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CHARACTERIZATION AND NUTRITIONAL COMPOSITIONS OF NOVEL FRUIT JAMS DEVELOPED FROM SELECTED FRUITS

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ABSTRACT: *Jam is a product made by boiling fruit pulp with sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position. Twelve fruit jams fortified with soya bean and sweetened with sucrose, fructose, and palm date (Phoenix dactylifera L.) were produced from Syzygium malascence (Malay rose apple), Spondias mombin (hog plum), and Cola lepidota (yellow monkey kola) fruits. The characterization and nutritional compositions of the formulated fruit jams (FFJ) were determined using standard methods. The physicochemical results ranged as follows: pH 3.07 ± 0.06 to 4.67 ± 0.40; total soluble solids [Brix] 33.00 ± 1.41 to 81.75 ± 1.06, and viscosities ranged between 204.30 ± 2.97 to 401.00 ± 1.41Pa.s. Fortification of these FFJ with soybean using the different sweeteners significantly ($p<0.05$) increased protein and mineral contents. Jams formulated with dates, followed by fructose as sweetener significantly ($p<0.05$) increased ash and fibre contents and ($p<0.05$) reduced energy content. The microbial load did not exceed the standard ($x10^6$) after four weeks of storage at room temperature. Studies on the sensory evaluation showed no significant ($p>0.05$) difference between overall acceptance of all the FFJ and commercial jam. The study revealed that FFJ using palm date fruit and fructose had low calorie with more nutrient content and can replace sucrose based.*

KEYWORD: Novel, Fruit jams, Characterization, Nutritional composition.

INTRODUCTION

The wealth of nutrients is found in different types of fruits and that is why a great preference is given to fruit and its products in a healthy diet. Fruits are seasonal and they top the list of most perishable agricultural food commodities due to their high moisture content in conjunction with various readily available nutrients/growth factors (Arah *et al*., 2016). Nowadays, various post harvest strategies for reducing wastage, all round year availability and increasing the nutrients intake from fruits are being implemented. These include increasing consumption of fresh fruits, increasing levels of essential nutrients through fortification and improving nutrients bioavailability by processing them into products like jam, jelly, marmalades, candy, squash and so on.

Fruit jams are made by boiling fruit pulp with a sufficient amount of sugar (i.e sucrose), pectin, acid, and other ingredients such as preservatives, colouring agents and flavouring materials to a gel like consistency that is firm enough to hold the tissues of the fruit in position. Sucrose is added to jams for sweet taste and acts as a natural preservative in inhibition of microbial growth by binding the water in the jam (Alsuhaibani &Al-Kuraieef, 2018), thereby making it unavailable for microbial activity thus extending the shelf life.

High consumption of sugar is often associated with high energy intake that could result in higher risks for obesity, diabetes, and cardiovascular diseases. In this regard, some sweeteners are used in the processing of jams, such as sorbitol, mannitol, sucralose, acesulfame K, saccharin, aspartame, stevioside, cyclamate and xylitol (Ruiz-Ojeda *et al*., 2019) which may not contemplate the expected sweetness and still present an "aftertaste". Hence there is a need for substituting sucrose with natural sweeteners to produce pleasant flavoured low calorie fruit jams that are similar to conventional ones.

Date palm (*Phoenix dactylifera L.*) is an important member of the Palmaceae family grown mostly in semi-dried and dried regions of the world. The fruit is commonly consumed in various parts of the world for its health benefits and pleasant taste and is considered a staple food in the Middle East and North Africa (Juhaimi *et al.*, 2012). Date fruits have many health benefits regardless of their varieties because of the nutrient content, such as high fibre, carbohydrates, minerals, proteins, lipids, moisture, and phenolic compounds (Al-Shahib & Marshall, 2003). In addition, the antioxidant (Vayalil, 2002), anti-mutagenic, anti-carcinogenic (Rahmani *et al*., 2014), antimicrobial (Taleb Hajer *et al.*, 2016), and anti-inflammatory (Tang *et al.*, 2013) of date fruits phytochemicals have been reported.

Apart from fruits like strawberry, mango, apple, orange that are popularly processed into jams, fruits such as hog plum, yellow monkey kola can also be used to produce jams. Hence, this work was designed to characterise and determine the nutritional composition of novel fruit jams developed from Malay rose apple (*Syzygium malaccense*), yellow monkey kola (*Cola lepidota*) and hog plum fruit (*Spondias mombin*).

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MATERIALS AND METHODS

Samples Collection and Preparation

Malay rose apples, yellow monkey kola, hog plum, palm date fruits, and soybeans were purchased from a local market in Obio/Akpor Local Government Area of Rivers state, Nigeria. The samples were purchased from six randomly selected vendors in the market. From this pool of fruits, the samples for the analysis were obtained. Mature and undamaged fruits were selected for this research.

Preparation of Date Palm Fruit Pulp

The dried palm date fruits (Deglet Noor variety) were hand-picked from unwanted materials, quickly and thoroughly washed in clean tap water to remove dust and specks of dirt. The palm fruit dates were then deseeded by using a stainless steel knife to open up the fruit, remove the seed, and cut the fruit into smaller pieces. The pulp with pericarp was cut into smaller pieces, spread on foil paper and then oven-dried at 50°C or 60 hours. The dried broken up dates were ground into powder and allowed to pass through a clean 0.35mm mesh sieve to obtain a fine homogenised powdery substance (date palm fruit pulp). The palm date pulp produced was stored in a clean airtight container at room temperature till further use.

Preparation of Soybean Flour

The soybeans were sorted to remove pebbles, stones and other extraneous materials. It was wet cleaned and steeped for 10 hours. The steeped soybeans were drained and precooked for 15 minutes at 100°C after which it was dehulled (by rubbing between the palms) and the hulls were removed by rinsing with clean water. The dehulled soybeans were dried in the cabinet drier at 100°C for 5 hours and dry milled into fine flour. The soybean flour was sieved using a sieve of 250µm aperture size to obtain smooth flour. The soybean flour was packaged in a low-density polyethene bag till further use.

Preparation of fruits pulp

The yellow monkey kola and Malay apple fruits were separately washed in clean water and were longitudinally sliced with the help of stainless steel knives to remove the seeds (after which the outer skin of yellow monkey kola was peeled off) and dipped in 0.2% citric acid solution that was already prepared to avoid browning. The sliced fruits were weighed and blended with a home blender grinder. The whole hog plum fruits were washed, weighed and blended in a blender. Water was added and sieved using a coarse sieve to separate the seeds from the pulp, then the weight of the seeds was taken to know the weight of the pulp obtained. The pulps of the three fruits were refrigerated until further use.

Production of Fortified Fruit Jams

Twelve fruit jams formulations were prepared according to the method described by Alsuhaibani & Al-Kuraieef (2018) with slight modification as shown in Table 1. The fruit pulp was boiled while mixing the earliest soaked soybean flour alongside with either sucrose, fructose or date fruit pulp (powder) and pectin was mixed with part of the date fruit pulp and added to the mixture. The mixture was boiled until the desired concentration was reached; citric acid and sodium benzoate were added with continuous mixing for an additional one minute. The mixture was poured directly into an already sterilised jar and then cooled in cold water.

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The characterization of the formulated fruit jams was conducted immediately after the production.

