Research Article

Effect of Packaging and Storage Temperature on Storage Behaviour of Appetizer (Spiced Squash) Prepared from Wild Aonla (*Phyllanthus Emblica* L.) Fruits

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Abstract

Investigations were conducted to develop a commercial appetizer (spiced squash) and evaluate its quality during storage. Different combinations of juice and sugar syrup were tried to standardize a proper combination for appetizer. The spiced squash prepared by following the best selected recipe (35 % juice and 40 ^{o}B TSS) was packed in glass and PET bottles and stored for six months under ambient and refrigerated conditions. Appetizer could be safely stored for a period of six months under both the ambient and refrigerated conditions without much change in various quality characteristics. However, the changes in the quality characteristics of the appetizer were slower in refrigerated storage conditions as compared to ambient conditions. Both the packaging materials viz., PET and glass bottles were found suitable, with comparatively less changes occurring in glass bottles under refrigerated conditions than others.

Keywords: Wild aonla, appetizer, spiced squash, packaging material, storage

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Introduction

Wild aonla (*Phyllanthus emblica* L.) belongs to Euphorbiaceae family and also known as Indian gooseberry. It is indigenous to tropical South East Asia, particularly in Central and Southern India from where it spread to Sri Lanka, Malaysia and China [1, 2]. In India, it is widely distributed in Uttar Pradesh, Maharashtra, Gujarat, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, Haryana and Himachal Pradesh. Aonla is a rich source of ascorbic acid, phenols, sugars, pectin, starch and minerals like iron, calcium, phosphorous and magnesium [3]. It is one of the richest sources of vitamin-C after barbados cherry. Aonla has been reported to be hepatoprotective and possesses expectorant, purgative, spasmolytic, antibacterial, hypoglycemic and hypolipidemic activities [4]. Its fruits are astringent, carminative, digestive, stomachic, altrant, aphordisac, diuretic, antipyretic and trichogenous 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 [5]. Aonla is not consumed as fresh in its raw state due to its highly acidic and astringent taste. The cultivated aonla fruits have been used to prepare various processed products like ready-to-serve (RTS) beverage, murraba, candy, pickles, jam, pickles, squash, toffees, fruit bar, powder, etc. [6]. 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 the present studies were under taken to develop appetizer from this fruit and study its storage life.

Materials and methods

Procurement of raw material and extraction of juice

The mature fruits of *Phyllanthus emblica* L. procured from Chandesh area of Mandi district of Himachal Pradesh and used for juice extraction and preparation of appetizer. The juice from the wild aonla fruits was extracted by using hydraulic press machine.

Development of appetizer (spiced squash)

Aonla appetizer (spiced squash) was prepared by mixing its juice with sugar syrup in different concentrations as given in **Table 1**. A constant amount of spice extract (100 ml/litre appetizer) was also added to all the combinations. Spice extract was prepared by boiling a ground mixture of pre-determined quantities of spices as per the standard method

like cardamom (1 g), cumin (2.5 g), black pepper (2.5 g), common salt (5 g) in 200 ml of water, then straining and mixing the extract with mint extract (10 ml) and ginger juice (15 ml). To get the desirable concentration of acid (1.20 %) in appetizer, citric acid was added in different treatment combinations. SO_2 (350 ppm) was added at the end of product preparation of appetizer in all the combinations.

Table 1 Treatment combinations of wild aonla appetizer

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Juice (%)	25	30	35	40	25	30	35	40
TSS (^{o}B)	40	40	40	40	45	45	45	45

Packaging and storage

The appetizer prepared by following the best selected recipe was packed in pre-sterilised glass and PET bottles (700 ml capacity). All the packed products were properly labelled and stored in ambient (20-25 ^{o}C) and low temperature (4-7 ^{o}C) conditions for six months. The physico-chemical and sensory characteristics of all the products were estimated at zero, three and six months of storage.

Physico-chemical analysis and sensory evaluation

The colour of appetizer in terms of Red (R) and Yellow (Y) was observed with Tintometer (Lovibond Tintometer Model-E). The apparent viscosity of the appetizer was determined by using Ostwald viscometer and was expressed in time (flow rate in seconds) taken for samples to pass through the tube. TSS, sugars, titratable acidity and ascorbic acid content of samples were determined according to Ranganna [7]. Total phenol content was determined by Folin-Ciocalteu procedure given by Singleton and Rossi [8].

