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Chemical Composition, Physicochemical Properties, Microbial Analysis and Sensory Properties of Jam Produced from Orange (*Citrus sinensis*) and Watermelon (*Citrullus lanatus*) Juice Purchased from Mile 12 Market, Lagos State, Nigeria

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ABSTRACT: Inadequate storage and processing facilities has limited the consumption of fruits as they are seasonal in nature. Jams made from fruits are good bread spread as they serve as adequate balance diet and it contains antioxidant (vitamin C and A) which play an important role in preventing cancer, cardiovascular problem and improvement of eyesight. Therefore, the objective of this paper is to determine the chemical, physicochemical, microbial and sensory properties of jam produced from orange and watermelon juice purchased from Mile 12 Market, Lagos State, Nigeria using appropriate standard methods. The result obtained show that proximate composition: moisture, crude fiber, crude ash and carbohydrate ranged from 10.03±0.03% to 21.83±0.04%, 0.16±0.04% 0.40±0.04%, 0.09±0.04%-0.99±0.04% and 72.36±0.03%--86.67±0.02% respectively. Total plate count (TPC) for the samples after six weeks storage showed a gradual decrease in microorganisms. Sample WES and UYC had minimum value of 1.8×10^5cfu/ml while sample DBS had the maximum value of 2.6×10^5Cfu/ml. Yeast and mold count for 4weeks showed a gradual decrease at the end of storage with sample SPD having maximum value of 3.1×10^4Cfu/ml. The pH, vitamin C, viscosity ranged from 5.40±0.04 to 7.06±0.03, 3.16±0.02 to 17.48±0.02mg/100g and 6,252.50±3.549 to 575±1.76.78mpa respectively. The mineral content showed that calcium content ranged from 168.16±0.01 to 687.58 ±0.2mg /100g, iron content was from 6.07±0.04 to 23.78mg/100g, and potassium content was from 0.91 ± 0.04 to 1.63± 0.02mg/100g. Sensory evaluation at ($p\leq0.05$) showed that colour and overall acceptability differs significantly while sample ZAS (50% orange and 50% watermelon) was the most acceptable by panelists. The findings reveal that fresh orange and watermelon could be used in the preparation of a quality jam with better nutritional and sensory properties with satisfactory shelf life and has an enormous potential to reduce the post-harvest loss of fresh fruits, and value-added product jam provides health-promoting compounds to human health.

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Fruits are rich in nutrients that are essential for body upkeep; nevertheless, they are available when in season's and can easily get spoilt when they are matured for consumption (Joy and Abraham, 2013).

