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Evaluation of Canned Papaya (*Carica papaya)* and Guava (*Psidium guajava* L.) Fruits in Sudan

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Abstract
The papaya (*Carica papaya*) and Guava (*Psidium guajava*) are widely grown in the Sudan, where the fruits are usually consumed in fresh form. Many producing areas in the country are known to have a surplus of production which could be wasted because of the seasonality of production, difficulties in marketing and perishable nature of the products.
The objective of the research was the effort to preserve Papaya and Guava fruits by means of canning in forms of slices in syrup, and to determine the effect of canning method on some Papaya and Guava constituents.
White Guava was brought from Food Research Centre experimental farm, while Papaya was brought from Eldamazin Research Station. Canning was done by conventional method with double seaming and heated by steam. The effect of canning method on products quality was evaluated by chemical and organoleptic analysis; there was considerable decrease in vitamin C for Papaya from 43.77 to 18.80 mg/100g, moreover, vitamin C decreased in Guava from 568.77 to 131.27 mg/100g. Acidity decreased for Papaya from 0.2650 to 0.00115, whereas in Guava there was dramatically decrease from 0.45 to 0.17; moreover, reducing sugars showed slightly decrease from 3.90 to 3.60 % and from 5.90 to 5.30 % for Papaya and Guava respectively. The total sugar revealed a significant increase from 4.00 to 9.90 % and from 8.90 to 12.70 % for Papaya and Guava, respectively. Papaya pH was increased from 5.90 to 6.20, whereas in Guava increased from 5.19 to 5.30. Furthermore, TSS showed a highly increase from 3.0 to 11.0 and from 6.0 to 12.0 for Papaya and Guava, respectively.
The effect of canning on products' quality was also evaluated by organoleptic analysis. Papaya recorded for color 8.1 out of 10, flavor 12 out of 20 and texture 14.7 out of 20. For Guava for color 8.7 out of 10, flavor 16.5 out of 20 and texture 14.2 out of 20. According to these organoleptic results, the color, flavor and texture were well accepted by the panelists.

Keywords: Canned Papaya (*Carica papaya)*, Guava (*Psidium guajava* L.), Sudan

1. Introduction
References should be like this [1]
In Sudan papaya (*Carica papaya)* and guava (*Psidium guajava* L.) fruits are consumed in fresh form. Large amounts of papaya and guava that exceed the local consumption demands are lost due to the relatively poor marketing, low prices, lack and difficulties of transportation, lack of storage facilities, low exporting opportunities and absence of processing. Preservation methods should be adopted to lengthen the shelf life of these fruits. Canning may be considered as one of the preservation tools that can be made for both fruits [1].
The preservation of papaya and guava fruits by canning is expected to have the following benefits: (a) The product become stable, not requiring refrigeration, and can be easily transported, thus making it possible for the consumers to have a varied and nutritive diet the whole year round and at all geographical locations, (b) Canning can increase papaya and guava shelf life, reduce the transportation cost and improve the living standard of the farmers by improving the price of papaya guava in the production area. (c) A product of good quality of canned papaya and guava can be exported and hence contribute in improving the national economy [2].
The present work is planned to achieve the following objectives:
Preservation of papaya and guava fruits by means of canning in form of readily reconcilable slices in syrup.
Determination of the effect of canning method on some papaya and guava constituents. Panel

2 Materials and Methods
2.1 Materials
Papaya was brought from Aldmazin Agricultural Research Station. It was treated at green mature stage. White guava was purchased from Food Research Centre experimental farm. The samples collected were kept in a refrigerator at 12º C until they were used. The used chemicals were of analytical grade. The needed equipment include: blender, refractometer and pH meter.

2.2 Methods of chemical and physical analysis of fresh papaya and guava
A) Preparation of samples
For the analysis of fresh papaya and guava fruits, the samples were peeled and the seeds were removed from papaya but not from guava. Then the fleshes of samples were blended to form homogenous samples.

B) pH value
The pH was measured using digital pH meter, the pH meter was calibrated using standard buffer solutions of pH 4.0 and 7.0.

C) Total Soluble Solids (TSS)
The total soluble solids were measured using hand refractometer at room temperature according to method described by [3].

D) Titrable Acidity and Reducing Sugars
They were measured according to the method described by [4].

E) Ascorbic Acid
It was determined according to [5].

2.3 Processing of Papaya and Guava Fruits
The following shows the materials, equipment and methods used in processing of papaya and guava fruits.

