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QUALITY AND SENSORIAL CHARACTERISTICS OF OSMOTICALLY DEHYDRATED PLUM (*CV. SANTA ROSA*) WITH SYRUPS OF SUGAR AND HONEY

Mandeep Kour, Neeraj Gupta*, Fozia Hameed and Monika Sood

Division of Food Science and Technology, Chatha, SKUAST- Jammu, J&K UT, 180009

*E-mail: neeruguptapht@gmail.com

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ABSTRACT

Osmotic dehydration is becoming more popular as a complementary treatment in the processing of dehydrated foods, since it presents some advantages such as minimising heat damage to the colour and flavour, inhibiting enzymatic browning and reduce energy costs.The objective of the present study was to evaluate the effect of sugar and honey syrups as osmotic agents in the dehydration of plum.Plum fruits were dipped in different concentration (40, 50, 60 and 700Brix) of sugar and honeyfor the preparation of osmotically dehydrated plum followed by packing in LDPE bags. The processed product was stored at ambient conditions and subjected to chemical and sensory evaluationat an interval of one month for a period of three months. With the advancement of storage period, a decreasing trend was observed in moisture, ascorbic acid and anthocyanin.The osmotically dehydrated plum prepared from the treatment T9 (700Brix honey syrup) adjudged as the superior on the basis of colour, texture and taste, respectively. The study concluded better retention of osmotically dried plum prepared with 700Brix honey while as control resulted in greater loss of nutrients.

Keywords: Chemical composition, Osmo-dehydration, *Santa rosa*, Sensory acceptance, Storage time

INTRODUCTION

Plum is one of the most important stone fruits crops of the world and includes numerous familiar stone fruits like apricot, cherry and peach. There are more than2000 varieties of plums, among which relatively few are of commercial importance (Somogai, 2005). Plum is a very tender and perishable fruit having high percentage of water content (86.6%), protein (0.5g), carbohydrates (12.3 g), niacin (0.5 mg), riboflavin (0.03mg), calcium (12mg), phosphorous (18mg), iron (0.5mg), sodium (1mg) and potassium (170mg) per 100 grams of edible portion. All this composition makes plum a good nutritious fruit (Nakatani *et al.,* 2000). Plums also enhance the competence of the immune system in combating free radicals, as they have a strong antioxidant impact. Finally, it needs to be mentioned that plums also have cosmetic values, as they improve the condition of the skin (Nergiz and Yildiz, 1997). Drying of fruits is one of the traditional method or form of food preservation techniques known to man and is a complex process involving simultaneous heat and mass transfer resulting in significant changes in the chemical composition, structure and physical properties of food material. Loss of water and heating causes stresses in the cellular structure of the food leading to change in microstructure and shrinkage (Rahman, 2003). In traditional air drying process, plums undergo oxidative damage, browning, loss of flavour and shrinkage, which lead to lower sensory and nutritional quality of the products (Aguilera and Karel, 1997). To improve product quality and reduce drying time, osmotic dehydration can be an advantageous method for plum drying. It is a pre-treatment for fruits and vegetables prior to drying (Heredia *et al.,* 2007; Torrenggiani, 1993; Torreggiani and Bertolo, 2004) and other heat assisted processing like canning, freezing, and minimal processing as osmotic dehydration does not lowers the product moisture (Brennan, 19994). Thus, drying has the ability to extend the shelf life of food materials. The consumption of the dried plum may lower the risk of chronic diseases and relieve constipation and this effect is mainly associated with biologically active substances like phenolic compounds, carotenoids, vitamin C and dietary fibre that are naturally present in fruit (Stacewicz-Sapuntzakis, 2013). With increased awareness of food nutrition and health, consumers have become more selective and challenge the researchers to develop ways for creating high quality dried commodities (Saga and Suresh, 2010). Osmotic dehydration is the technique which is used for partial removal of free water molecules using a process of osmosis by immersing fruits or vegetables in aqueous solution of high osmotic pressure (Pandharipande *et al.,* 2012).Plums have high sugar content, so to maintain the nutritional and sensory quality, dehydration to desired moisture content, sub atmospheric conditions is desirable. In view of the above facts, the purpose of this paper is to study the effect of osmotic agents (Sugar and honey syrup) on quality and sensory characteristics of plum during storage.

