

The Impact of Refrigerated Storage on the Chemical, Physiochemical and Sensory Characteristics of Some Fruit Nectars

Abdel Moneim E.Sulieman, Rean A. Abdalla and Sirelkhatim B. El-Hardallou

Department of Food Science and Technology, Faculty of Engineering and Technology, University of Gezira, p.O.Box 20, Wad-Medani, Sudan.

ABSTRACT

This study aimed to evaluate the effect of refrigerated storage on fruit nectars prepared from: guava, mango and orange fruits. Physiochemical, chemical and sensory analysis was carried out for fresh and stored fruit nectars at 5°C. Guava nectar had the highest stability compared with orange and mango nectars, and also it had the highest value of 2.9 ± 0.04 % fiber, 0.38 ± 0.02 % fat and 199 ± 0.22 mg/100gm ascorbic acid. The mango nectar had the highest values of total soluble solids (28.2 brix). As for orange nectar, it had the highest value of protein ($0.80 \pm 0, 1\%$) and it had been changed during storage period. The sensory evaluation showed acceptance of fresh and stored fruit nectars at the second and fourth day of storage except orange nectars. which was accepted just as fresh and at second day of storage, indicating that it was more determinable than the other two fruit nectars.

INTRODUCTION

Fruits and vegetables have potential to become an important source of income generation for African farmers through creating job opportunities as well as improving their diet by providing micronutrients and vitamins (Mohamed, 1993).

Nutritional value of Fruits is generally high in fiber, water, minerals and vitamin C. Regular consumption of fruit is associated with reduced risks of cancer, cardiovascular disease, stroke, Alzheimer, cataracts, and some of the functional declines associated with aging (Nagy and Shaw 1980).

Fruit nectars and drinks are nutritious and offer great health benefits. The Dietary Guidelines for Americans (2005) recommended consumption of several cup per day of fruit and vegetable. Most of fresh nectars are unpasteurized; this means that there is a chance the product may contain harmful bacteria. Most people can enjoy unpasteurized nectars, so the harmful effect can be severe or even deadly in young children, the elderly and people with weakened immune systems (Esteve, 2007).

Nectar is a liquid naturally contained in fruit or vegetable tissue. Nectar is prepared by mechanically squeezing or macerating fresh fruits or vegetables without the application of heat or solvents. It may be prepared

in the home from fresh fruits and vegetables using variety of hand or electric juicers. Many commercial types of nectar are filtered to remove fiber or pulp. Nectar may be marketed in a concentrate form, sometimes frozen, requiring the user to add water to reconstitute the liquid back to its "original state". Nectars are often consumed for their health benefits. For example, orange nectar is rich in vitamin C, while prune nectar is associated with a digestive health benefit. Cranberry nectar has long been known to help prevent or even treat bladder infections, and it is now known that a substance in cranberries prevents bacteria from binding to the bladder. The overall consumption of fruit nectars consumption in Europe, Australia, New Zealand and the USA has increased in recent years, probably due to public perception of nectars as a healthy natural source of nutrients, and increased public interest in health issues (<http://en.wikipedia.org/wiki/Nectar.html>.2008).

The objective of the present study was to investigate the impact of refrigerated storage on the chemical and sensory characteristics of some fruit nectars namely guava, mango and orange.

MATERIALS and METHODS

Materials

In this study three kinds of fruits (guava, mango, and orange) were brought from Wad Medani vegetables and fruits market randomly during October, 2008. Nine dozens of fruits were transported to the laboratory in baskets in order to carry out chemical, physiochemical analyses and sensory evaluation.

Production of fruit nectars

Firm ripe fruits (guava, mango and orange) were washed by tap water, peeled and destoned manually, the flesh was sliced into cubic shapes by stainless steel knife.

Two hundred and fifty g of prepared samples from the various fruits slices were placed in a laboratory blender; 500 ml distilled water and 100 g of sugar were added. The contents were then mixed by blender in order to get nectars. The obtained fruits nectars were filtered by mesh net pending analysis which was carried out for fresh nectars and for fruit nectars stored at refrigerator at 5°C for different periods (two, four, six; and eight days).

