coating (PC) = T_1, Perforated Polythene Cover (PPC) = T_2, Un-perforated Polythene Cover (UPC) = T_3, Hot Water (HW) (55± 2°C) = T_4 and Low Temperature (LT) (4± 1°C) = T_5. Each block contained 12 treatments.

Preparation of storage stimuli: Solid paraffin wax was made liquid by heating in a large aluminum pot. The 19×15 cm sized polyethylene covers were perforated with scissors at nine equal positions of the bags and the same sized polyethylene covers were also used as unperforated polythelene cover. The tap water was heated in a hot water bath (55±2°C) for a period of 5 min. Mangoes were stored in a refrigerated incubator at 4±1°C temperature. The temperature of the refrigerated incubator was maintained by adjusting the button on the incubator.

Studied parameter: Vitamin C and Titratable acidity of the mango pulp was estimated by the titrimetric method as denoted by Ranganna (1979). The pulp pH was determined using pH 7 and 4 buffer tablets (BDH chemicals Ltd., Poole, England).Total Soluble Solid (TSS) content of mango pulp was estimated by using Abbe Refractometer. Temperature correction was done using the methods as described by Ranganna (1979). Total Sugar (TS) content of mango pulp was determined calorimetrically by the Anthrone method (Jayaraman, 1981). Reducing Sugar (RS) content of mango pulp was determined by Dinitrosalicylic Acid Method as narrated by Miller (1972). Non-Reducing Sugar (NRS) content of the mango pulp was calculated as:

$$NRS\ (\%) = TS-RS$$

Statistical analysis: The collected data was statistically analyzed by analysis of variance method. The means of different parameters was compared using DMRT as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effects of cultivars: The Postharvest Langra enriched a greater amount of vitamin C and titratable acidity in comparison with the Khirshapat at different days of storage (Fig. 1 and 2). The quantities of constitutes drastically decreased with the time of storage. The decreasing behavior appeared higher from initial to 6th day and thereafter they decreased slightly. Initially,

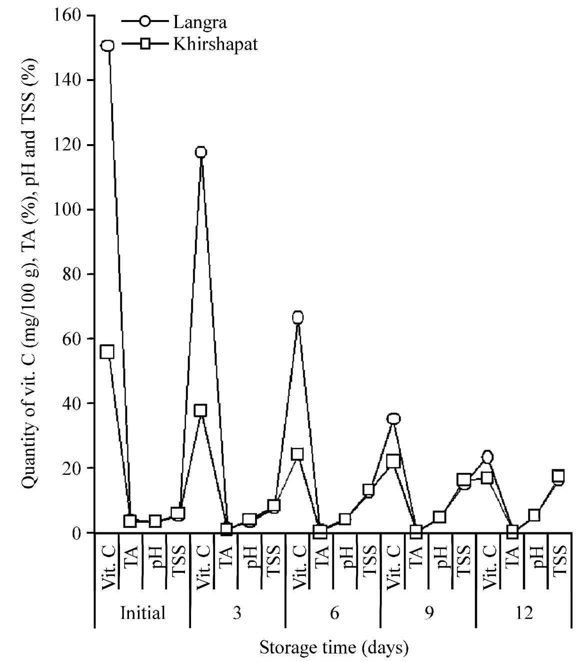

Fig. 1: Quantitative status of vitamin C, titratable acidity (TA), pH and TSS of pulp of the two postharvest mango varieties at different days of storage

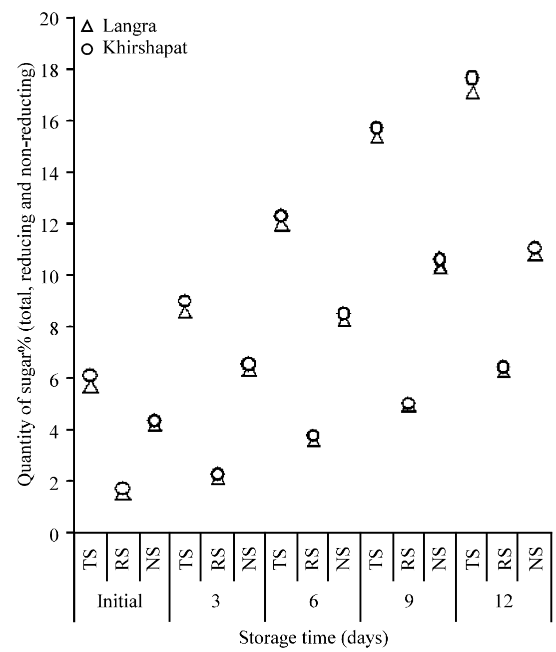

Fig. 2: Quantity of total sugar (TS), reducing sugar (RS) and non-reducing sugar (NS) content of pulp of the two postharvest mango varieties at different days of storage

