Biochemical constituents and storability of postharvest mango (*Mangifera indica* L.*)* influenced by different levels of gibberellic acid

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Abstract: An experiment was conducted with two mango genotypes, namely the Langra and the Khirshapat treated with four different doses of gibberellic acid (GA_3) solution, *viz.* control, 100, 200 and 400 ppm to study the pattern of biochemical composition and storability of postharvest mango. Data obtained from various biochemical analyses and storability of postharvest mango, were recorded and analyzed statistically for comparison among the mean values using DMRT and LSD. The Langra showed better performance in accumulation of higher quantity of crude fiber, lipid, water soluble protein, and potassium over the Khirshapat. Alternatively, the Khirshapat showed extended shelf life than the Langra during storage. The results explored that some physicochemical constituents like crude fibre, total lipid, water soluble protein and potassium were rapidly increased and crude fiber along with shelf life drastically decreased in untreated mangoes. The solution of 400 ppm of GA_3 showed better performance in delaying the changes in physicochemical properties and extended shelf life. The combination of the Langra using control progressively increased total lipid, water soluble protein and potassium content up to a phase of metabolic cycle and thereafter, these compositions decreased. The Khirshapat along with 400 ppm of GA_3 solution extended shelf life up to 18.00 days of storage.
Key words: Postharvest, mango, cultivars /varieties, GA_3, storage.

Introduction

Mango (*Mangifera indica L.*) is one of the most important fruit crop in tropical and subtropical regions of the world under the family Anacardiaceae and it was originated in South Asia or Malayan archipelago. The main mango producing countries of the world are India, Pakistan, Mexico, Brazil, Haiti and the Philippines, of which India being the largest producer (Salunkhe and Desai, 1984).

Mango is one of the most popular fruit crop owing to its greater utility, characteristics flavor, attractive color, pleasant aroma, delicious taste and nutritional value. It contains substantial quantity of appreciable β carotene, vitamin C, and dietary fibre (Pal, 1998) as well as soluble sugars and different minerals which are used for good sources of nutrition and readily available and easily assumable in human body (Singh, 1960) and therefore, is capable to prevent many deficiency diseases (Samad *et al.,* 1975, Purohit, 1985, Anon., 1962). An adult individual needs about 2222 K cal atleast of which 2.5% K cal should come from fruits daily as the gross food requirements, but he/she obtains only 1% K cal (Mondal, 2000). A considerable amount of fresh fruits goes waste every year through post-harvest decay. The magnitude of post harvest losses in fresh fruit is estimated to be about 5 to 25% in developed countries and 20 to 50% in developing countries (Khader, 1985). To extend the postharvest life of mango, its respiration rate should be reduced as for as possible. Ripening of fruits starts after synthesis of ethylene which causes ripening fast. The factors which strongly influence the rate of respiration and inhibit the synthesis of ethylene are very essential for reduction of losses and extension of shelf life of postharvest mango. Hormonal treatment like GA_3 is also excellent ethylene inhibitors. The treatment performed effectively in reduction of postharvest decay, and extension of shelf life of mango (Ranjan *et al.,* 2005; Dhemre and Waskar, 2004; Gautam *et al.* 200_3; Reddy and Haripriya, 2002; Ahmed and Singh, 2000). Apparently, the treatments deteriorate the qualities of fruits to some extent, but the reduction of losses and extension of postharvet life of mango will help to increase the market price in the off seasons which play a good role in the economic development of a country.

Materials and Methods

Experimental materials and design: Two green mango cultivars, the Langra and the Khirshapat were taken from a greater mango growing areas of Baneshore, Cerghat Upazila in Rajshahi district and gibberellic acid (GA_3) used as experimental material was bought from Royal Scientific shop at Co-operative market of Rajshahi city. The two factors experiment was assigned in randomized complete block design (RCBD) with three replications. The Langra (V_1) and the Khirshapat (V_2) were treated with different levels of Gibberellic Acid (GA_3) solution, namely control (G_0), 100 ppm (G_1), 200 ppm (G_2) and 400 ppm (G_3). Each block contained 8 treatments.

Preparation of GA_3 solution: The solution of GA_3 was prepared as 100, 200, and 400 ppm by dissolving 100, 200, and 400 mg of GA_3 in one litre of distilled water. The fruits of both varieties were dipped into the solution for a period of 5 minutes. Care was taken to ensure sufficient absorption of GA_3 by the fruits and then they were stored at room temperature on brown paper.

