International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 329-333

Received: 22-01-2018
Accepted: 26-02-2018

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Studies on effects of different chemical treatments on wholesomeness and post-harvest storage qualities of drumstick (*Moringa oleifera*) Pods

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Abstract
In the present investigation has been made to estimate the effects of different chemical treatments on wholesomeness and post harvest storage qualities of drumstick pods (*Moringa oleifera*). Drumsticks have good nutritional and therapeutic values used to prevent or treat protein-energy malnutrition. The storage of *moringa* makes the pods available throughout the year and enables the farmer to get fair price even during the peak production seasons. The fresh and cleaned drumstick pods were treated with calcium chloride (1%) and bavistin (0.1%) and packed in LDPE and HDPE packaging material and finally stored at ambient and refrigerated condition. the data obtained from outcome of research revealed that the sample packed in HDPE and stored at refrigerated condition founded better results as compare to other samples. The drumsticks pods treated with calcium chloride solution found superior results as compare to bavistin solution. From the research it was concluded that calcium (1%) treated drumstick pods stored under refrigeration condition which packed in HDPE packaging material was better in overall qualities.

Keywords: Bavistin, calcium chloride, drumstick pods, HDPE, LDPE, storage, condition

Introduction
Drumstick (*Moringa oleifera* Lam.) or *Moringa* is one of the world's most nutritious crop and is one the most popular vegetables grown throughout India, with predominant crop culture prevalent in semi- arid regions of southern India (Palada and Chang, 2003) [14]. The genus *Moringa* consists of 13 species but the most popular and cultivated type is *Moringa oleifera*. It adopts well in different soils and adjusts well even in marginal conditions. Incredible ability of *Moringa* to survive in harsh weather and even to drought has made this crop a wider spread in varying situations (Singh, 2010).

Moringa oleifera are widely promoted in areas of chronic malnutrition as nutritional supplements for weaning infants and nursing mothers. The leaves, seeds and flowers all have good nutritional and therapeutic values used to prevent or treat protein-energy malnutrition and other nutritional related diseases (Tete-Benissan *et al.*, 2012) [23].

The tree ranges in height from 5 to 12 m and the fruits (pods) are around 50 cm long. *Moringa oleifera* is esteemed as a versatile plant due to its multiple uses. The leaves, fruits, flowers and immature pods are edible and form part of traditional diets in many countries of the tropics and sub-tropics (Siddhuraju and Becker, 2003) [21]. It is documented in eastern allopathic medicine to possess various pharmacological actions, such as analgesic, antihypertensive activity, anti-inflammatory effects (Shahid and Bhanger, 2006) [20]. Different parts of this plant contain a profile of important minerals and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics (Anwar *et al*., 2007) [2]. The seed cake remaining after oil extraction has the utility as manure (Rashid *et al*., 2008) [18]. The plant has also been reported to be hepatoprotective against antitubercular drug such as isoniazid and rifampicin (Fakurazi *et al*., 2008) [6].

Moringa oleifera helped mankind in combating malnutrition in children and increase immunity. It is a multi function plant cultivated in the tropics around the world for high protein, vitamins, minerals and carbohydrate content, nutrition for both human and live stock. It has high oil content with medicinal uses and water purifier (Bukar *et al*., 2010) [4].

There is increase in demand of food with the increasing population every year in India and Gujarat too. Production of drumsticks during peak seasons is in excess of local demand and

hence, the farmers are not able to get remunerative price for their produce. There are so many preservation and storage techniques to reduce the postharvest losses and increase the shelf life of the vegetables like, chemical treatment freezing, dipping in preservatives, canning, controlled atmosphere storage, low temperature storage and different packaging material etc. Drumstick is very hardy crops even though it cannot be keep for longer period of time for storage because of its shorter life span. There has been increasing demand of fresh like fruits and vegetables as it has numerous health benefits.

Materials and Methods

Collection of drumstick pods

The prominent variety of drumstick i.e. local variety (Koimtoor -1) majorly grown in Marathwada region was purchase from parbhani local market.

