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Standardization of Method for the preparation of Preserve from Wild Aonla (*Phyllanthus emblica* L.) Fruits and its quality evaluation during storage

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Abstract
In present investigations method for preparation of wild aonla preserve was standardized. 5 different blanching pretreatment were given to fruits as T_1:blanching with plain water, T_2: blanching with sodium sulphite (0.5%), T_3: blanching with alum (2%), T_4: blanching with sodium sulphite and alum (0.5% and 2%) and T_5: blanching with plain water and dipping in lime water (3%) after dipping them in brine (4%) for 24 h. Further, blanched fruits were dipped in syrup (40 ˚B) for 24 h after adding citric acid (0.5%) and next day, syrup TSS raised by 5 ˚B, this process was repeated every alternate day till the TSS of syrup reaches to 70 ˚B. For stabilization of the TSS fruits were dipped in 70 ˚B syrup for 5 days. So, out of 5 pretreatments tried, T_3 was found best after preparation (15 days) on the basis of some physico-chemical and sensory characteristics. It could safely be stored for a period of 6 months under both storage conditions as well as both the packaging materials without much change in various quality characteristics.

Keywords: Wild aonla, preserve, storage, ascorbic acid, total phenols, packaging material

1. Introduction
Wild aonla (*Phyllanthus emblica* L.) is one of the unique fruit which has got great importance because of its high antioxidant and medicinal properties. Wild aonla (*Phyllanthus emblica* L.) or Indian gooseberry belongs to family Euphorbiaceae and is indigenous to tropical South East Asia, particularly in Central and Southern India (Parmar and Kaushal, 1982) [1] from where it spread to Sri Lanka, Malaysia and China (Bose *et al*., 2002) [2]. India ranks first in the world with respect to area and production of cultivated aonla (Priya and Khatkar, 2013) [3]. The estimated production of aonla in the country during the year 2014-15 was 1319 thousand tonnes from an area of 107 thousand whereas, in HP its production has been estimated as 2390 MT from an area of 2158 ha (Anonymous, 2015) [4]. It is widely distributed in Uttar Pradesh, Maharashtra, Gujarat, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, Haryana and Himachal Pradesh. Although the wild aonla is widely distributed in the forests of HP up to an elevation of 1450 m above mean sea level (Parmar and Kaushal, 1982) [1], but there are no records of its area and production. Aonla fruit is a rich source of ascorbic acid, phenols, sugars, pectin, starch and mineral like iron, calcium, phosphorous and magnesium (Nath *et al*., 1992)[5]. Being rich source of ascorbic acid, it contains about 20 times more vitamin C than the citrus fruits (Parmar and Kaushal, 1982) [1]. Its fruits are astringent, carminative, digestive, stomachic, diuretic and antipyretic and also useful in curing many diseases like diabetes, cough, asthma, bronchitis, headache, ophthalmic disorders, dyspepsia, colic, flatulence, skin diseases, leprosy, jaundice, scurvy, diarrhoea and greyness of hair (Ganachari *et al.*, 2010) [6]. It also contains leucoanthocyanins along with polyphenols which maintain the stability of ascorbic acid as well as astringency of the fruit (Radha and Mathew, 2007) [7]. Tannins (gallic acid and elagic acid) and glucose render its value as antiscorbutic in fresh as well as dried conditions (Pareek and Kaushik, 2012) [8]. Due to its high astringency and perishable nature after harvest aonla fruits are not popular as table fruit (Kumar and Nath, 1993) [9]. Being highly perishable nature of cultivated aonla, it has limited period of availability under north Indian conditions (Bhattacherjee *et al*., 2012) [10]. But scattered information is available in the

literature with respect to the development of value added products from wild aonla. So, in view of its availability in abundance and various health benefits there is need to make use of this wild fruit for the development of various value added products. Keeping in view the availability of this fruit in the forests of HP and importance with respect to its quality characteristics, the present studies were carried out with the following objectives to develop preserve from wild aonla fruits and its quality evaluation during storage. According to FSSAI, 2006 preserve means the product prepared from sound, whole, cut or grated fruits, rhizomes or vegetables, singly or in combination, by impregnating it with sweeteners to an adequate concentration to preserve it. According to FSSAI, 2006 preserve contains at least 55 per cent fruit part and 68 ºB TSS.

