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Quality Evaluation and Consumer Acceptability of Mixed Fruit Jam from Blends of Pineapple (*Ananas sativa* Lindl.), Tomato (*Lycopersicon esculentum* Mill.) and Pawpaw (*Carica papaya*)

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Authors' contributions

This study was carried out in collaboration between all authors. All the authors jointly designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed literature searches. Authors SJ, MAU and SO managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Mixed fruit jam was prepared from blends of pineapple, tomato and pawpaw at different ratios while, commercial jam from strawberry served as the control. Jams made from different fruit ratios and the control were examined for their proximate composition, mineral contents as well as sensory

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attributes. The result of the proximate composition shows that, the control (commercial strawberry jam) was found to be significantly (p<0.05) high in moisture, fat and crude protein. However, the test samples were significantly (p<0.05) high in ash and carbohydrate contents and favourably compete with the control in vitamin c. The calcium content of the control was significantly (p<0.05) high than the test samples however, the test samples showed superiority in manganese, iron, magnesium and phosphorus contents. In sensory attributes, the control and the test samples showed no significant difference in texture and flavour. In taste, the test samples were found to be significantly (p<0.05) high than the control. In appearance and general acceptability, the control and the test samples compared favourably. Hence, samples b (17% pineapple, 14% tomato and 13% pawpaw) and c (16% pineapple, 16% tomato and 12% pawpaw) compared favourably with the control in chemical and sensory attributes. The new formulated product can serve as a good spread on bread and a dessert.

Keywords: Jam; fruits; proximate; mineral; sensory attributes.

1. INTRODUCTION

Jam is a product made from whole fruit, cut into pieces or crushed. The fruit is heated with sugar and water to activate the pectin in the fruit [1]. Generally, jam is produced by taking mashed or chopped fruit or vegetable pulp and boiled with sugar and water until a suitable consistency is obtained [2]. Jam varies in their nutritional and organoleptic properties as a result of different process technology and types of fruit and vegetable used [1]. A good jam has the following attributes: even consistency without distinct pieces of fruit, good fruit flavor, bright color, semi-jelled texture, easy to spread and have no free liquid, because it is neither a solid nor a liquid [3]. However, other jams have distinct pieces of whole fruits [2].

Many tropical fruits have been used in the production of jam [2]. Grapes and strawberry are mostly used. Other fruit such as roselle calyx, tomato, water melon, orange, pawpaw, banana etc. are also exploited in jam production [4-7]. In jam production, pectin can be obtained from fruit peels like orange which increases the dietary fibre of the end product and also reduces blood sugar when consumed [8].

Pineapple contains mainly water, carbohydrate, vitamin A, C, and carotene. It contains low amount of protein, fat and fibre. It is also rich in different antioxidant, for example flavonoids [9]. Tomato is widely consumed either raw or often processed and can provide a significant proportion of total antioxidant in the diet [10]. Furthermore, tomato has diverse nutrients such as vitamins C, E, B, mineral matter and secondary metabolites (carotene, lycopene, flavonoid, organic acid, phenolic and chlorophyll) which are important for human health and physiology [11]. Pawpaw is a good source of folate, vitamins A, B and E, magnesium, copper, pantothenic acid and fiber [12]. This author further revealed that, pawpaw also have alpha and beta carotene, lutein and lycopene which are antioxidant most commonly associated with tomato.

It has been reported that, in developing countries Nigerian inclusive, farmers suffer high postharvest losses of fruits and vegetables most especially during harvest time. This could be attributed to non-availability of storage facilities which normally involve large capital outlay, nonchalant attitude of government on agriculture, illiterate farming population among others. Processing these perishable produce in to finished form is one way of addressing these problems. This would minimize losses, optimize profit and provide variety of products before the consumer. The use of these fruits (pineapple, tomato and pawpaw) in jam production is one such way of enhancing their utilization. Furthermore, what is obtained commercially in the market is jam made from single fruit such as pineapple, strawberry, cherry etc. Hence, blending these fruits would minimize their postharvest wastage, create jam with enhanced nutritional composition, rich phytochemical contents that would provide physiological benefit besides nutrient supply to the consumer’s health.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Source of raw materials

Pineapple, tomato and pawpaw fruits were obtained in August, 2014 from Kure Ultra-Modern Market in Minna, Nigeria. Pectin and citric acid were purchased from Panlac Stores Minna.