Sensory evaluation

The sensory evaluation of samples was carried out by hedonic rating test [9]. The samples were evaluated for sensory qualities based on colour, body, 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 appetizer were analysed by completely randomized design (CRD) before and during storage, whereas, data pertaining to the sensory evaluation were analyzed by using randomized block design (RBD). The experiments on recipe standardization and for storage studies were replicated three times.

Results and Discussion

Standardization of recipe for the development of wild aonla appetizer

Data pertaining to physico-chemical and sensory characteristics of wild aonla appetizer prepared by following different recipes are presented in **Tables 2-3**.

Physico-chemical characteristics

Data in Table 2 highlight that visual red and yellow TCU (Tintometer colour units) of different recipes ranged between 0.78 to 1.05 and 5.22 to 6.74, respectively. The maximum (1.05) red TCU were recorded in T_1 which were statistically at par with T_2, T_5 and the lowest (0.78) red TCU were recorded in recipe T_8 which were statistically at par with T_4 and T_7. The highest (6.74) yellow TCU were recorded in T_4 which were statistically at par with T_8 and lowest (5.22) in recipe T_5.

TSS of first four recipes was maintained 40 ^{o}B and rest were kept at 45 ^{o}B, during the preparation of the product. The total phenols content of different recipes of this beverage varied from 4.01 to 6.45 mg/ g. The highest (6.45 mg/ g) value was recorded in T_4 which was statistically at par with T_8 and lowest (4.01 mg/ g) in T_5 which was statistically at par with T_1, T_2 and T_6. The ascorbic acid content of wild aonla appetizer ranged between 149.20 to 222.76 mg/100

g. The highest ascorbic acid content (222.76 mg/100 g) was recorded in recipe T_4 which was statistically at par with T_8 and the lowest (149.20 mg/100 g) in T_5 which was statistically at par with T_1.

Data presented in Table 2 show that recipes T_4 and T_8, contain higher content of total phenols and ascorbic acid which might be due to higher content of juice used as compared to other recipes. Variation in juice content of different recipes might have contributed towards the variation in the red and yellow TCU of this product.

Table 2 Physico-chemical characteristics of different recipes of wild aonla appetizer

Treatments	Physico-chemical characteristics				
	Colour (TCU)		TSS	Total phenols	Ascorbic acid
	R	Y	(°B)	(mg/ g)	(mg/100 g)
T_1	1.05	5.35	40.00	4.02	150.10
T_2	0.97	5.92	40.00	4.67	174.87
T_3	0.89	6.49	40.00	5.58	198.93
T_4	0.81	6.74	40.00	6.45	222.76
T_5	1.02	5.22	45.00	4.01	149.20
T_6	0.94	5.87	45.00	4.65	172.67
T_7	0.85	6.40	45.00	5.57	194.89
T_8	0.78	6.69	45.00	6.43	221.61
$CD_{0.05}$	0.09	0.07	-	0.71	1.89

Table 3 Sensory characteristics scores of different recipes of wild aonla appetizer

Treatment	Colour	Body	Taste	Aroma	Overall acceptability
T_1	7.18	7.60	7.60	6.00	7.63
T_2	7.44	7.56	7.90	7.83	7.95
T_3	8.12	8.00	8.29	8.54	8.12
T_4	7.82	7.91	7.01	8.62	7.05
T_5	7.29	6.40	5.96	6.58	6.69
T_6	7.57	6.80	6.46	6.82	6.94
T_7	7.43	6.72	5.80	7.35	7.15
T_8	7.81	6.50	5.50	8.02	7.92
$CD_{0.05}$	0.57	0.63	0.70	0.61	0.49

Sensory Characteristics

Data on sensory characteristics of different recipes of wild aonla appetizer given in Table 3 indicate that the mean colour score was obtained highest (8.12) in recipe T_3 which was statistically at par with T_4, T_6 and T_8, while lowest (7.18) score were awarded to recipe T_1 which was statistically at par with T_2, T_5, T_6 and T_3.

The maximum body score of 8.00 was obtained in same recipe which was statistically at par with T_1, T_2 and T_4, and minimum (6.40) in T_5 which was statistically at par with T_6, T_7 and T_8. The highest score (8.29) of taste was awarded to T_3 which was statistically at par with T_1 and T_2, while T_8 got the lowest score of 5.50 which was statistically at par with T_5 and T_7. The maximum (8.62) score for aroma was recorded in the T_4 recipe which was statistically at par with T_3, and minimum score of 6.00 was recorded in T_1 which was statistically at par with T_5.The highest score (8.12) of overall acceptability was obtained in T_3 which was statistically at par with T_2, and T_8, and lowest (6.69) in T_5 which was statistically at par with T_4, T_6 and T_7. The higher colour, body, taste, and aroma scores obtained in recipes T_3 might be due to higher juice content and better combination of juice-acid-spices blend which ultimately led the judges to award the highest scores to this recipe as compared to others. Nearly similar results have been reported by Thakur *et al*. [10] in box myrtle appetizer.

