Annals of Plant and Soil Research 24(4):586-591 (2022)
https://doi.org/10.47815/apsr.2022.10212

Effect of treatments, packaging and storage on nutritional quality of dehydrated Spine Gourd (*Momordica dioica Roxb*.)

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Received: June, 2022; Revised accepted: September, 2022

ABSTRACT

Spine gourd (Momordica dioica.) is very nutritive vegetable available in market for very short period. The selected spine gourd fruits were cut manually with stainless steel knife and 0.5 cm thick slices were prepared. Slices were allowed for pre treatments and blanching was carried out in boiling water for 3 min. The spine gourd slices were dried by vacuum and cabinet drier up to a moisture content of 6%. Among the pre treatment KMS (0.2%) solution for 20 min. and dried in vacuum driver showed batter retention of chlorophyll content (26.75 mg/100g) ascorbic acid (56.55 mg/100g) total phenol (19.28mg/100g) antioxidant (61.05 µmole TE/ gm) and higher rehydration ratio with less moisture content. Among the packaging material of 200g ALPE, HDPE and LDPE, sample packed in 200g ALPE pouches followed by stored at low temperature (7±1) was found best for six month of storage, As it retain higher ascorbic acid, total phenol, total antioxidant and total chlorophyll content, rehydration radio and less moisture during storage.

KEY WORDS: Spine Gourd, Nutritional quality, Packaging, Dehydrated slices, Storage.

INTRODUCTION

Vegetable sector has emerged as an important component of Indian agriculture. Vegetable have contributed largely towards food and nutritional security of the people, particularly the poor. India is the second largest producer of vegetable in the world after China. Spine gourd (*Momordica dioica Roxb*.) is a cucurbitaceous, dioecious perennial vegetable which is normally seen in the Indian markets in the session of monsoon. It fetches the very good price in the market. It is indigenous and is grown in Assam, Meghalaya, West Bengal, Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh, Gujarat and Andaman Islands. West Bengal and Karnataka are two major Indian states that grow spine gourd commercially. It is locally known as Meetha Karela, Khekhsa, Padora, Bhaat Karela, etc in different localities. It is a highly prized vegetable in indian sub-continent. Fruits of spine gourd botanically described as a pepo is oval to ovoid dark green vegetable usually shorter than 6 cm densely covered with false spine. Individual fruit weight is around 10-15 g and attains up to 30g. Spine gourd is rich in nutrients, including carotenoids, fatty acids, vitamin E, polyphenols compounds and flavonoids. These phytochemical are present in all parts of the fruits, so fruits has the potential to utilize all parts in processed products. Phenolics compounds could be a major determinant of antioxidant potentials of food plants and could therefore be natural sources of antioxidants. Spine gourd is generally harvested at half green and half white stage when it attains desirable size. But being perishable nature it is liable to change in their colour and quality very fast due to shriveling, pathogenic rot caused by *Pythium aphanidermantum.* The average nutritional value per 100 g edible spine gourd contains 84.1% moisture, 7.7 g carbohydrate, 3.1 g protein, 3.1 g fat, 3.0 g fibre and 1.1 g minerals. It also contained small quantities of essential vitamins like ascorbic acid, carotene, thiamin, riboflavin and niacin (Talukdar and Hossain, 2014). Spine gourd is also used as medicine to cure different health problem in different forms. Dehydration is one of the best methods of preservation; the main principle of preservation of product is to remove the moisture content to a level where micro-organism may not able to spoil the product. Dehydration of spine gourd not only increases its value but also its availability. Proper drying method helps for better nutritional status of dehydrated spine gourd slices for extended storage and availability. The preservation methods such as dehydration,

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steeping (salt solution) and pickling can be successfully adapted to preserve products for off-season. (Sonkamble et al 2017)