2.1.2 Preparation of raw materials

Ripe pineapple, tomato and pawpaw fruits were thoroughly washed in a clean water to remove dirt, gums, wax, sand particles and all sources of contaminants. Pineapple and pawpaw fruits were peeled, cut into cubes, washed and drained. While fully ripe and sound tomato was cut into cubes and the seeds removed using clean stainless steel knife. Seed-free-cubes were then blanched for 5 min in hot water to facilitate seed coat removal. Prepared pineapple, pawpaw and tomato were packaged individually inside high density polyethylene bag and kept under refrigeration prior to product formation.

2.1.3 Product formulation

The products were formulated based on the following ratios shown in the design block. Commercial strawberry jam served as the control (Sample A).

Ingredient	Sample (%) per 100g		
	B	C	D
Pineapple	17	16	15
Tomato	14	16	18
Pawpaw	13	12	11
Sugar	54	54	54
Commercial pectin	1	1	1
Citric acid	1	1	1

Source: [2]

2.1.4 The process

The ingredients (pineapple, tomato and pawpaw) were blended in to their ratios and pulped. Half of the sugar (50%) was heated gently with continuous stirring in a stainless steel pot and the mixture of the fruit pulp was added with continuous heating and stirring. 50% citric acid solution was prepared with pectin solution by heating equal quantities in equivalent amount of water. The prepared solution was added to the remaining sugar and the entire mixture was poured in to the pan containing heated sugar and stirred continuously. The remaining pectin was later added to the boiling solution and the pH was adjusted to 3.3 with citric acid solution. The jam was cooled in cold water to 64℃, filled in glass jars and stored in a cool place.

2.2 Methods

2.2.1 Determination of moisture content

The percentage moisture content was determined according to the method described by [13]. Two gramme of the sample was weighed into a petri dish of known weight and the moisture substantially evaporated over water bath. The sample was immediately transferred into an oven and dried at 105±2℃ for 3 to 5 h. The sample was then removed from the oven and placed in a desiccator to cool for 15 min before weighing. The process was repeated until constant a weight was recorded. The loss in weight from the original weight was reported as the moisture content.

$$\text{Percentage moisture content} = \frac{\text{Weight loss}}{\text{Weight of sample taken}} \times 100$$

2.2.2 Determination of fat content

Fat content was determined using Soxhlet solvent extraction method outlined in [13]. Two gramme of the sample labeled A were weighed into the extraction thimble and the thimble was blocked with cotton wool. It was then placed back in the Soxhlet apparatus fitted with a weighed flat bottom flask (B) which was filled to about three quarter of its volume with petroleum ether with boiling point of 40 to 60℃. The extraction was carried out for a period of 4 to 8 h after which complete extraction was done. Petroleum ether was removed by evaporation on water bath and the remaining portion in the flask was removed along with water during drying in an oven at 80℃ for 30 min. Defatted sample was then cooled in a desiccator and weighed (C). The percentage fat was calculated as:

$$\text{Percentage fat} = \frac{C - B}{A} \times 100 = \frac{\text{Weight of extracted}}{\text{Weight of sample}} \times 100$$

Where; A = Weight of sample; B = Weight of empty flask and C = Weight of flask + oil.

2.2.3 Determination of crude protein

Kjeidahl method was used for the determination of protein content as described by [14]. The sample (1.0 g) was first digested in Kjeldahl digesting system. The digestion process involve weighing 1.0 g of sample into 500 ml Kjeldahl flask, followed by the addition of two selenium tablets. Twenty milliliters of concentrated sulfuric acid was then added gently down the side of the flask, and swirled. The content of the flask was heated gently in a fume cupboard in an inclined position and swirl occasionally until the liquid was clear. The digested sample was allowed to cool and then distilled into 2% boric acid solution containing screened methyl orange indicator, after being appropriately diluted with water and the introduction of 40% sodium hydroxide solution. The distilled samples were then titrated against 0.1 M HCl solution. A blank titration was carried out and the percentage protein content was estimated as percentage nitrogen × 6.25 (1 ml of 0.1M HCl = 0.014 g N)

$$\% \text{ Nitrogen} = \frac{(S-B) \times 0.1N \times 14.01}{\text{Weight of sample}} \times 100$$

Where; S= Sample titre value; B= Blank titre value and % crude protein was obtained as % N × 6.25

2.2.4 Determination of ash content

The ash content was determined as described by [14]. The weight of the crucible dish was determined. Two gramme of the sample was added to the crucible. The dish and content was placed on the furnace rake and the furnace temperature was set to 500℃ for 16 h until the sample completely turned into ashes. The crucible dish was removed and kept in desiccator to cool and percentage ash was calculated as:

$$\text{Percentage ash} = \frac{\text{Weight of extracted ash}}{\text{Weight of sample}} \times 100$$

