Multidisciplinary

Quality evaluation of formulated banana, mango and watermelon low sugar jam

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Abstract

Quality evaluation of banana, mango and watermelon low sugar jam was investigated. Normal and low sugar jams of mango, watermelon and banana were prepared following modified method. The jam samples were subjected to physicochemical, microbiological and sensory analysis using standard methods. The result of the physicochemical analysis showed significant (p<0.05) difference for ash, crude protein, fibre, moisture, carbohydrate, TTA and pH. However, the total soluble solid (TTA) showed no significant (p>0.05) difference across all the samples. The result obtained from the microbial analysis showed that bacterial count of sample C had the highest bacterial count and highest total fungal count (2.0 X 10^3 and 2.4 X 10^2 Cfu) respectively, compared to others. Both the prepared normal sugar jams and low sugar jam samples showed excellent taste, high nutritive values and good sensory acceptability. Low sugar jam samples prepared with mango and watermelon fruits showed better crude protein (0.56-1.11%) and fiber contents (2.63-4.37%). The study concluded that low-sugar jams could be satisfaction for people with restricted diet even for weight maintaining person.

Keywords: jam, low sugar jam, physicochemical, microbiological and sensory properties

1. Introduction

Jam is food that is cooked using the meat/juice of fruits or vegetables which are then converted into jelly-like form. In general, jam is made using only one type of fruit with the characteristics of a good jam is to have a soft and even texture, favorable color and good fruit taste (Khan, 2020) [21]. Jam production can use various types of fruit, but in general the fruit that is used contains pectin. Pectin is a sugar/polysaccharide compound that makes jam to have a soft but thick texture. Low-sugar jams are jams in which some of the sucrose has been replaced by sweeteners (e.g., sorbitol, xylitol, or steviol glycosides) (Abolila *et al*., 2015) [1]. Fruits have mostly enough acidity and pectin content (extracted during cooking), contributing to the texture development in jam. It tends to apprehend shape, but normally less firm compared to jelly. Jam has prolonged shelf life so that it can be available round the year. Production of jam requires ingredients (fruit pulp, acid, pectin and sugar) of correct quantities for having desired finished product. Raw material quality and process of manufacturing are the exponents to the quality of finished goods (Rana *et al.*, 2021) [30].

Fruits are important foods with excellent nutritional and functional properties. Populations that consume diet rich in fruits and vegetables have significantly lower rates of many types of cancers (Fila *et al*., 2010) [16]. Fruit and vegetables are either consumed directly or after being processed to products such as fruit purees or jams (Javanmard and Endan, 2010) [20].

Banana is one of the oldest fruits probably originated in the warm moist tropical Asia. Most edible bananas originated from two species; M. *acuminate* and *M. balbisiana* (Ploetz *et al.*, 2017) [29]. Bananas and plantain have the potential of contributing to strengthening national food security and decreasing rural poverty (Adejoro *et al*., 2012) [2]. Banana is an excellent source of vitamin B6, soluble fibre, and contain moderate amount of vitamin C, manganese, and potassium.

Mango is an edible stone fruit produced by the tropical tree *Mangifera indica*. It is believed to have originated between northwestern Myanmar, Bangladesh, and northeastern India (Morton, 2017). Worldwide, there are several hundred cultivars of mango. Depending on the cultivar, mango fruit varies in size, shape, sweetness, skin color, and flesh color, which may be pale yellow, gold, green, or orange (Morton, 2017). Mango is the national fruit of India, Pakistan and the Philippines, while the mango tree is the national tree of Bangladesh (Oka *et al*., 2014) [25]. Mango pulp has a sweet and pleasant flavor. It has been reported that mangoes are a good source of vitamins (A and C) and minerals (potassium, calcium) (Favier *et al.* 1993) [15]. For example, the pulp of the Tommy Atkins mango variety has a provitamin A content of 2,300 IU/100 g (Godoy and Rodriguez-Amaya, 1987) [18]. Processing of mango into jam will help reduce postharvest loss and increase consumption of the fruits.

