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Quality Evaluation and Sensory Acceptability of Jam Produced from African Star Apple (*Chrysophyllum Albidum*) and Pineapple (*Ananas Comosus*) Blends

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Abstract

This present study was designed to determine the nutritional, physicochemical, storage and organoleptic properties of mixed fruit jams developedfrom blends of African star apple and pineapple pulps. The mixed fruit jams were prepared from African star apple and pineapple pulps in varied ratios (90:10, 80:20, 70.30, 60:40 and 50:50), while the jam produced from 100 % African star apple pulp was used as a reference sample. The nutritional, physicochemical, storage and organoleptic qualities of the samples were investigated using standardmethods. The proximate composition of the mixed fruit jam samples was 6.68 to 15.92 % moisture, 2.41 to 4.06 % ash, 2.68 to 6.19 % crude fibre, 2.28 to 3.00 % fat, 1.14 to 1.68 % protein, 79.65 to 83.55 % carbohydrate and 321.83 to 367.92 kJ/100g energy. The moisture, ash and crude fibre contents of the samples increased with increasedsubstitution of pineapple pulp with a slight decrease in their fat, protein, carbohydrate and energy contents. The mineral composition of the samples had a range of 32.67 to 44.32 mg/100g calcium, 20.74 to 36.23 mg/100g magnesium, 1.98 to 2.57 mg/100g sodium, 46.24 to 89.31 mg/100g potassium, 8.74 to 11.14 mg/100g iron and 1.24 to 1.95 mg/100g zinc.Results showed that the mineral contents of the mixed fruit jam samples increased with increased supplementation of pineapple pulp. The vitamin composition of the samples also showed that the thiamine, riboflavin, niacin, vitamin A, ascorbic acid and folic acid contents of the samples increased with increase in the addition of pineapple pulp to the products. The physicochemical properties also revealed that the pH, total soluble solids and titratable acidity of the mixed fruit jam samples ranged from 2.66 to 3.07, 61. 17 to 68.23 °Brix and 0.72 to 1.03%, respectively. Results showed that the pH, total soluble solids and titratable acidity increased with increased substitutionof the pineapple pulp. The storage properties of the jam products also showed that the pH decreased gradually at refrigerated temperature storage conditions (4°C), while the total soluble solids and titratable acidity increased at room temperature storage (30 ±2°C) than at refrigerated temperature conditions during the 90 - days storage period. The organolepticproperties of the mixed fruit jamsequally revealed that the sample prepared from 50% African star apple and 50% pineapple pulps was the most preferred by the panellists and also showed significant (p <0.05) differences in colour, taste, aroma and texture from the control (Jam prepared from 100% African star apple pulp). Generally, the mixed fruit jam samples developed from the blends of African star apple and pineapplepulps were more acceptable by the judges than the control sample and hence, they were scored higher than the control African star apple jam in all the sensory attributes evaluated by the judges in this present study.

Keywords: *Jam, African star apple, pineapple, nutritional, physiochemical characteristics, storageability, sensory properties.*

INTRODUCTION

Fresh fruits and vegetables are perishable agricultural food commodities due to their high moisture content and presence of readily available nutrients which can easily encourage the growth of micro organisms and activities of enzymes [1]. Jam is a semi-solid food product, prepared by cooking of either fruit or vegetable pulp with sugar, citric acid and pectin. Jam can be defined as an intermediate moisture food prepared by cooking of fruit pulp with sugar, pectin, acid and other ingredients to a good and acceptable consistency. Jam usually contains 65% or more of total soluble solids (TSS) and aminimum of 45% pulp. Jams are generally classified into two; the one which is developed from the pulp of a single fruit, and the other that is prepared by blending together of two or more fruit pulps [2].

Jam is a fruit spread made from either the chopped pulp of one type of fruit or mixture of two or more fruit pulps, cooked with sugar and pectin until it thickens into a spreadable consistency[3,4]. Jam is a type of fruit-based product that can be canned and stored for a longer period of time. The process of jam making involves the disruption of tissues of the fruit followed by chopping of the fruit pulp and boiling of the pulp with water, sugar and pectin until a desired spreadable consistency is achieved [5]. In jam production, sugar prevents the growth of micro-organisms and preserves the products. Sugar alsobinds the water to improve the shelf-life of the product. Pectin,which is a gelling agent is responsible for formation of gel during the production of jam.The addition of pectin also helps to improve the stability and textural characteristics of jam.[6, 7].

Citric acid is essential for the maintenance of good acid balancethat is required in the preparation of jam. In the preparation of jam, citric acid can be replaced with lime and lemon juices because they are relatively high in citric acid [8].

Indigenous tropical fruits such as African star apple (*Chrysophyllum albidum*) are often neglected, and allowed to waste due to their excess supply during their season. In view of this problem, localfarmers are often encouraged to throw away their produce or allow it to rot away because these fruits are highly perishable, and have a very short shelf-life span after harvest. To prevent this loss, processing of thesefruitsinto valuable products that are more nutritious and have prolonged keeping qualities in urban areas is of great importance. The processing of the gluts from these fruits has received less attention until when intensive and concerted effort towards the processing of these fruits into preserves, jellies, jams, drinks and other fruit-based products have gathered momentum in recent times. Farm produce is often preserved in high sugar and/or salt solutions to extend its shelf-life or add variety to common food products as an alternative means of preservation. One of themost important methods of preserving fruits is by processing them into jam or any other fruit-based product. Processing of fruits into different products like jam, jellies and preserves not only serve as a good preservation techniquebut also play a vital role in the diversification of economy, reduction of imports and stimulationof agricultural production by providing marketable products, generate employment, reduce wastage due to post-harvest losses and develop new-value added products that would be available during the off-season periods[9, 10]. The most common method used for the preservation of fruits and vegetables relies on the preservative effect of high concentration of sugar that has the ability to bind the water, thereby making it unavailable for the proliferation of microorganisms particularly bacteria inorder to extend the shelf-life of such food products [11, 12].

Pineapple (*Ananas comosus*) is a delicious fruit that is mostly consumed by different categories of people due to its attractive colour and flavour. The world production of pineapple is always on a steady increase over the years,and the reason for the increase is due to the expansion of the pineapple processing industry in the developing countries especially in the East Africa and Latin America. Pineapple is rich in vitamins A, B and C. It also contains high amounts of calcium, carbohydrate, iron and carotene e.t.c. It equally contains the protein –hydrolyzing enzyme known as bromelain[13, 14]. Pineapple is one of the tropical fruit that may be enjoyed whole and fresh, juiced or canned [15]. The pineapple pulp is yellow to golden yellow in colour, sweet and juicy. It may be used fresh, prepared into juiced and dried and made into candies. It can be also used to improve the colour, flavor, texture and mouthfeel of food drinks and beverages[16].

Fruits and vegetables are important sources of micro nutrients and dietary fibrefor people of all age groups and they are only available during specific seasons. The production of jam and other preserves from fruits and vegetables with the addition of sugar, pectin and edible acids is another way of transforming or converting these perishable agricultural produce into more nutritious, shelf-stable and attractive products in both developed and less developed countries of the world [5]. In the production of jam, the use of adequate proportion of essential ingredients such as fruit pulp, sugar, citric acid and pectin is required in order to achieve the desired result. The objective of this study was to determine the nutritional, physicochemical, storage, and organoleptic properties of jam produced from blendsof African star apple and pineapple pulps.