the Langra produced higher amount of vitamin C (151.23 mg/100 g) and titratable acidity (4.31%), whereas the Khirshapat produced lower amount of vitamin C (56.00 mg/100 g) and titratable acidity (3.55%), respectively. Diminishing behavior of vitamin C and titratable acidity might be due to breaking down of ascorbic acid and titratable acidity and formation of sugar. The results of the present study are in agreement with the findings of Gafur *et al.* (1997). The Khirshapat progressively showed more pulp pH, received with larger amount of TSS and sugar (TS, RS and NRS) content over the Langra as mentioned in Fig. 1-2. The amount of pulp pH, TSS and sugar content increased with the advance of storage times. At 12th day, the Khirshapat gave a greater amount of pulp pH (5.83), TSS (18.00%) and sugar (TS = 17.62%, RS = 6.51% and NRS = 11.06%) content whereas the Langra produced lower amount of pulp pH (5.67), TSS (17.04%) and sugar (TS = 17.17%, RS = 6.33%) and NRS = 10.84%) content, respectively. An increasing trend of pulp pH was also reported by Shahjahan *et al.* (1994). This phenomenon might be due to oxidation of acid during storage resulting in higher pulp pH. Absar *et al.* (1993) reported that TSS was increased with the maturity of mango fruit. But, they found the highest TSS in the Langra. The results are in conformity with the findings of Shahjahan *et al.* (1994). Tsuda *et al.* (1999) also found the similar results. The results regarding reducing sugar content are in agreement with the findings of Castrillo, *et al.* (1992). The results of non-reducing sugar content are in conformity with the findings of Absar *et al.* (1993).

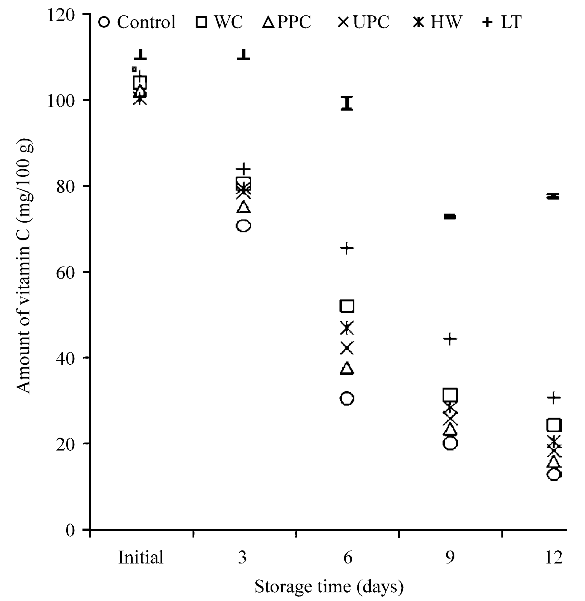

Fig. 3: Vitamin C content of pulp of the postharvest mango influenced by different storage treatments at different days of storage. Vertical bars represent LSD at 0.05 levels

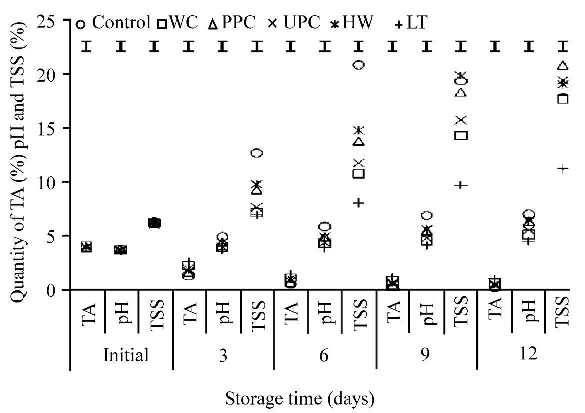

Fig. 4: Titratable acidity, pH and TSS of the postharvest mango pulp influenced by different storage treatments at different storage times. Vertical bars represent LSD at 0.05 levels