A) Materials
Papaya, guava, sucrose and citric acid.

B) Equipment
Autoclave, sealing machine, oven, refractometer, digital balance and stainless steel knifes.

C) Preparation of fruits
Firm ripe fruits (papaya and guava) were washed with tap water, the papayas were peeled and the seeds were removed by stainless steel knife and sliced. For guava fruit the seeds were not removed.

D) Preparation of syrup
Sucrose was added to boiled distilled water to make syrup with Brix 20. In this step, 3.0 mgs citric acid were added for guava and 6.0 mg for papaya.

E) Preparation of containers
The containers used were tin plate containers which were sterilized before packing the product.

F) Canning of papaya and guava
Before filling, the slices of fruits were blanched in boiling water for 2 minutes.

G) Filling and closing
The blanched slices of fruits were filled in containers, and then the syrup was added before closing, the containers were put in exhausting chain to exhaust air from containers, and then the double seaming machine was used for closing the containers.

H) Sterilization
The sealed cans were autoclaved at 120ºC for a process time of 45 minutes.

I) Cooling
After heat processing, the hot cans were quickly cooled to around 38-41ºC using cold water.

2.4 Analysis of Canned Fruits
A) Chemical and physical analysis
The papaya and guava products were blended to homogeneous samples. Chemical and physical analysis of samples were carried out (total soluble solids, pH, viscosity, titrable acidity, reducing sugars, ascorbic acid) using the same methods that used for analysis of fresh samples.

B) Microbiological Analysis
i) Preparation of serial dilutions
The serial decimal up to (10^{-6}) were prepared as described by [6]. Total viable count was carried out using the pour-plate method as described by [6].

ii) Mould and yeast count
It was carried out according to [7], PDA (Potato Dextrose Agar) was used for count of moulds and yeasts. Decimal of 0.1 ml of suitable dilutions was transferred to diluted samples and was spreaded onto surface, inoculated and incubated at 28ºC for 48-72 hours.

C) Sensory Evaluation
Quality of food product may be better understood as a measure of desir-ability of product and how that product is closely related to consumer acceptance [8]. Ratio scoring [9] was used to determine the degree of preference or acceptance of color out of (10), flavor out of (20) and texture out of (20). The scoring: excellent (20-15) or (10-8.5), very good (14-13) or (8-7), good (12-10) or (6-5), fair (9-7) or (4-3), poor (6-4) or (2), very poor (3-1) or (1).

D) Statistical Analysis
The statistical analysis was carried out by using a computer program called Statistical Package for Social Scientist (SPSS).

3. Results and Discussion
The Physical and Chemical Analysis of Papaya and Guava
3.1 Total Soluble Solids (TSS)
The total soluble solids of papaya before and after canning were 3% and 11% respectively, whereas total soluble solids of guava before and after canning were 6% and 12% as shown in Table 1 and Table 2 respectively. This result for guava is lower than the result obtained by [2] as he found that the total soluble solids before and after canning were 12% and 14.5% respectively.
It was noted that the total soluble solids in both fruits increased after canning and this may be due to the presence of fruit slices in syrup.

A) pH values
The results were presented in Table 1. The pH values of papaya fruit before and after canning were 5.9 and 6.2 respectively; this result was in agreement with [10] pH values for guava before and after canning were 5.19 and5.3 respectively as shown in Table 2. The pH values of guava were within the range of 4.7 – 5.4 reported by [11] and this result is higher than the result obtained by [2] who reported that the pH-values of guava before and after canning were 3.9 and 4.0 respectively. It was observed that the pH values for both fruits were slightly increased by canning.

Table 1: Some chemical and physical parameters of papaya slices before and after canning

	pH	TSS	Acidity	T. sugar	R. sugar	Ascorbic acid
Fresh	5.90a	3.00a	0.265a	4.00a	3.90a	43.77a
Canned	6.20a	11.00b	0.064b	9.90b	3.60a	18.80b

Values having different superscript letters in columns and rows differ significantly ($p \leq 0.05$).

Table 2: Some chemical and physical parameters of guava slices before and after canning

pH	TSS%	Acidity	T. Sugar	R. Sugar	Ascorbic acid	pH
Fresh	5.19^a	6.00^a	0.47^a	8.90^a	5.90^a	568.77^a
Canned	5.30^a	12.00^b	0.17^b	12.70^b	5.30^a	131.27^b

Values having different superscript letters in columns and rows differ significantly ($p \leq 0.05$).