MATERIALS AND METHODS

Procurement of Raw Materials

The fresh and ripe African star apple and pineapple fruits used for this study were bought from Ogbete Main Market, Enugu, Enugu State, Nigeria. Sugar, pectin and citric acid used for the preparation of jam were also bought from the same market.

Preparation of African Star Apple Pulp

Fresh and firm ripe African star apple fruits (1400g), were sorted and cleaned with 2 litres of potable water to remove the adhering contaminants. After that, the inedible portion and the seeds were removed and cut into smaller slices with a stainless steel kitchen knife. The slices were boiled at 80°C for 20 min, pulped, cooled at room temperature and sievedthrough300 micron mesh sieve. After sieving the pulped African star apple, fresh African star apple pulp was obtained. The pulp was then packaged in a sterilized airtight plastic container, labelled and stored in a refrigerator for further use.

Preparation of Pineapple Pulp

Fresh and firm ripepineapple fruits (1000g), were sorted and with 2.5 litres of potable water to remove the adhering contaminants. Thereafter, thefruits were peeled manually and cut into smaller slices with a stainless steel kitchen knife and cleaned. The slices were boiled, pulped, cooled and sieved through300 micron mesh sieve. After sieving, the required pulp was obtained. The resultant pulp was then packaged in a sterilized plastic container, labelled and stored in a refrigerator for further use.

Preparation of Jam from African Star Apple and Pineapple Pulps

The jam products were produced as described by [17] with little modifications. The African star apple and pineapple pulps were blended together in different proportions:- 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 of African star apple to pineapple as shown in Table 1. One hundred grams (100g) of sugar was added to four hundred grams (400g) of the heated fruit blends and the mixture was further heated at 80°C for 20min to ensure complete dissolution of sugar.

The pectin (2g) was added and the mixture was continuously heated at 80°C until the total soluble solids content (TSS) of 67 °Brix was attained. After that, citric acid (0.03g) was added and heating was stopped. Finally, the hot prepared jam samples were separately filled in sterilized glass containers, labelled and stored in a refrigerator for further studies. Jam from 100% African star apple pulp was similarly prepared and used as control. The flow diagram for the preparation of jam from African star apple and pineapple pulps was given in Figure 1.

Table 1: Different blends of African star apple and pineapple pulps used for the production of fruit jams

Fruit	A	B	C	D	E	F
African star apple (%)	100	90	80	70	60	50
Pineapple (%)	0	10	20	30	40	50

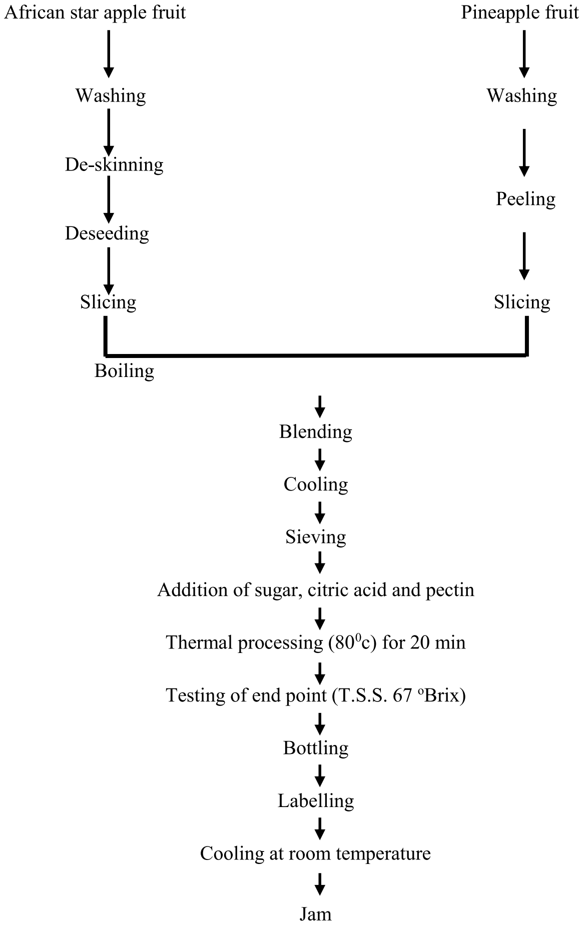

Figure 1: Flow diagram for preparation of jam from blends of African star apple and pineapple pulps

Proximate Analysis

The moisture content was determined by oven drying of the samples at a temperature of 105°C to constant weight using the method [18]. The ash, crude protein (N X 6.25), crude fibre and fat were determined using the standard analytical methods [18]. The carbohydrate content was calculated by difference. The energy value was calculated by multiplying the percentage values of protein, fat and carbohydrate contents of the samples by the Atwater factors of 4, 9 and 4, respectively [18]. All determinations were carried out in triplicate samples on a wet weight basis.

Mineral Analysis

The mineral elements were extracted by dry ashing of each sample in a muffle furnace at a temperature of 550°C to constant weight followed by the dissolution of the ash from each sample in a volumetric flask by the addition of 50mL of de-ionized water and a few drops of Hydrochloric acid. The calcium, magnesium and sodium contents of the samples were determined on a wet weight basis by the use ofatomic absorption spectrophotometer (AAS Model SP9, China). The potassium, iron and zinc contents were also determined using the Techcomp AA600 atomic absorption spectrophotometer and further confirmed by the use of a digital flame photometer using the methods [18].

All the determinations were carried out in triplicate samples.

Vitamin Analysis

The thiamine, niacin and ascorbic acid contents of each sample were determined on a wet weight basis usingan atomic absorption spectrophotometer (Perkin-Elmer, Model 300, Norwalk, CT, USA) after extraction. The riboflavin and folic acid contents were determined by the use of a digital flourimeter. The vitamin A content was determined using the ultraviolet absorption spectrophotometer after extraction with chloroform. All determinations were carried out in triplicate samples according to the standard analytical methods [18].

Physicochemical Analysis

The pH of the samples was determined using a digital pH meter (Model pH 500, Clean Instrument Co. Ltd, Shanghi, China). The total soluble solids content was determined using a digital refractometer (Model DR 301 – 95, A, Kruss Optronic Co. Ltd, Germany). The titratable acidity was determined after centrifugation and dilution followed by the titration of the diluent against 0.1N Sodium hydroxide solution using phenolphalthalein as an indicator. All determinations were carried out in triplicate samples on a wet weight basis according to standard analytical methods [18].

Storage Properties

The jam products were separately packaged in sterilised glass containers, kept under room (30±2 °C) and refrigeration (4 °C) temperature conditions.The pH, total soluble solids (TSS) and titratable acidity were tested for a period of three (3) months at intervals of 18 days. The total soluble solids (TSS) was determined by a digital hand refractometer, pH was tested using a digital pH meter and titratable acidity was determined using the method[18].

