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Effect of Sucrose on the Physicochemical Properties, Organoleptic Qualities and Shelf-Life Stability of Aonla (*Emblica Officinalis*) Candy

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Abstract: *This study was conducted with a view to find out the most suitable concentration of sugar for the preparation of aonla candy. In this research, six sets of aonla candy samples were made with varying syrup concentration (80 %, 70 %, 60 %, 50 % and 40 %) using sucrose and fresh aonla candy was used as control. The shelf-life stability of aonla candy was studied for 0 to 120 days at ambient temperature. The results obtained from the study revealed that moisture and total fiber content of aonla candy decreased with storage time while protein, fat, ash, total carbohydrate were increased. Ascorbic acid and total phenol content was found to decrease with increasing storage period. However, sufficient amount of ascorbic acid was retained in all samples. Titrable acidity was also increased with progressive increase of storage. Reducing sugar and total sugar was found to increase while non-reducing sugar decreased with the advancement of storage time. Almost all samples had good sensory in terms of colour, flavour, texture, taste and overall acceptability. On the basis of the results obtained in the present investigation, it can be drawn that application of various concentration of sugar syrup significantly affected the quality parameters of aonla candy.*

Keywords: *Aonla, candy, sucrose, physicochemical properties, organoleptic quality, Shelf-Life*

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I. Introduction

Fruits are among the most important foods of mankind as they are both nutritive and indispensable for maintenance of health. Being rich source of carbohydrates, minerals, vitamins and dietary fibers, these constitute an important part of our daily diet. Moreover, they add flavour and diversity to diet (Dar et al., 2011). Aonla, among fruits commonly known as Indian Gooseberry (*Emblica officinalis* G.) finds a particular place in Indian subcontinent as it has got immense medicinal values. It is reported to be the native of India, and ranks first in the World in area and production of aonla crop (Singh et al., 2009). Besides India, naturally growing aonla trees are also found in different parts of the world, viz. Sri Lanka, Cuba, Puerto Rico, China, Thailand and Japan. In Bangladesh, the fruit is found growing wild or in cultivated form in different parts of the country. It can grow well in dry region and salt affected soils. Aonla is a rare example of an edible material, which is rich in tannins as well as ascorbic acid (Kalra, 1988). Aonla fruits are the richest source of ascorbic acid among fruits except Barbados cherry. The presence of polyphenols or leucoanthocynins owes a lot to the stability of ascorbic acid. The vitamin C content in aonla varies from 200-900 mg /100 g depending upon the variety and size of the fruit (Anonymous, 1988; Barthakur and Arnold, 1991). Aonla is credited with medicinal value such as antisorbutic, divretic, laxative and antibiotic. The fruit also possesses pronounced expectorant, antiviral, cardiotonic and hypoglycaemic activity (Mehta and Tomar, 1979). Gallic acid present in aonla fruit has antioxidant property. The fresh fruits are generally not consumed as it is highly acidic and astringent; therefore, it is not a popular table fruit. But, it has got great potential in processed forms (Nayak et al., 2011). The fruit is also use as several nutritional and medicinal products but its use is limited. Hence attention has been focused on the preparation of different value added products from aonla. Aonla can be made into various products such as pickles, preserve, sauce, jam, jelly, dried chips, tablets, etc. (Singh and Kumar, 2000). Candy is a sweet food prepared from fruits or vegetables by impregnating them with sugar syrup followed by draining of excessive syrup and then drying the product to a shelf stable state. Fruits and vegetables like apples, ginger, mangoes, guava, carrots and citrus peels have been used to prepare candies (Mehta and Bajaj 1984; Sharma et al. 1998; Ribeiro and Sabaa-Srur 1999; Chandu and Prasad 2006). White sugar is the usual sweetening agent used in preparation of candies. Such sugar contains sucrose (99.7%) (Durrani, 2011). Aonla candies are becoming more and more popular because of high acceptability, minimum volume, higher nutritionally value and longer storage

life. These have additional advantage of being least thirst provoking and ready to eat snacks (Vikram et al., 2014). The dried products save energy, money and space in packaging, storage and transportation (Nayak et al., 2012). Aonla is presently an underutilized fruit, but has enormous potential in the world market. It is almost entirely unknown in the world market and needs to be popularized. In view of the health benefits, there is need to make the fruits more and more amenable to value added products. Among the unique products of aonla, the candy has much demand in domestic as well as export point of view. To strengthen market, storability and superior quality of aonla candy is of prime importance. Hence, the attempt to processing aonla to various value added products like aonla candies will be helpful in alleviating distress sale of the aonla fruits often observed in the market when the harvesting reaches the peak. Therefore, the present workhas been attempted to investigate the effects of sucrose concentration on the physicochemical properties, organoleptic qualities and storage stability of aonla candy.