Materials and methods

Collection of fruit and standardization of recipe

The mature fruits of *Phyllanthus emblica* L. procured from Chandesh area of Mandi district of Himachal Pradesh in the year 2015-16 and used for various physico-chemical analysis. Aonla preserve was prepared by slow method for complete osmosis of syrup into the fruit. The fruits were selected, sorted and pricked manually followed by washing. After that fruits were dipped in 4 per cent brine for 24 h in ambient storage conditions and then washed to remove salt solution. These fruits were further blanched as per the different treatment combinations as T_1: blanching with plain water, T_2: blanching with sodium sulphite (0.5%), T_3: blanching with alum (2%), T_4: blanching with sodium sulphite (0.5%) + alum (2%) and T_5: blanching with plain water and dipping in lime water (3%)**.** Further, blanched fruits were dipped in syrup of 40 ˚B for 24 h after adding 0.5 per cent citric acid. Next day, syrup was boiled to raise the TSS by 5 ˚B after removal of fruits from syrup. Again, fruits were dipped in syrup of 45˚B for 24 h. Then the process was repeated for raising the TSS by 5 ˚B after every alternate day till the TSS of syrup reaches to 70 ˚B. Further, fruits were dipped in 70 ˚B syrup for 5 days for stabilization of the TSS. After that prepared product were filled in presterilised PET (polyethylene terephthalate) and glass jars of 500 ml capacity, kept for storage after proper capping. Preserve packed in different packaging materials were properly labelled and stored in ambient (20-25 ºC) and low temperature (4-7 ºC) conditions for six months. The physico-chemical and sensory characteristics of best selected recipe were estimated at zero, three and six months of storage.

Physico-chemical analysis

The colour of preserve was observed visually by comparing with the colour cards of Royal Horticulture Society, London and the card numbers were mentioned along with the colour. TSS (Fruits and syrup), sugars, titratable acidity and ascorbic acid of prepared product were determined according to Ranganna (2009) [11]. The pH of the samples was determined by using a digital pH meter (CRISON Instrument, Ltd, Spain). Total phenols content was determined by Folin-Ciocalteu procedure given by Singleton and Rossi (1965) [12].

Sensory evaluation

The sensory evaluations of samples were carried out by hedonic rating test (Amerine *et al*., 1965) [13]. The samples were evaluated for sensory qualities based on colour, texture, taste, aroma and overall acceptability. Sensory panel (10 numbers at a time) comprised of faculty members and postgraduate students of department of Food Science and Technology, UHF, Solan (HP) were selected randomly with the care to accommodate different sections and age groups to evaluate the sensory parameters.

Statistical analysis

Data on physico-chemical characteristics of preserve was analysed by using Completely Randomized Design (CRD) before and during product development and storage. Whereas, data pertaining to sensory evaluation of aonla preserve was analyzed by using Randomized Block Design (RBD) as described by Mahony (1985) [14]. Various experiments conducted during study period were replicated three times.

Results and Discussion

Standardization of pretreatments for the preparation of wild aonla preserve

The data pertaining to physico-chemical and sensory characteristics of wild aonla preserve prepared by following different recipes are presented in Table 1 and 2.

Physico-chemical characteristics

Data pertaining to physico-chemical characteristics of different pretreatments of wild aonla preserve presented in Table 1 indicate that the visual colour of all pretreatments were yellow green group 152 (B). The TSS of the syrup of the pretreatments were maintained constant (70 ºB) during the product preparation but varied TSS in fruits ranging from 49.02 to 59.05 ºB have observed after product preparation. The highest TSS (59.05 ºB) of preserve was recorded in T_3 and the lowest (49.02 ºB) in T_1. The highest total phenols content (10.75 mg/ g) of preserve was recorded in T_3 and the lowest (9.67 mg/ g) in T_5 which was statistically at par with T_2. The ascorbic acid content of preserve varied from 158.52 to 167.82 mg/100 g among the different pretreatments. The highest (167.82 mg/100 g) ascorbic acid content was recorded in T_5 and lowest (158.52 mg/100 g) in pretreatment T_2.