Application of GA_3 solution: Different levels of GA_3 used in the experiment were sequentially assigned to the collected fruits. After applying the treatments, the fruits were kept on a brown paper, which was previously laid out in Randomized Complete Block Design and placed on the laboratory floor at ambient condition. For each treatment combination of replication, there were six fruits, of which one was kept for recording shelf life. The remaining five fruits were preserved in a deep refrigerator (-85^0 C) at Protein and Enzyme Laboratory in the Department of Biochemistry and Molecular Biology, University of Rajshahi for recording the data periodically at five different dates (at 3 days interval). Five fruits from each treatment combination of every replicate were chemically analyzed for the determination of the changes in crude fibre, total lipid, protein and potassium content.

Physicochemical Parameters: Crude fibre of the mango pulp was determined following the procedures as given in the Biochemical Methods for Agricultural Sciences as stated by Sadasivam and Manickam (1992). Total lipid content of fruit pulp was calculated using the method as described by Bligh and Dyer (1959). Water soluble protein content of mango pulp was estimated following the

method as described by Lowry *et a*l. (1951). Potassium content of mango pulps was determined following the procedure as stated by Petersen (2002).

Shelf life: Shelf life (days) of mango as influenced by different levels of GA_3 solution and varieties was estimated by counting the days required to ripen fully with retaining optimum marketing and eating qualities.

Statistical analysis: The accumulated data obtained from the chemical determination were analyzed statistically by analysis of variance method. The means of different parameters were compared using DMRT and LSD as described by Gomez and Gomez (1984).

Results and Discussion

Crude fibre content: The means of crude fibre was found to be highly significant between two cultivars at different days of storage. The Langra was found better in the accumulation of crude fibre. At initial day, the Langra produced the highest (1.29%) quantities of crude fiber as compared to the Khirshapat (1.18%). The amount of crude fiber reduced gradually with the increase of storage period in both the varieties. At 12th day, the highest (0.56%) quantity of crude fiber was recorded from the Langra whereas the lowest (0.41%) was recorded from the Khirshapat (Table 1).

Table 1. Changes in crude fibre and lipid content of mango pulp between varieties during storage at ambient condition

Treatments	Crude fibre (%) at different days					Lipid content (%) at different days				
Variety(V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.29 a	1.17 a	0.90 a	0.73 a	0.56 a	0.19 a	0.37 a	0.52 a	0.68 a	0.70 a
V_2	1.18 b	0.98 b	0.71 b	0.54 b	0.41 b	0.18 b	0.35 b	0.49 b	0.63 b	0.65 b
Level of significance	*	***	***	***	***	***	***	***	***	***

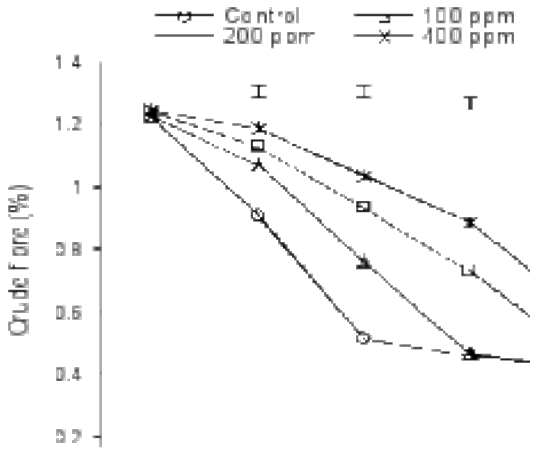

Figure 1. Crude fibre content of mango pulp as influenced by different doses of GA_3 at different days after storage. Vertical bars represent LSD at 0.05 level

The results are in partially conformity with the findings of Peter *et al.* (2007). The results showed that crude fiber dereased gradually with the advance of storage period (Fig. 1). At all days of storage, it denoted that crude fiber was comparatively higher at the fruit treated with GA_3 solution. At 3rd day, the maximum amount (1.19%) of crude fiber was observed from 400 ppm solution of GA_3 which was statistically at par with 100 ppm and 200 ppm treatments and the lowest (0.91%) was recorded from control. At 12th day, the maximum (0.62%) was obtained from 400 ppm whereas the lowest (0.42%) was obtained from 100 ppm treatment which was also statistically at par with control and 200 ppm. The diminishing trend of crude fiber influenced by 400 ppm treatment might be possible due to interruption of ripening resulted in lower reducing trend of crude fiber content. The results also demonstrated that crude fibre fell off gradually with the increase of storage period (Table 2).

