

Extraction of pectin from some local fruits and its use in jam processing

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ABSTRACT

In the present study, pectin was extracted from orange, grapefruit and guava fruits and used in jam processing. The percentages of pectin extracted from orange, grapefruit and guava powder were 28%, 26.4% and 2.8%, respectively. Jam made using pectin extracted from grapefruit (GrPJ), orange (OPJ) and guava (GuPJ) contained 66%, 67% and 67% total soluble solids, respectively. The reducing sugar contents of GrPJ, OPJ and GuPJ were 4.7%, 5%, and 4.1%, respectively, while the total sugar contents were 8.7%, 8.5% and 8.4%, respectively. The pH values of GrPJ, OPJ and GuPJ were 3.5, 3.4 and 3.6, respectively. Moisture contents of GrPJ, OPJ and GuPJ were 53.7%, 45.8% and 47.4%, respectively, and the ash contents were 0.23%, 0.18%, and 0.21%, respectively. The contents of sodium were 36, 34 and 35 mg/100g in OPJ, GrPJ and GuPJ, respectively, while the contents of potassium were 60, 68 and 69 mg/100 g, respectively. The contents of calcium were 80, 79 and 78 mg/100 g, respectively. The content of vitamin C of OPJ, GrPJ and GuPJ were 0.01, 0.02, and 0.02 mg/100g, respectively. Microbial analysis revealed that all jam samples were devoid of *coliforms*, *staphylococci*, yeasts and moulds. The sensory analysis indicated that all types of jams were accepted by panelists who preferred them in the order of jam made using commercial pectin followed by jam made using pectin extracted from orange, grapefruit and guava. Most panelists preferred the jam made using commercial pectin due to its appealing color and appearance.

INTRODUCTION

Fruits and vegetables have a 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. Nutritional value of fruits is generally high in fiber, water, minerals and vitamin C. Fruits also contain various photochemicals and they 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). Many fruits, such as oranges and grapefruits are generally eaten fresh. They are typically peeled and can be easily split into segments. Grapefruit is more commonly halved and eaten out of the skin with a spoon. Pectin is a heterosaccharide derived from the cell wall of plants. Pectins vary in their chain length, complexity and the order of each of the monosaccharide units. Under acidic conditions, pectin forms a gel, and it can be used as an edible thickening agent in processed foods. This effect is used for making jams and jellies. Citrus fruits are produced all over the Sudan. The main production areas are centered in northern and River Nile States, central States, Kassala, and at Jabel Mara in western Sudan (Ahmed, 2002). In the Sudan, there are five big jam factories, in addition to many small scale jam industries, most of them concentrated 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 (Ahmed, 2002). The objectives of the present study were to extract pectin from orange, grapefruit, and guava fruits and use it in the production of jam and assessment of the chemical, microbiological and sensory characteristics of the jam product.

MATERIALS AND METHODS

Materials

Four dozens of three kinds of fruits guava, orange, and grapefruit were purchased from Wad Medani vegetables and fruits market in March, 2009 and transported to the laboratory in baskets. The fruits were freed from extraneous materials and washed using tap water pending extraction of pectin and analyses.

Preparation of fruits

Firm ripe fruits (guava, grapefruit and orange) were washed using tap water. Guava was mixed and seeds were removed manually. The flesh was sliced into cubic shapes. Oranges and grapefruits were peeled and the flesh was sliced.

Weight of fruits

Ten mature grapefruit, orange and guava fruits were thoroughly washed. Each fruit was weighed separately. The fruits were halved with a stainless steel knife and juice was extracted. Juice, seeds, and residue of the fruits were weighed.

Extraction of pectin

Extraction of pectin was done according to Mc Comb and Mc Cready (1952). Total pectin was determined as g/100g sample. Oranges and grapefruits were peeled and dried for four days and powdered. A sample of 500 g each of orange and grapefruit powder and 1 kg of guava were used. Then, 5 liter of distilled water and 50 ml HCl were added for each blend and then mixed and left for 24 hours, then filtered. One liter of juice was added to 1 liter ethanol (95%); the mixture was centrifuged, then left for one hour and filtered through Buchner funnel. Acidified ethanol was added to the residues. The filtrate was then washed with 250 ml acetone and dried at room temperature for 24 hours. The product was ground into fine powder and sieved through 40 mesh sieve to separate pectin from fiber.

