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Effect of osmotic agents on quality and storability of osmo-dried plum

Mandeep Kour, Neeraj Gupta*, Monika Sood and Anju Bhat
Division of Food Science and Technology, SKUAST- Jammu - 180009, J&K, India.

ABSTRACT

Plum is a highly palatable and perishable fruit with a very high moisture content. Hence, it is being processed widely due to the fruit's perfect blend of sugar and acid content. Osmotic dehydration of the fruits by dipping them in a hypertonic solution is a convenient alternative for utilizing them as osmo-dried fruits. In order to enhance their shelf life, ripe fruits of Santa Rosa plums were treated with osmotic agents, viz., sugar and honey (40, 50, 60 and 70% each) for the development of osmo-dried plums. After drying, osmo-dried plums were packed in low density polypropylene and stored for three months under ambient temperature (34-38°C). An increasing trend was recorded in TSS, reducing sugars, total sugars and non-enzymatic browning. However, titratable acidity, dehydration ratio, rehydration ratio and total phenols tended to decline during storage. The osmo-dried plum developed from 70° Brix honey syrup was the best osmotic agent, based on overall acceptability, followed by 60 °Brix honey syrup. Storability studies revealed that all the treatments could retain the osmo-dried fruits for 3 months without affecting the quality.

Keywords: *Prunus salicina*, Honey, Polypropylene, Sugar

INTRODUCTION

Plum is an important temperate fruit crop, mainly grown in mid-hill areas. It ranks next to peach fruit in economic importance. The main plum growing states in India are Himachal Pradesh, Uttarakhand and hills of Nilgiri in Tamilnadu, Karnataka and Kerala (Jindal and Chandel, 13). In J&K UT, plum is also an important fruit crop grown mainly in Kashmir valley along with temperate districts of Jammu region. In J&K, plum is cultivated on 4,038 hectares area with a production of 11,860 metric tonnes per annum. The main cultivar grown commercially on monoculture basis is ‘Santa Rosa’. Besides, two other varieties namely ‘Silver plum’ and ‘Chogandhra’are also grown on small scale (Anonymous, 3).

The plum fruits are available in a wide size, colour, pleasant and nourishing in nature. The fruit is an outstanding source of antioxidants, vitamin C, fibre; various essential minor nutrients like iron, magnesium, calcium and major nutrient potassium. Due to poor shelf-life (3-4 days at room temperature and 8-14 days under refrigerated conditions) and non-availability of storage infrastructure, it is marketed immediately after harvesting, which causes glut in market with heavy post harvest losses. These losses can be minimized, if processed during the main harvesting seasons. Very high moisture content (85-90 %) tends plum fruits to be highly perishable which is mainly responsible for spoilage of fruits. The rate of spoilage can be decreased by removing the free water molecules, and for increasing shelf life of plum, osmo drying as a vital method of its preservation. Pandharipande *et al.* (19) also recommended the technique of osmotic dehydration for the removal of free water molecules partially by immersing fruits in high osmotic pressure aqueous solution. Bandral *et al*. 5 reported osmotic dehydration with different concentration to ensure the desired nutritional and sensory properties of dried product The aim of this study was to standardize the osmotic agent to extend the storability of dried Santa Rosa plum.

MATERIALS AND METHODS

The fruits of Santa Rosa plum were procured from Narwal Mandi of Jammu, graded manually, and only sound fruits of uniform shape and size were selected for the experiment purpose. The plum fruits were washed and wiped. Different concentrations of sugar and honey’s osmotic solutions were prepared (40, 50, 60 and 70°Brix of each). The pierced fruits were dipped in the osmotic solutions for 24 h, drained and dried in tray drier for 2 days at 55-60°C thereafter, and no osmotic treatment was given to the control fruits. Plums were packed in low density polypropylene and stored under ambient conditions for three months. The control and treated osmotic plums were analyzed regularly at one month interval for various quality attributes and organoleptic rating. Hand refractometer was used for the estimation of total soluble solids. The procedure given by Lane and Eyon (15) was used for the estimation of total sugars and reducing sugars. Titratable acidity was estimated as per the

*Corresponding authorl: neeruguptapht@gmail.com

procedure suggested by AOAC (4). The dehydration ratio was expressed as the ratio of the sample before drying to the dried weight of sample (Kalra, 14). The rehydration ratio was articulated as the ratio of weight of rehydrated product to weight of dried product as per the procedure suggested by Lidhoo and Agrawal (16). Total phenols and non-enzymatic browning were estimated as per the procedure of Icier (12) and Srivastava and Kumar (22), respectively. A Semi-trained panel of judges was used for the organoleptic evaluation (on 9-point hedonic scale) of the finished product. As per the procedure coined by Amerine *et al.* (2), score of 5.5 and above was reflected as acceptable. The experiment was laid out in factorial CRD with nine treatments and replicated thrice. The data obtained were statistically analysed as per the procedure of Gomez and Gomez (9) using OPSTAT software.

