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Research Paper

Quality assessment of fresh and processed farm-grown stone fruits: Physiochemical and sensory aspects

Rafiya Munshi[1], Shafat A. Banday[2], Ishfaq Abidi[2], Eajaz A. Dar[2], Farooq A Ahanger[2], Shaheen Farooq[2] and Suja Nabi Qureshi[2]

[1]*Division of Community Sciences, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar Jammu and Kashmir (India);* [2]*KVK Ganderbal, Faculty of Veterinary Sciences and Animal Husbandry-FVSc &AH (SKUAST-K), Shuhama, Ganderbal, Jammu and Kashmir, India.*
*e-mail: *rafiataf16@gmail.com*

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ABSTRACT

This study explored the potential for value addition of fruits grown at KVK Ganderbal (1.0 ha), focusing on the processing and preservation of Santa Rosa plums and Golden Amber apricots. Optimal dehydration conditions were determined for both fruits (55±2°C to 18-20% moisture for plums; 60±2°C to 10-12% for apricots). Acceptable jam was produced from apricots and black plum pulp separately with specific additions of sugar, pectin, and citric acid, achieving a final Brix of 65-68°. Furthermore, a method for pickling Lemon plums in oil with vinegar (125ml/kg fruit) and spices was established. The physico-chemical and sensory stability of the dehydrated fruits, jams, and pickles were monitored over a 90-day storage period at room temperature in air-tight containers.

Key words: Apricot, dehydration, plum, storage, value added products

Plum (*Prunus domestica*) and Apricot (*Prunus armeniaca L.)*, both belong to the family *Rosaceae* are cultivated throughout the temperate regions of the world, especially in the Mediterranean. In India, after Ladakh, Himachal Pradesh and Jammu & Kashmir are India's major apricot producing states while as primary producers of plum are Himachal Pradesh, Jammu and Kashmir and Uttar Pradesh. In Kashmir region, 1,500 hectares of land is under plum cultivation. Kashmir produces 46514.32 MT of apricot, peach, plum and cherry as per the 2022-23 data available with the Directorate of Horticulture, Kashmir. Budgam produces highest quantity of plum around 5898.94 MT and Ganderbal grows highest quantity of peaches around 1346 MT and cherries around 9086 MT. Baramulla is leading in production of apricot around 2103.10 MT and Srinagar stands second in Kashmir region in the production of cherry around 2983.22 MT. However, Ganderbal produces other stone fruits also, like apricot (778 MT) and plum (264.94 MT) [1]. Stone fruits are visually attractive, delicious in taste and highly nutritious. They have often been appreciated for their gustatory nutritive qualities and are seasonal. These fruits are considered to be a good source of bioactive ingredients like carotenoids, anthocyanins and other antioxidant polyphenols.[2-4]

Drying of plums and apricot in open sun is a common process in the region leading to their contamination and discolouration, compromising hygiene and taste of the end product. This in turn increases the need for scientific intervention for the preparation of good quality dried and other value added products. There has been a considerable shift in the eating habits of the urban populations, and

also a strong demand for fast and take away foods in India. So popularity of convenience food is becoming a new trend now a day. These value added products are not only convenient to carry but have an increased shelf life and adds diversity to our taste buds. Keeping in view the losses of stone fruits being highly perishable and possibly meeting out the recent trend of the consumers plus helping the growers to increase their income through value addition, efforts have been made by the KVK Ganderbal to characterize the suitability of plum and apricot fruits for the manufacture of market ready dehydrated fruits and other products.

Krishi Vgyan Kendra Ganderbal is spread over an area of 20 hectares and the fruit orchard occupies an area of 1.0 hectare. The different fruits mainly grown on KVK farm of Ganderbal are Apple (Both HDP and traditional varieties), Stone fruits (Peach Plum, Cherry and Apricots), Grapes and Hazel nuts. The production of stone fruits especially plum and apricots is around 250 Kgs each year. Due to highly perishable nature, plum and apricots were selected for value addition which is the best option to control the huge postharvest losses which can occur at ambient temperatures also. Even at low temperature (0-4°C) they can only be stored for 2-4 weeks[5].

