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Quality evaluation of liquid jaggery based beverage (Squash) blended with aonla and beetroot juice during storage

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Abstract
The liquid jaggery based squash beverage was prepared by using aonla juice (15%), beetroot juice (10%), tamarind juice (5%), lemon juice (5%) and ginger juice (2%). The prepared squash was filled in poly ethylene terephthalate bottles and stored at room (R_1) and refrigeration (R_2) temperature. Stored squash beverage was subjected to physicochemical analysis to determine the effect of storage on different properties such as pH, TSS, acidity, total sugar, reducing sugar, non-reducing sugar, ascorbic acid and betalain. It was observed that pH, TSS, total sugar, reducing sugar showed increasing trend while acidity, non-reducing sugar, ascorbic acid and betalain showed decreasing trend. The results of sensory evaluation revealed that squash beverage was stored for 30 days and 90 days at room temperature and refrigeration temperature respectively without affecting its sensorial quality attributes like color, appearance, flavour, taste.

Keywords: Squash, storage study, physico-chemical analysis, sensory attributes

Introduction
Aonla (*Emblica officinalis*) is native of India and Southeast Asia which is generally called as 'Indian gooseberry'. Aonla fruits are yellowish green in colour and become greenish- yellow on ripening, having six vague perpendicular furrows enclosing seeds. Internationally Indonesia, Philippines, India, Brazil are major producers of amla. India is one of the largest producers of aonla in terms of area as well as production. Commonly cultivated varieties of aonla in India are Kanchan, NA 5, NA 6, Chakaiya and Francis. Indian gooseberry is the richest source of ascorbic acid containing 600 mg per 100 g of fruit. Major phytochemical present in aonla are alkaloid, benzoid, diterpene, sterol, flavonoid and furanolactone, tannins etc. Aonla possess antioxidant activity due to presence of two hydrolysable tannins such as emblicanin A and emblicanin B (Dasaroju and Gottumukkala, 2014) [4].
Aonla fruit is used in treatment of hemorrhage, dysentary, diarrhea, gastric disorder, constipation, headache, jaundice. Consumption of aonla juice mixed with fresh bitter guard juice help to regulate blood sugar in case of diabetics. Aonla possess anti-cancer properties due to presence of Emblicanin A & B. The major pathways that are responsible for anti-carcinogenic activity of amla is blocking the expression of mutagens, inhibition of apoptosis, immune protective, reducing ROS (Naseer *et al*. 2021) [10].
The Beetroot (*Beta vulgaris*) is an herbaceous taproot portion of beet plant belong to the *Chenopodiaceae* family. Beetroot is alkaline in nature and having pH of 7.5-8.0. There are different varieties of beetroot such as Crimson Globe, Crosby Egyptian, Detroit dark red etc. of which crimson globe is commonly grown in India. Some cultivated varieties of beet include the sugar beet which is used for sugar production, leaf vegetable chard and mangelwurzel which is fodder crop.
Beetroot can be eaten raw, used for juice extraction, baked, delicious red beets are roasted, pickled, eaten in salad, or converted to soup which is very famous in central and eastern European countries. The red colour of beetroot is due to presence of pigment betacyanin of which betanine account for 75-95% minor amount of betaxanthine and degradation product of betalain may contribute to colouring.
Beetroot ranks among the top ten most potent vegetables with respect to antioxidant property. It makes an excellent dietary supplement being not only rich in minerals, nutrients and vitamins but also possess unique phytonutrients which have medicinal properties.

Beetroot shows various medicinal functions such as antioxidant, antidepressant, anti-microbial, anti-fungal, anti-inflammatory, diuretic, cancer preventive, carminative (Neha *et al*. 2018) [12]. As being natural food consumption of beetroot boost energy in athletes due to presence of nitrate and sugar.

As Indian people are most sweet lover's sucrose is commonly used as sweetening agent in manufacturing confectionary, juices. By considering changes in consumer dietary needs, adverse effect of sucrose and to meet requirements and demand for sugar free products, alternative sweeteners such as jaggery can used for new product development

Jaggery is a natural sweetener made by concentration of sugarcane juice, it contains natural goodness of minerals and vitamins inherently present in sugarcane juice and this crowns it as one of the most wholesome and healthy sugars in the world. The composition of liquid jaggery per 100 g is: water 30-35 gm, invert sugar 15-25 gm, sucrose 40-60 gm, fat 0.1 gm, protein 0.5 gm, and total mineral 0.75 gm. calorific value of liquid jaggery is 300 Kcal/100 gm.

