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Effect of different packaging materials on quality and storability of osmotically dehydrated wild apricot fruit under ambient storage condition

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ABSTRACT

Purpose: Wild apricot fruit is a rich source of carbohydrates, minerals and vitamins. Its shelf life is very short due to its perishability characteristics. High perishable nature, high acidity and low sugar content of wild apricot fruits are the major limitations for their utilization as fresh fruits. **Research method:** In this research, Wild apricot fruits were osmotically dehydrated and packed in different packaging materials viz. polyethylene, aluminium laminated and shrink packages were than stored under ambient conditions for six months and analysed for quality and sensory parameters at two months intervals. Osmotic dehydration is a technique where moisture is partially removed and the sweetness is increased by dipping the fruits in concentrated sugar solution, followed by final drying in hot air. Potassium metabisulphite is added in sugar solution as preservative and to improve colour of the final product. After draining the syrup, the fruits are dried in a mechanical dehydrator to a constant weight. **Main findings:** Results showed that aluminium laminated packaging material proved to be best among the all packaging materials in maintaining superior quality up to six months of storage as indicated by higher mean titratable acidity (5.78%), reducing sugars (10.11%), total sugars (37.71%), ascorbic acid (4.77 mg/100g) and lower moisture content (11.14%). All the sensory parameters including colour, taste, texture, flavour and overall acceptability declined significantly during storage period of six months. **Limitations:** There were no limitations to report. **Originality/Value:** It was found that the most suitable packaging material was aluminium laminated whereas the greatest change in sensory parameters was observed in polyethylene packaging.

INTRODUCTION

Wild apricot (*Prunus armeniaca* L.) popularly known as 'chulii' is most common fruit of Jammu and Kashmir, Himachal Pradesh and mid hills of Uttarakhand. The wild apricot plants are drought resistant, salt tolerant, prolific bearers and less susceptible to insects, pests and diseases. Therefore, it can easily be grown with minimum care in the tracts, which are otherwise unfit for cultivation of other temperate fruits. But the high acidity and low sugar content of wild apricot fruits makes them unsuitable for fresh consumption and drying purpose also. Taking into cognizance of the problem, it becomes imperative to develop appropriate technology for the efficient utilization of wild apricot fruits which otherwise go waste. Drying with the help of the sun and wind is one of the oldest methods of fruit preservation known to man, but artificial drying (dehydration) has been developed extensively during the last three decades. Fruit dehydration industry has not shown a satisfactory growth in India due to a variety of reasons like non-availability of promising varieties in adequate quantity, location disadvantage, lack of up-gradation and innovation in the area of product technology (Kapoor, 1998). In recent years more emphasis had been placed upon osmotic dehydration of fruits.

Osmotic dehydration is a technique where moisture is partially removed and the sweetness is increased by dipping the fruits in concentrated sugar solution, followed by final drying in hot air. The osmotic dehydration of wild apricot fruits followed by packing in suitable packaging materials would help to increase in shelf- life of the product and also help the growers to supply their produce according to the market demand and fetches them better prices. The present investigation was conducted to study the effect of different packaging materials on quality and storability of wild apricot under ambient conditions.

MATERIALS AND METHODS

The fruit of wild apricot were harvested at optimum maturity from the experimental orchards of Horticulture Department, Hill Campus, Ranichauri, G. B. Pant University of Agriculture & Technology. For the study healthy and uniform sized fruits were selected, washed and cut into halves to remove the stones. The fruits were lye-peeled in 1.0% NaOH solution in boiling water for 30 seconds followed by immediate cooling and washing in running tap water to remove excess alkali. A 70^{o} Brix sugar syrup containing 0.05% potassium metabisulphite (KMS), with temperature maintained at 50^{o}C was used as osmotic dehydration solution for immersing the lye-peeled fruits of wild apricot for 6 hours in 1:3 ratio (fruit : syrup). During dipping time, the product was agitated periodically at 1 hour interval with a wooden laddle. The dipped fruits were removed from sugar solution and dried in a cabinet dehydrator at 55 $\pm$ 2 ^{o}C temperature up to an almost constant weight. The osmo-dried fruits were packed in three different packaging materials viz., polyethylene pouches (25µ), laminated aluminium pouches (10µ) and shrink packages (20µ) and stored at ambient temperature for a period of six months. The experiment consisted of three treatments and four storage intervals with three replications for each treatment and each storage interval. The change in physico-chemical and sensory parameters were evaluated periodically (0 month, 2, 4, 6 months) at 2 month interval.

