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MINERALOGICAL RESPONSE OF THE POSTHARVEST MANGO (*MANGIFERA INDICA L.)* TO DIFFERENT LEVELS OF BAVISTIN DF

(Tindak balas Minerologi Lepas Tuai Terhadap Mangga (*Mangifera Indica L.*) Pada Tahap Bavistin DF Berbeza)

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Abstract

This study was carried out with the postharvest mangoes (*viz.*, the Langra and the Khirshapat) treating with different levels of Bavistin DF solution (namely, 250, 500, and 750 PPM) for obtaining results on the mineral content changes as well as storability of postharvest mango. The results of the experiments exhibited that only the single effect of varieties was found to be significant in most of the parameters studied. The Langra enriched a greater quantity of magnesium, iron and manganese constituents over the Khirshapat. On the other hand, Khirshapat enriched higher quantities of calcium, copper and zinc content at all the storage duration. Different postharvest treatments subjected to the investigation demonstrated significant variation in most of the mineralogical properties of mango at different days of storage. The result explored that calcium, magnesium, iron, and manganese contents were rapidly increased. On the other hand copper and zinc content drastically decreased from untreated mangoes.

Keywords: mango; postharvest treatment; Bavistin DF; mineral content.

Abstrak

Kajian lepas tuai ini dijalankan terhadap mangga lepas (Langra dan Khirshapat) yang dirawat dengan larutan Bavistin DF pada tahap yang kepekatan berbeza (iaitu, 250, 500 dan 750 ppm) untuk mendapatkan keputusan tentang perubahan kandungan mineral serta tempoh keboleh simpanan mangga lepas tuai. Keputusan eksperimen menunjukkan bahawa hanya kesan tunggal didapati penting dalam kebanyakan parameter yang dikaji. Jenis Langra diperkayakan dengan kuantiti magnesium, ferum dan mangan lebih basar berbanding Khirshapat. Sebaliknya, Khirshapat diperkayakan kuantiti kalsium, kuprum dan zink lebih tinggi kandungannya pada setiap tempoh penyimpanan. Rawatan lepas tuai yang berbeza tertakluk matlamat kajian yang menunjukkan perbezaan ketara di dalam kebanyakan sifat-sifat mineralogi mangga pada perbezaan hari penyimpanan. Hasil kajian mendapati bahawa kandungan kalsium, magnesium, ferum dan mangan meningkat dengan pesat. Sebaliknya kandungan kuprum dan zink menurun secara drastik daripada mangga dirawat.

Kata Kunci : mangga, rawatan lepas tuai, Bavistin DF, kandungan mineral

Introduction

Mango is one of the most important, popular and tasteful fruit crop not only in Bangladesh but also in the world owing to its greater utility, characteristics flavor, attractive color, pleasant aroma, delicious taste and nutritional value. It is consumed as fresh ripe and green fruits. Both the green and ripe fruits are also used to make different varieties of processed products like juice, chutney, pickles, jam, jelly etc. For this reason, it is acknowledged as the king of fruits in Bangladesh as well as in other South-East Asian countries [1]. Nutritionally, it contains substantial quantity of appreciable β carotene, vitamin C, and dietary fibre [2] 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 and therefore, is capable to prevent many deficiency diseases [3].

Malnutrition and under nutrition have now become an alarming problem of the people of the third world countries affecting their economic and physical development. Protein–energy malnutrition, vitamin and mineral deficiencies are the most serious nutritional disorder in low income groups. Due to these deficiencies, under–weights and high mortality are prevalent in pre- school children and infants. Nutritionally, it contains substantial quantity of appreciable β carotene, vitamin C, and dietary fibre [2] 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 [4] and therefore, is capable to prevent many deficiency diseases [3, 5,]. Approximately 30-50% fruits go waste during postharvest handling, storage and ripening [6]. These treatments strongly impede in ethylene synthesis that resulted in low respiration and delay ripening. These materials also reduced the losses and prolonging the shelf life of mango [7].

In addition, fungicidal treatments like Bavistin DF (BDF) are also excellent ethylene inhibitors. These treatments performed effectively in reduction of postharvest decay, and extension of shelf life of mango [8]. Apparently, these treatments deteriorate the qualities of fruits to some extent, but the reduction of losses and extension of postharvest life of mango will help to increase the market price in the off seasons which play a good role in the economic development. Several researchers used BDF for controlling spoilage of different fruits [9, 10]. The efficacy of Bavistin against the fruit rot pathogen was reported by several workers [11, 12]. In this present study we did investigation on mineralogical constituents of the postharvest mango at various concentrations of BDF treatment during postharvest storage. It was also aimed to reveal the effect of same treatments on target variety.