Jaggery may be value added with different natural flavours (ginger, black pepper, cardamom etc.), nutrition (protein, vitamins and phytochemicals), texture (additives) and taste (additives like nuts, spices, cereal and pulses). Moreover, different value-added products are prepared traditionally using jaggery instead of sugar such as rosagolla, Peda, curd, laddu but there is no specific literature or process technology available for commercial exploitation (Nath *et al*. 2015) [11].

Keeping in view of nutritional profile of aonla, beetroot and liquid jaggery the present study was undertaken in order to develop and evaluate liquid jaggery based squash beverage blended with aonla and beetroot juice during storage.

Materials and Methods

The good quality sound fruits are selected for juice extraction, they are processed to extract juice. The aonla and beetroot juice were blended with each other in different ratios for developing squash beverage i.e., T_0: 25:0, T_1: 20:5, T_2: 15:10, T_3: 10:15, T_4: 5:20. The quantity of other minor juices such as lemon, ginger, tamarind was kept constant in every treatment. The desired quantity of liquid jaggery was mixed with water. Such solution is added in 25% blend of juices by maintaining TSS and acidity of squash beverage as per standards given by FSSAI. Then the juice blend containing liquid jaggery was heated at 80 °C for 5 minutes and allowed to cool. The required amount of sodium benzoate was added in squash beverage and mixed well. The prepared squash was poured in a sterilized bottle (capacity 250ml) leaving headspace 2cm and capped airtight. The squash beverage was stored at ambient and refrigeration temperature to study the storage behavior with respect to the changes in physicochemical qualities. The product was evaluated immediately after preparation and then at an interval of 30 days up to 90 days of storage. Reducing sugar, total sugar, non-reducing sugar, titratable acidity, ascorbic acid was determined as per the method suggested by Ranganna (1986) [15]. The samples were evaluated by semi trained panelist for judging organoleptic characteristics using 9-point headonic scale.

Result and Discussion

Changes in pH, Acidity, TSS and Ascorbic acid content of liquid jaggery based beverage on storage

The acidity of beverage witnessed a decreasing trend during storage period. This might be due to hydrolysis of polysaccharide and non-reducing sugars where acid is utilized for converting them to hexose sugars (reducing sugar) or complexing in the presence of metal ions. The declining trend might also be due to chemical interaction between the chemical constituents of juice induced by temperature influencing enzymatic action (Palaniswamy and Muthukrishnan, 1974) [13]. Degree of reduction in acidity of beverage was dependent on concentration of sugar as reported by Bhatia *et al*. (1956) [2]. Reduction in acidity during storage was noticed by Awan *et al*. (1980) [1] in lemon squash and Jasim Ahmed, (1996) [8] in watermelon squash.

The pH of beverage indicated an increasing trend during 90 days of storage period as mentioned in Table 4.13. As storage proceed (from 0 day to 90 days) the titratable acidity of beverage decreases from 1.10 percent to 0.98 percent stored at room temperature and 1.10 percent to 1.01 percent stored at refrigeration temperature. A decrease in acidity was due to the chemical reaction taking place between organic acids and pigments and that also could be responsible for change in pH. Similar observation was recorded by Gajanana (2002) [17] in amla juice and Thakur and Barwal (1998) [18] in squash from kiwi fruit.

From Table 1 it is evident that total soluble solids of stored beverage were slightly increased 45-degree brix (zero day) to 47.20-degree brix (90 days) stored at room temperature and 45-degree brix (zero days) to 46.49-degree brix (90 days) stored at refrigeration temperature. This might be due to increase in soluble solid content and total soluble sugars caused by hydrolysis of polysaccharides like starch, cellulose, and pectin substances into simpler substances. Similar results were observed in squash prepared from lemon, jack, bael, and orange (Bhatia *et al*. 1956 and Jain *et al*. 1984) [2].

