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Effect of Different Osmotic Pretreatments on Weight Loss, Yield and Moisture Loss in Osmotically Dehydrated Guava

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ABSTRACT

The osmotic dehydration is that the water diffuses from dilute solution to concentrated solution (hypertonic solution) through a semi-permeable membrane until concentration equilibrium is reached. The driving force is the water activity gradient caused due to the osmotic pressure. In the present investigation, higher weight loss and solid gain were observed in Allahabad Safeda slices than the Pink Flesh. Higher moisture loss was observed in osmosed Pink Flesh slices than Allahabad Safeda. Maximum effect on the weight loss 34.55 per cent, moisture loss 53.24 per cent, solid gain 13.97 per cent, were observed when guava slices were pre treated with 70° Brix syrup for 24 hours (T_9). It was also observed that an increase in duration of osmosis and syrup concentration increased weight loss, moisture loss and solid gain in slices of both Allahabad Safeda and Pink Flesh. The osmosed slices prepared from Pink Flesh variety recorded lower (43.91%) moisture content than the Allahabad Safeda (46.81%). Dried yield was highest in Allahabad Safeda (34.73%) than Pink Flesh (33.79%). In case of variety Allahabad Safeda the drying ratio of osmotically dehydrated slices ranged from 2.58:1 to 3.02:1. In case of variety Pink Flesh the drying ratio of osmotically dehydrated slices ranged from 2.46:1 to 3.23:1. Osmotic treatment of guava slices 70° Brix syrup for 24 hours (T_9) resulted in highest yield and lowest drying ratio.

Keywords : Moisture loss, Osmotic Dehydration, Guava, Moisture Content

INTRODUCTION

Guava (*Psidium guajava L.*) is one of the most common and popular fruit with high dietary fiber and nutritional value. Guava is a native of tropical America and seems to have been growing from Mexico to Peru and it is one of the commercial fruits of tropical as well as subtropical regions. Important guava growing countries in the world are Cuba, Brazil, Mexico, Southern China, India and Malaysia. It occupies an important place in the horticultural wealth of our nation and ranks fourth with respect to area and production after mango, banana and citrus. Guava is not only a wholesome fruit but it is also provides lot of vitamins and minerals. It is rich source of vitamin C and pectin. Ascorbic acid mainly present in skin, secondly in pulp and very little in central pulp portion. Pulp varies from 56 to 600 mg. and may range to 350-450 mg in nearly ripe fruit. It can decline to 50- 100 mg. Canning or other heat processing destroys about 50% of the ascorbic acid. According to Mehta and Tomer (1980) guava contains 76.90 per cent water, 0.45 per cent acidity, 3.68 per cent reducing sugars, 5.76 per cent total soluble solids.

Guava is a seasonal fruit with very short shelf life therefore it is required to make a self stable value added products from guava using simple drying technology. There are several techniques of preservation or processing available for different fruits. Teles *et al.,* (2006) reported that the osmotic dehydration represents a technological alternative to reduce post-harvest losses of fruit. Osmotic dehydrated products that removes about 30 to 70% of water were ready to use, and can be utilized in bakery, dairy and candy industries. If food looked like fresh then 20 to 30% water can be removed by the process of osmotic dehydration. This osmotic dehydrated

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food was utilized to produce the concentrates of vegetables and fruits. Osmotic dehydration has gained attention recently due to its potential application in the food processing industry. It is a useful technique for the production of safe, stable, nutritious, tasty, economical and concentrated food obtained by placing the solid food, whole or in pieces in sugar or salt aqueous solution of high osmotic pressure (Fito *et al.*, 2001) Apart from this, problems of marketing, handling and transportation becomes much simpler and fruits could be made available to the consumer throughout the year. The principle of osmosis as a means of water removal has been known for a long time. Osmotic dehydration is one of most important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decrease the energy costs (Alakali et al., 2006). The inclusion of osmotic process in conventional dehydration has two major objectives i) quality improvement and ii) energy savings. Osmosed products fall under the group of intermediate moisture foods (Gláucia et al., 2012). The present investigation was undertaken with the objectives of evaluating sensory quality parameters of osmotically dehydrated product