Sensory Evaluation

The jam products along with bread which served as a carrier were presented to a panel of twenty (20) semi-trained panellists consisting of staff and students of the Department of Food Science and Technology, Enugu State University of Science and Technology, (ESUT) Enugu, Nigeria. The criteria for selection were that the panellists were 18 years and above, regular consumers of jams and not allergic to any food. The jam products were evaluated for sensory attributes of colour, taste, aroma, texture and overall acceptability using a nine-point Hedonic scale with 1 and 9 representing dislike extremely and like extremely, respectively [19]. Jam samples were randomly presented to the panellists in white plastic cups with plastic teaspoons. Also, clean drinking water was provided to judges to rinse their mouths after tasting each sample to avoid residual effect. The panellists were asked to indicate their observations and rate the products based on their level of preference and acceptance of each sample. Expectoration cups with lids were provided topanellists who did not want to swallow the samples after tasting each of them.

Statistical Analysis

The data generated was subjected to one-way analysis of variance (ANOVA) using Statistical Productand Service Solution (SPSS, Version 29) software. Significant means was separated using the Tukey's test at $p < 0.05$.

RESULTS AND DISCUSSION

Proximate Composition of Jam Samples

The proximate composition of the jam samples is presented in Table 2.

The moisture content of the jam samples showed significant ($p<0.05$) differences from each other. The moisture content ranged from 6.68% to 15.72% with the control (Jam produced from made with 100% African star apple pulp) having the lowest moisture content (6.68%), while the composite jam substituted with 50% pineapple pulp had the highest value (15.72%). The variation in the moisture content observed might be probably due to the high water content of pineapple fruit coupled with the mild heating process involved in the preparation of the jam products which resulted in increase in the moisture content of the composite jam products. Water removal during the preparation of the jam samples led to a change in the concentration of food nutrients [44]. Moisture content has a greater impact on the shelf-life of jam and other fruit based products [20]. Moisture and dry matter levels of any food material is a measure of the shelf-life of such a food product [21]. The values (6.68 to 15.72%) obtained in this study were higher than the moisture content (2.68 to 14.62%) reported by [13] for functional jam produced from blends of banana, pineapple and watermelon pulps. High moisture content can cause microbial infection in jams, preserves and other jelly products.

The ash content of the jam products ranged from 2.41 to 4.06% with the composite jam containing 50% African star apple and 50% pineapple pulps having the highest value (4.06%), while the control African star apple jam had the lowest ash content (2.41%). The differences in the ash content could be probably attributed to variation in the proportions of raw materials used for the preparation of the jam samples. The result showed that the ash content (2.56 to 4.06%) obtained for the composite jam samples produced in this study was higher than the values (0.33 to 0.53%) reported by [4] for jam produced from apple and banana blends. The ash content which gives an indication of the mineral composition of food sample is of great importance in many biochemical reactions that encourage the physiological functions[4, 22].

The crude fibre content of the jam samples ranged from 2.68 to 6.19%. The control (Jam produced from 100% African star apple pulp) had the lowest fibre content of 2.68%, while the mixed fruit jam produced from 50% African star apple and 50% pineapple pulps had the highest value (6.19%). The result showed that the crude fibre content of the jam products increased with increase in the addition of pineapple pulp to the products. This increase could be as a result of high fibre content of pineapple pulp. The crude fibre content (2.68 to 6.19%) obtained in this present study was higher than the values (1.25 to 3.03%) reported by [13] for functional jam produced from blends of banana, pineapple and watermelon pulps. The consumption of fibre-rich diets has the potential to reduce the cholesterol level and risk of coronary heart diseases inhuman body [23].

The fat content of the jam samples ranged from 2.28 to 3.00%. The control (Jam produced from 100% African star apple pulp) had the highest fat content (3.00%), while the mixed fruit jam 50% African star apple and 50% pineapple pulps had the lowest fat content (2.28%). There were significant ($p<0.05$) differences in the fat content of the samples.The values obtained (2.28 to 3.00%) in this study were lower than the fat content (2.83 to 3.81%) reported by [24] for jam made from black-plum fruit. The variation in fat content could attributed to differences in the proportion of the fruit pulps used for preparation the jam products. The fat content of many foods has an impact on their general physical attributes. Fat is a major source of energy as well as a source of essential fatty acids in human body [25].

The protein content of the jam samples ranged from 1.14 to 1.68%. The composite jam made from 50% African star apple and 50% pineapple pulps had the lowest value (1.14%), while the control sample had the highest protein content (1.68%). The values (1.14 to 1.68%) obtained in this study were similar to the protein content (1.00 to 1.54%) reported by [15] for jam made from pineapple and pumpkin pulp blends. The reduction in the protein content of the composite jams compared to the control could be attributed to the low protein content of pineapple fruit which also decreasedwith increase in the proportion of pineapple pulp used for their preparation. Studies have showed that most processed fruit-based products such as jams have low nutrient content than the fresh fruits due to the heating process employed during their preparation [5, 26]. Protein is needed for the synthesis of new cells, hormones and enzymes that are essential for growth and development of tissues in humans[27].

The carbohydrate content of the jam samples ranged from 73.65 to 83.55% with the control having the highest carbohydrate content (83.55%), while the mixed fruit jam produced from 60% African star apple and 40% pineapple pulps had the lowest value (73.65%). The result showed that the control (Jam produced from 100% African star apple pulp) had higher carbohydrate content than the composite jam products. This clearly revealed that African star apple has higher carbohydrate content than pineapple. The observation is in agreement with that of [5] who reported a similar increase in carbohydrate content of African star apple jam compared to the composite jam samples produced from blends of African star apple and pineapple pulps. Carbohydrate supplies quick energy for the regulation of nerve tissue transmission and enhancement of physical activity in human body [23].

The energy value of the jam samples ranged from 321.83 to 367.92 kJ/100g with composite jam produced from 60% African star apple pulp and 40% pineapple pulps having the lowest energy content (321.83 kJ/100g), while the control had the highest energy value (367.92 kJ/100g). There were significant ($p<0.05$) differencesin the energy value of the samples. The observed increase in energy value of control sample (Jam made with 100% African star apple pulp) might be probably due to its highfat, carbohydrate and protein contents compared to the composite jam samples. The energy value estimates the amount of energy that is available in a food material for easy utilization by the body for the performance of basic physiological and metabolic functions in both man and animals.

Thepreparation of composite jam products from blends of African star apple and pineapple pulps relatively increased the ash and crude fibre contents of the products compared to the control African star apple pulp and jam, while the fat, protein, carbohydrate and energy contents decreased.