From the above results it was concluded that the recipe with 35 per cent juice and 40 °B TSS (T_3) and 1.2 per cent acidity was found best on the basis of sensory and some physico-chemical characteristics of appetizer.

Storage of wild aonla appetizer

Data regarding to the effect of packaging on various physico-chemical and sensory characteristics of wild aonla appetizer during storage have been presented in **Figure 1-3**.

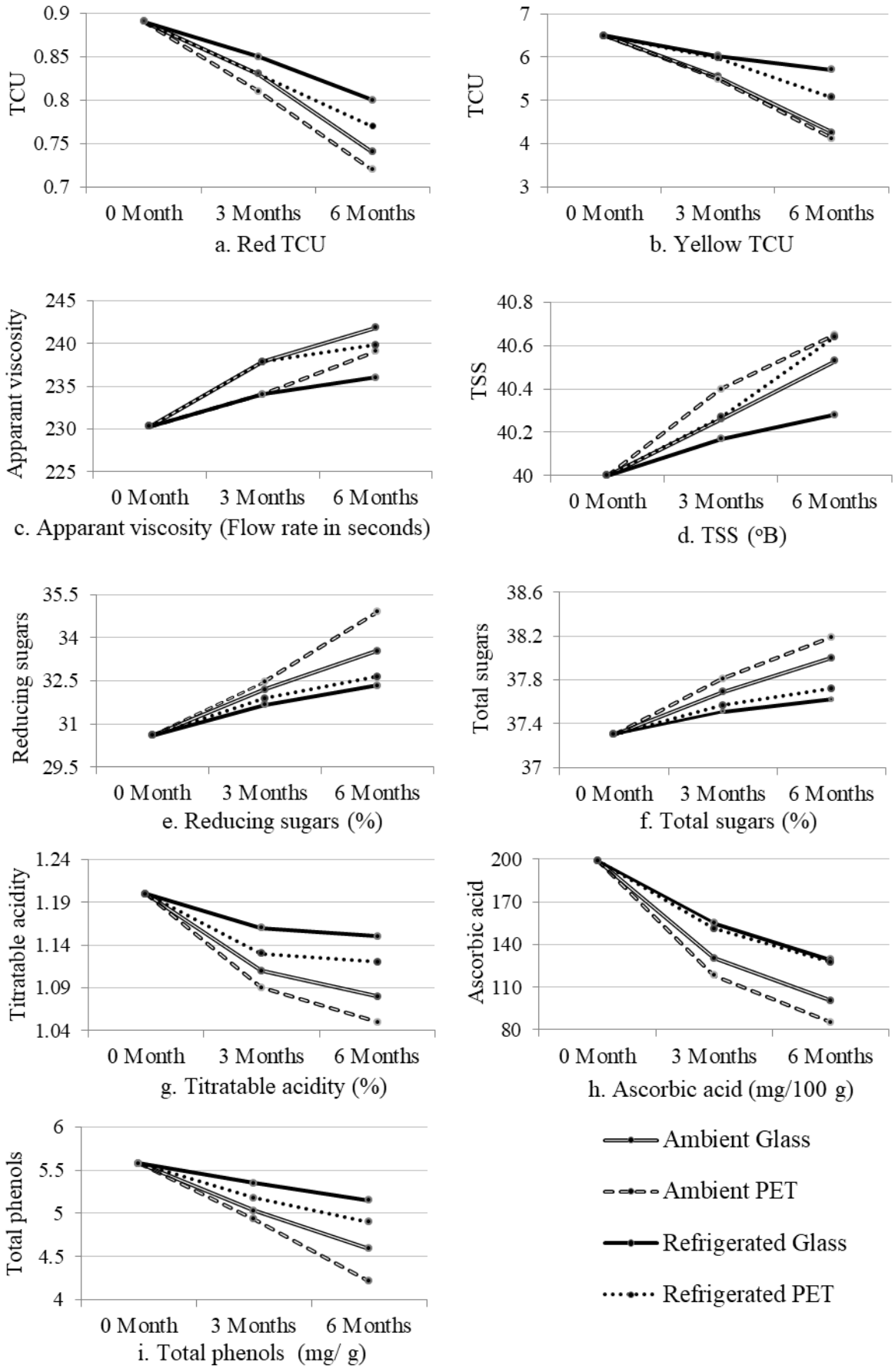

Figure 1 Effect of storage on physico-chemical characteristics of wild aonla appetizer

Physico-chemical characteristics

There was a gradual decrease in red and yellow TCU of wild aonla appetizer during storage (Figure 1a and 1b). The reason for decrease in colour units of appetizer during storage might be due to browning caused by copolymerization of organic acids of the product. Similar trend of decrease in red and yellow TCU has been reported by Thakur *et al.* [10] in box myrtle appetizer, Hamid and Thakur [11] in mulberry appetizer and Thakur *et al.* [12] in wild pomegranate appetizer.

