Aceh Int. J. Sci. Technol., 2 (2): 51-58
August 2013
DOI: 10.13170/AIJST.0202.02

Aceh International Journal of Science and Technology

ISSN: 2088-9860
Journal homepage: http://jurnal.unsyiah.ac.id/aijst

Response of Some Biochemical and Mineral Constituents of the Postharvest Mango (*Mangifera indica* L.) Influenced by Different Levels of Bavistin DF

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Received : May 28, 2013
Accepted : June 11, 2013

Abstract

An investigation 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 biochemical and 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 crude fiber, lipid, water-soluble protein, phosphorus, and potassium constituents over the Khirshapat. It is revealed that the expansion of mineral contents in the mango was intimately associated with ripening during storage. The results also noticed to be an increasing trend of lipid and protein content in mango pulp with the advance of storage period using Bavistin DF.

Keywords: Postharvest mango; Biochemical constituents; mineral contents; Bavistin DF.

Introduction

Mango (*Mangifera indica* L.) is one of the most important, popular and tasteful fruit crop in tropical and subtropical regions of the world owing to its greater utility, characteristics flavor, attractive color, pleasant aroma, delicious taste and nutritional value. Nutritionally, 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, 2000) and therefore, is capable to prevent many deficiency diseases (Purohit, 1985; Samad *et al.,* 1975).

Postharvest losses can be considerably reduced by applying improved storage technology and prolonging the shelf life of fruits. A considerable amount of fresh fruits goes waste every year through postharvest decay. The marketability of this perishable fruit is closely linked with the development of suitable technology which reduces the losses at different stages of harvesting and storage condition. Losses in terms of quality and quantity of fruits occur at all stages in the post harvest system from harvesting to consumption. Many workers (Baez *et al.,* 1993; Dara *et al.,* 1982; Feng *et al.,* 1991; Inyang and Agbo, 1995; Sankat *et al.,* 1993) studied the effects of many postharvest treatments with a large number of mango cultivars and observed the extended shelf life.

The huge amount of important fruit crops are being spoiled due to prevailing temperature, humidity, inappropriate post-harvest handling as well as sub- optimal knowledge in the field of postharvest technology after harvesting. This spoilage of fruit is attributed to adverse biochemical changes, namely loss of weight owing to respiration and transpiration, loss of flesh hardness, loss of resistance to different microbial attack and overall devastating deterioration of carbohydrate, protein, lipid, some oxidative enzymes, minerals and nutrient status.

Minerals play an important role in physiological function of the body especially in the buildings and regulation process. Mango is one of the favored fruits of the country and considered as a good source of

vitamins, proteins, sugars, fat and dietary minerals including calcium, potassium, magnesium, iron and so many others (Mumzuroglu *et al.*, 2003; Rathore *et al.*, 2007). It has an excellent flavour, attractive fragrance, delicious taste and high nutritional value that have made it one of the best fruits (Pal, 1995). The quality related attributes and mineral content of mango varies from variety to variety and ripening stage viz. from immature to mature and mature to ripened stage (Mahayothee *et al.*, 2007; Appiah *et al.*, 2011).

Application of different postharvest treatments i..e. paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water treatment and low temperature in refrigerator are very much important obstacles to normal respiration of mango fruits. 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 (Benitez *et al.,* 2006; Fawaz, 2006; Fonseca *et al.,* 2004; Muy *et al.,* 2004; Tefera *et al.,* 2007). 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 (Ahmed and Singh, 2000; Dhemre and Waskar, 2004; Gautam *et al.,* 2003; Ranjan *et al.,* 2005; Reddy and Haripriya, 2002). 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. Mango always decays after harvest and postharvest losses can be considerably reduced by applying improved storage technology and prolonging the shelf life of fruits. Several researchers used BDF for controlling spoilage of different fruits (Sakhale and Kapse, 2012; Sandeep *et al.,* 2012). The efficacy of Bavistin against the fruit rot pathogen was reported by several workers (Azad, 1992; Misra, 1988).

In view of our previous work, the present study has been undertaken to evaluate the potential of BDF treatments on the biochemical and mineral constituents of the postharvest mango at various concentrations during its storage. It was also aimed to reveal the effect of same treatments on target variety.