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Fruits can be eaten raw (desserts) or made as jams, jellies, marmalades, juice and squashes as a way of preservation. In past years, when there were no refrigerators, fruits harvested were used to produce homemade jams and stored or given as a gift (Plunkett, 2006). Jam is a moisture food characterized as a sweet spread made after boiling grated or chopped fruits pulp with adequate amount of sugar, gelatin, citric acid, and other ingredients such as preservatives, coloring, and flavoring materials to a gel like consistency which is sufficiently firm to hold the fruit tissues in position (Hussain, 2001; Sindumathi and Amutha, 2014). Jams can be produced from a single fruit or combination of two or more fruits, fruit pulp and juice of varieties of fruits (whole fruit) and gelled fruit packaged and stored for a long period of time which is used as fillings, bread spread and food jellies (Ihediohanma *et al*., 2014). Fruit jam must have at least 45% fruit and may contain added pectin to compensate for the natural pectin level found in fruit; 68.5% complete soluble substances and 45% of the fruits pulp and must contain over 65% all out dissolvable solids in finished product (Codex, 2009, Baker *et al*., 2001). Jam and jelly is one basic natural product prepared from fruits (Manay and Shadaksharaswamy, 2005). Orange (*Citrus sinensis*) is the citrus fruit belonging to the *Rutaceae* family, of the genus; Citrus. The family also includes other species of oranges such as tangerine, lemon, grape fruit and pomelo. It contains essential nutrient vitamins, minerals for healthy growth and development. Oranges whose flavor may vary from sweet to sour are commonly peeled and eaten fresh or squeezed for juice. The thick bitter rind is usually discarded, but can be processed into animal feed by desiccation using pressure and heat. It is also used in certain recipes as food flavoring or garnish. The outermost layer of the rind is popular in cooking because it contains oil and has a strong flavor similar to that of orange pulp. The white part of the rind is a source of pectin, orange peel is edible and has significant content of vitamin C, dietary fiber, total polyphenols, carotenoids and dietary minerals. The fruit contains no saturated fat or cholesterol, but rich in dietary fiber. Watermelon (*Citrullus lanatus*) belongs to the family *Cucurbitaceae*, the same family as cucumber, pumpkin, and squash. It grows in countries that have a long, warm growing season such as China, Africa, India, and the United States (Maynard, 2001). China is the world's largest watermelon producer with 13.9 billion pounds produced in 2008, followed by Turkey, Iran, Brazil, and the United States, which produced 4.3 billion pounds that same year (ERS and USDA, 2011). Watermelon originated in Africa and it has been an important vegetable in Egypt for at least 4,000 years (Perkins-Veazie *et al.,* 2006). For many years, it has been a source of water in the Kalahari Dessert and other areas of Africa. Watermelons are mostly eaten fresh, but in Africa they can also be cooked (Quek *et al.,* 2007). In south parts of the old Soviet Union, watermelon juice is made into a fermented drink or it can be boiled down into syrup (Falade *et al.,* 2007). The rind can be pickled or candied and the seeds can be roasted or eaten as it is done in the Orient and Middle East (Falade *et al.,* 2007). The sweet juicy flesh is usually deep red to pink with many black seeds. It is a good source of lycopene and carotenoids. The whole watermelon is edible including the rind. Watermelons are sweet popular fruits of summer usually consumed fresh in slices, diced, in mixed fruit salads or as juice. Most people avoid eating watermelon rinds due to their unappealing flavor. It contains vitamin A and vitamin C in form of disease fighting beta-carotene and which are generally common to all fruits and vegetables (Adekunle *et al.,* 2007, Abdelwahab *et al*., 2011). They are used for making pickles sometimes eaten as vegetables, stir-fried or stewed. Citrulline is produced in watermelon rind and the pulp contains carotenoids including lycopene (Perkins *et al.,* 2006) The production of jam from orange and watermelon serve as a means to preserve the fruits when they are not available in season. It also helps to provide a wide array of jams in super market shelves all over the world. The jam to be produced will provide the nutrients needed by the body for proper functioning. Watermelons contain mostly water of over 90%. With water been essential for human life, watermelon is an excellent source of hydration. Watermelons are low in calories, vitamin A, B_6 and C. Watermelons contain lycopene which is a powerful antioxidant that has the ability to quench free radicals that cause damage to cells in the body. Lycopene present in this fruit as being linked with heart health, bone health and the prevention of prostate cancer. It also contains amino acids which are building blocks of proteins. On the other hand, oranges are known to contain low glycemic index. This is explained from facts that oranges are rich in polyphenols and fiber which moderate the rise in blood sugar. It also helps to prevent cancer (leukemia) in children at the early stage of development. The presence of potassium, calcium, vitamin C and choline helps to prevent cardiovascular diseases. The seasonal nature of most fruits available on the Nigerian market coupled with inadequate storage and processing facilities has limited the consumption of these commodities by majority of the people in the country (Falana, 1997). Orange and watermelon fruits have been reported to be nutritive and high in antimicrobial and antioxidant

properties that can scavenge free radicals, thereby improving the antioxidant status of the body (Adedeji and Oluwalana, 2013). It is therefore deemed fit to produce jam from these fruits in other to make them available all through the year and as well as providing varieties to food commodities. This will indeed be of benefit to the people in terms of food quality, well-being and economy. Therefore, objective of this paper is to determine the chemical composition, physicochemical properties, microbial analysis and Sensory Properties of jam produced from orange (Citrus Sinensis) and watermelon (Citrullus Lanatus) juice purchased from Mile 12 Market, Lagos State, Nigeria

MATERIALS AND METHODS

Source of Materials: Orange and watermelon fruits were purchased from Mile 12 Market, Lagos State. Other materials include sugars, flavor and pectin that were sourced from a local dealer in Lagos State. All reagents used in the study were of analytical grade.