Effects of storage stimuli: A significant decrease of vitamin C and titratable acidity and the profound increase of pulp pH, TSS and sugar (TS, RS and NRS) content of the mango pulp influenced by different storage stimuli with the advance of storage period are presented in Fig. 3-5. Initially, low temperature (4±1°C) had profound influence to produce a good amount of vitamin C (105.50 mg/100 g) and titratable acidity (4.01 %). They were decreased with the progress of times. A higher decreasing trend of vitamin C and titratable acidity was recorded from control whereas lower trend was recorded from low temperature (4±1°C) (Fig. 3-4). The decreasing trend in vitamin C and titratable acidity from both the treated and untreated mangoes at different storage period might be due to oxidation and low temperature might be possibly caused delay ripening resulting in lower oxidation. The results are strongly supported by the findings of Hossain (1999) in case of vitamin C and partially supported by the findings of Tefera *et al.* (2007) in case the of titrable acidity. Pulp pH, TSS and sugar content (TS, RS and NRS) of the mango pulp significantly increased from control, whereas low temperature retarded the rapid changes (Fig. 4-5). At 12th day of storage, higher pulp pH (6.95) was noticed from control whereas the influence of low temperature gave lower pulp pH (4.45). The results of pulp pH are in strongly supported by the findings of Tefera *et al.* (2007). Higher quantities of TSS (20.67%) were recorded from control and perforated polyethylene cover and the lowest amount (11.09%) was noticed from low temperature. The results are in partially supported by the findings of Jacobi *et al.* (2000). At 12th day of storage, a greater amount of sugar (TS = 20.70%, RS = 7.13% and NRS = 13.15%) content was obtained from the effect of hot water and the lowest amount (TS = 11.94%, RS = 4.91% and NRS = 6.27%) was recorded from the effect of low temperature. Puttaraju and Reddy (1997) stated in their findings that low temperature was most effective in delay ripening but the quality of these fruits were unacceptable due to higher rate of spoilage. Increase in reducing sugar during storage was stated by Tripathi (1988). The results are in agreement with the reports of Rangavalli *et al.* (1993).

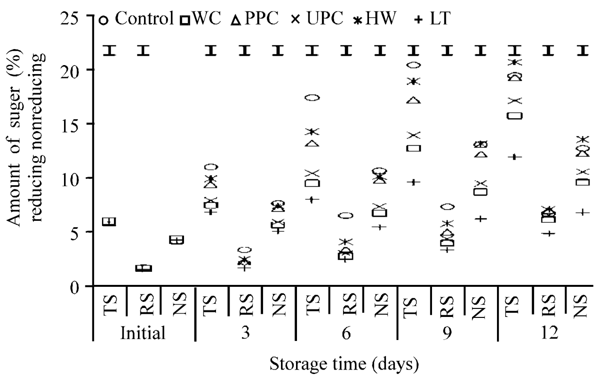

Fig. 5: Amount of sugar content (total, reducing and non-reducing) of pulp of the postharvest mango influenced by different storage treatments at different days of storage. Vertical bars represent LSD at 0.05 levels

Combined effects of cultivars and storage stimuli: A decreasing trend of the amount of vitamin C and titratable acidity and the increasing trend of pulp pH, TSS and sugar (TS, RS and NRS) content of the postharvest mango pulp influenced by cultivars and different external storage stimuli are presented in Table 1-3. The pulp of the Langra using low temperature accumulated a greater amount of vitamin C (155.30 mg/100 g) and titratable acidity (4.42%) whereas the pulp of the Khirshapat using hot water produced a lower amount of vitamin C (52.50 mg/100 g) and titratable acidity (3.48%) at initial day of storage. The amount of the constituents decreased with the advance of storage times. At 12th day of storage,

Table 1: Combined effects of cultivars and different storage stimuli on vitamin C content and titratable acidity of the postharvest mango