Table 2. Combined effects of varieties and different doses of gibberellic acid solution on crude fibre and lipid conten t of postharvest mango pulp during storage at ambient condition

Treatments combination	Crude fibre (%) at different days					Lipid content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	1.28	1.00	0.60	0.55	0.52	0.22	0.45	0.74 a	0.84 a	0.69 c
V_1G_1	1.29	1.16	0.86	0.56	0.51	0.20	0.39	0.54 c	0.76 b	0.80 a
V_1G_2	1.30	1.22	1.02	0.82	0.57	0.19	0.33	0.43 e	0.58 d	0.68 cd
V_1G_3	1.30	1.28	1.13	0.98	0.63	0.17	0.30	0.38 g	0.53 e	0.63 e
V_2G_0	1.16	0.81	0.41	0.36	0.34	0.20	0.43	0.67 b	0.75 b	0.60 f
V_2G_1	1.17	0.97	0.67	0.37	0.32	0.18	0.37	0.52 d	0.69 c	0.74 b
V_2G_2	1.18	1.03	0.83	0.63	0.38	0.16	0.31	0.41 f	0.56 d	0.66 d
V_2G_3	1.20	1.10	0.95	0.80	0.60	0.16	0.28	0.36 h	0.51 e	0.61 ef
Level of sign.	NS	NS	NS	NS	NS	NS	NS	**	***	***
CV%	8.59	9.90	13.03	14.72	14.69	5.53	2.99	2.11	1.64	1.53

It also elucidated that the treatment combination of V_1G_3 was observed to be better in receiving of crude fiber content at all storages duration. At 6th day, the highest (1.13%) quantity of crude fiber was recorded from the treatment combination of V_1G_3 which was statistically at par with V_1G_2 and V_2G_3 and the lowest (0.41%) was noted from the treatment combination of V_2G_0.

Total lipid content: It was noticed that an enhancing trend of lipid content was recorded in mango pulp with the increase of storage duration. At all days of storage, the Langra was observed as high content of lipid producer comparing to the Khirshapat. At 12th day, higher amount of lipid (0.70%) was noticed from the Langra and lower (0.65%) was noticed from the Khirshapat (Table 1). The phenomenon might be possible due to the genetically dissimilarities between two varieties. It was exposited that a growing up trend of lipid content was found with the passing of storage period at various days of storage (Fig. 2).

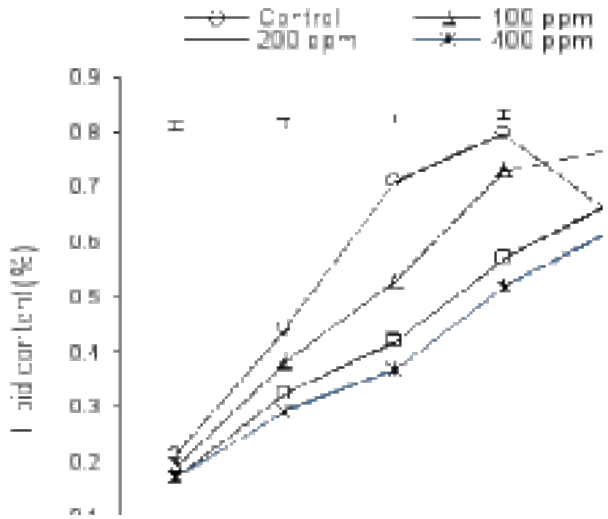

Figure 2. Lipid content of mango pulp as influenced by different doses of GA_3 at different days after storage. Vertical bars represent LSD at 0.05 level

It also demonstrated that without treatment accumulated comparatively higher amount of lipid followed by G_1, G_2 and G_3 treatments from initial to 9th day of storage; and then, it fell off due to starting of decay. At 12th day, G_1 treated fruit gave the highest (0.77%) amount of lipid and the lowest (0.62%) was noted from the fruit treated with G_3 treatment. The results denoted that an increasing trend of lipid content in mango pulp was visible with the increase of storage duration (Table 2). It also showed that the treatment combination of V_1G_0 produced more quantity of lipid at initial to 9th day and then, it came down due to starting in deterioration of fruits. At this time, lower quantity was recorded from the treatment combination of V_2G_3. At 9th day, the highest (0.84%) quantity of lipid was recorded from the treatment combination of V_1G_0 whereas; the lowest (0.51%) was recorded from the treatment combination of V_2G_0, which was statistically at par with V_2G_3.