Table 2: Proximate composition (%) of jam samples

Samples	% Substitution ASAP:PP	Moisture	Ash	Crude Fibre	Fat	Crude Protein	Carbohydrate	Energy kJ/100g
A	100:00:00	$6.68^{f}\pm0.03$	$2.41^{f}\pm0.07$	$2.68^{f}\pm0.04$	$3.00^{a}\pm0.00$	$1.68^{a}\pm0.02$	$83.55^{a}\pm0.05$	$367.92^{a}\pm0.03$
B	90:10:00	$8.77^{e}\pm0.07$	$2.56^{e}\pm0.07$	$2.75^{e}\pm0.07$	$2.74^{b}\pm0.07$	$1.63^{b}\pm0.07$	$81.55^{b}\pm0.03$	$357.38^{b}\pm0.06$
C	80:20:00	$10.47^{d}\pm0.02$	$2.62^{d}\pm0.07$	$3.89^{d}\pm0.06$	$2.65^{c}\pm0.05$	$1.58^{c}\pm0.03$	$78.79^{d}\pm0.07$	$345.33^{c}\pm0.10$
D	70:30:00	$12.86^{c}\pm0.06$	$3.75^{c}\pm0.07$	$4.02^{c}\pm0.05$	$2.53^{d}\pm0.02$	$1.45^{d}\pm0.04$	$75.39^{e}\pm0.02$	$330.13^{e}\pm0.02$
E	60:40:00	$13.57^{b}\pm0.04$	$3.89^{b}\pm0.07$	$5.12^{b}\pm0.04$	$2.43^{e}\pm0.03$	$1.34^{e}\pm0.07$	$73.65^{f}\pm0.04$	$321.83^{f}\pm0.11$
F	50:50:00	$15.72^{a}\pm0.05$	$4.06^{a}\pm1.40$	$6.19^{a}\pm0.03$	$2.28^{f}\pm0.07$	$1.14^{f}\pm0.05$	$79.65^{c}\pm1.05$	$343.68^{c}\pm 1.62$

Values are mean+ standard deviation of triplicate replications. Means in the same column with different letters are significantly ($p<0.05$) different from each other

A- Jam prepared from 100% African star apple pulp. B- Jam prepared from 90% African star apple and 10% pineapple pulps.

C- Jam prepared from 80% African star apple and 20% pineapple pulps. D- Jam prepared from 70% African star apple and 30% pineapple pulps.

E- Jam prepared from 60% African star apple and 40% pineapple pulps. F- Jam prepared from 50% African star apple and 50% pineapple pulps.

ASAP- African star apple pulp, PP- Pineapple pulp

Mineral Composition of Jam Samples

The mineral composition of the jam samples is presented in Table 3.

The calcium content of the jam products ranged from 32.67 to 44.32mg/100g. There were significant ($p<0.05$) differences in calcium content of the samples. The control (Jam produced from 100% African star apple pulp) had the lowest value (32.67 mg/100g), while the sample prepared from 50% African star apple and 50% pineapple pulps had the highest calcium content (44.32mg/100g). The observed increase in calcium content of the samplecould be due to high level of calcium in pineapple fruit that was used for the preparation of the product. The values (32.67 to 44.32mg/100g) obtained in this study were higher than the calcium content (30.16 to 41.36mg/100g) reported by [14] for mixed fruit jam prepared from pineapple and sweet gourd. Calcium is one of the most important minerals that is required by the body for certain metabolic processes. Calcium is also important for the development of strong bones and teeth in human body [28].

The magnesium content of the jams ranged from 20.74 to 36.23 mg/100g. The result showed that the mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps had the highest magnesium content (36.23 mg/100g), while the control sample had the lowest value (20.74 mg/100g). It was also observed from the study that the magnesium contents of all the composite jam products were relatively higher than that of the control (jam produced from 100%) African star apple pulp). The magnesium content (20.74 to 36.23 mg/100g) obtained in this present study was higher than the values (18.23 to 30.70 mg/100g) reported by [13] for functional jam prepared from blends of banana, pineapple and watermelon pulps. Magnesium activates many enzyme systems and improves the component of chlorophylls. Magnesium in combination with calcium helps in blood clothing and contraction of muscles. It also regulates blood pressure and lung function inhuman body. [29].

The sodium content of the jam productsranged from 1.98 to 2.57 mg/100g. The control sample (Jam prepared from 100% African star apple pulp) had the highest (2.57 mg/100g) value, while the composite jam prepared from 50% African star apple and 50% pineapple pulps had the lowest value (1.98 mg/100g). The decrease in the sodium content of the mixed jam samples could be due tohigh proportion of African star apple pulp used for the preparation of the products. This is an indication that pineapple is not a good source of sodium [30]. The values (1.98 to 2.57 mg/100g) obtained in this study were lower than the sodium content (4.06 to 8.01 mg/100g) reported by [26] for jam produced from grape, apricot and blueberry fruit blends. The relatively low levels of sodium recorded by all the jam samples produced in this study are a clear indication that the products would be consumed by people of all ages including those suffering from high blood pressure and other cardiovascular diseases. Sodium helps in theregulation of water equilibrium level in the body tissues. It also plays an important role in the transportation of some non-electrolytes inhuman body [31, 44].

The potassium content of the jam samples ranged from 46.24 to 89.31 mg/100g. The control (Jam prepared from 100% African star apple pulp) had the lowest value (46.24 mg/100g), while the composite jam produced from 50% African star apple and 50% pineapple pulps had the highest calcium content (89.31 mg/100g). The values (46.24 to 89.31 mg/100g) obtained in this study were higher than the potassium content (59.50 to 80.77 mg/100g) reported by [13] for jam produced from blends of banana, pineapple and watermelon pulp. The result showed that the potassium content of the composite jam products increased with increase in the addition of pineapple pulp. Potassium is a cofactor that is essential in the synthesis of protein, activation of enzymes and maintenance of water and electrolyte balance inhuman body [32].

The iron content of the jam samples ranged from 8.74 to 11.14 mg/100g. The iron content of the samples differed significantly ($p<0.05$) from each other. The mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps had the highest iron content (11.14 mg/100g), while the control sample had the lowest value (8.74 mg/100g). The increase in the iron content of the mixed jam samples could be probably due to the addition of pineapple pulp which increased as thelevel of inclusion of pineapple pulp increased. The values (8.74 to 11.14 mg/100g) obtained in this study were higher than the iron content (10.33 to 24.84 mg/100g) reported by [27] for jam prepared from carrot and apple blends. Iron improves the component of cytochromes which help in the formation of red blood cells in the body [33]. It is also essential for transportation of oxygen to the tissues inhuman body.

The zinc content of the jam products ranged from 1.24 to 1.95 mg/100g. The composite jam prepared from 50% African star apple and 50% pineapple pulps had the highest zinc content (1.95 mg/100g), while the control sample had the lowest zinc value (1.24 mg/100g). The zinc content of the samples was significantly ($p<0.05$) different from each other. The result showed that the zinc content of the mixed fruit jam samples increased with increase in the proportions of African star apple and pineapple pulps used in their production. The zinc content (1.24 to 1.95 mg/100g) obtained in this study was lower than the values (2.68 to 4.16 mg/100g) reported by [13] for functional jam prepared from blends of banana, pineapple and watermelon pulps. Zinc is one of the basic elements that is needed for the activation of specific enzymes in human body. It also plays a vital role in gene expression and regulation of cellular growth in both man and animals[34]. Generally, the subtitution of African star apple pulp with pineapple pulps in the production of composite jams greatly increased the mineral contents of the composite jam products compared to the control African star apple jam.