Materials and Methods

Experimental materials

Two mango varieties namely, Langra and Khirshapath were selected as experimental materials. The mango varieties that undertaken for investigation were collected from mango grower of Kansart, Shibgonj Upazila of ChapaiNowabgonj district and Chirghat upazila of Rajshahi district, Bangladesh and others material used as postharvest treatments *viz.*, BDF were collected as analytical grade. The experiment consisted of two factors and was conducted in Randomized Complete Block Design (RCBD) with three replicates.

Five fruits from each treatment combination of every replicate were chemically analyzed for the determination of the changes in edible portion, crude fibre, total lipid, protein, different minerals etc. To ensure the application of the different storage treatment of the fruits for each variety, the following procedure was accomplished. Crude fibre of mango pulp was estimated following the procedure as given in the Biochemical Methods for Agricultural Sciences by Sadasivam and Manickam (1992). Total lipid content of fruit pulp was determined by the method of Bligh and Dyer (1959). Water soluble protein content of mango pulp was determined following the method of Lowry *et al.,* (1951). A graph was drawn by plotting conc. against absorbance and from the graph the amount of protein was calculated in the supplied sample (Figure 1).

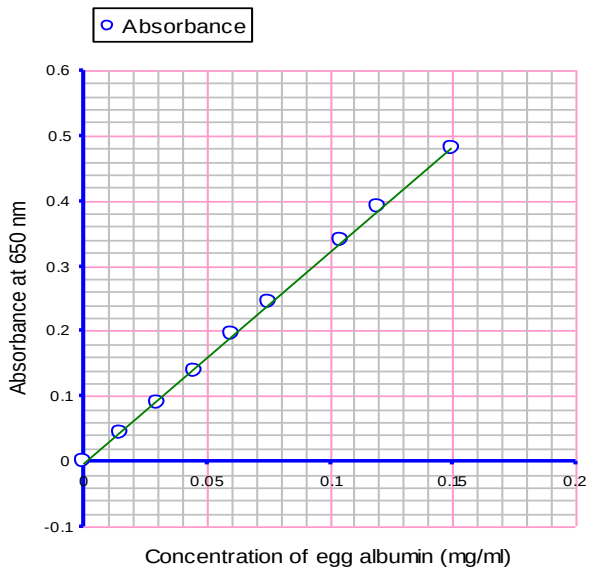

Figure 1. Standard curve of protein for estimation of water soluble protein

Determination of different minerals

Different important minerals of mango pulps were determined following the procedure as described by (Petersen, 2002). Ground mango pulp was digested and minerals were released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer.

Results and Discussion

Crude fibre content

The analysis of variance of mango varieties subjected to this investigation was perceived to be significant in respect of crude fiber content of mango pulp at different days after storage. The results denoted that a decreasing trend of crude fibre was noticed from both the varieties at different days of storage. It stated that the Langra was found better in accumulation of crude fiber content. At initial day, the Langra gave higher (1.22%) quantity of crude fibre as compared to the Khirshapat (1.12%). The quantity of crude fibre came down in a continuous stream with the increase of storage period from both the varieties. At 12th day, higher (0.51%) quantity of crude fiber was obtained from the Langra while; lower (0.39%) was obtained from the Khirshapat (Table 1). The results of the present investigation were strongly supported by the findings of Islam *et al.* (2011). The falling off of crude fibre content with the rising of storage period might be probable due to metabolic activities resulting in hydrolysis of cellulose and lignin into simple molecules.

Table 1. Behavior of crude fibre and lipid content of postharvest mango pulp in varieties during storage environments at ambient condition. * indicates at 5% level; ** indicate at 1 % level; ** indicate at o.1% level; NS = non- significant

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	1.22 a	1.01 a	0.77 a	0.65 a	0.51 a	0.18	0.31	0.48	0.60 a	0.64
V_2	1.12 b	0.90 b	0.69 b	0.53 b	0.39 b	0.17	0.30	0.46	0.58 b	0.63
Level of significance	***	***	**	***	***	NS	NS	NS	***	NS

Various doses of BDF solution used in this trial were observed to be significant on crude fiber content of mango pulp at different days after storage except initial day. The results elucidated that crude fibre content decreased successively with the advance of storage period (Figure 2). At all days of storage, it was found that crude fibre content was noticed to be comparatively more amount from B_3 treatment followed by others. At 3rd day, the maximum (1.07%) amount of crude fiber was recorded from B_3 treatment which was statistically at par with B_2 treatment and the lowest (0.77%) was recorded from B_0 treatment. At 12th day, the maximum (0.60%) was obtained from B_3 treatment while, the lowest (0.38%) was obtained from B_0 treatment which was also statistically at par to B_1 and B_2 treatment. The results of the present study are partially supported by the findings of Mathooko (2000). The diminishing trend of crude fiber influenced by B_3 treatment might be possible due to retardation to ripening resulting in lower declining trend of crude fiber content during storage.