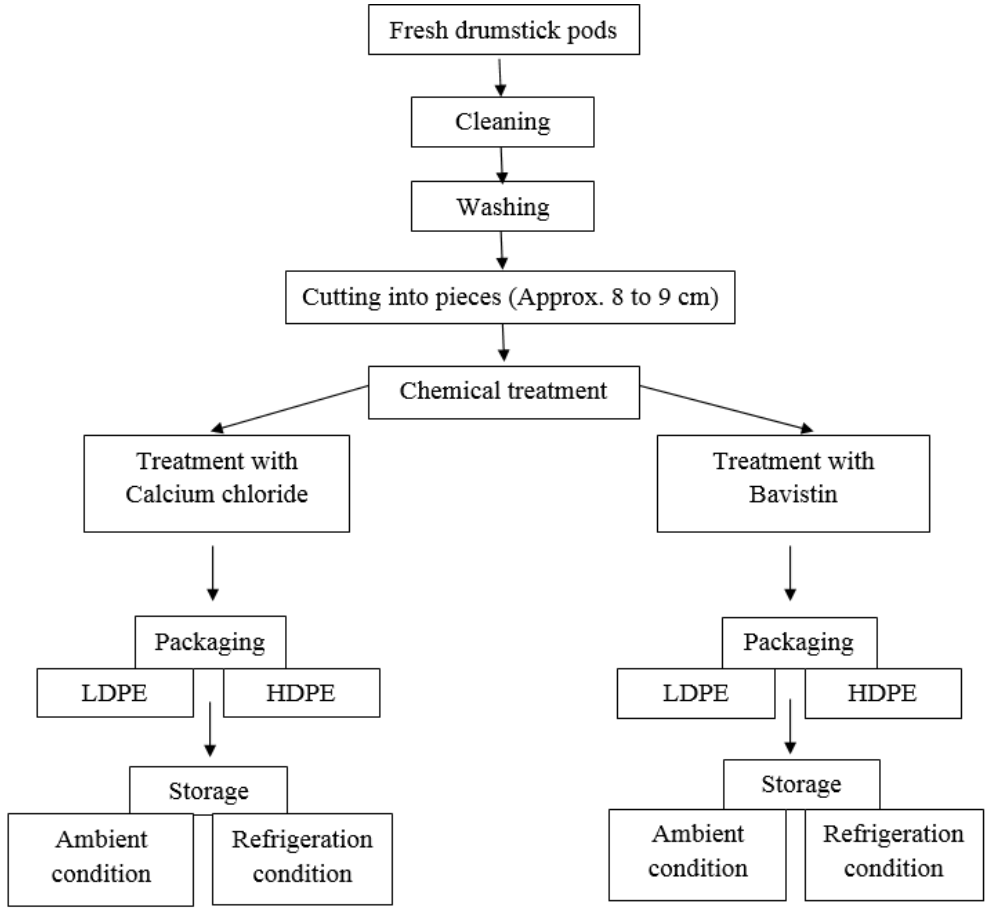
The present investigation was carried out in Department of Food Engineering with collaboration of Department of Food Science and Technology and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani during year 2017-18.

Chemical treatment of drumstick pods

The chemical treatments are necessary to inhibit bacterial action. Pretreatment is not only a way to extend shelf life and visual appearance of food, but a way to inhibit all enzyme and substrate released by disrupted cells, consequently reducing microbial spoilage, excessive tissue softening and tissue browning. Three chemical treatments (calcium chloride and bavistin) were given to drumstick pods.

1. **Calcium chloride (CaCl2):** It is well known that calcium maintain the textural quality of produce. 1 g calcium chloride was dissolved in 100 ml distilled water (1%) and drumsticks pods kept submerged for 10 minute. after that dried and packed.
2. **Bavistin:** Treatment It is fungicide which retard the fungus. 0.1 g bavistin was dissolved in 100 ml distilled water (0.1%) and drumstick pods kept submerged for 10 minute. after that dried and packed.

Process Flowchart



Determination of Moisture Loss

Moisture was estimated by accurately weighing the 5 g sample, it was ground and subjected to oven drying at 105^{0}C for 4 hr. It was again weighed after cooling in desiccators until constant weight. The resultant loss in weight was calculated as moisture content (AOAC, 2005) [3].

$$\text{Moisture loss}\,\% = \frac{\text{Initial weight} - \text{final weight}}{\text{Total weight of sample}} \text{ X } 100$$

Physiological Loss in Weight

The physiological loss in weight was measured through weighing balance. The initial weight of drumsticks was recorded and weight after treatment each 3 days interval recorded as a final weight throughout the storage. The physiological loss in weight was calculated in percentage. (Parmpal *et al*. 2015) [16].

$$\text{Physiological loss in weight} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}} \text{ X } 100$$

Firmness

The firmness in terms of penetration force of drumstick was determined by Stable Micro System *TAXT2 plus* Texture Analyzer.

