PHYSIO-CHEMICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF COMPOSITE JAMS FROM PINEAPPLE, AVOCADO AND MANGO PULPS

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Abstract
The study evaluated physico-chemical, microbiological and sensory characteristics of composite jams from pineapple, avocado and mango blends. The pineapple, avocado and mango were processed into pulps and mixed at varying proportions. Sugar was then added to the different blend. The blends were heated for 12-25 minutes after which citric acid and pectin were added. Samples were analyzed using standard methods. The result of the proximate analysis showed protein to range from 1.08 to 2.13% with sample SDB (85% Pineapple; 10% Avocado, 5% Mango) having the lowest value and sample SAE (70 Pineapple; 10% Avocado, 20% Mango) having the highest value and fat ranged from 0.23-0.41% with sample SAE having the lowest value and sample SDB having the highest value. The results for vitamin A showed sample SDB having the highest value (0.51 mg/100g) while that of vitamin C showed sample SAE having the highest value (13.71 mg/100g). Physiochemical properties like ◦brix (42.03-49.03 with sample SAE having the highest value), pH (3.26-3.77 with sample SAE having the highest value) were also examined. Sensory evaluation showed sample SDB as the least acceptable while sample SAE was the most acceptable of the composite jams. These results indicate that the supplementation of pineapple with avocado and mango could be adopted by food industries in the production of Jams thereby improving on the nutritional and organoleptic quality.

Keywords: Mango, Pineapple, Avocado, Jam, Sensory evaluation.

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Introduction
In the tropics there is a great deal of different fruits produced within season all year round. Most fruits are perishable in their natural state. After harvest; deterioration sets in almost immediately due to metabolic activities which continue. The perishable nature makes it difficult to store and preserve fruits; hence, there is gradual loss of *flavour* and nutritional value. Large quantities of fruits are produced and wasted in Nigeria and many other developing countries. They do not

receive the desired attention due to technological hindrances. This has led to wastage of these highly perishable fruits before reaching the consumer's table. It has therefore become imperative to explore ways of processing this fruit into shelf stable products to minimize postharvest losses. With the advancement of research into food processing and preservation, conversion of fruits into jams offer an easy, cheap, and economic yet reliable means of reducing postharvest losses (Ray and Ravi, 2005). Fruits and vegetables are fundamental and vital elements in the human diet. They are the best source of vitamins A and C, considered as protective foods and are inexpensive. Fruits are not only consumed as fresh, but are also processed in the form of value-added products. With the advances in food science and technology, processing and preservation have ensured maximum utilization of lower quality grade fruits, including deformed, de-shaped, under developed fruits for utilization and conversion into valuable food products.

Methodology

Sample Preparation

The fruits (mango, avocado and pineapple) were sorted and washed thoroughly with tap water to get rid of adhering soil or debris on the skin of the fruits. The fruits were peeled and cut into small pieces, and then crushed/blended. Sugar was then added to the different blend proportions of mango, avocado and pineapple. The blends were heated for 12-25 minutes, citric acid and pectin were then added (Kowalska *et al.*, 2018). The jam is ready when the bubbles form at the sides of the vessels. The hot jams were poured in clean, dry, wide-mouthed jars or bottles and cooled to a temperature of around 35^{o}C in a water bath for gel formation and to make sure it gels completely, they were stored at room temperature for 24 hours.

Blend formulation

Three blends gotten from the resulting pulps of mango, avocado and pineapple were mixed in different proportions in accordance with the standard regulation governing the production of composite jams as outlined by Ihekoronye and Ngoddy (1985). The composite jams will be formulated as shown below.

Table 1: Formulation for jam production

Samples	Pineapple (%)	Avocado (%)	Mango (%)
SEA (control)	100	0	0
SDB	85	10	5
SCC	80	10	10
SBD	75	10	15
SAE	70	10	20

SEA (Control) = 100% Pineapple
SDB = 85% Pineapple; 10% Avocado, 5% Mango
SCC = 80% Pineapple; 10% Avocado, 10% Mango
SBD = 75% Pineapple; 10% Avocado, 15% Mango
SAE = 70 Pineapple; 10% Avocado, 20% Mango

Analytical Methods

Proximate Composition

The moisture content, crude fibre, crude fat, crude protein and ash content were determined using the method of AOAC (2005) while carbohydrate content of the samples was determined in accordance with the method described by Ihekeronye and Ngoddy (1985).