Determination of moisture content

The moisture content after each interval of storage was determined by the method of AOAC (2000). The ten grams of sample were kept in a hot air oven at 60 $\pm$ 1^{o}C for drying to a constant weight. The weight of the sample was taken after cooling it in a desiccator and expressed as moisture percentage (1).

$$\text{Moisture (per cent)} = \frac{\text{Loss in weight on drying (g)}}{\text{Weight of sample taken (g)}} \times 100 \quad (1)$$

The titratable acidity, reducing sugars, total sugars and ascorbic acid were estimated as per standard procedures (Ranganna, 2009).

Determination of titratable acidity

The titratable acidity was determined by the method described by Ranganna (2009). Ten grams of sample were blended and mixed thoroughly in a pestle and mortar with 20-25 milliliters of distilled water. It was then transferred to 100 ml volumetric flask, makeup the volume 100 ml and filtered. Ten milliliters of aliquot was taken and titrated against 0.1N NaOH solution using Phenolphthalein as an indicator. The recorded titratable acidity was expressed in terms of per cent citric acid (2).

$$\text{Acidity (percent)} = \frac{\text{Titre value x Normality of alkali} \times \text{Equivalent weight of acid} \times \text{Volume made} \times 100}{\text{Volume of sample taken} \times \text{Weight of sample} \times 1000} \quad (2)$$

Determination of sugars

The reducing and total sugars were estimated by Lane and Eynon (1923) method as detailed by Ranganna (2009).

Preparation and standardization of Fehling's Reagent

Fehling's reagent was prepared fresh by adding Fehling's solution A and Fehling's B in equal amount with constant stirring and the content was filtered through Whatman filter paper No.2. Ten milliliters of Fehling's reagent were titrated against standard dextrose solution of concentration 2.5 mg/ml using methylene blue as an indicator.

Preparation of sample

A ten gram sample was transferred to a 100 milliliters beaker. It was added with about 50 milliliters of distilled water and the content was neutralized by adding 0.1N NaOH. It was heated to boil. Thereafter, the content was transferred to 250 milliliters volumetric flask using several washings with distilled water. Two ml of 45 per cent neutral lead acetate was added, stirred and allowed to stand for 10 minutes. It was added with predetermined amount (1.9 milliliters) of 22 per cent solution of potassium oxalate and the volume was made up to the mark with distilled water. Thereafter, it was filtered through Whatman filter paper No.1 so as to get the clarified sugar sample.

Reducing sugars

The prepared clarified sample was titrated with freshly prepared and pre-standardized Fehling's reagent using methylene blue as an indicator. The reducing sugars content was calculated as follows (3):

$$\text{Reducing sugar (percent)} = \frac{\text{Dilution} \times \text{Fehling's factor} \times 100}{\text{Titre} \times \text{Volume of sample}} \quad (3)$$

Total sugars

Twenty five milliliters of sample sugar solution were taken in a 100ml volumetric flask and 5 milliliters of HCl (1+1) were added. This was kept for 24 hours at the ambient temperature for the hydrolysis of non-reducing sugars to the reducing ones. Thereafter, the content was neutralized with 1 N NaOH and made up to 100ml with distilled water. It was titrated against freshly prepared and standardized Fehling's reagent as described above.

Non-reducing sugars

The content of non-reducing sugars was calculated by the formula given below (4):

$$\text{Non-reducing sugars (percent)} = (\text{Total sugars - Reducing sugars}) \times 0.95 \quad (4)$$

Results were expressed as per cent of reducing, non-reducing and total sugars on the basis of sample.

Estimation of ascorbic acid

Ascorbic acid content in fresh fruits and in stored jelly products were estimated by using 2, 6-Dichlorophenol Indophenol (DCPIP) Visual Titration Method (Ranganna, 2009). Ten grams of sample was blended with an aqueous solution of metaphosphoric acid (3 per cent) and the volume was made upto 100 milliliters with metaphosphoric acid solution. The content was filtered through a Whatman filter paper No. 1. Ten milliliters of the aliquot were titrated against dye solution till the appearance of light pink colour. Dye was standardized with freshly prepared standard ascorbic acid solution (0.1mg/ml) prepared in 3 per cent metaphosphoric acid solution. This method involves reduction of 2, 6-Dichlorophenol indophenol dye, blue in alkaline solution to a colourless form of ascorbic acid. The ascorbic acid content was expressed in terms of mg/100g and calculated by using following formula (5).

$$\text{Ascorbic acid} \left(\frac{\text{mg}}{100\text{g}}\right) = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot taken} \times \text{Weight or Volume of sample taken}} \quad (5)$$

Organoleptic evaluation

The dehydrated fruits were evaluated by a panel of 7 semi-trained members using 9 point Hedonic scale for colour, taste, texture and overall acceptability i.e. like extremely 9, like very much 8, like moderately 7, like slightly 6, neither like nor dislike 5, dislike slightly 4, dislike moderately 3, dislike very much 2, dislike extremely 1 (Amerine et al., 1965).