RESULTS AND DISCUSSION

The results revealed that the contents of TSS of osmo-dried plums increased significantly during three months of storage (Table 1). Initially, significantly higher TSS (67.23°Brix) was recorded in T_9 (70°Brix honey syrup) while it was lowest (33.53°Brix) in control. After three months of storage, treatment T_9 (70°Brix honey syrup) showed the highest TSS (72.12°Brix) significantly, followed by T_5, T_8 and T_4 treatments, while the lowest (36.58°Brix) was registered in control. The storage mean values of TSS increased from 48.19 to 52.87°Brix during the three months of storage period. This might be due to decline in moisture content or due to the partial hydrolysis of the complex carbohydrates into simple carbohydrates. These findings are in accordance with Ravi (21), who observed while working on osmotic dehydration of aonla.

The titratable acidity decreased significantly during three months of storage (Table 1). At the start, ranged from 1.45 to 5.15 %, being lowest and highest in T9 and control, respectively. Of the various treatments, the highest titratable acidity (4.65 %) was recorded in control, whereas it was lowest (1.27 %) in T_9 (70°Brix honey syrup). The consumption of acids mainly for conversion of non-reducing sugars to reducing sugars might be the possible reason for acid loss in osmo-dried plum during storage in non-enzymatic browning reactions. These findings corroborate the results of Kushwaha *et al.* (17) while working on osmo-dried guava fruit and Gupta *et al.* (11) in osmo-dried *galgal* peel sticks.

The contents of total and reducing sugars were significantly increased with the advancement of storage duration (Table 2). Initially, the highest reducing sugars (56.42%) and total sugars (65.15%) were noticed under T_9 (70°Brix Honey syrup) treatment, while their lowest values were recorded in untreated control. In general, the sugars followed

Table 1. Effect of osmotic agents on total soluble solids and titratable acidity of osmo-dried plum during storage.

Treatments	Total soluble solids (°Brix)					Titratable acidity (%)				
	Storage period (months)					Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean
T_1: Control	33.53	34.38	35.74	36.58	35.06	5.15	5.09	4.85	4.65	4.93
T_2: 40°Brix Sugar Syrup	35.07	35.89	36.17	40.83	36.99	1.67	1.60	1.52	1.46	1.56
T_3: 50°Brix Sugar Syrup	43.72	43.95	44.11	47.87	44.91	1.64	1.56	1.49	1.41	1.52
T_4: 60°Brix Sugar Syrup	51.05	52.15	53.01	56.25	53.11	1.60	1.52	1.45	1.36	1.48
T_5: 70°Brix Sugar Syrup	64.00	64.85	65.20	68.23	65.57	1.57	1.50	1.44	1.38	1.47
T_6: 40°Brix Honey Syrup	38.18	38.95	39.20	42.93	39.81	1.58	1.51	1.47	1.40	1.49
T_7: 50°Brix Honey Syrup	46.80	47.25	48.10	52.33	48.62	1.53	1.46	1.39	1.32	1.42
T_8: 60°Brix Honey Syrup	54.10	55.00	56.23	58.65	55.99	1.48	1.43	1.37	1.30	1.39
T_9: 70°Brix Honey Syrup	67.23	68.25	69.00	72.12	69.15	1.45	1.39	1.33	1.27	1.36
Mean	48.19	48.96	49.64	52.87		1.96	1.89	1.81	1.73	
CV (%)			4.92					13.1		
$CD_{(0.05)}$										
Treatment (T)			2.00					0.20		
Storage (S)			1.33					0.13		
T × S			NS					NS		

Table 2. Effect of osmotic agents on reducing sugar and total sugar of osmo-dried plum during storage.

Treatments	Reducing Sugars (%)					Total sugars (%)				
	Storage period (months)					Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean
T_1	14.18	14.75	15.32	15.80	15.01	15.10	15.45	16.00	16.32	15.72
T_2	30.25	31.12	32.36	33.15	31.72	38.92	39.65	40.32	41.65	40.13
T_3	38.40	39.23	40.45	41.05	39.78	45.49	46.15	47.05	48.32	46.75
T_4	51.32	52.08	53.12	54.32	52.71	55.05	56.10	57.15	58.75	56.76
T_5	53.75	54.82	55.09	56.12	54.94	63.90	64.18	65.58	66.10	64.94
T_6	32.25	33.11	34.18	35.25	33.69	40.90	41.15	42.65	43.35	42.01
T_7	40.15	42.82	43.18	44.05	42.55	47.25	48.35	49.60	50.25	48.86
T_8	52.40	53.35	54.12	55.20	53.76	57.18	58.40	59.60	60.20	58.84
T_9	56.42	57.10	58.32	59.02	57.71	65.15	66.05	67.25	68.15	66.65
Mean	41.01	42.04	42.90	43.77		47.66	48.39	49.47	50.34	
CV%			3.43					6.61		
$CD_{(0.05)}$										
Treatment (T)			1.89					2.64		
Storage (S)			0.79					1.76		
T × S			NS					NS		