Sensory evaluation

The sensory evaluation was performed for seven days on the samples by (20) semi-trained panelists. Colour, mouthfeel, *flavour*, taste and general acceptability were estimated using a nine-point Hedonic scale with 9 and 1 representing 'Liked Extremely' and 'Disliked Extremely' respectively (Iwe, 2007)

Statistical Analysis

Data were reported as mean ± SD. Statistical significance was established using One-Way Analysis of Variance (ANOVA) at 5% level of confidence as described by Steel *et al.* (1997). The mean separation for parameters found to be significantly different was carried out using Duncan's Multiple Range Test (Ihekoronye and Ngoddy, 1985).

Results

The result for the proximate composition of the jam samples from pineapple, avocado and mango fruit blends is presented in Table 2. Moisture content of the jam samples ranged from 20.03% - 27.81% with sample SAE (70:10:20) having the highest value while sample SDB (85:10:5) had the lowest value. It has been reported by Eke-Ejiofor and Owuno (2013) that moisture has a great impact on the shelf life of products. Ashage and Adeleke (2019) also stated that the moisture content of any food material is a measure of its shelf life. The high moisture content observed in this study for pineapple composite jam is comparable to that reported by Correa *et al.* (2011) and Aina *et al.* (2015) for pineapple jam.

Crude protein values of the jam samples ranged between 1.08%- 2.13% with SSC (80:10:10), having the highest and SDB (85:10:5) the lowest. Results showed that SEA (100:0:0), SSC (80:10:10), SAE (70:10:20) were not significantly ($p < 0.05$) different from each. Protein contents observed in this study are within the ranges for pineapple composite, water melon and apple jams reported by Nafisah *et al.* (2020).

The fat contents of the jam samples showed SDB (85:10:5) had the highest and SAE (70:10:20) had the lowest with no significant difference ($p \leq 0.05$) among all the jam samples. The crude fat content of the jam was lower than the 3.40% reported for pineapple jam by Aina *et al.* (2015). This could be attributed to the ratio of the fruits in the pulps as was reported by Nafisah *et al.* (2020). The carbohydrate content of the jam samples ranged from 69.31%- 77.89%. Jam samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets (Ogori *et al.*, 2021). The carbohydrate contents of the fruit jam samples were similar to the findings of Homi (2016) for pineapple jam (63.73%-70.98%).

Table 2: **Proximate composition of jams from fruit blends**

Sample	Moisture	Protein	Fat	Fibre	Ash	CHO
SEA	$23.41^{c} \pm 0.84$	$1.95^{a} \pm 0.07$	$0.37^{a} \pm 0.01$	$0.08^{a} \pm 0.01$	$0.30^{c} \pm 0.07$	$73.89^{e} \pm 0.48$
SDB	$20.03^{d} \pm 1.88$	$1.08^{c} \pm 0.05$	$0.41^{a} \pm 0.01$	$0.05^{a} \pm 0.01$	$0.41^{c} \pm 0.05$	$77.12^{d} \pm 0.23$
SCC	$24.27^{c} \pm 0.35$	$2.13^{a} \pm 0.08$	$0.31^{a} \pm 0.02$	$0.09^{a} \pm 0.03$	$0.60^{b} \pm 0.06$	$73.50^{c} \pm 1.78$
SBD	$26.56^{b} \pm 0.35$	$1.46^{b} \pm 0.05$	$0.26^{a} \pm 0.01$	$0.06^{a} \pm 0.02$	$0.76^{a} \pm 0.08$	$70.90^{b} \pm 1.98$
SAE	$27.81^{a} \pm 0.75$	$1.80^{a} \pm 0.04$	$0.23^{a} \pm 0.01$	$0.05^{a} \pm 0.01$	$0.80^{a} \pm 0.11$	$69.31^{a} \pm 0.06$
LSD	0.87	0.33	0.15	0.05	0.15	1.61