Total soluble solids, total titrable acidity, and pH:

The total soluble solids, total titrable acidity (citric acid %), and pH of fruit nectars was carried out, and the total soluble solids were determined using hand Refractometer. pH values were determined using a pH meter, while the total titrable acidity was determined according to A, O, A, C, (2000) using the following method:

The Impact of Refrigerated Storage on the Chemical, Physiochemical

Ten ml of the tested solution was taken in a beaker. Twenty ml of distilled water were added and brought to boil, 2-3 drops of phenolphthalein indicator were added and the sample was then titrated with 0.1M sodium hydroxide solution until the color of solution changed to faint pink coloration persisted. The total titrable acidity was then calculated as follows:

$$\% \text{ Acid} = \frac{(\text{ml of NaOH}) \times (\text{N.NaOH}) \times (\text{dil. Factor}) \times (\text{Equ. Wt citr.}) \times 100}{\text{wt. of sample}}$$

Chemical composition

The fruit and fruit nectar samples were analyzed for the contents of moisture, ash, protein, fibre, fat according to the AOAC (1990) methods. The carbohydrates contents were calculated by difference. The experiments were repeated three times and the average was calculated.

Determination of ascorbic acid

The ascorbic acid (vitamin C) was determined according to AOAC (2000) using the titration method as follows; thirty gram of the pulp sample was blended with reasonable amount of 0.4% oxalic acid and then filtered by Whatman No. 1 filter paper. The volume of the filtrate was completed to 250 ml with 0.4% oxalic acid. 20 ml of the filtrate was pipetted into a beaker and then titrated with dye solution (0.2g 2,6-dichlorophenol-indophenol dissolved in 500ml solution) to a faint pink color. The ascorbic acid content was calculated by the following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{titer (ml)} \times \text{dye strength} \times 100}{\text{wt. of sample}}$$

$$\text{Factor} = \frac{\text{sample wt. (30g)} \times \text{sample volume for titration (20ml)}}{\text{Total volume of sample (250ml)}}$$

The dye strength was determined by taking 5ml of standard ascorbic acid (0.05g ascorbic acid/ 250ml 10% oxalic acid solution) in a beaker and titrated with dye solution to faint pink color.

$$\text{Dye strength} = \frac{1}{\text{Titer}}$$

Determination of minerals

Potassium (K) and calcium (Ca) determinations were accomplished by means of flame photometer model (Corning 400) according to the AOAC (1970) in which different concentrations (5, 10, 15, 20, 25 ppm) were prepared from stock solutions of Ca and K using the flame photometer. The readings were taken and a graph was made. Corresponding concentrations were determined from the graph to give the quantities of element.

Sensory evaluation

Nectars before and after storage for two, four, six and eight days were subjected to sensory evaluation using 10 panelists. The panelists were asked to assess each sample for texture, flavor, appearance and color, using a questionnaire form designed by the Department of Food Sciences and Technology of the Faculty of Engineering and Technology of the University of Gezira. All analysis took place in a room free from disturbing noises, with uniform, intensity level of lighting; fresh air was provided with water for rinsing. All those conditions were equalized used for all tests. The order of presentation for samples were randomized and the samples were given codes before being tested . Results were recorded and analyzed statistically.

Hedonic test

Ten judges were selected to express their preference of fruit nectars before and after storage in the laboratory. The samples were presented so that each sample had equal chance to be tested first, second, or last. The results obtained by the panelists were converted to scores ranging from like extremely (9) to dislike extremely (1) (Larmond 1983). The scores were subjected to statistical analysis.

Statistical analysis

The scores obtained by the panelist in Hedonic test were subjected to analysis of variance at 5% level according to method MSTAT (1982). To determine whether there were significant difference between means for each variable, Complete Randomize Design (CRD) was used.