Watermelon is a member of the cucurbitaceae family, and it is a warm-season crop related to cantaloupe, squash, cucumber and pumpkin (Sari *et al.*, 2018) [31]. The whole watermelon is edible, including the rind. It is low in calories but highly nutritious; it contains Vitamin C and Vitamin A in form of the disease fighting beta-carotene. Lycopene and beta-carotene

work in conjunction with other plant chemicals not found in vitamin/mineral supplements. Potassium is also available in it which is believed to help in the control of blood pressure and possibly prevent strokes (Sari *et al*., 2018) [31].

Low sugar jam provides many valuable constituents such as vitamins, minerals, and polyphenols, reducing the risk of cardiovascular disease and cancer (Basu *et al*., 2011) [8]. High sugar jam has been identified with increasing rate of health problems (obesity, metabolic syndrome, heart related issues and diabetes) and a host of other cardiovascular diseases. Banana is rich in nutrients and has been reported to improve blood sugar levels (Touati *et al*., 2016) [32]. There is therefore the need for the development of acceptable low sugar jam for diabetics. Mango is an excellent source of immune-boosting nutrients and has also been found to be low in calories and helps in preventing diabetes (Valente *et al.*, 2011; Eyarkai *et al.*, 2017) [33, 14].

Similarly, watermelon contains high levels of antioxidants vitamin A, vitamin C, and vitamin E (Murcia *et al*., 2011) [23]. Watermelon being high in antioxidants helps in reducing the risk of heart disease (Virginia and Ajit, 2014) [34]. Therefore, banana, mango and watermelon are very good sources of health-promoting compounds (Muraki *et al*., 2013) [22] and if used in low sugar jam production would help improve human health. This research work was therefore designed to determine the quality of banana, mango and watermelon low sugar jam.

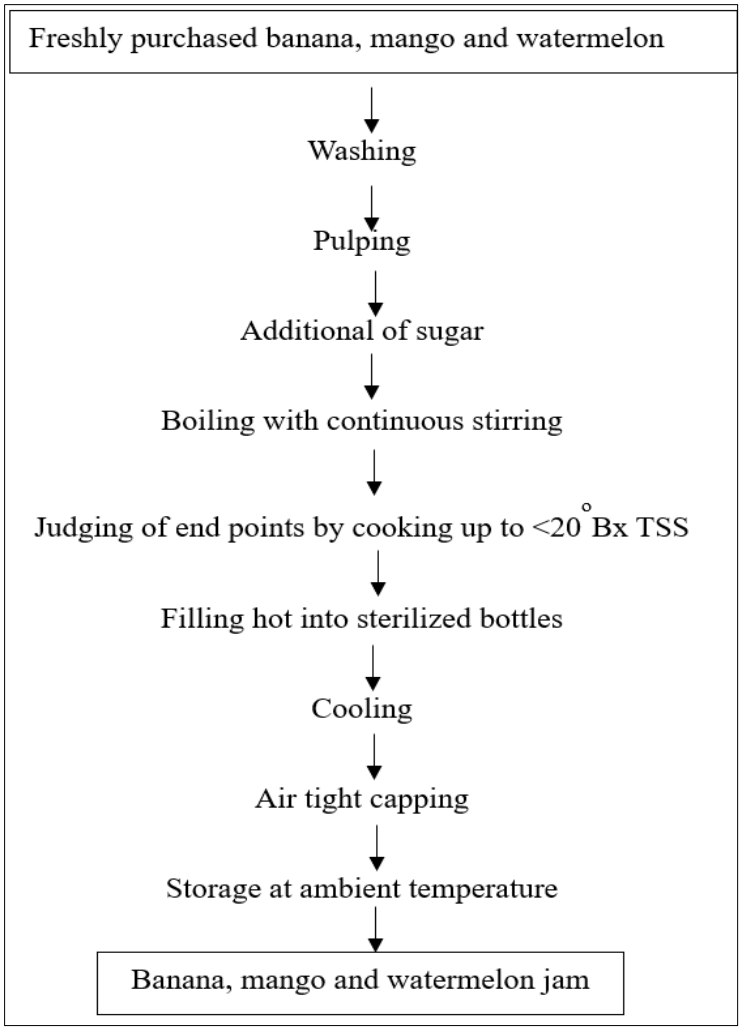
2. Materials and methods

2.1 Materials procurement

The banana, mango and watermelon, and other ingredients necessary for the production and formulation of jam were purchased from fruit market in Makurdi and were taking to the Department of Food Science and Technology, Joseph Sarwuan Tarka University, Makurdi for further processing.