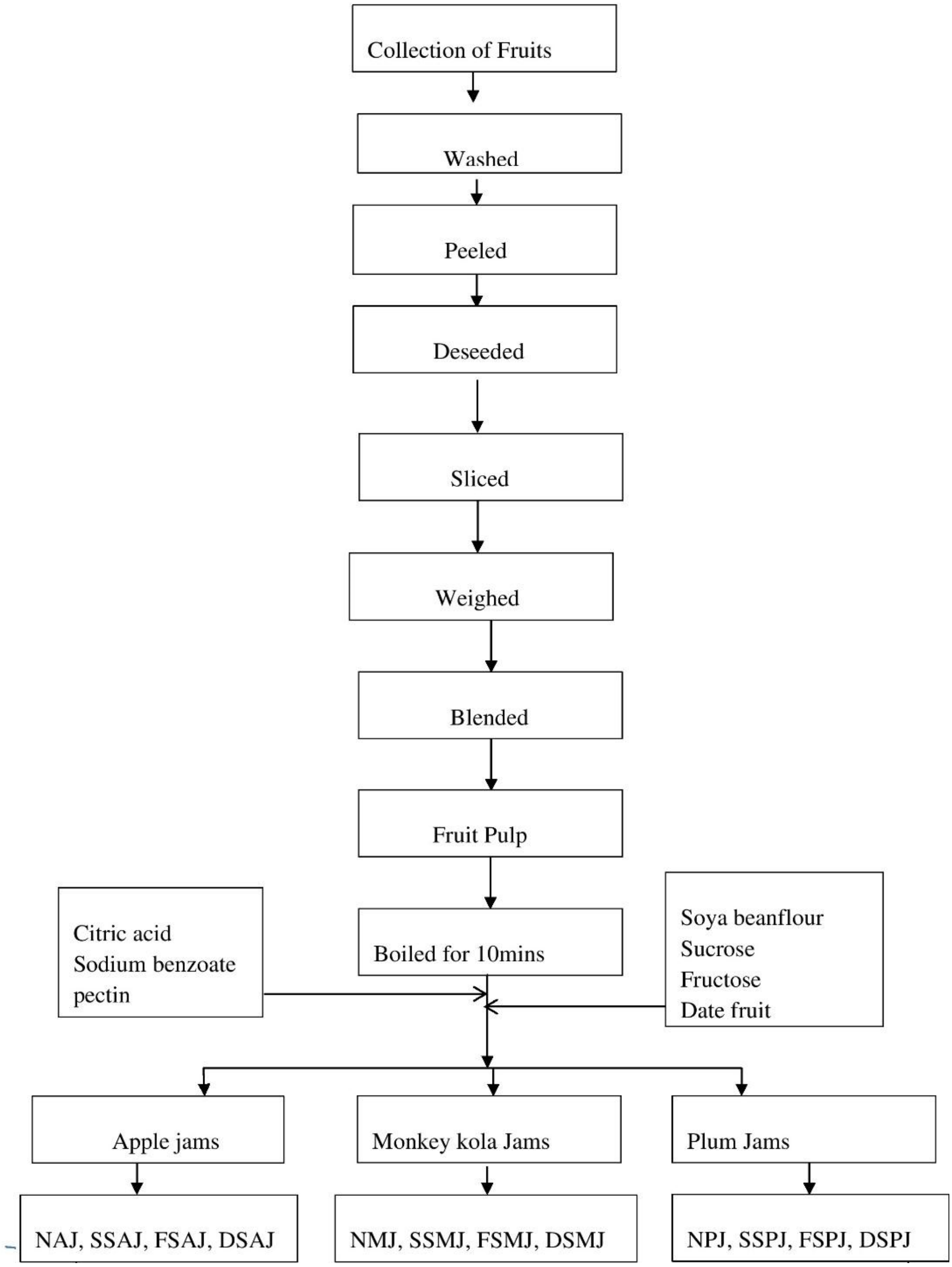

Figure 1: Flow chart for the production of the formulated fruit jams.

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Table 1: Ingredient used for Preparing the Twelve fruit Jams formulations

formulations	Fruits (g)	Sucrose (g)	Fructose (g)	Dates Pulp (g)	Citric acid(g)	Sodium benzoate (g/kg)	Pectin (g)	Soaked Soybeans (g)
NAJ	1000	1000	-	-	-	-	-	-
SSAJ	950	1000	-	-	-	-	-	50
FSAJ	950	-	625	-	2.5	-	-	50
DSAJ	950	-	-	900	7.0	0.8	2	50
NMJ	1000	1000	-	-	-	-	-	-
SSMJ	950	1000	-	-	-	-	-	50
FSMJ	950	-	625	-	2.5	-	-	50
DSMJ	950	-	-	900	7.0	0.8	2	50
NPJ	1000	1000	-	-	-	-	-	-
SSPJ	950	1000	-	-	-	-	-	50
FSPJ	950	-	625		2.5	-	-	50
DSPJ	950	-	-	900	7.0	0.8	2	50

NAJ: Normal Apple Jam, SSAJ: Sucrose Soybeans Apple Jam FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ Sucrose Soybeans Monkey Kola Jam, FSMJ Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam.

Characterization of the Formulated Fruit Jams

Determination of pH

The pH was measured using a pH metre (HANNA instruments, Model, HI9813-6N). The pH metre was standardised using 4.01 and 7.0 standard reference solutions at 25^0C. The pH of the fruit jam samples was determined by inserting the pH electrode directly into a beaker containing the fruit jam samples. The pH metre was then rinsed with deionised water and dried immediately after each reading and the reading for each sample of the fruit jams was taken in triplicates.

Determination of Viscosity

The viscosity of the formulated fruit jams at ambient temperature was determined with the aid of a rotary digital viscometer (NDJ 85, China). About 50 grams of formulated fruit jams were poured into the viscometer cup, the rotor was suspended into the sample to rotate and the values were determined in the pascal-second unit at ambient temperature.

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Determination of Total Soluble Solids in ºBrix

The total soluble solids for the formulated fruit jam were determined. Teaspoons of jam samples were placed on the prism of the handheld Abbey refractometer to obtain the total soluble solids reading in ºBrix.

Determination of Total Titratable Acidity

The total acidity was determined according to the standard method of AOAC (1984). Briefly, 2 grams of the fruit jams were dissolved in 25ml distilled water, three drops of Phenolphthalein indicator were added and the mixture was titrated with 0.1 N NaOH till pink colour appeared. This was done in triplicates. Total titratable acidity was calculated as;

$$\%Citric\ acid = \frac{titre\ value\ \times 0.1N \times 0.064}{Sample\ weight} \times 100$$

Microbial Load Count

Total bacterial and fungal counts were carried out using standard methods. The media used were Nutrient Agar (NA) for bacteria count and Potato Dextrose Agar (PDA) for fungi count. They were all prepared according to the manufacturer's instructions. 10 grams of each of the fruit samples was homogenised, serially diluted under aseptic conditions (dilution 4) and surface plated on NA and PDA. The NA plates were incubated at 37ºC for 48 hours, while the PDA plates were incubated at 25ºC for 5 days. After incubation, the Colonies on plates were counted and multiplied by the dilution factor.

Sensory Evaluation

The formulated fruit jams produced together with commercial jam were evaluated by a panel of twenty panellists who were randomly selected from the final year students of the Department of Food Science and Technology, Rivers State University, Port Harcourt, Rivers State. The samples were packaged in transparent jam bottles and presented in a coded manner. The sensory quality attributes of the samples were colour, taste, flavour, texture, spreadability and overall acceptance. In the questionnaire presented to the panellists, they were requested to observe and taste each sample as coded with sliced bread provided and grade them based on a 9-point hedonic scale showing least acceptable to most acceptable in all attributes. The room was equipped with proper light. They were also provided with potable water to rinse their mouth after evaluating each sample to check taste interference.

Proximate Analysis

The proximate composition of the formulated fruit jams was determined following standard methods of AOAC (2006) and energy value was computed using the Atwater factors of 4, 9 and 4. This was calculated by multiplying the mean values of crude protein, fat and carbohydrate by the Atwater factors of 4, 9 and 4 respectively, summing up the total and expressing the result in the Kcal/100g sample.