The combined effect of varieties and different doses of BDF solution were observed to be non significant variation in terms of crude fiber content of mango pulp at different days after storage. The results annotated that crude fibre content came down continuously with the passing of storage period. It denoted that the treatment combination of V_1B_3 was found to be better in accumulation of crude fibre content at all storage period. At 6th day, the highest (1.00%) quantity of crude fibre was reported from the treatment combination of V_1B_3 and the lowest (0.39%) was reported from the treatment combination of V_2B_0, respectively.

Total lipid content

The analysis of variance of varieties showed non-significant variation in terms of lipid content in mango at different days after storage except 9th day. The results were noticed to be an increasing trend of lipid content in mango pulp with the advance of storage period. At all days of storage, the Langra was perceived to be higher in enriching lipid content than the Khirshapat. At 9th day, higher (0.60%) amount of lipid was obtained from Langra and lower (0.58%) was obtained from Khirshapat (Table 1). These occurrences might be possible due to genetically dissimilarities between two varieties. Islam *et al.* (2000) reported the similar findings.

Different doses of BDF solution induced in this trial in terms of lipid content were observed to be highly significant at different days after storage. The results were exposited an increasing trend of lipid content with the progress of storage period at various days of storage (Figure 3). It illustrated that control treatment provided comparatively higher amount of lipid followed by B_1, B_2 and B_3 treatments from initial to 9th days of storage; and then, it came down due to starting decay. At 9th day, the highest (0.76%) amount of lipid was derived from control whereas; the lowest (0.44%) was derived from B_3 treatment. At 12th day,

B_2 treated fruit produced the highest (0.71%) amount of lipid which was statistically at par with B_1 and the lowest (0.57%) was recorded from B_3 treatment which was also statistically at par with control. These occurrences might be possible due to B_3 treatment caused delay ripening that resulted in lower production of lipid content and keeping the quality good. These results are partially supported by the statement of Bandyoppadhyay and Nair (1990).

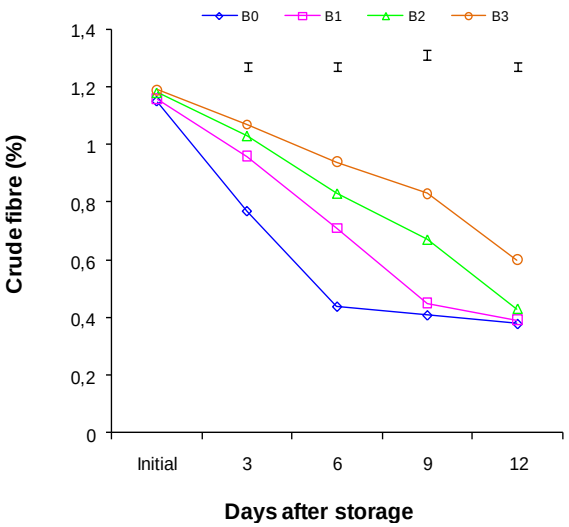

Figure 2. Crude fibre content of mango pulp as influence by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

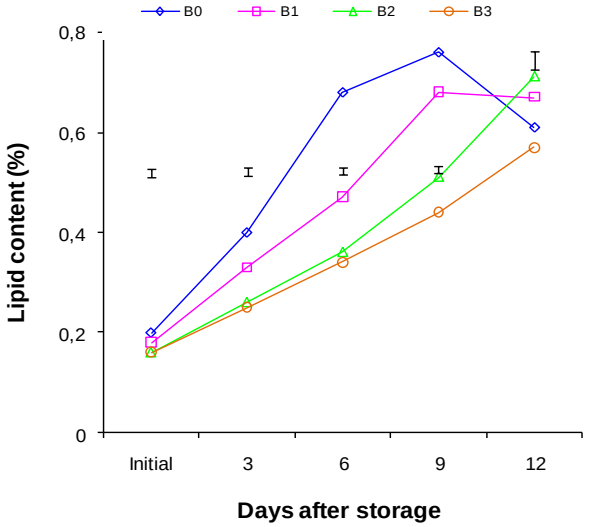

Figure 3. Lipid content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

The interaction effects of varieties and implied different doses of BDF solution in this investigation showed significant variation in terms of lipid content of mango pulp at different days after storage except 9th day. The results indicated that a slightly growing up trend of lipid content in mango pulp was noticed with the advancement of storage duration. It revealed that the treatment combination of V_1B_0 was found as more producers (0.78%) of lipid at initial to 9th day and then, it fell off due to starting bad fruits situation. At this time, lower (0.43%) quantity was noticed from the treatment combination of V_2B_3.