Materials and Methods

Two mango varieties namely, Langra and Khirshapath were selected as experimental materials. The mango varieties that undertaken for investigation were collected from mango growing areas of Kansart, Shibgonj Upazila of Chapai Nowabgonj district and Chirghat upazila of Rajshahi district and others material used as postharvest treatments *viz*., Bavistin DF (BDF) were collected as analytical grade. The experiment consisted of two factors and was conducted in Randomized Complete Block Design (RCBD) with three replicates. The post-harvest treated fruits were assigned at random in each replication. The required numbers of unblemished physically similar, more or less uniform size, shape and color fruits for the experiment were harvested manually from each plant of the varieties, Langra and Khirshapath. The fruits were carefully selected during harvest. The skin of fruits was cleared with the help of a cloth just after harvesting. The solution of BDF of 250, 500, and 750 ppm were prepared by dissolving 250, 500 and 750 mg of BDF in one litre of distilled water. The fruit of both the varieties were dipped into the BDF solution for a period of 5 minutes. Care was taken to ensure enough quantity of BDF being absorbed by the fruits and stored at ambient condition on brown paper. 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 [13].

Determination of different minerals

Different important minerals of mango pulps were determined following the procedure as stated by Petersen [14].

Preparation of plant sample

Procedure of drying

The cleaned porcelain crucibles were placed in an oven at 105^0 C for overnight. The crucibles were allowed to cool in a desiccator's and these were weighed. The mango pulps were collected with spatula and put into crucible and again weighed. The crucibles were placed in the oven at 105^0 C for 24 hours. Then, the crucibles were allowed to cool in a desiccator and weighed. The crucibles were again placed in the oven at 105^0 for 2 hours. These were cooled in a desiccator and weighed again. Drying, cooling and weighing were accomplished repeatedly until the weight became constant. The dried pulps were stored in airtight plastic container. The moisture content was calculated in the sample.

Procedure of grinding

The dried plant material was ground in a mortar with pestle. These were further kept in an oven at 105^0 C for overnight due to absorption of moisture in the time of grinding for keeping the weight constant.

Determination of calcium content

Ground mango pulp was digested and Ca was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer. Reagents **a.** HNO_3 (68%) and b. Diluted HNO_3 1: 100. Twenty ml of 68% HNO_3 was transferred to 2000 ml volumetric flask and made the volume with distilled water and mixed well.

$LaCl_3$ solution

The 435 g of $LaCl_3$ $7H_2O$ was weighed into a beaker. One hundred ml of 5 M HNO_3 and 400 ml water were added in it. The salt was heated gently until it was dissolved. After cooling, 300 ml of more 5 M HNO_3 was added and the solution was transferred to 5 l volumetric flasks. It was made to volume with water and mixed. The solution contained 3.25% of La.

Digestion procedure

Ground pulp material (0.3 g) was taken into digestion tube. The two remaining tubes were blanks. Five ml of 68% nitric acid was added to each of all the 40 tubes. The content was mixed in each tube and was kept the tubes overnight. The tubes were placed in the digester and the tubes were covered with the exhaust manifold. The temperature was set at 125^0 C. The digester was turned on and the digestion was continued for 4 hours after boiling started. It was observed that no tubes became dry.

After cooling, the digestion mixture was transferred with distilled water to a 200 ml volumetric flask. The flask was made up to the mark with distilled water and mixed well. It was filtered on a dry filter into a dry bottle which could be closed with a screw cap. The filtrate was kept in the closed bottle and used for estimation of Phosphorus.

Measurement of calcium

20 ml of diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. The $LaCl_3$ solution (5 ml) was added to make a volume with water and mixed well. The content of Ca was measured by atomic absorption spectrometer. When the reading was found to be higher than the reading of the highest standard solution, a larger dilution was made. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1:100 HNO_3 and filtrates was equal to 20 ml. Amount of Ca was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{a \times 25000}{b \times c}$$

where a = mg of Ca per litre, b = amount of filtrate transferred into the 50 ml volumetric flask for determination of Ca, c = g of plant material taken into the digestion tube.

Determination of magnesium content

Ground material of mango pulp was digested and Mg was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer. Reagents and digestion was used same as describe in calcium procedure.

Measurement of Magnesium

Diluted filtrate (5 ml) was transferred into a 50 ml volumetric flask using a pipette. The $LaCl_3$ solution (5 ml) was added to make a volume with water and mixed well. The content of Mg was measured by atomic absorption spectrometer. When the reading was found to be higher than the reading of the highest standard solution, a larger dilution was made. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1:100 diluted HNO_3 and filtrate was equal to 5 ml. Amount of Mg was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{\text{a} \times 25000}{\text{b} \times \text{c}}$$

where a = mg of Mg per litre, b = ml of diluted filtrate transferred into the 50 ml volumetric flask for determination of Mg, c = g of plant material taken into the digestion tube.