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Determination of Minerals

Determination of calcium, potassium and sodium was carried out using Atomic Absorption Spectrophotometer while magnesium, zinc, and iron were determined by flame photometry.

Determination of Vitamins

The vitamins A and E analyses of the fruit jams were carried out using an ultraviolet-visible spectrophotometer based on the principle of Beer-Lambert's law. Vitamin C content was determined using 2,6-Dichlorophenol indophenol. About 2g of the fruit jam samples was dissolved in 25ml of distilled water in a volumetric flask and stirred. 25ml of oxalic acid was added (as a stabilising agent) and was stirred, the mixture was allowed to shake on an orbital shaker for 30minutes after which it was filtered to get a clear solution (extract). The volume of this extract was measured and 10ml was titrated with indophenol solution, (2,6-dichlorophenol indophenol) to a permanent pink colouration. Vitamin C content was calculated as;

$$\text{Vitamin C (mg/100g Jam)} = \frac{Volume\ of\ indophenol\ used\ x\ Ascorbic\ equivalent\ of\ dye}{Weight\ of\ sample\ in\ aliquot\ titration}$$

Statistical Analysis

The data were analysed by the analysis of variance (ANOVA) using the SPSS program (version 20.0). Data were expressed as mean ± standard deviation (SD) and p value less than 0.05 was considered as significant ($p < 0.05$).

RESULTS

The Characterization of the Fruit Jams

The results show that the pH of the fruit jams ranged from 3.07 ± 0.06 in a normal plum jam (NPJ) to 4.67 ± 0.40 in date soybean monkey kola and sucrose soybean monkey kola jam (DSMJ and SSMJ). Total titratable acid (TTA) ranged from 0.25 ±0.04% in normal monkey kola jam (NMJ) to 1.50 ± 0.00% in fructose soybean plum jam (FSPJ). Monkey kola jams had higher pH values and lower TTA when compared to plum and apple jams.

Fructose and date based fruit jams had significantly ($p<0.05$) reduced total soluble solids and dry matter. Also, the organic matter contents of all the formulated fruit jams were observed to be within a close range of above 90%. The viscosity of the formulated fruit jams was observed to range from 204.30±2.97 Pa.s in dates apple jam (DSAJ) to 401.00 ±1.41 Pa.s in sucrose monkey kola jam (SSMJ). The fortification of the fruit jams with soya beans significantly ($p<0.05$) increased the viscosity. Also, fructose and date based fruit jams had significantly ($p<0.05$) decreased viscosity when compared to sucrose based fruit jams. Date based fruit jams had significantly ($p<0.05$) decreased viscosity when compared to fructose in all the formulated fruit jams.

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Table 2: The Characterization of the Formulated Fruit Jams

JAMS	pH	%TTA	TSS (^{o}Brix)	Dry matter(g)	Organic matter(g)	Viscosity (Pa.s)
NAJ	3.27±0 .38^{ab}	0.37 ± 0.21^{b}	71.50± 0.00^{c}	78.12± 0.41^{h}	99.90 ±0.00^{e}	251.50 ± 4.52^{d}
SSAJ	3.73± 0.65^{abc}	0.45 ± 0.01^{c}	72.50± 0.71^{c}	72.07± 3.31^{g}	99.78 ± 0.04^{e}	282.65 ± 3.04f
FSAJ	3.90 ±0.44^{bc}	0.49 ±0.01^{c}	50.50 ± 0.71^{b}	65.03± 0. .06^{e}	99.69 ± 0. .02de	235.55 ± 10.39^{c}
DSAJ	3.43 ±0.06^{abc}	1.12 ±0.01^{f}	33.00 ± 1.41^{a}	39.04± 0.01^{a}	99.43 ± 0.03^{cd}	215.35 ± 3.89^{b}
NMJ	4.07 ±0.46^{cd}	0.25 ±0.04^{a}	81.40 ± 0.57^{d}	79.43± 0.72^{h}	99.84 ± 0.02^{e}	390.25 ± 2.47^{h}
SSMJ	4.67 ±0.38^{d}	0.28 ±0.01^{a}	71.50 ± 0.00^{c}	76.93±0.00^{h}	99.72 ±0.01^{de}	401.00 ± 1.41^{h}
FSMJ	4.63 ±0.42^{d}	0.29 ± 0.01^{a}	49.50 ± 0.00^{b}	60.13± 2.69^{d}	99.68 ± 0.01^{de}	319.30 ± 5.94^{g}
DSMJ	4.67 ±0.40^{d}	0.55 ± 0.01^{d}	33.00 ± 1.41^{a}	45.00± 0.72^{b}	99.35 ± 0.07^{c}	265.55 ± 5.87^{e}
NPJ	3.07 ±0.06^{a}	1.05 ±0.04^{e}	81.75 ± 1.06^{d}	80.35± 0.02^{h}	99.63 ± 0.03^{cde}	239.55 ± 1.06^{c}
SSPJ	3.27 ±0.02^{ab}	1.03 ± 0.06^{e}	71.75 ± 0.35^{c}	79.30± 2.06^{h}	98.60 ± 0.01^{b}	253.60 ± 1.56^{d}
FSPJ	3.23 ±0.15^{ab}	1.50 ± 0.00^{g}	51.75 ± 0.35^{b}	68.69± 1.63^{f}	98.42 ± 0.08^{b}	229.00 ± 7.07^{c}
DSPJ	3.86 ±0.01^{bc}	1.00 ±0.00^{e}	35.75 ± 3.89^{a}	49.70± 0.06^{c}	97.75 ± 0.44^{a}	204.30 ± 2.97^{a}

Values are means ± SD. Values with different superscripts down the column are significantly different (P<0.05). NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam TTA: Total titrable acid TSS: Total soluble solids.

The Microbial Load of the Formulated Fruit Jams in Storage for 4 Weeks

Table 3 represents the total bacterial count, TBC, total mould count, TMC and total yeast count TYC of formulated fruit jams stored at ambient temperature for four weeks. The results showed that the total bacterial count for week zero ranged from 1.0x10^3cfu/g-3.1 x10^3cfu/g with sample SSMJ having the highest count and sample NMJ having the lowest count. Week 2 had a bacteria count ranging from 1.2x10^3cfu/g - 5.0 x10^3cfu/g with NMJ having the lowest count while sample SSMJ had the highest total bacteria count. Week 4 total bacteria count was

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between 3.0 x10^3cfu/g - 9.0 x 10^3cfu/g with NMJ showing the lowest total bacteria count and sample FSMJ showing the highest total bacteria count.

The total mould count is also presented in Table 3. The result showed that for week 1, the total mould count was between 1.0 x 10^2 cfu/g – 2.0 x 10^3cfu/g with sample DSAJ having the lowest total mould count and sample NAJ had the highest total mould count, but there was no observed mould growth in samples FSAJ and FSPJ. For week 2, the total mould count ranged between 1.0 x 10^2cfu/g – 3.1 x 10^3cfu/g with the lowest and the highest count observed in the samples FSAJ and SSAJ respectively. Week 4 total mould count ranged from 2.1 x 10^2cfu/g – 6.1 x 10^3cfu/g with sample FSAJ having the lowest total mould count and sample SSAJ having the highest total mould count.