Processing of jam

A fully mature pumpkin 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. Pumpkin 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. Addition of pectin to the jam was done according to the method used by Saeed and Elmubarak (1974). In this method, 10 parts of commercial pectin were mixed with 20 parts sugar in a dry container and the mixture was added slowly to 70 parts water which was heated in advance to boiling with constant agitation till the pectin was completely dissolved. Boiling is desirable in order to cause intimate mixing of the fruit pulp and the sugar and to partially concentrate the product by evaporation of excess moisture. Aluminum open-kettle was used. An abbe refractometer was used to determine the finishing point (67% soluble solids). Hot jam was poured in glass jars, tightly closed without delay, put upside down, and cooled.

Analysis of the product

The quality of jams produced using the pectin extracted from orange, grapefruit, and guava fruits or commercial pectin were examined using chemical, microbiological and sensory methods. The pH, total soluble solids, moisture and ash were determined. Titratable acidity was determined as citric acid. Ten grams of the jam were diluted with recently boiled distilled water to 250 ml; the solution was titrated using 0.1 N sodium hydroxide using phenolphthalin indicator.

Consistency was examined using ADAMS consistometer (Kramer and Twigg, 1962). The distance traveled by the paste in one minute was measured. Reducing sugars were estimated by Nelson's method in which 1 ml sample was pipetted in a test tube, 1 ml of copper reagent and 1 ml of Harding's reagent were then added. The contents of the test tube were shaken and heated in boiling water for 10 minutes. After cooling, 1 ml of Nelson's reagent was added to each tube. After the addition of Nelson's reagent, the volume in the tube was completed to 10 ml with distilled water. The tubes were allowed to stand for 10 minutes to complete color development. The absorbency of the tube content was recorded at 600 nm against a distilled water blank tube (control) using a spectrophotometer. The sugar value was estimated from the glucose standard curve plotted earlier. Reducing sugar percent was calculated as follows:-

$$\text{Reducing sugar (\%)} = \frac{50}{V} \times \frac{y}{w} \times \frac{100}{1000 \times 100}$$

where:

V = Volume of tested sample.

Y = glucose concentration.

W = weight of sample.

The ascorbic acid (vitamin C) was determined by using the titration method, in which 30 g of the pulp sample was blended with a reasonable amount of 0.4% oxalic acid and then filtered using Whatman No.1 filter paper. The volume of the filtrate was completed to 250 ml with 0.4% oxalic acid. A sample of 20 ml of the filtrate was pipetted into a beaker and then titrated with a dye solution (0.2g 2,6-dichlorophenol-indophenol dissolved in 500ml solution) to a faint pink color. The ascorbic acid content was calculated using the following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titer (ml)} \times \text{dye strength}}{\text{Dilution factor}} \times 100$$

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

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 a faint pink color

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

Determinations of potassium, sodium, and calcium concentrations were accomplished by means of flame photometer (Model Corning, 400).

Microbiological analyses

Ten gram samples of orange, grapefruit and guava were homogenized with 90 ml of distilled water by shaking for several minutes, from this suspension, 1 ml was taken from the dilution and transferred to another tube to make serial dilutions, each contains 9 ml of distilled water.

The total viable count per ml of sample was obtained by pouring suitable dilutions in triplicates on plate count agar (oxoid) following the method of Inspect (1967). MacConkey agar was used for the enumeration of coliforms and Baird parker agar for *Staphylococcus* and *Salmonella*. Incubation was accomplished at 30°C for 48 hours. Plates containing between 30 and 300 colonies were counted (c.f.u) per ml of sample. The yeasts and moulds counts were enumerated by culturing on potato dextrose agar (PDA) medium and incubating for 72 hours at 25°C, then the yeasts and moulds were counted. Plates containing between 30 and 3000 colonies were counted as colony forming units (c.f.u) per ml of sample.

Sensory analysis

Jam 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 Department of Food Science and Technology, Faculty of Engineering and Technology, University of Gezira, Wad Medani, Sudan.

RESULTS AND DISCUSSION

Weight analysis

The data presented in Table 1 show the weight of grapefruit, orange and guava juice, seeds and residue. The average weights of grapefruit, orange and guava were 315.9 g, 316.4 g and 135.9 g, respectively. The average weight of grapefruit was similar to that obtained by Ismail and Habeeb (1968) who recorded 315 g for average weight of three grapefruit cultivars. The percentages of the peel of grapefruit, orange and guava were 69.45%, 69.5 % and 67.42%, respectively. While the percentage of grapefruit, orange and guava juice were 27.54%, 27.5% and 21.33% respectively. Percentage of grapefruit juice was less than that obtained by Hendrickson and Kesterson (1966) who reported 49.3% in a seedy variety of grapefruit and orange.