MATERIALS AND METHODS :

The materials used during the present investigation on osmotic dehydration of guava are Allahabad Safeda and Pink flesh. The experiment was conducted at the Processing Laboratory of Division of Post-harvest Technology, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore. Matured and ripe guava fruits were procured from local fruit market, Bangalore. Fresh fruits with uniform size and shape free from transportation injuries, bruises, insect damages and diseases were selected for making the nutritious osmotically dehydrated slices. Guava slices of 1 kg each were dipped in 50, 60 and 70 °Brix sugar syrup solution in the ratio of 1:2 fruit to syrup and allowed to continue osmosis for 4, 18 and 24 hours at room temperature(20-30°C). During the process of osmosis, water flows out of the fruit pieces to the syrup and fraction of solute moves into the fruit slices. At the end of the treatment for a particular osmotic duration, the fruit slices were taken out of the osmotic solution and were rinsed quickly with water in order to remove the sugar coating adhering to the surface of the slices. These osmosed guava slices were weighed to know the extent of water removal from the slices by osmosis.

Pre-treatments

T_1 : Dipping in 50° Brix sugar syrup for 4 hours

T_2 : Dipping in 50° Brix sugar syrup for 18 hours

T_3 : Dipping in 50° Brix sugar syrup for 24hours

T_4 : Dipping in 60° Brix sugar syrup for 4 hours

T_5 : Dipping in 60° Brix sugar syrup for 18 hours

T_6 : Dipping in 60° Brix sugar syrup for 24 hours

T_7 : Dipping in 70° Brix sugar syrup for 4 hours

T_8 : Dipping in 70° Brix sugar syrup for 18 hours

T_9 : Dipping in 70° Brix sugar syrup for 24 hours

T_{10} : Control (Dip in 0.1% KMS+0.1%NaMS for 10 min.)

The following characteristics (Eq.1 to 5) of fresh and osmo-air dehydrated guava fruits were recorded during experimentation.

$$\text{Weight loss (\%)} = \frac{\text{Initial weight} - \text{weight at time}}{\text{Initial weight}} \times 100 \quad \text{(Eq.1)}$$

$$\text{Moisture loss (\%)} = \frac{\text{Initial moisture} - \text{moisture at time}}{\text{Initial moisture}} \times 100 \quad \text{(Eq.2)}$$

$$\text{Solid gain (\%)} = \text{Moisture loss (\%)} - \text{weight loss (\%)} \quad \text{(Eq.3)}$$

$$\text{Dehydrated Yield (\%)} = \frac{\text{Weight of dehydrated slices}}{\text{Weight of fresh slices}} \times 100 \quad \text{(Eq.4)}$$

$$\text{Dehydration ratio} = \frac{\text{Weight of fresh slices}}{\text{Weight of dehydrated slices}} \times 100 \quad \text{(Eq.5)}$$

Moisture content of fresh slices, osmosed slices as well as osmotically dehydrated samples were determined on per centage basis (Eq. 6). Ten grams of sample was taken in a pre-weighed China dish and kept in a hot air oven for overnight and then the weight was recorded using electronic balance. Moisture content was determined on fresh weight basis. Total solids were calculated by subtracting moisture content from 100.

$$\text{Moisture content (\%)} = \frac{\text{Moisture loss}}{\text{Sample weight}} \times 100 \quad \text{(Eq.6)}$$

RESULTS AND DISCUSSION

Weight Loss during Osmosis

Significant differences were recorded in per cent weight loss of osmosed guava slices as influenced by varieties, treatments as well as interaction between varieties and treatments. Comparatively higher weight loss was observed in Allahabad Safeda slices than the Pink Flesh. Further, maximum effect on the above parameter was observed when guava slices were pre treated with 70 °Brix syrup for 24 hours (T_9) having 34.55 per cent value. It was also observed that an increase in duration of osmosis and syrup concentration increased weight loss in both Allahabad Safeda and Pink Flesh slices (Table 1). Among treatments highest weight loss 34.55 per cent was recorded in treatment T_9 (70 °Brix syrup for 24 hours) whereas lowest (22.73%) was in slices treated with 50 °Brix syrup for 4 hours (T_1). Like wise, increase in osmotic duration resulted in increase in weight loss of mango and pineapple slices (Pokharkar and Prasad, 1998a; Tiwari and Jalali 2004a & 2004b)

