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EFFECT OF TREATMENTS, DRYING METHODS AND STORAGE CONDITIONS ON DEHYDRATED BITTER GOURD SLICES

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ABSTRACT

Drying is one of the important postharvest method to increase the shelf life of produce which make the availability of the produced during off season. An experiment was carried out to evaluate the dehydration behaviour of bitter gourd slices. Bitter gourd rings were prepared after peeling and cutting into slices followed by dehydration in vacuum drier at 40±2°C with an atmospheric pressure of 640 mmHg and in cabinet drier at 58±2°C with an air flow 120m/sec, using different pre-treatments. Among the pre-treatments and drying methods, bitter gourd slices blanched in boiling water followed by soaking in 0.2 per cent KMS solution for 20 minutes and dried in vacuum drier showed better retention of chlorophyll content, ascorbic acid, total phenol, antioxidant activities and higher rehydration ratio with less moisture, non-enzymatic browning and titratable acidity as compared to cabinet dryer. Among three packaging materials of 200 gauge HDPE, 400 gauge LDPE and 260 gauge COEX pouches. Samples packed in 260 COEX pouches followed by storage at low temperature (7±1°C) was found best for six months of storage. As it retained higher ascorbic acid, total phenol, total antioxidant and total chlorophyll content, rehydration ratio and less moisture and non enzymatic browning (NEB) in the finished product.

Keywords:
Vacuum drier, cabinet dryer, bitter gourd slices, chlorophyll, anti oxidant, dehydration ratio, phenol content, treatments

INTRODUCTION

Vegetables are having importance, mainly because of vitamins, minerals and dietary fibre. Preservation of these vegetables can prevent wastage as well as make them available in lean season. The post-harvest losses of bitter gourd are about 25 per cent. Main reason for this much of loss is due to ripening and mechanical damage during transport. Bitter gourd fruits are used as vegetables in many ways and are quite commonly used as cooked, stuffed, fried forms and the fruits are also pickled, canned and dehydrated (Anonymous, 2010). Bitter gourd is a seasonal vegetable and very bitter in taste and it is a rich source of phosphorous, besides Vitamin C, Vitamin A and Iron. The needs of phosphorous in human body can be fulfilled by its regular use of bitter gourd. Bitter gourd purifies blood, activates spleen and liver and is highly beneficial in diabetes. The fruits of bitter gourd are very much consumed as fresh and as dried vegetable for curries, bakery products, pickle or stuffed products and juices. Pre-treatments check the undesirable physico-chemical and other qualitative changes that may occur during drying process and subsequent storage and thereby help to extend keeping quality of dried products. Various pre-treatments employed are sulphuring, balancing in hot water, brining, steeping in solutions of certain chemicals like salt, potassium meta- bisulphite and acetic acid for specific period. The preservation methods such as dehydration, steeping (salt solution) and pickling can be successfully adapted to preserve bitter gourds for off-season. The suitability of a particular drying methods and pre-treatment needs to be worked out for specific vegetables in order to get product of high quality with consumer acceptability with this back ground an investigation on dehydration of bitter gourd slices was carried out

MATERIALS AND METHODS

The study was conducted at Division of Food Science and Postharvest Technology laboratory at IARI, New Delhi during 2015-2016. The bitter gourds were purchased from the Inderpuri New Delhi market. After cutting the tips and stem portions, the bitter gourd fruits were cut into 0.5cm thick slices by knife and then slices were allowed for further pre-treatments as, blanched in boiling water for 3 min, blanched followed by soaking in 0.1 per cent KMS, 0.2 per cent KMS and 0.25% KMS solution for 20 min and

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blanched in boiling water for 3 min followed by soaking in 2.5 per cent and 5% salt solution for 20 min, respectively along with control then treated samples were allowed to dry in vacuum and cabinet dryer (Siva Kumar et al. 1991 and Singh et. al., 2008). After drying, dried slices were cooled and packed in 200 guage high density polyethylene bags (HDPE), 400g LDPE and 260g COEX pouches and stored at dry and cool place. (Manimegalai and Ramah, 1999 and Shams-Ud-Din and Shraji, 2008). The dried slices were subjected for chemical analysis at initially and 2 months interval upto 6 months of storage. The physical and chemical parameters like dehydration ratio, rehydration ratio, moisture, titratable acidity ,ascorbic acid, chlorophyll , total phenol, total antioxidant and non-enzymatic browning of dried bitter gourd slices were determined according to methods of (Ranganna, 1979).