2.2 Sample preparation

The modified methods of Ghodke and Mane (2017) [17] was used for the production of banana and mango jam (Figure 1). Freshly harvested banana (100g), mango (165g) and watermelon (152g) were washed with plenty of water. They were crushed using water through grinder to obtain pulp. Then sugar was added to pulp and boiling was carried out till the end point was obtained which was judged when product obtained <20°Bx TSS. The finished product was immediately filled into sterilized glass bottle of 500 ml capacity. The product was allowed to cool and bottles were sealed air tight.



Source: Ghodke and Mane (2017) [17]

Fig 1: Preparation of Banana, Mango and Watermelon Jam

Table 1: Recipe formulation for normal sugar jam

Product/fruits	Pulp (ml)	Sugar (g)	Gelatin (g)	Lemon (ml)
Mango	350	250	15	20
Banana	350	250	15	20
Watermelon	350	250	15	20

Table 2: Recipe formulation for low sugar jam

Product/fruits	Pulp (ml)	Sugar (g)	Gelatin (g)	Lemon (ml)
Mango	350	125	15	20
Banana	350	125	15	20
Watermelon	350	125	15	20

2.3 Proximate analysis of banana, mango and watermelon jam

2.3.1 Determination of moisture content

The moisture content was determined by hot air oven method as described by (AOAC, 2012) [5]. Empty crucible was weighed and 2g of the sample was transferred into the crucible. This was taken into the hot air oven and dried for 24 hours at 100^0C. The loss in weight was regarded as moisture content and expressed as:

$$\% \, Moisture = \frac{W2 - W1}{W} \, X \, 100$$

Where:
W_2=Weight of the crucible and dry sample;
W_1=Weight of empty crucible
W=Weight of the sample

2.3.2 Determination of crude protein by kjeldahl method

The Kjeldahl method as described by AOAC (2012) [5] was used to determine the percentage crude protein. Two (2) grams of sample was weighed into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01g 6.6LB). A catalyst mixture weighing 0.88g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) was added. Concentrated sulphuric acid (7 ml) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25 ml with distilled water in a volumetric flask. Ten (10) ml of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8 ml of 40% NaOH. To the receiving flask, 5 ml of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100 ml conical flask and titrated with 0.01 HCl. A blank titration was done. The percentage nitrogen was calculated from the formula:

$$\% \text{ Nitrogen} = \frac{(\text{S} - \text{B}) \times 0.0014 \times 100 \times \text{D}}{\text{sample weight}}$$

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor
% Crude Protein = % Nitrogen x 6.25 (correction factor).

2.3.3 Determination of crude fat

Crude fat content was determined using Soxhlet method as described by AOAC (2012) [5]. Samples was weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the flat bottom extractor of the Soxhlet apparatus. Flat bottom flask (250 ml) of known weight containing 150 – 200 ml of 40 – 60°C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8 h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferred into a hot air oven (GENLAB, England B6S, serial no: 85K054) at 105ºC for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 minutes before weighing. Percentage fat content was calculated as:

$$\% \text{ Crude Fat} = \frac{\text{weight of extracted fat}}{\text{Weight of Sample}} \text{ x } 100$$

2.3.4 Determination of ash content

The (AOAC, 2012) [5] method for determining ash content was used. Two (2) grams of sample was weighed into an aching dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content were then heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \, Ash = \frac{(W3 - W1)}{(W2 - W1)} \, x \, 10$$

Where: W1 = Weight of empty crucible, W_2 = Weight of crucible + sample before ashing,
W_3 = Weight of crucible + content after ashing.