Treatments combination	Vitamin C content (mg/100 g) at different days					Titratable acidity (%) at different days				
Varieties×Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	150.60^{bc}	110.70^{e}	45.60^{f}	24.80^{g}	15.60^{b}	4.25^{bc}	1.50	0.60	0.35^{h}	0.18^{g}
V_1T_1	152.30^{b}	120.40^{b}	75.50^{b}	36.50^{b}	27.35^{b}	4.30^{b}	2.45	1.20	0.87^{c}	0.65^{c}
V_1T_2	149.60^{cd}	114.60^{d}	55.30^{e}	28.60^{e}	19.20^{f}	4.20^{c}	1.82	0.75	0.45^{g}	0.29^{f}
V_1T_3	151.40^{bc}	118.30^{c}	62.40^{d}	30.70^{d}	21.60^{e}	4.35^{cb}	2.02	0.92	0.62^{e}	0.42^{e}
V_1T_4	148.20^{d}	119.70^{bc}	68.60^{c}	33.80^{c}	23.50^{d}	4.32^{b}	2.30	1.05	0.75^{d}	0.53^{d}
V_1T_5	155.30^{c}	125.80^{c}	95.60^{c}	58.20^{c}	35.80^{c}	4.42^{c}	2.83	1.60	1.35^{c}	1.10^{c}
V_2T_0	58.60^{e}	30.60^{i}	15.60^{l}	15.60^{k}	10.33^{j}	3.55^{ef}	0.95	0.45	0.24^{i}	0.15^{g}
V_2T_1	55.20^{f}	40.50^{fg}	28.80^{h}	26.30^{f}	21.65^{e}	3.65^{d}	1.99	0.95	0.67^{e}	0.62^{c}
V_2T_2	54.70^{f}	35.80^{h}	20.30^{k}	18.60^{j}	12.83^{i}	3.50^{ef}	1.25	0.57	0.34^{h}	0.26^{f}
V_2T_3	59.40^{e}	38.75^{g}	22.45^{j}	21.30^{i}	15.50^{h}	3.52^{ef}	1.45	0.72	0.44^{g}	0.37^{e}
V_2T_4	52.50^{g}	39.40^{g}	25.60^{i}	23.40^{h}	17.85^{g}	3.48^{f}	1.49	0.84	0.55^{f}	0.49^{d}
V_2T_5	55.61^{f}	42.20^{f}	35.55^{g}	30.85^{d}	25.93^{c}	3.60^{de}	2.35	1.25	0.95^{b}	0.82^{b}
Level of significance	***	*	***	***	***	*	NS	NS	***	***
CV%	1.01	1.34	1.62	0.36	1.06	1.33	6.89	11.46	4.10	2.38

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table 2: Combined effects of cultivars and different storage stimuli on pulp pH and TSS content of the postharvest mango

Treatments combination	Pulp pH at different days					TSS content (%) at different days				
Varieties×treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	3.70	4.80	5.70^{b}	6.80^{c}	6.90^{c}	5.82	12.13	20.22	18.75^{d}	17.25^{h}
V_1T_1	3.60	3.80	4.10^{h}	4.40^{g}	5.10^{g}	5.63	6.62	10.12	13.63^{i}	16.83^{i}
V_1T_2	3.70	4.30	4.80^{d}	5.30^{d}	6.20^{c}	5.74	8.74	13.21	17.72^{e}	20.22^{b}
V_1T_3	3.60	3.90	4.30^{fg}	4.70^{f}	5.40^{f}	5.51	7.05	11.12	15.13^{g}	18.72^{e}
V_1T_4	3.50	4.20	4.60^{e}	5.20^{d}	6.00^{d}	5.73	9.24	14.24	19.24^{c}	18.45^{f}
V_1T_5	3.50	3.60	3.80^{i}	4.00^{h}	4.40^{h}	5.65	6.43	7.56	9.25^{k}	10.75^{k}
V_2T_0	3.80	4.90	5.90^{c}	6.90^{c}	7.00^{c}	6.72	13.05	21.13	19.62^{b}	18.13^{g}
V_2T_1	3.70	3.90	4.20^{gh}	4.60^{f}	5.00^{g}	6.56	7.52	11.23	14.73^{h}	18.23^{g}
V_2T_2	3.80	4.40	4.90^{d}	5.50^{c}	6.30^{c}	6.62	9.62	14.11	18.62^{d}	21.12^{c}
V_2T_3	3.60	4.00	4.40^{f}	4.90^{e}	5.60^{e}	6.53	8.12	12.15	16.15^{f}	19.75^{c}
V_2T_4	3.80	4.50	5.10^{c}	5.80^{b}	6.60^{b}	6.64	10.13	15.12	20.12^{c}	19.32^{d}
V_2T_5	3.60	3.70	3.90^{i}	4.10^{h}	4.50^{h}	6.53	7.35	8.42	9.92^{j}	11.42^{j}
Level of significance	ns	ns	*	**	***	ns	ns	ns	*	***
CV%	2.85	2.50	2.24	2.01	1.81	1.70	1.24	0.79	0.65	0.59

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table 3: Combined effects of cultivars and different storage stimuli on total, reducing and non reducing sugar content of the postharvest mango