Table 3: Mineral content (mg/100g) of jam samples

Samples	% Substitution ASAP:PP	Calcium	Magnesium	Sodium	Potassium	Iron	Zinc
A	100:0	$32.67^{f}±0.05$	$20.74^{f}±0.07$	$2.57^{a}±0.03$	$46.24^{f}±0.09$	$8.74^{f}±0.05$	$1.24^{f}±0.05$
B	90:10	$33.74^{e}±0.07$	$23.33^{e}±0.06$	$2.51^{b}±0.05$	$53.54^{e}±0.08$	$8.98^{e}±0.07$	$1.31^{e}±0.04$
C	80:20	$36.17^{d}±0.02$	$25.18^{d}±0.03$	$2.47^{b}±0.03$	$68.21^{d}±0.05$	$9.67^{d}±0.06$	$1.45^{d}±0.03$
D	70:30	$38.23^{c}±0.04$	$29.39^{c}±0.06$	$2.32^{c}±0.04$	$75.02^{c}±0.05$	$9.92^{c}±0.03$	$1.65^{c}±0.04$
E	60:40	$40.07^{b}±0.05$	$32.53^{b}±0.02$	$2.18^{d}±0.07$	$83.11^{b}±0.07$	$10.55^{b}±0.04$	$1.81^{b}±0.08$
F	50:50	$44.32^{a}±0.07$	$36.23^{a}±0.04$	$1.98^{e}±0.06$	$89.31^{a}±0.08$	$11.14^{a}±0.07$	$1.95^{a}±0.09$

Values are mean+ standard deviation of triplicate replications. Means in the same column with different letters superscripts are significantly ($p<0.05$) different from each other.

A-Jam prepared from 100% African star apple pulp. B- Jam prepared from 90% African star apple and 10% pineapple pulps

C-Jam prepared from 80% African star apple and 20% pineapple pulps. D- Jam prepared from 70% African star apple and 30% pineapple pulps. E- Jam prepared from 60% African star apple and 40% pineapple pulps. F- Jam prepared from 50% African star apple and 50% pineapple pulps.

ASAP- African star apple pulp, PP- Pineapple pulp

Vitamin Composition of Jam Samples

The vitamin composition of the jam samples is presented in Table 4.

The thiamine content of the jam products ranged from 1.27 to 1.87 mg/100g. The mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps had the highest value of 1.87 mg/100g, while the control Jam produced from 100% African star apple pulp had the lowest thiamine content (1.27 mg/100g). There were significant ($p<0.05$) differences in thiamine content of the samples. The increase in the thiamine content of composite jam samples could be due to substitution effect caused by the addition of pineapple pulp to the products. The values (1.27 to 1.87 mg/100g) obtained in this study were lower than the thiamine content (5.30 to 6.01 mg/100g) reported by [4] for jam produced from apple and banana blends. Thiamine is essential for glucose metabolism in human body. It also plays a vital role in the maintenance of proper function of the nerves, heart and muscles. [35].

The riboflavin content of the jam samples varied from 1.16 to 1.61 mg/100g. The control sample (Jam made with 100% African star apple pulp) had the lowest value of 1.16 mg/100g, while the mixed-fruit jam made with 50% African star apple 50% pineapple pulps recorded the highest value (1.61 mg/100g). There were significant ($p<0.05$) differences in riboflavin content of the samples. The values (1.16 to 1.61 mg/100g) reported in this present study were higher than the riboflavin content (0.86 to 1.08 mg/100g) obtained by [36] for coconut-based jam. Riboflavin (vitamin B_2) acts as a coenzyme in protein, fat and carbohydrate metabolism in human body. It also plays a vital role in the maintenance of energy supply in the body [37].

The niacin content of the jam products differed significantly ($p<0.05$) from each other. The control (Jam prepared from 100% African star apple pulp) had the lowest value (1.03 mg/100g), while the mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps had the highest value (1.44 mg/100g). The result showed that the niacin content of the sample increased with increase in the addition of pineapple pulp. Niacin plays an important role in the metabolism of glucose, fat and alcohol [35].Niacin is also important in the treatment of cardiovascular diseases in human body [38].

The pro-vitamin A content of the jam samples ranged from 1.32 to 1.62 mg/100g. The pro-vitamin A content of the samples increased with increase in the addition of pineapple pulp to the products. The composite jam prepared from 50% African star apple and 50% pineapple pulps recorded the highest pro-vitamin A content (1.62 mg/100g), while the control sample prepared from 100% African star apple pulp had the lowest value (1.32 mg/100g). The provitamin A content (1.32 to 1.62 mg/100g) reported in this study was lower than the values (2.46 to 3.58 mg/100g) obtained by [12] for mixed fruit jam prepared from coconut and pineapple blends. Vitamin A which is a fat soluble vitamin is important in maintenance of good sight. Vitamin A also serves as a natural defense to the body against certain illnesses and infections. It is also important in the maintenance of the health of epithelial tissues and skins [31, 35].

The ascorbic acid content of the samples ranged from 2.14 to 5.16 mg/100g. The composite jam prepared from 50% African star apple and 50% pineapple pulps recorded the highest value of ascorbic acid (5.16 mg/100g), while the control sample (Jam prepared from 100% African star apple pulp) had the lowest value of 2.14 mg/100g. The values (2.14 to 5.16 mg/100g) reported in this study were lower than the ascorbic acid content (5.30 to 6.01 mg/100g) obtained by [4] for jam made from apple and banana fruit blends.

The ascorbic acid content showed significant (p<0.05) differences among the samples. The increasein ascorbic acid content of mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps could be probably due to the substitution effect caused by the addition of high proportionof pineapple pulp to African star apple pulp in the preparation of the product [39]. Theascorbic acid content (2.14 to 5.16 mg/100g) reported in this study was lower than the values (5.12 to 8.12 mg/100g) obtained by [13] for composite jam produced from banana, pineapple and watermelon pulps. Ascorbic acid is one of the major vitamins derived mainly from the consumption of fruits and fruit products, and therefore, is considered important to consumers from the nutritional stand point. It is also an effective antioxidant that has the capacity to scavenge free radicals such as reactive oxygen species (ROS) and reactive nitrogen species (RNS) from human body. It also facilitates the healing of wounds in conjunction with protein inhuman body [40].

The folic acid content of the jam produced increased significantly (p<0.05) from 1.09 mg/100g in the control (Jam prepared from 100% African star apple pulp) to 1.43 mg/100g in the composite jam sample prepared from 50% African star apple and 50% pineapple pulps. Theresult showed that the composite jam samples generally had higher folic acid contents than the control sample. The increase could be probably due to the addition of pineapple pulp to African star apple pulp in the preparation of the products. The values (1.09 to 1.43 mg/100g) reported in this present study were lower than the folic acid content (2.48 to 3.18 mg/100g) obtained by [26] for jam made from apricot and blueberry fruit blends. Folic acid is necessary for the proper function neurons and its deficiency could lead to mental imbalance in humans[31,32].

Generally, the use of the mixture of African star apple and pineapple pulps in the preparation of composite jam samples relatively increased their vitamin contents compared to the control African star apple jam. However, the values obtained for all the vitamins evaluated in this study were quite low with the exception of ascorbic acid which recorded higher values in all the composite jam products.