2.3.5 Determination of crude fiber

The method described by AOAC (2012) [5] was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2ºC for 2 hours, cooled in a dessicator and weighed. The residue was then transferred in to a muffle furnace (Shanghai box type resistance furnace, No.: SX2-4-10N) and ignited at 550ºC for 30 minutes, cooled and weighed. The percentage crude fibre content was calculated as:

$$\% \text{ Crude fibre } = \frac{\text{Loss in weight after incineration}}{\text{Weight of original food}} \times 100$$

2.3.6 Determination of carbohydrate content

Carbohydrate content was determined by difference according to (Ihekoronye and Ngoddy, 1985) as follows:

$$\%\,Carbohydrat = 100 - \begin{pmatrix} \%moisture + \%Protein + \% \\ Fat + \%Ash + \%Fibre \end{pmatrix}$$

2.4 Microbiological analysis of Banana, Mango and Watermelon Jam

2.4.1 Serial dilution

One gram of each sample was weighed and dispensed into 9ml of sterile distilled water as a diluent. Serial dilution was conducted by adding 1ml from tube one into the second test tube and mixed carefully by shaking it gently. The same procedure was made several times (Bukar *et al*., 2009) [10].

2.4.2 Plating, culture incubation

A pour plate technique was used for plating the jam culture. A triplicate of sterile petri- dishes were labelled corresponding to the number of tubes containing the culture. Separate sterile pipettes were used to transfer 1ml of sample from the dilution tube to the corresponding petri-dishes before pouring molten nutrient agar that has been cooled to 45°C after sterilization. This was swirled gently to mix the agar and allowed to solidify before it was incubated at 37°C for 24hours (Cheesbrough, 2016) [11].

2.4.3 Viable cell count

The total plate count for the growth of bacterial colonies on plates was observed by colony counter to count and record the number of colonies on each plate. The actual number of bacterial colonies was calculated as colony forming unit (CFU/ml) as described by Badau *et al.* (2018) [7].

2.5 Sensory evaluation of banana, mango and watermelon jam

The jam samples collected were subjected to sensory evaluation for the attributes of colour, flavour, taste, texture and overall acceptability. A semi-trained fifteen-member panel were used comprising of under graduate students, and scores will be allocated by the panelists based on a 9-point Hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). The data collected will be subjected to statistical analysis to determine possible differences among samples.

2.6 Statistical analysis

The data to be generated will be subjected to analysis of variance (ANOVA) and means will be separated using Duncan's multiple range test (D M R T) while significance deference will be tested at 5 % level of probability.

3. Results and discussion

3.1 Physicochemical properties of banana, mango and watermelon low sugar jam

The result of the physicochemical analysis of jam produced from banana, mango and watermelon fruit is presented in Table 3. The moisture content of the produced jam ranged from 0.16 to 0.57 % for sample A and B respectively. Generally, there was a significant (p<0.05) difference in the moisture content for sample A to F. Sample B (0.57%) had the highest moisture content while sample A recorded the least moisture content of 0.16%. It has been reported by Eke-Ejiofor and Owuno (2013) [12] that moisture has a great impact on the shelf life of products. Ashage and Adeleke (2009) also stated that the moisture content of any food material is a measure of its shelf life. The low moisture content reported in this study is however in disagreement with study done by Rana *et al*. (2021) [30] where high moisture content was reported for coconut and pineapple. The ash content of food materials gives an indication of the mineral composition of the food sample which is very important in many biochemical reactions. The ash content of the jam samples ranged between 0. 03%-0.27% with sample A and sample C recording significantly (P<0.05) lower and higher values, respectively. Emelike and Akusu (2019) [13] equally reported similar range of ash values for jams and marmalades produced from some selected tropical fruits. This is evident that mango, watermelon and banana are embedded with a high amount of ash and hence, good quality mineral compositions. The value observed for low sugar jams is higher than the findings of Kang who reported 0.02% ash for sour-sop jam and lower to that reported by Aina *et al*. (2015) with the value 5.10% for pineapple jam. Patil *et al*. (2014) [28] also reported 0.25% ash in guava jam which is in agreement with the one observed in the present study with the value of 0.26%.