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MATERIALS AND METHODS

The varieties of Plum mainly grown on KVK farm are *santa rosa,* lemon plum (*Green gage*), *black plum* and *cherry plum. Santa rosa* was selected for its value addition to prunes –a dehydrated form of plums providing more concentrated source of energy besides, having good amount of minerals and nutrients, while as, Jam was prepared from black plums, often delightful to be consumed with breads. Lemon plums (*Green gage*) were fermented to pickles, and *cherry plum* was sold fresh. Plums and apricots (*Golden Amber*) were harvested at optimum stage of maturity from the KVK Ganderbal farm and were used for dehydration and development of other processed products like jams and pickle.

Preparation of fruits for dehydration: Plums (120 Kg of *santa rosa* variety) and apricot (35Kgs of *Golden Amber*) were sorted, washed and blanched by dipping in 1.0% common salt solution in water for 55 sec to remove peel followed by dipping in ice cold water to stop further enzymatic reaction. Halving and pitting was done by hand and fruits were again dipped in 1% citric acid solution in water for 15 min to prevent discoloration. For making prunes from plum, 68°Brix sugar solution was prepared and once cooled; fruit was dipped in it overnight. The plum was removed from the sugar solution and placed on a wire mesh to drain excess liquids, loaded on trays (76×56 cm, 3 Kg fruit per tray) and placed in an air drying dehydrator maintained at a temperature of 55± 2°C for 5-6 hours till the moisture level reaches to 18 – 20%. Halving and pitting in plum fruits kept in the dehydrator was done when they attained about 40% moisture content. While as apricots were not dipped in the sugar solution but once treated with citric acid were loaded in aluminium trays (76×56 cm, 3 Kg fruit per tray), placed inside the air dehydrator maintained at 60± 2°C.Apricots were dried to final moisture content ranging from 10-12 per cent while as plum was dried to a final moisture content ranging between 18-20%.

Preparation of fruit jams: Plums (*Black plums*- 45 Kgs) and apricots (*Golden Amber* variety 25 Kgs) were sorted, washed and pitted and blended separately without addition of water to make into a smooth paste. For making apricot jam sugar to fruit was in the ration of 1:1, while as for plum jam Sugar was added to the fruit pulp in the ratio of 50: 45. Pectin was used @ 15 grams /kg of pulp for its setting and citric acid @ 4 grams/kg of pulp in both the jams. The jams were cooked for some time with sugar, small amount of the contents were added with the mentioned amount of pectin in a separate bowl. The pectin + pulp mixture was then added to the main fruit mix followed by the addition of the specified quantity of citric acid to bring down the pH and enhance its setting. The mixture was cooked and examined at regular intervals for the desired brix of 68° B. The glass bottles (500 ml each) used for filling were pre sterilized and contents were filled when hot. Few filled bottles selected as samples, were stored at room temperature and analysed after 0, 30, 60 and 90 days for different parameters.

Preparation of plum pickle: Lemon plums (*Green gage* 15 Kgs) were selected for pickling because of their firmness and acidity. Plums were sorted washed, pitted, weighed and sprinkled with enough rock

salt. The fruit started giving out some water which was discarded. Oil (250 ml/Kg of fruit) was heated and plums were slightly fried and set aside. The oil was cooled, all the spices (desired amount of chili powder, coriander seeds, turmeric powder, fenugreek powder, mustard seeds) were added along with one Kg of garlic cloves, 125 ml white vinegar/Kg fruit, and all ingredients were thoroughly mixed. Fried plums were added to the mixture and cooked for some time till the liquids got completely reduced. The pickle was cooled and filled in sterilized food grade transparent boxes for storage. Since this pickle was cooked, so it was ready to use within few days (5-6). The acidity of the pickle was maintained @ 2.5-3.0 before storage.

Physical analysis: Parameters like fresh fruit like length and width was recorded with vernier caliper while weight was recorded by weighing the individual fruit in top pan balance. Dehydration ratio was calculated by recording the loss in weight at an interval of 1 h till the desired level of moisture was attained and per cent yield of the dried halves was calculated by dividing the weight of the dried fruit by the weight of fresh fruit and multiplied by 100.