Table 4: Vitamin content (mg/100g) of jam samples

Samples	% Substitution ASAP:PP	Thiamine	Riboflavin	Niacin	Provitamin A	Vitamin C	Folic acid
A	100:0	$1.27^{f}\pm0.01$	$1.16^{f}\pm1.07$	$1.03^{f}\pm0.03$	$1.32^{f}\pm0.02$	$2.14^{f}\pm0.07$	$1.09^{f}\pm0.07$
B	90:10	$1.33^{e}\pm1.64$	$1.27^{e}\pm0.05$	$1.09^{e}\pm0.04$	$1.37^{e}\pm0.03$	$2.64^{e}\pm0.06$	$1.16^{e}\pm0.10$
C	80:20	$1.44^{d}\pm1.99$	$1.33^{d}\pm0.04$	$1.17^{d}\pm0.05$	$1.44^{d}\pm0.05$	$2.96^{d}\pm0.03$	$1.22^{d}\pm0.09$
D	70:30	$1.57^{c}\pm1.65$	$1.39^{c}\pm0.02$	$1.27^{c}\pm0.06$	$1.50^{c}\pm0.06$	$3.78^{c}\pm0.04$	$1.29^{c}\pm0.07$
E	60:40	$1.64^{b}\pm1.29$	$1.45^{b}\pm0.04$	$1.35^{b}\pm0.03$	$1.56^{b}\pm0.04$	$4.55^{b}\pm0.09$	$1.36^{b}\pm0.13$
F	50:50	$1.87^{a}\pm1.90$	$1.61^{a}\pm0.03$	$1.44^{a}\pm0.04$	$1..62^{a}\pm0.03$	$5.16^{a}\pm0.10$	$1.43^{a}\pm0.11$

Values are mean± standard deviation of triplicate replications. Means in the same column with different letters are significantly (p<0.05) different from each other

A-Jam prepared from 100% African star apple pulp. B- Jam prepared from 90% African star apple and 10% pineapple pulps

C-Jam prepared from 80% African star apple and 20% pineapple pulps. D- Jam prepared from 70% African star apple and 30% pineapple pulps. E-Jam prepared from 60% African star apple and 40% pineapple pulps. F- Jam prepared from 50% African star apple and 50% pineapple pulps.

ASAP- African star apple pulp, PP- Pineapple pulp

Physicochemical Properties of Jam Samples

The physicochemical properties of the jam samples are presented in Table 5.

The pH of the jam products ranged from 2.66 to 3.07. The composite jam made from 50% African star apple and 50% pineapple pulps had the lowest value of 2.66, while the control (Jam made from 100% African star apple pulp) had the highest pH of 3.07. The result showed that the pH values reported for all the composite jam products were significantly (p<0.05) different from each other.The variation in pH might be due to the combination of African star apple and pineapple pulps in their production. The pH of the fruit used for the production of jam is very important because it helps in the formation of optimum gel. The values (2.66 to 3.07) reported in this study were higher than the pH (2.55 to 2.87) obtained by [7] for jam made from fresh mandarin fruit. The optimum pH of jam product has been reported to be within the range of 3.2 to 3.4. A pH above 3.4 could lead to improper setting of jam, while a pH that is below 3.0 would lead to the syneresis of the jam during storage [25]. The pH values (2.66 to 3.07) obtained in this study were relatively below the optimum pH values (3.2 to 3.4) required for proper gel formation of the jam. This showed that both the whole and composite jam samples produced in this study could be easily spoiled by yeasts and moulds during storage due to their relatively low pH values which were below the optimum pH values of 3.2 to 3.4 required for proper gelling of the jam [11].

The total soluble solids content of the jam samples ranged from 61.17 to 68.23 °Brix. There were significant (p<0.05) differences in the total soluble solids content among the jam samples. The mixed fruit jam prepared from 50% African star apple and 50% pineapple pulps had the highest totalsoluble solids content (68.23 °Brix), while the control sample had the lowest value (61.17 °Brix). The differences observed in total soluble solids content of the composite jams could be due to supplementation of African star apple pulp with pineapple pulp in their production. It has been reported that jams with total soluble solids content below 66 °Brix would be readily spoiled by microorganisms such as yeasts and moulds due to their high water activity and would also have poor setting property [3, 25]. The jam samples produced in this study had the total soluble solids contents that were not within the range of 66 °Brix with the exception of the samples prepared from 60:40 and 50:50 African star apple and pineapple pulps. This showed that both the control and other composite jam products produced in this study could be easily spoiled by yeasts and moulds during storage.

The titratable acidity of the jam samples ranged from 0.72 to 1.03%. The control sample (Jam prepared from 100% African star apple pulp) had the lowest value (0.72%), while the composite jam sample prepared from 50% African star apple and 50% pineapple pulps recorded the highest titratable acidity (1.03%). The titratable acidity of the composite jam samples was observed to increase with increase in the amount of pineapple pulp used for their preparation. The titratable acidity(0.72 to 1.03%) reported in this study wascomparable to the values (0.70 to 1.80%) obtained by [4] for jam produced from apple and banana blends. The total titratable acidity of jam is very important in that it helps to enhance its flavour and taste, and also aids in the preservation of the product [44]. Generally, the preparation of composite jam products from blends of African star apple and pineapple pulps increased the total soluble solid content and titratable acidity with a slight decrease in their pH compared to the sample prepared from 100% African star apple pulp (control). However, the pH values (2.66 to 3.07) and the total soluble solids content (61.17 to 68.23 °Brix) obtained in this study were lower than the optimum pH (3.2 to 3.4) and total soluble solids content of 66 °Brix required for the proper gelling and storage of jam products. This optimum pH range was not met by any of the samples produced but optimum total soluble solids content of 66 °Brix was met by the composite jam samples produced from 60: 40 and 50: 50 African star apple and pineapple pulps.

Table 5: Physicochemical properties of jam samples

Samples	% Substitution ASAP:PP	pH	Total soluble solids (°Brix)	Titratable Acidity (%)
A	100:0	$3.07^{a}\pm0.03$	$61.17^{f}\pm0.03$	$0.72^{c}\pm0.03$
B	90:10	$2.93^{b}\pm0.07$	$62.47^{e}\pm0.02$	$0.74^{c}\pm0.02$
C	80:20	$2.85^{c}\pm0.03$	$63.74^{d}\pm0.05$	$0.79^{bc}\pm0.05$
D	70:30	$2.77^{d}\pm0.02$	$65.34^{c}\pm0.04$	$0.84^{b}\pm0.06$
E	60:40	$2.71^{e}\pm0.05$	$67.88^{b}\pm0.03$	$0.87^{b}\pm0.07$
F	50:50	$2.66^{f}\pm0.08$	$68.23^{a}\pm0.07$	$1.03^{a}\pm0.09$

Values are mean± standard deviation of triplicate replications. Means in the same column with different letters are significantly (p<0.05)different from each other.

A-Jam prepared from 100% African star apple pulp. B-Jam prepared from 90% African star apple and 10% pineapple pulps. C-Jam prepared from 80% African star apple and 20% pineapple pulps. D- Jam prepared from 70% African star apple and 30% pineapple pulps. E-Jam prepared from 60% African star apple and 40% pineapple pulps. F- Jam prepared from 50% African star apple and 50% pineapple pulps.

ASAP- African star apple pulp, PP- Pineapple pulp

Effect of Storage Properties on Jam Samples

The changes in the physicochemical properties of the jam samples during storage are presented in Figures2, 3 and 4, respectively.