2.2.5 Crude fiber determination

This was determined as described by [14]. Five gramme of the sample was weighed into a 500 ml beaker and the content was boiled in 200 ml hydrochloric acid (1%) for 30 min. The suspension was filtered and the residue was washed vigorously with boiling water until it was no longer acidic. The sample residue was then boiled again in a 200 ml sodium hydroxide solution for 30 min, filtered through filter paper (Whatman no.1) and the residue obtained was transferred into a crucible in an air oven 80℃ for 30 min. The dried residue was then cooled in a desiccator and weighed. The weighed sample residue was ashed in a muffle furnace at 550℃ for 30 min. The sample was removed from furnace when its temperature was 200℃. It was cooled in a desiccator and weighed. The loss in weight of the incinerated residue before and after incineration was taken as the crude fiber content.

Percentage crude fiber was calculated as:

$$\frac{\text{Total weight of fibre}}{\text{Weight of sample}} \times 100$$

2.2.6 Determination of carbohydrate content

Carbohydrate was determined by difference as described by [13].

% Carbohydrate content = 100 - (% protein + % moisture + % fat + % ash)

2.2.7 Determination of vitamin C

5 ml of the standard solution was pipetted into a 100 ml conical flasks. 10 ml of 4% oxalic acid was titrate against the dye. The end point was marked by the appearance of pink colour persisting for a few minutes. The amount of the dye consumed is equivalent to the amount of ascorbic acid.

2.3 Minerals Determination

The minerals were evaluated using an atomic absorption spectrophotometer (Buck 2010, VGP Germany) as described by [14]. The samples were digested and filtered with Whatman 1 quantitative circles 125 mm filter paper. The filtrates were placed in different cuvettes and labeled accordingly. Since each metal has its characteristics wavelength that it absorbs, the Specific Hitachi Hallow Cathode Lamp were selected accordingly. The slit width for each element was also identified. Samples were aspirated into the flame. The metal present in the sample absorbed some of the light thus reducing the intensity of the light. The computer data system converted the changed intensity of light into an absorbance which is directly proportional to the concentration of the metal ion present in the sample. The concentration of metals present were determined from the working curve after calibrating the instrument with standard of known concentration.

2.4 Sensory Evaluation

The sensory evaluation was carried out by a panel of 20 judges made up of staff and students of the Department of Food Science and Technology, Federal University of Technology Minna, Nigeria. The samples were ranked on a 7-point Hedonic scale with 1 representing dislike strongly and 7 like strongly. The samples were presented in a random pattern and judged in terms of texture, flavor, taste, appearance and general acceptability. A glass of water was presented to rinse mouth in between each determination.

2.5 Statistical Analysis

The data obtained was subjected to analysis of variance (ANOVA) and separation of the mean values was carried out using Duncan Multiple Range Test at ($p<0.05$) level.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of the Test Samples and the Control

Proximate composition of mixed fruit jam and the control is shown in Table 1. The result shows that, all samples were significantly ($P<0.05$) different in the proximate parameters measured. Sample A (control) was found to be significantly ($P<0.05$) high in moisture content than the test samples. This implies that, the test samples would likely keep longer than the control. The moisture content of various jam preparation in this study (18.64 to 19.02%) was found to be low compared to 22.60 to 29.80% for jam from blends of African star apple and tamarind [8]. Furthermore, the value compared low to 28.74% for jam from dry dark red roselle calyx stored at ambient temperature [5]. The moisture of jam made from low proportion of pineapple and pawpaw and high proportion of tomato (Sample D) showed significantly ($P<0.05$) low moisture content. This implies that, varying the proportion of the raw material influenced the moisture content of the final product. The moisture, fat and crude protein contents of the control were found to be significantly high compared with the test samples. In fat content, the control was significantly ($P<0.05$) high compared to the test samples. The significantly low level of fat content of the test samples would favour their storage life due to less likelihood of rancidity. The crude protein content of the control was significantly ($P>0.05$) high than the test samples and samples B and D had the lowest values. Generally, fruits have low protein contents and the contribution of the test ingredients did not influence the protein content. Sample having low proportion of pineapple and pawpaw and high proportion of tomato (sample D) had the highest crude fibre content. The crude fibre content in this work agrees with the findings of [13] who reported 0.15 to 6.85% crude fibre in fruits.