The total yeast count of the formulated fruit jams in storage for 4 weeks at ambient temperature is also represented in Table 3. The result showed that, for week 1, the total yeast count ranged between 1.0 x 10^2cfu/g - 4.6 x 10^2cfu/g with sample FSMJ having the lowest total yeast count and NPJ having the highest total yeast count, but no observable growth in the samples NAJ, SSAJ, FSAJ and SSPJ. For week 2, the total yeast count was between 1.0 x 10^2cfu/g - 4.5 x 10^2 cfu/g with sample SSPJ having the lowest count and sample SSMJ having the highest count. However, in week 4 total yeast count ranged between 3.5 x 10^2 cfu/g – 9.2 x 10^3 cfu/g with sample NAJ having the lowest count and sample SSMJ having the highest count.

TABLE 3: Microbial Load of the Formulated Fruit Jams in Storage for 4weeks

Jam samples	Durations (weeks)	TBC (cfu/g)	TMC (cfu/g)	TYC (cfu/g)
NAJ	0	2.1 x 10^3	3.7× 10^2	NG
	2	3.0 × 10^3	6.0 × 10^2	2.0 × 10^2
	4	7.0 ×10^3	1.1 × 10^3	3.5 × 10^2
SSAJ	0	2.2 × 10^3	2.0 × 10^3	NG
	2	3.1 × 10^3	3.1 × 10^3	3.0 × 10^2
	4	7.6 × 10^3	6.1 × 10^3	5.0 × 10^2
FSAJ	0	2.4 × 10^3	NG	NG
	2	3.3 × 10^3	1.0 × 10^2	6.0 × 10^2
	4	7.8 × 10^3	2.1 × 10^2	1.0 × 10^3
DSAJ	0	1.5 × 10^3	1.0 × 10^2	1.3 × 10^2
	2	2.0 × 10^3	7.0 × 10^2	3.5 × 10^2
	4	5.0 × 10^3	3.0 × 10^3	4.0 × 10^2
NMJ	0	1.0 × 10^3	4.0 × 10^2	4.0 × 10^2
	2	1.2 × 10^3	7.0 × 10^2	6.5 × 10^2
	4	3 .0 ×10^3	1.4 × 10^3	1.2 × 10^3
SSMJ	0	3.1 × 10^3	2.3 × 10^2	3.0 × 10^3
	2	5.0 × 10^3	4.5 × 10^2	4.5 × 10^3

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	4	8.0×10^3	7.0×10^2	9.2×10^3
FSMJ	0	2.3×10^3	1.7×10^2	1.0×10^2
	2	4.3×10^3	3.0×10^2	2.0×10^2
	4	9.0×10^3	5.0×10^2	4.0×10^2
DSMJ	0	3.0×10^3	1.7×10^2	2.8×10^2
	2	4.2×10^3	3.5×10^2	4.5×10^2
	4	8.9×10^3	5.0×10^2	8.0×10^2
NPJ	0	1.4×10^3	3.0×10^2	4.6×10^2
	2	2.0×10^3	7.0×10^2	8.5×10^2
	4	5.0×10^3	9.0×10^2	1.4×10^3
SSPJ	0	1.8×10^3	1.5×10^2	NG
	2	4.0×10^3	3.0×10^2	1.0×10^2
	4	7.1×10^3	5.0×10^2	2.0×10^2
FSPJ	0	1.8×10^3	NG	3.5×10^2
	2	2.8×10^3	1.5×10^2	7.5×10^2
	4	6.0×10^3	3.0×10^2	7.1×10^3
DSPJ	0	2.4×10^3	2.0×10^2	3.2×10^2
	2	3.5×10^3	4.0×10^2	8.0×10^2
	4	6.8×10^3	6.0×10^2	1.0×10^3

TBC: Total Bacterial Count TMC: Total Mould Count TYC: Total Yeast Count CFU: Colony Forming unit NG: no growth. NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam.

The Sensory Properties of the Formulated Fruit Jams and Commercial Formulated Jam (Strawberry)

The sensory evaluation of the formulated fruit jams and commercial fruit jam is represented in Table 4. The results showed that the sensory score for the colour ranged from 8.14- 4.57 with sample NAJ having the highest sensory score while DSAJ scores the lowest. Fortification of normal fruit jams with soybeans significantly ($p< 0.05$) reduced the colour acceptability for all the fruit jams except for plum jam where the fortification with soya beans had no significant ($p>0.05$) effect on the colour acceptability.

The sensory score for the flavour of the fruit jams ranged from 8.00-6.00, CFJ and NAJ score the highest while DSAJ scores the lowest. Fortification with soya beans significantly ($p<0.05$) reduced the sensory score for flavour in all the fruit jams.

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The taste scored between 8.5-6.75 with NPJ scoring the highest while FSPJ and FSAJ scored the lowest.

Texture ranged from 7.40-4.40 with CFJ and NAJ scoring the highest and FSMJ scoring the lowest. Fortification with soya beans significantly ($p<0.05$) reduced the sensory score for texture in all the fruit jams.

Spreadability is between 7.00-4.00 with NAJ and NPJ scoring the highest and FSMJ scoring the lowest.

The sensory score for overall acceptance ranged from 8-4.3 with NPJ scoring the highest and DSAJ scoring the lowest. There was no significant ($p>0.05$) difference between the sensory properties studied in all the formulated fruit jams when compared to the commercial fruit jams.

Table 4: The Sensory Properties of the Formulated Fruit Jam and Commercial fruit Jam (Strawberry)

Jams samples	Colour	Flavour	Taste	Texture	Spreadability	Overall acceptance
CFJ	7.57 ± 1.0^{ef}	8.00 ± 0.71^{d}	8.25 ± 0.50^{a}	7.40 ± 1.52^{d}	5.33 ± 1.53^{ab}	6.33 ± 1.53^{abc}
NAJ	8.14 ± 0.90^{f}	8.00 ± 0.77^{d}	7.75 ± 1.26^{ab}	7.40 ± 1.56^{d}	7.00 ± 1.73^{b}	7.00 ± 1.00^{bcs}
SSAJ	6.43 ± 0.98^{cd}	6.40 ± 0.55^{ab}	7.25 ± 0.96^{ab}	5.60 ± 0.55^{abc}	6.00 ± 1.73^{b}	5.67 ± 2.08^{abc}
FSAJ	5.86 ± 0.89^{bc}	6.60 ± 0.55^{abc}	6.75 ± 0.96^{ab}	5.00 ± 1.00^{a}	6.32 ± 0.58^{ab}	6.00 ± 1.00^{abc}
DSAJ	4.71 ± 0.76^{a}	6.00 ± 0.71^{a}	7.00 ± 0.82^{ab}	5.20 ± 0.84^{ab}	5.67 ± 1.53^{ab}	4.23 ± 0.58^{a}
NMJ	7.50 ± 0.53^{ef}	7.40 ± 1.14^{bcd}	8.00 ± 0.82^{ab}	6.80 ± 0.84^{bcd}	6.00 ± 1.00^{ab}	6.00 ± 1.00^{abc}
SSMJ	6.43 ± 0.53^{cd}	6.20 ± 0.84^{a}	7.25 ± 0.50^{ab}	4.80 ± 0.86^{a}	5.00 ± 1.001^{ab}	4.77 ± 0.58^{ab}
FSMJ	7.00 ± 0.58^{de}	6.40 ± 0.55^{ab}	7.20 ± 0.97^{ab}	4.40 ± 1.14^{a}	4.00 ± 1.00^{ab}	5.33 ± 1.53^{ab}
DSMJ	5.00 ± 1.00^{ab}	6.40 ± 0.52^{ab}	7.00 ± 1.41^{ab}	5.00 ± 1.00^{a}	5.00 ± 1.00^{ab}	5.00 ± 1.73^{ab}
NPJ	6.86 ± 0.90^{de}	7.60 ± 1.52^{cd}	8.50 ± 0.57^{b}	7.00 ± 2.00^{cd}	7.00 ± 1.00^{ab}	8.00 ± 1.00^{c}
SSPJ	6.71 ± 0.76^{cde}	6.80 ± 0.84^{abc}	7.50 ± 0.77^{ab}	5.20 ± 0.76^{ab}	6.00 ± 1.00^{ab}	6.32 ± 1.15^{abc}
FSPJ	5.86 ± 0.69^{bc}	6.60 ± 0.55^{abc}	6.75 ± 1.26^{a}	5.40 ± 0.89^{ab}	6.33 ± 2.08^{ab}	5.67 ± 1.15^{abc}
DSPJ	4.57 ± 0.79^{a}	6.6 ± 0.50^{abc}	7.00 ± 0.82^{ab}	5.40 ± 0.92^{ab}	4.76 ± 1.15^{ab}	4.33 ± 0.58^{a}

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Values are means ± SD. Values are different. Superscripts down the column are significantly different ($p<0.05$). NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam3.4 The Proximate Composition of The Formulated Fruit Jams

The proximate composition of the formulated fruit jams is presented in Table 5. The results showed that soybean fortified fruit jams had significantly ($p<0.05$) reduced carbohydrate content compared to normal fruit jams.