Determination of copper content
Powder form of mango pulp was digested and Cu was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer. Digestion was used same as describe in calcium procedure.

Measurement of copper
The content of Cu was measured by atomic absorption spectrometer (AAS) directly in the undiluted filtrate. Amount of Cu was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

where d = mg of Cu per litre, c = g of ground pulp material taken into the digestion tube.

Determination of iron content
Ground mango pulp material was digested and Fe was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry. Digestion was used same as describe in phosphorus procedure.

Measurement of iron
The content of Fe was measured by atomic absorption spectrometer (AAS) directly in the undiluted filtrate. Amount of Fe was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

where d = mg of Fe per litre, c = g of ground pulp material taken into the digestion tube.

Determination of manganese content
Ground material of mango pulp was digested and Mn was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry. Digestion was used same as describe in phosphorus procedure.

Measurement of manganese
The content of Mn was measured by atomic absorption spectrometer directly in the undiluted filtrate. Amount of Mn was determined by the following formula

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

where d = mg of Mn per litre, c = g of ground pulp material taken into the digestion tube.

Determination of zinc content
Ground mango pulp material was digested and Zn was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry. Digestion was used same as describe in phosphorus procedure.

Measurement of zinc
The content of Zn was measured by atomic absorption spectrometer directly in the undiluted filtrate. Amount of Zn was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

where d = mg of Zn per litre, c = g of ground pulp material taken into the digestion tube.

Results and Discussion

The data obtained from different behavior of mineral contents during storage period of mango fruits are presented and fairly interpreted in the following sub-headings.

Calcium content

Analysis of variance of induced varieties to this investigation in connection with Ca content demonstrated highly significant variation at different days after storage. The results were perceived an increasing trend of Ca content with the extending of storage time from both the varieties (Table 1). It also narrated that the Khirshapat was better in accumulation of Ca content as compared to the Langra. At 12^{th} day, higher (22.98 mg/100 g) quantity of Ca was recorded from the Khirshapat and lower (21.25 mg/100 g) was recorded in Langra. These occurrences might be possible due to genetical variation between two varieties.

Different doses of BDF solution on Ca content of mango pulp demonstrated significant variation at different days after storage. At various days of storage, the results of Ca content extended in a continuous stream with the passing of storage time (Figure 1). It also stated that Ca content of control extended sharply from initial to 6^{th} day and then, it extended smoothly and thereafter, it declined due to starting of decomposition. At the same time, Ca content from the fruit treated with B_3 treatment gathered very smoothly. At 9^{th} day, the highest (24.76 mg/100 g) quantity of Ca was recorded from untreated fruit while; the lowest (16.69 mg/100 g) was recorded from the fruit treated with B_3 treatment. These phenomena caused by B_3 treatment might be possible due to delay ripening that caused in lower dissemination of Ca content from peel and stone to pulp of mango [15].

The combined effect of varieties and different doses of BDF solution in terms of Ca content of mango pulp had significant variation at different days after storage except 6^{th} day. The results of Ca content were noticed an increasing trend from various treatment combinations (Table 1). At 9^{th} day, the highest (25.58 mg/100 g) quantity of Ca was observed from the treatment combination of V_2B_0 and the lowest (15.94 mg/100 g) was observed from the treatment combination of V_1B_3. The results of the present investigation annotated that the treatment combination of V_1B_3 was better in mango preservation.

Table 1 Changes of calcium and magnesium content of the postharvest mango pulp between two varieties during storage environments at ambient condition

Treatments	Calcium content (mg/100 g) at different days					Magnesium content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	10.74b	13.29b	16.63b	19.92b	21.25b	17.01a	17.53a	18.03a	18.08a	17.81a
V_2	12.39a	15.01a	18.44a	21.64a	22.98a	16.02b	16.49b	17.01b	17.11b	16.85b
Level of significance	***	***	***	***	***	***	***	***	***	***

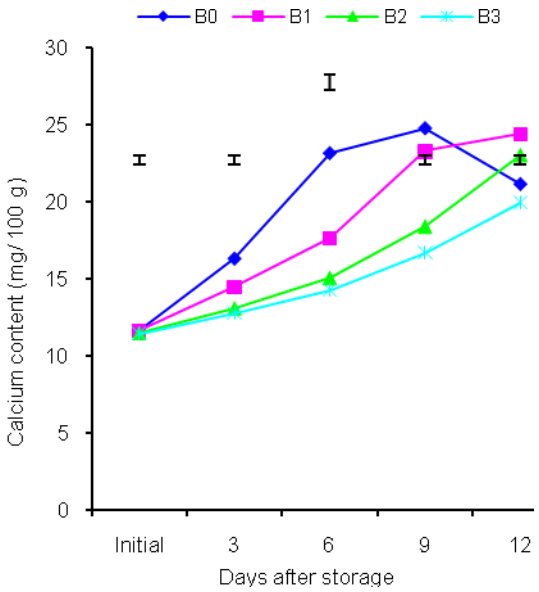

Figure 1. Calcium content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 levels.