Variation in weight loss during osmotic dehydration among the varieties of apricot was observed by Sharma *et al.,* (2004). These findings are also in conformity with observations made by other workers in case of mango (Varany-Anond et al., 2000), banana, apple and kiwi fruit (Panagiotou et al., 1998), pineapple (Rahaman and Lamb,1990; Pokharkar and Prasad,1998) and banana (Thippanna, 2005).

Moisture Loss

The effect of various pretreatments on moisture loss in guava slices was statistically significant with respect to both varieties and treatment but there was no significant variations observed for interaction between varieties and treatments. Comparatively higher moisture loss was observed in osmosed Pink Flesh slices than Allahabad Safeda. This difference in behaviour of these two varieties may be due to there different structure, compactness of tissues, size of contact surface between fruit and the syrup and also other intrinsic properties of these two fruits (Giangiacomo et al.,1987)

Further, maximum moisture loss (53.24%) was observed when guava slices were pre treated with 70 °Brix syrup for 24 hours (T_9) and and minimum 36.16 in treatment T_1 (50 °Brix syrup for 4 hours). It was also observed that an increase in duration of osmosis and syrup concentration increased weight loss of slices of both Allahabad Safeda and Pink Flesh (Table 2). The soluble solids diffusion during osmosis depends mainly on molecular size, ionic state and solubility of solute in water. Water loss depended not only on the solution or fruit a_w gradient but also on the gain of solids. This phenomenon presumably caused a water diffusion

Table 1: Effect of different osmotic treatments on weight loss (%) and solid gain (%) in osmosed slices of guava varieties Allahabad Safeda and Pink Flesh.

Treatments		Weight Loss (%)			Solid Gain (%)		
		Variety			Variety		
		Allahabad Safeda	Pink Flesh	Treatment mean	Allahabad Safeda	Pink Flesh	Treatment mean
50° B 4h	T_1	24.24	21.22	22.73	6.86	5.63	6.24
50° B 18h	T_2	26.86	23.60	25.23	9.26	8.06	8.66
50° B 24h	T_3	30.05	25.12	27.58	10.83	9.96	10.39
60° B 4h	T_4	28.77	23.95	26.36	10.93	10.37	10.65
60° B 18h	T_5	32.31	25.85	29.08	12.08	11.81	11.94
60° B 24h	T_6	32.97	27.32	30.14	14.29	13.55	13.92
70° B 4h	T_7	34.45	25.63	30.04	12.08	11.77	11.93
70° B 18h	T_8	35.51	26.17	30.84	12.68	12.48	12.58
70° B 24h	T_9	39.01	30.09	34.55	14.59	13.35	13.97
Variety mean	31.57	25.44		11.51	10.77		
		SEm ±	LSD 0.05	SEm ±	LSD 0.05		
Variety (V)		0.02	0.07	0.08	0.22		
Treatment (T)		0.05	0.14	0.16	0.47		
V×T		0.07	0.20	0.23	NS		

NS = Non-significant

coefficient reduction in the product – solution interface.

Variation in moisture loss among the varieties of apricot was observed by Sharma *et al.,* (2004). These findings also in conformity with observations made by other workers in case of mango (Varany-Anond et al., 2000), banana, apple and kiwi fruit (Panagiotou *et al.,* 1998), pineapple (Rahaman and Lamb,1990; Pokharkar and Prasad,1998) and banana (Bongirwar and Srinivasan, 1997; Pokharkar and Prasad,1998; Thippanna,2005; Tiwari, 2005).

Table 2: Effect of different osmotic treatments on the moisture loss (%) and moisture content (%) in osmosed slices of guava varieties Allahabad Safeda and Pink Flesh.

