Effect Of The Inclusion Of Fruit Peel On Consumer Acceptability, Dietary Fiber And Chemical Properties Of Jam Products

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Abstract: Jam products were prepared from mango and pineapple fruits separately. The pulp and peel of each fruit were used. The effect of the inclusion of fruit peel on consumer acceptability, dietary fiber and other chemical properties of jam products were investigated. Dietary fiber was significantly (P>0.5) higher in jam produced with pulp and peels together. Pineapple jam with pulp and peel contained the highest dietary fiber of 30%. There was significant (P> 0.05) variation in pH, titratable acidity and total soluble solid of the different jam products. The samples also varied significantly (p=0.05) in terms of the colour, taste and other sensory attributes. When a mixture of pulp and peel of fruit were used together in jam making, mango jam had the lowest acceptability score of 5.6 while pineapple had a score of 7.0. Qualitative descriptive analysis of the jam samples revealed that jam from the mixture of fruit peel and pulp requires improvement only in smoothness compared with that from the fruit pulp. The use of edible fruit peels in food product such as jam is therefore recommended. Ijioma BC,
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1.0 Introduction

Jams are centuries old and have been recognized worldwide for their fragrance and rich fruit taste. Lawrence and Franklin (1998) defined jam as thick, sweet spreads made by cooking crushed or chopped fruits with sugar, pectin and water. Broomfield in 1988, defined jam as a mixture of fruits and sweetening agent brought to a suitable gelled consistency with or without other permitted ingredients. Though the traditional understanding of jam is that it is a self preserved cooked mixture of fruits and sugar with many fruits including mango and pineapple are used for jam making because they are rich in natural sugar, acids and pectin. Jam is not eaten alone. It is usually for eating bread, cake and other baked products. It is spread on top of bread, like butter or margarine. It helps to boost the taste, and nutritional value of the main food. Some baking industries use jam (pure jelly) in place of caramel for flavoring and coloring of baked products, since it is naturally produced from fruits (Michigan State University, 2003). One of the health problems associated with jam production is that of sugar management. Diabetics and other related diseases such as obesity, heart attack, and high cholesterol level are all elicited by blood high sugar level. The high level of sugar used during the manufacture of jam for gel formation affects the health of people especially those prone to insulin failure or who are having insufficient insulin in their body to regulate or control the sugar level in the body. At present effort are being made by food scientists, biochemists and some health practitioners to produce jam suitable for diabetics; where sugar is no longer added during the jam production. It is believed that the fruits contain compound that does not affect sugar level drastically, since the insulin does not require fructose or sorbitol, it is recommended by United Kingdom Food Regulation and Law 1978 and 1981, that the use of sucrose (sugar) in jam production for diabetics is prohibited, instead fructose or sorbitol. Any fructose or sorbitol-based products used must be clearly specified on the label.

In addition to the restriction of sucrose in diabetic jam we are of the opinion that the other factors, which affect blood sugar level such as glycemic index of foods, should also be considered. Reports have it that some of these factors including pH, and photochemical (dietary fiber, antioxidants) are abundant in the peel of most fruits. Incidentally fruit peels are not normally used during jam making. Inclusion of fruit peel (where the peel is not toxic and of course many are not) during jam making helps to increase the dietary fiber content of the finished product. The aroma and other biochemical content may also get improved. The health benefits of dietary

fiber and other photochemical in the peel of fruits are abound (Brain. 1982, Cumings, *et al,* 1982, Boyer and Liu 2004 and Girdwain 2013). No wonder health workers have advised that we should each our fruits with their peels. A diet rich in dietary fiber again serves as a barrier against a range of diseases, while a diet low in dietary fiber is a causative factor in the etiology of diseases. Soluble dietary fiber has been shown to lower selectively serum cholesterol and improve glucose metabolism and insulin response (Cumings *et a.;* 1982). Jam rich in dietary fiber may be beneficial in weight reduction and in the control of diseases such as hyperlipidemia and diabetics (Anderson, 1987 Anderson 2009). One of the ways to increase the dietary fiber content of jam product and its health benefits will be to include the peels of the fruit used in the jam making. We are anticipating that the acceptance of such products will be difficult initially, the health benefits notwithstanding. Hence the objectives of this research work were:

1. To improve the nutritional qualities of jam products through the inclusion of fruit peels.
2. To access the acceptance of jam made from whole fruit (pulp and peel together).