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Chemical Analysis:

Titrable acidity and pH value: The acidity was calculated by titration method (Rangana, 1986), and it measures the stability and shelf life of jam. All the acids whether naturally present in the produce or incorporated while making of jam contribute to the acidity and decrease the *pH*. The *pH* was measured by the standard procedures of AOAC (AOAC, 2005). A 25 gm sample was dissolved in 200ml of distilled water followed by boiling on a water bath for 1 hour. The solution was cooled and made up to 250ml by adding distilled water, then filtered and used for analysis. The *pH* was determined by using a digital *pH* meter. The titrable acidity was expressed as % citric acid and calculated by the following formula:

$$\% \text{ Titrable Acidity} = \frac{\text{Titer} \times \text{normality of alkali} \times \text{vol. made up} \times \text{eq. wt. of major acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{wt. of sample taken} \times 1000}$$

Reducing sugars and total sugars: The reducing sugars as determined by Lane and Enyon method (Rangana, 1986) are expressed as invert sugar that reduces the copper in Fehling's solution to red, insoluble cuprous oxide. The procedure was followed by blending 50 gm of sample with 400 ml of water and neutralizing it with 1N sodium hydroxide using phenolphthalein indicator, followed by gently boiling for about an hour and maintaining its water level during the boiling. The solution is left for cooling and then transferred to 500ml volumetric flask marking up the volume and taking out 100ml aliquot added with 200ml water and 2ml neutral lead acetate solution, the excess of the later is precipitated with potassium oxalate solution. The sugar solution is then titrated with 10 ml of mixed Fehling's solution and 50 ml water in a 250 ml flask to reduce almost completely the Fehling's solution. The flask boiled for 15 seconds with persistence of blue colour indicating unreduced Fehling's solution and adding few more ml of sugar solution until whole of the Fehling's solution gets reduced. The presence of slightest hue of perceptible blue colour is the time for adding few drops of methylene blue followed by adding sugar solution until the indicator is completely decolorized. The readings were recorded and calculation made of % reducing sugars as:

$$\% \text{ Reducing Sugars} = \frac{\text{mg of invert sugar} \times \text{dilution} \times 100}{\text{Titer} \times \text{volume of sample} \times 100}$$

TSS and sensory analysis: The fresh fruit as well as value added products were analysed for total soluble solids (TSS) by using hand refractometer. The total soluble solids (TSS) content Brix (°B) was measured by placing a small amount of juice in a handheld refractometer (*Atago, Tokyo, Japan*) and the readings were noted. Moisture (%) was calculated by oven drying method, specific gravity by water displacement method, rehydration ratio by water soaking and boiling method.

Storage stability: The analysed acidity (%), pH, TSS (°B), reducing sugars (%) and total sugars (%) and sensory evaluation of Jam pickle, dried apricots and prunes were evaluated after preparation and at an interval of 30, 60 and 90 days to record the changes during the storage period.

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Statistical Analysis: All the procedures of physical and chemical parameters were replicated in triplicate for fresh and prepared products for standard error of mean and for sensory evaluation data was evaluated by following randomized block design according to standard procedures. To check the effect of storage on various parameters after regular intervals analysis of variance (ANOVA) was applied.

Table 1: Physical characteristics* of fresh fruit

Parameters	Plum (Santa rosa)	Plum (Black plum)	Plum (Green gage)	Apricot (Golden amber)
Moisture %	85.30±0.011	89.20±0.006	85.10±0.017	88.20±0.006
Total soluble solids, %	15.60±0.046	16.43±0.03	13.90±0.06	13.80±0.025
Titrable acidity, %	1.81±0.003	1.61±0.005	2.01±0.007	1.71±0.006
Reducing sugars, %	6.81±0.057	7.21±0.057	7.53±0.057	3.91±0.017
Total sugars, %	8.91±0.033	9.13±0.015	9.32±0.031	10.05±0.021
Ascorbic acid, mg/100 g	6.59±0.003	6.21±0.003	8.89±0.006	16.13±0.016