The initial pH of the jam samples ranged from 2.66 to 3.07 which decreased gradually to 2.52 to 2.91 and 2.55 to 2.99 when packaged in sterilized glass containers and stored under ambient temperature condition (30±2 °C) and refrigeration condition (4 °C), respectively. The pH of the jam samples stored at ambient temperature condition was stable before the decrease in the values occurred. The decrease in pH values of the composite jam samples observed during storage at ambient temperature condition (30±2 °C) was similar to values reported by [12] for fruit jam made from coconut and pineapple pulps. Also, the initial pH range of 2.66 to 3.07 decreased gradually to a range of 2.52 to 2.91 under room temperature (30±2 °C) for the 90 - day storage period. The pH of the jam samples stored under refrigeration condition (4 °C) with the initial pH range of 2.66 to 3.07 equally decreased slowly to a range of 2.55 to 2.99. The result showed that the storage of jam products under room temperature drastically reduced the pH of the samples at a faster rate compared to the samples stored under refrigeration condition. The increase in the level of acidity observed in jam samples duringstorage could be probably due to the formation of acidic compounds which may have resulted in a decrease in pH. The resultsobtained in this present study are correlated with those of [41] for strawberry jam and [27] for carrot and apple blended jam. This showed clearly that jams would be of better storage under room temperature condition than at refrigeratedtemperature condition after production, with a minimal change in the pH of the products.

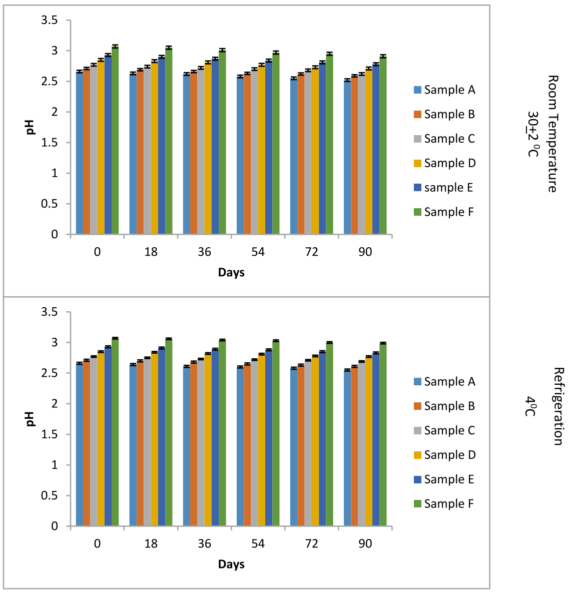

Figure 2: Changes in pH of jam samples stored under room temperature and refrigeration conditions.

Figure 3 shows that the initial total soluble solids content of the jam samples ranged from 61.17 to 68.23 °Brix which increased gradually from 62.25 to 70.08 °Brix during storage under ambient temperature condition (30±2 °C)and 61.98 to 69.47 °Brix when stored under refrigeration condition (4 °C). The observed increase in the total soluble solids content of jam samples during the 90-day storage period was relatively higher under room temperature condition compared to the samples stored under refrigeration condition. The possible increase in total soluble solids content of the jam samples might be due to the formation of mono and disaccharides which resulted from the hydrolysis of starch into simple sugar [34, 36]. The result obtainedin this studyis in agreement with that of [41] who observed an increase in total soluble solids content of strawberry jam during 90 - day storage. Similarly, [21] also observed an increase in total soluble solids contents in the range of 62.5 to 66.8 °Brix in jelly made from wood apple fruits during storage. The study revealed that the total soluble solids contentof the jam products under room temperature condition stored was relatively high compared to the samples stored under refrigeration condition.

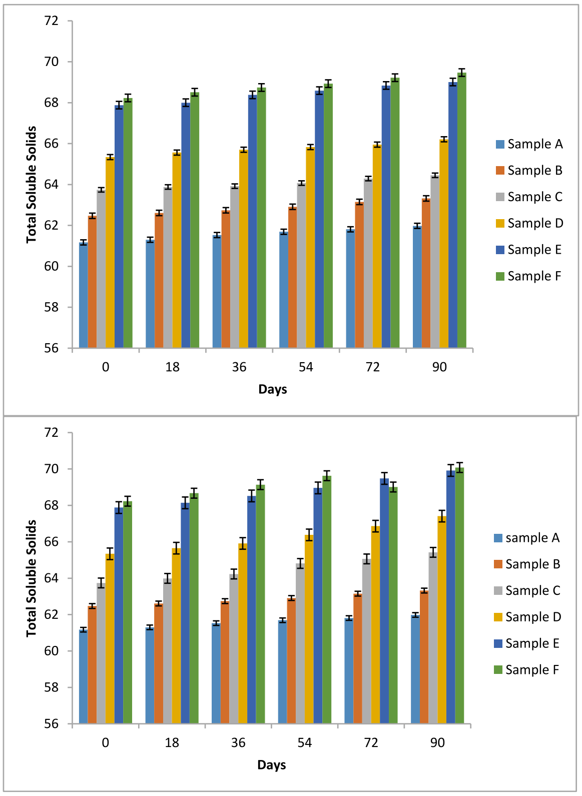

Figure 3: Changes in total soluble solids content of jam samples stored under room temperature and refrigeration conditions.

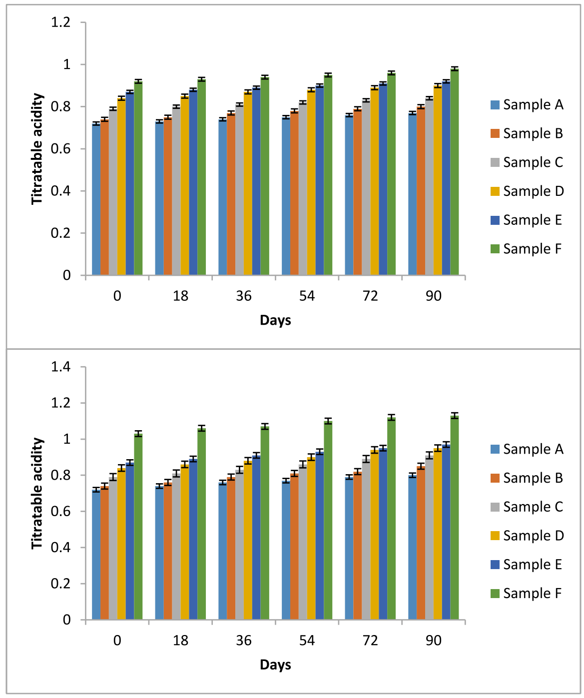

Figure 4: Changes in titratable acidity of jam samples stored under room temperature and refrigeration conditions

The initial titratable acidity of the jam samples (Figure 4) ranged from 0.72 to 1.03% which increased gradually from 0.80 to 1.13% during storage under room temperature of (30±2 ^{0}C)and 0.77 to 0.98% when stored under refrigeration condition (4 ^{0}C). The result showed that the titratable acidity of the jam samples stored under ambient temperature condition was relatively high compared to composite jams stored under refrigeration condition for the 90 - day storage period. The high acidity of fruit jams during storage might be probably due to the hydrolysis of pectin [40]. In addition, the increase in acidity of fruit jams could also occur as a result of the breakdown of sugar coupled with increase in total soluble solids content of the samples [4, 27]. The results of present study are in line with that of [43] who reported an increase in acidity of apricot jam from 0.68 to 0.72% during the 60 –day storage period under ambient temperature condition. Similar increase in acidity from 0.72 to 0.88% was also reported by [9] for value-added papaya and pineapple jams. The study showed that the storage of the jam products under room temperature condition resulted in an increase in titratable acidity than when stored under refrigerated temperature condition.