2.0 Materials and Methods

Ripped whole fruits of mango (*Mangifera indica*) and pineapple used for the project work were obtained from Ochanja Relief Market Onitsha, Anambra State, and Owerri Market. Other materials used which included sucrose (sugar), lime, citric acid, Sodium benzoate, NaOH, indicator, HCL, H_2S04, were collected from Food Science and Technology and Crop Production Laboratories at Federal University of Technology Owerri.

2.1 Preparation of Samples

Partially ripped mango and pineapple fruits were washed and cleaned with hard brush. For the mango fruit half of the fruit were peeled and sliced into pieces of $0.5cm^3$ while the other half were sliced together with the peels. Each of samples was ground with an electric blender into a fine mixture. The sample that was ground together with the peel was designated as "MPP" while that with only pulp was designated as "MPO". Samples were collected from the MPP lot and diluted with water to reduce the viscosity to equal that of sample MPO. [Sample MPP was originally very viscous] This sample with the adjusted viscosity was designated as "MPV". Again sugar (20g) was added to a portion of sample MPV in order to bring up to have the same sugar level as sample MPO. This fourth sample was designated as "MPS". For the pineapple fruits only two products were made. One sample "PPO" was made with pineapple together. Altogether six samples were prepared; four from mango and two from pineapple. Lime fruit was washed, cut and the juice extracted. The juice was deseeded and stored in a clean closed container.

2.2 Jam Preparation

Thirty grams of sugar and 10mls of lime juice were used for each of the six samples during jam preparation. The sugar was added into 40mls of water and brought to boil. Then fruit samples were introduced with continuous stirring. Throughout the cooking the temperature was under control. Lime juice was added with continuous stirring at the temperature of 105^0C. When the mixture was set the heating was stooped. The jam was poured into bottles already sterilized and kept in oven at about 100^0C. The bottles and it's content were cooled, sealed with paraffin wax, closed with the lid, labeled and stored. The flow chart for the jam making process is in figure 1.

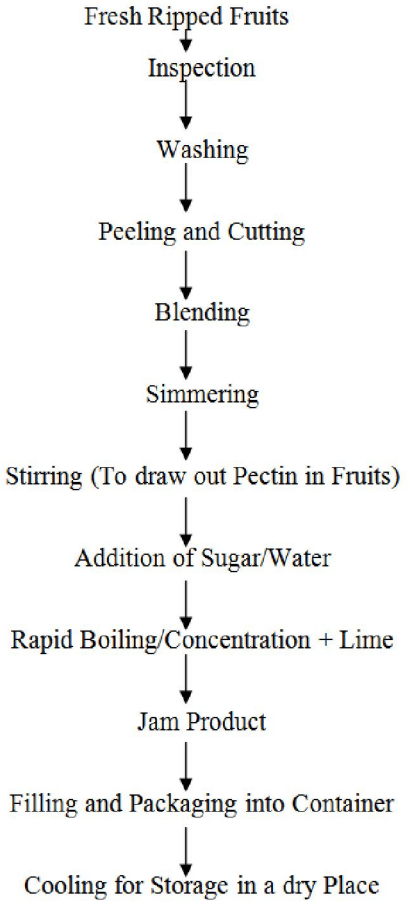

Figure 1: Flow Chart for Jam Production

2.3.1 Protein Determination

Kjedahi digestion method as described by A.O.A.C (1995) was used. Only 2g of the sample was weighed into 100ml Kjedahi flask and 30ml of concentrated sulphuric acid (H_2S0_4 (vi)) Was added

which boiled gently at first on the Kjedahi digestor until it blanked and stopped. This was heated until the solution is cleaved. The flask was allowed to cool, rinsed the neck dawn with distilled water. Further heat was done until the specks disappeared. The content was then transferred with several washing into a 250ml volumetric flask and made up to the mark after cooking. The steam was allowed to pass through Markham micro Kjedahi distillation apparatus for about 10 minutes. 5mls of boric acid indicator was introduced on the surface of the liquid. This was placed under the condenser such that the condenser was tipped on the surface of the liquid. 5mls of diluted digest was measured and placed in the distilled water. The cup was closed with the rod and 60% Na0H was added. This was carefully left behind to prevent ammonia escaping. This was allowed to leave through for about 5 collected against from green to purple. The colour of this was noted.