Magnesium content

Highly significant variation was observed in terms of Mg content between the varieties means at different days after storage. The results indicated that Mg content augmented gradually with the advancement of storage period (Table 1). It also denoted that Mg content extended steadily of initial to 9 days thereafter; it came down slightly due to starting decay of the fruit. At 9th day, higher (18.08 mg/100 g) was derived from the Langra and lower (17.11 mg/100 g) was derived from the Khirshapat. These phenomena might be probably due to genetical dissimilarities between the varieties. There were no available research findings in connection with Mg content during storage in the scientific literature. But, the data of the present study revealed that the Langra contained more Mg over the Khirshapat.

Different doses of BDF solution used in this trial exhibited highly significant on Mg content of mango pulp at different days after storage. The results indicated a smooth gathering trend of Mg content of mango pulp with the extension of storage period (Figure 2). It was also noticed that Mg content of control extended gradually from initial to 6 days and then, it abated very sharply. The highest (18.72 and 18.00 mg/100 g) quantity of Mg was obtained from control and B_1 treatment at 6 and 9th day while, the lowest (16.83 and 17.18 mg/100 g) was obtained from the fruit treated with B_3 treatment, respectively. The increasing tendency of Mg content in mango pulp during storage period might have been related to starting of ripening. This result is very much similar to the report of Peter *et al.* [15].

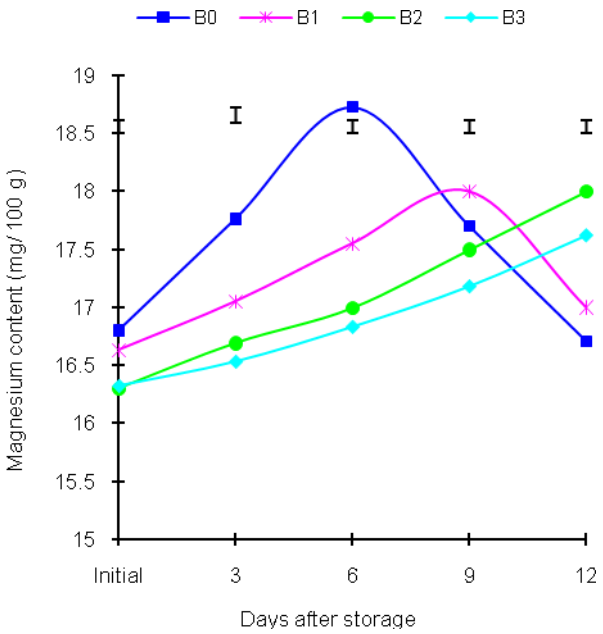

Figure 2. Effect of different doses of BDF on Magnesium content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 levels.

Copper content

Variation between varieties mean in terms of Cu content of mango pulp demonstrated highly significant at different days after storage. The results denoted that Cu content of mango pulp diminished in a continuous stream with the passing of storage period (Table 3). It also narrated that Cu content of the Khirshapat was higher as compared to Langra. At initial day, higher (0.36 mg/100 g) content of Cu was noted in the Khirshapat and lower (0.33 mg/100 g) was noticed in Langra, respectively. At 12th day, Khirshapat gave higher (0.19 mg/100 g), quantity of Cu and lower (0.16 mg/100 g) was noted in the Langra. These happened might be probably due to genetical dissimilarities between the varieties. There were no available research reports on Cu content of mango pulp at the scientific literature. The results of the present studies revealed that green mangoes contained more copper comparing to stored mangoes and the Khirshapat was fairly good in copper accumulation than the Langra. The present research findings also revealed that Cu content came down gradually during storage period.

Different doses of BDF solution implied to the present study in connection with Cu content of mango pulp exhibited significant variation at different days after storage. The results narrated that Cu content fell off gradually with the advancement of storage period. The diminishing trend from control was higher than the fruit treated with B_1, B_2 and B_3, treatments respectively (Figure 3). At 12th day, higher quantity of Cu (0.24 mg/100 g) was noticed from the fruit treated with B_3 treatment but, it was statistically at par with B_2 treatment while; lower (0.11 mg/100 g) was noticed from control. The data of B_3 treatment recorded from the investigation was fairly good over the other treatments in Cu preservation. So, the present findings revealed that B_3 treatment was much better in mango preservation.