Production of Jam: Watermelon and pawpaw fruits were sorted washed and peeled. They were further diced and blended in a coffee mill with 20mls of water separately. They were then sieved into a covered container and kept in a refrigerator at a temperature of 4-10°C until used. The juices were mixed in various ratio: orange to watermelon extract (90:10, 80:20, 70:30, 60:40,50:50, 10:90, 20:80, 30:70,40:60 and 100:0) v/v after the addition of sugar at 75%w/v sugar to extract, pectin at 2% ratio, 5ml lemon juice and 2ppm sodium benzoate as shown in Table 1. The blends were then boiled with constant stirring for 10mins. The jam samples were filled into sterile glass jam bottles and pasteurized at 75 ^{o}C for 15 mins. The modified method of Fellows was used for the production of the jam (Fellows, 1997).

Sample formulation: Ten different jam samples were produced and coded as DBS, SPD, IRS, WXA, ZAS, WES, UYC, XBD, and CDA. Sample CDA served as control and contained 100% orange. Samples DBS contains 90% orange and 10% watermelon, SPD contain 80% orange and 20% watermelon, WXA contain 70% orange and 30% watermelon, IRS contain 60% orange and 40% watermelon, ZAS contain 50% orange and 50% water melon, WES contain 10% orange and 90% watermelon, UYC contain 20% orange and 80% watermelon, DAA contain 30% orange and 70% watermelon, XBD contain 40% orange and 60% water melon.

Chemical Analysis

Determination of Proximate composition: The moisture content, total solids, ash, crude fibre, fat and protein content calculated as N x 6.25 and carbohydrate by difference (AOAC, 2005), while the total soluble solids and total dietary fibre content by (AOAC, 2005) respectively.

Table 1: Formulation of ingredients for jam preparation

Samples	ORA	WTM
DBS	90	10
SPD	80	20
IRS	60	40
WXA	70	30
ZAS	50	50
WES	10	90
UYC	20	80
DAA	30	70
XBD	40	60
CDA	100	0

ORA- Orange fruit WTM-Watermelon fruit

Physicochemical Analysis

Determination of pH: The pH was measured directly using a pH meter (Jenway Model) as described by Nielsen, (2003). 20 ml of the sample was put in a 50 ml glass beaker. The electrode of the pH meter was put inside the sample solution and the reading was read directly from the screen of the meter when the pointer becomes steady.

Determination of total titratable acidity: The total titratable acidity of the samples was determined according to the method illustrated by Wireko-Manu et al., (2016). 250 ml beaker was filled with 100 ml distilled water and a few drops of phenolphthalein indicator were added and mixed. The mixture was titrated with 0.1N NaOH to a pale pink colour. 10 ml of jam sample was measured into the mixture and titrated against 0.1 NaOH to a pale pink colour which persisted for at least 30 s.

$$\text{Total titratable acidity (A)} = 75 \times \text{N} \times \frac{\text{T}}{\text{S}} \quad (1)$$

where; N = normality, T = titre value, S = sample volume and 75 = constant

Determination of Vitamin C: The titrimetric method by Barakat *et al.,* (1973) was used. Twenty grams of each processed sample was homogenized in 50 ml of 6% trichloro-acetic acid EDTA extracting solution. The homogenate was centrifuged at 3000 rpm for 10 min and the supernatant was decanted and its volume needed (V_f). 20 ml of the extract was dispersed into a conical flask and 10 mls of 10% Potassium iodide and 1% starch were added as indicators. After mixing well, the mixture was titrated against 0.01N $CuSO_4$ solution. Titration was done to bluish end point. A reagent blank was carried out using 20mls of the extracting solution for titration. The vitamin C content was calculated as shown below:

$$Vitamin\ C\left(\frac{mg}{100g}\right)\frac{100 * Vf * 0.88 * T}{W * Va} \quad (2)$$

Where; W= weight of sample used, V_f= Total extract volume, Va = Volume of extract titrated; T = Titre value less blank.