Water soluble protein content

The analysis of variance of mango varieties was perceived to be significant variation in connection with water soluble protein (WSP) content in mango at different days after storage except 3, 9 and 12th day. The results elucidated an increasing trend of WSP content with the increase of storage period. It denoted that the Langra was observed to be better in WSP content accumulation as compared to the Khirshapat at all the stages of storage. At 6th day, higher (0.91%) synthesis of WSP content was derived from the Langra while; lower (0.79%) was recorded from the Khirshapat (Table 2). Anon (1962) suggested that protein content might be differed from cultivar to cultivar and stages of maturity as well as ripening. These events was possible due to some of seed protein of mango might have to be disseminated to pulp portion through complex metabolic activities during ripening and also might have the genetically variation between the varieties.

Table 2. Changes of water soluble protein and phosphorus content of postharvest mango pulp in varieties during storage at ambient condition. NS = non- significant

Treatments	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.56 a	0.72	0.91 a	1.03	1.21	19.06 a	20.24 a	21.78 a	23.16 a	23.60 a
V_2	0.48 b	0.63	0.79 b	0.95	1.15	16.75 b	17.94 b	19.38 b	20.85 b	21.62 b
Level of significance	*	NS	*	NS	NS	***	***	***	***	***

Different doses of BDF solution implied to this investigation in terms of WSP content demonstrated significant variation at different days after storage except initial and 12th day. Various results of WSP content were found to be an augmenting trend in the mango pulp with the increase of storage period (Figure 4). It indicated that WSP content was gathered more from untreated fruit followed by B_1, B_2 and B_3, treatments. The growing up trend of WSP content in control was hastily increased from initial to 6th days thereafter; it declined due to starting decay. At the same time, the increasing trend from B_3 treatment was very slow due to delay ripening. At 9th day, the highest (1.23%) gathering of WSP content was notified from control which was statistically at par with B_1 treatment and the lowest (0.74%) was notified from B_3 treatment which was also statistical at par with B_2 treatment. It elucidated that extension of WSP content synthesis was strongly depended upon fruit ripening during storage. Lakshminarayana (1980) reported that mango fruits contained different quantity of protein during storage period. Peter *et al.* (2007) recommended that protein content increased with the advances of storage duration.

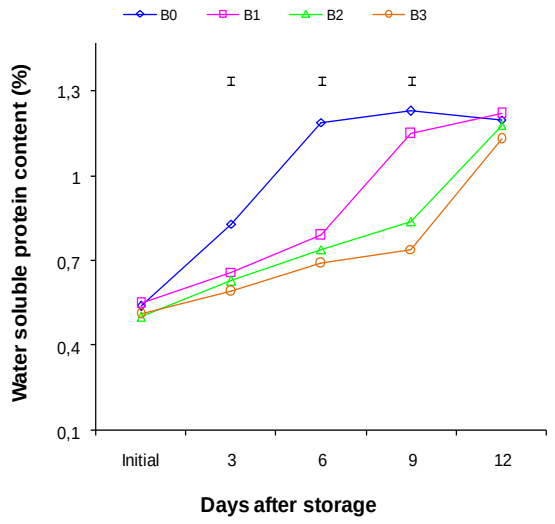

Figure 4. Effect of different doses of BDF on water soluble protein content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