Crude protein values of the jam samples ranged between 0.56%- 1.11% with sample E recording the highest and sample D the lowest. However, the crude protein showed significant (p<0.05) difference across the six samples. The highest protein value observed in sample E of this study is in agreement with the work of Akomolafe and Ajayi (2015) [4] who also reported high protein value for mango and banana jam. This might be attributed to the high protein content of the banana fruit as compared to other fruits (Akomolafe and Ajayi, 2015) [4]. Protein values of 0.52% and 0.60% for guava and mango jams, respectively reported by Homi (2016) and Olugbenga *et al*. (2018) are within the ranges observed in this study.

The crude fat content of the jam samples ranged from 0.01%-0.03% with sample C recording the highest and sample F the lowest with no significant (p>0.05) difference among all the jam samples. The crude fat contents of the jam samples were lower than 3.40% for pineapple jam and similar with 0.02% sour-sop jam reported by Aina *et al*. (2015). This could be attributed to the ratio of composition of the fruits used for the study. The fat content of 0.03% in guava jam was also observed by Tarwar *et al*. (2014) [28]. This value is in comparison with the value of sample A to F observed in this study. This is an indication that the fat content of the produced jam samples is in a minute quantity; hence, suitable for health-conscious individuals.

The crude fibre contents of the products ranged from 2.63% to 4.37% for sample A and sample D respectively. Watermelon low sugar jam (sample D) recorded the highest (4.37%) fibre content and was followed by watermelon normal sugar jam (sample C). The observed high fiber contents maybe as a result of high fibre content of watermelon (Oyeleke *et al*., 2013; Adesuyi and Ipinmoroti, 2011) [27, 3]. Fibre consumption has been linked to decreased incidence of heart disease, various types of cancer and diverticulosis (Wildman, 1999). Also, high levels of fibre in foods help in digestion of foods and also

contribute to the health of the gastrointestinal tract and system in man by aiding normal bowel movement thereby reducing constipation problems which can lead to colon cancer (Schneeman, 2002). The high fibre contents of the produced jams suggest that they would be ideal food for people suffering from obesity, diabetes, cancer and gastrointestinal disorders (Ufot and Inemesit, 2016). According to Schnceman (2012), the crude fibre contributes to the health of the gastrointestinal system and metabolic system in man (Olorode *et al.*, 2017; Bhosale and Udachan, 2018) [26, 9].

The carbohydrate content of the jam samples ranged from 94.56%- 96.42% with sample D recording the lowest and sample A with significantly highest (p<0.05) value. The carbohydrate content of the mango fruit jam was high as compared to other fruits and this might be attributed to the carbohydrate content of mango as compared to other fruits such as guava 15.43% and sour-sop 12.66% (Ozioma *et al.*, 2013). Jam samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets. Carbohydrate content of the low sugar jam samples was similar with the findings of Aina *et al.* (2015) and Homi (2016) for pineapple and guava low sugar jams with the values of 58.6% and a range of 63.73%-70.98%, respectively.

The TTA of the different samples ranged from 2.11% (sample C) to 5.38% (sample A), which was within the predetermined acidity range for fruit jams (Singh *et al*., 2009; Viana *et al*., 2012). These variations were attributed to the acid content of the various fruits and their proportions within the study. Sample C presented lower TTA values and higher pH due to the higher acidic content of the fruit sample. Viana *et al.* (2012) also verified an increase in acidity and a reduction of the pH in mixed jams made with papaya and mango pulp in which higher proportions of Mango were used.

The total soluble solid ranged from 6.10 ^{o}Brix to 6.22 ^{o}Brix for sample B and sample F respectively. Sample F recorded the highest Brix of 6.22 ^{o}Brix. The higher values for Brix in this study may be attributed to the natural sugar level present in the fruits. The range of Brix reported in this study is similar to that reported by Emelike and Akusu (2019) [13].