There was a significant ($p<0.05$) increase in protein and fats content of soya beans fortified jams compared to normal fruit jams. Fructose had no significant ($p>0.05$) effect on the protein content of fructose sweetened fruit jams while date-based jams had significantly ($p<0.05$) reduced protein content compared to sucrose sweetened soybean fortified fruit jams, from 3.19 ± 0.02, 3.93 ± 0.24 and 4.50 ± 0.00 to 2.62 ± 0.03, 3.52 ± 0 .00 and 3.89 ± 0.18% in Malay apple, yellow monkey kola and hog plum jams respectively. Generally, plum jams had the highest protein content, followed by monkey kola jams.

The fortification with soybeans and the use of fructose as sweetener had no significant ($p>0.05$) effect on ash content of all the formulated fruit jam except hog plum jams where the fortification with soybeans significantly ($p<0.05$) increased the ash content.

Date based fruit jams had significantly ($p<0.05$) increased fibre content in all the formulated fruit jams except for yellow monkey kola where the fibre content increase was not significant ($p>0.05$). Fortification with soya beans and the use of fructose as sweetener significantly ($p<0.05$) increase fibre content only in plum jam.

Fructose and dates fruit as sweeteners significantly ($p<0.05$) increased the moisture content but fortification with soya beans had no significant effect on the moisture content in all the formulated fruit jams when compared to normal fruit jams.

Fortification with soybeans had no significant effect ($p>0.05$) on energy content in all the formulated fruit jams except in apple jams where fortification with soya beans significantly decreased the energy content.

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Table 5: The Proximate Analysis of the Formulated Fruit Jams in %

Jams	Carbohydrate	Protein	Lipids	Ash	Fibre	Moisture	Energy (kcal/100g)
NAJ	75.51 ± 0 .52^{g}	1.75 ± 0.00^{a}	0.33± 0.00^{a}	0.10 ± .00^{a}	0.44 ± 0.07^{a}	21.88 ± 0.41^{a}	324.43 ±1.87^{f}
SSAJ	66.11 ± 3.25^{e}	3.19 ± 0.02^{c}	1.78 ± 0.02^{bc}	0.26 ± .01^{ab}	0.78± 0.04^{ab}	27.93 ±3.31^{b}	300.85 ± 13.40^{e}
FSAJ	58.77 ± 0.13^{d}	3.37 ± 0. 00^{cd}	1.91 ± 0.00^{c}	0.26 ± .06^{ab}	0.68 ± 0.18^{ab}	34.98 ± 0.06^{d}	271.61±1.6 6^{d}
DSAJ	31.05 ± 0.99^{a}	2.62 ± 0.03^{b}	1.48 ± 0.03^{bc}	0.57 ± .03^{bc}	3.80 ± 1.06^{d}	60.97 ± 0.01^{h}	149.60 ±1 .98^{a}
NMJ	77.00 ± 0.03^{g}	1.84 ± 0.03^{a}	0.31 ± 0.03^{a}	0.17 ± .02$_{a}$	0.23 ± 0.01^{a}	20.58 ± 0.06^{a}	330.77± 8.13^{f}
SSMJ	70.55 ± 0.45^{f}	3.93 ± 0.24^{e}	1.53 ± 0.24^{bc}	0.29 ± .01^{ab}	0.64± 0.00^{ab}	23.08 ± 0 .73^{a}	319.37± 2.80^{f}
FSMJ	53.31 ± 0.13^{c}	4.03 ± 0.03^{e}	1.68 ± 0.03^{bc}	0.32 ± .01^{ab}	0.80± 0.14^{ab}	39.87 ± 0 .00^{e}	248.46± 2.81^{c}
DSMJ	38.12 ± 2.05^{b}	3.52 ± 0 .00^{d}	1.38 ± 0.00^{b}	0.65 ± .07^{c}	1.33± 0.59^{b}	55.00 ± 2.69^{g}	180.88± 2.34^{b}
NPJ	76.67 ± 0.71g	0.93 ± 0.06^{a}	0.32 ± 0.06^{a}	0.37 ± .03^{abc}	1.01± 0.01^{ab}	19.65 ± 0.72^{a}	329.69± 3.02^{f}
SSPJ	69.75 ± 2.14^{f}	4.50 ± 0.00^{f}	1.50 ± 0.00^{bc}	1.41 ± .01^{d}	2.15 ± 0.06^{c}	20.70 ± 2.06^{a}	317.30 ± 8.97^{f}
FSPJ	56.79 ± 1.48^{d}	4.57 ±0.22^{f}	1.77 ± 0.22^{bc}	1.59 ± .08^{d}	4.00 ± 0.02^{d}	31.32 ± 1.63^{c}	265.31± 7.08^{d}
DSPJ	37.14 ± 0.78^{b}	3.89 ± 0.18^{e} `	1.63 ± 0.18^{bc}	2.25 ± .44^{e}	4.80 ± 0.13^{e}	50.31 ± 0.06^{f}	179.76 ± 3.11^{b}

Values are means ± SD. Values with different superscripts down the column are significantly different ($P<0.05$). NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam.

The Minerals contents of the Formulated fruit jams

The mineral contents of the formulated fruit jams are represented in Figures 2-3. The results showed that the minerals content was higher in date based fruit jams when compared to fructose and sucrose based jams. Fortification with soybeans increased the magnesium, iron and zinc contents of all the fruit jams (Figure 2). The sodium and potassium contents of the formulated fruit jams ranged between 0.1718mg/kg in NAJ to 0.9039mg/kg in DSPJ, DSMJ while the potassium content ranged between 0.1939mg/kg in NAJ to 1.8159mg/kg in DSAJ, DSPJ (Figure 3). The calcium content of the formulated fruit jams is also depicted in Figure 3. The

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results showed that the calcium content was highest in DSPJ (0.948mg/kg) and lowest in SSMJ (0.5711mg/kg).