The combined effect of varieties and various doses of BDF solution were observed to be non significant in connection with Mg content at various days after storage. The results were noticed to be slightly extending trend of Mg content of mango pulp with the growing up of storage time (Table 2). At 6th day, the highest quantity (19.15

mg/100 g) of Mg was manifested from the treatment combination of V_1B_0 while; the lowest (16.25 mg/100 g) was reported from the treatment combination of V_2B_3.

Table 2. Combined effects of varieties and different doses of BDF solution on calcium and magnesium content of the postharvest mango pulp during storage at ambient condition

Treatments combination	Calcium content (mg/100 g) at different days					Magnesium content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	10.75 d	15.48b	22.32	23.93c	20.32g	17.25	18.22	19.15	18.12	17.16
V_1B_1	10.82 d	13.42d	16.62	22.26d	23.35c	17.15	17.55	18.05	18.55	17.55
V_1B_2	10.65 d	12.25e	14.23	17.55f	22.17d	16.75	17.23	17.52	17.92	18.42
V_1B_3	10.72 d	12.02 f	13.34	15.94g	19.16h	16.88	17.12	17.41	17.72	18.12
V_2B_0	12.58 a	17.15a	23.98	25.58a	21.98e	16.35	17.30	18.28	17.28	16.27
V_2B_1	12.48ab	15.48b	18.67	24.32b	25.42a	16.11	16.55	17.05	17.45	16.45
V_2B_2	12.35 b	13.95c	15.92	19.22e	23.84b	15.85	16.15	16.45	17.05	17.55
V_2B_3	12.16 c	13.47d	15.17	17.45f	20.68f	15.75	15.95	16.25	16.65	17.12
Level of significance	*	**	NS	**	**	NS	NS	NS	NS	NS
CV%	0.92	0.75	1.15	0.51	0.48	0.64	0.67	0.61	0.60	0.62

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; * and ** indicate 5%, and 1% levels of probability, and NS =non-significant.

Table 3. Pattern of copper and iron content of the postharvest mango pulp between two varieties during storage environments at ambient condition

Treatments	Copper content (mg/100 g) at different days					Iron content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.33 b	0.28 b	0.24 b	0.20 b	0.16 b	2.59 a	3.26 a	4.44 a	5.02 a	4.72 a
V_2	0.36 a	0.32 a	0.27 a	0.23 a	0.19 a	1.70 b	2.32 b	3.50 b	3.80 b	3.30 b
Level of significance	***	***	***	***	***	***	***	***	***	***

Different doses of BDF solution implied to the present study in connection with Cu content of mango pulp exhibited significant variation at different days after storage. The results narrated that Cu content fell off gradually with the advancement of storage period. The diminishing trend from control was higher than the fruit treated with B_1, B_2 and B_3, treatments respectively (Figure 3). At 12th day, higher quantity of Cu (0.24 mg/100 g) was noticed from the fruit treated with B_3 treatment but, it was statistically at par with B_2 treatment while; lower (0.11 mg/100 g) was noticed from control. The data of B_3 treatment recorded from the investigation was fairly good over the other treatments in Cu preservation. So, the present findings revealed that B_3 treatment was much better in mango preservation.

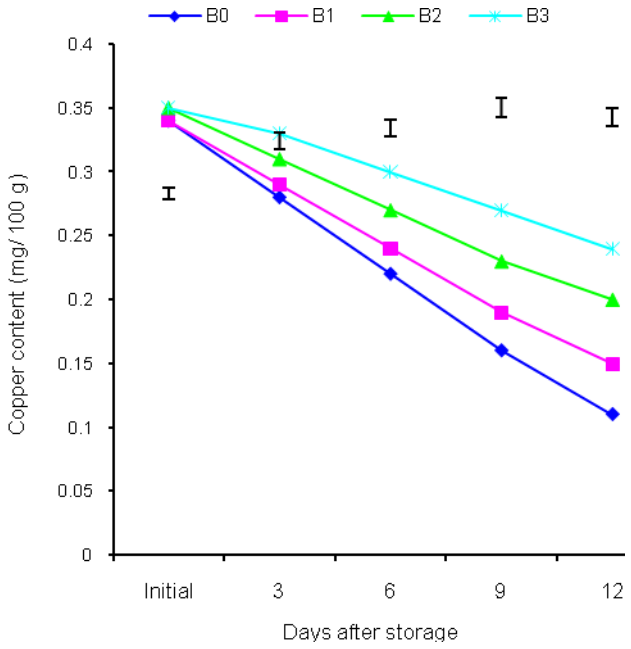

Figure 3. Effect of different doses of BDF on copper content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 levels.