** Results from replicates (n = 3) are reported as mean values ± Standard error*

RESULTS AND DISCUSSION

Physical Parameters of Fresh Apricot and Plums: While analysing the fresh fruit the average weight of apricot *(Golden Amber)* was calculated 48.22 g and fruit length and fruit width were 45.18mm and 46.70 mm, respectively. The value for specific gravity of fruit was found to be 1.04 thus showing that the fruit was at optimum maturity. The fruit was light orange in colour and the edible portion was around 91.23% of total weight. The recorded parameters as shown in Table 1 were within the range and closer to the resulted reported by earlier researchers[6]. On analysing different varieties of plum, the red-skinned plum (*santa rosa*) with a purple bloom and juicy amber flesh weighed about 52.90 g with a length of 47.23mm and width around the fruit was 50.64mm. The specific gravity was recorded to be 1.02 for this variety of plum and it had an edible portion of 47.93 g. The black plum slightly oblong fruit with smooth blue-black colour weighed about 55.32 g and was quite firm on harvest. Its colour and sweetness made us to select it for making of jam. Similarly, *Green gage* plum with a pale yellow – greenish yellow colour and a round shape was also analysed for different physical parameters. All the fruits had a single large seed. The said results were in close agreement with those reported earlier[6] and the slight differences are due to different agro-climatic conditions of the growing area.

Table 2: Chemical characteristics* of fresh fruit

Parameters	Plum (Santa rosa)	Plum (black plum)	Plum (Green gage)	Apricot (Golden Amber)
Fruit length, mm	47.23±0.012	53.67±0.013	49.50±0.009	45.18±0.98
Fruit width, mm	50.64±0.029	49.87±0.018	48.75±0.006	46.70±0.55
Weight, g	52.90 ±0.54	55.32±0.68	49.61±0.92	48.22±0.072
Colour	red-skinned	blue-black	greenish yellow	light orange
Specific gravity	1.02±0.02	1.02±0.01	1.01±0.02	1.04±0.03
Edible portion, %	90.60±0.017	91.50±0.006	89.98±0.09	91.23±0.012

** Results from replicates (n = 3) are reported as mean values ± Standard error*

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Chemical parameters of fresh apricot and plums: The fresh produce of apricot (*Golden Amber*) and plums were analysed for different chemical parameters as shown in Table 2. The moisture content of black plum (89.20±0.006 %) was recorded higher as compared to other two varieties. Black plum also had higher TSS value of 16.93 % than *santa rosa* and green gage as presented in the table 2. Higher percentage of Titrable acidity and reducing sugar, total sugar and ascorbic acid content was recorded in green gage at 2.01%, 7.53%, 9.32% and 8.89 mg/100g respectively. The values recorded are almost similar to the percentages recorded by earlier researchers as well[6-7].

For *golden Amber* variety of apricot, all the chemical parameters are also given in Table 2. The variety had a good percentage of Vitamin C content which indicates its nutritional significance. Close to similar results were recorded in earlier studies as well[8].Besides, apricot is rich in other vital nutrients like carotenoids, phenolic compounds, and minerals[9].

Storage stability pH: The pH of the fruit is an important parameter that effects various chemical reactions occurring during processing and storage. The chart shows the changes in pH of value added products over a period of 90 days. The value of pH (as shown in the graph (Fig. 1) shows a decline over storage due to the formation of acidic compounds in all the value added products which were prepared from stone fruits. A similar result of decreasing pH over storage has been observed in previous studies on development of products from stone fruits[10]. Storage study on changes in pH helps us to know whether it was maintained or not during the period.