Values are Mean ± SD
Values with the same superscript in the same column are not significantly different
SEA (Control) = 100% Pineapple
SDB = 85% Pineapple; 10% Avocado, 5% Mango
SCC = 80% Pineapple; 10% Avocado, 10% Mango
SBD = 75% Pineapple; 10% Avocado, 15% Mango
SAE = 70 Pineapple; 10% Avocado, 20% Mango

Vitamin and Physical properties of jam from pineapple, avocado and mango fruit blends are presented in Table 3. Vitamin A values of the jam samples ranged between 0.38%-0.51 mg/100g with SEA having the highest and SAE the lowest. Vitamin C values of the jam samples ranged between 11.50%-13.71 mg/100g with SDB having the highest and SAE the lowest.

From the result, vitamin C content was higher; which is similar to the result obtained for vitamins A and C analysis of fresh grape fruit jam (Jaranmond and Endan, 2010). Vitamin A, and in particular vitamin C are some of the major non-enzymatic antioxidants in the body that produce beneficial health effects by scavenging free radicals (Xu *et al.*, 2008). The application of prolonged heat treatments on fruits, such as in the case of jams, can lead to important losses of the beneficial properties of these citrus fruits (Jaranmond and Endan, 2010). Vitamin C functions as a water-soluble antioxidant, and it is also an effective antioxidant that readily scavenges reactive oxygen species (ROS) and reactive nitrogen species (RNS). Sample SAE had the highest amount of vitamin C which might be as a result of high vitamin C in pineapples and mango. Vitamin A (retinol) is required by humans for the normal functioning of the visual system (Annette, 2002). Another main function of vitamin A is in the maintenance of growth and epithelial cellular integrity and immune function in the body.

Brix is an important parameter in the production of jams. Pineapple jam had the highest brix value of 49.03 °Brix. This may be attributed to the natural high sugar level present in the fruit. All the jam samples had sugar contents significantly ($p<0.05$) different from each other.

Result showed that pH ranged from 3.26-3.77. pH values for the composite jam samples were slightly lower than that reported by Fasogbo *et al.* (2013) for pineapple jam (3.95%). The pH of all the jam samples is within the acidic pH range and thus, are desirable for the inhibition of bacterial growth (Rahman *et al.*, 2003). This range of pH could be associated with the natural low pH value of the selected fruits and high level of sugar content in the products. High pH values and sugar contents are recommended to hinder microbial growth and maintain keeping quality (Aina and Adesina, 1999).

Table 3: Vitamins A and C, Brix and pH of jams from fruit blends

Sample	Vitamin A mg/100g	Vitamin C mg/100g	Brix	pH
SEA	0.43a±0.07	12.56d±0.05	42.76e±0.11	3.77d±0.07
SDB	0.51a±0.09	11.50c±0.01	42.03d±0.01	3.60c±0.03
SCC	0.50a±0.05	11.56c±0.00	45.13c±0.04	3.56b±0.00
SBD	0.41a±0.07	11.63b±0.01	45.51b±0.07	3.43b±0.00
SAE	0.38a±0.09	13.71a±0.09	49.03a±0.21	3.26a±0.01
LSD	0.20	0.09	0.21	0.11

Values are Mean ± SD
Values with the same superscript in the same column are not significantly different
SEA (Control) = 100% Pineapple
SDB = 85% Pineapple; 10% Avocado, 5% Mango
SCC = 80% Pineapple; 10% Avocado, 10% Mango
SBD = 75% Pineapple; 10% Avocado, 15% Mango
SAE = 70 Pineapple; 10% Avocado, 20% Mango

The Total Fungi Counts of the formulated jam samples are shown in table 4. The result indicated that all the samples are safe for human consumption with the total plate counts not exceeding the acceptable limits of $>10^5$ recommended by the International Commission of Microbiology Specifications of Foods, (ICMSF, 2005). Presence of microorganisms in food items usually hastens quality degradation. In severe cases, it makes preserved food items unsuitable for human consumption.