Ascorbic acid content of beverage reduced considerably during storage period. With the advancement of storage period from 0 to 90 days, content of ascorbic acid in beverage was decreased from 50.95 mg per 100ml to 48.67 mg per 100ml stored at room temperature and 50.95 mg per 100ml to 49.38 mg per 100ml stored at refrigerated temperature. The decline in ascorbic acid concentration could be due oxidation when exposed to air, process of oxidation accelerated in presence of light and high temperature as a result on storage for 90 days the ascorbic acid in beverage reacts with oxygen leading to degradation and decrease in vitamin C content. Hence at refrigeration temperature the decline in ascorbic acid content of beverage was less as compare to beverage stored at ambient temperature. (Brock *et al*., 1998) [3]. Similar trends of declining in the ascorbic acid content of stored product was noticed by Roy and Singh (1979) [16] in bael fruit squash.

Changes in total sugar, reducing sugar, ascorbic acid and betalain content of liquid jaggery based beverage on storage

From the Table 2 it could be seen that the gradual increase in total sugar content of beverage was observed i.e., from 34.06 percent to 34.40 percent in case of beverage stored at room temperature, while in case of refrigerated storage condition total sugar content of beverage increased from 34.06 percent to 34.29 percent. The total sugar of beverage stored at room temperature increases more than that stored at refrigeration temperature. This may be due to more activity of microorganism such as bacteria and yeast at higher temperature leads to the hydrolysis of polysaccharides during

storage resulted in increase of soluble sugars. The total sugars of squash were dependent on the total soluble solids as anticipated.

It was observed that, in case of beverage stored at room temperature, the reducing sugar content increased from 9.0 percent (0 days) to 28.86 percent (90 days) and when beverage stored at refrigeration temperature, reducing sugar content increases from 9.0 percent (0 days) to 27.77 percent (90 days). While the non-reducing sugar content of beverage with the advancement of storage period were gradually decreases from 25.06 percent to 5.54 percent at room storage and 25.06 percent to percent to 6.5 percent at refrigerated storage. This could be due to inversion of non-reducing sugars to reducing sugars caused by acids present in beverage. Enzyme (invertase) could also contribute to this inversion to a little extend. Increase in reducing and total sugar and decrease in non-reducing sugar during storage was a general phenomenon as noticed by Roy and Singh (1979) [16] in bael squash and Awan *et al*. (1980) [1] in orange, lemon and bael fruit squash.

At 0 days betalain content in beverage was 40.60 mg per100 ml. After 90 days of ambient storage, it was reduced to 38.12 mg per 100 ml, whereas in refrigeration storage betalain content were reduced to 39.20 mg per 100 ml after 90 days. It can be concluded that, the betalain content was best retained in sample stored at refrigeration temperature as compared to ambient temperature till 90 days, due to accelerated degradation of betalain by enzymes as well as oxidation which occur more rapidly at ambient temperature while refrigeration slows down these degradation processes providing more stable environment for maintaining the nutritional quality of beverage. The findings of storage studies are in close agreement with the results of earlier investigations reported by Hamid *et al*. (2017) [6].

Table 1: Effects of storage on acidity, pH, TSS, and ascorbic acid content of liquid jaggery based beverage at ambient storage (27 °C) and refrigerated storage (4 °C)

Storage period	Acidity (%) storage condition		pH storage condition		TSS (◦Brix) storage condition		Ascorbic acid (mg/100 ml) storage condition	
	R_1	R_2	R_1	R_2	R_1	R_2	R_1	R_2
0	1.10	1.10	2.37	2.37	45	45	50.95	50.95
30	1.06	1.08	2.45	2.41	45.55	45.27	50.40	50.6
60	1.03	1.05	2.52	2.46	46.30	45.78	49.58	50.09
90	0.98	1.01	2.60	2.53	47.20	46.49	48.67	49.38

R_1- Ambient storage (27 °C), R_2- Refrigerated storage (4 °C)

Table 2: Effects of storage on total sugar, reducing sugar, non-reducing sugar, and betalain content of liquid jaggery based beverage at ambient storage (27 °C) and refrigerated storage (4 °C)

Storage period	Total sugar (%) storage condition		Reducing sugar (%) storage condition		Non-reducing sugar (%) storage condition		Betalain (mg/100 ml) storage condition	
	R_1	R_2	R_1	R_2	R_1	R_2	R_1	R_2
0	34.06	34.06	9.0	9.0	25.06	25.06	40.60	40.60
30	34.14	34.10	18.55	16.17	15.59	17.93	39.92	40.21
60	34.26	34.18	25.19	22.68	9.07	11.5	38.72	39.61
90	34.40	34.29	28.86	27.77	5.54	6.52	38.12	39.20

R_1- Ambient storage (27 °C) R_2- Refrigerated storage (4 °C)