Table 1: Physico-chemical characteristics of different recipes of wild aonla preserve

Treatments	Physico-chemical characteristics					
	TSS (ºB)		Titratable acidity	pH	Ascorbic acid (mg/100 g)	Total phenols (mg/g)
	Syrup	Fruit				
T_1	70	49.02	0.62	4.35	160.57	10.11
T_2	70	55.00	0.58	4.39	158.52	9.89
T_3	70	59.05	0.62	4.35	160.64	10.75
T_4	70	58.50	0.55	4.42	149.39	9.12
T_5	70	57.07	0.51	4.49	167.82	9.67
$CD_{0.05}$	-	0.18	0.07	0.04	0.60	0.29

Data in Table 1 show that treatment T_3 contain higher amount of total phenols and ascorbic acid, it might be due to biochemical changes occur within the tissue of the fruit which prevent leaching of ascorbic acid and phenols. It also contains

higher TSS in fruit because of good penetration of sugar in to the fruit. Nearly similar results have been reported by Egerg *et al.*, (1977) [15].

Sensory Characteristics

Data of sensory characteristics of different pretreatments of wild aonla preserve given in Table 2 indicate that the colour score was obtained highest (8.18) in T_3 and lowest colour (6.30) was awarded to T_5. The maximum texture score as 8.22 was obtained in T_3 treatment which was statistically at par with T_5 and minimum (6.82) in T_1 closely followed by T_2. The highest score (8.30) of taste was awarded to T_3 treatment which was statistically at par with T_4 while T_5 got the lowest score as 5.50. The maximum (8.20) score of aroma was obtained in treatment T_3 which was statistically at par with T_4 and minimum (7.32) was awarded to treatment T_1 closely followed by T_5. The highest score (8.12) of overall acceptability was observed in T_3 and lowest (7.11) in T_5 which was statistically at par with T_2.

Table 2: Sensory characteristics (score) of different recipes of wild aonla preserve

Treatment	Colour	Texture	Taste	Aroma	Overall acceptability
T_1	7.41	6.82	7.78	7.32	7.45
T_2	8.05	7.20	7.90	7.88	7.10
T_3	8.18	8.22	8.30	8.20	8.12
T_4	7.12	7.92	8.22	8.13	7.25
T_5	6.30	8.10	5.50	7.49	7.11
$CD_{0.05}$	0.13	0.30	0.15	0.22	0.18

There was a significant effect (Table 2) of fruit-acid-sugar blend and penetration of sugar in fruit on the sensory scores of different pretreatment of preserve. The higher colour, texture, taste, aroma and overall acceptability scores in treatment T_3 might be due to the better combination of acid-sugar blend because of maximum penetration of sugar in the fruit and attractive aroma which ultimately led the judges to award the highest scores to this treatment as compared to others. Nearly similar results have been reported by Patel and Kushwaha (2014) [16] in aonla preserve. So, pretreatment T_3 (blanching with 2% alum) was best on the basis of its some physico-chemical characteristics like colour, TSS, acid, total phenols, ascorbic acid and higher scores obtained for sensory parameters like colour, texture, taste, aroma and overall acceptability. Values of sensory parameters as well as total phenols and ascorbic acid obtained in this recipe were high. All these factors might have led the judges to award highest scores to this recipe.

Storage of wild aonla preserve

Best selected recipe T_3 (Fig. 1) was further filled in presterilised PET and glass jars of 500 ml capacity, kept for storage in ambient (20-25 ºC) and low temperature (4-7 ºC) conditions for six months after proper capping and labelling. The physico-chemical and sensory characteristics of this recipe were estimated at zero, three and six months of storage.

Physico-chemical characteristics

Colour

The colour of wild aonla preserve changed slightly during six months of storage under refrigerated and ambient storage conditions. However, no change in colour shade has been observed in the product under refrigerated storage conditions (in both glass and PET jars) as initial colour of preserve was Yellow Green 152 A, after 3 months storage colour shade changes to Yellow Green 152 B and after 6 months storage colour shade changes to Yellow Green 152 C. However, slight change in colour shade has been observed in the product under ambient storage conditions (in both glass and PET jars) as initial colour of preserve was Yellow Green 152 A, after 3 months storage colour shade changes to Yellow Green 153 A and after 6 months storage colour shade changes to Yellow Green 154 A.