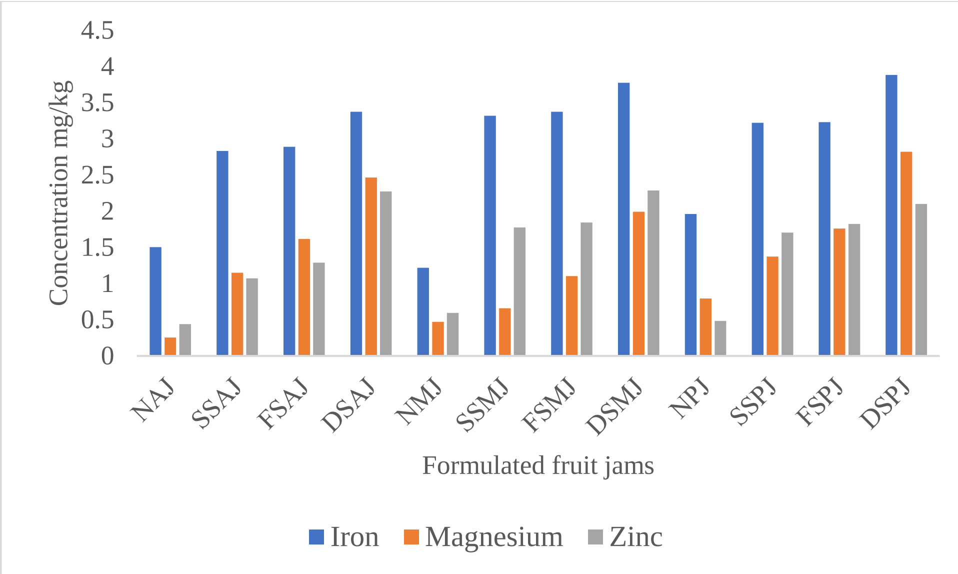

Figure 2: Iron, Magnesium and Zinc Composition of the formulated fruit Jams.

NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam.

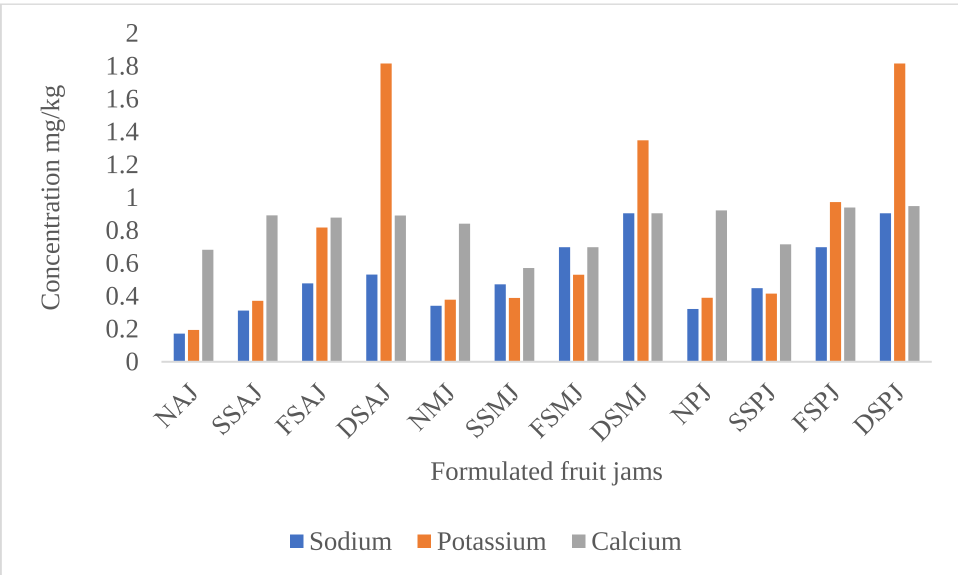

Figure 3: Sodium, Potassium and Calcium Composition of the formulated fruit Jams.

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The Vitamins Compositions of the Formulated Fruit Jams

Figure 4 depicts the Vitamin A composition of the formulated fruit jams. The results showed that fortification with soybeans increased the Vitamin A composition of all the soybean fortified fruit jams when compared to normal fruit jams. Sweeteners did not affect the Vitamin A content of the formulated fruit jams. However, hog plum jams had highest content of vitamin A (4.241, 5.372, 5.893, 8.269mg/l) followed by Malay rose apple (1.461, 3.177, 2.972, 3.183mg/l) and monkey kola jams (1.349, 3.193, 2.455, 4.651mg/l).

The Vitamin E composition of the formulated fruit jam is represented in Figure 5. The results showed that the vitamin E content ranged from 14.989 IU/L in date soybean plum jam (DSPJ) to 7.948IU/L in normal monkey jam (NMJ).

The Vitamin C composition of the formulated fruit jams is represented in Figure 6. The results showed that the vitamin C content of the fruit jams ranged from 0.0175 ± 0.0035 mg/100g to 0.1095 ± 0.0007 mg/100g, with NPJ having the highest Vitamin C content and SSMJ having the lowest vitamin C content. Plum jams are richer in vitamin C compared to yellow monkey kola and apple jams.

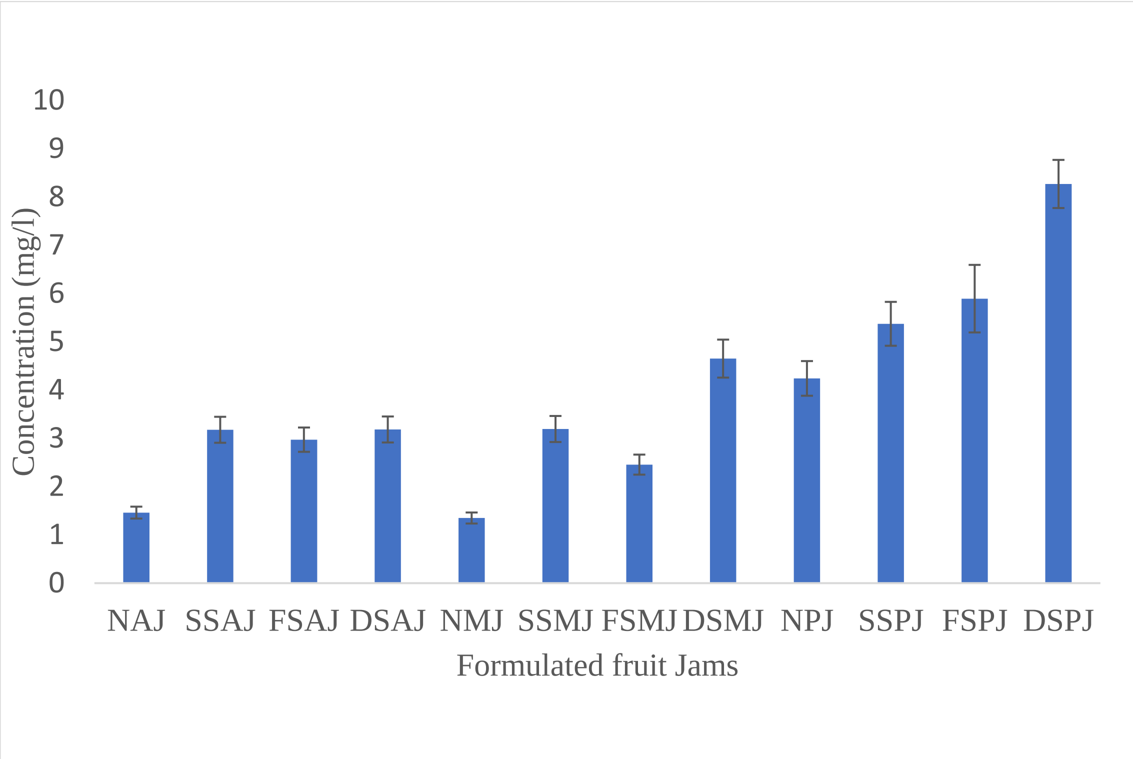

Figure 4: Vitamin A Composition of the formulated fruit Jams

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NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam.