The pH values ranged from 3.94- 4.54, with the sample B having the lowest pH. The pH in the present study was slightly lower than that of jackfruit (Eke-Ejiofor and Owuno, 2013) [12] and pineapple jam (Hanan *et al*., 2012) which ranged from 4.8 to 6.3 in low calorie baladi rose petals jam. The pH of jam is an important factor to obtain optimum gel condition. This range of pH observed in this study could be associated with the natural pH value of the fruits and high level of sugar content in the products. There is a natural phenomenon of sugar being used to restrain the growth of microbes and therefore reduce food spoilage to the barest minimum which science has proven right. This is in agreement with the statement of Aina and Adesina (2019) that high values for pH and sugar are recommended to hinder microbial growth and maintain keeping quality.

3.2 Microbiological properties of mango, watermelon, and banana low sugar jam

Table 4 shows total bacteria count and total fungal count of normal and low sugar jams produced from mango, watermelon and banana. The total bacterial load ranged from 1.1X10^3 to 2.0 X 10^3 CFU/g. While the total fungal count ranged from 1.3 X 10^3 to 2.4 X 10^3 CFU/g compare with the microbiological standards of fortified blended foods, total viable count TVC < 100 cfu/g. The result is still within acceptable value. These show that the normal and low sugar jams produced are acceptable and it reflects high hygiene standards adopted in the food preparation. Improper processing, handling and storage can allow the level to increase. The total coliform count (TCC) recorded no growth across the six samples.

The result obtained from the analysis showed that bacterial count of sample C had the highest bacterial count and highest total fungal count compared to others, which could be as a result of poor processing method, poor hygiene practice, improper and unhygienic handling of the product after production, bad sanitation operations and use of unclean utensils. This agrees with the fact that immense microbial contamination of food is linked to poor post processing handling practices (Badau *et al*., 2018) [7].

Table 3: Physicochemical properties of banana, mango and watermelon low sugar jam

Sample	Ash (%)	Crude Protein (%)	Fibre (%)	Fat (%)	Moisture (%)	Carbohydrate	TTA	Brix	pH
A	0.03^{e}±0.00	0.74^{b}±0.03	2.63^{f}±0.04	0.03^{a}±0.02	0.16^{d}±0.01	96.42^{a}±0.01	5.38^{a}±0.03	6.19^{a}±0.02	4.27^{c}±0.01
B	0.22^{a}±0.01	0.75^{b}±0.01	3.03^{e}±0.04	0.03^{a}±0.01	0.57^{a}±0.08	95.42^{b}±0.11	4.48^{b}±0.03	6.10^{a}±0.14	3.94^{d}±0.01
C	0.27^{b}±0.02	0.61^{c}±0.01	4.06^{b}±0.08	0.04^{a}±0.01	0.27^{d}±0.02	94.86^{c}±0.08	2.11^{e}±0.01	6.19^{a}±0.01	4.54^{a}±0.01
D	0.26^{a}±0.01	0.56^{c}±0.06	4.37^{a}±0.06	0.02^{a}±0.01	0.26^{cd}±0.01	94.56^{d}±0.18	2.38^{d}±0.04	6.05^{a}±0.07	4.46^{b}±0.01
E	0.15^{a}±0.01	1.11^{a}±0.01	3.43^{d}±0.04	0.02^{a}±0.00	0.15^{b}±0.01	94.87^{d}±0.05	3.37^{c}±0.04	6.16^{a}±0.57	4.47^{b}±0.01
F	0.25^{a}±0.04	1.10^{a}±0.01	3.83^{c}±0.04	0.01^{a}±0.00	0.25^{c}±0.04	94.51^{c}±0.01	3.46^{c}±0.06	6.22^{a}±0.02	4.54^{a}±0.01

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscripts are significantly (p<0.05) different