RESULTS AND DISCUSSIONS

General physical and chemical properties of dried bitter gourd slices are presented in Table 1. The time taken for drying was influenced by both drying methods and pre-treatments. Control samples took less time for drying in both the driers as compared to treated samples. It might be due to pre-soaking of slices in different solution. With regard treatments, blanched and soaked in KMS solution samples took less time to dry in comparison of bitter gourd slices treated with common salt. This might be due to faster removal of water from the slices soaking in KMS solution as compared to soaked in common salts solution. Cabinet drier reduce the drying time as compared to vacuum drier. Lesser number of hours taken for drying with cabinet drier might be due to constant drying temperature of 60ºC as compared to 25 to 40ºC temperature in vacuum drier (Hiremath et al. 2009). Both drying methods & treatments were found statistically significant.

The moisture content was recorded higher in control samples in comparison of treated samples dried in both the driers. However, moisture content slightly increased with increase of KMS & salt concentration. This might be due to variation of rate of water removal and uptake of the KMS & salt by the slices in different concentrations. The difference in moisture content with respect to driers & treatments were found statistically significant at 5% level.

The control slices retain slightly higher acidity in comparison of treated bitter gourd slices. It may be attributed to the leaching of acids form the product during soaking in KMS & salt solution. However reduction in acid content by both drying methods & treatments were found statistically significant.

Ascorbic acid was higher in the dehydrated bitter gourd slices treated with KMS followed by salt solution in both drying methods. This might be due to protection of ascorbic acid by KMS during dehydration process as sulphur dioxide inhibit the oxidative changes of ascorbic acid. The reduction of ascorbic acid was slightly more in the slices dried in vacuum drier as compared to cabinet drier. This might be due to lesser degradation of ascorbic acid due to lower temperature as ascorbic acid is very heat sensitive to heat. However, reduction in ascorbic acid in respect of treatments & drying methods were found statistically significant.

Similarly total chlorophyll content was higher in the treated bitter gourd slices dried in both driers. This might be due to better protection of antioxidant by the preservative agent of KMS & salt, which might have reduced the discoloration of the dried bitter gourd (Siva kumar et. at. 1991). With regard to driers vacuum drier retain high content of chlorophyll then cabinet drier. This might have due to less degradation of chlorophyll in the slices dried in vacuum drier due to low temperature as compared to cabinet dryer. The reduction in chlorophyll content due to treatment as well as drying methods were found statistically significant.

The total phenol content were slightly higher in control samples in comparison of treated slices and it vary with KMS & salt concentration. Decrease in phenolic content in treated samples might be due to leaching of phenol content during soaking & blanching time in water. This is in accordance with the studies of Myojin et. al. (2008), Amin et. al. (2006), Wen et. al. (2010) and Miglo et. al.(2008). There was significant difference in the total phenolic content due to treatment variations. The dehydrated bitter gourd slices dried in vacuum drier retain higher total phenolic content significantly as compared to cabinet drier. This might be due to less loss of phenolic compound in the slices dried in vacuum drier.

The total antioxidant activity was slightly higher in treated samples then control. This might be due to suppression of oxidation by antioxidants due to thermal inactivation of oxidative enzymes (Yamaguchi et. al. 2001). In addition of the blanching process may distruct the cell wall and sub cellular compartment thus releasing the potent radical scavanging antioxidants. Significant increase in total antioxidant activity in pepper, green beans, broccoli and spinch has also been reported by Turkman et. al. (2005). However, retention of total antioxidant activity were higher in the samples dried in vacuum drier as compared to cabinet drier. This might be due to less degradation of antioxidants in vacuum drier. The differences due to drier and treatments were found statistically significant.

Table -1 Effect of pre treatments & drying methods on quality attribute of dehydrated bitter gourd slices

Drying methods	Treatments	Parameters								
		Drying time (Min)	Moisture (%)	Acidity (%)	Ascorbic Acid (mg/100g)	Total Chlorophyll (mg/100g)	Total phenol content (mg GAE/100g)	Total anti-oxidant activity (µg TE/g)	Rehydration ratio (RR)	Sensory Score(9)
Cabinet drier	Control	290	6.55	0.59	43.56	23.25	19.15	40.10	1:5.14	7.0
	Water Blanch (WB)	300	5.51	0.52	52.60	24.77	18.23	42.47	1:5.20	7.2
	WB + soaking in 0.1% KMS	300	5.75	0.48	55.20	25.4	18.25	50.58	1:6.0	7.5
	WB + soaking in 0.2% KMS	310	5.80	0.38	56.55	26.55	19.80	58.36	1:6.10	8.0
	WB + soaking in 2.5% Salt	380	6.10	0.35	54.80	25.55	19.49	52.89	1:5.8	7.8
	WB + soaking in 5% Salt	410	6.45	0.35	53.10	25.10	17.56	57.05	1:5.2	7.5
Vacuum drier	Control	290	6.52	0.58	44.1	23.50	19.50	42.13	1:5.18	7.0
	Water Blanch (WB)	310	5.50	0.50	52.8	25.10	18.25	46.46	1:5.19	7.3
	WB + soaking in 0.1% KMS	330	5.53	0.48	56.25	25.50	18.80	55.69	1:6.10	7.8
	WB + soaking in 0.2% KMS	340	5.62	0.36	56.85	26.76	19.28	62.07	1:6.20	8.5
	WB + soaking in 2.5% Salt	390	5.88	0.32	55.3	25.70	18.58	57.54	1:6.0	8.0
	WB + soaking in 5% Salt	410	6.20	0.30	54.0	25.20	18.10	58.77	1:5.90	7.5
CD	Drier	10.547	0.136	0.022	0.242	0.253	0.164	0.196	0.12	0.357
	Treatment	18.263	0.236	0.039	0.418	0.438	0.285	0.339	0.209	0.618