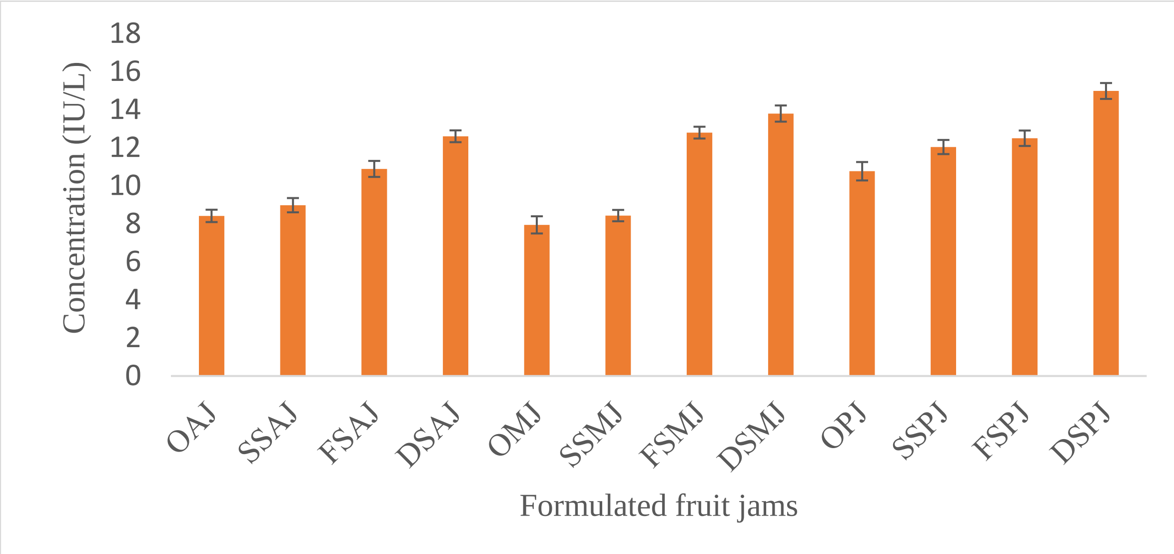

Figure 5: Vitamin E Composition of the formulated fruit Jams

NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum Jam DSPJ: Date Soybean Plum Jam

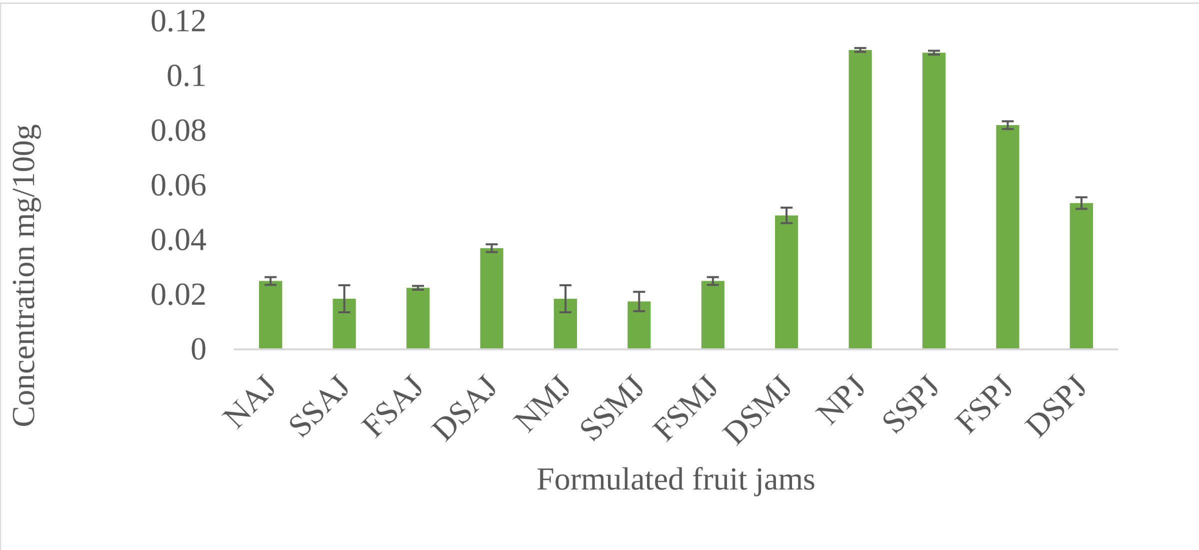

Figure 6: Vitamin C Composition of the formulated fruit Jams

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NAJ: Normal Apple Jam, SSAJ -Sucrose Soybeans Apple Jam, FSAJ: Fructose Soybeans Apple Jam, DSAJ: Date Soybean Apple Jam, NMJ: Normal Monkey kola Jam, SSMJ: Sucrose Soybeans Monkey Kola Jam, FSMJ: Fructose Soybeans Monkey kola Jam, DSMJ: Date Soybean Monkey kola Jam, NPJ: Normal Plum Jam, SSPJ: Sucrose Soybeans Plum Jam, FSPJ: Fructose Soybeans Plum

DISCUSSION OF FINDINGS

Fruits are perishable and seasonal. They are of great importance in human nutrition. The lack of appropriate techniques for postharvest transport and storage results in great losses. Owing to their perishable nature and seasonal availability, several types of fruits have been reutilized in the production of more stable and value-added food products, such as jams, jellies, juices, pickles and many more products to significantly extend their shelf-life allowing their consumption all year.

Physicochemical property is very important in determining the characteristic quality of a fruit jam. The jam samples were analysed for physicochemical properties like pH, total titratable acidity, total soluble solids, dry matter, organic matter and viscosity. The physiochemical attributes of different formulations of jams are presented in Table 2.

Food acidity is expressed in two ways, pH and total titratable acid (also known as active acidity and total acidity respectively). They are important parameters necessary for optimal gel formation, to hinder the growth of food poisoning microorganisms and as well to maintain the quality of the jam. The pH values for most of the formulated fruit jams in the present study is within the range of 3 to 4. This range of pH was also reported for fresh carrot and apple blended jams by Ullah *et al*. (2018).

The total soluble solids (TSS) is a refractometric index that indicates the proportion (%) of dissolved solids in a solution. It is the sum of sugars (65%), acids (citrate and malate, 13%) and other components (phenols, amino acids, soluble pectin, ascorbic acid and minerals). Sugar generally contributes to TSS and according to the Codex Alimentarius standard (2009), normal fruit conserves or preserves must contain at least 60% soluble solids. A decrease in TSS of dates and fructose based jams implies a decrease in sugar content.

Dry matter and organic matter contents of the formulated fruit jams were also estimated (Table 2). Organic matter includes carbohydrates, lipids, proteins, and nucleic acids, which are all carbon-based substances found in nature. Organic matter is necessary as a source of nutrients in the diet. Food with a high dry matter content has a lower water activity, which helps to prevent microbiological and biochemical deterioration to some extent. Sucrose enhances ^{o}Brix (TSS) and dry matter content in fruit jams. This explains why sucrose-based jams have a higher dry matter and TSS content than dates-based jams. In prior research, similar findings were made for several fruit jams. Mandarin jam contained 70.38 percent dry matter according to Aksay *et al.* (2018), whereas melon jam had 75.80 percent dry matter and 99.8 percent organic matter according to Benmeziane *et al*. (2014).

Viscosity is the measurement done to evaluate the jam's resistance to movement. The viscosity of fruit jams is affected by several elements, such as temperature, pH, sugar, and pectin. Soybean flour also offers beneficial functional properties, such as promoting water binding,

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emulsification, fat absorption, and gelation. The viscosity range of the formulated fruit jams in this study is lower than the range of 47841 to 46093 (poise) published by Shahnawaz *et al*. (2011) for jamun jam and greater than the viscosity range of 13.62 to 19.32 (Pa.s) reported by Eke-Ejiofor *et al*. (2019), for squash jams. In sucrose soybean fruit jams, sucrose and soybeans were shown to greatly increase viscosity. The high pectin content of yellow monkey kola also contributes to the increased viscosity observed.