Apparent viscosity of wild aonla appetizer increased significantly during the storage period (Figure 1c). Increase in apparent viscosity may be due to increase in TSS and soluble sugars which increased strain and shearing rate and decreased the flow index of the product. As the flow index decreases, it helped to develop pseudo plasticity and increased the apparent viscosity of the product [13]. Similar results have been reported by Thakur *et al.* [14] in box myrtle drink, Thakur and Thakur [15] in box myrtle squash and Thakur *et al.* [12] in wild pomegranate appetizer.

The TSS content of appetizer increased slightly during storage (Figure 1d) and this increase in TSS during storage might be due to hydrolysis of polysaccharides into monosaccharide and soluble disaccharides. Reducing and total sugars (Figure 1e and 1f) of appetizer showed a slightly increase during storage which might be because of the hydrolysis of starch into soluble sugars. The titratable acidity of wild aonla appetizer showed slight decrease during storage (Figure 1g) which was higher under ambient storage conditions than refrigerated conditions. Decrease in titratable acidity of appetizer could be attributed to the chemical interactions of organic acids of appetizer with sugars and amino acids. There was a continuous decrease in ascorbic acid content of appetizer with advancement of storage period (Figure 1h). Decrease in ascorbic acid content during storage might be due to its degradation into dehydro-ascorbic acid or furfural. However, decrease was significantly lower under refrigerated conditions as compared to ambient conditions. Ascorbic acid is highly sensitive to heat; therefore its degradation was more in ambient conditions.

A gradual decrease in total phenols content of appetizer was observed during storage (Figure 1i) which was slower under refrigerated storage conditions than ambient conditions. Significant decrease in total phenols content during storage might be due to their involvement in the formation of polymeric compounds by complexing of phenols with protein and their subsequent precipitations. Similar observations have also been reported by Lal *et al.* [16] in apple appetizer, Barwal and Sharma [17] in plum appetizer and Selvamuthukumaran and Khanum [18] in seabuckthorn appetizer.

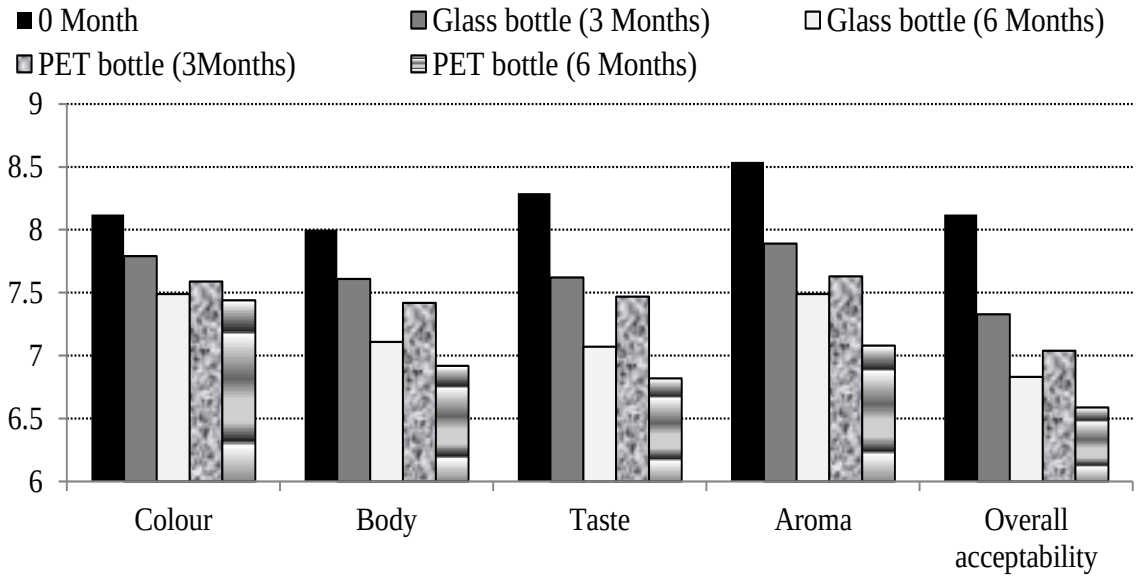

Figure 2 Effect of storage conditions on sensory characteristics of wild aonla appetizer under ambient temperature conditions