MATERIAL AND METHODS

Plums (*cv. Santa rosa*) were purchased from fruit Mandi Narwal, Jammu. Fresh plums with uniform size and shape, free from transportation injuries, bruises, insect damages

Table 1 - Effect of treatments and storage period on moisture content and ascorbic acid of osmo-dried plum

Treatments	**Moisture content Storage period (months)**					**Ascorbic acid Storage period (months)**				
	0	1	2	3	Mean	0	1	2	3	Mean
T1: Control	12.60	12.52	12.42	12.30	12.46	12.05	11.90	11.23	10.85	11.51
T2: Dipping in 40 0Brix Sugar Syrup	15.85	15.72	15.05	14.90	15.38	13.35	12.65	11.35	10.89	12.06
T3: Dipping in 50 0Brix Sugar Syrup	15.80	15.69	15.00	14.55	15.26	14.05	13.93	12.65	11.42	13.01
T4: Dipping in 60 0Brix Sugar Syrup	15.75	15.25	14.93	14.78	15.18	15.20	14.85	13.45	12.15	13.91
T5: Dipping in 70 0Brix Sugar Syrup	15.68	15.10	14.85	14.63	15.06	16.05	15.75	14.25	13.80	14.96
T6: Dipping in 40 0Brix Honey Syrup	15.40	15.12	14.91	14.70	15.03	14.85	13.01	12.85	11.15	12.96
T7: Dipping in 50 0BrixHoney Syrup	15.32	14.95	14.69	14.25	14.80	15.05	14.65	13.32	12.50	13.88
T8: Dipping in 60 0Brix Honey Syrup	15.20	14.65	14.21	14.00	14.51	15.85	14.90	14.00	13.65	14.60
T9: Dipping in 70 0Brix Honey Syrup	15.09	14.56	14.12	13.97	14.43	16.32	16.00	15.65	14.73	15.67
Mean	15.19	14.85	14.46	14.23		14.75	14.18	13.17	12.34	
Effect		CD(5%)					CD(5%)			
Treatment		0.04					0.05			
Storage		0.02					0.03			
Treatment x Storage		0.08					0.01			

Table 2 - Effect of treatments and storage period on anthocyanin content and colour of osmo-dried plum

Treatments	**Anthocyanin content Storage period (months)**					**Colour Storage period (months)**				
	0	1	2	3	Mean	0	1	2	3	Mean
T1: Control	56.85	56.45	55.93	55.78	56.25	6.00	5.90	5.80	5.50	5.80
T2: Dipping in 40 0Brix Sugar Syrup	48.16	48.00	47.90	47.82	47.97	7.00	6.89	6.78	6.60	6.82
T3: Dipping in 50 0Brix Sugar Syrup	56.45	56.05	55.89	55.68	56.02	7.30	7.20	7.10	6.90	7.12
T4: Dipping in 60 0Brix Sugar Syrup	65.53	65.10	64.90	64.88	65.10	7.65	7.52	7.40	7.30	7.47
T5: Dipping in 70 0Brix Sugar Syrup	75.45	75.18	74.96	74.80	75.01	7.85	7.75	7.63	7.50	7.68
T6: Dipping in 40 0Brix Honey Syrup	46.16	45.93	45.79	45.55	45.86	7.10	7.00	6.90	6.80	6.95
T7: Dipping in 50 0BrixHoney Syrup	54.20	53.79	53.45	52.01	53.36	7.50	7.30	7.20	7.10	7.27
T8: Dipping in 60 0Brix Honey Syrup	63.32	63.00	62.89	62.72	62.98	7.90	7.82	7.60	7.50	7.70
T9: Dipping in 70 0Brix Honey Syrup	73.05	72.90	72.78	72.64	72.84	8.00	7.90	7.80	7.69	7.85
Mean	59.91	59.60	59.39	59.01		7.37	7.25	7.13	6.99	
Effect		CD(5%)					CD(5%)			
Treatment		0.06					0.02			
Storage		0.04					0.01			
Treatment x Storage		0.01					0.05			

Table 3 - Effect of treatments and storage period on texture and taste of osmo-dried plum

Treatments	Texture Storage period (months)					Taste Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean
T1: Control	6.00	5.90	5.80	5.68	5.84	5.45	5.39	5.20	5.10	5.28
T2: Dipping in 40 0Brix Sugar Syrup	7.00	6.90	6.80	6.69	6.85	5.85	5.70	5.49	5.40	5.61
T3: Dipping in 50 0Brix Sugar Syrup	7.15	7.05	6.91	6.80	7.05	6.00	5.55	5.51	5.470	5.63
T4: Dipping in 60 0Brix Sugar Syrup	7.45	7.31	7.20	7.10	7.35	6.65	6.60	6.56	6.50	6.58
T5: Dipping in 70 0Brix Sugar Syrup	7.90	7.80	7.70	7.59	7.75	7.50	7.45	7.41	7.35	7.43
T6: Dipping in 40 0Brix Honey Syrup	7.00	6.90	6.80	6.70	6.85	6.25	6.00	5.90	5.80	5.99
T7: Dipping in 50 0BrixHoney Syrup	7.20	7.10	7.00	6.91	6.98	6.65	6.55	6.41	6.38	6.41
T8: Dipping in 60 0Brix Honey Syrup	7.50	7.40	7.30	7.20	7.26	7.00	6.53	6.45	6.38	6.59
T9: Dipping in 70 0Brix Honey Syrup	7.95	7.88	7.78	7.70	7.83	7.65	7.61	7.57	7. 53	7.59
Mean	7.24	7.14	7.03	6.93		6.56	6.38	6.28	6.21	
Effect		CD(5%)					CD(5%)			
Treatment		0.02					0.04			
Storage		0.01					0.02			
Treatment x Storage		0.03					0.09			