Statistical analysis

Statistical analysis of the data pertaining to the sensory evaluation of osmotically dehydrated fruits were analysed according to randomized block design (Mahony, 1985) while, that on physico-chemical characteristics by factorial completely randomized design (Cochran & Cox, 1967). The values were compared at 5% level of significance.

RESULTS AND DISCUSSION

A steady increase in mean moisture content of the osmotically dehydrated wild apricot fruits from 11.32 to 12.70% was observed with the advancement of storage period (Table 1).

Aluminium laminated packaging registered the lowest mean moisture content (11.14%) followed by shrink wrapped packaging (12.68%). The polyethylene packed osmotically dehydrated fruits, on the other hand, had maximum moisture content and registered average moisture content of 12.99 percent at the end of the storage period of six months. The moisture content of the osmotically dehydrated wild apricot fruits during different storage intervals for polyethylene packaging, aluminium laminated packaging and shrink wrapped packaging ranged between 11.32-13.68, 11.32-11.08, and 11.32-13.33 percent, respectively between 0 to 6 months of storage. The gradually increase in mean moisture content in osmotically dehydrated fruits throughout six months of storage might be due to absorption of moisture from atmosphere by the product stored at ambient conditions. Similar results were also reported by Ahmed (2005) in dried apricot. The higher mean moisture content in osmotically dehydrated wild apricot fruits packed in polyethylene packaging during six months of storage was observed which might be attributed to permeability of polyethylene packages to air and water, whereas minimum loss in moisture content in the samples stored in aluminium laminated packages was due to the better moisture barrier properties of the package. A similar trend has also been documented in dried apples (Sharma et al., 2000).

During storage period of six months the titratable acidity of osmotically dehydrated wild apricot fruits experienced a small reduction from an average initial value of 5.82 to 5.66 per cent. The titratable acidity of osmotically dehydrated fruits packed in different packaging materials showed a linear declining trend with the advancement of storage period (Table 1). The highest mean titratable acidity (5.78%) was recorded in the osmotically dehydrated fruits packed in aluminium laminated packages, followed by shrink wrapped packages (5.73%). The lowest mean titratable acidity (5.71%) was recorded in polyethylene packed osmotically dehydrated fruits. A gradual decline in titratable acidity with the advancement of storage period might be due to the utilization of acids during various biochemical reactions occurring in the products during storage. The maintenance of higher acidity in aluminium laminated packages may be due to the decreased hydrolysis of organic acids and subsequent accumulation of organic acids which were oxidized to the slower rate. The delay in the reduction of acidity of osmotically dehydrated fruits packed in aluminium laminated packages confirms the similar findings of Bhardwaj and Kaushal (1990) in dried apples.

The mean reducing sugar content of osmotically dehydrated wild apricot fruits were increased from 9.25 to 10.48 per cent after six months of storage (Table 1), which was probably due to the hydrolysis of non-reducing sugars during storage. Similar findings have also been reported in Papaya powder by Aruna et al. (1998). Among packages, although the mean contents of reducing sugars varied between maximum (10.11%) to a minimum (9.87%) for aluminium laminated packages and polyethylene packages, respectively, but the differences were statistically non-significant. Such results have also been recorded by Khedkar and Roy (1988) in dehydrated mango slices.

The decrease in mean total sugars of osmotically dehydrated wild apricot fruits from 38.46 to 36.89 per cent was observed with the advancement in storage period which might be due to the utilization of sugars in non-enzymatic browning reactions. The decrease in total sugar content in dehydrated products during storage was also observed by Sagar and Khurdiya (1999) in dehydrated mango slices. A negligible effect of packaging on mean total sugars content of osmotically dehydrated fruits was observed. However, the lowest mean total sugars content was observed in osmotically dehydrated fruits packed in polyethylene packages which might be due to higher moisture content in osmotically dehydrated products packed in polyethylene packages which favour faster non-enzymatic reaction during storage. Sharma et al. (2006) also observed similar trend for total sugars content in dehydrated apple products packed in different packages.