Treatments		Moisture loss (%)			Moisture content (%)		
		Variety			Variety		
		Allahabad Safeda	Pink Flesh	Treatment mean	Allahabad Safeda	Pink Flesh	Treatment mean
50° B 4h	T_1	33.56	38.75	36.16	54.20	49.11	51.66
50° B 18h	T_2	38.72	39.92	39.32	50.00	48.18	49.09
50° B 24h	T_3	44.85	47.39	46.12	44.99	42.19	43.59
60° B 4h	T_4	36.24	39.30	37.77	52.02	48.67	50.35
60° B 18h	T_5	40.67	42.01	41.34	48.40	46.50	47.45
60° B 24h	T_6	47.78	50.63	49.20	42.60	39.58	41.09
70° B 4h	T_7	42.39	47.22	44.80	47.03	42.12	44.57
70° B 18h	T_8	46.74	47.85	47.30	43.45	41.81	42.63
70° B 24h	T_9	52.66	53.83	53.24	38.62	37.02	37.62
Variety mean	42.62	45.21		46.81	43.91		
		SEm ±	LSD 0.05	SEm ±	LSD 0.05		
Variety (V)		0.42	1.26	0.33	0.98		
Treatment (T)		0.90	2.67	0.70	2.07		
V×T		1.27	NS	0.99	NS		

NS = Non-significant

Solid Gain

Higher solid gain (11.51%) was recorded in the slices of Allahabad Safeda than Pink Flesh (10.77%) after osmotic pretreatment (Table 1). Statistically significant variations in per cent solid gain among treatments were also observed. By increasing the duration of osmosis from 4 to 24 hour resulted in increase in solid gain from 9.96 to 13.24 per cent in Allahabad Safeda slices and 9.26 to 12.29 per cent in Pink Flesh respectively. On the other hand, an increase in the syrup concentration from 50 to 70 °Brix resulted in increase in solid gain which ranged from 8.98 to 13.12 per cent in Allahabad Safeda slices and 7.88 to 12.53 per cent in Pink Flesh slices respectively. Sample mass loss was reduced during treatment since sugar gain was prompted against water loss (Torres *et al.,* 2007). The effect of increase in syrup concentration as well as duration of osmosis resulted in increase in over all solid uptake. It has been reported by various workers that, the raw material characteristics such as variety and maturity of fruits mainly control water loss and solid gain in osmotic process (Torreggiani, 1993). These findings also in conformity with observations made by other workers in case of mango (Varany-Anond et al.,2000), banana, apple and kiwi fruit (Panagiotou et al., 1998), pineapple (Rahaman and lamb,1990; Pokharkar and Prasad,1998) and banana (Bongirwar and Srinivasan, 1997; Pokharkar and Prasad,1998 Thippanna,2005; Tiwari,2005).

Moisture Content in Osmosed Slices

Statistically significant difference were recorded for moisture content of osmosed slices due to varieties, different osmotic treatments but interaction between varieties and treatments was non significant (Table 2). The osmosed slices prepared from Pink Flesh variety recorded lower (43.91%) moisture content than the Allahabad Safeda (46.81) among treatments lowest moisture content was found in 70 °Brix syrup for 24 hours (T_9) and higher in 50 °Brix syrup for 4 hours (T_1). Variation in moisture content in osmosed guava slices was mainly due to loss of water as well as up take of solids which is supported by the findings during the investigation. This is also conformity of the findings of Lewicki and Lenart (1995) who

reported that osmotic dehydration removes 30-50% of water from fresh ripe fruits like mangoes, pineapple, sapota, papaya, guava, and jackfruit.

Yield of Osmotically Dehydrated Guava Slices

Significant differences were recorded for dehydrated yield of osmotically dehydrated guava slices as influenced by varieties, treatments as well as interaction between varieties and treatments (Table 3). Final product Yield was highest in Allahabad Safeda (34.73%) than Pink Flesh (33.79%). In case of Pink Flesh highest (40.60%) yield was recorded in pretreatment with 70 ^{0}Brix sugar syrup for 24 hours (T_9), while lowest yield 18.62 per cent was observed in control (T_{10}). Similar observations were made in case of Allahabad Safeda and values ranged from 17.95 (T_{10}) to 38.75 (T_9) per cent. Similar parallel trend has been noticed by Nanjundaswamy et al., (1978) in indigenous fruits and Adambounou and Costaigue (1983) in banana. It has been reported that due to increase in the solid gain and the volume reduction of the osmo-dehydrated products there was three fold increases in drier load and process yield (Thippanna, 2005).