Determination of total soluble solids: Total soluble solids of jam samples were determined according to the method of Wireko-Manu *et al.* (2016). A hand held refractometer (Atago's master series, Japan) was used. The refractometer was standardized by placing a drop of distilled water on the prism and placed such that it allowed entry of sunlight into the prism. The eye-piece was used to observe the standardization after adjusting the coarse and fine adjustment knob properly. A drop of jam sample was placed on the prism of refractometer and the lid was closed. The readings were taken by the graduated mark which indicated the total soluble solid values of the samples and was recorded in ^{o}Brix.

Determination of Viscosity: Viscosity was analyzed using a Rion-viscotester (NDJ-5S, Baoshishan). The fruit jam sample was poured into the viscometer cup, and the rotor suspended into the sample to rotate and the values was determined in deci-pascal-second unit at varying temperatures of 30°C, 40°C and 50°C (Awolu *et al*., 2013).

Microbiological analysis

Total viable count of bacteria (TVC): The microbiological analysis was carried out according to ICMSF (ICMSF, 2005). Plate count agar was used for enumeration of bacteria. A well homogenized sample was serially diluted with 0.1% peptone water up to 10^{-6}. One ml aliquot from a suitable dilution was transferred aseptically into sterile petri dishes. To each plate about 15ml of melted and cooled PDA (Potato Dextrose Agar) was added. The inocula was evenly mixed with media by rotating the plates and allowed to solidify. The inverted plate was incubated for 48 h. The TVC (cfu/ml) was determined using a colony counter.

Total coliform bacteria: Mac Conkey broth was used for the detection of coliform bacteria by the multiple tube technique. The medium was distributed in 9ml quantities standard test tubes with inverted Durham tube and was then autoclaved for 20mins at 121°C. Well homogenized samples were serially diluted (10^{-1} and 10^{-2}) with 0.1% peptone water, 1 ml from each dilution was aseptically inoculated into triplicate of 9 ml sterile Mac Conkey broth in standard test tube and incubated for 48 h at 37°C. Positive tests gave gas in the Durham tubes and changed the color of the medium (ICMSF, 2005).

Determination of Mineral Content: Determination of Calcium, Magnesium, Zinc, and Iron was carried out using Atomic Absorption Spectrophotometer while Potassium was determined by flame photometry (AOAC, 2005). The concentration of metals present was determined from the working curve after calibrating the instrument.

Sensory Evaluation: The jam samples along with bread serving as a carrier was presented to 20 semi-trained panelists from Food Science and Technology Department, Yaba College of Technology, Lagos. Multiple comparison test was used and the panelists were asked to indicate their observations and rate the samples parameters; flavor, colour, taste, spread ability and overall acceptability. The analysis was carried out on the ten (10) samples.

Statistical Analysis: Results were subjected to statistical analysis using SPSS statistical package (Version 17.0). Analysis of variance (ANOVA), Duncan's multiple range tests and mean ± standard deviation was chosen to determine any significant difference among the samples (Rattanathanalerk *et al.,* 2005)

RESULTS AND DISCUSSIONS

Proximate composition of jam produced from orange-watermelon blend: The results of the proximate analysis for the jam samples are presented in Table 4 below. The moisture content of the jam samples ranged from 10.03±0.03 to 21.83±0.04% with sample WES having the lowest value and sample IRS having the highest value. The control sample CDA had a relatively high moisture content of 17.73±0.03%. The fluctuation of moisture content of jam samples is due to high moisture content of orange and watermelon fruits. The values obtained here are different from the values reported by Adedeji (2017). The crude protein content of the samples ranged from 1.04±0.04 to 1.46±0.02% with sample DBS having the lowest value and sample WXA having the highest value. The control sample CDA has very little protein content of 0.96±0.04%. The values obtained are lower than the values reported by Ajenifujah-Solebo and Aina (2011). The crude fat content of the samples ranged from 1.02±0.04 to 4.66±0.04%with sample XBD having the lowest value and sample DBS having the highest value. Control sample CDA also had a high amount of fat present in it. The low crude fat content of the jam samples would prolong their shelf-life since there

will be less likelihood of rancidity (Samaila *et al*., 2016).