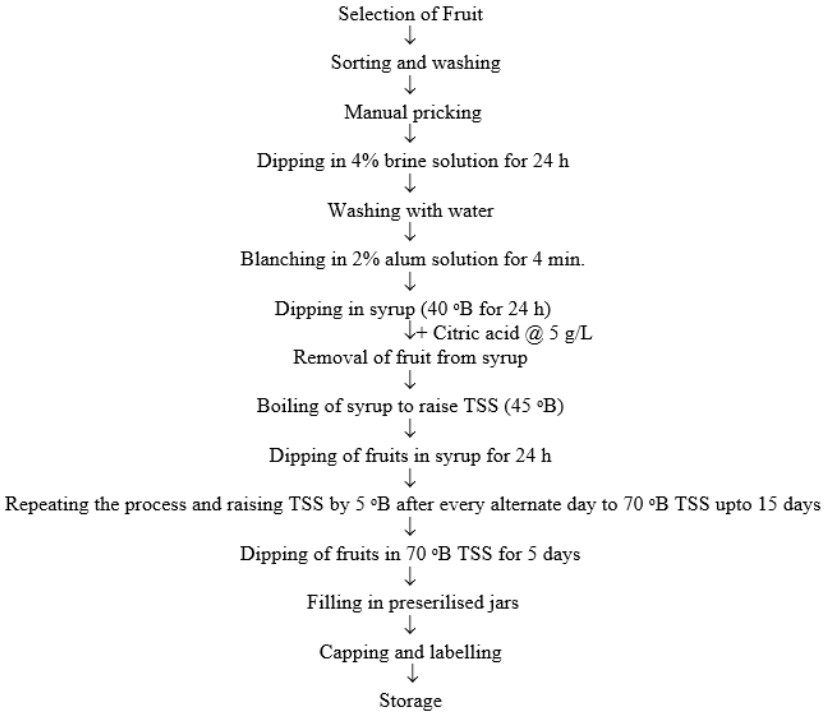

Fig 1: Unit operations for the preparation of wild aonla preserve

TSS

The TSS of preserve increased slightly during storage (Table 3) and this increase in TSS during storage might be due to hydrolysis of polysaccharides into monosaccharide and soluble disaccharides (Gould, 1983) [17]. Our results are in conformity with the findings of Tripathi *et al.* (1988) [18] and Durrani and Verma (2011) [19] in aonla preserve.

Table 3: Effect of different packaging on the TSS (ºB) of wild aonla preserve during storage

	V							
	Ambient storage (Months)			**Mean**	**Refrigerated storage (Months)**			**Mean**
S / T	**0**	**3**	**6**		**0**	**3**	**6**	
T_1	59.05	59.45	59.64	59.38	59.05	59.31	59.57	59.31
T_2	59.05	59.58	59.93	59.52	59.05	59.40	59.59	59.35
Mean	59.05	59.52	59.79		59.05	59.36	59.58	
Mean (V)	59.45				59.33			
					$CD_{0.05}$			
T	SxT Interaction Table						T= packaging material	
	0	3	6	Mean(T)	V= NS	V×S= NS	S= Storage period	
T_1	59.05	59.38	59.49	59.35	S= 0.16	V×T= NS	V= Storage conditions	
T_2	59.05	59.61	59.76	59.43	T= NS	S×T= NS	T_1= Glass jar	
Mean (S)	59.05	59.44	59.68			V×S×T= NS	T_2= PET jar	

Sugars

The sugars of preserve showed a significant increase during storage (Figure 2 to 3) which was comparatively more in ambient storage conditions than in refrigerated and this higher increase might be due to the faster rate of reactions because of high temperature in ambient conditions. This increase might be due to hydrolysis of starch into sugars inversion of non-reducing sugars as well as conversion of complex polysaccharides into simple sugars. As far as the packaging material is concerned, more increase in sugars recorded in preserve packed in PET jars as compared to glass jars might be due to faster rate of chemical reactions in the product packed in PET jars as a result of their thermal conductance properties. Similar increase in reducing sugars during storage has been reported by Durrani and Verma (2011) [19] and Patel and Kushwaha (2014) [16] in aonla preserve.