RESULTES AND DISCUSSION

Chemical composition of fruit nectars

The chemical composition of the different fruit nectars samples is shown in Table 1. The fresh orange nectar had the highest value of total protein (0.80 ± 0.1 %), followed by guava nectar (0.60 ± 0.03 %) and mango nectar 0.50 ± 0.02 %. These values were slightly lower than those of Jedah and Robinson (2002) who reported values of 1.1%, 0.80%, and 0.70%, in orange, guava and mango nectar, respectively. However, after storage slight decreases were observed in total protein of orange nectar which contained: 0.77 ± 0.01 %, 0.72 ± 0.02 % and $0.64, 0.01$ after four, six and eight days of storage, respectively. As for guava nectar, the total protein decreased in the sixth day to 0.59 ± 0.02 %, and in eighth day to 0.51 ± 0.01 %, while the protein content in mango nectar changed to $0.47, 0.02$ %, 0.42 ± 0.14 % and 0.34 ± 0.05 % in fourth, sixth and eighth day of storage, respectively.

The Impact of Refrigerated Storage on the Chemical, Physiochemical

Table 1. Chemical composition of fresh and stored nectars samples

Fruit nectar	Guava nectar			Mango nectar			Orange nectar		
	Protein%	Fat%	Fibre%	Protein%	Fat%	Fibre%	Protein%	Fat%	Fibre%
Fresh samples	0.60 ± 0.03	0.38 ± 0.02	2.9 ± 0.04	0.50 ± 0.02	0.20 ± 0.01	2.0 ± 0.04	0.80 ± 0.1	0.12 ± 0.03	1.1 ± 0.01
After 2 days storage	0.60 ± 0.01	0.38 ± 0.01	2.9 ± 0.14	0.50 ± 0.11	0.20 ± 0.01	2.0 ± 0.015	0.80 ± 0.01	0.12 ± 0.01	1.1 ± 0.00
After 4 days storage	0.60 ± 0.02	0.38 ± 0.00	2.9 ± 0.01	0.47 ± 0.02	0.17 ± 0.01	1.9 ± 0.12	0.77 ± 0.2	0.10 ± 0.02	1.08 ± 0.05
After 6 days storage	0.59 ± 0.02	0.34 ± 0.01	2.7 ± 0.01	0.42 ± 0.14	0.12 ± 0.02	1.3 ± 0.01	0.72 ± 0.02	0.06 ± 0.00	1.05 ± 0.06
After 8 days storage	0.51 ± 0.01	0.27 ± 0.01	2.0 ± 0.1	0.34 ± 0.05	0.05 ± 0.01	0.08 ± 0.00	0.64 ± 0.01	ND	1.01 ± 0.11

ND: Not determined

Guava fresh nectar had the highest values of fat and fiber content, (0.38 ± 0.02%), (2.9 ± 0.04%) respectively, followed by mango nectar which contained 0.20 ± 0.01% fat and 2.0 ± 0.04% fibre and orange nectars with values of 0.12 ± 0.03%) fat and 1.1 ± 0.01% fibre. These values are comparable (Jedah and Robinson (2002).

However, after storage slight decreases in fat and fiber were observed in guava nectar. As for mango nectar the fat contents were 0.17 ± 0.01%, 0.12 ± 0.02% , and 0.05 ± 0.01 % after four , six , and eight days of storage, respectively. While the fiber contents were 1.9 ± 0.12%, 1.3 ± 0.1 % and 0.08 ± 0.00 % after four, six and eight days of storage, respectively .

For orange nectar the fat contents were 0.10 ± 0.02% , 0.06 ± 0.00%, and 0.00% , while the fiber contents were 1.08 ± 0.05%, 1.05 ± 0.06% and 1.01 ± 0.11% after four , six , and eight days of storage, respectively.

Ascorbic acid

As shown in Fig. I guava fresh nectar had the highest value of ascorbic acid (199 ± 22 mg/100g) , followed by fresh orange nectar which contained (44.1 ± 0.2 mg/100g) and mango fresh nectar (28.9 ± 0.06 mg/100g), these values were in close agreement to those of Jedeh and Robison (2002) , who reported 200 mg/100g, 54 mg/ 100g and 37 mg/ 100g of vitamin C in guava, orange and mango nectars , respectively.