The ash content of sample B was found to be significantly ($P<0.05$) high compared to the control and the remaining test samples. Sample having moderate proportion of test ingredients had the lowest ash content. Ash content reported in this study (2.00 to 2.78%) was found to be high compared to 0.81% and 0.63% for jam from fresh dark red roselle calyx stored at ambient temperature and jam from dry light red roselle calyx stored at cold temperature respectively. However, the value compared favourably with 2.20% for jam made from blends of African star apple and tamarind at 75% and 25% ratio respectively [7]. The carbohydrate content of the test samples were significantly ($P<0.05$) high compared to the control. The vitamin C content of the test samples B and C compared favourably with the control. The vitamin C content in this study (7.90 to 13.00 mg/100 g) was low compared to 38.20 g/100 g for coconut based jam reported by [15]. However, the vitamin C content of sample C (13.00 mg/100 g) compared favourably with 13.82 mg/100 g for jam processed from dry dark red roselle calyx stored at cold temperature [5].

Table 1. Proximate composition of mixed fruit jam and control

Proximate (%)	A	B	C	D
Moisture	30.32^a±0.72	19.02^b±0.97	22.14^b±0.72	18.64^c±0.72
Fat	3.90^a±0.09	1.56^c±0.06	3.19^b±0.31	3.19^b±0.31
Ash	2.03^c±0.03	2.78^a±0.22	2.00^c±0.00	2.45^b±0.04
Crude fiber	2.32^b±0.15	1.23^c±0.10	1.68^c±0.04	3.41^a±0.45
Crude protein	2.26^a±0.16	2.06^c±0.01	2.31^b±0.09	2.12^c±0.14
Carbohydrate	59.85^c±1.04	73.34^a±0.93	68.67^b±0.98	72.99^a±1.76
Vitamin C	12.85^a±0.67	12.97^a±0.03	13.00^a±0.00	7.90^b±0.10

Values are means ± SD of duplicate determinations
Means in the same rows followed by the same superscript are not significantly (P≥0.05) different.
Key: A= Control (strawberry jam); B = 17% pineapple, 14% tomato and 13% pawpaw C = 16% pineapple, 15% tomato and 13% pawpaw D = 15% pineapple, 17% tomato and 12% pawpaw

3.2 Mineral Composition of Mixed Fruit Jam and the Control

Result of mineral composition of mixed fruit jam and the control is shown in Table 2. The result shows that, there was significant (P<0.05) variation in the mineral content of the samples. The sodium content of sample B compared favourably with the control and the sodium content of the two samples were found to be significantly (P<0.05) high compared with samples C and D. In potassium, sample C had the highest content. Jams from different blends of raw material in this study showed superiority in potassium content than the control (commercial strawberry). The calcium content reported in this study 4.24 to 10.53 mg/100 g was found to be low compared to 15.20 mg/10 g for coconut based jam [15]. However, the value is low compared to 21.35 mg/100 g for commercial strawberry. Jam with high proportion of tomato and low pineapple and pawpaw had low calcium content. However, jams having moderate amount of the raw material in this study (Sample C) had the highest calcium content. The manganese content of samples B and C were found to be significantly (p<0.05) high than the control and sample D. This implies that, moderate blends of the raw material and high proportion of pineapple and pawpaw positively influenced the manganese content of the final product. Similarly, the same trend as found in magnesium content was observed in the iron content of the control and the test samples. The magnesium content ranged from 61.10 mg/100 g in sample A (control) to 73.06 mg/100 g in Sample D. Sample D was found to be significantly (P<0.05) high in magnesium content while, samples C and the control had the lowest values. This could be attributed to different proportions of the raw material. Hence, high proportion of tomato and low proportion of pineapple and pawpaw positively favoured the magnesium content. The phosphorus content of the jams in this study (43.41 to 71.13 mg/100 g) was found to be high compared with 25.16 mg/100 g for coconut based jam reported by [15]. Jam with the highest proportion of tomato and low pineapple and pawpaw had the least phosphorus content (43.41 mg/100 g). This could be attributed to the contribution of the raw materials involved.

Jams from samples with moderate amount of the raw material in this work (Sample C) had the highest amount of potassium and manganese however, jam made from low proportion of pineapple and pawpaw and high amount of tomatoe (Sample D) significantly (P<0.05) showed low amount of minerals determined in this study except, in magnesium content. The reason could be possibly attributed to less proportion of pineapple and pawpaw compared to the remaining two samples which had high and moderate proportion of the raw material. This suggests that, the proportion of raw materials had influence on the mineral content of the final product.