Keys

A = Mango (Normal Sugar Jam)
B = Mango (Low sugar jam)
C = Watermelon (Normal sugar jam)
D = Watermelon (Low sugar jam)
E = Banana (Normal sugar jam)
F = Banana (Low sugar jam)

Table 4: Microbiological properties of mango, watermelon and banana low sugar jam

Sample code	TBC	TFC	TCC
A	1.4 X 10^3	1.8 X 10^2	Nil
B	1.1 X 10^3	1.3 X 10^3	Nil
C	2.0 X 10^3	2.4 X 10^2	Nil
D	1.8 X 10^3	1.4 X 10^2	Nil
E	1.6 X 10^3	2.0 X 10^2	Nil
F	1.2 X 10^3	1.6 X 10^2	Nil

Keys
TBC = total bacteria count
TFC = Total fungal count
TCC = Total Coliform Count

3.3 Sensory properties of banana, mango and watermelon low sugar jam

Data on the sensory attributes of banana, mango and watermelon low sugar jam are presented in Table 5. The sensory score for the appearance of the jam samples ranged from 7.40 to 8.80 with F as least preferred and sample A as most preferred with significant (p<0.05) difference as shown in Table 3. Aroma and taste of the jam samples ranged from 7.53 to 8.53 and 7.60 to 8.53. Mouthfeel of the jam samples ranged from 7.33 to 8.40 for samples E and A respectively. Overall acceptability of the jam samples ranged from 7.40 to 8.67 and sample A was rated most preferred while sample F was least preferred. The recorded sensory scores are an indication that the fruit jam samples were highly acceptable by the consumers. Also, the fact that their overall acceptability is beyond 5.50 on a 9-point hedonic scales revealed that they were equally acceptable by the panelists. The high sensory values of these jams could be due to the color, flavor, and texture of these fruits which is transferred to the final products on processing. Awolu *et al*. (2018) [6] also reported the same trend for banana, mango and watermelon jam blends in which mango jam recorded the best overall sensory acceptability due to the arrays of color and taste which this fruit supplies. Othman (2011) stated that banana and mango fruits are an excellent source of vitamins and minerals and supply a range of sensory characteristics which enhances their eating attractiveness.

Table 5: Sensory properties of banana, mango and watermelon low sugar jam

Sample	Appearance	Aroma	Taste	Mouthfeel	Overall acceptability
A	8.80^{a}±0.41	8.53^{a}±0.64	8.53^{a}±0.52	8.40^{a}±0.63	8.67^{a}±0.49
B	8.73^{a}±0.59	8.53^{a}±0.64	8.40^{a}±0.74	8.33^{a}±0.62	8.53^{a}±0.52
C	8.07^{b}±0.88	7.93^{b}±0.70	7.67^{b}±0.82	7.87^{ab}±0.83	7.93^{b}±0.59
D	8.07^{b}±0.70	7.73^{b}±0.88	7.73^{b}±0.96	7.73^{ab}±0.96	7.80^{b}±0.86
E	7.53^{bc}±0.83	7.53^{b}±0.64	7.73^{b}±1.10	7.33^{b}±1.05	7.73^{b}±0.88
F	7.40^{c}±0.99	7.73^{b}±0.70	7.60^{b}±0.91	7.47^{b}±0.99	7.40^{b}±1.06

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscripts are significantly (p<0.05) different

Keys
A = Mango (Normal Sugar Jam)
B = Mango (Low sugar jam)
C = Watermelon (Normal sugar jam)
D = Watermelon (Low sugar jam)
E = Banana (Normal sugar jam)
F = Banana (Low sugar jam)

4. Conclusion and recommendations

Quality of banana, mango and watermelon low sugar jam was assessed. Both the normal sugar jams and low sugar jam samples showed excellent taste, high nutritive values and good sensory acceptability. Low sugar jam Samples prepared with mango and watermelon fruits showed better crude protein and fiber contents. Based on the findings of this study, it was recommended that low-sugar jams could be satisfaction for people with restricted diet even for weight maintaining person.

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