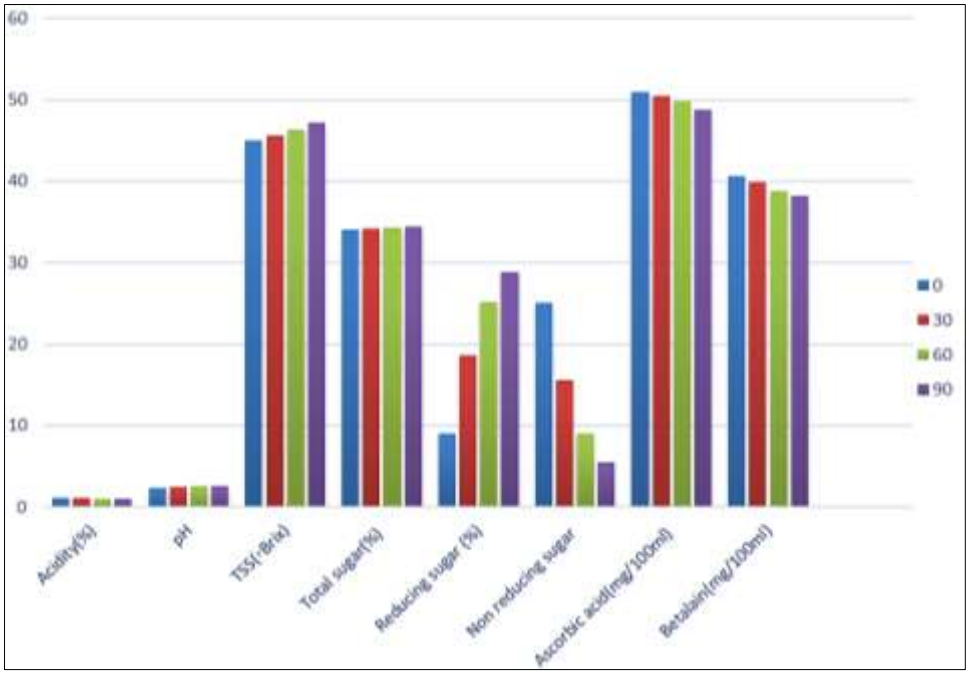

Fig 1: Effect of storage on physicochemical properties of beverage stored at ambient temperature (27 °C)

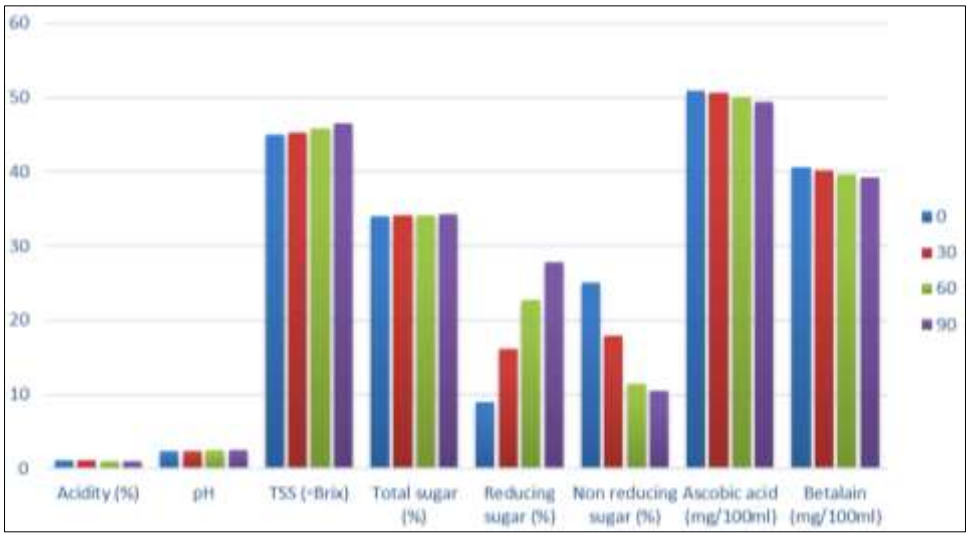

Fig 2: Effect of storage on physicochemical properties of beverage stored at refrigeration temperature (4 °C)

Sensory evaluation of liquid jaggery based squash beverage stored at ambient temperature (27 °C)

The overall sensory score was the highest in case of treatment T_2 with (15:10) aonla to beetroot juice proportion, 45-degree brix TSS and 1.10 percent acidity, treatment T_2 was further evaluated for sensory characteristics stored at ambient temperature (27 °C) for storage up to 90 days. The results obtained are depicted in table 3.