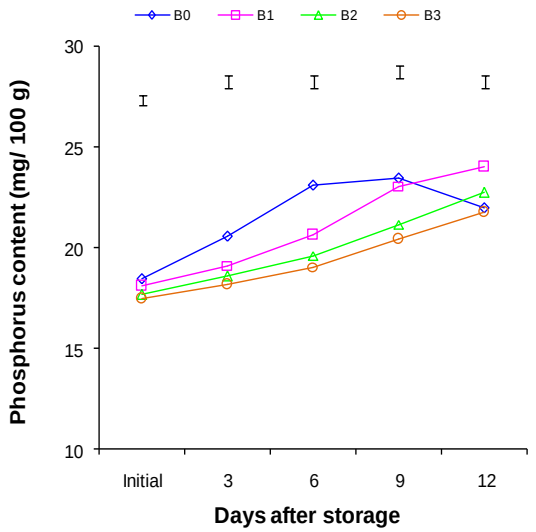

Figure 5. Effect of different doses of BDF on Phosphorus content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

The combined effect of varieties and imposed different doses of BDF solution in this experiment exhibited non significant variation in respect of WSP content at different days after storage. The results recorded from the studies annotated that WSP content increased in a continuous stream from initial to 9th days from the treatment combination of V_1B_0 then, it abated due to rotenning and decomposition while, the lowest increasing trend was observed from the treatment combination of V_2B_3. At 9th day, the highest (1.25%) quantity of WSPC was recorded from the treatment combination of V_1B_0 which was statistically at par with V_1B_1, V_2B_0 and V_2B_1 whereas; the lowest (0.70%) was recorded from the treatment combination of V_2B_3, which was also statistically at par with V_1B_3 and V_2B_2.

Phosphorus content

Analysis of variance of varieties in connection with P contents showed highly significant at different days after storage. The results provided a signal that P content increased smoothly in both the varieties with the expansion of storage period (Table 2). It was observed that the Langra produced more quantity of P as compared to the Khirshapat. The increasing trend of P in the Langra was more or less similar up to 9th day thereafter, it abated due to becoming spoilage of fruits. At 12th day, higher (23.60 mg/100 g) quantity of P was recorded from the Langra and lower (21.62 mg/100 g) was recorded from the Khirshapat. Anon (1962) elucidated that P content of mango pulp might be differed from cultivar to cultivar. Better performance in increasing trend of P content in the Langra might be probably due to genetical dissimilarities. It also revealed that the expansion of P content in the mango was intimately associated with ripening during storage. The data of the present study are in partially supported by the findings of Nadkarni (1963) when he worked with 16 cultivars and found the ranged between 10-30 mg/100 g among the cultivars.

Different doses of BDF solution subjected to this trial in relation to P content exhibited highly significant variation at different days after storage. The results narrated that P content increased steadily at

various days of storage. It denoted that P content in control augmented at slow rate from initial to 6th days thereafter; it augmented at very slow motion than its previous trend. After 9th day, it declined possibly due to rotenning and decomposition of fruits (Figure 5). At 9th day, the maximum (23.43 mg/100 g) quantity of P content was obtained from control and the minimum (20.40 mg/100 g) was obtained from B_3 treatment. Lower amount of P content from B_3 treatment might be probably due to delay ripening that resulted in lower accumulation of P content. Peter *et al. (*2007) stated that P content was increasingly changed during storage. Watt and Merrill (1963) found 13.00 mg per 100 g of fresh green mango pulp.

The combined effect of varieties and implied various doses of BDF solution demonstrated non significant variation on P content of mango pulp at different days after storage except 12th day. The results showed a growing up trend of P content with the advance of storage period. It annotated that P content increased gradually from initial to 9th day with the treatment combination of V_1B_0 and then, it fell off due to bad fruit situation. In this time, P content was noticed lower increasing trend from the fruit treated with the treatment combination of V_2B_3. At 12th day, the highest (24.45 mg/100 g) quantity of P was obtained from the treatment combination of V_1B_1 whereas; the lowest (20.66 mg/100 g) was obtained from the treatment combination of V_2B_3. It also explained that the Langra along with B_3 treatment was regarded as the best treatment combination in keeping the quality good in preservation followed by the other treatment combinations. This treatment combination strictly impeded the ripening of mango fruits during storage.

Potassium content

Adopted varieties in terms of K content demonstrated highly significant at different days after storage. The results explored a rising trend of K content was observed in both the varieties with the increase of storage period at different days. In all the storage period, the Langra was observed to be more producer of K content comparing to the Khirshapat. It also annotated that the increasing trend of K content was stopped at 9th day. At this period, higher (0.28%) amount of K was recorded from the Langra and lower (0.26%) was recorded from the Khirshapat (Table 3). These occurrences might be possible due to deterioration of fruits that resulted in lower metabolic activities. The Langra was found satisfactory in receiving of K content possibly due to genetically dissimilarities between varieties. At different storage period, K content increased might be possible due to transmission of K from stone and peel to pulp of mango during high metabolic activity. The results of the present investigation are in agreement with finding of Islam *et al.* (2011).