Result and Discussion

Table 1: Effects of chemical treatment (calcium chloride) on the moisture loss of *moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Initial Moisture = 82%

Storage (Days)	Ambient Condition (Control) %		Refrigerated Condition (Control) %		Ambient Condition %		Refrigerated Condition %	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
3	79.20	79.90	80.00	80.60	80.30	80.36	80.87	81.99
6	76.11	77.01	78.11	79.01	78.21	79.18	79.08	81.39
9	74.22	75.15	76.01	78.85	76.17	77.48	78.12	80.89
12	73.01	73.91	74.81	77.14	75.01	75.69	76.88	80.46

*Each value is average of three determinations

An effect of different packaging material on the quality of *moringa oleifera* pods stored at different temperature conditions is depicted in the table. From the investigation it was found that there was profound effect of calcium chloride (1%) solution on the physical properties of drumstick pods. On the first day of storage the initial moisture content was 82% and which was successively decreased with storage period of 12 days.

The control sample stored at ambient and refrigeration condition without any treatment showed a great reduction in moisture content. The pods stored in LDPE packaging material showed maximum reduction in moisture content among all the treatments. On third day of storage of sample the moisture content of control sample (LDPE) was 79.20 and this was redacted to 7.01% at 12 day. The control sample packed in HDPE Showed somewhat slight reduction in moisture content as compared to Pods Packed in LDPE.

Moringa oleifera pods (Controlled) packed in HDPE and LDPE at refrigeration had THE moisture content at 3rd day of storage was 80.00% for LDPE and 80.60 for HDPE. At the end i.e. 12 day of storage percent moisture content was 74.81% (LDPE), 77.14% (HDPE).

Moringa oleifera pods treated with 1% calcium chloride solution showed good results in retaining its freshness and physiology. Among the stored samples the sample stored in HDPE at refrigeration condition showed significant results with maximum retention of moisture content. From the investigation it was observed that there was only 3% reduction in moisture content of pods stored in HDPE at refrigeration condition throughout storage period. The results were shows the resemblance with the findings of Gharezi *et al.* (2012) [7] and Jiyoti *et al*., (2013)

Table 2: Effects of chemical treatment (calcium chloride) on the physiological loss in weight of *moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Storage (Days)	Ambient Condition (Control) (g)		Refrigerated Condition (Control) (g)		Ambient Condition (g)		Refrigerated Condition (g)	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
Initial wt.	10.12	11.23	17.45	16.94	16.49	16.28	16.02	15.10
3	9.09	9.23	17.67	15.93	16.21	16.16	15.84	14.96
6	8.81	8.56	15.99	14.91	15.11	14.52	15.69	14.87
9	7.28	7.01	13.99	13.78	14.23	13.78	15.62	14.81
12	5.80	5.89	12.99	12.59	12.86	12.99	15.42	14.70

*Each value is average of three determinations

Physiological losses in weight of drumstick pods were evaluated every after 3 days of interval. Maximum losses in weight recorded in pods packed in LDPE (Control) under ambient condition. The reduction was from 10.12gm to 5.80gm at the end of storage period. Pods packed in HDPE (Control) at ambient condition showed somewhat slight reduction in weight compared to LDPE.

Moringa oleifera pods stored at refrigeration condition showed reduction in weight from 17.45gm to 12.99 for LDPE and for HDPE was 16.94 gm to 12.59 gm. The physiological losses in weights of drumstick pods were more for controlled sample as compare treated one with 1% calcium chloride solution.

Results were most significant for pods packed in HDPE under refrigeration condition treated with 1% calcium chloride. Reduction in weight was up to 1% till 12 days of storage period. These physiological losses in weight are attributed due to respiration and transpiration during storage periods. The results which was obtained during storage period of 12 days shows the similar pattern of results with Muhammad *et al.* (2012) [12] and Preetha *et al*., (2015) [17].

Table 3: Effects of chemical treatment (calcium chloride) on the firmness of *Moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Initial Firmness = 26.1 (Kgf)

Storage (Days)	Ambient Condition (Control)		Refrigerated Condition (Control)		Ambient Condition		Refrigerated Condition	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
3	24.86	25.00	24.90	25.23	25.50	25.52	25.71	25.99
6	24.00	24.21	24.11	24.80	25.01	25.06	25.52	25.93
9	23.90	23.66	23.70	24.00	24.48	24.72	24.99	25.89
12	22.98	23.00	23.01	23.91	23.89	24.09	24.49	25.81

*Each value is average of three determinations

The effect of chemical treatment i.e. calcium chloride (1%) on firmness of moringa oleifera pods were evaluated over 12 days storage period. On the initial day of storage 26 Kgf force were required to check its firmness with TA-XT texturometer.

Results were not much significant for controlled samples as compare to treated one as firmness significantly decreased during storage period of 12 days. At the end of 12 day firmness of controlled sample packed in LDPE and HDPE under ambient condition was 22.98 and 23.00 respectively.
The controlled samples stored under refrigeration condition somewhat good firmness as compared to sample stored under ambient condition. The firmness of the samples was 23.01 and 23.91 for LDPE and HDPE respectively.