The calculation

$$\frac{W_1 \times W_2 \times (T_s - T_b) \times 100}{W3 \times 5}$$

T_s = Titre value for sample
T_s = Titre value for blank
W = weigh samples

2.3.2 Moisture Content Determination (Mc)

Moisture content is determined according to A.O.AC (1995). A clear dried moisture can was weighed in an electronic top loading satorious weighed balance. An aliquot of the jam was placed on the moisture can and the weighed of the sample was taken. The sampling was kept in an electric oven to dry at 105^0c for about 6 hours. It was removed and replaced on the dessicator to cool and was reweighed again. The process was repeated at about 2 hours intervals until a constant dry weight was reached.

The % moisture content calculation of MC% i.e. MC% =

$$\frac{\text{Weight of moisture}}{\text{Weight of sample}} \times \frac{100}{1}$$

$$\frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where W_1 = *mass of the sample* w_2 = *mass f sample + dish*

W_3 = *mass of sample + dish after drying.*

2.3.3 Ash Content Determination

Total ash content was determined according to standard analytical method in A.O.A.C 1995. Just 1g of jam sample was weighed into a previously ignited cooled and weighed crucible. The crucible and its content were transferred into muffle furnace at 550^0c and left until a light gray ask resulted after ignition. The crucible and the residue (i.e. ash) was taken from the furnace, cooled in a dessicator and reweighed. The ash was calculated as a percentage of the original sample given that weight of the empty crucible.

= w, weight of crucible + sample before ashing = W2

$$\frac{W3 - W1}{W2 - W1} \times \frac{100}{1}$$

2.3.5 Determination of Total Fat

3-4g of the sample was boiled with 50ml of 4ml hydrochloric acid. The fat was diluted and extract with light petroleum of n-hexane using the "wash-bottle" technique. The extracted fat was collected and was weighed in flask; the solvent in it was removed by evaporation. The fat was dried and weighed the fat, the hydrolyzed mass was poured into a filter paper, and was washed with hot water, the filter paper containing the residue was dried, rolled and inserted into an extraction thimble. This method was completed by the Soxhlet technique. (A. O. A. C. 1995).

2.3.7 Determination of pH and Total Titratable Acidity (TTA)

The method described by A.O.A.C (1990) was used. The solution of pH meter was pH7. then the pH of the different sample was measured at temperature of about 25^0C. Determination of titratable acidity was carried out according to the method of A.O.A.C (1995). 1g of the sample was weighed into a 250ml conical flask. 50ml of distilled water was added and allowed to stand for 40 minutes at room temperature and was stirring occasionally. The sample was filtered and 3drops of phenolphthalein indicator was added to the titrated 0.02N NaOH to a permanent pink and end point was noted. To calculate TTA:

Let the titre-blank be x; 50ml of sample contained 0.02x mg acid 1g sample

$$\% \text{ T.T.A} = \frac{0.02x}{100} \times \frac{1}{} \times \frac{100}{1}$$

$$= 0.002x$$

2.4 Determination Of Total Solution Sugar (Tss)

The anthrone method of A.O.A. C. (1995) was used to determine the total soluble sugar. 1g of the sample was weighed into a test tube and 2ml of concentration of H_2SO_5 was digested over a water bath for about 30 minutes. This was diluted with about 20ml of distilled water and was allowed to cool. 80ml of the Anthrone reagent was added and made up to wavelength using the spectrophotometer "UV Unicon spectrometer". A series of standards

was prepared and the optical density taken at the same wavelength.

Calculation

Let the parts per million (ppm) of pulp be x

1ml contains 50ng brine

hence 50ml contained 50 x 50x 1g of the sample.

$$\therefore \% \text{ brine} = 50 \times 50 \times 1 \times \frac{100}{1}$$

$$\% \text{ brine} = 0.25 \text{ x}$$

2.6 Determination Of Dietary Fiber

Jam formation (Gelatinization)

The water and samples contained in each 5ml beaker were stirred thoroughly to obtain a homogenous mixture. Water is poured in the bath and brought to boil. The samples were gelatinzed (gelled) at 100^0c with the steam from the water bath (AOAC, 1995). Analysis of total dietary fiber (TDF), insoluble dietary fiber (IDF) and soluble dietary (SDF) were determined as described by A. O.A. C (1995).