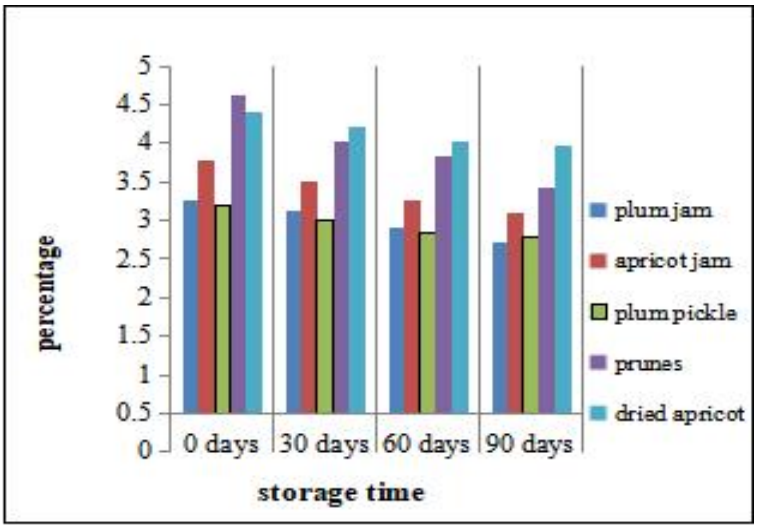


Fig. 1: Change in pH over storage in value added products

Titrable acidity: It is the measure of stability and shelf life of products and includes the acids present in the product and those incorporated in its making process. The titrable acidity was expressed as % citric acid and calculated through the given formula. The graph (Fig. 2) shows that the initial titrable acidity was high in dehydrated products as compared to pickle and jams and the results are in line with the values obtained in previous work related to dehydrated products of stone fruits[6]. However, the values showed a gradual increase on storage over a period of time in all value added products as depicted in other studies related to product development of stone fruits[11].

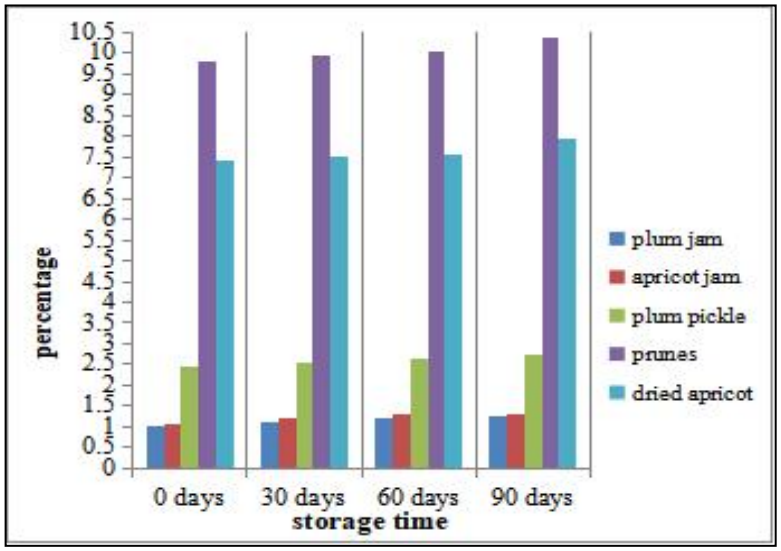


Fig. 2: Titrable acidity change on storage in value added products

Total soluble solids (°B): The values of TSS effect the fruit product structure and shelf life and in turn consumer preference. For plum jam value TSS was 65°B at the time of preparation which gradually increased with the storage time as shown in Table 3. Similar increase in TSS was also observed in

apricot jam, dried apricots and prunes over a period of 90 days. This increase in TSS may be due to the solubilisation of the jam constituents with time. More studies are available which have presented the similar results in their observations on TSS of value added products prepared from stone fruits.[10.12]

Table 3: Storage effect on the chemical constituents of value added products of stone fruits