Table 4: Total Fungi Counts of jams from fruit blends

Sample	Total Fungi Count (log CFU/g)
SEA	1.03a±0.06
SDB	1.08a±0.05
SCC	1.05a±0.06
SBD	1.00a±0.03
SAE	1.01a±0.05
LSD	0.13

Values are Mean ± SD
Values with the same superscript in the same column are not significantly different
SEA (Control) = 100% Pineapple
SDB = 85% Pineapple; 10% Avocado, 5% Mango
SCC = 80% Pineapple; 10% Avocado, 10% Mango
SBD = 75% Pineapple; 10% Avocado, 15% Mango
SAE = 70 Pineapple; 10% Avocado, 20% Mango

Sensory analysis is a scientific discipline used to evoke, measure, analyze and interpret reactions about the characteristics of foods and other materials as they are perceived by the senses of sight, smell, taste, touch and hearing. Sensory attributes include Appearance, aroma, texture, taste and overall acceptability. It is important in determining the overall characteristics of a product. Traditionally these attributes are evaluated independently of each other by receptors of the different senses, although the possibility of a multimodal perception by human beings has recently been suggested (Hui, 2006).

The result of the sensory properties of the jam from pineapple, avocado and mango fruit blends is as presented in Table 5. The sensory score for the *colour* of the jam samples ranged from 6.07-8.53 with sample SDB least preferred and sample SEA most preferred by panelists. Sample SEA was also the most preferred for taste and *flavour*. Overall acceptability of the jam samples showed sample SEA was most acceptable while SDB was least acceptable. Sample SDB (85:10:5), SCC (80:10:10), and SBD (75:10:15) were not significantly ($p<0.05$) different from each other.

The recorded sensory scores are an indication that the fruit jam samples were highly acceptable by the panelists with overall acceptability beyond 5.50 on a 9-point hedonic scales. The high sensory values of these jams could be due to the *colour*, *flavour*, and texture of these fruits which is transferred to the final products on processing. Olugbenga *et al.* (2018) reported the same trend for banana, pineapple and watermelon jam blends in which pineapple jam recorded the best acceptability due to the colour and taste which the fruit supplies. Othman (2011) stated that pineapple and mango supply a range of sensory characteristics which enhances their eating attractiveness.

Table 5: Sensory evaluation of jam from pineapple, avocado and mango fruit blends

Sample	Colour	Taste	Texture	Flavour	Appearance	General acceptability
SEA	8.53c±0.52	8.25c±0.79	8.70c±0.73	8.05b±1.05	8.65b±1.08	8.90b±1.59
SDB	6.87a±1.36	6.85a±1.81	7.70b±0.47	7.05a±1.47	7.50a±1.15	6.55a±1.28
SCC	6.07a±1.39	7.20ab±0.83	7.65b±0.93	7.65ab±1.09	7.55a±1.19	6.95a±1.15
SBD	7.20b±1.08	7.75bc±0.77	7.55b±1.10	7.70ab±0.66	7.55a±1.15	6.65a±1.60
SAE	7.67b±0.90	8.15c±0.93	6.45a±1.47	7.90b±0.91	7.60a±1.14	7.30ab±1.81
LSD	0.80	0.69	0.63	0.67	0.72	0.94

Values are Mean ± SD
Values with the same superscript in the same column are not significantly different
SEA (Control) = 100% Pineapple
SDB = 85% Pineapple; 10% Avocado, 5% Mango
SCC = 80% Pineapple; 10% Avocado, 10% Mango
SBD = 75% Pineapple; 10% Avocado, 15% Mango
SAE = 70 Pineapple; 10% Avocado, 20% Mango

Conclusions

This study revealed that acceptable jams can be produced from pineapple, avocado and mango pulp blends with good nutritional and organoleptic properties. Significant increase was observed for crude protein, ash, and brix compared to the control sample. Mango and Avocado substitution, however, decrease the protein and fat contents of the jams. This would make the jams less nutrient dense and suitable for a target group. The study also established an increase in vitamin A and C contents with increasing substitutions of mango pulp. From the study, the 70:10:20 levels of pineapple, avocado and mango pulp blend was the most acceptable of the experimental jams.

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