an upward trend throughout the period of storage, and at the end of storage, their highest and lowest values were registered in T_9 and control treatments, respectively. This might be due to the osmosis which leads to decrease in moisture content and a consequent increment in the content of sugar which might be due to sugar uptake from the syrup or due to overturn of non-reducing sugars to reducing sugars. These results are in agreement with Ahmed *et al.* (1) in osmo-air drying of peach. The possible reason behind the enhanced total sugars content might be due to conversion of starch into simple sugars; it may also be because of hydrolysis of polysaccharides which ultimately resulted into conversion of the various soluble compounds like sugars. Gupta and Kaul (10) also reported similar types of findings in ber chuhara.

The reduction in dehydration ratio was recorded in osmo-dried plums during 3 months of storage period (Table 3). Initially the maximum dehydration ratio (7.94) was recorded in control, whereas it was minimum (2.18) in T_5 (70°Brix sugar syrup), which declined thereafter as the storage period advanced. At the end of storage, control treatment maintained the highest dehydration ratio (7.31), while it was T_5 (70°Brix sugar syrup) which exhibited the lowest dehydration ratio (2.24). The rehydration ratio as influenced by storage duration and treatment (Table 3) showed the downward trend throughout the period of storage. In the beginning, the highest (1.65) and lowest (1.21) rehydration ratio were registered with control and T_9 (70°Brix Honey Syrup), respectively. Overall, the similar trend was also noticed at the end of storage duration. The reason for decrease in dehydration ratio during storage might be due to increased concentration of sugar syrup in which water transport from the fruit is high. Fatima *et al.* (8) also observed more or less similar type of results and also found a decline in dehydration ratio when studied dehydration ratio in Chikoo slices. Ahmed *et al.* (1) also reported the similar decrease in rehydration ratio in osmo-air dried peach.

Total phenol content decreased significantly from the initial value of 638.39 to 624.05 mg/100 g (Fig. 1).

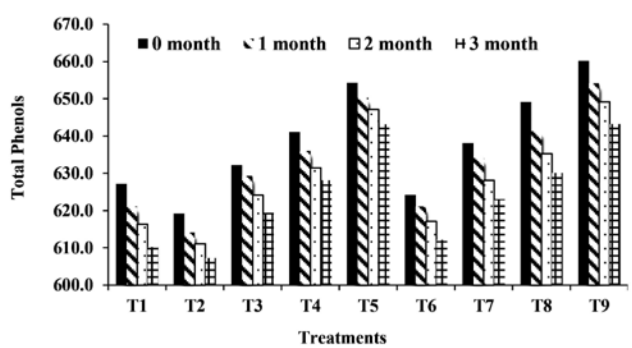

Fig. 1. Effect of osmotic agents on total phenols content (mg/100 g) of osmo-dried plum during storage.

Table 3. Effect of osmotic agents on dehydration and rehydration ratio of osmo-dried plum during storage.

Treatments	Dehydration ratio					Rehydration ratio				
	Storage period (months)					Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean
T_1	7.94	7.41	7.10	6.78	7.31	1.65	1.61	1.58	1.55	1.51
T_2	4.12	3.91	3.79	3.53	3.84	1.48	1.46	1.43	1.39	1.44
T_3	3.96	3.77	3.57	3.31	3.65	1.41	1.37	1.33	1.29	1.35
T_4	3.52	3.31	3.01	2.93	3.19	1.36	1.32	1.27	1.24	1.29
T_5	2.18	2.51	2.23	2.05	2.24	1.30	1.26	1.20	1.16	1.23
T_6	4.70	4.52	4.05	3.93	4.30	1.37	1.34	1.29	1.25	1.31
T_7	4.25	4.02	3.90	3.79	3.99	1.30	1.26	1.21	1.17	1.23
T_8	3.55	3.33	3.10	2.97	3.24	1.27	1.22	1.19	1.15	1.20
T_9	3.04	2.93	2.79	2.56	2.83	1.21	1.17	1.14	1.10	1.15
Mean	4.14	3.97	3.73	3.54		1.37	1.33	1.29	1.26	
CV (%)			3.29					10.70		
$CD_{(0.05)}$										
Treatment (T)			0.10					0.06		
Storage (S)			0.07					0.04		
T × S			0.20					NS		