However, slight changes in vitamin C contents were observed after four, six, and eight days of storage of the most stored fruits nectar samples. Ascorbic acid (vitamin C) contributes to the nutritional values of fruits juices and is essential water—soluble

vitamin. It also aids in the formation of liver bile which helps to detoxify alcohol and other substances. It has been reported that Citrus juices are a good option for gaining vitamin C, for a glass of either orange or lemon juice would provide a level in excess of the current Recommended Daily Allowance (UK-RDA) of 40 mg (Anon. , 1994). It had also been reported that ascorbic acid reduces the activity of the enzyme, aldose reductase which helps to protect people from diabetes. It may also protect the body against accumulation or retention of the toxic mineral lead (Raff el. al.,2004).

Physicochemical characteristics of fruit nectars

The pH values of the different nectars samples are shown in Table 2. The pH of fresh orange nectar (4.1 ± 0.1) was the lowest, followed by

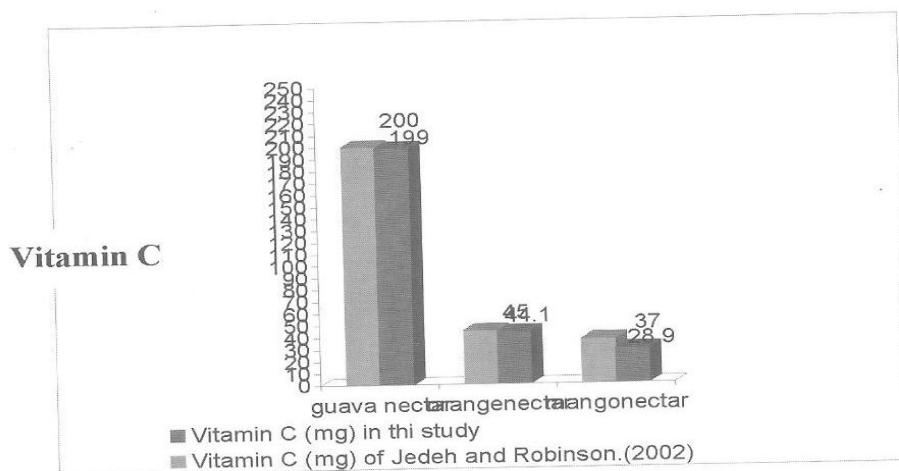


Figure 1. Vitamin C content (mg/ 100g) of orange, mango and guava fruit nectar as compared with the values determined by Jedeh and Robinson (2002).

The Impact of Refrigerated Storage on the Chemical, Physiochemical

Table 2. Some physiochemical characteristics of fresh and stored guava, man 50 and orange nectar.

Fruit nectar	Guava nectar			Mango nectar			Orange nectar		
	pH	Acidity %	TSS Brix ⁰	pH	Acidity %	TSS Brix ⁰	pH	Acidity %	TSS Brix ⁰
Fresh samples	4.6 ± 0.41	0.40 ± 0.21	17	4.4±0.11	0.58 ± 0.06	28.2	4.1 ± 0.2	1.05 ± 0.13	20.9
After 2 days storage	4.6 ± 0.2	0.40 ± 0.15	17	4.3 ±0.2	0.60 ± 0.03	28.2	3.8 ± 0.1	1.08 ± 0.11	20.8
After 4 days storage	4.6 ± 0.12	0.40 ± 0.2	17	3.9± 0.03	0.67 ± 0.05	27.6	3.5 ± 0.1	1.13 ± 0.02	20.0
After 6 days storage	4.4 ± 0.14	0.44 ± 0.01	16.9	3.3±0.12	0.75 ± 0.05	27.0	2.9 ± 0.16	1.20 ± 0.01	19.2
After 8 days storage	3.8 ± 0.11	0.51±0.01	16.4	4.4 ± 0.1	0.58 ± 0.02	28.2	4.1 ± 0.1	1.05 ± 0.03	20.9

mango nectar (4.4 ± 0.1) and guava nectar (4.6 ± 0.41). However, after storage the pH values dropped in all nectar samples. The pH value of orange nectar dropped to (3.5 ± 0.1) and (2.9 ± 0.16) in the sixth and eighth day, respectively, while in mango nectar, pH value dropped to 4.3 ± 0.2 , 3.9 ± 0.03 and 3.3 ± 0.12 in the fourth, sixth and eighth days of storage. As for the guava nectar, pH values were 4.6 ± 0.12 , 4.4 ± 0.14 , and 3.3 ± 0.11 in the fourth, sixth, and eighth day of storage, respectively.