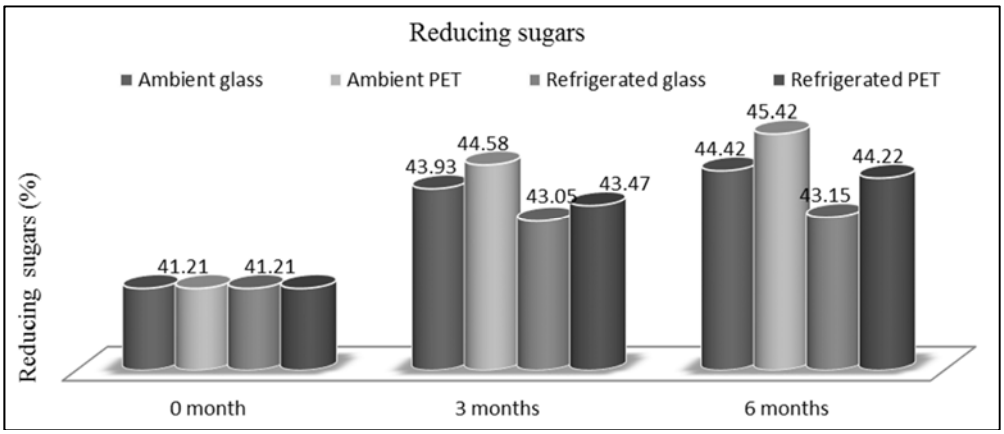

Fig 2: Effect of packaging and storage on reducing sugars (%) of wild aonla preserve

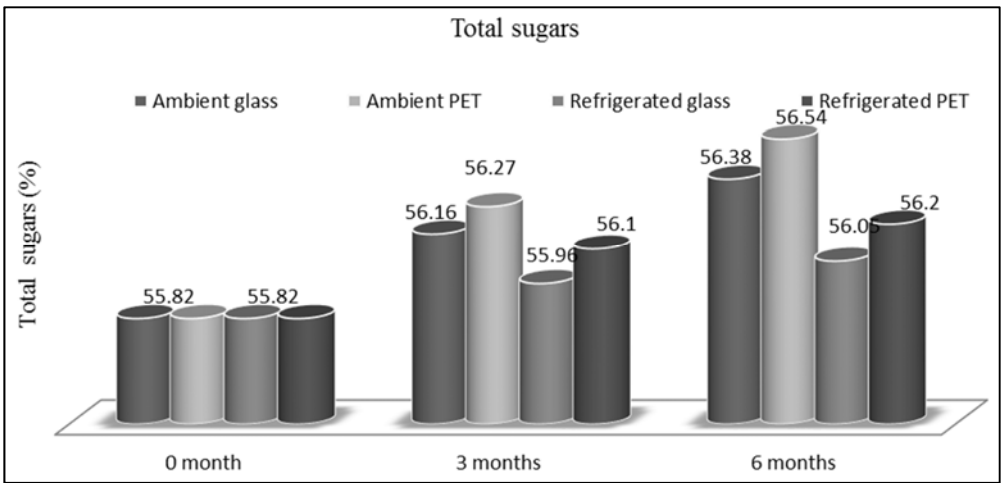

Fig 3: Effect of packaging and storage on total sugars (%) of wild aonla preserve

Titratable acidity and pH

The wild aonla preserve showed a slight decrease in titratable acidity during storage (Fig. 4). Decrease in titratable acidity during storage might be due to co-polymerization of organic acids with sugars and amino acids. Whereas, the pH of preserve showed a slight increase during storage might be due to the degradation of acid in the product during storage. However, the increase was lower in refrigerated storage conditions (increased from 4.35 to 4.43 and 4.47 in both glass and PET jars) than ambient conditions (increased from 4.35 to 4.40 and 4.41 in both glass and PET jars). Our results are in conformity with earlier findings of Durrani and Verma (2011) [19], (Priya and Khatkar, 2013) [3] and Patel and Kushwala (2014) [16] in aonla preserve and Devi (2014) [20] in wild pear preserve.