Treatments combination	Total sugar content (%) different days					Reducing sugar (%) at different days					Reducing sugar (%) at different days				
Varieties×treatments	Initial	3	6	9	12	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	5.85	10.86	17.27	20.12	19.15	1.65	3.25	6.46	7.26^b	6.57^{de}	4.21	7.61	10.48	12.86^b	12.58
V_1T_1	5.82	7.32	9.33	12.55	15.55	1.55	1.75	2.65	3.92^i	6.02^g	4.27	5.57	6.68	8.63^f	9.53
V_1T_2	5.75	9.25	13.05	17.12	19.12	1.62	2.12	3.32	4.95^e	6.93^c	4.11	7.13	9.73	12.17^c	12.19
V_1T_3	5.78	7.82	10.32	13.85	17.05	1.58	1.88	2.95	4.32^g	6.53^e	4.22	5.94	7.37	9.53^d	10.52
V_1T_4	5.72	9.78	14.07	18.79	20.56	1.66	2.46	4.06	5.78^c	7.03^b	4.06	7.32	10.03	13.01^b	13.53
V_1T_5	5.77	6.67	7.87	9.47	11.57	1.58	1.68	2.48	3.38^j	4.88^h	4.19	4.99	5.39	6.09^h	6.69
V_2T_0	6.25	11.25	17.58	20.78	19.77	1.88	3.48	6.65	7.43^c	6.85^c	4.37	7.77	10.93	13.35^c	12.92
V_2T_1	6.22	7.72	9.72	12.94	15.93	1.75	1.95	2.86	4.12^h	6.27^f	4.47	5.77	6.86	8.82^e	9.66
V_2T_2	6.18	9.67	13.48	17.42	19.57	1.82	2.32	3.52	5.13^d	7.12^b	4.36	7.35	9.96	12.29^c	12.45
V_2T_3	6.12	8.12	10.62	14.13	17.32	1.78	2.08	3.18	4.54^f	6.65^d	4.34	6.04	7.44	9.59^d	10.67
V_2T_4	6.21	10.13	14.48	19.15	20.84	1.75	2.55	4.15	5.87^c	7.22^c	4.46	7.58	10.33	13.28^c	13.62
V_2T_5	6.15	7.14	8.25	9.86	12.31	1.70	1.82	2.63	3.42^j	4.93^h	4.45	5.23	5.62	6.44^g	7.05
Level of significance	ns	ns	ns	ns	ns	ns	ns	ns	*	**	ns	ns	ns	*	ns
CV%	1.74	1.18	1.46	0.67	1.00	3.07	2.28	1.39	1.04	0.81	2.39	1.60	1.24	0.99	0.95

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

higher quantities of vitamin C (35.80 mg/100 g) and titratable acidity (1.1%) were recorded from the Langra with low temperature and the lowest amount of vitamin C (10.33 mg/100 g) and titratable acidity (0.15%) were obtained from the Khirshapat using no treatment (Table 1). The pulp pH and TSS content of the postharvest mango appeared to be increased from various treatment combinations with the passing of storage times (Table 2). At 12th day, the highest amount of pulp pH (7) was noticed from the Khirshapat using no treatment and the lowest (4.40) was found from the Langra using low temperature. The highest amount of TSS content (21.12%) was obtained from the Khirshapat treated with perforated polyethylene cover and the lowest (10.75%) was obtained from the Langra using low temperature at final stage of storage. The amount of sugar (TS, RS and NRS) content of the postharvest mango pulp slightly increased with the increase of storage period influenced by cultivars and storage treatments and found non-significant variation in most of the storage period (Table 3). The results are in partial agreement with the findings of Islam *et al.* (2011) when worked with different cultivars.

CONCLUSION

The two mango cultivars, mentioned in the investigation, namely the Langra and the Khirshapat are very much popular fruit crops in Bangladesh. But the pattern of physicochemical constituents of the two cultivars varies in manifold. Comparatively, the Langra enriches in plenty of vitamin C and titratable acid content as compared to the Khirshapat. On the other hand, Khirshapat showed a better performance for the production of TSS and sugar content over the Langra. It is found that vitamin C and titratable acid content decrease and pulp pH, TSS and sugar content increase with the advance of storage period. There also appears differentiation in the influence of different postharvest storage stimuli. The effect of control accelerates in the reduction of vitamin C and titratable acid content and influences in increasing in pulp pH, TSS and sugar content whereas, the effect of low temperature retards in the reduction of vitamin C and titratable acid content and also accelerates in the increase of pH, TSS and sugar content in the mango pulp which may help in mango storage in future.