In contrast to pH, the acidity (citric acid %) increased in all nectars samples with progressing time of storage (Tables 3), and the highest increase was noticed in orange nectar which ranged between $1.05\% \pm 0.03$ and $1.20\% \pm 0.01$, followed by mango nectar ($0.58\% \pm 0.02\%$ - $0.75\% \pm 0.05$) and finally guava nectar ($0.40\% \pm 0.2$ - $0.51\% \pm 0.01$).

Table 2 also shows that the highest values of TSS % were recorded in mango nectar (28.2 Brix⁰), followed by orange nectar (20.9Brix⁰) and finally guava nectar (17 Brix⁰). Generally the TSS decreased in most of the nectars samples with increasing storage period especially in orange nectar.

Minerals

The level of calcium content in the studied fresh fruit nectars was found to be 39 mg/100g, 16 mg/100g, and 10 mg/100g, in orange nectar, guava nectar, and mango nectar, respectively (Table 3). However, after storage variable changes in the values of the mineral were found in the

various nectars samples. The calcium contents of orange nectar at the fourth, sixth and eighth day were 37mg/ 100g, 33 mg/100g, and 27 mg/ 100g, respectively. While the calcium contents of guava nectar at the sixth day was 14mg/100g, and at the eighth day was 10 mg/100g. The content of calcium in mango nectar was at the fourth day 9 mg/ 100g at the sixth day was 6mg/100g, and at the eighth day was 2mg/100g. Also the level of potassium content in the fresh fruit nectars was found to be about 190mg/100g, 165 mg/100g, and 155 mg/100g, in guava nectar, mango nectar and orange nectar, respectively. However after storage variable changes in the values of the minerals were found in the various nectar samples the potassium content of guava nectar at the sixth and eighth day, were 188mg/100g and 183 mg/100g, respectively, while the calcium contents of mango nectar at the fourth day was 163 mg/100g, at sixth day was 159mg/100gm, and at the eighth day was 154 mg/100g. The content of potassium in orange nectar was 154 mg/100g, 152mg/100g and 146 mg/100g at the fourth, sixth and the eighth day of storage.

Table 3. Mineral content of fresh and stored guava, mango and orange Nectar

	Guava nectar		Mango nectar		Orange nectar	
Nectar sample	K (mg/ 100g)	Ca (mg/ 100g)	K (mg/ 100g)	Ca (mg/ 100g)	K (mg/ 100g)	Ca (mg/ 100g)
Fresh samples	190	16	165	10	155	39
After 2 days	190	16	165	10	155	39
After 4 days	190	16	163	9	154	37
After 6 days	188	14	159	6	152	33
After 8 days	183	10	154	2	155	39

Sensory evaluation

Tables 4, 5 and 6 show the sensory evaluation of nectars obtained from different fruits. There were significant differences in all samples of fruit nectars. The panelists gave high scores for fresh guava nectar and fresh mango nectar and those stored for two and four days. However, the acceptance of these fruit nectars decreased with progressing storage time. On the other hand, the panelists themselves gave the fresh orange nectar and orange nectar stored for two days high scores, but after that period of storage, orange nectar was unaccepted by the panelists.

The Impact of Refrigerated Storage on the Chemical, Physiochemical

Table 4. Sensory evaluation for fresh and stored guava nectar.

guava nectar	Color	Flavor	Texture	Over all acceptance
fresh	9 A	9 A	8.9 A	8.9 A
After 2 days	9 A	9 A	8.8 A	8.9 A
After 4 da s	9 A	9 A	8.8 A	8.8 A
After 6da s	7.3 B	6 B	5.8 B	5.8 A
After 8 da s	4 C	3.7 C	4.2 C	4.2 C

* The similarity of letter means there is no significant difference between the samples.

Table 5. Senso evaluation for fresh and stored manGo nectar.