Gelatinization of Starch

This procedure was developed by AOAC (1995). 10ml of distilled water measured into measuring cylinder for each sample was poured into 50ml beaker containing 1g of raw samples i.e. plant materials. The water and the raw sample mixture were homogenized. Water is poured into the water bath and brought to the boil. The starch was gelatinized at 100^0c with the help of steam from the water bath.

Termamyl Incubation

Following gelatinization of starch, the samples are now ready for termanyl incubation. This was done at pH 6.0 and the reagents used for the pH adjustment was acetic acid which helped to bring down the pH of these samples to 6.0. Some of the food samples had pH of 6.0 without adjustment using acetic acid. The pH was read off by the use of pH meter. After pH adjustment, 3mls of termamyl was added to the gelatinized samples and stirring continued. This termamyl incubation was done for 30 minutes at temperature of 100^0c. The degradation of starch could be accomplished in a very short time (i.e. 30 minutes) because termamyl was a powerful enzyme which could degrade the bulk of the starch rapidly at 100^0c.

Neutrase Incubation

Following termamyl incubation, the pH of each samples contained in the beaker were readjusted to pH 7.5. The adjustment of pH to 7.5 was carried by the use of 0.2M of sodium hydroxide (NaOH) and temperature reduced to 60^0c and read off by the use of thermometer. About 3mls of Neutrase enzyme was added to the sample each. Neutrase incubation at temperature of 60^0c during incubation period was done using Water bath.

Amloglucosides (AMG) Incubation

Following termamyl incubation, the pH of each samples contained in the beaker were further readjusted to pH 4.5. The adjustment of this pH to 4.5 was carried out by the use of acetic acid and read off with pH meter. The temperature of the contents in each beaker was maintained at 60^0c and 3mls amyloglucosidase (AMG) was added and stirred continuously. This AMG incubation was carried out at pH of 4.5 for 30 minutes at 60^0c. During this incubation, there was continuous stirring to ensure "complete" hydrolysis of starch.

Total Dietary Fiber (TDF) Determination

Following amyloglucosidase incubation, the content in each beaker was precipitated with 4 volumes of ethanol measured with measuring cylinder. After filtration of sample, each sample was washed with ethanol and acetone. Drying sample following washing of sample, the sample on the filter paper were then dried over the hot oven.

Determination of Soluble Dietary Fibre (SDF)

Following amloglucosidase (AMG) incubation above, the contents in each sample were filtered with the use of filter paper. There were residue and filtrate and the filtrate is not discarded. The residue obtained after filtration was then washed with ethanol and acetone. Drying was carried out with the use of hot oven at 60-65^0c. After drying of each sample what remained was the soluble dietary fiber (SDF), which was weighed with weighing balance.

2.7 Sensory Evaluation

Sensory evaluation of the six samples was conducted using 20-member panel randomly selected from the University community. The samples were packaged in a transportation jam bottles and presented in a coded manner. The sensory quality attributes of the sample evaluation were colour, taste, texture aroma and acceptability. In the questionnaire presented to the panelists, they were requested to observe and taste each sample as coded and grade them based on a 9-point hedonic scale where 9 = like extremely and 1 = dislike extremely (Iwe 2002).

Qualitative descriptive analysis (QDA) was used to further test the product so as to reveal areas and intensities of improvement on the products. Judges were asked to evaluate the intensity of the perceived attributes using a 15 point unstructured scale.

2.8 Statistical Analysis

The results obtained from the sensory evaluation were computed into means and the analysis of variance (ANOVA) was carried out based on all the sensory attributes. The null hypothesis and the alternative hypothesis were used to assess the

validity of the results. The least significant difference (LSD) was used to determine which of the sample that is significantly different.