Table-2 Effect of packaging and storage of dehydrated bitter gourd slices (6 months)

Parameters	Initial value	Storage period (month)	Packaging material						CD at %			
			200gHDPE		400g LDPE		260g COEX					
			RT	LT	RT	LT	RT	LT	P	T	S	P x T x S
Moisture %	5.65	2	9. 91	9.80	8.50	6.50	8.20	8.10	0.161	0.131	0.161	0.393
		4	11.21	10.10	9.60	8.50	9.50	8.0				
		6	12.56	11.50	10.50	9.60	9.0	7.80				
Ascorbic Acid (mg/100g)	56.50	2	50.62	52.15	51.20	53.20	53.10	54.60	0.153	0.125	0.153	0.376
		4	41.15	45.30	48.30	49.20	48.50	50.10				
		6	38.26	41.50	42.80	43.80	44.40	44.60				
Total Chlorophyll (mg/100g)	26.50	2	23.10	24.10	23.80	25.10	24.10	25.70	0.163	0.133	0.163	0.400
		4	20.30	23.10	22.50	24.12	23.51	24.62				
		6	20.50	21.80	21.20	23.05	22.23	23.56				
Total phenol (mg GAE/100g)	18.28	2	17.20	17.60	17.80	17.90	18.00	18.10	0.213	0.174	0.213	0.522
		4	16.10	16.60	17.00	16.01	17.05	17.10				
		6	15.30	15.80	16.40	16.10	16.10	16.25				
Total anti-oxidant activity (µg TE/g)	58.40	2	55.12	55.45	55.54	56.67	56.98	57.78	0.160	0.031	0.160	0.392
		4	53.43	54.54	55.10	55.76	56.65	56.54				
		6	51.65	52.43	52.45	53.65	53.68	54.72				
NEB (OD at 42nm)	0.25	2	0.36	0.33	0.34	0.32	0.32	0.30	0.024	0.019	0.024	0.058
		4	0.38	0.35	0.36	0.35	0.36	0.35				
		6	0.40	0.38	0.39	0.36	0.38	0.37				
Sensory score overall over all	8.50	2	7.00	7.50	7.50	8.0	8.0	8.25	0.441	0.360	0.441	1.079
		4	6.50	7.0	7.0	7.50	7.0	7.50				
		6	6.50	7.25	7.20	7.50	7.0	7.80				

HDPE – High density polyethylene, LDPE – Low density polyethylene, packaging, S- Storage
COEX – Coextruded film, RT – Room temperature, LT- Low temperature, P-

Rehydration ratio (RR) was found better in the slices blanched in boiling water and soaked in KMS and NaCl solution at both case- cold water (ambient temperature) as well as in hot water (70°C) water followed by slices blanched in boiling water. Rehydration ratio of bitter gourd slices was less in control slices. It could be due to control samples does not take up as much water, which means no crisper texture. Beside of that treated samples being higher in rehydration ratio can be exposed to the atmosphere for several hours without becoming sticky (Pointing et. al. 1966). However, rehydration ratio was found to be higher in the samples dried in vacuum drier in comparison to cabinet drier. It might be due to better texture of the finished product dried in vacuum driers. The difference in rehydration ratio between treatments & drying methods were found statistically significant.

The merits of any product depends upon the consumer acceptability, organoleptic is an important tool to know the consumer acceptability. Good quality of dehydrated bitter gourd slices with respect of organoleptic characters were obtained in the treated samples with KMS in both the driers in comparison of NaCl treated and control one. This might be due to better texture of the dehydrated slices which might help produce better rehydrated ratio. However, samples dried by vacuum driers retain higher sensory score in comparison to cabinet drier. The sensory score obtained due to treatments and drying methods was also found statistically significant.

The effect of packaging material on the quality and stability of dehydrated bitter gourd slices in terms of changes in moisture, ascorbic acid, total phenol content, total antioxidant, non enzymatic browning and sensory evaluation is presented in Table. 2.

