Scientific Research Publishing

World Journal of Engineering and Technology, 2022, 10, 458-471
https://www.scirp.org/journal/wjet
ISSN Online: 2331-4249
ISSN Print: 2331-4222

Consumer Acceptance and Physicochemical Properties of Developed Carambola (*Averrhoa carambola*) Candy

Most. Jesmin Akhter[1*], Md. Mojaffor Hosain[1], Md. Abdul Halim[2], Mehar Prabin[1], Shanaz Parvin[1], Ayesha Siddika[1], Fatehatun Noor[2], Md. Al-Amin[1]

[1]Department of Food Processing and Preservation, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh
[2]Department of Food Science and Nutrition, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh
Email: *jesminfpp@gmail.com

How to cite this paper: Akhter, M.J., Hosain, M.M., Halim, M.A., Prabin, M., Parvin, S., Siddika, A., Noor, F. and Al-Amin, M. (2022) Consumer Acceptance and Physicochemical Properties of Developed Carambola (*Averrhoa carambola*) Candy. *World Journal of Engineering and Technology*, **10**, 458-471.
https://doi.org/10.4236/wjet.2022.102027

Received: April 14, 2022
Accepted: May 28, 2022
Published: May 31, 2022

Abstract

The acceptability and physicochemical qualities of carambola candy were evaluated in order to increase fruit consumption. The goal of this investigation was to see whether there were any techniques to preserve carambola in the form of candy. Sugar in various forms (white sugar, corn syrup, icing sugar, and molasses) was employed in candy making process in this study. Moisture, protein, fat, ash, vitamin C, total sugar content, organoleptic quality and microbial status of the prepared candy were analyzed. Protein, fat, vit-C, and total sugar content of carrambola candy were found to be higher with white sugar solution but moisture and ash content was found to be higher with molasses. On the microbiological analysis, total fungal growth was tested visually at 0 to 90 days and compared with refrigeration and room temperature. Fungal growth was found at 90 days at room temperature for all types of carambola candy. Sensory attributes revealed that sample 2 (corn syrup-based candy) was most delicious and appreciated among other samples. The best characteristic of carambola candy was found with white sugar solution, with sufficient nutrient and lowest fungal growth than candy prepared with corn syrup, icing sugar solution and molasses.

Keywords

Carambola Candy, Proximate Composition, Organoleptic Properties, Shelf-Life Stability

1. Introduction

Candy is a confection made with sugar, honey, natural sweeteners, and artificial sweeteners, flavors as well as fruits and cereals. In terms of physical, textural, and sensory qualities, these ingredients can give consumers a variety of impressions. Depending on the ingredients and the manufacturing process, there are different types of candy [1]. Candy is developed by immersing in sugar solution, removing the extra sugar syrup, and drying the product to a shelf-stable phase [2]. It is a popular food item among people of all ages, particularly youngsters, because of its strong organoleptic indicators and inexpensive price.

In candy preparation, sucrose, glucose syrup, gelling agents (gelatin, starch, and pectin), water, and minor components such as food acids, flavorings, and colorings are the most commonly utilized compounds. Candy can be formulated using different kinds of sweeteners either reduce calories type or nutritive type to develop suitable sugar products. Among sweeteners, white sugar, corn syrup, icing sugar and molasses can be considered interesting because of their sufficient sweetening power, reasonably inexpensive, thermostable, and contain various levels of calories [3].

White sugar is used to sweeten traditional sweets, baked goods, beverages, confectionery, jams, jellies, and preserves in industry and at home. It has a clean sweet taste and hydrolyzes quickly. It's used as a bulking agent, texture and mouth feel modifier, flavor enhancer, gelling and discoloration agent and to keep food products from spoiling [4]. Many studies have shown that incorporating molasses into the formulations of various products can improve nutritional quality by increasing antioxidant potential and improving mineral pattern [3]. Corn syrup is fascinating for a number of reasons. It is sweeter and less expensive than other added sweeteners with the same caloric value [5]. Furthermore, icing sugar dissolves quickly in comparison to other sugars, making it ideal for food applications that do not require cooking. In addition, icing sugar contains about 3% corn starch, which results in increased thickness in products when compared to the effects of all other sugars [6].

Banana, guava, mango, jackfruit, papaya, and carambola for example are popular fruits that can be employed as functional ingredients in candy production. Fruit pulp candies are particularly nutritious since they contain most of the ingredients of the fruit from which they are made, and they are also a fantastic way to take advantage of fruits that are highly perishable and cannot be preserved for a long time [7] [8].