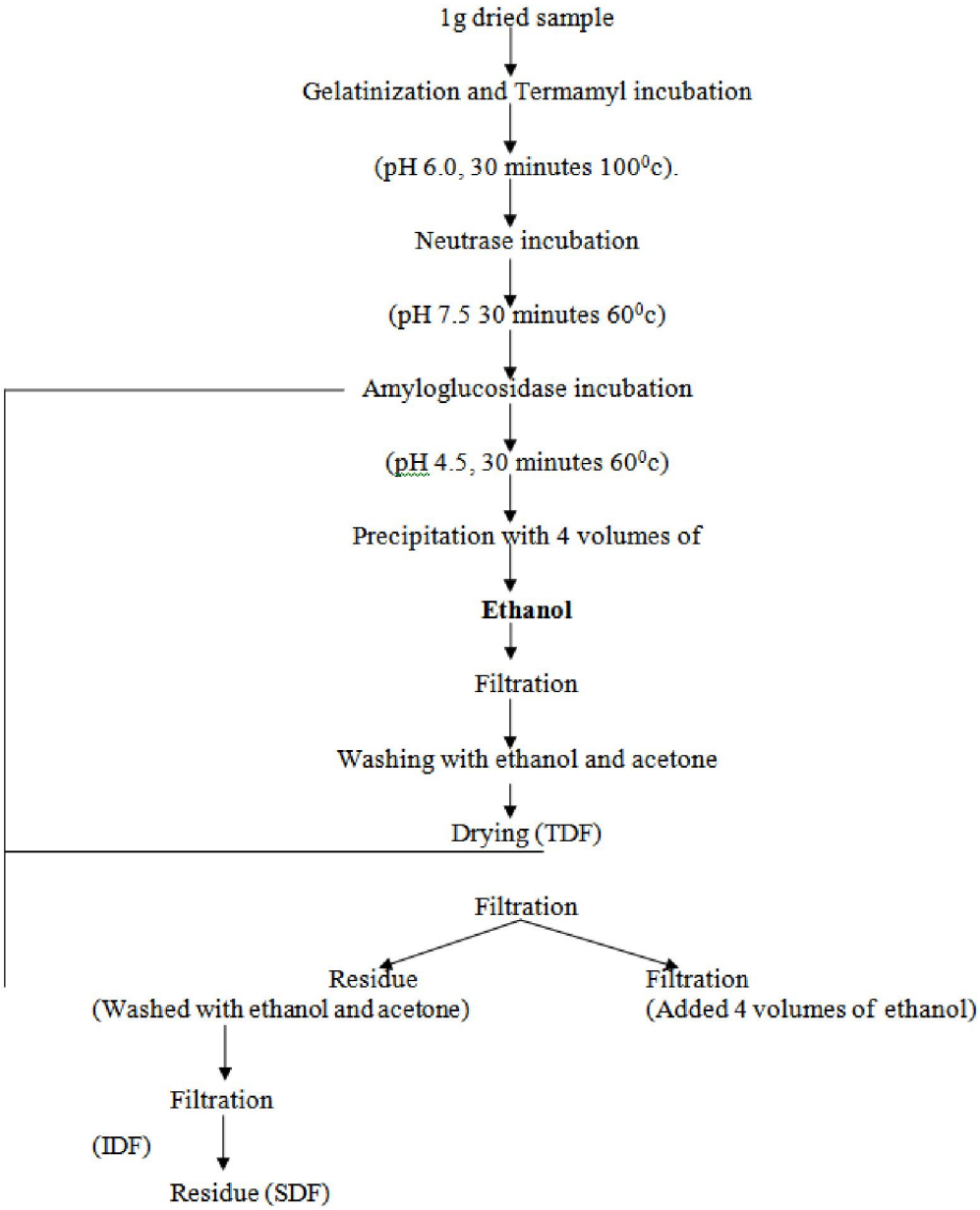

Fig. 2: Flow chart for determination of total dietary fibre (TDF), insoluble dietary fibre (IDF) and soluble dietary (SDF).

Source: Adapted from A.O.A.C international, (1995).

3,0 Results and Discussion

3.1 Chemical Properties of Jam made from the Pulp and Peel of Mango and Pineapple Fruit.

The result of chemical properties of the jam samples is shown in Table 1. There was significant (*P > 0.05)* variation on the pH, percentage total titrable acidity (TTA) and Total soluble solids (TSS) of the samples. The pH of the jam products was on the acidic side (3.52 – 3.51) with the mango sample (MPP) having the lowest pH of 3.52 while sample PPD had the highest pH value 3.91. The pH of the jam products was within the conventional pH value of 3.1 – 3.52 (NAFDAC, 2000). Percentage TTA of the samples ranged from 0.049 to 0.082. The sample PPP had lowest TTA% of 0.082. In both mango and pineapple, % TTA values increased with the inclusion of fruit peel. This could be because of the fact that there is usually higher concentration of the annual (Organic)

acids in the peels of fruit than in the pulp (Ihekoronye and Ngoddy, 1985). Jam product with a low pH and a high %TTA is considered adequate on health ground and for storage purposes. Total soluble solid (TSS) was 50% in sample PPP, which was significantly higher than the rest samples. Generally, pineapple jams had higher TSS than mango jams. Again jam made with the peel and pulp of either of the fruits had higher %TSS than their counter-part made with the pulp only (Álvarez *et al*., 2006).