The combined effect of varieties and applied different doses of BDF solution in relation to Cu content of mango pulp were found to be non significant variation at various days after storage. The results stated that Cu content in different treatment combination came down with the extension of storage duration. At 12th day, the highest (0.24 mg/100 g) was derived from the treatment combination of V_2B_3, which was statistically at par with V_1B_3, V_2B_2 and V_1B_2 and the lowest (0.09 mg/100 g) was derived from the treatment combination of V_1B_0 but, it was statistically at par with V_1B_1 and V_2B_2 (Table 4).

Iron content

The analysis of variance of varieties in connection with Fe content of mango pulp was observed to be highly significant at different days after storage. The results found an extending trend of Fe content with the advancement of storage duration. The growing up trend of Fe content was more or less similar from initial to 9 days thereafter, it abated slightly. At 12th day, higher (4.72 mg/100 g) quantity of Fe was reported from the Langra and lower (3.30 mg/100 g) was reported from the Khirshapat (Table 3). Highly significant variation was noticed to be due to the effect of different doses of BDF solution in connection with Fe content of mango pulp at various days after storage. The results obtained from the study indicated that Fe content was enriched hastily from initial to 6th day and then, it came down significantly at control and similarly B_1 treated fruits abated of Fe content after 9th day. But, Fe content

recorded from the other fruits treated with B_2 and B_3 treatment extended successively up to 12th day (Figure 4). At 12th day, the maximum (4.59 mg/100 g) quantity was derived from the fruit treated with B_2 treatment but, it was statistically at par with B_3 while; the lowest (2.89 mg/100 g) was derived from the untreated fruit due to starting decay. A smaller quantity of Fe obtained from untreated fruits at 12th day might be due to starting decomposition. On the other hand, B_3 treated fruits were fairly good because of its lower achievement of Fe content with the increase of storage duration.

Table 4. Combined effects of varieties and different doses of BDF solution on copper and magnesium content of the postharvest mango pulp at ambient condition

Treatments combination	Copper content (mg/100 g) at different days					Iron content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	0.31	0.25	0.19	0.14	0.09	2.82	3.82	5.92	5.32 a	3.42 c
V_1B_1	0.32	0.27	0.22	0.17	0.13	2.65	3.35	4.45	5.35 a	4.64 b
V_1B_2	0.34	0.30	0.26	0.22	0.19	2.52	3.12	3.92	5.02 b	5.52 a
V_1B_3	0.33	0.31	0.28	0.25	0.23	2.35	2.75	3.45	4.38 cd	5.31 a
V_2B_0	0.36	0.30	0.24	0.18	0.13	1.88	2.78	4.88	4.25 d	2.35 d
V_2B_1	0.35	0.31	0.26	0.21	0.17	1.73	2.32	3.42	4.45 c	3.75 c
V_2B_2	0.36	0.32	0.28	0.24	0.21	1.64	2.25	3.05	3.15 f	3.65 c
V_2B_3	0.37	0.34	0.31	0.28	0.24	1.53	1.94	2.64	3.35 e	3.46 c
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	***	***
CV%	3.10	3.54	4.16	5.02	6.10	4.96	3.80	2.67	2.41	4.78

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; *** indicates 0.1% level of probability, and NS = non-significant.

The combined effect of varieties and different doses of BDF solution were observed to be non significant variation in relation to Fe content of mango pulp at different days after storage except 9 and 12th day. The results narrated that enhancing trend of Fe content was found from initial to 6 days thereafter, it came down very fast from the treatment combination of V_1B_0 while; the lowest trend was found from the treatment combination of V_2B_3 (Table 4). At 9th day, the highest (5.35 mg/100 g) quantity was recorded from the treatment combination of V_1B_1 and the lowest (3.15 mg/100 g) was recorded from the treatment combination of V_2B_2.

Manganese content

Manganese content of mango pulp was noticed to be differed significantly in both the varieties mean at different days after storage. The results elucidated that Mn content extended gradually with the extension of storage period (Table 5). It also stated that the Langra performed better in Mn accumulation comparing to the Khirshapat. At 9th day, higher (1.20 mg/100 g) quantity of Mn was rnoted in the Langra while; lower (1.05 mg/100 g) was noted in Khirshapat. There were no available research reports in terms of Mn content in the scientific literature. The results of the present research revealed that the Langra was fairly good than the Khirshapat in Mn accumulation and it extended during storage period.