and diseases were selected for making the nutritionally rich osmotically dehydrated plum. Fully matured fruits of uniform size were washed thoroughly with clean water and wiped properly. The fruits were pierced gently with the help of fork. On the other hand, osmotic agents*viz.* sugar and honey syrup of different concentrations/treatments *viz* 40, 50, 60 and 70^{0}Brix were prepared. In control, no sugar or honey dipping treatment was applied. Then the plums were dipped in different concentrations/treatments of sugar and honey for 24 h. After completion of dipping time, sugar and honey syrups were drained and the osmo-dried plums were spread on trays. The plums were dried for two days at 55-60^{0}C. After drying, the plums were collected and packed in LDPE bags and stored at room temperature for a period of 3 months. The osmo-dried plums were analysed at an interval of 0, 1, 2 and 3 months of storage for chemical and organoleptic parameters. The moisture content was determined by using an electronic moisture analyser. Ascorbic acid was estimated as per the procedure described by Ranganna (1986). Anthocyanin content was estimated as per the method suggested by Harborne (1973). Organoleptic evaluation was carried out by semi-trained panelists on 9-point hedonic rating scale. A score of 5.5 and above was considered acceptable (Amerine *et al.,* 1965). The data obtained was statistically analysed using factorial CRD for interpretation of results through analysis of variance (Gomez and Gomez, 1987).

RESULTS AND DISCUSSION

A perusal of data in Table 1 indicated that moisture content of osmotically dehydrated plum decreased significantly during storage of three months. Initially the moisture content ranged from 12.60 to 15.09 per cent. The minimum moisture content of 12.60 per cent was observed in T_1 (control) whereas, the maximum moisture content value 15.85 per cent was observed in T_2 (40^0 Brix sugar syrup). After three months of storage, the maximum moisture content of 14.90 per cent was recorded in T_2 (40^{0}Brix sugar syrup) whereas, the minimum value of 12.30 per cent was recorded in control. The mean values of moisture content decreased from 15.19 to 14.23 per cent during the three months of storage period. The effect of interaction between treatment and storage period was also found significant at 5 per cent of significance. A gradual decrease in the moisture content was observed with the increase in osmotic concentration. Increase in osmotic syrup concentration increases diffusional changes. Further, the osmotic pressure exerted on the fruit cell structure resulted in greater moisture reduction in more concentrated solutions. Similar trend of decrease in moisture was also reported by Gupta and Kaul (2013) during their study on the effect of sugar concentration and time interval on quality and storability of ber chuhara. Mondal *et al.,* (2017) also reported decrease in moisture content of aonla candy which might be due to evaporation of moisture from the product.

The data pertaining to ascorbic acid depicted that at beginning, the highest ascorbic acid content of 16.32 mg/100 g was recorded in T_9 (70^{0}Brix honey syrup) and the lowest of 12.05 mg/100 g was recorded in control (Table 1). The ascorbic acid content decreased significantly during three months of storage. After three months of storage period, the maximum value of 14.73 mg/100 g was observed in T_9 (70 ^{0}Brix honey syrup) whereas, the lowest value of 10.85 mg/100 g was observed in control. The highest value of ascorbic acid was recorded in treatment T_9 (70 ^{0}Brix honey syrup) and lowest in control having values of 15.67 and 11.51 mg/100 g, respectively in treatment mean values. The mean values of ascorbic acid content significantly decreased from 14.75 to 12.34 mg/100 g during three months of storage. The interaction between the treatment and storage period was also found significant at 5 per cent of significance. Thermal degradation during dehydration process and subsequent oxidation in storage resulted in decreased ascorbic acid content. Beside this, leaching of ascorbic acid in hypertonic solution also plays a little role in loss of ascorbic acid. Similar results were also reported by Sreehari (2006) in sapota slices,Gupta *et al.,* (2020) in galgal peel sticksand Mini and Archana (2016) in osmo-dehydrated cashew apple (*Anacardium occidentale* L.).