Water soluble protein content: There appeared an increase trend of water soluble protein with the advance of storage time. It also revealed that the Langra was observed better in water soluble protein synthesis as compared to the Khirshapat at all the stages of storage. At 9th day, the highest (1.00%) synthesis of WSPC was noticed from the Langra whereas the lowest (0.88%) was noticed from the Khirshapat (Table 3). The events were possible due to some of seed protein of mango might have to be disseminated to pulp portion during ripening and complex metabolic activities. Various results derived from the analysis was noticed to be an augmenting trend of water soluble protein in mango pulp with the expansion of storage period (Fig. 3). It also denoted that water soluble protein was achieved more in untreated fruit followed by the fruit treated with G_1, G_2 and G_3, respectively. The growing up trend of water soluble protein in control was very sharp from initial to 6th day thereafter; it declined due to deterioration of fruit condition. At the same time, the increasing trend of water soluble protein from the fruit treated with G_3 treatment was very slow due to delay ripening. At 9th day, the highest (1.21%) accumulation of water soluble protein was obtained from control which was statistically identical with G_1 treatment and the lowest (0.69%) was obtained from G_3 treatment which was also statistically at par with G_2 treatment, respectively. The results denoted that water soluble protein grew up gradually from initial to 9th day with the treatment combination of V_1G_0 then, it abated due to putrefied condition of fruits whereas, the lower increasing trend was obtained from the treatment combination of V_2G_3. At 9th day, the highest (1.25%) quantity of water soluble protein was derived from the treatment combination of V_1G_0 which was statistically at par with V_1G_1 and V_2G_0 whereas; the lowest (0.65%) was derived from the treatment combination of V_2G_3, which was also statistically at par with V_2G_2 and V_1G_3 (Table 4).

Table 3. Changes in water soluble protein and phosphorus content of mango pulp in varieties during storage at ambient condition

Treatments	Water soluble protein content (%) at different days					Potassium (%) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.56 a	0.70 a	0.86 a	1.00 a	1.18	0.24 a	0.25 a	0.27 a	0.29 a	0.29 a
V_2	0.46 b	0.60 b	0.74 b	0.88 b	1.11	0.22 b	0.23 b	0.26 b	0.27 b	0.27 b
Level of significance	**	*	*	*	NS	***	***	**	***	***

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level, V_1 = Langra , V_2 = Khirshapat, *** indicate at 0.1% level, ** indicate at 1 % level , * indicates at 5% level, NS means non significant.

Potassium content: It was noticed that a rising trend of K content was found from both the varieties with the advance of storage period at different days (Table 3). In all the storage period, the Langra produced higher amount of K comparing to the Khirshapat. It also indicated that the rising trend of K content was stopped at 9th day. At this period, higher (0.29%) amount of K was noticed from the Langra and lower (0.27%) was noticed from the Khirshapat . At storage period, K content increased might be possible due to transmission of K from stone and peel

to pulp of mango. The results demonstrated that K content developed in a continuous stream with the increase of storage period. But, K content from the untreated fruit fell away at 9th day, whereas other treatments such as G_1, G_2 and G_3 treatment retained their increasing behavior (Fig. 4). In this period, it was found a very lower trend of changes of K content in the fruit treated with G_3. At 9th day, the maximum (0.30%) of K content was obtained from the untreated fruit whereas; the lowest (0.26%) was obtained from the fruit treated with G_3 treatment which was statistically at par with G_2 treatment. Lower quantity of K in the fruits treated with G_3 treatment might be possible due to delay ripening that caused lower transmission of K content. The results are in partially supported by the findings of Peter *et al.* (2007).

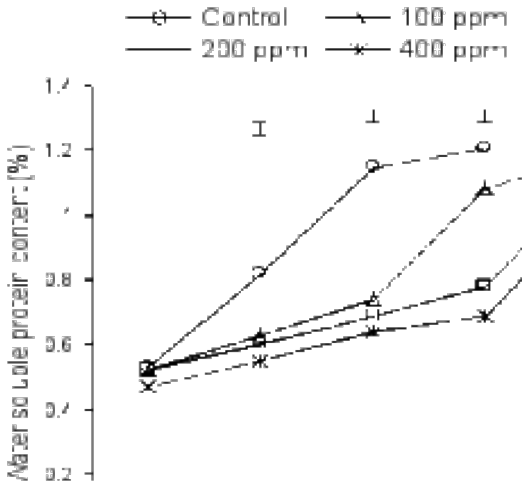

Figure 4. Potassium content of mango pulp as influenced by different doses of GA_3 at different days after storage. Vertical bars represent LSD at 0.05 level

Table 4. Combined effects of varieties and different doses of gibberellic acid solution on water soluble protein and phosphorus content of the postharvest mango pulp during storage at ambient condition