Storage Time	TSS (°B)	Reducing sugars (%)	Total sugars (%)	Mean
Plum Jam				
0 days	65.00	37.20	53.98	52.06
30 days	68.00	39.10	56.72	54.06
60 days	70.00	42.30	57.63	56.64
90 days	74.50	43.70	57.91	58.70
Mean	**69.37**	**40.57**	**56.56**	**55.36**
CD (p≤0.05)	**0.67**	**0.43**	**0.52**	
Apricot Jam				
0 days	68.00	38.90	55.71	54.20
30 days	70.50	42.80	57.79	57.03
60 days	73.70	43.76	57.93	58.46
90 days	76.01	44.09	58.02	59.37
Mean	**72.05**	**42.38**	**57.36**	**57.26**
CD (p≤0.05)	**0.71**	**0.66**	**0.42**	
Prunes				
0 days	55.02	48.30	56.50	53.27
30 days	54.73	46.71	57.83	53.09
60 days	54.01	44.30	58.91	52.40
90 days	53.72	42.90	59.62	52.08
Mean	**54.37**	**45.55**	**58.21**	**52.71**
CD (p≤0.05)	**0.47**	**0.33**	**0.14**	
Dried Apricots				
0 days	75.00	22.98	60.85	52.94
30 days	73.87	23.07	61.02	52.65
60 days	73.52	23.64	61.23	52.79
90 days	73.08	23.91	61.47	52.82
Mean	**73.86**	**23.40**	**61.14**	**52.80**
CD (p≤0.05)	**0.63**	**0.29**	**0.08**	

Reducing sugars and total sugars: Sugars present in products often influence the consumer preferences and over all acceptability score. In Table 4 the total sugar content, which is the sum of compounds that give sweetness, was recorded at 53.98% (p≤0.05) and reducing sugars; determining the starch material was 37.2% (p≤0.05) at the time of storing the plum jam just after preparation. The same values showed an increase with storage time and reached to total sugar 57.91% (p≤0.05) and reducing sugars 43.7% (p≤0.05) after 90 days.

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Table 4: Sensory score of value added products on storage

Storage Time	Colour	Taste	Texture	Overall acceptability	Mean
Plum Jam					
0 days	7.50	7.50	8.50	7.83	7.83
30 days	8.0	8.5	7.8	8.10	8.10
60 days	7.5	8.0	8.0	7.83	7.83
90 days	7.0	6.8	6.5	6.76	6.76
Mean	**7.5**	**7.7**	**7.7**	**7.63**	**7.63**
CD (p≤0.05)	**0.99**	**0.73**	**1.17**	**0.82**	
Apricot Jam					
0 days	7.8	7.8	8.5	8.03	8.03
30 days	8.0	8.2	8.0	8.06	8.06
60 days	7.0	7.5	7.0	7.16	7.16
90 days	6.8	7.0	6.5	6.76	6.76
Mean	**7.4**	**7.625**	**7.5**	**7.50**	**7.50**
CD (p≤0.05)	**1.01**	**0.68**	**0.52**	**0.91**	
Prunes					
0 days	8.5	8.8	8.5	8.6	8.6
30 days	8.0	8.5	7.8	8.1	8.1
60 days	7.5	7.5	7.2	7.4	7.4
90 days	7.0	7.0	7.0	7.0	7.0
Mean	**7.75**	**7.95**	**7.62**	**7.77**	**7.77**
CD (p≤0.05)	**0.97**	**0.38**	**1.14**	**0.72**	
Dried Apricots					
0 days	8.5	8.5	8.5	8.5	8.5
30 days	8.0	8.0	7.5	7.83	7.83
60 days	7.0	7.5	7.0	7.16	7.16
90 days	6.5	7.0	6.5	6.66	6.66
Mean	**7.5**	**7.75**	**7.375**	**7.54**	**7.54**
CD (p≤0.05)	**0.63**	**0.89**	**0.38**	**0.66**	
Plum Pickle					
0 days	7.5	8.0	7.5	7.6	7.6
30 days	8.0	8.5	8.5	8.3	8.3
60 days	8.0	8.0	8.0	8.0	8.0
90 days	7.5	7.0	7.0	7.16	7.16
Mean	**7.75**	**7.87**	**7.75**	**7.76**	**7.76**
CD (p≤0.05)	**0.31**	**0.53**	**0.51**	**0.61**	**0.21**

The table 4 shows similar trend of gradual increase in total and reducing sugars over storage time for other value added products as well. The possible cause of increase in these values is mainly due to the inversion of sucrose into reducing sugar (glucose and fructose) due to presence of acid and application of high temperature while preparing the products. And on storage, the increase can also be due

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hydrolysis of sugars with increase in acidity and decrease in pH over a period of time. Similar observations have also been reported by other researchers in previous studies on products prepared from stone fruits[12,13] however, slight variations may be attributed to the difference in product type, cultivar and methods used for product development. The statistical analysis of all the products prepared from stone fruits showed a non-significant effect of storage on TSS, total and reducing sugars. It can be seen that the type of the processing used in preparation of value added products had slightly influenced the final product biochemical composition.