II. Materials and Methods

Fully matured, large sized aonla fruits were purchased from the local market of Dinajpur district in Bangladesh. Special care was taken during the transportation of the fruits from market to laboratory so as to prevent any damage. Fruits having crack or skin injuries and specks were rejected. The selected fruits were washed with portable water to remove any extraneous matter adhering to the fruits. The physical parameters in terms of fruit size (length and diameter, cm), fruit weigh, pulp weight, seed weight were determined. Aonla candies were prepared by blanching the fruits in boiling water for 3 min and were placed on a dry cloth and excess water was allowed to drain off. The pricked and blanched aonla were made into segments and were soaked over-night in sucrose (white sugar) solution with varying concentration (80, 70, 60, 50, and 40%). Next day, the aonla segments were taken out from the syrup and syrup was boiled. The syrup was cooled and added again with aonla. The product was kept again for 24 h. On the third day, the pieces were taken out from the syrup and dried at 50^{o}C temperature in a cabinet dryer till they become non-sticky. Fresh aonla candy without sugar was used as control. The prepared candies were packed in glass jar and stored for 4^{th} month and data were obtained at 0, 60 and 120 days. Changes in nutritional composition in terms of moisture, fat, protein, ash, carbohydrate and total fiber contents of aonla candy was determined as per method mentioned by the Association of Official Analytical Chemists (2000). Oven drying method (at 105^{o}C for 6 hours) was used to determine the moisture content of the samples whereas solvent extraction method was used to determine the fat content. The protein (N × 6.25) content of the samples was determined by the Kjeldhal method. Meanwhile, the total ash content was determined using the muffle furnace at 550°C and carbohydrate was calculated by the difference method (Pearson, 1976). The total energy value of aonla candy samples were determined method described by Srivastava (2003). Total solids of candy were determined by subtracting the moisture content from 100whereas titratable acidity; reducing and total sugars were estimated as described by Ranganna (1986). VitaminC content was determined by the titration method described by Srivastava and Kumar (1994) while the total phenolic content was determined by the Folin-Ciocalteu method (Yoo, 2008). Sensory evaluation of developed aonla candy was conducted through a taste testing panel using 9-point hedonic scale (Bergara-Almeida et al., 2002). Each experiment was repeated in triplicate. The obtained data were analyzed by SPSS (version 20.0). Significant differences between the groups were assessed by one-way Analysis of Variance (ANOVA) test and means were separated by Duncan's Multiple Range Test (DMRT) at the 95% confidence level. Microsoft office excel (2013) was used for plotting graphs.

III. Results and Discussions

4.1 Physical Characteristics of Fresh Aonla Fruits

The data pertaining to physical characteristics of fresh aonla fruits have been presented in Table 4.2. The fruit length, fruit diameter, fruit weight, and pulp weight were found to be 3.83 cm, 4.38 cm, 43.67 g, and 94.76 %, respectively.

4.2 Chemical Characteristics of Fresh Fruits of Aonla

The fresh aonla fruits were evaluated for various chemical characteristics and the results recorded have been presented in Table 4.2. On fresh wet basis, moisture, protein, fat, ash, carbohydrate, total fiber content and value of fresh fruits was found to be 80.18 %, 1.94%, 1.07 %, 0.31 %, 16.50 % and 2.31 %, respectively. Titratable acidity was analyzed to be 1.46 %, whereas vitamin C, total phenol, reducing sugars, non-reducing sugars and total sugars were found to be 649.92 mg/100g, 24.58 mg/100g, 8.88%, 1.86% and 10.74 %, respectively.

4.3 Changes in Proximate Composition of Aonla Candy during Storage

4.3.1 Moisture Content

The change in moisture content of various treatments of aonla candy during storage is summarized in Fig.4.1. The data revealed that the moisture contents of the aonla candies were statistically significant ($P < 0.05$)

with respect to various concentration of sugar concentration. The moisture content aonla candy on zero day ranged from 14.63 to 12.02% being maximum in sample-1 (14.63%) and minimum in sample-2 (12.02 %). The moisture content in aonla candy decreased significantly with progressive increase in storage period, After120 days of storage, moisture content of aonla candy ranged from 13.97 to 11.21% being maximum in sample-1 (12.93%) and minimum in sample-3 (11.09 %).The moisture content here was also found to decrease with an increase in storage period .The decrease in moisture content in the various aonla candies with an increase in storage period might be due to the evaporation of moisture from the product. Decrease in moisture with storage of candies was also reported by Tripathi et al. (1988) in aonla candy, Mehta et al. (2005) in gal gal peel candy and Rani and Bhatia (1985) in pear candy.

4.3.2 Fat Content

The percent fat content of aonla candies prepared with different sugar concentration was recorded during storage as shown in Fig.4.2. The data revealed that the variations of fat content to various aonla candies were statistically significant ($P< 0.05$) with respect to sugar concentration. The fat content increased with an increase in storage period. After 120 days of storage, the fat content increased from an initial range of 1.04 to 4.69 % to a final of 1.13 to 4.84%.

4.3.3 Ash Content

The change in ash content of various treatments of aonla candy during storage is summarized in Fig.4.3. The data revealed that the ash contents of the aonla candies were statistically significant with respect to various concentration of sugar concentration. The ash content aonla candy on zero day ranged from 0.24 to 1.88 % being maximum in sample-1 (1.88 %) and minimum in sample-6 (0.24 %). The ash content in aonla candy increased significantly with progressive increase in storage period. After 120 days of storage, ash content aonla candy ranged from 0.29 to 1.95 % being maximum in sample-1 (0.29 %) and minimum in sample-6 (1.95 %). The ash content of aonla candy obtained in this study was higher than that reported by Hasanuzzaman et al. (2014) for tomato candy (0.87%).