MATERIALS AND METHODS

The experiment was conducted at Division of Food Science & Postharvest Technology Laboratory at Indian Agriculture Research Institute, New Delhi during 2018 - 2019. The spine gourd fruits were purchase from Azadpur Sabji Mandi, New Delhi. The fruits were cut into 0.5cm thick slices by stainless steel knife manually and then slices were allowed for pre-treatments as blanched in boiling water for 3 minutes, blanched followed by soaking in steeping solution of 0.2% potassium metabisulphite (KMS) and blanched followed by soaking in 2% salt (NaCl) solution for 10 minutes, respectively along with control. The treated samples were dry in vacuum and cabinet dryer up to 6% moisture level (Singh *et. al*., 2008). After drying, the dried slices were packed in 200 gauge high density polyethylene (HDPE) bags, 200 gauge low density polyethylene (LDPE) bags and 200 gauge aluminum laminated polyethylene (ALPE) bags and stored at room temperature (RT) 18-32°C and low temperature (LT) 7±2°C for storage study up to 6 months. The dried slices were subjected for chemical analysis at initially and 2 months interval up to 6 months of storage. The physical and chemical parameters like dehydration ratio, rehydration ratio, moisture, drying time, ascorbic acid, antioxidant activity, total phenol content, chlorophyll content and sensory score of dried spine gourd slices and fresh fruits were determined according to methods of Ranganna (1979).

RESULTS AND DISCUSSION

The time taken for drying was influenced by both drying methods and pretreatments. Control samples took less time for drying in both the driers as compared to treated samples (Table 1). 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 spine 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 reduced 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 drying ratio was higher in dehydrated spine gourd slices treated with salt followed by samples treated with KMS and control. However, differences were non significant. The drying ratio was more in control sample in both the dryer. This may be due to broken of the slices during dehydration. Similar trend has been reported by Meena and Lal (2005) in dehydrated kachri slices. The uptake of salt by product showed a possible effect on the course of drying.

Table 1: Standardization of pretreatments for dehydration of spine gourd slice

Treatment	Drying Characteristics					
	Drying time (h)		Dehydration ratio		Rehydration ratio	
	Cabinet	Vacuum	Cabinet	Vacuum	Cabinet	Vacuum
Water Blanched (WB)	8.60	9.20	8.80	9.00	3.50	3.60
(WB + 0.2% KMS)	8.50	9.30	8.50	9.20	3.82	3.90
(WB + 2% NaCl)	9.79	10.50	9.10	9.15	3.45	3.50
Control	9.13	11.15	10.20	10.30	3.30	3.40

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) followed by slices blanched in boiling water. Rehydration ratio of spine 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. 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 and drying methods were found statistically significant.

Table 2: Effect of treatment on chemical constituents of dehydrated Spine gourd slices

Drying Method	Treatment	Moisture (%)	Ascorbic acid (mg/100 gm)	Antioxidant (µmole TE/ gm)	Total phenol (mg/100 gm)	Chlorophyll (mg/100 mL)	Sensory Score (9.0)
Cabinet	Water Blanched (WB)	5.50	52.60	42.50	18.75	24.20	7.2
	(WB + 0.2% KMS)	5.50	55.50	58.36	19.70	26.50	8.0
	(WB + 2% NaCl)	6.45	53.15	57.40	17.56	25.24	7.8
	Control	6.51	43.56	40.15	19.20	22.50	7.0
Vacuum	Water Blanched (WB)	5.50	52.80	46.48	18.25	25.20	7.0
	(WB + 0.2% KMS)	5.62	56.55	61.05	19.28	26.75	7.3
	(WB + 2% NaCl)	6.20	54.00	58.25	18.20	25.20	8.5
	Control	6.52	43.25	42.13	19.60	23.50	7.5
CD							

The moisture content was recorded higher in control samples in comparison of treated samples dried in both the driers (Table 2). However, moisture content slightly decreased in blanched samples followed by treated samples with salt and KMS solution. This might be due to variation of rate of water removal and uptake of KMS and salt by the slices. The difference in moisture content with respect to driers and treatments were found statistically significant at 5% level. Ascorbic acid was higher in the dehydrated spine 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 sensitive to heat. However, reduction in ascorbic acid in respect of treatments & drying methods were found statistically significant. (Sagar and Jitendra, 2017). 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. In addition of blanching process may destruct the cell wall and sub cellular compartment thus releasing the potent radical scavenging antioxidants. Significant increase in total antioxidant activity in pepper, green beans, broccoli and spinach 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. 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 and blanching in boiling water. This is in accordance with the studies of Myojin *et al.* (2008), Wen *et al.* (2010) and Miglo *et al.*(2008). There was significant difference in the total phenolic content due to treatment variations. The dehydrated spine 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.

Similarly total chlorophyll content was higher in the treated spine 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 spine gourd. 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.