The percentages of seeds were 3.01%, 3% and 11.25% in grapefruit, orange and guava, respectively. The average weight of the seeds was less than that obtained by the former authors who recorded 6.32 g in Duncan cultivar. Hendrickson and Kesterson (1966) pointed out that the percentage of seeds in whole fruits sampled early in the season was twice as those sampled late in the season.

Table 1. Weight of grapefruit, orange and guava.

Component	Grapefruit		Orange		Guava	
	Weight (g)	%	Weight (g)	%	Weight (g)	%
Fruit	315.9	100.0	316.4	100.0	135.9	100.0
Peel	219.4	69.4	219.9	69.5	91.4	67.4
Juice	87.0	27.5	87.0	27.5	29.0	21.3
Seeds	9.5	3.0	9.5	3.0	15.5	11.2

Yield of pectin

As shown in Table 2, the amount of pectin extracted from 500 g orange powder was 140 g which is equivalent to 28% of total orange powder weight. The amount of pectin extracted from orange was similar to that obtained by Ahmed (1999) who recorded a value of 29.3% for pectin extracted from grapefruit. On the other hand, the amount of pectin extracted from 500 g grapefruit powder was 132 g which is equivalent to 26.4% of total grapefruit powder weight.

However, the amount of pectin extracted from grapefruit was similar to that obtained by Ahmed (2002) who recorded 27.6% for the percentage of pectin extracted from grapefruit. The amount of pectin extracted from 1 kg guava powder was 28 g which is equivalent to 2.8% of total guava powder weight. These results were similar to those obtained by Nagy and Shaw (1980) who determined a range of 0.5 - 1.8% for pectin in guava. The variation in pectin contents extracted from the various fruits could be attributed to the differences in the chemical constituents of fruits.

Table 2. Weights and percentages of pectin extracted from grapefruit, orange and guava.

	Weigh of pectin (g)	Percentage of pectin
Grapefruit	132.0	26.4
Orange	140.0	28.0
Guava	28.0	2.8

Chemical analysis of the jam product

The data presented in Table 3 show the results of the analysis of jam quality. The pH of jam made from pectin extracted from grapefruit (GrPJ), jam made from pectin extracted from orange (OPJ), jam made from pectin extracted from guava (GuPJ) and commercial pectin jam (CPJ) were 3.5, 3.4, 3.6, and 3.4, 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.

Total soluble solids of GrPJ, OPJ, GuPJ and CPJ were 66, 67, 67 and 68 brix, respectively; 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 GrPJ was similar to that obtained by Ahmed (2002) who recorded 66 brix for the total soluble solids of pectin jam extracted from grapefruit.

Table 3. Chemical composition of jam.

Parameters	GrPJ	OPJ	GuPJ	CPJ
pH	3.5	3.4	3.6	3.4
TSS (%)	66.0	67.0	67.0	68.0
Titratble acidity (%)	0.4	0.5	0.5	0.6
Consistency (cm/min)	7.0	6.5	5.5	6.0
Moisture (%)	53.7	45.8	47.4	45.2
Ash (%)	0.2	0.1	0.2	0.1
Total sugar (%)	8.7	8.5	8.4	12.0
Reducing sugar (%)	4.7	5.0	4.1	1.3
Vitamin C (mg/100g)	0.01	0.02	0.02	0.03

OPJ: orange pectin jam, GrPJ: grapefruit pectin jam, GuPJ: guava pectin jam and CPJ: commercial pectin jam.

Titratble acidity values expressed as citric acid (%) of GrPJ, OPJ, GuPJ and CPJ were 0.4%, 0.5%, 0.5% and 0.6%, respectively. These results were within the range required for jam manufacture. Cruess (1958) stated that the finished jelly will contain at least 0.5% total acidity, but preferably 0.75–1%.

As shown in Table 3, the consistency of GrPJ, OPJ, GuPJ and CPJ were 7, 6.5, 5.5 and 6 cm/min, respectively. The results were similar to that obtained by Ahmed (2002) who recorded 7, 6.5, 5 and 6 cm/min for the pectin jam extracted from grapefruit.

The moisture contents of GrPJ, OPJ, GuPJ and CPJ (Table 3), were 53.7%, 45.8%, 47.4% and 45.2%, respectively. These results were similar to those obtained by Ahmed (1999) who reported 53.37% and 45.25% for orange pectin jam and grapefruit pectin jam, respectively. Poore(1934) pointed out that the moisture content of grapefruit pectin jam ranged between 50%-52%. Generally, the moisture content of jam varies from 45% to 50% and is shown to be variable even in the same variety depending upon locality and other environmental factors (Joslyn, 1970).