4.3.4 Protein Content

The data pertaining to effect of various sugar treatments and storage on protein content of candy prepared from aonla fruits have been given in Fig.4.4. The protein content aonla candy on zero day ranged from 3.98 to 4.91 % being maximum in sample-2 (4.91 %) and minimum in sample-1 (3.98 %). The protein content in aonla candy increased significantly with progressive increase in storage period. After 120 days of storage, protein content aonla candy was ranged from 4.98 to 4.19% being maximum in sample-2 (4.98 %) and minimum in sample-1 (4.19 %).

4.3.5 Carbohydrate Content

The change in carbohydrate content of various treatments of aonla candy during storage is summarized in Fig. 4.5. The data revealed that the variation of carbohydrate contents of the aonla candies were statistically significant ($P < 0.05$) with respect to various concentration of sugar concentration. The carbohydrate content aonla candy on zero day ranged from 81.62 to 74.82 % being maximum in sample-3 (81.62 %) and minimum in sample-1 (74.82 %). The carbohydrate content in aonla candy increased significantly with progressive increase in storage period. After 120 days of storage, carbohydrate content of aonla candy ranged from 82.45% to 75.05 % being maximum in sample-3 (82.45 %) and minimum in sample-1 (75.05 %). Variation in carbohydrate content may be due to the compositional changes among the samples.

4.3.6 Total Fiber Content

During storage, changes in total fiber content of aonla candy prepared with different concentration of sugar are presented in Fig. 4.6. The results showed that total fiber content varied significantly ($P < 0.05$) among the samples of aonla candy stored at ambient temperature throughout the storage period from the processing day upto 120 days of storage. The total fiber content of the of aonla candy prepared with varying concentration of sugar was ranged between 2.81 to 13.69 % on the processing day while after 120 days of storage, this content was varied between 2.71 to 13.56 %. The variation in total fiber content of aonla candy during storage may be due to the compositional difference of the samples.

4.5 Titrable Acidity

The data with respect to effect of various sugar concentrations and storage on titratable acidity of candy prepared from aonla fruits is presented in Table 4.3. The variation of titratable acidity of aonla candy increased significantly with the progressive increase in storage time. It was varied with storage period as from initial 0. 35 - 1.75 % to final value of 0.54 – 1.81 %. There were significant differences among various sugar treatments as far as titratable acidity of aonla candy is concerned. In aonla candy, sample-1 showed maximum titratable

acidity (1.75 %) with minimum value being in sample-2 (0.53 %) on the processing day while titratable acidity was maximum in sample-1 (1.81 %) and minimum in sample-2 (0.54 %) after 120 days of storage. Acidity content did not change in the beginning of storage, there after it increased during storage. Pectic acid has been reported to increase the acidity in fruit products, hence, degradation of pectic substances into soluble solids might have contributed towards an increased in acidity of aonla products. An increase in acidity with storage period has also been observed in aonla preserve. Similar findings were also observed by Sethi (1980); Kumar and Singh (2001) in aonla products. These results were contrary to the results obtained by Divya et al. (2014); Rani and Bhatia (1985); Tripathi et al. (1988) in which the acidity decreases with storage.

4.6 Ascorbic Acid (Vitamin C) Content

Aonla is rich in ascorbic acid content which is very sensitive and decrease with heat treatment. The change in ascorbic acid content during storage of aonla candy prepared using various concentration of sugar has been presented in Table 4.3. The data revealed that storage had significant effect on ascorbic acid content of aonla candy. A significant decrease in ascorbic acid content of aonla candy was observed with enhancement of storage period. On zero day of storage, the ascorbic acid in aonla candy ranged from 135.83 to 250.35 mg/100g being maximum of ascorbic acid (250.35 mg/100g) recorded in sample-1 with minimum value being in sample-4 (135.83 mg/100g). At the end of 120 days of storage, maximum ascorbic acid (189.77 mg/100g) was observed in aonla candy of sample-1 and it was minimum (102.11 mg/100 g) in sample-5. The decline in ascorbic acid concentration could be due to thermal destructions during processing and subsequent oxidation during storage (Brock et al., 1998). Both ascorbic acid and dehydro-ascorbic acid are highly volatile and unstable forms of vitamin C (Divya et al., 2014). Reduction in vitamin C could be due to oxidation by trapped oxygen in the high density polythene pouch which results information of dehydro-ascorbic acid. Similar findings were also observed by Kumarand Singh (2001) and Tripathi et al. (1988) in aonla products.