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Table 1. Chemical properties of Jam made from the pulp and peel of mango and pineapple fruit.

Chemical properties (%)						
Products						
	pH	**TTA**	**MC**	**TSS**	**Protein**	**Ash**
MPP	3.52^{c}	0.057^{c}	67.21^{b}	20.0^{d}	0.84^{e}	0.40^{c}
PPD	3.91^{a}	0.062^{b}	64.97^{c}	24.0^{c}	1.66^{b}	0.20^{d}
PPS	3.89^{a}	0.059^{bc}	51.00^{d}	31.0^{b}	1.44^{c}	0.61^{b}
MPO	3.56^{c}	0.049^{d}	72.77^{a}	15.0^{e}	1.37^{d}	0.29^{d}
PPP	3.79^{b}	0.082^{a}	52.69^{e}	50.0^{a}	2.35^{a}	0.82^{a}
LSD	***0.049***	***0.004***	***1.24***	***2.69***	***0.03***	***0.08***

Means of column with the same superscript are not significantly ($p<0.05$) different.
MPP = Mango pulp and peel.
PPD = Pineapple pulp only.
PPS = Pineapple pulp and sugar.
MPS = Mango pulp only.
PPP = Pineapple peel and pulp.

Moisture content of the jam products ranged from 51.00 % to 72.77% moisture. Moisture was generally higher in mango jams (67.21 - 72.77) than in pineapple jams (50 - 64.97). The higher moisture content of the jam products could be because of the high humectants (sugar) content of the products. This is further explained by the fact that product with the peel had lower moisture content than those without the peels. However, the moisture contents are quiet high and need to be reduced in subsequent experiment. The percentage of protein content was generally low having a range of 0.84% to 1.37%. The result was expected since the fruits used are not known as protein sources (Ihekoronye and Ngoddy, 1985). Nevertheless product with the peels had a significantly ($p>0.05$) higher protein content than those with the peels. The percentage of ash was higher in pineapple jams than in mango products. Again the inclusion of fruit peels increased significantly the ash content of finished products.

3.2 Total dietary fiber content of jam made from the pulp and peel of mango and pineapple fruits.

Pineapple jams were found to contain a higher ($p=0.05$) total dietary fiber compared with mango jams (fig 3). The total dietary fiber content of the pineapple samples was PPP 30%, PPS 28% and PPD 20%. The mango jams had 20% and 22% for MPS and MPP respectively. Inclusion of fruit periderrm increased the total dietary fiber content of the jam products. Fruit peels are known to contain higher amount of fibers especially the insoluble fibers than fruit pulp. The higher total dietary fiber observed in pineapple jam could be due to a higher quantity of peels and fibrous materials in pineapple than in mango.

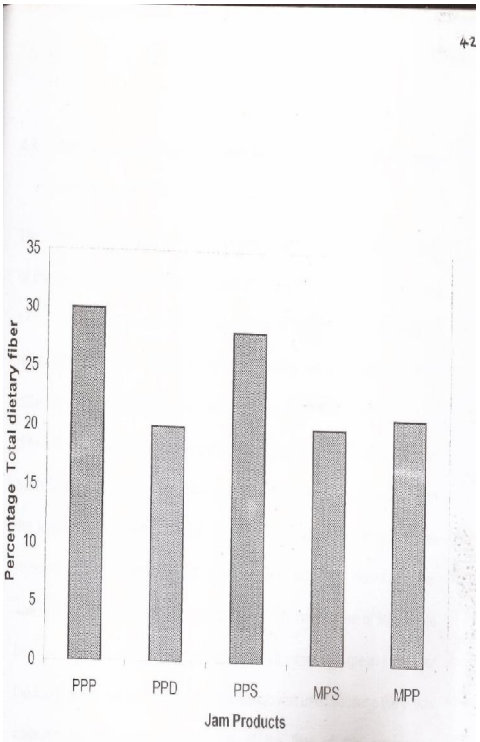

Fig 3 Percentage of Total Dietary Fiber content of Jam made from Mango and Pineapple pulp and peel

MPP = Mango pulp and peel.
PPD = Pineapple pulp only.
PPS = Pineapple pulp and sugar.
MPS = Mango pulp and sugar.
PPP = Pineapple peel and pulp.