Initially, the treatment T_9 (70°Brix honey syrup) recorded significantly higher value (660.15) of total phenol content which was immediately followed by T_5 (70°Brix sugar syrup) registering value to the tune of 654.30 mg/100 g. The increase in total phenolic content with increase in osmotic concentration might be because of higher sucrose concentration which promotes a protective effect on the surface of the fruit, thereby preventing the outflow of antioxidant compounds like tannins and phenolic acids (Rahman *et al.* 20). However, the lowest value of 619.20 mg/100 g observed in T_2 (40°Brix sugar syrup) which then decreased to 607.25 mg/100 g after completion of storage period. The various chemical processes like oxidation, degradation of phenolic compounds with proteins might be the possible reason for decreased levels of total phenols during storing. The other possible reason might be their condensation in brown pigments. Mishra *et al.* (18) also reported related type of findings in mango candy.

There was a pronounced effect of treatment and storage on non-enzymatic browning in osmo-dried plums (Fig. 2). At the beginning, maximum value (0.25 OD at 440 nm) of non enzymatic browning was observed in control, however minimum value (0.13 OD at 440 nm) noted in T_5 (70 °Brix sugar syrup), which increased thereafter as the storage period advanced. Durrani *et al.* (7) also recorded similar type of findings of increase in non-enzymatic

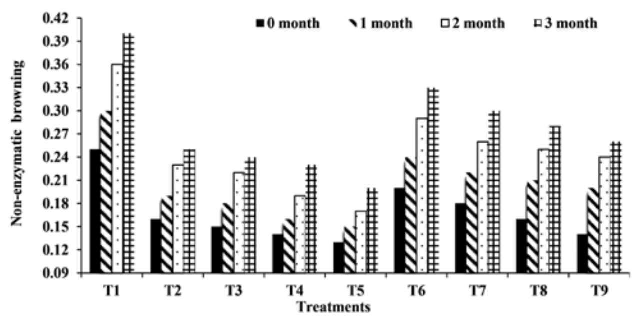

Fig. 2. Effect of osmotic agents on non-enzymatic browning of osmo-dried plum during storage.

browning in honey based carrot candy during storage. As the osmotic concentration increases, the rate of change of absorbance decreases. It might be due to the results of the combined effects of high reactant concentration and low water activity which help the reaction to take place and resulting high viscosity which reduced ion mobility and consequently their reactivity (Buedo *et al.* 6).

The effect of treatments and storage period on the mean score of overall acceptability of osmo-dried plum presented in Fig. 3. A significant reduction in the score of overall acceptability was noted from the initial value of 7.04 to 6.70 during storage. Maximum and minimum scores of 7.86 and 5.81 were recorded in treatment T_9 (70 °Brix honey syrup) and T_1 (control), respectively, initially. After three months

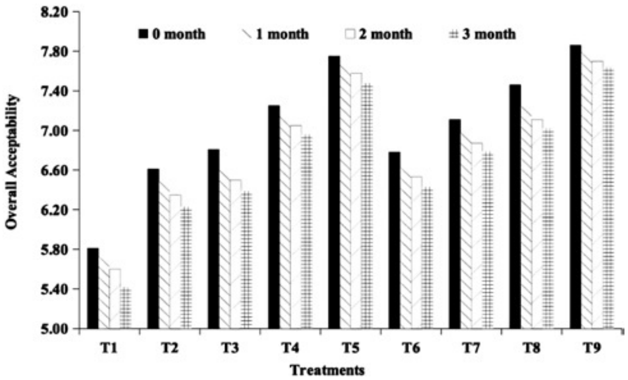

Fig. 3. Effect of osmotic agents on overall acceptability of osmo-dried plum during storage.

of storage period, the highest value of sensory score (7.64) for overall acceptability was recorded in T_9 (70 °Brix honey syrup) which was followed by T_5 and T_8 with the values of 7.48 and 7.02, respectively, while the lowest value of 5.42 was observed in control. The results are in conformity with Gupta and Kaul (10) in ber *chuhara.*

It can be concluded that Santa Rosa plum fruits can be successfully processed into osmo-dried plum. The honey syrup having concentration of 70°Brix to store for 3 months at ambient temperature.

AUTHORS' CONTRIBUTION

Conceptualization of research (NG), Designing of the experiment (NG, MS, AB), Contribution of experimental material (MK, NG, MS), Execution of lab experiment and data collection (MK, NG), Analysis of data and interpretation (MK, NG), Preparation of manuscript (NG)

DECLARATION

The authors declare no conflict of interest.

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