4.7 Total Phenolic Content

The principal antioxidant constituents of natural products are phenolic compounds which composed of phenolic acids and flavonoids that are potent radical terminators (Shahidi and Wanasundara, 1992, Ghasemnezha et al., 2011). It is reported by Riccardo et al. (2012) that a strong relationship between total phenolic content and antioxidant activity in fresh fruits which have a great importance for industrial use. There was no significant difference in total phenolic content of aonla candy prepared with varying concentration of sugar stored at ambient temperature throughout the whole storage period except sample-6 which was significantly different from others (Table 4.3). Initially, total phenolic content varied between 7.17 to 7.82 mg/100g while it was found to be in the range of 7.06 to 7.69 mg/100g towards the end of 120 days of storage. Thus, it was found that total phenolic content of all aonla candy samples decreased with the advancement of storage period. Many researchers also reported that total phenolic content was decreased after drying (Wiriya et al., 2009, Arnnok et al. 2012). The decrease in total phenolic content during storage might be due to their condensation into brown pigments (Fennema, 1976; Mehta, 1995).

4.8 Sugar Content

4.8.1 Reducing Sugar Content

The data pertaining to effect of various concentrations of sugar and storage on reducing sugars of candy prepared from aonla fruits have been presented in Table 4.3. The reducing sugar of aonla candy increased significantly with increase in storage period of 120 days. The sugar treatment had significant effect on reducing sugars of aonla candy. Sample-2 showed maximum reducing sugars (38.41%) and minimum in sample-1 (22.39 %) on the processing day while at the end of 120 days of storage, maximum reducing sugar (40.77 %) was in sample-2 and minimum in sample-1 (24.16 %). Increase in reducing sugar during storage of products is a general phenomenon as observed by many workers, Nayak et al. (2012) in amla candy, Vijay et al. (2005) inamla, squash and Vanilla, Gupta et al. (1980) in ber candy.

4.8.2 Non-Reducing Sugar Content

The data regarding effect of various concentration of sugar and storage on non-reducing sugars of candy prepared from aonla fruits have been presented in Table 4.3. Non-reducing sugars of aonla candy decreased significantly with increase in storage period. On the processing day, maximum non-reducing sugar was observed in sample-3 (29.18 %) and minimum in sample- 1 (17.15 %). On the other hand, maximum non-reducing sugar was observed in sample-3 (28.03%) and sample-1 (15.79 %) at the end of 120 days of storage. Decrease in non-reducing sugar due to inversion of non-reducing sugar to reducing is caused by acid present in products (Divya et al., 2014). Enzyme (invertase) would also contribute to this in version to a little extent; the rate of inversion was rapid initially in all the products which might be due to availability of more substrate for inversion at initial stages (Jain et al., 1984).

4.8.3 Total Sugar Content

The data regarding effect of various concentration of sugar and storage on total sugars of candy prepared from aonla fruits have been presented in Table 4.3. The total sugars of aonla candy increased significantly with increase in storage period. Maximum total sugar was observed in sample-2 (66.03 %) and minimum in sample-1 (39.54 %) on the processing day while it was maximum in sample-2 (68.08 %) and minimum in sample-1 (39.95 %) after 120 days of storage. Increase in total sugar content was found during storage of aonla candy which could be due to the hydrolysis of polysaccharides resulting in conversion of soluble compounds like sugars. Total sugar content of products was dependent on the total soluble solids. It was reported by Roy and Singh (1979) in squash hand nectar prepared from bael fruits. Choudary et al. (2006) also reported the increase in reducing and total sugar. The increased levels of total sugars were probably due to conversion of starch into simple sugars (Divya et al., 2014).

4.9 Changes in Organoleptic Quality of Aonla Candy during Storage

The data with pertaining to the effect of different sugar concentration and storage on sensory scores (9-point hedonic scale) for attributes like colour, flavour, texture, taste and overall acceptability of candy prepared from aonla fruits have been presented in Table 4.4. The mean scores for colour, flavour, texture, taste and overall acceptability of aonla candy on day zero ranged from 8.20 to 8.9, 8 to 8.6, 7.60 to 7.90, 7.80 to 8.70 and 7.90 to 8.52, respectively. From Table 4.4 it is seen that there was a significant decrease in mean score for sensory attributes of aonla candy during four months (120 days) of storage. Sample-2 had the highest (8.35) overall acceptability score while sample-1 had lowest (7.65) score.

IV. Figures and Tables

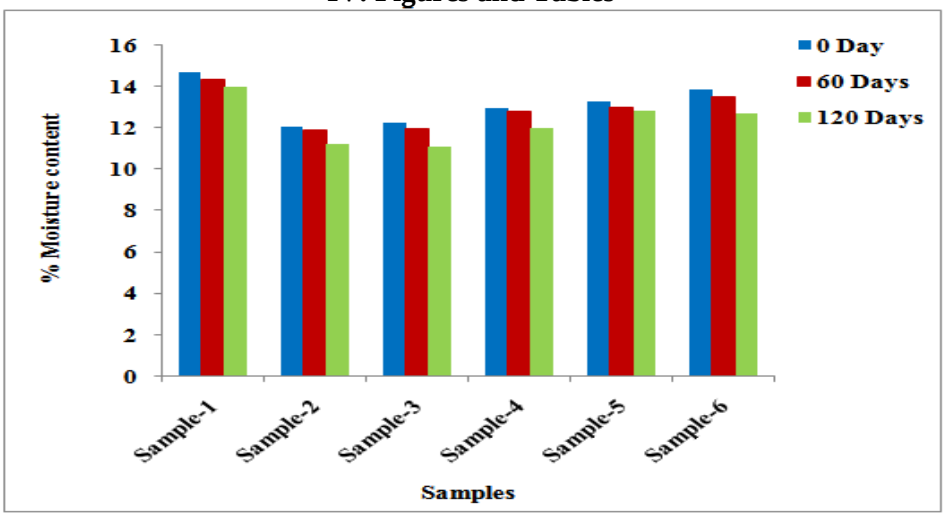

Figure 4.1: Effects of sucrose on moisture content of aonla candy during storage.