3.3 Sensory evaluation of jam made from the pulp and peel of mango and pineapple fruit.

The mean of the sensory evaluation of jam products from the peel and pulp of mango and pineapple fruits is shown in Table 2. In terms of texture, the samples scored 6.2 to 6.9 while a value range of 5.4 to 7.4 was recorded for taste. The scores for texture of the sample were not significantly ($p<0.05$) different but the scores for the rest attributes were significantly ($p.>0.05$) different, Sample PPD surprisingly scored highest in terms of taste followed by PPS and PPP. This implies that all the pineapple jams scored higher than the mango jams in terms of taste. The colour of sample MPP was almost rejected; it had the lowest ($p=0.05$) scored of 4.1, which was below average. The colour of MPP was actually not applying. The awful colour of MPP could be because of the colour of the mango peel used, which was green instead of the usual yellow colour. Green coloured mango was used because the yellow colored mangos were off-season as at the time of this experiment. Nevertheless, the color of MPP can be improved upon by addition of food grade synthetic colors. The most appreciated color was that of PPS (7.8). Again sample MPP scored lowest while sample PPS scored highest in aroma and over acceptability.

Sample PPS scored highest in all the attributes except in texture and taste. No wonder it recorded the highest in overall acceptability indicating that judges appreciated it more than other jam product (Besbes *et al*., 2009 and Tehranifar *et al*., 2010).

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Table 2. Mean of the sensory evaluation of jam made from the pulp and peel of mango and pineapple fruit.

QUALITY ATTRIBUTES					
Products					
	TEXTURE	**TASTE**	**COLOUR**	**AROMA**	**ACCEPTABILITY**
MPP	6.8 ± 1.5^{a}	5.4 ± 1.6^{b}	4.1 ± 0.9^{c}	4.9 ± 1.6^{b}	5.6 ± 2.2^{b}
PPD	6.3 ± 1.7^{a}	7.4 ± 1.5^{a}	7.6 ± 0.0^{a}	6.8 ± 1.9^{a}	7.2 ± 1.2^{a}
PPS	6.2 ± 1.6^{a}	7.2 ± 1.5^{a}	7.8 ± 0.9^{a}	7.1 ± 1.1^{a}	7.3 ± 1.1^{a}
MPO	6.8 ± 2.0^{a}	6.5 ± 0.5^{ab}	5.4 ± 1.2^{b}	6.4 ± 1.5^{a}	6.9 ± 1.2^{ab}
PPP	6.9 ± 1.4^{a}	7.1 ± 1.9^{a}	7.2 ± 1.8^{a}	6.9 ± 1.2^{a}	7.0 ± 1.6^{a}
LSD	***1.54***	***1.49***	***1.29***	***1.37***	***1.35***

Means with the same superscripts in a column are not significantly different from each other Evaluation was done with 9-poin hedonic scale.
MPP = Mango pulp and peel.
PPD = Pineapple pulp only.
PPS = Pineapple pulp and sugar.
MPS = Mango pulp only.
PPP = Pineapple peel and pulp.

3.4 Qualitative descriptive analysis of pineapple jam.

The result of qualitative descriptive analysis of pineapple jams is shown in figure 3. The analysis revealed that all the jam samples would need some improvement in smoothness. PPD had the most appreciated smoothness while PPP had the worst. The poor smoothness of the jams could be because of poor filtering process and for the fact that peel are bound to be rougher than the pulp. In terms of after-taste, it was discovered that sample PPS had a fruity taste whereas PPP had less fruity after-taste. This implies that the fruity aroma of sample PPP as well as sample PPD needs to be improved. For sweetness, there was no significant difference in the intensity of sweetness of the samples, though sample PPD had a lower intensity. This could be because no sugar was added to this sample.

There were significant difference ($p>0.05$) in the perceived thickness (viscosity) of the pineapple jams. The viscosity of sample PPP was most appreciated followed by that of PPS and finally PPD. Inclusion of peel improved the viscosity of the samples. The diabetic jam, PPD was observed to have the highest vale for ease of spreading. In other words it was much easier to spread sample PPD than the other two samples. Now a balance had to be stroke between viscosity and ease of spreading. It seems the two parameters have inverse relationship. Increase in sugar increased viscosity and reduced ability to spread (spreadability).

