

RESEARCH ARTICLE

## Chemical and Sensory Properties of Jam and Nectar Processed from Guava Fruit Fly Resistant Genotypes

Abdelaziz Gesmalla<sup>1,2\*</sup>, Azhari Siddeeg<sup>1,3</sup>, Mohammed H. Mekki<sup>1,3</sup>, Iqbal A. Abdelatif<sup>1,4</sup>,  
Ali O. Ali<sup>1,3</sup>, Ali E. Eljack<sup>1,4</sup> and Ammar Al-Farga<sup>5</sup>

<sup>1</sup>University of Gezira, P.O. Box-20, Wad-Medani, Sudan; <sup>2</sup>The National Institute for Promotion of Horticultural exports; <sup>3</sup>Dept. of Food Engineering and Technology, Faculty of Engineering and Technology; <sup>4</sup>Dept. of Horticultural Science, Faculty of Agricultural Sciences; <sup>5</sup>School of Food Science and Technology, Jiangnan University  
azizatnipe@gmail.com\*

### Abstract

Various genotypes of guava fruits from North Kordofan and Sennar States were used in jam and nectar processing. The selection of genotypes was based on resistance to the fruit fly pest in addition to the quality of the fruits. The acidity, pH, total soluble solid, vitamin C and sensory evaluation were studied. The total solid soluble were in the range 68-69. Results on pH of jam made from the different genotypes of Guava (4, 7, 12, 17 and 19) were 3.34 3.42 3.40, 3.46 and 3.40 respectively. Vitamins C analysis of Kordofan genotypes were in the range 22-37 mg/100 g. The highest score in the sensory evaluation was recorded by jam made of White flesh (genotype 19) followed by jam made of White flesh (genotype 18). Findings showed that the sensory evaluation were in the order of White flesh (genotype 19)>White flesh (genotype 18)>White flesh (genotype 17)>White flesh (genotype 12)>White flesh (genotype 7)>White flesh (genotype 4).

**Keywords:** Guava fruits, Kordofan, Sennar, sensory properties, genotypes.

### Introduction

Fruits and vegetables have a potential to become an important source of income generation for African farmers as well as improving their diet by providing micronutrients and vitamins. Nutritional value of fruits is generally high in fiber, water, minerals and vitamins. Fruits also contain various phytochemicals which are required for proper long-term cellular health and disease prevention. Regular consumption of fruit is associated with reduced risks of cancer, cardiovascular disease, stroke, Alzheimer disease, cataracts and some of the functional declines associated with aging (Sackman, 2005). The main production areas of guava are centered in northern and River Nile States, central States, Kassala and at Jabel Mara in western Sudan where guava are grown commercially (Ahmed, 2002). Fruit flies (Diptera: Tephritidae) are the key pests including some species of quarantine importance. In Sudan the fruit fly damage on guava fruits exceed 80% in some production areas such as Sennar State (Gesmallah, 2009). In Sudan, there are five big jam factories, in addition to many small scale jam industries, most of them are in Khartoum State. Proposed capacities of these factories are 5305 tons per year, while the actual production is 935 tons in 1995. Although, there are many jam factories, Sudan imports appreciable quantities of jam. The reports showed that total importation of jam were 4318 tons in 1994 and 4820 tons in 1995 (Azhari, 2009). The idea behind that is to select a number of guava genotypes with fruit fly resistance in order to reduce the residues of the immature fruit fly stages (eggs and larvae) on the processed guava fruits.

The objective of the present study is to use the selected guava genotypes in the production of jam and nectar and assess the chemical and sensory characteristics of the jam and nectar products.

### Materials and methods

**Collection of fruits:** Guava were collected from different guava genotypes grown in Sennar and North Kordofan States, Republic of Sudan and the selection of guava genotypes was based on fruit fly resistance and the quality of the fruits, where the infestation indices were estimated by means of total number of pupae per fruit and accordingly the genotypes were classified into resistant, moderately resistant, susceptible and highly susceptible and then transported to Food Engg. and Technol. laboratory in University of Gezira, Gezira State, Republic of Sudan. This study is a part of research project financed by the Ministry of higher Education and scientific Research- Sudan, the project aiming at evaluation of guava genotypes grown in North Kordofan and Sennar States. A number of genotypes (white and red flesh fruit) were selected.