3.3 Sensory Properties of the Mixed Fruit Jam and the Control

The result (Table 3) of the sensory analysis showed that both the control and the test samples were not significantly (P>0.05) different in texture and flavor attributes. In taste, the test samples were found not significantly (P>0.05) different from each other however, significantly (P<0.05) high than the control (sample A). In appearance, samples C and D compared favourably with the control while sample B showed superiority in appearance. In the general acceptability, samples B and D were not significantly (P>0.05) different from each other but, significantly high than samples A and C. The result of the taste implies that, varying the proportion of the test ingredients had no influence. However, the taste of jam processed from blends of pineapple, tomato and pawpaw showed superiority over the control (commercial strawberry jam). The taste in this study (7.85 point) compared slightly low to jam from apple (8.3 point) and coconut based jam (9.0 point) [16,15]. However, the taste was high compared with 6.0 point for jam from clementine [17]. In appearance, sample B received the highest acceptability. Possibly, the combination of fruits: pineapple, tomato and pawpaw favoured the appearance of the product. Unlike the control (sample A) which was made from a single fruit (strawberry). The general acceptability of jam made from moderate amount of raw material (sample C) in this work compared favourably with the control. However, they were found to be significantly (P<0.05) low compared with jam made from other blends. The general acceptability in this study (7.65 point) compared favourably with 7.6 point for jam from African star apple [7]. However, it was found to be high compared to 5.3 point and 6.8 point for jam made from dry light red roselle calyx stored at cold temperature and jam made from 1:1 African star apple and tamarind respectively [5,7].

Table 2. Mineral composition of mixed fruit jam and control

Mineral (mg/100 g)	A	B	C	D
Sodium	21.00^{a}±0.00	20.20^{a}±0.98	18.60^{b}±0.60	15.75^{c}±0.55
Potassium	19.47^{d}±0.52	69.73^{b}±0.25	75.73^{a}±0.25	49.00^{c}±0.00
Calcium	21.35^{a}±1.35	10.53^{c}±0.25	13.93^{b}±0.95	4.25^{d}±0.25
Manganese	0.60^{b}±0.10	1.02^{a}±0.02	1.11^{a}±0.01	0.67^{b}±0.25
Iron	0.70^{c}±0.00	6.60^{a}±0.00	4.93^{b}±0.95	0.80^{c}±0.10
Magnesium	61.10^{c}±1.00	68.00^{b}±0.00	61.60^{c}±2.60	73.06^{a}±1.05
Phosphorous	68.09^{b}±0.02	71.13^{a}±0.03	63.45^{c}±0.02	43.41^{d}±0.00

Values are means ± SD of duplicate determinations
Means in the same rows followed by the same superscript are not significantly (P≥0.05) different.
Key: A= Control (strawberry jam); B = 17% pineapple, 14% tomato and 13% pawpaw C = 16% pineapple, 15% tomato and 13% pawpaw D = 15% pineapple, 17% tomato and 12% pawpaw

Table 3. Results of sensory properties of mixed fruit jam and control

Sensory	A	B	C	D
Texture	7.35^{a}±1.56	8.10^{a}±0.85	7.55^{a}±1.14	7.65^{a}±0.98
Taste	6.95^{b}±1.27	7.85^{a}±0.81	7.70^{a}±1.03	7.70^{a}±1.12
Flavor	7.35^{a}±1,26	7.55^{a}±0.94	7.35^{a}±0.93	7.60^{a}±1.18
Appearance	7.10^{b}±1.37	8.00^{a}±0.85	7.30^{b}±1.08	7.20^{b}±1.15
G.A.	6.70^{b}±1.40	7.65^{a}±0.67	7.20^{b}±0.95	7.50^{a}±0.76

Values are means ± SD of duplicate determinations
Means in the same rows followed by the same superscript are not significantly different (P≥0.05)
Key: A= Control (strawberry jam); B = 17% pineapple, 14% tomato and 13% pawpaw C = 16% pineapple, 15% tomato and 13% pawpaw D = 15% pineapple, 17% tomato and 12% pawpaw, GA. = General Acceptability

4. CONCLUSION

The result of this study indicated that samples B and C compared favorably with the control in the proximate composition, minerals and general acceptability. In mineral composition, potassium, magnesium and phosphorous are relatively high in the test samples compared to the control. However, sodium, calcium, iron and manganese were low compared to the control. The sensory properties of the mixed fruit jam of samples B (17% pineapple, 14% tomato and 13% pawpaw) and C (16% pineapple, 16% tomato and 12% pawpaw) were generally acceptable compared favourably with the control. Therefore jam preparation using a mixture of pawpaw, tomato and pineapple is capable of being commercialized for industrial use.

5. RECOMMENDATION

It is recommended that pineapple, tomato and pawpaw should be used in the production of mixed fruit jam to reduce post-harvest losses. From the result of the chemical composition of the test samples and sensory evaluation conducted, we recommend that mixed fruit jam from pineapple, tomato and pawpaw with these ratios 17:14:13 and 16:15:13 respectively should be introduced for industrial production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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