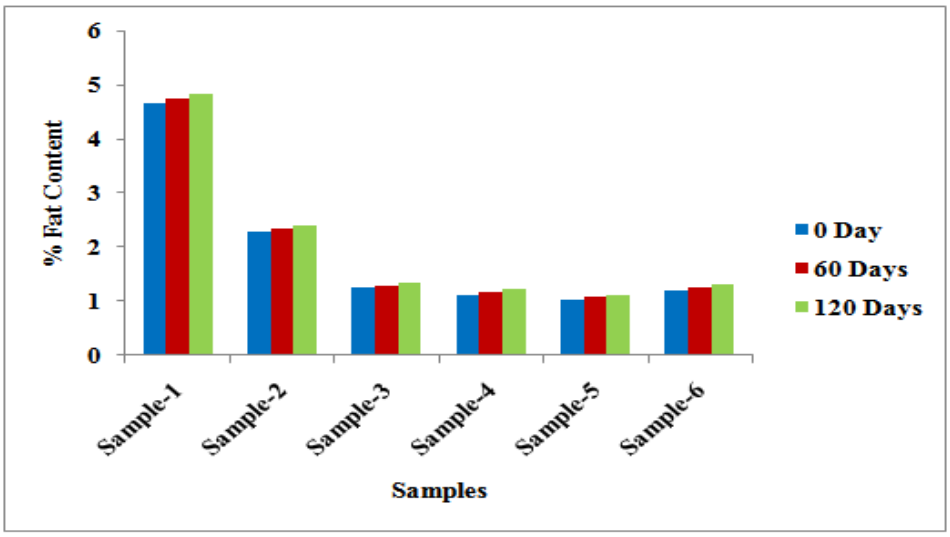

Figure 4.2: Effects of sucrose on fat content of aonla candy during storage.

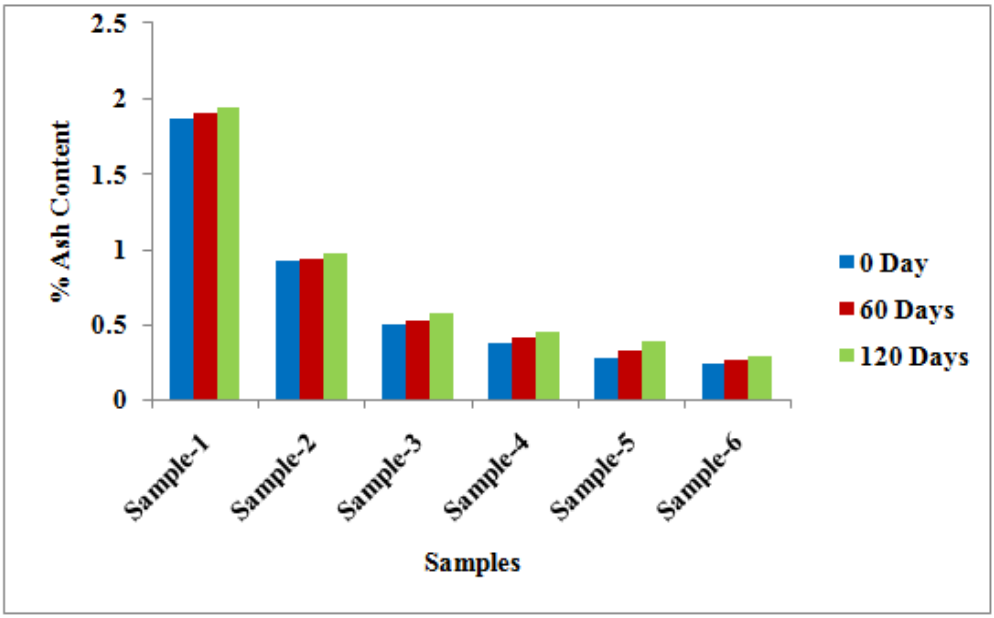

Figure 4.3: Effects of sucrose on ash content of aonla candy during storage.