Ascorbic Acid content: To analyse the effect of drying method on retention of ascorbic acid in apricots, traditionally dried apricots (sun dried) were compared to those dried in air drying dehydrator. Ascorbic acid retention in dried fruits is often influenced by factors like temperature, exposure to open air and light exposure, water activity, pH, cultivar and type of pre-treatment given. Exposure to light and air are considered as the factors promoting degradation of ascorbic acid[14]. This also explains in part the lower ascorbic content of sun-dried samples as compared to air dehydrator dried samples in this study as shown in Fig. 3, because of prolonged exposure to light and air. Similar observations on effect of method of drying on ascorbic acid content have been observed in previous study on apricots as well[8].

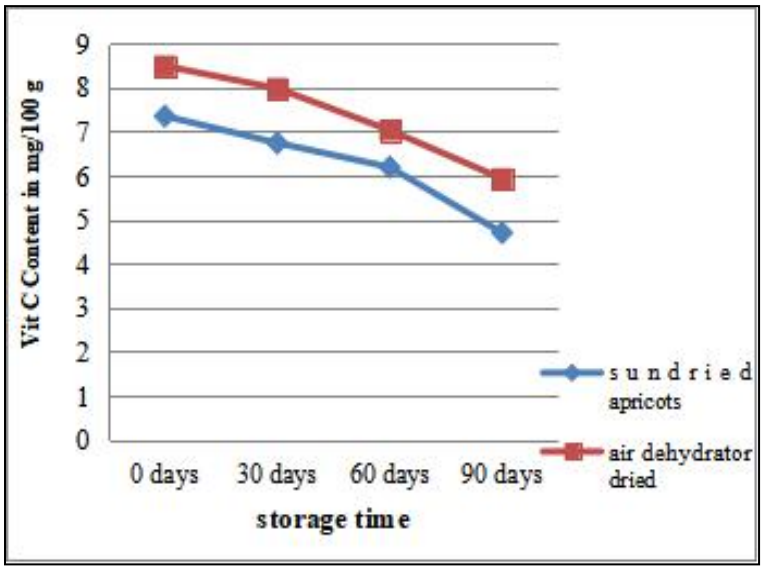


Fig. 3: Change in ascorbic acid content over storage of apricots

Sensory evaluation: All the value added products were organoleptically evaluated for three months on regular intervals to assess their acceptability score. The samples were evaluated for attributed like colour, taste, texture and overall acceptability score for a period of three months after one month interval. Table 4 reflects that the initial overall acceptability (OAA) score of plum jam was 7.83 which decreased significantly to 6.76 after three months of storage but the mean of the values shows non-significant difference over a period of time. A similar change in OAA on storage was also noted in other dehydrated products of stone fruits like, apricot jam, prunes and dried apricot. In previous studies on products prepared from stone fruits similar biochemical changes on storage have been noted[6]. The OAA scores are often carried out for shelf life studies and acceptance of products by consumers over a period of time. This reduction in OAA is due to enzymatic browning to some extent and changes in chemical composition of the product and loss of colour and flavour during storage period. The overall non-significant differences in organoleptic attributes depicts that the product may remain acceptable over some period of time, however it may show significant changes over extended period of storage. It may be noted that no other chemical preservative except a dip in a minimum concentration of citric acid solution has been added while preparing the products.

CONCLUSION

From the present study on preparation of value added products, it can be concluded that the fruits of apricot and plum are quite suitable for making of jams, dehydrated fruits (apricot and prunes) and pickle. Consequently, the developed intervention has a scope for commercial exploration at industry level for manufacturing shelf-stable products of these fruits for their efficient and profitable utilization thereby ensuring reduction in post-harvest losses and better returns to the growers. It further supports the use of processing methods a step towards nutritional security. The critical contribution of this

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research is the establishment of robust correlations between objective instrumental measurements and subjective sensory perceptions.

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