Carambola (*Averrhoa carambola* L.), commonly known as star fruit, belongs to the family Oxalidaceae and cultivate throughout tropical and warm subtropical areas. The fruit has also high commercial value [9]. Carambola cannot be consumed directly because of its sour taste besides high water content can cause easily rotten if stored for a long time. Thus to increase the shelf life and high selling power, carambola can be used in processed food. It has a meaty, crunchy, juicy texture as well as a sour, acidic, and sweet flavor. Carambola has a star-shaped,

golden-yellow look and is commonly used in fruit salads and fruit platters, as a garnish in cocktails and beverages, or squeezed into juice and offered as a functional beverage. Due to its high moisture content and perishability, it is often used in jellies, ice creams, preserves, and sweets, particularly in tropical regions [10] [11] [12] [13].

Carambola is mostly utilized for decorating food and has beneficial therapeutic effects. Fruits must be stored fresh and available throughout the year to meet human dietary needs. It is high in natural phytochemicals such as flavonoids, terpenes, saponins, alkaloids, proanthocyanidins, vitamin C, tartaric acid, oxalic acid, ketoglutaric acid, citric acid, vitamin B1 and B2, carotene, pectin, cellulose, gallic acid, epicatechin, fatty acids, volatile flavors, fibers, hemicellulose, polysaccharides [14]-[19].

Processed carambola products are not available in our market, and very little work has been done on carambola processing in our country. The storage system of fresh carambola is inadequate in Bangladesh and many fruits are lost every year. Carambola candy is an alternative method of preserving carambola that is more appealing to consumers because it has a variety of nutrients. With all of these therapeutic properties and efficient ingredients in value-added products, carambola candy in convenience food has a long way to go in terms of utilizing the carambola fruit for marketability and creating jobs for rural women for economic development. So, the purpose of this research work was to develop carambola candy using several types of sugars (White sugar, Corn syrup, Icing sugar, Molasses), and analyze its physicochemical, organoleptic as well as microbiological properties.

2. Materials and Methods

2.1. Sample Collection

Fully matured and large size carambola fruits were procured from local market of Dinajpur district in Bangladesh. Special care was taken during the transportation system to prevent any kinds of damage. Other ingredients (White sugar, Corn syrup, Icing sugar, Molasses) was also collected from the local market of Dinajpur. All the chemicals and materials used were analytical grade.

2.2. Manufacturing Process of Carambola Candy

Four types of carambola candy were prepared using the method described by Durrani [2] with slight modification. Fresh, mature and golden yellow carambolas were selected and prior to processing, dirt, dust, and other contaminants were removed from the carambola fruits. After washing, removing seeds and inedible portion, carambolas were pricked with stainless steel fork and cut into pieces of 1.2 - 1.5 cm. These pieces were blanched in boiling water for 3 mins at 65˚C and were placed on a dry cloth and excess water was allowed to drain off and dried in a cabinet dryer at 60˚C for 4 hours. Thereafter, sugar syrups were prepared separately by adding white sugar, corn syrup, icing sugar, molasses

with water. The pricked and blanched carambola pieces were immersed in the syrup overnight into a deep vessel with 4 combinations: S1 (80 g white sugar + 50 g carambola), S2 (80 g corn syrup + 50 g carambola), S3 (80 icing sugar g + 50 g carambola) and S4 (80 g molasses + 50 g carambola) at room temperature (25˚C - 30˚C). Next day, the carambolas were taken out from the syrup and syrup was boiled. The syrup was cooled and added again with carambola. The product was kept again for 24 h. On the third day, the process was repeated with addition of carambola in hot syrup and product was kept again for 24 h. Next day, the carambola and syrup were cooked together till the candies were of 70˚ Brix and then removed from the syrup concentration and dried in an oven dryer at 65˚C for 4 hours. The prepared candies were packed in plastic jar and LDPE pouches of 500 - 600 μm film thickness and stored for further analysis. The flow diagram for candy preparation was presented in Figure 1.

2.3. Determination of Moisture Content

The moisture content of carambola candy was determined using a standard method developed by the Association of Official Analytical Chemists [20]. Sample (5 gm) was taken in a clean, dry and pre-weighed petridish and weighed using an analytical balance. Then the petridish with sample was transferred to oven and dried at 105˚C for 24 hours. After that it was cooled at desiccator and weighed. Moisture content was calculated by following formula:

$$\text{Moisture Content} = \frac{W_1 - W_2}{W} \tag{1}$$

where,

W_1 = Weight of sample with petridish;

W_2 = Weight of dried sample with petridish;

W = Weight of sample.