Table 3. Changes of potassium and calcium content of postharvest mango pulp between varieties during storage environments at ambient condition. *Note:* In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Treatments	Potassium content (%) at different days				
Variety (V)	Initial	3	6	9	12
V_1	0.23 a	0.24 a	0.26 a	0.28 a	0.28 a
V_2	0.19 b	0.22 b	0.24 b	0.26 b	0.26 b
Level of significance	***	***	***	***	***

Different levels of BDF solution imposed to this experiment in terms of K content of the mango pulp were perceived to be significant at different days after storage. The results exposited that K content accumulated in a continuous stream with the advance of storage period, but, K content from the untreated fruit came down after 9th day, while other treatments *viz.*, B_1, B_2 and B_3 retained their increasing behavior (Figure 6). In this period, it noticed a very lower extending trend of K content from B_3 treatment. At 9th day, the maximum (0.29%) of K content was recorded from the untreated fruit but it was statistically at par with B_1 and B_2 treatment while; the lowest (0.25%) was recorded from the fruit treated with B_3 treatment which was also statistically at par with B_1 and B_2 treatment. Lower quantity of K from B_3 treatment might be possible due to delay ripening that caused lower transmission of K with good keeping quality. Peter *et al.* (2007) showed that K content was increased during storage. The results of the present investigation interpreted that K content of mango pulp was grown up slightly in the storage period, but, B_3 treatment interrupted its growing up trend during storage period.

The combined effect of varieties and imposed different doses of BDF solution in relation to K content of mango pulp demonstrated non significant variation at different days after storage. The results denoted that K content of mango pulp was slightly increased from different treatment combination with the progress of storage time. But, only the treatment combination of V_1B_0 produced the higher content of K up to 9th day. In this period, the highest (0.30%) quantity was reported from the treatment combination of V_1B_0

which was statistically at par with V_1B_1, V_1B_2, V_1B_3, V_2B_0, and V_2B_1, whereas, the lowest (0.24%) was obtained from the treatment combination of V_2B_3 which was also statistically at par with V_2B_2. The results of the present investigation are strongly supported by the report of Islam *et al.* (2011).

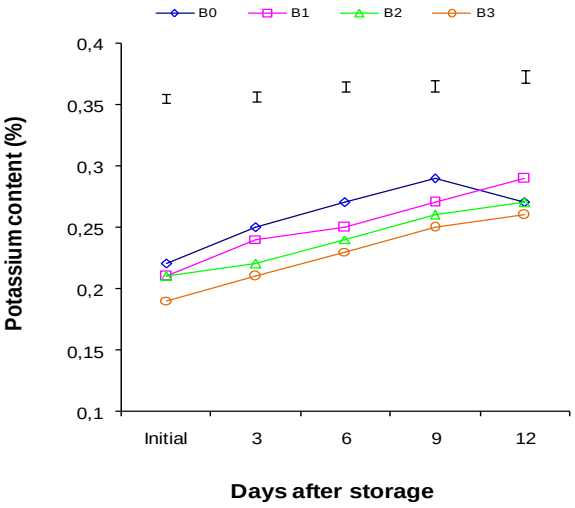

Figure 6. Potassium content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

Conclusions

The results explored that some biochemical properties *viz.,* lipid, water soluble protein, and minerals viz., phosphorus and potassium content were rapidly increased along with shelf life compare to untreated mangoes. The quantity of crude fibre came down in a continuous stream with the increase of storage period from both the varieties. At 12th day, higher (0.51%) quantity of crude fiber was obtained from the Langra while; lower (0.39%) was obtained from the Khirshapat. The falling off of crude fibre content with the rising of storage period might be probable due to metabolic activities resulting in hydrolysis of cellulose and lignin into simple molecules. The combined effect of varieties and imposed different doses of BDF solution in this experiment exhibited non-significant variation in respect of lipid and water soluble protein content at different days after storage. Better performance in increasing trend of P content in the Langra might be probably due to genetically dissimilarities. It also revealed that the expansion of phosphorus and potassium content in the mango was intimately associated with ripening during storage.

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