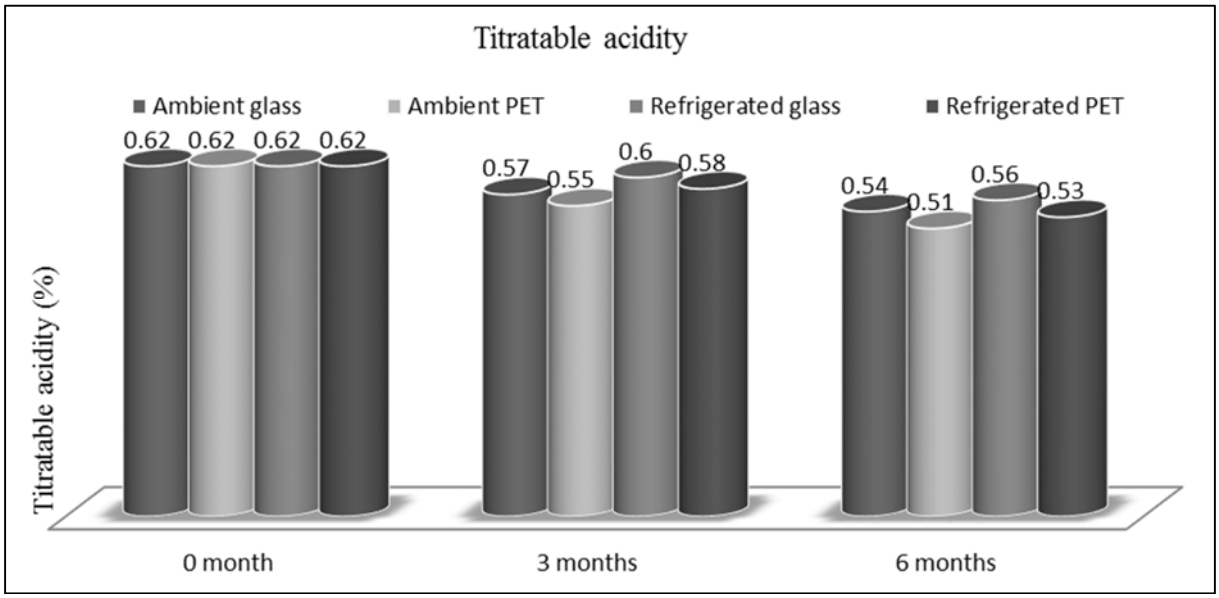

Fig 4: Effect of packaging and storage on titratable acidity (%) of wild aonla preserve

Ascorbic acid: Ascorbic acid content of preserve decreased significantly during storage (Table 4); however, the decrease was lower in refrigerated storage conditions than ambient conditions. Decrease in ascorbic acid content might be due to its degradation into dehydro-ascorbic acid or leaching out of ascorbic acid in preserve during storage. Less decrease of ascorbic acid in refrigerated storage might be due to the slower rate of its leaching as well as its degradation in low temperature as compared to ambient storage conditions because of its susceptibility to high temperature. Retention of higher ascorbic acid of preserve in glass jar may be due to the slower rate of reactions in glass jar as glass absorbs heat at slower rate as compared to PET jar during storage. The findings of the present studies are in agreement with the results reported by Durrani and Verma (2011) [19] and Patel and Kushwala (2014) [16] in aonla preserve and Devi (2014) [20] in wild pear preserve.