Table 1. Effect of different packaging materials on moisture content, titratable acidity, reducing sugar, total sugar and ascorbic acid of osmotically dehydrated apricot fruits during storage

Storage interval (months)	Polyethylene	Aluminium Laminated	Shrink wrapped	Mean
		Moisture (%)		
0	11.32	11.32	11.32	11.32
2	13.46	11.08	12.84	12.46
4	13.52	11.08	13.25	12.61
6	13.68	11.08	13.33	12.70
Mean	12.99	11.14	12.68	
$CD_{0.05}$	Treatment = 0.16	Storage = 0.19 Treatment × Storage = 0.33		
		Titratable acidity (%)		
0	5.82	5.82	5.82	5.82
2	5.75	5.80	5.78	5.78
4	5.67	5.77	5.72	5.72
6	5.60	5.75	5.62	5.66
Mean	5.71	5.78	5.73	
$CD_{0.05}$	Treatment = 0.03	Storage = 0.04 Treatment × Storage = 0.09		
		Reducing sugar (%)		
0	9.25	9.25	9.25	9.25
2	9.98	10.02	10.28	10.09
4	10.20	10.17	10.34	10.24
6	10.07	11.01	10.35	10.48
Mean	9.87	10.11	10.03	
$CD_{0.05}$	Treatment = NS	Storage = 0.56 Treatment × Storage = NS		
		Total sugar (%)		
0	38.46	38.46	38.46	38.46
2	36.84	37.74	36.92	37.17
4	36.66	37.35	36.82	36.94
6	36.59	37.30	36.79	36.89
Mean	37.14	37.71	37.25	
$CD_{0.05}$	Treatment = NS	Storage = 0.63 Treatment × Storage = NS		
		Ascorbic acid (mg/100g)		
0	5.00	5.00	5.00	5.00
2	4.50	4.80	4.55	4.62
4	4.20	4.80	4.28	4.43
6	3.80	4.50	4.10	4.13
Mean	4.37	4.77	4.48	
$CD_{0.05}$	Treatment = 0.13	Storage = 0.15 Treatment × Storage = 0.32		

The ascorbic acid content of osmotically dehydrated fruits followed a decreasing trend from 5.00 to 4.13 mg/100 g during six months of storage which was mostly due to its oxidation with the passage of time and its role as a substrate in non-enzymatic browning reactions (Khedkar & Roy, 1988). It was also observed that the osmotically dehydrated fruits packed in aluminium laminated packages retained maximum (4.77 mg/100 g) mean ascorbic acid content, whereas, osmotically dehydrated fruits packed in polyethylene packages had minimum (4.37 mg/100g) mean ascorbic acid content. The osmotically dehydrated fruits packed in aluminium laminated packages showed highest retention of ascorbic acid content, while, in polyethylene pouches there was maximum loss during six months of storage period which might be attributed to maintenance of lower moisture content in laminated pouches thereby permitting less degradation of ascorbic acid. Similar evidences have been reported by Tripathi et al. (1988) in dehydrated aonla.

Table 2. Effect of different packaging materials on colour, taste, texture, flavour and overall acceptability of osmotically dehydrated apricot fruits during storage

Storage interval	Polyethylene	Aluminium Laminated	Shrink wrapped	Mean
		Colour		
0	8.48	8.48	8.48	8.48
2	6.88	7.84	7.56	7.43
4	6.23	7.82	7.23	7.09
6	6.17	7.66	7.02	6.95
Mean	6.94	7.95	7.57	
$CD_{0.05}$	Treatment = 0.16	Storage = 0.18	Treatment × Storage = 0.31	
		Taste		
0	6.22	6.22	6.22	6.22
2	5.56	5.84	5.55	5.65
4	5.36	5.45	5.42	5.41
6	5.02	5.28	5.22	5.17
Mean	5.54	5.70	5.60	
$CD_{0.05}$	Treatment = 0.19	Storage = 0.23	Treatment × Storage = 0.44	
		Texture		
0	6.45	6.45	6.45	6.45
2	5.94	6.28	6.14	6.12
4	5.53	6.08	5.86	5.82
6	5.23	5.78	5.55	5.52
Mean	5.79	6.15	6.00	
$CD_{0.05}$	Treatment = 0.17	Storage = 0.19	Treatment × Storage = 0.38	
		Flavour		
0	8.23	8.23	8.23	8.23
2	7.82	8.04	7.92	7.93
4	7.14	7.77	7.33	7.41
6	6.50	6.93	6.65	6.69
Mean	7.42	7.74	7.53	
$CD_{0.05}$	Treatment = 0.11	Storage = 0.12	Treatment × Storage = 0.25	
		Overall acceptability		
0	7.05	7.05	7.05	7.05
2	6.13	6.65	6.43	6.40
4	5.71	6.45	6.17	6.11
6	5.47	6.24	5.93	5.88
Mean	6.09	6.60	6.40	
$CD_{0.05}$	Treatment = 0.10	Storage = 0.12	Treatment × Storage = 0.23	