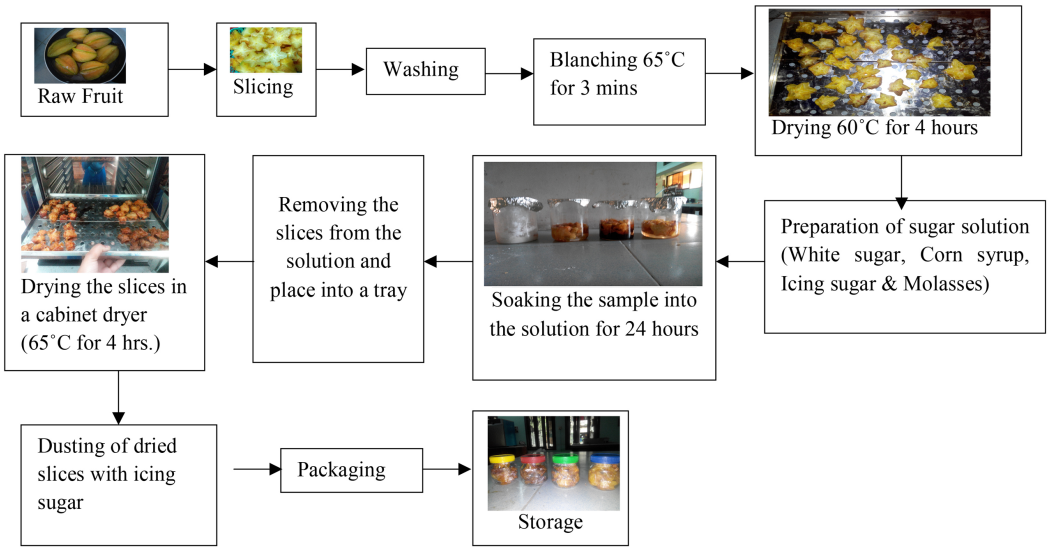

Figure 1. Flow diagram of carambola candy preparation.

2.4. Determination of Ash Content

Total ash content of carambola samples was measured by AOAC [20] method. Sample (5 gm) was weighed and taken in a clean, dry and pre-weighed crucible. Then the crucible was kept into muffle furnace at 550˚C for 6 hours. Muffle furnace was turned off and waited to open until the temperature has dropped to at least 250˚C, preferably lower. Door was opened carefully and cooled ignited powder at desiccator and weighed. The ash content was calculated using the following formula:

$$\text{Ash content}(\%) = \frac{W_1 - W_2}{W} \times 100 \quad (2)$$

Here,

W_1 = weight of ash with crucible;

W_2 = weight of empty crucible;

W = weight of sample.

2.5. Determination of Fat Content

Fat content was determined by extracting 3 g of sample with hexane using Soxhlet apparatus for 6 hours at 80˚C. When hexane was reached a small volume; it was poured into a dry (previously weighed) petridish. All of the hexane was evaporated in a drier at 100˚C for 1 hour, cooled and weighed [20]. Difference in the weights was the hexane soluble material present in the sample. The percent of crude fat was expressed as follows:

$$\%\ \text{Fat} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100 \quad (3)$$

2.6. Determination of Protein Content

According to the AOAC [20] methods, protein content was determined using the Kjeldahl method. In a digestion tube, 1 g of sample was mixed with 0.2 g $CuSO_4$, 1 g K_2SO_4, and 20 ml of water. Samples were added to a tube with concentrated H_2SO_4. The sample was let digested on digestion block until white fumes can be seen and continued heated for about 60 - 90 minutes until cleared with no charred material remaining. Tube was placed in the distillation apparatus and 50 ml NaOH 32% was added. The ammonia in the sample was steam distilled for 5 minutes into a receiving flash containing 4% boric acid. The sample was titrated with H_2SO_4 0.1 N solution. The total nitrogen value was then calculated by using the following formula:

$$\%\ \text{N} = \frac{\text{Burette reading} \times \text{normality of } H_2SO_4 \times \text{mili equivalent weight of nitrogen}}{\text{Weight of sample}(\text{g})} \times 100 \quad (4)$$

% Nitrogen = (burette reading × normality of H_2SO_4 × mili equivalent weight of nitrogen × 100)/Weight of sample (g).

Here, Normality of H_2SO_4 = 0.1 N; mili equivalent weight of N_2 = 1.4.

The amount of crude protein was then calculated by multiplying the percent

(%) of total nitrogen with the protein conversion factor 6.25, which is generally used in calculating the protein content.

% Protein = % Nitrogen × 6.25.

2.7. Determination of Ascorbic Acid Content

With minor modifications, the ascorbic acid content was measured using Adebayo's [21] approach. Each sample (2 gm) was combined with 5 mL of a 20% metaphosphoric acid solution and filtered through Whatman No. 1 filter paper. 1 mL filtrate was combined with 10 mL deionized water in a small beaker. After that 2 mL was transferred to a beaker, agitated with 2 drops of phenolphthalein solution, and titrated against 2, 6-dichlorophenol indophenol until the pink hue formed. The following equation was used to determine the amount of ascorbic acid:

$$\text{Ascorbic acid}\left(\frac{\text{mg}}{100\text{ g}}\right)=\frac{\text{Titre}\times\text{Dye factor}\times\text{Volume made up}\times 100}{\text{Volume of filtrate taken}\times\text{weight of sample}} \quad (5)$$

Here, Dye factor = 0.5/Titre, where 0.5 implies that 5 mL of the standard ascorbic acid solution contains 0.5 mg ascorbic acid.