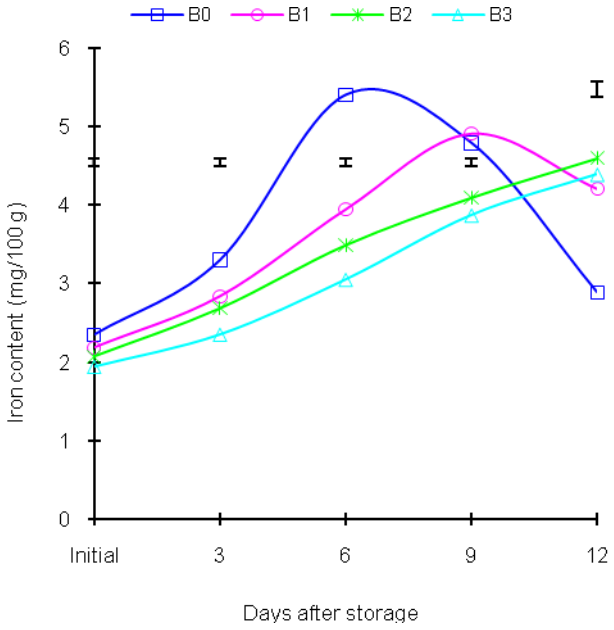

Figure 4. Iron content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 levels.

Table 5. Behavior of manganese and zinc content of the postharvest mango pulp in two varieties during storage environments at ambient condition

Treatments	Manganese content (mg/100 g) at different days					Zinc content (mg/100 g) At different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.63 a	0.84 a	1.07 a	1.21 a	1.20 a	1.26 b	1.19 b	1.06 b	0.90 b	0.73 b
V_2	0.47 b	0.68 b	0.91 b	1.05 b	1.05 b	1.47 a	1.30 a	1.18 a	1.02 a	0.85 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Different doses of BDF solution were found to be highly significant in connection with Mn content of mango pulp at different days after storage. The results explained that Mn content extended continuously from initial to 6th days, and then it came down sharply in control. On the other hand, it increased from initial to 9th day thereafter; it diminished in the fruit treated with B_1 treatment. At the same time, very lesser augmenting trend of Mn content was perceived from the fruit treated with B_3 treatment (Figure 5). At 12th day, Mn content ranged between 0.89 to 1.33 mg per 100 g of fresh mango pulp. The maximum (1.33 mg/100 g) was recorded from B_2 treated fruits and the minimum (0.89 mg/100 g) was recorded from control. There were no available research findings in terms of Mn

content in the scientific literature. But, the data of the present research revealed that B3 treatment showed profound effect in delay ripening which resulted in lesser extending trend of Mn and keeping the quality good in preservation.

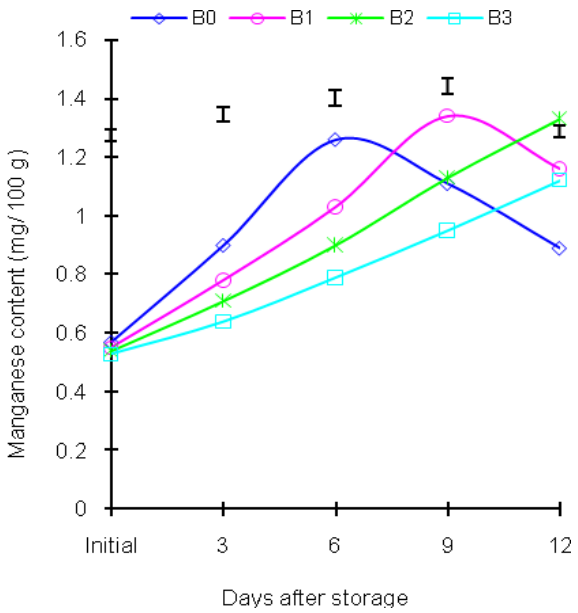

Figure 5. Manganese content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 levels.

The combined effect of varieties and imposed different doses of BDF solution in relation to Mn content of mango pulp were observed to be non significant at various days after storage. The results were exposited that a growing up trend of Mn content was perceived in different treatment combination with the extension of storage duration (Table 6). At 9th day, the highest (1.42 mg/100 g) was listed from the treatment combination of V_1B_1 and the lowest (0.87 mg/100 g) was listed from the treatment combination of V_2B_3.

Zinc content

Variation in respect of Zinc content of mango pulp due to the effect of varieties showed highly significant at different days after storage. The results indicated that Zn content came down markedly with the extension of storage duration from both the varieties (Table 5). It was also exposited that the Khirshapat was noticed better in Zn content accumulation as compared to the Langra. At initial stage, higher (1.47 mg/100 g) was derived from control and lower (1.26 mg/ 100 g) was derived from the Langra. Again, at 12th day, higher (0.85 mg/100 g) was noticed from Khirshapat and the lesser (0.73 mg/100 g) was recorded from the Langra. There were no available research findings in terms of Zn content in the scientific review. The results of the present studies invented that green mango especially, the Khirshapat received more quantity of Zn than Langra, but, it continuously reduced with the increase of storage duration.