Table 2 shows that the anthocyanin content of all the treatments decreased during three months of storage period. Initially, anthocyanin content in osmotically dehydrated plums ranged from 56.85 to 73.05 mg/100 g. At the beginning, maximum anthocyanin content of 75.45 mg/100 g was recorded in T_5 (70 ^{0}Brix sugar syrup) while minimum value of 46.16 mg/100gwas recorded in T_6 (40 ^{0}Brix honey syrup). During the three months of storage, values of anthocyanin decreased from its initial values in all the treatments under study. In treatment mean values, the maximum value of 75.01 mg/100 g was recorded in T_5 (70 ^{0}Brix sugar syrup) which was followed by T_9 (70 ^{0}Brix honey syrup) with the value 72.84 mg/100 g, while as lowest value of (45.86 mg/100 g) observed in T_6 (40^{0}Brix honey syrup). The mean values of anthocyanin content decreased from 59.91 to 59.01 mg/100 g during three months of storage. The interaction between storage and treatment was also found to be significant at 5 per cent of significance. The decrease in anthocyanin content might be due to the increase in browning which occurs as a result of lower activation energy of anthocyanin. These results are in accordance with Tsai *et al.,* (2004) while studying effect of sugar on anthocyanin degradation and water mobility in Roselle anthocyanin and Bandral *et al.,* 2019 in osmotically dried whole strawberries.

The scores for colour gradually decreased from the initial level of 7.37 to 6.99 during three months of storage (Table 2). At the beginning, maximum and the minimum colour scores were recorded in T_9 (70 ^{0}Brix honey syrup) and control, having values of 8.00 and 6.00, respectively. After storage period of three months, the maximum colour score 7.69 recorded in T_9 (70 ^{0}Brix honey syrup) which was followed by T_8 and T_5 having values of 7.50 each and lowest value of 5.50 recorded in control. The maximum mean treatment value of colour score observed in T_9 (70 ^{0}Brix honey syrup) and minimum in control with the values of 7.85 and 5.80, respectively. The interaction between the treatments and storage period was found significant at 5 per cent of significance. The colour mean scores decreased during three month of storage due to enzymatic and oxidative browning. The results are also in conformity with Dhiman *et al.,* (2016) in osmotically dehydrated wild pear.

Perusal of data revealed a decreasing trend in texture score of osmotically dehydrated plum during storage period of three months (Table 3). Initially, lowest value for texture score was 6.00 recorded in control and highest value of 7.95 was recorded in T_9 (70 ^{0}Brix honey syrup) followed by 7.90 and 7.50 in T_5 and $T_{8,}$ respectively whereas same pattern was followed by three months of storage period. Highest mean treatment value for texture score was 7.83 recorded in T_9 (70 ^{0}Brix honey syrup), whereas the lowest mean treatment value of 5.84 recorded in control. The mean value of texture score decreased from 7.24 to 6.93 during the three months of storage period. The effect of interaction between treatment and storage period was found non- significant at 5 per cent of significance. This could be due to better solid gain and optimum water loss. Further, the absorption of moisture and hygroscopic nature of osmo-dehydrated products resulted in decreased texture; whichin turn softens the tissue in pulp. These results are in accordance with those of findings of Durrani *et al.,* (2011) in honey based carrot candy and Pritika (2015) in osmotically dried pumpkin cubes.

The data related to changes in sensory score for taste of osmotically dehydrated plum during storage have been depicted in Table 3. During three months of storage, the scores for taste decreased with the advancement of storage period from initial value of 6.56 to 6.21. Initially in different osmotic treatments maximum taste score of 7.65 recorded in T_9 (70 ^{0}Brix honey syrup) whereas the lowest value of 5.45 was recorded in control which decreased to 7.53 and 5.10 after three months of storage. The highest value for taste score 7.59 recorded in T_9 (70 ^{0}Brix honey syrup) which was followed by T_5, T_8 and T_4 having values of 7.43, 6.59 and 6.58, respectively while lowest value of 5.28 was observed in control in treatment mean values. The interaction between the treatments and storage period was found to significant at 5 per cent of significance. Taste mean score decreased with advancement of three months storage period from 6.56 to 6.21 because of dilution of sugars and change in acidity in product. The results were also supported by Mahesh *et al.,* (2017) in osmotic dehydration of pineapple slices.

Conclusion

Dehydration is a traditional method of food preservation. To improve the product quality, osmotic dehydration can be used successfully for 50% weight reduction in the material and to enhance the shelf life. It is an energy saving and quality improvement process. On the basis of the sensory evaluation (colour, texture and taste), the treatment T_9 (70 ^{0}Brix honey syrup) was adjudged superior among all the other treatments. Nutritionally enriched osmotically dehydrated plum developed in this study are rich source of phenolic corresponding to high anthocyanins thus suggesting that such dehydrated fruits can be commercialized and therefore could be an important component of diet.

CONFLICTS OF INTEREST

The author claims no conflicts of interest to conduct this research work.

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