Table 4: Effect of packaging the ascorbic acid (mg/100g) of wild aonla preserve during storage

	V							
	Ambient storage (Months)			**Mean**	**Refrigerated storage (Months)**			**Mean**
S / T	**0**	**3**	**6**		**0**	**3**	**6**	
T_1	160.64	117.65	84.86	121.05	160.64	137.21	115.71	137.85
T_2	160.64	110.21	61.12	110.66	160.64	136.05	111.76	136.15
Mean	160.64	113.93	72.99		160.64	136.63	113.74	
Mean (V)	115.85				137.00			
					$CD_{0.05}$			
T	**SxT Interaction Table**						T= Packaging material	
	0	3	6	Mean(T)	V= 0.30	V×S= 0.53	S= Storage period	
T_1	160.64	127.43	100.28	129.45	S= 0.37	V×T= 0.43	V= Storage conditions	
T_2	160.64	123.13	86.44	123.40	T= 0.30	S×T= 0.53	T_1= Glass jar	
Mean (S)	160.64	125.28	93.36			V×S×T= 0.74	T_2= PET jar	

Total phenols: A significant decrease in total phenols of preserve was recorded during storage (Table 5) and this decrease was lower under refrigerated storage conditions than ambient. The decrease in total phenols in preserve during storage might be due to their involvement in the formation of polymeric compounds by complexing with protein and their subsequent precipitation. These reactions may be slower in refrigerated storage conditions and faster in ambient conditions during storage. As far as packaging material is concerned, more retention of phenols in preserve packed in glass jar than PET jar might be due to the difference in their thermal conductance properties which affected internal reactions. Similar trend of decrease in phenols content has been reported by Devi (2014) [20] in wild pear preserve.

Table 5: Effect of packaging on the total phenols (mg/g) of wild aonla preserve during storage

	V							
	Ambient storage (Months)			**Mean**	**Refrigerated storage (Months)**			**Mean**
S / T	**0**	**3**	**6**		**0**	**3**	**6**	
T_1	10.75	10.56	10.19	10.50	10.75	10.55	10.32	10.54
T_2	10.75	10.14	9.84	10.24	10.75	10.44	10.25	10.48
Mean	10.75	10.35	10.02		10.75	10.50	10.29	
Mean (V)	10.37				10.51			
					$CD_{0.05}$			
T	**SxT Interaction Table**						T= Packaging material	
	0	3	6	Mean(T)	V= 0.02	V×S= 0.04	S= Storage period	
T_1	10.75	10.56	10.29	10.52	S= 0.03	V×T= 0.03	V= Storage conditions	
T_2	10.75	10.26	10.05	10.36	T= 0.02	S×T= 0.04	T_1= Glass jar	
Mean (S)	10.75	10.42	10.15			V×S×T= 0.06	T_2= PET jar	

Sensory characteristics: Data regarding all sensory characteristics of wild aonla preserve have been presented in Figure 5 to 6. The colour scores of preserve decreased significantly during storage and this decrease was more pronounced under ambient storage conditions than refrigerated. Non-enzymatic browning of the product might have also contributed towards the loss of intensity of colour indirectly during retention of higher colour scores of preserve in refrigerated storage conditions might be due to slower rate of non-enzymatic browning of the product as compared to ambient storage conditions which led the judges to award higher scores to the product in this condition. The possible reason for decrease in texture scores might be due to the degradation of original texture/shape as a result of hydrolysis of pectin during storage, which led the judges to award lower scores. The decrease in taste scores of product during storage might be due to loss of sugar-acid blend responsible for taste. Retention of higher taste scores in refrigerated conditions might be due to the better retention of original sugar-acid blend as a result of slower reaction rate at low temperature. The loss of aroma scores during storage might be due to the possible loss of volatile aromatic compounds which led the judges to award the lower scores. Retention of higher scores of aroma in refrigerated conditions might be due to the minute losses of aromatic compounds at low temperature during storage as compared to ambient conditions. Preserve packed in glass jar retained more overall acceptability scores than PET jar. Decrease in overall acceptability scores might be due to cumulative loss in appearance, texture and flavour of the product during storage. Retention of higher overall acceptability scores in refrigerated conditions might be due to the better retention of appearance, texture and flavour of the product as a result of slower reactions rates at low temperature. However, the retention of better overall acceptability scores of preserve in glass jar might be due to the better retention of above given parameter as a result of slower reaction rate in glass jar as compared to PET jar as a result of variation in their thermal conductance properties. Similar findings have been reported by Devi (2014) in wild pear preserve and Patel and Kushwaha (2014) in aonla preserve.