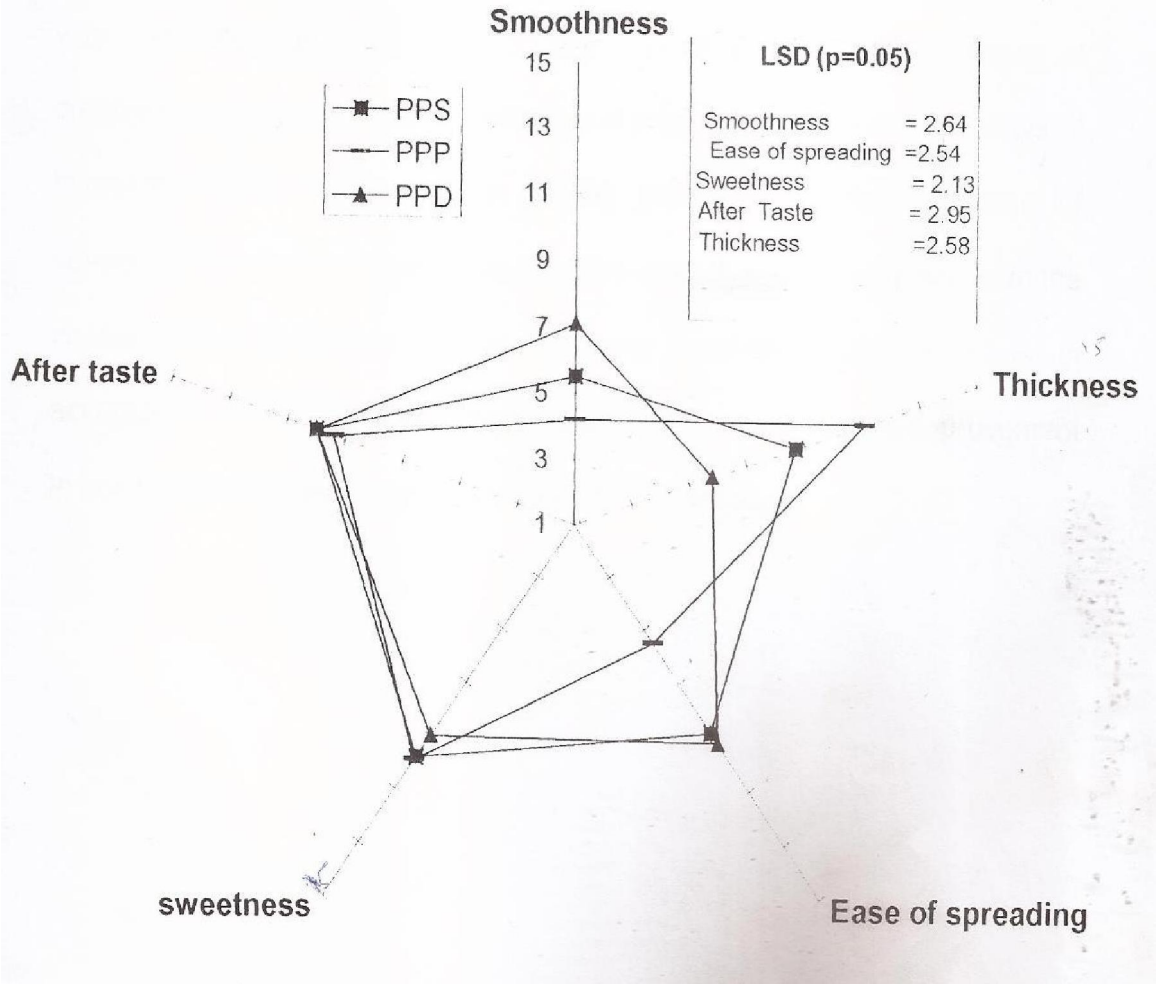

Fig 4. Qualitative descriptive analysis of pineapple jam

3.5 Conclusion

The dietary fiber of the jam product made from a mixture of fruit pulp and peel was relatively high (20% - 30%). This implies that the supplementing of dietary fiber through the use of edible fruit peels could be one of the ways of improving intake of dietary fiber among jam eaters. From the result of sensory evaluation and qualitative descriptive analysis, jam obtained from the combination of pulp and peel of fruits was considered second to best in acceptability and taste. Nevertheless such jam products require improvement in colour unless overripe (yellow coloured) fruit are used.

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