**Processing of guava jam:** Jams were prepared at the Food Engineering and Technology Laboratory of the University of Gezira, Wad Medani, Sudan, following good manufacturing practices. A fully matured guava was peeled and sliced using a fruit and vegetable cutter machine (KG 40. Nihon Conk co. Ltd., Japan) after discarding the seeds.

The slices were blanched. Guava puree was obtained by passing the blanched slices through narrow orifices of pulper (PPT-180. Seikensha Co. Ltd., Japan). Then, total soluble solids (TSS) and pH of the puree were measured (Azhari, 2009).

Addition of pectin to the jam was done according to the method of Saeed and Elmubarak (1974). Boiling is desirable in order to cause intimate mixing of the fruit pulp and the sugar and to partially concentrate the product by evaporation to remove excess moisture. Refractometer was used to determine the finishing point (67% soluble solids). Hot jam was poured in glass jars, tightly closed without delay and cooled.

**Processing of nectar:** Fresh guava fruits were first processed into concentrated juice in the laboratory of Food Engineering and Technology, University of Gezira, Wad Medani, Sudan, for the production of pasteurized nectar. In order to monitor the process, 17 steps of nectar processing were identified and defined which resulted with a total of all samples for analysis, each with 5 independent replicates. Samples were snap frozen in liquid nitrogen and ground to a fine powder. These were subsequently transported on dry ice, where the samples were stored at  $-80^{\circ}\text{C}$  until analysis. All samples were then freeze dried at  $-80^{\circ}\text{C}$ , b1 mP pressure for 20 h using a freeze-dryer (Snijders Scientific, LY-5FM).

**Chemical analysis:** All the analysis was performed according to regulations of the AOAC (1998). pH was measured using a digital pH meter, total soluble solids ( $^{\circ}\text{Brix}$ ) was measured by refractometry using a ABBE refractometer, water activity ( $A_w$ ) was measured using Aw Sprint-Novasina TH-500 equipment, acidity (% citric acid) with solution NaOH (0.1 M), ash by muffle, moisture by drying kiln. All chemical analysis was performed in triplicate and results were expressed as mean  $\pm$  standard deviation.

**Sensory analysis:** Jam and nectar products 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 designed by the Dept. of Food Engineering and Technology, Faculty of Engineering and Technology, University of Gezira, Wad Medani, Sudan. A sensory acceptance test, 9-point Hedonic Scale Test, permitted the comparative evaluation of both formulations with regard to the aspects of appearance, aroma, flavor and texture. The scale ranged from 1-dislike extremely to 9-extremely like.

**Statistical analysis:** All experiments were conducted at least in triplicate and statistical analyses were performed using SPSS version 16.0 software for Windows (SPSS Inc., Chicago, IL, USA). One-way analysis of variance (ANOVA) was used to determine the significant differences between means and Tukey's test was used to perform multiple comparisons between means. The significance level was defined as  $p < 0.05$ .

## Results and discussion

**Chemical analysis of jam and nectar:** Eleven guava genotypes were selected and used during this study for food processing. Table 1 and 2 showed the level of fruit fly resistance and some characteristics of the selected genotypes. The data presented in Table 3 shows the results of the chemical analysis of jam processed from various samples of Guava from North Kordofan state. The pH of jam made from different kinds of Guava (genotypes: 4, 7, 12, 17 and 19) were 3.34 3.42 3.40, 3.46 and 3.40 respectively. These results are similar to those required for quality control of jam. Saeed and Elmubarak (1974) stated that the pH of jam should be kept in the range of 3.2 to 3.4. The results obtained in this study fall within the range reported by Herschdoerfer (1972) who pointed out that the normal pH range is 3.1-3.2 with extreme values of 3.0 to 3.4.

Table 1. Some characteristics of the selected genotypes in Sennar state.

General observation	Fruit weight (g)	Fruit fly infestation rate	Flesh color	Genotype number
Very productive and small size fruit	21	Moderately Resistant	Red	1
Medium size fruit	32	Resistant	Red	4
Small size fruit	28	Highly Susceptible	Red	7
Big size fruit	112	Susceptible	White	11
Big size fruit	100	Susceptible	White	17

Table 2. Some characteristics of the selected genotypes in Kordofan State.

General observation	Fruit weight (g)	Fruit fly infestation rate	Flesh color	Genotype number
Big size fruit	85	Resistant	white	4
Highly productive and small size fruit	25	Highly susceptible	Red	7
Small size fruit	31	Resistant	white	12
Big size fruit	75	Resistant	Red	17
Big size fruit	87	Highly susceptible	white	18
-	45	Resistant	-	19

-Data not available.