B) Titrable Acidity

The importance of acidity of fruit is that it is used as a chemical index in determining harvest maturity. It also contributes to the taste and flavor in ripe fruits. The acidity of fruits expressed in terms of citric acid % or malic acid % [12].

Titrable acidity of Papaya and guava were determined before and after canning and the results are shown in Table 1 and Table 2 res-pectively. The titrable acidity of papaya slices before and after canning were 0.265 and 0.064 respectively.

The titrable acidity of guava slices before and after canning were 0.47 and 0.17 respectively. This result is lower than the results obtained by [2] who reported that the acidity of guava before and after canning were 6.00 and 4.50 respectively.

It was noted that the titrable acidity of both fruits decreased after canning and this may be due to the presence of fruit slices in syrup.

C) Total and Reducing Sugars

The principal free sugars present in the papaya fruit are sucrose, glucose and fructose [10]. The white guava contained 3.8% fructose, 3% glucose and 0.24% sucrose [13]

Total and reducing sugars in papaya and guava were determined before and after canning. Total sugars in papaya before and after canning were 4.0 and 9.90% respectively. Reducing sugars in papaya before and after canning were 3.90 and 3.60 respectively. The total sugars in guava before respectively. The reducing sugars in guava before and after canning were 5.90 and 5.30 respectively. This result is higher than the result obtained by [2] who found that the reducing sugars in guava before and after canning were 3.53 and 2.10% respectively. The result shown in Tables 1 and 2 indicate that the total sugars in both fruits were increased while reducing sugars were decreased.

D) Ascorbic Acid

The vitamin content of the fruit varies between cultivars. Papaya is good source of vitamin C, while guava is a rich source. Ascorbic acid content was determined for papaya and guava fruits before and after canning. The results are shown in Tables 1 and 2 respectively. Ascorbic acid contents of papaya before and after canning were 43.77 and 18.80 mg/100g, respectively. The result is less than that obtained by [1] who indicated that the ascorbic acid in papaya before and after processing were 69.4 and 55.3 mg/100g respectively.

For guava the ascorbic acid contents before and after canning were 568.77 and 131.27 mg/100g, respectively. This result falls within the range of [14]; [15], and higher than the result obtained by [1] who reported that the mg/100g respectively. A substantial loss in vitamin C was observed after canning due to the high temperature applied during canning.

3.2 Microbiological Test

Microbiological test for the presence of thermophilic bacteria, yeast and molds was carried out for assurance of heat processing. The result showed no growth of any type of microorganisms in cans. This indicated the efficiency of the heat treatment applied.

3.3 Sensory Evaluation

Ten panelists evaluated the color, flavor and texture of canned papaya and guava fruits. The scores for the papaya were as follows: color (8.1) out of (10), flavor (12) out of (20), and texture (14.7) out of (20).

For guava: color (8.7) out of (10), flavor (16.5) out of (20) and texture (14.2) out of (20).

4. Conclusions and Recommendations

4.1 Conclusions

The objectives of this research were to preserve papaya and guava fruits by canning in form of slices in syrup and to determine the effects of canning on the quality of the processed products. To achieve these objectives a number of analyses were conducted before and after canning, these are: total soluble solids, pH, titrable acidity, total and reducing sugars and ascorbic acid.

It was found that the total soluble solids were increased. This is attributed to the presence of slices in syrup. The acidity was decreased; this also may be attributed to presence of slices in syrup. Most of the vitamin C (ascorbic acid) was lost in processed products. This attributed to high temperature used in canning process. Sensory evaluation was used to determine the acceptance of the panelists for canned products. Ratio scoring was used to determine the effect of canning on color, flavor and texture of products. It was found that the color and flavor for guava is perfect, the texture is very good; for papaya the color and texture were very good and flavor was good.

4.2 Recommendations

It is recommended that:

1. Intensive and integrated work is required to test other preservation methods than canning.
2. More studies should be carried out with addition of artificial colors and flavors. These are cheap, but they should be safe for human consumption.
3. The shelf life of the canned products should be studied under different storage conditions in order to determine the most suitable methods for storage and packaging.
4. The effect of canning on quality of products should be determined using advanced equipment and techniques such as high performance liquid chromatography (HPLC) and gas liquid chromatography; this will give more qualitative and quantitative accurate results.

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