Table 3: Effect of treatment on drying ratio of dehydrated Spine gourd in cabinet dryer

Treatment	kg of weight / kg of dry matter						
	0	2	4	6	8	10	12
Water Blanched (WB)	6.5	4.30	3.32	2.18	1.90	1.60	1.62
(WB + 0.2% KMS)	6.5	4.35	3.35	2.20	2.00	1.70	1.71
(WB + 2% NaCl)	6.5	4.40	3.38	3.00	2.10	1.90	1.85
Control	6.5	4.45	3.40	3.10	2.18	2.05	1.85

Good quality of dehydrated spine 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 to produce better rehydration 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 drying rate decreased with increase in time of drying. Drying rate was faster in the blanched samples followed by samples treated with KMS. This might be due to faster removal of moisture from the samples. However the drying rate was slower in the control sample followed by sample treated with NaCl. This must be due to very slow removal of water from the control sample and higher solid gain from the salt during treatment. The effect of packaging material on the quality and stability of dehydrated spine gourd slices in terms of changes in moisture, ascorbic acid, total phenol content, total antioxidant and sensory evaluation (Table 4).

Table 4: Effect of storage condition of quality of dehydrated spine gourd slices

PARAMETERS	Initial Value	Storage Period (Months)	Storage tem. & Packing Material								
			LT			RT			CD		
			HDPE (200g)	LDPE (200g)	ALPE (200g)	HDPE (200g)	LDPE (200g)	ALPE (200g)	T	S	P
MOISTURE (%)	5.85	2	6.15	6.40	5.94	6.49	6.69	6.15	-	0.293	0.293
		4	6.52	6.83	6.09	6.66	7.03	6.31			
		6	6.86	6.94	6.22	6.96	7.16	6.56			
ASCORBIC ACID (mg/100 gm)	74.21	2	66.51	56.15	56.12	45.69	66.51	114.51	-	0.456	0.456
		4	62.15	41.89	66.12	51.98	29.8	62.13			
		6	33.81	24.72	42.90	25.63	20.45	32.72			
ANTI-OXIDANT (µ mole TE/gm)	48.26	2	41.81	37.27	42.67	39.24	35.37	40.86	-	0.496	0.496
		4	33.45	32.53	40.53	37.44	33.12	39.16			
		6	32.80	31.27	38.37	34.48	30.90	37.29			
TOTAL PHENOL (mg/100 gm)	190.2	2	176.83	170.85	185.55	173.13	168.55	180.85	0.561	0.687	0.687
		4	171.00	165.23	180.80	168.40	162.90	175.58			
		6	168.80	160.30	176.03	165.93	159.55	170.45			
CHLOROPHYLL (mg/100 mL)	9.436	2	8.12	7.63	8.65	8.05	7.45	7.25	0.195	0.239	0.239
		4	7.21	7.05	7.56	7.12	7.02	6.50			
		6	6.15	5.48	6.25	6.05	5.51	6.05			
Sensory Score (9.0)	8.75	2	6.39	6.12	7.66	6.19	5.64	7.17	0.282	0.345	0.345
		4	6.29	6.05	7.19	6.15	5.45	6.64			
		6	5.58	5.75	6.46	5.43	4.35	5.84			

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. 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 aluminum laminated pouchs. 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 trends of ascorbic acid content were found mostly due to its oxidation during the storage period as ascorbic acid 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 spine gourd slices. Retention of ascorbic acid was higher in samples stored at low temperature. This might be due to high level of SO2 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. A decrease trend in antioxidant was found during storage. At the end of 6 months, the antioxidant activity decreased from 48.26µg TE/g to 30.90µg TE/g. However, the decrease found least during storage in the samples packed in 200g aluminum laminated pouches 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.

Total phenol content decrease, with increase in storage period from 190.2 (mgGAE/100g) to 159.55(mg/GAE/100g). The decrease was found least in the samples packed in 200g aluminum laminated 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 was 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 9.43mg/100g to 5.48mg/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. The mean score of judges for overall acceptability were significantly (P<o.o5) decreased from 7.80 to 6.50 during 6 months storage. The maximum mean score was observed in the dehydrated slices packed in 200g aluminum laminated pouches and stored at low temperature during storage. This might be due to retention of batter colour and texture of the dehydrated spine gourd slices during storage packed in 200g aluminum laminated pouches. However, mean score in respect of packaging, treatments and storage as well as interaction among them were found statistically significant.

Dehydrated spine gourd have the potential to become an important value added products because of rich in several nutrients which are essential for human health and easily and quickly to cook. 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 6 months of storage. Better quality of dehydrated spine gourd slices could be prepared from spine gourds after 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 spine gourd slices could be stored for six months with better nutritional quality after packaging in 200 gauge aluminum laminated 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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