Table 3. Chemical analysis of jam processed from various samples of Guava from North Kordofan state.

Genotypes	Acidity	TSS	pH
White flesh (4)	76.72±0.11	68.40±0.33	3.34±0.16
White flesh (7)	71.78±0.13	69.20±0.16	3.42±0.32
White flesh (12)	79.36±0.21	68.20±0.33	3.40±0.13
White flesh (17)	90.88±0.15	63.50±0.13	4.46±0.14
White flesh (18)	90.88±0.15	63.50±0.13	4.46±0.14
White flesh (19)	78.08±0.19	68.30±0.15	3.40±0.17

Table 4. Chemical analysis of nectar processed from various samples of Guava from North Kordofan state.

Genotypes	Acidity	TSS	pH	Vitamin C
White flesh (4)	23.89±0.11	4.40±0.31	4.9±0.18	34.35±0.11
White flesh (7)	34.13±0.13	3.90±0.18	4.46±0.39	37.71±0.31
White flesh (12)	34.99±0.24	4.46±0.33	3.50±0.19	24.92±0.13
White flesh (17)	32.43±0.17	4.43±0.13	4.50±0.14	25.01±0.17
White flesh (18)	32.43±0.17	4.43±0.13	4.50±0.14	25.01±0.17
White flesh (19)	29.01±0.14	4.34±0.15	3.90±0.17	35.47±0.14

Table 5. Chemical analysis of jam processed from various samples of Guava from Sennar state.

Genotypes	Acidity	TSS	pH
White flesh (4)	30.29±0.13	66.41±0.13	3.38±0.13
White flesh (7)	22.17±0.13	66.40±0.13	3.35±0.13
White flesh (12)	29.87±0.13	65.0±0.13	3.40±0.13
White flesh (17)	23.89±0.13	65.0±0.13	3.56±0.13
White flesh (18)	29.87±0.13	66.11±0.13	3.38±0.13

Table 6. Chemical analysis of nectar processed from various samples of Guava from Sennar state.

Genotypes	Acidity	TSS	pH	Vitamin C
White flesh (4)	6.51±0.18	3.41±0.12	4.70±0.13	56.07±0.11
White flesh (7)	3.52±0.11	3.91±0.08	4.70±0.33	130.13±0.10
White flesh (12)	5.98±0.14	3.92±0.18	4.73±0.22	99.06±0.17
White flesh (17)	2.99±0.15	3.90±0.14	4.94±0.15	36.27±0.16
White flesh (18)	4.92±0.09	4.40±0.17	3.41±0.16	99.40±0.11
White flesh (19)	6.51±0.18	3.41±0.12	4.70±0.13	56.07±0.11

Table 7. Mean score for sensory attributes of jams processed from various samples of Guava from North Kordofan state.

Genotypes	Appearance	Texture	Color	Flavor	Overall acceptability
White flesh (4)	5.4	6.9	6.3	6.3	6.5
White flesh (7)	6.5	7.7	7.5	7.6	7.8
White flesh (12)	7.2	7.4	6.9	7.1	7.7
White flesh (17)	7.5	7.3	6.8	6.6	7.2
White flesh (18)	7.2	7.4	6.9	7.1	7.7
White flesh (19)	7.5	7.3	6.8	6.6	7.2

Table 8. Mean score for sensory attributes of jams processed from various samples of Guava from Sennar state.

Genotypes	Appearance	Texture	Color	Flavor	Overall acceptability
White flesh (4)	5.4	6.9	6.3	6.3	6.5
White flesh (7)	6.5	7.7	7.5	7.6	7.8
White flesh (12)	7.2	7.4	6.9	7.1	7.7
White flesh (17)	7.5	7.3	6.8	6.6	7.2
White flesh (18)	7.2	7.4	6.9	7.1	7.7
White flesh (19)	7.5	7.3	6.8	6.6	7.2

Total soluble solids of Kordofan samples were in the range 68-69 brix, Fox and Cameron (1982) pointed out that in Great Britain, jam must contain not less than 68.5% soluble solids unless packed in hermetically sealed containers in which case, it must contain not less than 65%. The total soluble solids of Kordofan samples were similar to that obtained by Ahmed (2002) who recorded 66 brix for the total soluble solids of pectin jam extracted from grapefruit. As shown in Table 4, vitamin C contents of Kordofan genotypes were in the range of 22-37 mg/100 g. These results were more than those obtained by Ahmed (1999) who recorded a range of 0.03 mg/100 g–0.04 mg/100 g ascorbic acid for grapefruit pectin jam and orange pectin jam, respectively. The pH of Sennar genotypes were 3.38, 3.35, 3.40, 3.56, and 3.38 for the white flesh samples 1, 4, 7, 11 and 17, respectively. These results were in the range of those obtained by Azhari (2009) who recorded a range of 3.40-4.60 for orange jam and grapefruit jam, respectively. Total soluble solids of Sennar genotypes were measured (Table 5).