2.8. Determination of Total Sugar

To estimate sugar, the volumetric method of Lane and Eynon [22] was employed, and samples for diverse products were made using Ranganna's approach [23]. The cleared filtrate was placed into a conical flask with a capacity of 250 mL. It was then diluted with 50 ml water and 5 g citric acid. The mixture was gently simmered for 10 minutes after cooling. The liquid was neutralized with 1 N NaOH and the volume was raised to 250 ml using phenolphthalein indicator. Total sugars were then determined by the following equation

$$\text{Total sugar}(\%)=\frac{\text{Factor}\times\text{dilution}\times 100}{\text{Titre Volume}\times\text{Wt. of sample}} \quad (6)$$

2.9. Storage Studies

The candies were packaged in plastic jar. Candies were kept at room temperature (27˚C ± 3˚C) and refrigerated temperature (5˚C - 7˚C). Visual fungal growth and color were also monitored periodically at an interval of 30 days. Organoleptic rejection and visible microbial growth were observed to determine spoilage.

2.10. Sensory Evaluation

Sensory evaluation of prepared fresh candies was done by taste testing panel. The panel consisted of 20 panelists each evaluated the sensory characteristics of all types of candies for various sensory attributes. Before the evaluation, all of the panelists were briefed. Sensory attributes such as color, taste, texture, and overall acceptability were evaluated using nine-point hedonic scales for all samples. The

hedonic scale was in the following order: 9 = Extremely like, 8 = Very much like, 7 = Moderately like, 6 = Slightly like, 5 = Neither like nor dislike, 4 = Dislike slightly, 3 = Dislike moderately, 2 = Dislike very much, and 1 = Dislike extremely. To avoid bias, the samples were coded with letters and served at random to the panelists.

2.11. Statistical Analysis

The data from the experiments were statistically analyzed for analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was used to determine significant differences among the various samples in triplicate and expressed as mean value ± standard deviation. Data were analyzed at the 0.05 level using IBM SPSS Statistics, version 20 software. Least significant difference (LSD) test at 5% level of probability and Duncan's Multiple Range Test (DMRT) were used to compare the significance of difference among the means.

3. Results and Discussion

3.1. Chemical Composition of Fresh Carambola

The data for chemical composition of fresh carambola as raw material was analyzed and presented in Table 1. The moisture, Ash and protein content of fresh carambola samples were measured by AOAC [20] method. The fat content of carambola was measured using Soxhlet apparatus and the ascorbic acid content was measured using Adebayo's approach. The volumetric method of Lane and Eynon was employed for total sugar estimation. The pH, moisture, protein, fat, ash, vitamin C, carbohydrate and total sugar of carambola was found to be 3.44%, 91.4%, 1.01%, 0.3%, 0.32%, 34.4 mg/100g, 6.73% and 3.98 mg/100g, respectively. According to Basena [24], carambola has moisture content of 90% and pH of 3.71% which is very close agreement to this study. Narain [25] and Patil [26] both reported similar findings. On another work, Muthu [17] recorded the content of vitamin C (25.8 mg/100g fruit) which is lower than this analysis. These dissimilarities in results could be due to the variety and climatic conditions of the environment. Furthermore, Basena [24] found that carambola had the ash content and total sugar content of 2.88% and 6.39%, which was slightly higher than the result obtained in this study and which could be varied in star fruit according to stages of maturity.

Table 1. Chemical composition of fresh carambola.

Parameters	Composition (%)	Parameters	Composition (%)
pH	3.44 ± 0.22	Fat	0.3 ± 0.10
Moisture	91.4 ± 0.01	Ash	0.32 ± 0.30
Protein	1.01 ± 0.03	Carbohydrate	6.73 ± 0.28
Vitamin C	0.0344 ± 1.11	Total sugar	3.98 ± 1.24

Values represent means (± standard deviation).

3.2. Chemical Composition of Carambola Candy

Table 2 represents the data on chemical composition of carambola candy. Moisture is an important parameter of food which indicates the nutritional and microbiological quality of foods. According to the findings, there were significant differences in the moisture content ($P \leq 0.05$) of the carambola candy. The highest and lowest values were observed in samples S4 and S2 (19.3 and 15.5), respectively. However, these results were higher than that as reported by Alam [27] and Urooj [28], who studied the moisture content of ginger candy and passion fruit sugar candy was 7.04% to 7.47% and 12.68%, respectively. Similar results were also obtained by Aggarwal and Michael [29] for Kinnow candy (MC ranging from 17.1% to 17.9%). As a result of these observations, this outcome was consistent with the others due to a number of factors which includes different type sugar, fruits, drying time, and temperature.