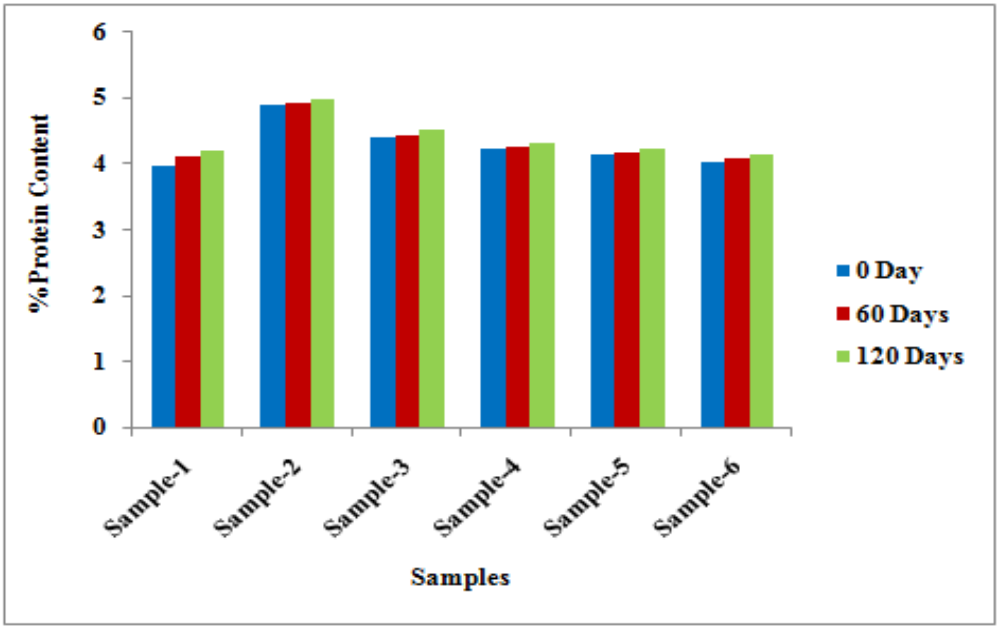

Figure 4.4: Effects of sucrose on protein content of aonla candy during storage.

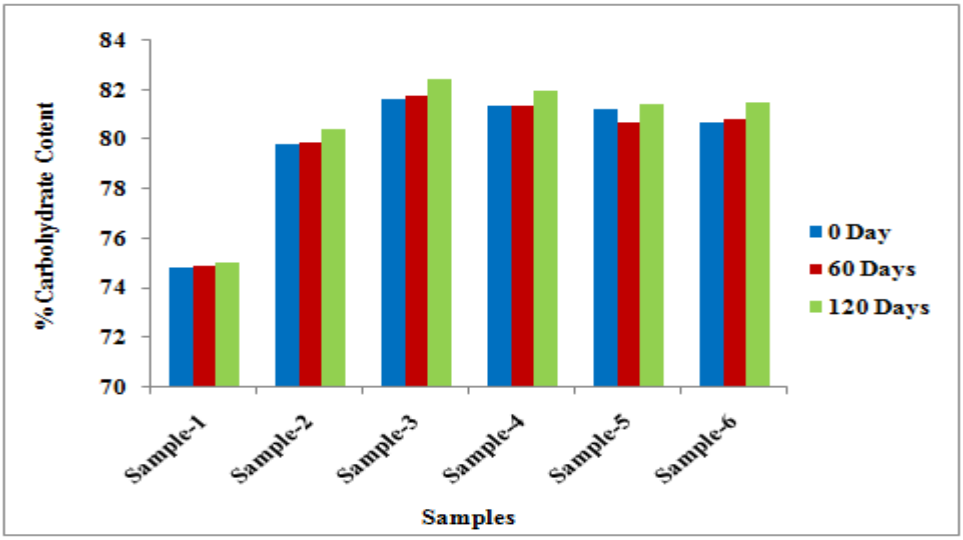

Figure 4.5: Effects of sucrose on carbohydrate content of aonla candy during storage.

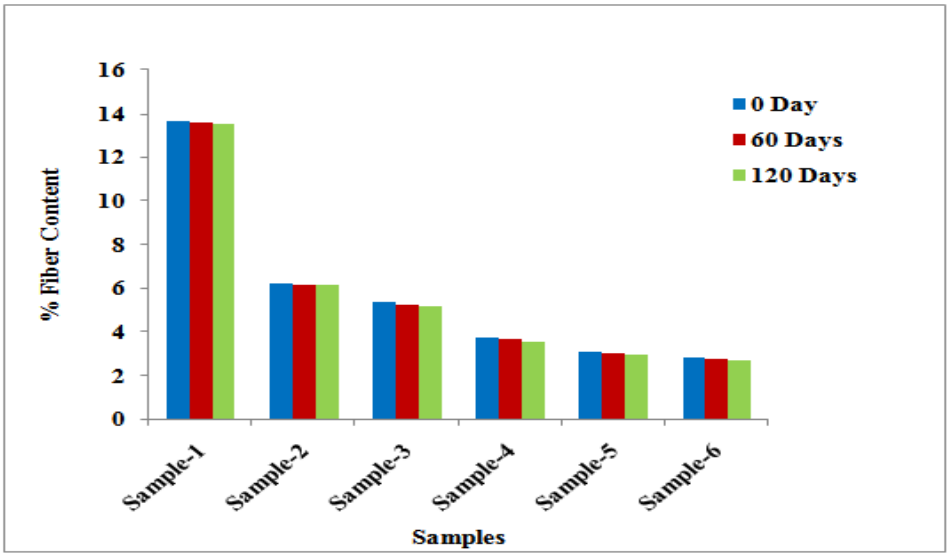

Figure 4.6: Effects of sucrose on fiber content of aonla candy during storage.