Different doses of BDF solution were found to be significant in connection with Zn content of mango pulp at different days after storage. The results observed an extending trend of Zn content of mango pulp with the advancement of storage period from the fruit treated with different doses of BDF solution. It also stated that the coming down trend was very high in control and very low in the fruit treated with B_3 treatment (Figure 6). At 12th day, the maximum (0.96 mg/100 g) was noticed from the fruit treated with B_3 treatment and the lowest (0.65 mg/100 g) was noticed from control. Zn content of mango pulp decreased during storage period was possibly due to transmission of Zn from pulp to stone and peel at stored condition or Zn content of mango pulp might have been depressed or suppressed as influenced by metabolic activities during storage.

The combined effect of varieties and subjected to different doses of BDF solution on Zn content of mango pulp demonstrated non significant variation at different days after storage except initial day. An expanding trend of Zn content of mango pulp was recorded from various treatment combinations (Table 6). At initial day, the maximum (1.52 mg/100 g) quantity of Zn was obtained from Khirshapat along with B_3 treatment while; the lowest (1.24 mg/100 g) value was obtained from Langra using no treatment.

Table 6. Combined effects of varieties and different doses of BDF solution on iron and manganese content of postharvest mango pulp at ambient condition

Treatments combination	Manganese content (mg/100 g) at different days					Zinc content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	0.65	0.98	1.34	1.19	0.96	1.26 c	1.13	0.97	0.76	0.53
V_1B_1	0.64	0.87	1.12	1.42	1.24	1.28 c	1.17	1.02	0.85	0.67
V_1B_2	0.62	0.78	0.97	1.21	1.40	1.24 c	1.21	1.10	0.96	0.82
V_1B_3	0.60	0.72	0.86	1.02	1.19	1.25 c	1.25	1.14	1.03	0.91
V_2B_0	0.49	0.82	1.18	1.03	0.82	1.45 b	1.26	1.10	0.89	0.66
V_2B_1	0.46	0.69	0.94	1.25	1.07	1.46 b	1.29	1.15	0.98	0.81
V_2B_2	0.47	0.63	0.82	1.05	1.25	1.44 b	1.32	1.21	1.07	0.93
V_2B_3	0.45	0.56	0.71	0.87	1.05	1.52 a	1.34	1.24	1.13	1.01
Level of significance	NS	NS	NS	NS	NS	*	NS	NS	NS	NS
CV%	3.87	2.81	2.14	1.88	1.89	1.56	1.70	1.90	2.21	2.68

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; * and *** indicate 5% and 0.1% level of probability, and NS = non-significant

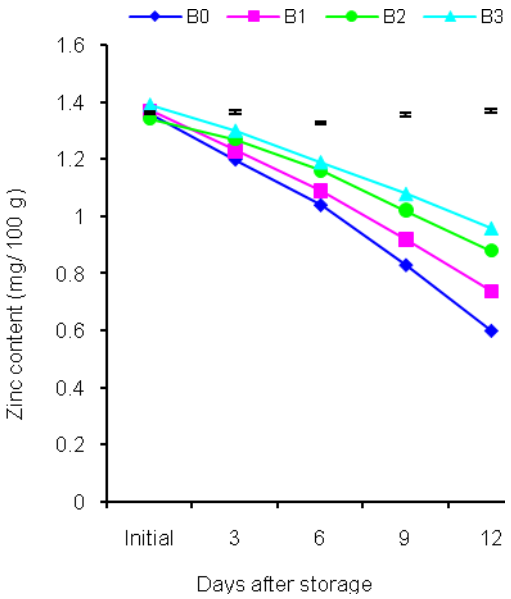

Figure 6. The effect of different doses of BDF on Zinc content of mango pulp at different days

after storage. Vertical bars represent LSD at 0.05 levels.

Conclusion

Results of the interaction effect of varieties and different treatments in different experiments were found to be non-significant in terms of most of the mineralogical properties. The combination of the Langra and control treatment progressively augmented in magnesium and iron content up to a point of ongoing metabolic cycle and thereafter, these compositions decreased. The Khirshapat using no treatment accumulated calcium content up to ongoing metabolic activities but, using 750 ppm of bavistin DF solution strongly interrupted these activities. The Khirshapat along with 750 ppm of Bavistin DF solution extended shelf life up to 17.33 days after storage. Therefore, 750 PPM solution of Bavistin DF was found the best method for preservation and delay ripening of postharvest mango which might be easily adopted by common people for mango preservation.

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