The protein content of the carambola candy was found to be ranged 0.30% to 0.37%. In case of indigenous carambola candy, it is studied that candy with 80% sugar solution was found of having the highest average score of protein content, which was of 0.37%, whereas the lowest score of 0.30% was found in candy with 80% molasses. These results are less similar to the outcomes reported for passion fruit sugar candy (2.2%) and wood apple sugar candy (1.3%) by Urooj [28].

The fat content of carambola candies made with different sugars is shown in Table 2. The data revealed that differences in fat content in various carambola candies were statistically significant ($P < 0.05$) when compared to sugar variation. The fat content of carambola candy ranged from 0.45% to 0.57%. The highest fat content was found in carambola candy which is made from 80% sugar solution. It was also observed that reduction in fat content was shown in carambola candy which was prepared with 80% molasses. However, these results were higher than that studied by Joshi [30] who reported the fat content of guava candy was 0.15% to 0.24%. According to Urooj [28], wood apple candies have a higher fat content than carambola candy. The variation of fat content might be due to the different types of sugar used.

Ash is the inorganic residue after removing water and organic matter from food by heating in the presence of an oxidizing agent, and it serves as a measure

Table 2. The chemical composition of carambola candy.

Sample	Moisture	Protein	Fat	Ash	Vitamin C	Total Sugar
S1	18.80 ± 0.06^{b}	0.37 ± 0.01^{a}	0.57 ± 0.01^{a}	0.19 ± 0.01^{b}	33.33 ± 0.43^{a}	62.65 ± 0.12^{b}
S2	15.50 ± 0.12^{d}	0.36 ± 0.01^{a}	0.48 ± 0.01^{bc}	0.15 ± 0.01^{c}	30.25 ± 0.14^{b}	53.96 ± 0.03^{d}
S3	18.00 ± 0.06^{c}	0.35 ± 0.01^{a}	0.51 ± 0.01^{b}	0.17 ± 0.01^{bc}	27.67 ± 0.19^{c}	61.17 ± 0.12^{c}
S4	19.30 ± 0.06^{a}	0.30 ± 0.01^{b}	0.45 ± 0.02^{c}	0.23 ± 0.01^{a}	20.07 ± 0.02^{d}	59.72 ± 0.05^{a}

Here superscript a, b, c, d indicates the level of significant difference among samples. Sample means having the same letter meaning that does not differ at 5% level of significance. S1, S2, S3 and S4 indicate white sugar, corn syrup, Icing sugar and molasses-based carambola candy respectively.

of the total amount of minerals present in the food (Table 2). It is very important in many biochemical reactions which aid the physiological functioning of major metabolic processes in the body. The ash content of the carambola candy in sample S4 (80% molasses) had the highest (0.23%) value whereas sample S2 (80% corn syrup) had the lowest value (0.15%) which was found relatively safe as the maximum permitted value of ash is 1.0% [27]. The ash level of carambola candy is practically identical to those of Aggarwal and Michael (29), who reported the value of kinnow candy ranging from 0.50% to 0.53%. Further, the ash content of carambola candy obtained in this study was higher than that reported by Hasanuzzaman [31] for tomato candy.

The following Table 2 shows the results of the vitamin C levels in the candy. Sample S4 (80% molasses) had the highest vitamin C levels (33.33 mg/100g), while sample S1 (80% white sugar) had the lowest (20.07 mg/100g) value. According to Hariadi [32], the vitamin C concentration of fresh star fruit is higher than prepared candy. The loss in vitamin C content was found to be due to the effect of light and prevailing high temperature conditions. This discrepancy between current and previous research findings could be attributed to a number of factors which includes manufacturing process, slicing, heating, drying time and temperature. The decrease in vitamin C could be attributed to oxidation by trapped oxygen in the high density polythene pouch, which results in dehydro-ascorbic acid information. In aonla products, Kumar and Sing [33] and Tripathi [34] discovered similar results. Shortening the cooking time and adding citric acid can help to avoid vitamin C loss.

It was observed that the total sugar in candies prepared with 80% corn syrup was low as compared to other prepared samples. The sugar content of fresh carambola was 3.98 percent, while the total sugar content of carambola candy ranged from 59.72 to 62.65 percent. Total sugars were recorded the highest in candies prepared with 80% white sugar followed by 100% sucrose, then in the samples prepared with other sweetening agents like corn syrup, icing sugar and molasses . There was a significant ($P \leq 0.05$) difference shown in total sugars for all the candies prepared. These values were higher than Divya [35] who studied the sapota candy and reported total sugar content was 22.7%. The increased levels of total sugars were probably due to conversion of starch into simple sugars [35]. Moisture loss and inversion of sucrose were considered by the above authors as major reasons for this increase in total sugars [29].