Drying Ratio of Osmotically Dehydrated Guava Slices

Significant variations were observed in different treatments, in case of variety Allahabad Safeda, the minimum drying ratio (2.58:1) was recorded in pretreatment with 70 ^{o}Brix sugar syrup for 24 hours and values for osmotically treated samples ranged from 2.58:1 to 3.02:1, while the maximum drying ratio (5.57:1) was recorded in control (T_{10}). Similar results were obtained in case of variety Pink Flesh (Table 3). It also showed that the drying rate was better in concentrated syrup due to the increased osmotic pressure in the sugar syrup at higher concentrations, which increased the driving force available for water transport. These results are in conformity with the findings of Thippanna (2005) in case of banana.

Comparatively higher weight loss and solid gain were observed in Allahabad Safeda slices than the Pink Flesh. Higher moisture loss was observed in osmosed Pink Flesh slices than Allahabad Safeda. Further, Other popular cultivars of guava may be evaluated for osmotic dehydration. One of the next possible steps could be to undertake an economic evaluation of the complete process to document its economic advantage.

Table 3 : Effect of different osmotic treatments on the yield (%) and dehydration ratio in osmotically dehydrated slices of guava varieties Allahabad Safeda and Pink Flesh.

Treatments		Yield (%)			Dehydration Ratio		
		Variety			Variety		
		Allahabad Safeda	Pink Flesh	Treatment mean	Allahabad Safeda	Pink Flesh	Treatment mean
50° B 4h	T_1	33.16	31.58	32.37	3.02:1	3.17:1	3.09:1
50° B 18h	T_2	35.71	30.94	33.32	2.80:1	3.23:1	3.02:1
50° B 24h	T_3	38.50	33.51	36.00	2.60:1	2.98:1	2.79:1
60° B 4h	T_4	34.40	32.58	33.49	2.91:1	3.07:1	2.99:1
60° B 18h	T_5	36.10	37.03	36.56	2.77:1	2.70:1	2.74:1
60° B 24h	T_6	38.90	39.42	39.16	2.59:1	2.54:1	2.56:1
70° B 4h	T_7	37.20	35.58	36.39	2.69:1	2.81:1	2.75:1
70° B 18h	T_8	36.60	38.03	37.31	2.73:1	2.63:1	2.68:1
70° B 24h	T_9	38.75	40.60	39.67	2.58:1	2.46:1	2.52:1
Control	T_{10}	17.95	18.62	18.28	5.57:1	5.37:1	5.47:1
Variety mean	**34.73**	**33.79**		**3.02:1**	**3.10:1**		
		SEm ±	**LSD 0.05**	**SEm ±**	**LSD 0.05**		
Variety (V)		0.34	NS	0.11	NS		
Treatment (T)		1.77	2.27	0.24	0.72		
V×T		1.09	3.21	0.34	NS		

NS = Non-significant

CONCLUSION

It was concluded that an increase in duration of osmosis and syrup concentration increased weight loss, moisture loss and solid gain in slices of both Allahabad Safeda and Pink Flesh. The osmosed slices prepared from Pink Flesh variety

recorded lower (43.91%) moisture content than the Allahabad Safeda (46.81%). Dried yield was highest in Allahabad Safeda (34.73%) than Pink Flesh (33.79%). In case of variety Allahabad Safeda the drying ratio of osmotically dehydrated slices ranged from 2.58:1 to 3.02:1. In case of variety Pink Flesh the drying ratio of osmotically dehydrated slices ranged from 2.46:1 to 3.23:1. Osmotic treatment of guava slices 70 ^{o}Brix syrup for 24 hours (T_9) resulted in highest yield and lowest drying ratio.

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