The data in the table 3 revealed that there were degradative changes in sensory qualities as storage proceeds up to 90 days. The changes in quality parameters represented graphically in figure 2. The data indicated in above table revealed that there was significant deviation in all the sensory parameters and shown to decreased from 8.8 to 7.4.

The color and appearance found to be acceptable up to 30 days and received sensory score i.e., 8.5, beyond 30 days of storage the sensory score was reported to be decreased to 7.7 on 90th days of storage at ambient temperature. While flavor scored 8.9 at 0 days of storage and scored 7.5 after storage of 90 days.

Data from table 3 shows that sensory score for taste of the beverage was ranged from 8.8 to 7.2 up to 90 days storage. During storage of beverage from 0 to 30 days there was decrease in sensory score for overall acceptability (8.2) which was found to be at par with fresh sample. On 90th day of storage there was significant decrease in sensory score for flavor, taste and overall acceptability but liked moderately by the semi trained panel members. It can be concluded that liquid jaggery based beverage can be stored for 30 days at ambient temperature without affecting sensorial parameters. However freshly prepared beverage was found to be highly organoleptically acceptable. The squash beverage stored at room temperature (27 °C) scored less for colour, appearance, flavour, taste and overall acceptability as compared to the sample stored at refrigerated temperature (4 °C). Similar results for organoleptic characteristics of stored samples were reported by Panjiar *et al*. (2015) [14]. Statistical data revealed that overall acceptability score was noticed to be significant in case of all sensory parameters.

Sensory evaluation of liquid jaggery based beverage stored at refrigeration temperature (4 °C)

The data in table 4 shows that there were slight changes occurred in sensorial parameters up to 90 days of storage. Changes in organoleptic qualities were observed as 30 days interval. The degradative changes in sensory qualities are represented graphically in figure 3. It was observed that fresh beverage scored highest (8.8) for overall acceptability as compare to stored beverage.

It is evident from table 4 that there was slight change in color, flavor and taste of the squash beverage was observed. Taste of the beverage scored 8.8 for freshly prepared sample while sensory rating decreases up to 7.5 after the storage period of 90 days.

During storage of beverage from 0 to 90 days there was decrease in sensory score for overall acceptability from 8.8 to 7.6. On 90th day of storage there was significant decrease in sensory score for flavor, taste and overall acceptability but liked moderately by the panel members. It can be concluded from the score that squash beverage can be stored for 90 days at refrigeration temperature without affecting sensorial parameters. However, 30 days stored squash beverage was found to be highly organoleptically acceptable by panel members. Similar results were reported during storage of beverage by Kathiravan *et al*. (2015) [9]. The squash beverage stored at refrigeration temperature (4 °C) was ranked the best for colour, appearance, flavour, taste and overall acceptability as compared to the sample stored at room temperature (27 °C).

Moreover, it can be seen from the results that there was gradually decreasing the sensory score of all attributes in ambient condition as compared to refrigerated condition, however after 60 days samples stored at ambient condition showed yeast and mould growth and hence not served to the panelists. After 90 days, refrigerated stored squash beverage was found to be in good condition and found to be acceptable. Similar results for organoleptic characteristics of stored samples were reported by Gupta *et al*. (2015) [5]. Statistically the values for overall sensory acceptability were found to be varied significantly with respect to storage period. It was observed that the values of flavour and taste were similar with each other on 90th day of storage.

Table 3: Organoleptic evaluation of liquid jaggery based beverage stored at ambient temperature (27 °C)

Storage days	Colour and appearance	Flavour	Taste	Overall acceptability
0	8.8	8.9	8.8	8.8
30	8.5	8.3	7.9	8.2
60	8.1	7.6	7.5	7.7
90	7.7	7.5	7.2	7.4
SE ±	0.08413	0.0796	0.09252	0.07481
CD @ 5%	0.2532	0.2396	0.27851	0.22520

Table 4: Organoleptic evaluation of liquid jaggery based beverage stored at refrigeration temperature (4 °C)