Microbial evaluation is considered as an index of the quality of food products. Results regarding microbial count in the formulated fruit jams during storage at room temperature for four weeks showed a gradual increase in total bacteria count (TBC), total mould count (TMC) and total yeast count (TYC) from week 0 to week 4. Normal fruit jams showed the lowest bacteria count, this could be as a result of the preservative effect of a high proportion of sucrose used in their production. However, fortification with soybean increases TBC as the week progresses. The decrease in acidity (that is increase in pH value) brought about by the addition of soybean could be responsible for this observation. An increase in pH value was also observed when papaya jam was fortified with soy protein isolate as reported by Pinandoyo *et al.* (2019). The highest total bacteria count in this study was recorded in yellow monkey kola fruit jams with higher pH values and lower total titratable acidity. A mild decrease was observed in the progression of TMC and TYC among fructose and dates sweetened fruit jam, this could be that yeasts had a slightly higher preference for glucose than for fructose, the sodium benzoate used in the production of dates sweetened fruit jams could also be a contributing factor. However, the microbial load (TBC, TMC and TYC) of all the formulated fruit jams did not exceed the standard ($\times 10^6$ cfu/g) (ICMSF, 2002). Similar results were obtained by Makanjuola and Alokun (2020) who evaluated total plate count and total fungi count of date and orange jam to be below the limit established by law.

Sensory evaluation is one of the parameters used to determine a consumer's acceptance of a particular product. The results of the sensory evaluation showed that the fortification with soya beans reduced the consumer acceptance of colour, flavour and texture while the use of dates as sweetener reduced the consumer acceptance of colour and texture. Colour is an important quality parameter of jams; it is closely related to the perception and reception of the product. Texture makes the product acceptable to the consumer, together with a very good taste. The beany flavour of soya beans and deterioration in colour caused by dates are responsible for these results. There was no significant difference in the panellist's preference for the taste, spreadability and overall acceptance of all the formulated fruit jams when compared to the control (commercial jam). This indicates that all the formulated fruit jams were considerably accepted.

The proximate analysis of the formulated fruit jams is represented in Table 5. The high carbohydrate content observed in all the normal fruit jams can be correlated to a large amount of sugar (sucrose) used in the preparation of the normal fruit jams which had more influence on the total carbohydrate. A significant reduction of carbohydrate content observed when soybean was added could be attributed to the low carbohydrate content of soybean (about 35%) which are mainly pectin and raffinose. The dates contain almost half of the amount of sugar in the form of fructose together with other nutrients like dietary fibres (Ali *et al*., 2009). The overall effect of soybean and dates resulted in the drastic reduction in carbohydrates observed in the date sweetened jams fortified with soya beans

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The results of the proximate analysis also showed that fortification of normal fruit jams with soybean significantly increased the crude protein, fat content and decreased the carbohydrate content. These results agree with Alsuhaibani and Al-Kuraieef (2018), who recorded an increase in protein and fat content with a decrease in carbohydrate content of an ordinary pumpkin jam when soybean was added. However, the value of the fat content reported by Alsuhaibani and Al-kuraieef (2018) is close to the values observed in the present study but the value of the protein content observed in this study is far from the value reported by Alsuhaibani and Al-kuraieef (2018), for pumpkin jam fortified with soybean. The observed variation in the protein content might have been as a result of geographic, climatic and seasonal variations as well as different fruits and analytical methods used.

The fortification of the normal fruit jams with soya bean increased the ash and crude fibre content. Ash is an index of mineral content and an indication of the stability of food. Legumes are known to contain a percentage amount of fibre, which are mainly cellulose, hemicelluloses, pectin, and lignin. The date is a good source of dietary fibre, which could be soluble and insoluble fibres. The joint effect of the crude fibre in soybean and dates explain the highly significant increase in crude fibre content of date based jams observed in this study. Crude fibre helps in the prevention of heart diseases, colon cancer, diabetes, etc. It decreases the absorption of cholesterol from the gut in addition to delaying the digestion and conversion of starch to simple sugars, which is a very crucial step in the management of diabetes.

The amount of moisture in a food product determines how long it will last (Fellows, 2000). Typically, high sugar content prevents germs from growing in moisture, extending the shelf life of foods (Afoakwa *et al*., 2006). Food with high moisture content is vulnerable to bacteria and enzymes. When comparing date-based jams to fructose and sucrose-based jams, the researchers discovered that date-based jams had much higher moisture content. This suggests that jams made with sucrose and fructose may have a longer shelf life than date based jams.

The calculated results for the calorie value showed that the fruit jam processed using dates and fructose had significantly lower calorie value than the ordinary fruit jam processed using sucrose. This is because fructose and dates have lower calorie values compared to sucrose. According to the Food Act (Act 281) and Regulation Malaysia (2017), a food product is said to be a reduced-calorie food product, if it contains at least 25% less calories than the reference. Going by this standard all the dates sweetened fruit jams (DSAJ, DSMJ and DSPJ) can be considered as reduced-calorie jams, as their calorie value was reduced over 45% as compared to the normal fruit jams (NAJ, NMJ and NPJ)- the reference food.

Minerals play an important role in maintaining proper function and good health in the human body. Inadequate intake of minerals in the diet is often associated with increased susceptibility to infectious diseases due to the weakening of the immune system. The results of mineral (Mg, Zn, Na, K, Ca and Fe) content of the formulated fruit jams showed that Iron had the highest value and calcium had the lowest value.

Calcium builds and protects bones and teeth. It helps with muscle contractions and relaxation, blood clotting, and nerve impulse transmission. Iron helps haemoglobin in red blood cells and myoglobin in muscle cells to carry oxygen throughout the body. It can be deduced that all the formulated fruit jams are a good source of Iron. Date based fruit jams (DSAJ, DSMJ and DSPJ) were the richest in magnesium and zinc, followed by fructose based fruit jams (FSAJ, FSMJ and FSPJ) and sucrose sweetened soybean fruit jams (SSAJ, SSMJ and SSPJ) while normal

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fruit jams had the lowest values. This implies that date and soybeans are good sources of magnesium and zinc.

The results also showed that hog plum jams were the richest in potassium, followed by yellow monkey kola jams and Malay rose apple jams were the least in terms of potassium content. Soybeans and the use of dates as sweeteners increased the overall potassium content. Researches have shown that the Na/K ratio of less than one is essential for preventing hypertension and cardiovascular diseases prior to clinical onset. The formulated fruit jams in the study had a good and acceptable Na/K ratio (less than 1). The result of this finding is in agreement with (Awolu *et al.*, 2018), who reported Na/K ratio of jams produced from blends of banana, pineapple and watermelon pulp to be less than one. This implies that all the date based formulated fruit jams are recommended for healthy and ideal living.

The vitamins A, E and C in the formulated fruit jams are eqaully represented in figure 4,5 and 6 respectively. Vitamin C content from this result was low and vitamin E content was high. This is different from the results obtained for vitamin (A, C, and E) analysis of functional jam produced from blends of banana, pineapple and watermelon pulp reported by Awolu *et al*., (2018), where vitamin C content was the highest. The low vitamin C content observed in this study is similar to the result of Eke-Ejiofor *et al*. (2019), where the low vitamin C content of squash fruit jam was attributed to the heat processing method involved in the jam production.

CONCLUSION

Date based jams had more nutrient contents than fructose and sucrose based jams. Jams formulated with dates and fructose produced reduced calorie jams compared to sucrose based jams. All the formulated fruit jams were microbiologically safe for human consumption as they did not exceed standard microbial load. NPJ had the highest while DSAJ had the lowest overall acceptance but there was no significant difference between the overall acceptance of all the formulated fruit jams when compared to commercial fruit jam and could be produced commercially.

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