3.3. Sensory Evaluation of Carambola Candy

Sensory evaluation is an important and best parameter for examining newly developed products which provide quality measure and production control. The carambola candies were prepared and analyzed organoleptically on initial day. The samples were graded by numerical scoring, on a nine point hedonic scale. The effect of substitution of various sweetening agents on the sensory attributes of the candies is shown in Table 3. Based on Table 3, the carambola candy has differed significantly from each other. The hedonic scores of S1, S2, S3, and S4

were statistically similar for texture; nevertheless, different in color, taste and overall acceptability. The candies prepared with 80% corn syrup ranked superior to allowing to the better retention of texture, taste and overall acceptability. The least acceptable was the sample with 80% molasses. Therefore, the results outlined that S1, S2 and S3 were significantly more acceptable than S4; and all the panelists preferred S2 the most.

3.4. Storage Condition of Carambola Candy

The visual fungal growth and color of the samples are also shown in Table 4.

Table 3. Mean scores of sensory evaluation of carambola candy.

Sample	Sensory attributes			
	Color	Texture	Taste	Overall acceptability
S1	7.4 ± 0.23^{a}	6.8 ± 0.34^{a}	6.4 ± 0.11^{b}	6.6 ± 0.22^{b}
S2	6.6 ± 0.46^{b}	6.9 ± 0.27^{a}	7.4 ± 0.37^{a}	7.4 ± 0.40^{a}
S3	6.1 ± 0.34^{c}	7.0 ± 0.19^{a}	6.3 ± 0.22^{b}	6.2 ± 0.32^{b}
S4	5.9 ± 0.21^{c}	6.7 ± 0.61^{a}	5.7 ± 0.13^{c}	5.6 ± 0.27^{c}
LSD (<0.05)	0.455	0.528	0.409	0.408

Here superscript a, b, c indicates the rank on level of significant difference among samples. Sample means having the same letter meaning that does not differ at 5% level of significance. S1, S2, S3 and S4 indicate white sugar, corn syrup, Icing sugar and molasses-based carambola candy, respectively.

Table 4. Visual observation during storage of carambola candy.

Storage condition	Days	Visual result	S1	S2	S3	S4
Room temperature (27˚C ± 3˚C)	0	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	30	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	60	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	90	Color	Smoky	smoky	Dark	Dark
		Fungal Growth	Visible	visible	Visible	Visible
Refrigerated temperature (5˚C - 7˚C)	0	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	30	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	60	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible
	90	Color	Yellow	Yellow	Brown	Deep Brown
		Fungal Growth	Not visible	Not visible	Not visible	Not visible

The carambola candies were stored for 0 day, 30 days, 60 days and 90 days at room temperature (27˚C ± 3˚C) as well as refrigeration temperature (5˚C - 7˚C). The total fungal counts of the sample are also shown in **Table 4**. It was found that the fungal count for all candy samples was nil during 2 months of storage at room temperature and 3 months of refrigeration temperature. After 2 months at room temperature, it was also observed that the color of candy turned to smoky and dark. The alterations may have occurred as a result of fermentation in the presence of fungus. Mold and yeast are the principal spoiling organisms for fruits, according to Fraziar and Westheff [36]. In the event of refrigerated storage, no significant changes in color and fungal growth were observed up to 90 days in the complete storage time reported in **Table 4**.

4. Conclusion

The different sugar solutions affect the moisture, ash, protein, fat, vitamin C, total sugar content, color, flavor, texture, and taste of carambola candy. The goal of the study was to determine the best sugar form for carambola candy production. In this study, four different types of sugar were used to make carambola candy samples, including white sugar, corn syrup, icing sugar, and molasses. White sugar solution produced the best carambola candy. We know that the higher the water content of food, the more probable it is to be damaged. Carambola candy is a wonderful source of vitamin C and other nutrients that can be provided as a dessert or dried fruit to individuals of all ages. After processing, the prepared candy still had enough vitamin C and other nutrients. Sample S1 had a sufficient amount of nutritional value when compared to other samples. The candy made with corn syrup (S2) appeals to potential customers more in terms of texture, flavor, and taste. On the other hand, the storage stability of carambola candy was tested for 0 to 90 days at both room and refrigeration temperatures. It was obtained that, all samples of carambola candy were best at refrigeration temperature with no fungal counts. This research will help the food producer or confectionary manufacturer in selecting the appropriate sugar solution for making candy and consumers can reduce the spoilage of carambola to preserve them by making nutritious candy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Samakradhamrongthai, R. and Jannu, T. (2021) Effect of Stevia, Xylitol, and Corn Syrup in the Development of Velvet Tamarind (*Dialium indum* L.) Chewy Candy. *Food Chemistry*, **352**, Article ID: 129353. https://doi.org/10.1016/j.foodchem.2021.129353

[2] Durrani, A.M., Srivastava, P.K. and Verma, S. (2021) Development and Quality Evaluation of Honey Based Carrot Candy. *Journal of Food Science and Technology*,

48, 502-505. https://doi.org/10.1007/s13197-010-0212-0

[3] Kurt, A., Bursa, K. and Toker, O.S. (2022) Gummy Candies Production with Natural Sugar Source: Effect of Molasses Types and Gelatin Ratios. *Food Science and Technology International*, **28**, 118-127. https://doi.org/10.1177/1082013221993566

[4] Kumar, C.S., Ali, A. and Manickavasagan, A. (2020) Health Benefits of Substituting Added Sugars with Fruits in Developing Value-Added Food Products: A Review. *The International Journal of Nutrition*, *Pharmacology*, *Neurological Diseases*, **10**, 75-90.