Sensory Properties of Jam samples

The sensory scores of the jam products are presented in Table 6.

The score for colour of the jam samples ranged from 6.10 to 7.75. The control (Jam made from 100% African star apple pulp) had the lowest score (6.10), while the mixed fruit jam made with 50% African star apple and 50% pineapple pulps had the highest score (7.75). The brighter colour observed in composite jams compared to the control could be due to the addition of pineapple pulp to the products. The variation in colour observed in different jam samples might be probably due to degradation of ascorbic acid and occurrence of enzymatic browning on exposure of the products to light due to improper sealing or premature setting of the products during preparation [27, 42]. The colour of a food product is one of the most important sensory attributes which determines the acceptability of a food product by the consumers.

The score for taste of the jam products ranged from 5.85 to 7.55. The composite jam prepared from 50% African star apple and 50% pineapple pulps had the highest value (7.55), while the control had the lowest value (5.85). The preference in taste of the jam samples was enhanced by increase in the addition of pineapple pulp to the products since pineapple fruit is known for its sweetness and tartness.

The observation is in agreement with that of [13] for composite jam produced from blends of banana, pineapple and watermelon pulps. The change in the taste of the jams could be as a result of fluctuations in fruit acids or reduction in pH which may be caused by improper sealing or storage of the samples after preparation [43].
The score for aroma of the jam products ranged from 6.00 to 7.55 with the composite jam prepared from 50% African star apple and 50% pineapple pulps having the highest score (7.55), while the control sample (Jam made with 100% African star apple pulp) had the least score (6.00). The result revealed that the increase in the addition of pineapple pulp resulted in a remarkable improvement in the aroma of the products. It was also observed that the score for aroma of the sample prepared from 50% African star apple and 50% pineapple pulps was liked moderately by the panellists. The observation is in accordance with the report of [9] for value-added papaya and pineapple jams.
The score for the texture of the jam samples ranged from 5.75 to 7.40. The control sample had the lowest value (5.75), while the mixed fruit jam produced from 50% African star apple and 50% pineapple pulps had the highest score (7.40).
The result showed significant ($p<0.05$) differences in texture among the samples. The score for texture of composite jams was found to increase with increase in the inclusion of pineapple pulp to the products. Theobservation is in agreement with that of [27] who reported an increase in texture of fruit jam prepared from pineapple and sweet gourd.The score for overall acceptability of the jam samples ranged from 5.80 to 7.30. The composite jam sample prepared from 50% African star apple and 50% pineapple pulps had the highest score (7.30), while the control sample (Jam prepared from 100% African star apple pulp) had the lowest value (5.80). The increase in the addition of pineapple pulp to the products resulted in acceptability of composite jams compared to the control sample produced from 100% African star apple pulp. The observation is in an agreement with that of [9] for value-added papaya and pineapple jams.
Generally, the composite jam sample prepared from 50% African star apple and 50% pineapple pulps was most preferred by the panellists because it was rated higher in all the sensory attributes evaluated. However, all the composite jam products were scored higher compared to the control in all the sensory parameters assessed by the panellists.

Table 6: Sensory properties of jam samples

Samples	% Substitution ASAP:PP	Colour	Taste	Aroma	Texture	Overall acceptability
A	100:00:00	$6.10^{f}\pm1.55$	$5.85^{f}\pm1.30$	$6.00^{f}\pm1.48$	$5.75^{f}\pm1.37$	$5.80^{e}\pm1.05$
B	90:10:00	$6.30^{e}\pm1.41$	$6.05^{e}\pm1.43$	$6.05^{e}\pm1.19$	$5.95^{e}\pm1.05$	$5.85^{d}\pm1.30$
C	80:20:00	$6.35^{d}\pm1.18$	$6.20^{d}\pm1.15$	$6.70^{d}\pm1.34$	$6.15^{d}\pm1.03$	$6.00^{c}\pm1.77$
D	70:30:00	$6.75^{c}\pm1.40$	$7.10^{c}\pm1.37$	$6.80^{c}\pm1.32$	$6.50^{c}\pm1.23$	$6.00^{c}\pm0.79$
E	60:40:00	$6.90^{b}\pm1.11$	$7.40^{b}\pm1.42$	$6.95^{b}\pm1.23$	$6.60^{b}\pm1.50$	$6.35^{b}\pm1.49$
F	50:50:00	$7.75^{a}\pm1.25$	$7.55^{a}\pm1.27$	$7.55^{a}\pm1.27$	$7.40^{a}\pm1.18$	$7.30^{a}\pm1.55$

Values are mean± standard deviation of twenty (20) semi – trained panellists. Means in the same column with different letters are significantly ($p<0.05$) different from each other.
A-Jam prepared from 100% African star apple pulp. B- Jam prepared from 90% African star apple and 10% pineapple pulps, C-Jam prepared from 80% African star apple and 20% pineapple pulps. D- Jam prepared from 70% African star apple and 30% pineapple pulps. E-Jam prepared from 60% African star apple and 40% pineapple pulps. F- Jam prepared from 50% African star apple and 50% pineapple pulps.
ASAP- African star apple pulp, PP- Pineapple pulp

CONCLUSION

The study revealed that nutritious and organoleptic acceptable jams could be produced by the use of African star apple and pineapple pulps in the ratios of 90:10, 80:20, 70:30, 60:40, and 50:50, respectively without adverse effects on their nutritional, physicochemical, storage and sensory properties compared to the control (Jam made with 100% African star apple pulp). The proximate, mineral and vitamin compositions of composite jam productsrevealed that the ash, crude fibre, calcium, magnesium, sodium, potassium, iron, zinc, ascorbic acid riboflavin, niacin, provitamin A, thiamine and folic acid contents of the products increased with increase in the inclusion of pineapple pulp to the products. In addition, the jam prepared from 50% African star apple and 50% pineapple pulps had higher nutrient contents than the sample prepared from 100% African star apple pulp (control). The physicochemical properties equally showed that the pH of the products decreased, while the total soluble solids content and titratable acidity increased with increase in the amount of pineapple pulp used for their preparation. The storage stability of the samples showed a gradual increase in both the total soluble solids contentand titratable acidity but the increase was relatively higher under room temperature storage compared to refrigerated temperature storage condition. In addition, the pH of the samples also decreased with the extension of the storage time and the decrease was higher under room temperaturecondition compared to refrigerated temperature storagecondition.
The sensory properties equally showed that the composite jam produced from 50% African star apple and 50% pineapple pulps was most preferred by the panellists and had the overall best sensory properties followed the mixed fruit jam prepared from 60% African star apple and 40% pineapple pulps, while the control (Jam made with 100% African star apple pulp) was the least preferred jam sample.

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