The mean sensory scores for colour of osmotically dehydrated fruits during storage period of 6 month showed gradual decrease from 8.48 to 6.95 (Table 2). Among packages, laminated packages retained maximum (7.95) mean sensory colour score, while, polyethylene packed dehydrated fruits retained minimum (6.94) colour score during 6 month of storage. The change in colour was significantly higher in polyethylene and shrink wrapped osmotically dehydrated fruit and aluminium laminated packages had minimum loss in colour. The decrease in mean sensory score for colour during storage was observed which might be due to occurrence of non-enzymatic browning reactions and oxidation of ascorbic acid to dehydrosascorbic acid and tannins to gallic acid. Similar findings have been reported in different varieties of apricot (Sharma et al., 2004).

The average sensory score for taste decreased from initial level of 6.22 to 5.17 after six months of storage (Table 2). However, on the basis of different packaging materials, the mean sensory scores of taste were found to be higher (5.70) in osmotically dehydrated fruits packed in aluminium laminated packages, whereas lowest (5.54) mean scores were recorded in polyethylene packed osmotically dehydrated fruits during 6 months of storage period. During storage, the mean sensory score for taste showed decreasing trend from initial to 6 months irrespective of packaging, whereas osmotically dehydrated fruits packed in laminated packages had minimum loss in taste during storage.

The mean texture score on 9 point hedonic scale was found to decrease gradually from 6.45 to 5.52 during 6 months of storage. On the other hand, the mean texture scores of osmotically dehydrated apricot fruits packed in different packaging materials varied from 5.79 to 6.15 with the highest score in aluminium laminated packages and lowest in the products packed in polyethylene packages (Table 2). The mean values of texture followed a decreasing trend from initial to six month of storage and samples packed in aluminium laminated packages maintained best texture.

The sensory scores for flavour of osmotically dehydrated wild apricot fruits followed decreasing trend from 8.23 to 6.69 for the mean scores during six months of storage (Table 2). Among packages, aluminium laminated packages retained maximum (7.74) mean sensory score for flavour while, polyethylene packed osmotically dehydrated fruits retained minimum (7.42) flavour score during 6 month of storage.

The overall acceptability mean scores during storage period of 6 months declined from an initial value of 7.05 to 5.88 after 6 months of storage period (Table 2). However, among packages, the mean overall acceptability scores for aluminium laminated osmotically dehydrated wild apricot fruits were found to be higher (6.60), while, polyethylene packed and shrink wrapped packages exhibited mean scores of 6.09 and 6.40, respectively. A general trend was observed in reduction of mean sensory scores during storage period which might be attributed to change in chemical composition of osmotically dehydrated fruits, change in sugar-acid blend and loss of aromatic compounds due to oxidation. Slight change in the texture upon storage was probably due to the degradation of pectic substances during storage. Similar reduction in sensory scores during storage has been reported by Sagar et al. (1998) in dehydrated ripe mango slices. However, the lower mean sensory scores observed in osmotically dehydrated apricot products packed in polyethylene packages which might be due to higher moisture absorption and gas permeability characteristics of the polyethylene, thereby affecting texture and colour of the packed products. The sensory scores were significantly higher in osmotically dehydrated products packed in aluminium laminated packages which might be due to impermeable nature of laminated packages. Similar evidences have also been made by Ahmed and Choudhary (1995) in osmotically dehydrated papaya.

CONCLUSIONS

From the present study it can be concluded that osmotically dehydrated wild apricot fruits can successfully be stored at ambient conditions after packing in aluminium laminated packaging material for a period of six months without any considerable loss in sensory as well as nutritional quality. The successful transfer of such technology after pilot scale testing may open new avenues for the processing industry for the efficient utilization of this fruit which is otherwise being wasted in Uttarkhand state. This may also attract entrepreneurship and may help the youth getting self-employment.

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Conflict of interest

The authors have no conflict of interest to report.

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