Mango Nectar sample	Color	Flavor	Texture	Over all acceptance
fresh	9A	9 A	8.9 A	8.9 A
After 2 days	9A	9 A	8.9 A	8.9 A
After 4 da s	9A	8.9 A	8.8 A	8.6 A
After 6da s	6.1 B	5.4 B	5.1 B	5.2 A
After 8 da s	4 C	2.6 C	2.4 C	2.6 C

• The similarity of letter means there is no significant difference between the samples.

Table 6. Sensory evaluation for fresh and stored orange nectar.

Orange nectar	Color	Flavor	Texture	Over all acceptance
fresh	9 A	9 A	8.9 A	8.9 A
After 2 days	9 A	8.9 A	8.9 A	8.8 A
After 4 da s	6.2 A	6 A	6.9 B	6.8 B
After 6da s	3.1 B	2.4 B	3.7 C	3.7 C
After 8 da s	1.8 C	2.1 C	2.1 D	2.3 D

• The similarity of letter means there is no significant difference between the samples.

CONCLUSION

The analysis emphasized decrease in levels of protein, fiber, fat and ascorbic acid with extending refrigerated storage period of the studied fruit nectars. The results indicated increase of the acidity in all fruit nectars with decrease in the pH and total soluble solids (TSS) values during the same period. Extended storage time lead to observable adverse change in sensory quality and palatability of fruit nectars especially orange, while the change was very slight and not detectable in mango nectar at fourth day and observed clearly at the sixth and eighth day of storage. For guava nectar, it showed high stability since the change occurred at the sixth and eighth day of the storage.

The sensory evaluation showed clear variance of acceptance between all the samples of the fruit nectars, this acceptance was notable for fresh nectar, second and fourth day of storage for all samples of fruit nectars, except orange nectar which was accepted just as fresh and at second day of the storage, indicating that it deteriorates faster when compared with the other examined fruit nectars. It is highly recommended to use good raw fruits in order to have good quality fruit nectars, which have stable quality and extended shelf life during storage. In addition the prepared fruit nectars should be stored immediately in refrigerator at temperature around 50C.

REFERENCES

- Anon. , 1994. Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. HMSO, London.
- A.O.A.C. (1970). Association of Analytical Chemists. In the Association of Official Analytical Chemists. 11 edition. Benjamin Franklin Station. Washington, DC 20044.
- A.O.A.C. (1990). Official Methods of Analysis. 15th edn. Assosiation of Official Analytical Chemists, ,(AOAC) Washington, D,CU,S.A.
- A.O.A.C. (2000). Official Methods of Analysis (17th Ed.) Association of Official Analytical Chemists, Arlington, VA,USA.
- Dietary Guidelines for Americans (2005). United States Department of Health and human Services United States Department of Agriculture
[www . healthierus .gov / dietary guidelines](http://www.healthierus.gov/dietaryguidelines).
- Esteve , M .J. (2007). Refrigerated fruit nectars; Quality and safety issues

The Impact of Refrigerated Storage on the Chemical, Physiochemical

Ady. Food Nutr Res, 52: 103-139.

Jedah, J.H. and Robinson, R. K. (2002). Nutritional value and Microbiological Safety of Fresh Fruits Nectars, Food Contal Lab. Doha. 'Qatar. pp79-80.

Larmond, E . (1983). Libratory Methods for Sensory Evaluations of Food Minster of Supply and Services *Canada p 20-22

Lewis S. (2002). CRC Dictionary of Agricultural Sciences. CRC Press, Pp 37S-376.

Mohamed , I. H. (1993). Preservation of Pure Mango by Dehydration and its Effect on Mango Quality. M.Sc. Thesis, University of Gezira, Wad- Medani, Sudan.

STAT (1982). Miching State University. East lansing, MI, USA

Nagy, S. and Shaw, E. (1980). Tropical and Subtropical Fruit Composition Properties and Uses. AVI publishing company, INC. West Connecticut, pp,281-289.

Raff .H. Windmaier ,P . W. and Strang ,T.S. (2004) Vander , Sherman & Lucien's Human Physiology, the Mechanisms of Body Function 9th ed Mcccgrem —Hill, pp 23-25.

<http://en.wikipedia.org/wiki/Nectar.html.2008>