As shown in Table 3, the ash content of GrPJ, OPJ, GuPJ and CPJ were 0.23%, 0.18%, 0.21% and 0.13%, respectively. These results were less than those obtained by Ahmed (1999) who recorded 1.02% and 1.05% ash content for orange pectin jam and grapefruit pectin jam, respectively. This variation in pectin ash contents extracted from the various fruits could be attributed to the differences in the chemical constituents of fruits.

The total sugar contents of GrPJ, OPJ, GuPJ and CPJ which are presented in Table 3 were 8.7%, 8.5%, 8.4% and 12%, respectively. The results were in agreement with those reported by Saeed and Elmubarak (1974) who found that the total sugar of jam ranged from 5 to 11%, and also agreed with the range of normal total sugar (4.5 - 11%) as reported by Ahmed (2002).

The reducing sugar contents of GrPJ, OPJ, GuPJ and CPJ were 4.7%, 5%, 4.1% and 12% respectively. These percentages agreed with those reported by Ahmed (2002) who found that reducing sugars in jam were not less than 4.5%.

As shown in Table 3, vitamin C contents of GrPJ, OPJ, GuPJ and CPJ were 0.01mg/100, 0.02mg/100, 0.02mg/100 and 0.03mg/100, respectively. These results were slightly less than those obtained by Ahmed (1999) who recorded a range of 0.03 mg/100g – 0.04 mg/100g ascorbic acid for grapefruit pectin jam and orange pectin jam, respectively.

The minerals content of GrPJ, OPJ, GuPJ and CPJ were presented in Table 4. The contents of sodium were 36, 34 and 35 mg/100g in OPJ, GrPJ and GuPJ, respectively, while the contents of potassium were 60, 68 and 69 mg/100 g, respectively. The contents of calcium were 80, 79 and 78 mg/100 g, respectively. The results were in agreement to those reported by Saeed and Elmubarak (1974).

Table 4. Minerals contents of jams.

Minerals (mg/100g)	GrPJ	OPJ	GuPJ	CPJ
Sodium	34	36	35	44
Potassium	68	60	69	43
Calcium	79	80	78	64

OPJ: orange pectin jam, GrPJ: grapefruit pectin jam,
GuPJ: guava pectin jam and CPJ: commercial pectin jam.

Microbial analysis of jam

The microbial analyses of jam made from commercial pectin (CPJ) and extracted pectin (OPJ, GrPJ and GuPJ) are shown in Table 5. The analyses revealed the presence of (4×10^4), (4×10^4), (3×10^4) and (4×10^4) c.f.u/g of total viable counts in OPJ, GrPJ, GuPJ and CPJ, respectively. This result is similar to that obtained by Ibnoof (2007) who reported 3×10^4 c.f.u/g and 3×10^4 c.f.u/g for tamarind pectin jam and commercial pectin jam, respectively. The increase of total microbial load in OPJ, GrPJ and GuPJ could be attributed to post contamination or cross-contamination during the extraction process. Moreover, usually heat treatment employed during production of commercial pectin reduces the microbial load and eliminates the spoilage and pathogenic bacteria (Folkertsma *et al.*, 1966).

The Table also shows absence of *coliforms* in OPJ, GrPJ and GuPJ and CPJ. *Coliforms* are a group of microorganisms which include *E.coli* and *Salmonella*. It also shows absence of *Staphylococcus* and yeasts and moulds in all tested jam samples. It is known that *Staphylococci* cannot grow in a medium with a high sugar concentration. *Staphylococcus* sp cause food poisoning from enterotoxin B in food. Yeast and moulds are fungi which are responsible for the food spoilage and produce mycotoxin (Buchanan and Durward, 2006). Yeasts spoil food rapidly, and both yeast and mould grow well in acidic food with low water activity (Cliver, 1990). Yeasts and moulds are considered as spoilage organisms resulting in flavor and textural deterioration including softening, discoloration and slime formation.

Table 5. Microbial load (c.f.u/g) of jam made from extracted pectin and commercial pectin.

Jam sample	Total viable counts (c.f.u/g)	<i>Coliforms</i> counts (c.f.u/g)	<i>Staphylococci</i> counts (c.f.u/g)	Yeast and mould counts (c.f.u/g)
GrPJ	3×10^4	Nil	Nil	Nil
OPJ	4×10^4	Nil	Nil	Nil
GuPJ	4×10^4	Nil	Nil	Nil
CPJ	2×10^4	Nil	Nil	Nil

OPJ: orange pectin jam, GrPJ: grapefruit pectin jam, GuPJ: guava pectin jam and CPJ: commercial pectin jam.