Treatments combination	Water soluble protein content (%) at different days					Potassium content (%) at different days					shelf life
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12	Days
V_1G_0	0.55	0.88	1.20	1.25	1.23	0.25	0.27	0.30	0.31	0.28	7.67
V_1G_1	0.56	0.68	0.80	1.16	1.22	0.24	0.25	0.28	0.30	0.31	12.67
V_1G_2	0.58	0.65	0.75	0.86	1.18	0.23	0.24	0.26	0.28	0.29	14.33
V_1G_3	0.53	0.60	0.70	0.73	1.08	0.22	0.23	0.25	0.27	0.28	16.00
V_2G_0	0.50	0.75	1.10	1.16	1.18	0.23	0.25	0.28	0.29	0.26	8.67
V_2G_1	0.48	0.58	0.67	1.00	1.15	0.22	0.23	0.26	0.27	0.28	13.67
V_2G_2	0.45	0.55	0.62	0.70	1.10	0.21	0.22	0.25	0.26	0.27	15.33
V_2G_3	0.40	0.50	0.57	0.65	1.00	0.20	0.21	0.24	0.25	0.26	18.00
Level of sign.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	14.80	14.22	13.32	11.30	9.28	4.71	4.47	4.00	3.81	3.59	5.66

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level, V_1 = Langra , V_2 = Khirshapat, G_0 = Control, G_1 = 100 ppm of GA_3 solution, G_2 = 200 ppm of GA_3 solution, G_3 = 400 ppm of GA_3 solution, *** indicate at 0.1% level, ** indicate at 1 % level , * indicates at 5% level, NS means non significant.

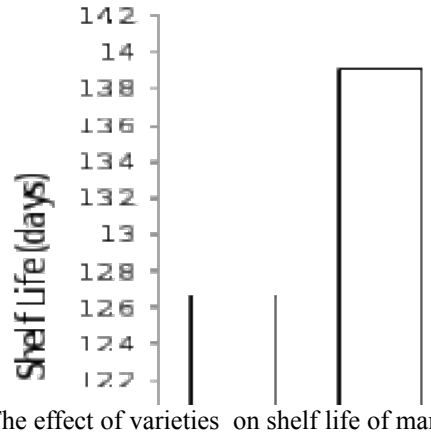

Figure 5. The effect of varieties on shelf life of mango

The results also indicated that K content of mango pulp from different treatment combination developed gradually with the increasing of storage time (Table 4). But, K content from the treatment combination of V_1G_0 had diminished at 9th day. In this period, the highest (0.31%) quantity of K was notified from the treatment combination of V_1G_0 which was statistically identical with V_1G_1 and V_2G_0 whereas; the lowest (0.25%) was notified from the treatment combination of V_2G_3.

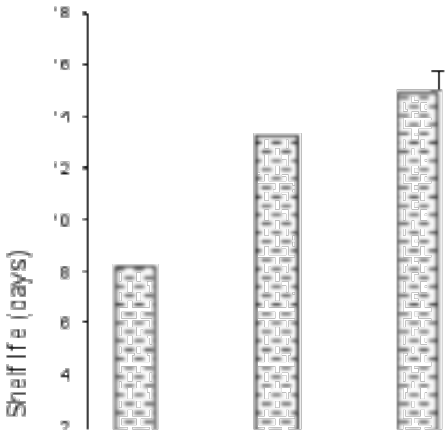

Figure 6. Effect of different doses of GA_3 on shelf life of mango. Vertical bars represent LSD at 0.05 level

Shelf life: It was found to be highly significant variation between the varieties on shelf life of mango (Fig. 5). The longest shelf life (13.92 days) was obtained from the Khirshapat and the shortest (12.67 days) was obtained from the Langra. Variation in shelf life between varieties might be possible due to genetical.

Applied different doses of GA_3 solution in this investigation in terms of shelf life of mango showed highly significant. The longest shelf life (17.00 days) was observed from the fruit treated with G_3 treatment followed by the shelf life of the fruits treated with G_2 (14.83 days), and G_1 (13.17 days) treatments whereas; the shortest shelf life (8.17 days) was observed from control, (Fig. 6). The results of the present investigation are in conformity with the findings of Ranjan *et al.* (2005), Jain and Mukherjie (2001) and Mondal *et al.* (1995). The combined effects of varieties and different doses of GA_3 solution in terms of shelf life of mango were observed non significant (Table 4). The longest shelf life (18.00 days) was noticed from the treatment combination of V_2G_3, whereas the shortest (7.67 days) was noticed from V_1G_0, respectively.

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