Storage days	Colour and appearance	Flavour	Taste	Overall acceptability
0	8.8	8.9	8.8	8.8
30	8.7	8.5	8.1	8.4
60	8.5	8.0	7.9	8.1
90	7.7	7.6	7.5	7.6
SE ±	0.15687	0.06018	0.08012	0.09515
CD @ 5%	0.47223	0.18115	0.24119	0.28643

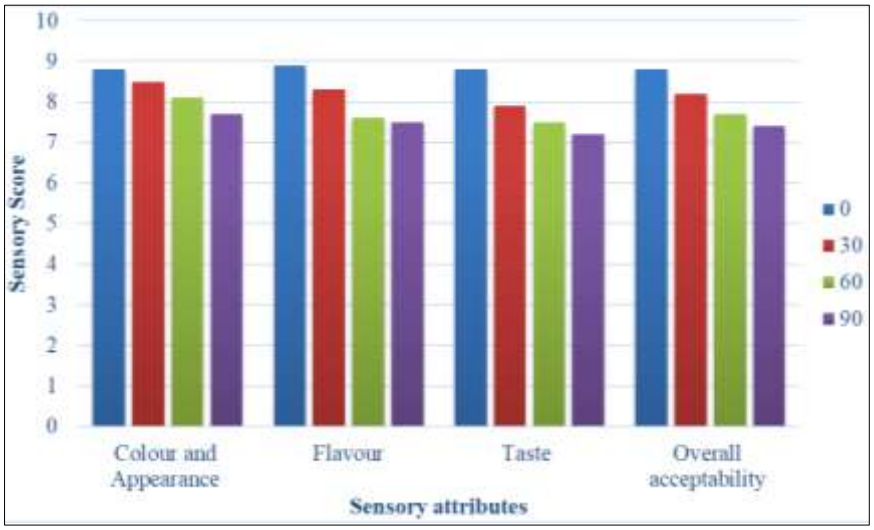

Fig 2: Organoleptic evaluation of beverage stored at ambient temperature (27 °C)

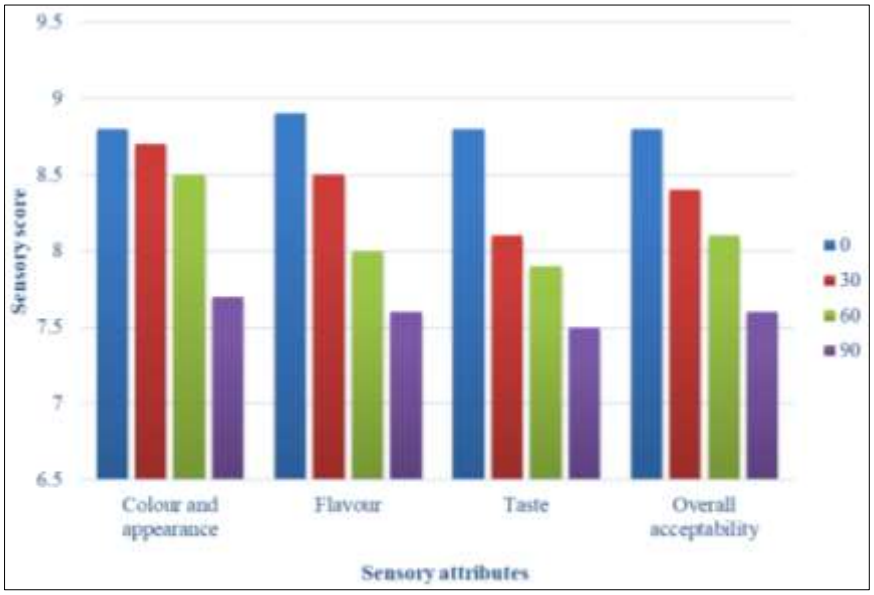

Fig 3: Organoleptic evaluation of beverage stored at refrigeration temperature (4 °C)

Conclusion

The present investigation can be concluded from above findings that squash prepared from 25 percent fruit juice blend comprising 15 percent aonla juice, 10 percent beetroot juice, 5 percent lemon juice, 5 percent tamarind juice, 2 percent ginger juice with 45 ◦Brix TSS, 1.10 percent acidity and 600 ppm sodium benzoate was found to be best on 9-point headonic scale by the panel of semi trained judges during organoleptic evaluation. The TSS, pH, total sugar, reducing sugar was increased, whereas acidity, non-reducing sugar, ascorbic acid, betalain and organoleptic quality was decreased during storage when stored in PET bottles at ambient temperature and refrigeration temperature.

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