The chemically treated samples showed great retention of firmness of pods over 12 days of storage. These particularly due to the calcium chloride tend to hold moisture within pods and lower its respiration rate. At the end from the study it was observed the samples stored at refrigeration condition showed maximum retention of firmness. At 12 day firmness of treated sample packed in LDPE and HDPE under refrigeration condition was 24.49 and 25.81 respectively. Findings of Sangeetha *et al*., (2017) [19] were found similar to the obtained results.

Table 4: Effects of chemical treatment (bavistin) on the moisture loss of *Moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Storage (Days)	Ambient Condition (Control)		Refrigerated Condition (Control)		Ambient Condition		Refrigerated Condition	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
3	77.82	79.51	78.64	79.01	78.44	80.42	79.49	80.13
6	75.94	77.96	76.97	78.77	76.31	78.97	77.98	79.98
9	74.00	75.96	75.53	77.56	74.89	77.32	76.12	79.01
12	73.01	74.40	73.54	76.14	73.99	75.29	74.99	78.11

Initial Moisture = 82%
*Each value is average of three determinations

Bavistin is an antifungal chemical and which was at the extent of to check the loss of moisture of pods. Samples were stored for 12 days of storage and assessed for loss in weight over 12 days of period.
At the initial day of storage the moisture content was about 82%. Samples stored under controlled conditions. Samples stored under ambient condition had the moisture content at the end of storage period 73.01 and 74.40% for LDPE and HDPE pack. Controlled samples stored under refrigeration condition showed somewhat retention of moisture content of pods but which is not significant as compared to treated one. The findings were similar to that of Kader (2000) [9].

Table 5: Effects of chemical treatment (bavistin) on the physiological loss in weight of *Moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Storage (Days)	Ambient Condition (Control) (g)		Refrigerated Condition (Control) (g)		Ambient Condition (g)		Refrigerated Condition (g)	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
Initial wt.	11.53	18.65	17.45	12.50	13.42	13.62	11.16	15.55
3	10.79	15.50	17.01	12.23	13.01	13.44	10.88	15.26
6	8.12	14.08	16.21	11.08	12.59	12.98	10.62	14.01
9	6.72	12.98	15.06	10.01	12.11	12.51	10.35	13.31
12	5.12	11.92	13.87	8.30	11.71	12.01	10.15	12.87

*Each value is average of three determinations

The loss in physiology that is in weight of drumstick pods treated with bavistin an antifungal chemical showed a great reduction in weight of the drumstick pods. The samples stored under refrigeration and ambient condition had the weight at the end of 12 day 5.12, 11.92gm for LDPE and HDPE packed pods. For the pods packed under refrigeration condition had the weight of 13.87 and 8.30 gm. The results were not significant for the untreated pods of drumstick.
The pods treated with bavistin showed somewhat good results as compared to treated one. The HDPE packed pods stored under refrigeration condition had the great retention of weight among all others. At the end 12 day weight was 10.15 and 12.77 gm rept. Similar findings were made by Nath *et al*., (2012) [13] and Alam *et al.*, (2013) [1],

Table 6: Effects of chemical treatment (bavistin) on the firmness of *Moringa oleifera* pods packed in different packaging materials at refrigeration and ambient temperatures.

Storage (Days)	Ambient Condition (Control)		Refrigerated Condition (Control)		Ambient Condition		Refrigerated Condition	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
3	24.21	24.96	24.00	25.10	24.29	25.09	24.49	25.71
6	23.01	24.00	23.50	24.90	23.51	24.71	23.89	25.41
9	21.90	23.10	22.90	23.56	22.01	24.42	23.37	24.04
12	21.60	22.70	21.00	22.99	21.61	24.04	22.94	23.86

Initial Firmness = 26.1 (Kgf)
*Each value is average of three determinations

It was observed that with storage period firmness of drumstick continuously declined. The average initial values of firmness of the drumstick pods were 26.0 kgf. It is evident from the table that with increase in storage period firmness was decreased definitely. The minimum firmness was recorded in the LDPE packed pods (Controlled) stored under ambient temperature condition. The lowest percent decrease in firmness was recorded for the bavistin treated pods packed in HDPE and stored under refrigeration condition. This indicates that bavistin treated sample stored under refrigeration was more efficient. The results of effects of bavistin treatment on the firmness of drumstick pods were similar to the findings of Eleni and Theodoros (2011) [5] nath *et al*., (2012) [13].

Conclusion

Present study with evaluation of storage stability of drumstick pods under variables of treatments, packaging condition and temperature showed varying degrees of results. Finally it was concluded from the study that calcium (1%) treated drumstick pods stored under refrigeration condition showed most better results as compared to bavistin treated one.

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