TSS was in the range from 65.0-66.41. Great Britain jam must contain not less than 68.5% soluble solids unless packed in hermetically sealed containers in which case, it must contain not less than 65% (Ibnoof, 2007). The acidity of Sennar types was reported as 30.29, 22.17, 29.87, 23.89 and 29.87 for the white flesh samples 1, 4, 7, 11 and 17, respectively (Table 5). The acidity, TSS, pH, and vitamin C of Sennar genotypes were reported in Table 6. Acidity of nectar samples was in the range of 2.99-6.51, TSS; 3.41-4.40, pH; 3.41-4.94, vitamin C; 56.07–130.13. Buchanan and Durward (2006) reported that the resulting low pH value of jam inhibits the growth of food spoiling bacteria, most of which are acid sensitive; in addition, other bacteria cannot successfully grow like *Staphylococci*, *Salmonella* and *E. coli*.

**Sensory evaluation:** Sensory evaluation is carried out by the senses of taste, smell, touch, and hearing when food is eaten. The complex sensation that results from the interaction of the senses is used to measure the food quality in programs for quality control and new product development. The results of the taste panel of jam products are shown in Table 7 and 8. The sensory analysis indicated that all types of jams processed from Sennar genotypes were accepted by panelists. Results showed that the sensory evaluation were in the order of White flesh (genotype 19)>White flesh (genotype 18)>White flesh (genotype 17)>White flesh (genotype 12)>White flesh (genotype 7)>White flesh (genotype 4). Most panelists preferred the jam made using White flesh (genotype 1) due to its appealing flavor, color and appearance.

## Conclusion

In this study, various types of guava fruits from North Kordofan and Sennar city were used in jam and nectar processing. The results of sensory evaluations ensured a potential consumption of guava jam and nectar. Most panelists preferred the jam made using White flesh (genotype 1) due to its appealing flavor, color and appearance. Based upon the findings on chemical analysis and sensory evaluation, good quality jams and nectar can be made from these genotypes of guava.

## Acknowledgements

Authors thank the Ministry of Higher Education and Scientific Research, The Republic of Sudan for the financial support.

## References

1. Ahmed, H.M.O. 1999. Extraction, fractionation and characterization of pectin substances of Grape fruit Peels. M.Sc. Thesis. Faculty of Agriculture, University of Khartoum, Sudan.
2. AOAC. 1998. Official methods of analysis of AOAC International. Association of official analytical chemists.
3. Ahmed, G.M.E. 2002. Utilization of grapefruit residue as pectin source in jam processing. M.Sc. Thesis. Faculty of Engineering and Technology, University of Gezira, Wad Medani, Sudan.
4. Fox, B.A. and Cameron, A.G. 1982. Food Science: Chemical Approach. 4<sup>th</sup> ed. Hodder and Stoughton. London. U.K.
5. Gesmallah, A.E. 2009. Identification, damage, host range, seasonality and chemical control of mango fruit fly specie in Sennar state, Sudan, Ph.D. Thesis, University of Gezira, Sudan.
6. Herschdoerfer, S.M. 1972. Quality control in the food industry. Vol. 3. Academic Press. London and New York.
7. Ibnoof, S.M. 2007. Extraction of pectin from Tamarind "*Tamarindus indica* L" pulp and its use in jam production. M.Sc. Thesis. Faculty of Engineering and Technology, University of Gezira, Wad Medani, Sudan.
8. Sackman, D.C. 2005. History of Citrus Industry in California, U.S.A.
9. Saeed, A, and A. Elmubarak. 1974. A guide to Manufacture of Jams for the Industry. Technical Report No, 3. Food Research Center. Khartoum, Sudan.
10. Azhari S. A. 2009. Extraction of pectin from some local fruits and their usage in jam production. M. Sc. Thesis. Faculty of Engineering and Technology. University of Gezira. Sudan.