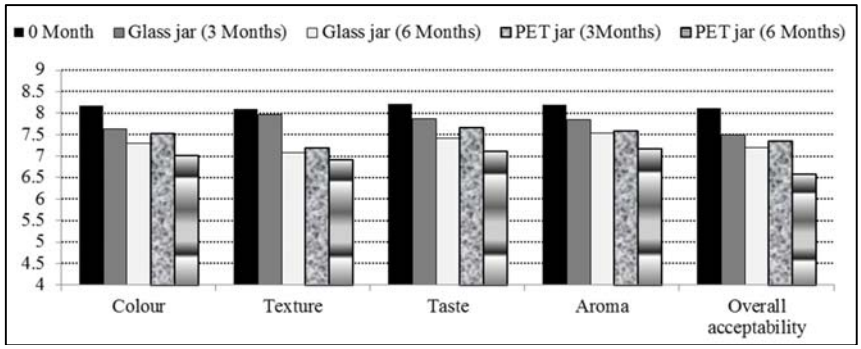

Fig 5: Effect of storage and packaging on sensory characteristics of wild aonla preserve stored under ambient conditions

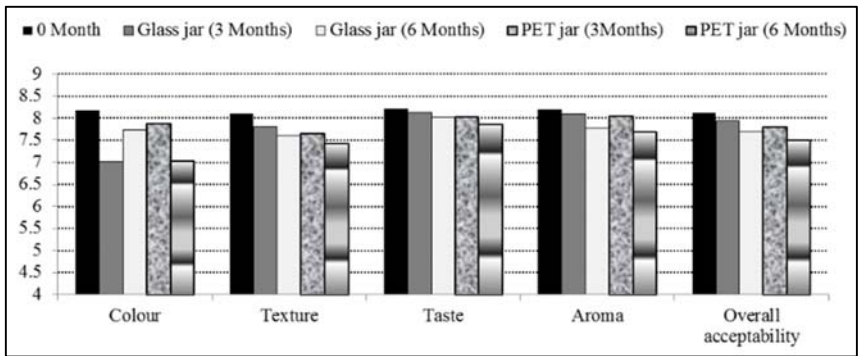

Fig 6: Effect of storage and packaging on sensory characteristics of wild aonla preserve stored under refrigerated conditions

Cost of production: Data in Table 6 clearly shows that the cost of production of 500 g preserve was Rs. 24.49 in glass jar, whereas, it was observed slightly higher as Rs. 29.49, in PET jar.

Table 6: Cost of production of wild aonla preserve (500 g)

Particulars	Quantity	Rate (Rs)	Amount (Rs)	
			T_1 (Glass jar)	T_2 (PET jar)
Fruit	300 g	20/kg	6	6
Sugar	140 g	40/kg	5.6	5.6
Common salt	12 g	20/kg	0.24	0.24
Alum	10 g	80/kg	0.8	0.8
Citric acid	1 g	530/kg	0.53	0.53
Processing Cost @ 10 %	-	-	1.32	1.32
Glass jar (500 g)	1	10/jar	10.00	-
PET jar (500 g)	1	15/jar	-	15.00
Total Cost (500 g Jar)	-	-	24.49	29.49

Conclusion

Five pretreatments of blanching of fruits were tried and it was concluded that the pretreatment T_3 (blanching with 2% alum) was best on the basis of its some physico-chemical characteristics such as TSS (59.05 ˚B of fruit), titratable acidity (0.62 %), ascorbic acid (160.64 mg/100 g), total phenols (10.75 mg/100 g) and sensory parameters like colour (8.18), texture (8.22), taste (8.30), aroma (8.20) and overall acceptability (8.12). Preserve can be prepared by blanching the fruits in 2 per cent alum followed by the standard method of making the product within 15 days. The preserve could be stored safely for a period of six months under both storage conditions and also in both packaging materials like PET and glass jars. However, comparatively minimum changes in preserve packed in glass jar and stored under refrigerated storage conditions were observed as compared to PET jar. By preparing this product underutilized wild aonla fruits can be exploited in the preparation of a variety of good quality and nutritionally enriched processed products at remunerative cost.

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