[5] Bray, G.A., Nielsen, S.J. and Popkin, B.M. (2004) Consumption of High-Fructose Corn Syrup in Beverages May Play a Role in the Epidemic of Obesity. *The American Journal of Clinical Nutrition*, **79**, 537-543. https://doi.org/10.1093/ajcn/79.4.537

[6] Food and Drug Administration (FDA) (2020) US Department of Health and Human Services. CFR Code of Federal Regulations Title 21, Part 184.

[7] Domale, J.N., Kotecha, P.M. and Pawar, V.D. (2008) Studies on Preparation of Toffee from Aonla Pulp. *Beverage and Food World*, **35**, 39-40.

[8] Kohinkar, S.N., Chavan, U.D., Pawar, V.D. and Amarowicz, R. (2014) Studies on Preparation of Mixed Fruit Toffee from Fig and Guava Fruits. *Journal of Food Science and Technology*, **51**, 2204-2209. https://doi.org/10.1007/s13197-012-0691-2

[9] Luan, F., Peng, L., Lei, Z., Jia, X., Zou, J., Yang, Y., He, X. and Zeng, N. (2021) Traditional Uses, Phytochemical Constituents and Pharmacological Properties of *Averrhoa carambola* L.: A Review. *Frontiers in Pharmacology*, **12**, Article ID: 699899. https://doi.org/10.3389/fphar.2021.699899

[10] Valim, F.P., Aguiar-Oliveira, E., Kamimura, E.S., Alves, V.D. and Maldonado, R.R. (2016) Production of Star Fruit Alcoholic Fermented Beverage. *Indian Journal of Microbiology*, **56**, Article ID: 476481. https://doi.org/10.1007/s12088-016-0601-9

[11] Chua, C.B., Sun, C.K., Tsui, H.W., Yang, P.J., Lee, K.H., Hsu, C.W., *et al.* (2017) Association of Renal Function and Symptoms with Mortality in star Fruit (*Averrhoa carambola*) Intoxication. *Clinical Toxicology*, **55**, 624-628. https://doi.org/10.1080/15563650.2017.1314490

[12] Huynh, N.K. and Nguyen, H.V.H. (2017) Effects of Juice Processing on Oxalate Contents in Carambola Juice Products. *Plant Foods for Human Nutrition*, **72**, 236-242. https://doi.org/10.1007/s11130-017-0615-4

[13] Jia, X., Xie, H., Jiang, Y. and Wei, X. (2018) Flavonoids Isolated from the Fresh Sweet Fruit of *Averrhoa carambola*, Commonly Known as Star Fruit. *Phytochemistry*, **153**, 156-162. https://doi.org/10.1016/j.phytochem.2018.06.007

[14] Shui, G. and Leong, L.P. (2006) Residue from Star Fruit as Valuable Source for Functional Food Ingredients and Antioxidant Nutraceuticals. *Food Chemistry*, **97**, 277-284. https://doi.org/10.1016/j.foodchem.2005.03.048

[15] Benkeblia, N. and Lopez, M.G. (2015) Saccharides and Fructooligosaccharides Composition of Green and Ripe *Averrhoa carambola*, *Blighia sapida* and *Spondias dulcis* Fruits. *Food Chemistry*, **176**, 314-318. https://doi.org/10.1016/j.foodchem.2014.12.080

[16] Leivas, C.L., Nascimento, L.F., Barros, W.M., Santos, A.R.S., Iacomini, M. and Cordeiro, L.M.C. (2016) Substituted Galacturonan from Starfruit: Chemical Structure and Antinociceptive and Anti-Inflammatory Effects. *International Journal of Biological Macromolecules*, **84**, 295-300. https://doi.org/10.1016/j.ijbiomac.2015.12.034

[17] Muthu, N., Lee, S.Y., Lee, S.Y., Phua, K.K. and Bhore, S.J. (2016) Nutritional, Medicinal and Toxicological Attributes of Star-Fruits (*Averrhoa carambola* L.): A Re-

view. *Bioinformation*, **12**, 420-424. https://doi.org/10.6026/97320630012420

[18] Yang, D.-P., Liu, X., Teng, C.P., Owh, C., Win, K.Y., Lin, M., *et al.* (2017) Unexpected Formation of Gold Nanoflowers by a Green Synthesis Method as Agents for a Safe and Effective Photothermal Therapy. *Nanoscale*, **9**, 15753-15759. https://doi.org/10.1039/C7NR06286A

[19] Zulfajri, M., Dayalan, S., Li, W.Y., Chang, C.J., Chang, Y.P. and Huang, G.G. (2019) Nitrogen-Doped Carbon Dots from Averrhoacarambola Fruit Extractas a Fluorescent Probe for Methyl Orange. *Sensors*, **19**, 5008. https://doi.org/10.3390/s19225008

[20] AOAC (2012) Official Methods of Analysis. 19th Edition, Association of Official Analytical Chemist, Washington DC.