Table 4.1: Physical characteristics of fresh fruits of aonla.

Characteristics	Data obtained
Fruit length (cm)	3.83 ±0.07
Fruit diameter (cm)	4.38 ±0.02
Fruit weight (g)	43.67±0.05
Pulp weight (%)	94.76±0.04
All values are mean ± SEM	

Table 4.2. Physicochemical characteristics of fresh fruits of aonla.

Parameters	Composition
Moisture (%)	80.18 ±0.98
Protein (%)	1.94±0.07
Fat (%)	1.07±0.01
Ash (%)	0.31±0.01
Carbohydrate (%)	16.50 ±1.70
Total Fiber (%)	2.31±0.01
Titrable acidity (%)	1.46±0.05
Vitamin C (mg/ 100g)	649.92±1.54
Total Phenol (mg/100 g)	24.58 ± 1.23
Reducing Sugar (%)	8.88±0.04
Non-reducing Sugar (%)	1.86±0.24
Total Sugar (%)	10.74±0.27
All values are mean ± SEM of three replicates.	

Table 4.3: Effects of processing methods on functional compounds of prepared candy during storage.

Samples	Storage Period (Days)	Sensory Attributes					
		Titrable Acidity (%)	Vitamin C(mg/100g)	Total Phenol (mg/100g)	Reducing Sugar (%)	Non-reducing Sugar (%)	Total Sugar (%)
Sample-1	0	1.75 ± 0.02a	250.35 ± 0.33a	7.49 ± 0.02ab	22.39 ± 0.24f	17.15 ± 0.23c	39.54 ± 0.21f
	60	1.76 ± 0.02a	222.69 ± 0.42a	7.41 ± 0.01ab	23.33 ± 0.19f	16.28 ± 0.17d	39.61± 0.19d
	120	1.81 ± 0.02a	189.77 ± 0.24a	7.35 ± 0.03ab	24.16 ± 0.17f	15.79 ± 0.21c	39.95± 0.28d
Sample-2	0	0.53 ± 0.01f	151.05 ± 0.25c	7.82 ± 0.01a	38.41 ± 0.11a	27.62 ± 0.16b	66.03 ± 0.31a
	60	0.53 ± 0.01f	123.05 ± 0.26b	7.73 ± 0.01a	39.76 ± 0.12a	27.51 ± 0.13b	67.27 ± 0.33a
	120	0.54± 0.01f	100.67 ± 0.33c	7.68 ± 0.03a	40.77 ± 0.05a	27.31 ± 0.18b	68.08 ± 0.22a
Sample-3	0	0.65 ± 0.01e	142.38± 0.23e	7.80 ± 0.05a	36.12 ± 0.31b	29.18 ± 0.22a	65.30 ± 0.23b
	60	0.66 ± 0.01e	127.18 ± 0.20e	7.74 ± 0.04a	36.86± 0.46b	28.91± 0.27a	65.77± 0.20b
	120	0.66 ± 0.01e	115.66 ± 0.13b	7.69 ± 0.04a	37.35 ± 0.29b	28.03± 0.22a	65.38± 0.22b
Sample-4	0	0.71 ± 0.01d	135.83 ± 0.02d	7.61 ± 0.01a	35.63 ± 0.34c	29.07 ± 0.29a	64.70 ± 0.04c
	60	0.72 ± 0.01d	121.81 ± 0.02c	7.56 ± 0.01a	36.55± 0.27c	28.62 ± 0.24a	65.17± 0.04b
	120	0.74± 0.01d	109.98 ± 0.04c	7.49 ± 0.01a	37.21 ± 0.15c	27.80 ± 0.16b	65.01 ± 0.10b
Sample-5	0	0.75 ± 0.01c	151.22 ± 0.11c	7.54 ± 0.01a	34.46 ± 0.21d	27.38 ± 0.34b	61.84 ± 0.32e
	60	0.76 ± 0.01c	119.57 ± 0.15b	7.49 ± 0.01a	35.38 ± 0.20d	26.75 ± 0.28b	62.13 ± 0.28c
	120	0.77± 0.01c	102.11 ± 0.06c	7.41 ± 0.01a	36.34± 0.14d	26.06 ± 0.05c	62.40± 0.16c
Sample-6	0	0.83 ± 0.01b	175.26 ± 0.07b	7.17 ± 0.25b	34.33 ± 0.09e	27.91 ± 0.19b	62.24 ± 0.19d
	60	0.84 ± 0.01b	133.94 ± 0.09b	7.12 ± 0.25b	35.51 ± 0.02e	27.05 ± 0.13bc	62.56 ± 0.18c
	120	0.85 ± 0.01b	115.32 ± 0.06b	7.06 ± 0.25b	36.36± 0.05e	26.61 ± 0.06b	62.97± 0.13c

All values are mean ± SEM of three replicates.
[a-f]The test values along the same column carrying different superscripts for each composition contents are significantly different ($p < 0.05$) within days.
Sample-1: Without sugar; **Sample-2:** 80% sugar; **Sample-3:** 70% sugar; **Sample-4:** 60% sugar; **Sample-5:** 50% sugar; **Sample-6:** 40% sugar;

Table 4.4: Effects of processing methods on organoleptic quality of prepared candy during storage.