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REFERENCES

Absar, N., M.R. Karim and M.A.L. Amin, 1993. A comparative study on the changes in the physico-chemical composition of ten varieties of mango in Bangladesh at different stages of maturity. Bangladesh J. Agric. Res., 18: 201-208.

Benitez, M.M., A.L. Acedo, P. Jitareerat and S. Kanlavanarat, 2006. Mango fruit softening response to postharvest treatments. Acta Hort., 712: 811-816.

Castrillo, M., N.J. Kruger and F.R. Whatley, 1992. Sucrose metabolism in mango fruit during ripening. Plant Sci., 84: 45-51.

Fawaz, S.A., 2006. Effect of postharvest treatments on physicochemical characters of mango fruits (cv. Bullock's heart) during storage. Ann. Agric. Sci. Moshtohor, 44: 705-716.

Fonseca, M.J.O., P.R. Cecon, L.C.C. Salomao and R. Pushmann, 2004. Fungicides and wax in postharvest preservation of mango Haden. Acta Hort., 645: 557-563.

Gafur, A, M.Z. Shafique, M.O.H. Helali, M. Ibrahim, M.M. Rahman and M.S. Alam, 1997. Studies on extension of postharvest storage life of mango (*Mangifera indica* L.). Bangladesh J. Sci. Ind. Res., 32: 148-152.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, pp: 67-215.

Hossain, M.M., 1999. A study of the physicochemical changes during storage and shelf life of mango. M.S. Thesis, Department of Horticulture Bangladesh Agricultural University, Mymensingh, Bangladesh.

Islam, M.K., A.K.M.R. Islam and N. Absar, 2011. Postharvest Storage and Shelf Life of Mango. Lap Lambert Academic Publishing, Germany, pp: 1-286.

Jacobi, K.K., E.A. MacRae and S.E. Hetherington, 2000. Effects of hot air conditioning of Kensington mango fruit on the response to hot water treatment. Postharvest Biol. Technol., 21: 39-49.

Jayaraman, J., 1981. Laboratory Manual in Biochemistry. 1st Edn., Wiley Eastern Ltd., New Delhi, India.

Khader, A.K., 1985. Postharvest technology of horticultural crops, cooperative extension. University of California, Special Publication No. 331, pp: 35-43.

Miller, G.L., 1972. Use of dinitro salicylic acid reagent for determination of reducing sugar. Anal. Chem., 31: 426-428.

Mukherjee, P.K., 1956. The behaviour of mango varieties Dashehari and Langra under low temperature. Annual Report of Fruit Research, State Saharanpur, India, pp: 60.

Muy, R.D. J.C. Siller, J.P. Diaz and B.T. Valdez, 2004. Storage condition and waxing affect water status and quality of mango. Rev. Fitotcnia Mexicana, 27: 201-209.

Purohit, A.G., 1985. Fruit trees for social forestry. Indian Hort., 30: 3-3.

Puttaraju, T.B. and T.V. Reddy, 1997. Effect of precooling on the quality of mango (cv. Mallika). J. Food Sci. Technol., 34: 24-27.

Ranganna, S., 1979. Manual of Analysis of Fruits and Vegetables Products. Tata McGraw Hill Publ. Co. Ltd., New Delhi, India, Pages: 634.

Rangavalli, K., C. Ravisankar and P.H. Prasad, 1993. Postharvest changes in mango (*Mangifera indica* L.) var. Baneshan. South Indian Hort., 41: 169-170.

Shahjahan, M.S., M.A. Sheel, M.A. Zaman and M.A. Sakur, 1994. Optimization of harvesting maturities for major mango cultivars in Bangladesh. Bangladesh J. Sci. Res., 12: 209-215.

Tefera, A., T. Seyoum and K. Woldetsadik, 2007. Effect of disinfection, packaging and storage environment on the shelf life of mango. Biosyst. Eng., 97: 201-212.

Tripathi, J.S., 1988. Postharvest changes during storage and ripening of Gaurjeet mango fruit. Madras Agric. J., 75: 155-156.

Tsuda, T. K. Chachin and Y. Ueda, 1999. Studies on keeping quality of imported Carabao mango fruit from the Philippines. J. Jap. Soc. Hort. Sci., 68: 669-674.