[21] Adebayo, A.O.A. (2010) Effect of Processing Methods on Chemical and Consumer Acceptability of Kenaf and Corchorus Vegetables. *Journal of American Science*, **6**, 165-170.

[22] Lane, J.H. and Eynon, L. (1923) Methods for Determination of Reducing and Non-Reducing Sugars. *Journal of Sciences*, **42**, 32-37.

[23] Ranganna, S. (1997) Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Second Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 11-12.

[24] Basena, N.K., Kv, J. and Rafed, R. (2019) Physico-Chemical Properties of Starfruit (*Averrhoa carambola*). *International Journal of Chemical Studies*, **7**, 1258-1260.

[25] Narain, N., Bora, P.S., Holschuh, H.J. and Vasconcelos, M.A.D. (2001) Physical and Chemical Composition of Carambola Fruit (*Averrhoa carambola* L.) at Three Stages of Maturity. *Ciência e Tecnologia de Alimentos*, **3**, 144-148. https://doi.org/10.1080/11358120109487721

[26] Patil, A.G., Patil, D.A., Phatak, A.V. and Chandra, N. (2010) Physical and Chemical Characteristics of Carambola (*Averrhoa carambola* L.) Fruit at Three Stages of Maturity. *International Journal of Applied Biology and Pharmaceutical Technology*, **1**, 624-629.

[27] Alam, M.S., Kamruzzaman, M., Khanom, S.A.A., Patowary, M.R.H., Elahi, M.T., Hasanuzzaman, M. and Paul, D.K. (2018) Quality Evaluation of Ginger Candy Prepared by Osmotic Dehydration Techniques. *Food and Nutrition Sciences*, **9**, 376-389. https://doi.org/10.4236/fns.2018.94030

[28] Urooj, A. (2021) Development of Fruit Candies from Wood Apple (*Limonia acidissima*) and Passion Fruit (*Passiflora edulis*), Nutritional and Acceptability Study during Storage. *Journal of Food and Dietetics Research*, **1**, 14-18.

[29] Aggarwal, P. and Michael, M. (2016) Effect of Replacing Sucrose with Fructose on the Physico-Chemical Sensory Characteristics of Kinnow Candy. *Czech Journal of Food Sciences*, **32**, 158-163. https://doi.org/10.17221/221/2013-CJFS

[30] Joshi, H., Kochhar, A. and Boora, R.S. (2019) Organoleptic Characteristics and Nutritive Value of Candy Developed from New Varieties of Guava. *IJCS*, **7**, 2124-2127.

[31] Hasanuzzama, M., Kamruzzaman, M., Islam, M.M., Khanom, S.A.A., Rahman, M.M., Lisa, L.A. and Paul, D.K. (2014) A Study on Tomato Candy Prepared by Dehydration Technique Using Different Sugar Solutions. *Food and Nutrition Sciences*, **5**, 1261-1271. https://doi.org/10.4236/fns.2014.513137

[32] Hariadi, H. (2019) The Influence of Carambola Starfruit (*Averrhoa bilimbi*) and Papaya (*Carica papaya*) on the Quality of the Organoleptic Properties, Vitamin C Content, and Fiber at Jelly Candies. *Earth and Environmental Science*, **443**, Article ID: 012017. https://doi.org/10.1088/1755-1315/443/1/012017

[33] Kumar, S. and Singh, I.S. (2001) Storage Studies of Aonla Fruit Products at Ambient Temperature. *Horticulture Programming*, **33**, 169-173.

[34] Tripathi, V.K., Singh, M.B. and Singh, S. (1988) Studies on Comparative Compositional Changes in Different Preserved Products of Aonla (*Emblica officinalis* Gaertn.) var. Banarasi. *Indian Food Packer*, **42**, 60-66.

[35] Divya, A.R., Jayashree, S. and Bhogi, B. (2014) Effect of Storage Methods on the Nutritional Quality of Sapota Candy. *Asian Journal of Dairy & Food Research*, **33**, 104-108. https://doi.org/10.5958/0976-0563.2014.00584.3

[36] Fraziar, W.C. and Westheff, D.C. (1978) Food Microbiology. 3rd Edition, McGraw-Hill Book Co., New York.