Samples	Storage Period (Days)	Sensory Attributes				
		Colour	Flavour	Texture	Taste	Overall Acceptability
Sample-1	0	8.20 ± 0.20^{e}	8.0 ± 0.20^{a}	7.60 ± 0.20^{a}	7.80 ± 0.20^{a}	7.90 ± 0.12d
	60	7.80 ± 0.20^{a}	7.90 ± 0.20^{a}	7.50 ± 0.20^{a}	7.80 ± 0.20^{a}	7.75 ± 0.08d
	120	7.70 ± 0.18^{a}	7.80 ± 0.20^{a}	7.40 ± 0.20^{a}	7.70 ± 0.20^{a}	7.65 ± 0.08e
Sample-2	0	8.90 ± 0.21^{ab}	8.60 ± 0.16^{a}	7.90 ± 0.12^{a}	8.70 ± 0.13^{a}	8.52 ± 0.21a
	60	8.80 ± 0.13^{ab}	8.40 ± 0.13^{a}	7.80 ± 0.16^{a}	8.60 ± 0.12^{a}	8.40 ± 0.21a
	120	8.70 ± 0.11^{a}	8.30 ± 0.13^{a}	7.80 ± 0.13^{a}	8.60 ± 0.13^{a}	8.35 ± 0.20a
Sample-3	0	8.80 ± 0.16^{b}	8.50 ± 0.23^{a}	7.90 ± 0.18^{ab}	8.70 ± 0.21^{ab}	8.47 ± 0.20a
	60	8.70 ± 0.13^{b}	8.40 ± 0.16^{a}	7.80 ± 0.15^{b}	8.60 ± 0.21^{b}	8.37 ± 0.20a
	120	8.60 ± 0.16^{bc}	7.90 ± 0.16^{c}	7.70 ± 0.12^{a}	8.50 ± 0.15^{b}	8.17 ± 0.22b
Sample-4	0	8.70 ± 0.16bc	8.20 ± 0.13^{a}	7.70 ± 0.21^{a}	8.60 ± 0.13^{a}	8.30 ± 0.22ab
	60	8.50 ± 0.13^{a}	8.10 ± 0.12^{a}	7.70 ± 0.16^{a}	8.60 ± 0.15^{a}	8.22 ± 0.20b
	120	8.50 ± 0.10^{ab}	7.90 ± 0.13^{a}	7.60 ± 0.21^{a}	8.50 ± 0.17^{ab}	8.12 ± 0.22c
Sample-5	0	8.60 ± 0.20^{c}	8.20 ± 0.26^{b}	7.70 ± 0.26^{b}	8.50 ± 0.22^{b}	8.25 ± 0.20b
	60	8.50 ± 0.17^{ab}	7.90 ± 0.21^{b}	7.60 ± 0.21^{ab}	8.50 ± 0.20^{ab}	8.13 ± 0.22c
	120	8.40 ± 0.20^{c}	7.80 ± 0.19^{b}	7.50 ± 0.13^{a}	8.40 ± 0.15^{b}	8.03 ± 0.22d
Sample-6	0	8.50 ± 0.20^{d}	8.10 ± 0.20^{a}	7.60 ± 0.20^{a}	8.40 ± 0.20^{a}	8.15 ± 0.20c
	60	8.40 ± 0.18^{a}	8.0 ± 0.20^{a}	7.60 ± 0.20^{a}	8.30 ± 0.20^{a}	8.08 ± 0.17c
	120	8.10 ± 0.19^{a}	7.90 ± 0.20^{a}	7.50 ± 0.20^{a}	8.30 ± 0.20^{a}	7.95 ± 0.17d

All values are mean ± SEM of three replicates.
[a-e]The test values along the same column carrying different superscripts for each composition contents are significantly different ($p < 0.05$) within days.
Sample-1: Without sugar; **Sample-2:** 80% sugar; **Sample-3:** 70% sugar; **Sample-4:** 60% sugar; **Sample-5:** 50% sugar; **Sample-6:** 40% sugar;

V. Conclusion

The results obtained from the study revealed that moisture and total fiber content of aonla candy decrease with storage time while protein, fat, ash, total carbohydrate were increased. Ascorbic acid and total phenol content was found to decrease with increasing storage period. However, sufficient amount of ascorbic acid was retained in all samples. Titrable acidity was increased with progressive increase of storage. Reducing sugar and total sugar were found to increase while non-reducing sugar decreased with the advancement of

storage time. Almost all samples had good sensory acceptance towards potential customers in terms of colour, flavour, texture, taste and overall acceptability. On the basis of the results obtained in the present investigation, it can be drawn that application various concentration of sugar syrup significantly affect the quality parameters and also increases the shelf-life of aonla candy. Although the present research tried to maintain a sound methodology and analysis of data, it is not free from limitations as we only used sucrose syrup. Therefore, the present study paved the ways for further research supplemented with others treatments to improve the quality of aonla candy during storage at different conditions.

Disclosure

We (authors) declare that there is no conflict of interest to disclose.

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