Sensory evaluation of jam

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 food quality in programs for quality control and new product development. The results of the taste panel of jam product using pectin extracted from grapefruit, orange and guava residue paste is shown in Table 6. There was no significant differences in texture, color, flavor, and overall acceptability between the four types of jams (GrPJ, CPJ, GuPJ and OPJ), but there was a significant difference ($P \geq 0.01$) in appearance between GrPJ and OPJ. The sensory analysis indicated that all types of jams were accepted by panelists who preferred them in the order: jam made from commercial pectin followed by jam made from pectin extracted from orange, grapefruit and guava. Most panelists preferred the jam made from commercial pectin due to its appealing color and appearance.

Table 6. Mean score for sensory attributes of various samples of jams.

Sample	Appearance	Texture	Color	Flavor	Overall acceptability
GrPJ	5.4	6.9	6.3	6.3	6.5
CPJ	6.5	7.7	7.5	7.6	7.8
GuPJ	7.2	7.4	6.9	7.1	7.7
OPJ	7.5	7.3	6.8	6.6	7.2

GrPJ: grapefruit pectin jam, CPJ: commercial pectin jam, GuPJ: guava pectin jam and OPJ: orange pectin jam.

CONCLUSION

The process of extracting pectin from some fruits, such as grapefruit, orange and guava is considered to be of enormous economic feasibility in view of the ease of the process of extraction and the abundance of these fruits, especially in the seasons of production compared to the high prices of commercial pectin which is imported from abroad. So it is necessary to take advantage of these available resources and to encourage local small-scale industries, which would increase their income and lead to self-sufficiency.

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إستخلاص البكتين من بعض الفواكه المحلية وإستخدامه في تصنيع المربي

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الخلاصة

تم في هذه الدراسة إستخلاص البكتين من بعض الفواكه المحلية (القريب فروت , البرتقال والجوافة) وأستخدم في تصنيع مربي بإستعمال القرع كمادة خام. وقد وجدت النسبة المئوية للبكتين المستخلص من مسحوق البرتقال تساوي 28 % ، ومن مسحوق القريب فروت تساوي 26.4 % والنسبة المئوية للبكتين المستخلص من الجوافة يساوي 2.8 % . إحتوت المربي المصنعة باستخدام البكتين (على 66 % ، 67 % و 67 % من المواد الصلبة الذائبة (GuPJ) والجوافة (OPJ، البرتقال GrPJ) المستخلص من القريب فروت) على 4.7 % ، 5 % ، و 4.1 % على التوالي، في حين بلغ GuPJ و OPJ ، GrPJ الكلية ، على التوالي. كانت نسبة السكر المختزل لـ 3.5 ، 3.4 ، و 3.6 GuPJ و OPJ ، GrPJ % على التوالي. كانت قيم الأس الهيدروجيني لـ 8.4 إجمالي السكر 8.7 % ، 8.5 % و كان 53.7 % ، 45.8 % و 47.4 % على التوالي ، وكان محتوى GuPJ و OPJ ، GrPJ على التوالي. كان محتوى الرطوبة لـ OPJ ، GrPJ الرمامد 0.23 % و 0.18 % و 0.21 % على التوالي. محتوى الصوديوم هو 36 ، 34 ، و 35 (ملجم/100جم) في ملجم/100جم) علي التوالي، ومحتوى الكالسيوم كان (، على التوالي ، في حين أن محتوى البوتاسيوم كان 60 ، 68 ، و 69 GuPJ و كان 0.01 ، 0.02 ، 0.02 ، GuPJ و GrPJ و OPJ 80 و 79 و 78 (ملجم/100جم) على التوالي. محتوى فيتامين "ج" من (ملجم/100جم) ، على التوالي. أشار التحليل الميكروبي إلى أن جميع عينات المربي كانت خالية من البكتريا القولونية، البكتريا العنقودية، ومن خلايا الأعفان والخمائر. التحليل الحسي أشار إلى أن جميع أنواع المربي وجدت قبولاً من المحكمين بدرجة كبيرة خصوصاً بالنسبة للمربي المصنعة باستخدام البكتين التجاري بالمقارنة مع مربي البكتين المستخلص من البرتقال، القريب فروت والجوافة على التوالي. فضّل معظم المحكمين مربي البكتين التجاري حسب اللون والمظهر الجذاب.