Sensory characteristics

The colour, body, taste, aroma and overall acceptability scores of appetizer decreased significantly (Figure 2 and 3) during storage and this decrease was more pronounced under ambient than refrigerated storage conditions. Retention of higher sensory scores in refrigerated conditions might be due to the better condition of the appetizer during storage as a result of slower rate of chemical reactions. Decrease in colour scores during storage might be due to browning

caused by copolymerization of organic acids of the product and this might have led the judges to award the lower scores during storage. The possible reason for decrease in body scores might be due to the formation of precipitates in the product as a result of interactions between phenols and protein as well as the formation of cation complexes with pectin and phenols. The possible reason for decrease in taste scores might be due to the loss of sugar-acid-salt blend responsible for taste during storage. The loss of aroma scores during storage might be due to the possible loss of volatile aromatic compounds. Decrease in overall acceptability scores might be due to the loss in appearance, flavour compounds and uniformity of the product during storage. The retention of better sensory scores of appetizer packed in glass bottles might be due to the better retention of above given factors as a result of slower reaction rate in glass bottles as compared to PET. The results were in conformity with the findings of Selvamuthukumaran and Khanum [18] in seabuckthorn appetizer, Shalini *et al.* [19] in aonla squash and Sharma and Tandon [20] in bitter gourd spiced squash.

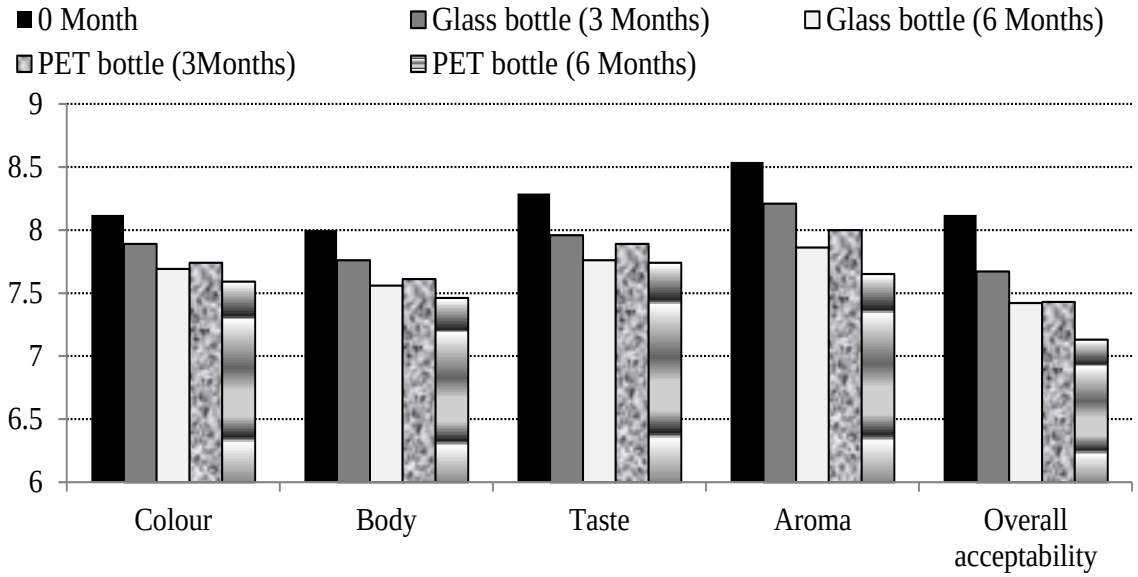

Figure 3 Effect of storage conditions on sensory characteristics of wild aonla appetizer under refrigerated temperature conditions

Conclusion

Wild aonla appetizer was developed by mixing 35 per cent juice, 40 ^{o}B TSS and with a spice extract of cardamom (1 g), cumin (2.5 g) black pepper (2.5 g), common salt (5 g), mint juice (10 ml) and ginger juice (15 ml) on the basis of some of its physico-chemical and sensory characteristics. The appetizer could be stored safely for a period of six months under both storage conditions and also in both packaging materials like PET and glass bottles. However, best quality of this beverage could be maintained in glass bottle stored under refrigerated storage conditions as compared to PET bottle.

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