It has been observed that there was continuous picking up of moisture by the product in all the samples during storage and it was found to be maximum during the initial period of storage. The gain of moisture was highest at ambient temperature as compared to low temperature. It may be due to more absorption of moisture from the atmosphere by the slices being hygroscope in nature. Similar trend was also described by Helkel et .al. (1972) in dried mango sheets. With regard to packaging material, the samples stored in higher gauge of polyethylene bags gained less moisture in all the condition of storage as compared to lower gauge polyethylene. It may be due to lower permeability to water vapour at higher gauge. The differences due to packaging material, storage period, temperature as well as interaction among them were found statistically significant.

Ascorbic acid reduced rapidly during storage when sliced were packed in 200g HDPE and stored at room temperature. Whereas reduction was very less when samples were stored under low temperature and packed in co-extruded film. This might be due to less permeability of these pouches to light and oxygen. Reduction of ascorbic acid was more in slices stored at room temperature. It could be due to thermal degradation during dehydration and subsequent oxidation of ascorbic acid during storage. The decrease trend of ascorbic acid content were found mostly due to its oxidation as substrate in non-enzymatic browning during the storage period is very sensitive to heat. It might be lost due to application of heat during drying. An antioxidant that might have reduced the discolouration of the dried better gourd slices. (Siva Kumar et at, 1991). Retention of ascorbic acid was higher in samples stored at low temperature. This might be due to high level of SO_2 and less degradation of ascorbic acid at low temperature as compared to room temperature, as also reported by Sagar et. al. (1999) in mango slices. Decrease in ascorbic acid due to packaging material, storage period, temperature as well as interaction among them were found statistically significant.

Chlorophyll content was found to decrease gradually during storage. Chlorophyll content decrease due to heat and oxidation during drying, longer drying time and higher drying temperature, produce greater pigment loss. The overall mean of treatments chlorophyll content decreased from 26.50mg/100g to 20.30mg/100g after six months of storage. statistically analysis showed that there was a significant effect of treatments and storage period. Deore (2008) reported that the chlorophyll content of bitter gourd juice decrease from 5.63 to 2.69 mg/lit. during 6 month storage. The reduction in total chlorophyll content due to packaging material, storage period, temperature as well as interaction among them were found statistically significant.

Total phenol content decrease, with increase in storage period from 18.28 (mgGAE/100g) to 15.30(mg/GAE/100g). The decrease was found least in the samples packed in 260g COEX pouches and stored at low temperature. A decrease trend in total phenol content has also been reported in tomato juice after 9 months of storage by Vallverdu Queralt 2011). The difference due to packaging materials storage temperature, storage period as well as interaction among them were found statistically significant.

A decrease trend in antioxidant was found during storage. At the end of 6 months, the antioxidant activity decreased from 58.40µg TE/g to 51.65µg TE/g. However, the decrease found least during storage in the samples packed in 260g COEX stored at low temperature. It has been reported that the decrease in antioxidant activity may be linked to a decrease in total phenolic content and vitamin C during storage (Klimczak, 2007). According to them antioxidant activity of orange juice decreased by 45% after 6 months of storage at 28°C. The difference due to packaging, storage period, storage temperature and interaction among them were found statistically significant.

The non enzymatic browning was more in 200 gauge HDPE pouches and least in 260 gauge COEX pouches. This may be due to low moisture content in 260 gauge COEX pouches, which helped to maintain the better colour of the product. An increasing trend in non-enzymatic browning due to packaging material, storage temperature, storage period as well as interaction among them were found statistically significant.

The mean score of judges for overall acceptability were significantly ($P<0.05$) decreased from 7.80 to 6.50 during 6 months storage. The maximum mean score was observed in the dehydrated slices packed in 260g COEX film and stored at low temperature during storage. This might be due to retention of batter colour and texture of the dehydrated bitter gourd slices during storage packed in 260gCOEX pouches. However, mean score in respect of packagings, treatments and storage as well as interaction among them were found statistically significant.

CONCLUSION

Dehydrated bitter gourd have the potential to become an important value added products because of relatively inexpensive, easily and quickly cook able and rich in several nutrients which are essential for human health.

It was concluded that among these samples, blanched + soaked in 0.2 per cent KMS solution for 20 minutes was found most acceptable on overall quality basis even after 180 days of storage. Better quality of dehydrated bitter gourd slices could be prepared from bitter gourds after peeling and cutting into 5 mm thick slices followed by dehydration in vacuum drier at 40 **±2°C** with an atmospheric pressure of 640 mm Hg. Dehydrated bitter gourd slices could be stored for six months with better nutritional quality after packaging in 260 gauge COEX pouches followed by storage at low temperature 7±1°C. Dehydrated bitter gourd slices have potential for its easily adaptable in small scale industries operating in rural areas. Therefore, developed new packaging and storage techniques will help in extending shelf life of the product.

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