Table 2: proximate composition of orange and watermelon jam blends

Samples	%Moisture	%Protein	%Fat	%Ash	%Fiber	%Carbohydrate
DBS	17.58±0.04^{f}	1.04±0.04^{ab}	4.66±0.04^{g}	0.82±0.04^{e}	0.40±0.04^{c}	75.45±0.04^{ab}
SPD	16.78±0.04^{e}	1.15±0.04^{a}	1.20±0.04^{b}	0.62±0.04^{e}	0.29±0.04^{b}	79.95±0.04^{a}
IRS	21.83±0.04^{h}	1.28±0.04^{ab}	3.97±0.01^{f}	0.43±0.04^{c}	0.16±0.04^{a}	72.36±0.03^{ab}
WXA	14.81±0.01^{c}	1.46±0.02^{a}	2.02±0.02^{c}	0.43±0.04^{c}	0.29±0.01^{b}	81.35±0.04^{c}
ZAS	15.02±0.04^{d}	1.42±0.02^{b}	3.29±0.03^{d}	0.62±0.04^{d}	0.19±0.01^{a}	79.46±0.02^{b}
WES	10.03±0.03^{a}	1.21±0.04^{a}	6.44±0.02^{h}	0.99±0.01^{f}	0.27±0.04^{b}	81.11±0.04^{ab}
UYC	10.92±0.02^{b}	1.09±0.02^{a}	3.82±0.02^{e}	0.09±0.01^{a}	0.27±0.04^{c}	83.72±0.04^{b}
DAA	10.10±0.05^{a}	1.30±0.04^{c}	1.04±0.02^{a}	0.36±0.03^{c}	0.25±0.02^{d}	86.65±0.03^{a}
XBD	10.09±0.02^{a}	1.32±0.05^{c}	1.02±0.04^{a}	0.38±0.04^{c}	0.27±0.01^{d}	86.67±0.02^{a}
CDA	17.73±0.03^{g}	0.96±0.04^{b}	4.02±0.04^{f}	0.22±0.04^{b}	0.27±0.04^{c}	76.65±0.04^{c}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange: watermelon), SPD=80:20 (orange: water-melon), IRS=60:40 (orange: watermelon), WXA=70:30(orange: watermelon), ZAS=50:50 (orange: watermelon), WES=10:90(orange: watermelon), UYC=20:80(orange: watermelon), XBD=40:60(orange: watermelon),CDA=100% (Orange).

The ash content of the jam samples ranged from 0.09±0.04-0.99±0.01%with sample UYC having the lowest value and sample WES having the highest value. This is higher than the ash content present in the control sample CDA. Ash content is an indication of mineral content present in food (Adelakun *et al*., 2009). Most of the jam samples had more minerals content compared with the control sample. The crude fiber content ranged from 0.16±0.04 to 0.40±0.04% with sample IRS having the lowest value and sample DBS having the highest value. This shows that the jam samples are rich in fiber. Studies shows that diet low in fiber is undesirable as it can cause constipation and other diseases like pile, appendicitis and colon cancer and some digestive disorders (National soya bean Research Laboratory, 2002). The carbohydrate content of the jam samples ranged from 72.36±0.03 to 86.67±0.02% with sample IRS having the lowest value and sample XBD having the highest value. The control sample CDA had a carbohydrate content of 76.65±0.04%which is within range of result obtained but low compared to other samples.

Physicochemical properties of Jam produced from orange-watermelon blends: The sweetness of the sugar is reduced by the acid and helps in maintaining pH required to set the pectin. A part of acid also comes from fruits or vegetables used in preparing jam. To bring the pH within the optimum range for gel formation and for flavor a fruit acid may also be added. pH ranging from 3.0 to 3.3 is needed for the setting of the gel depending on the pectin content. The pH of lime juice is lower than 3.3 as lime juice was added to bring the pH down. The pH values of formulated jam sample from orange–watermelon are represented in Table 3 below. The pH values ranged from 5.40±0.04 to 7.06±0.03. The pH has great importance in maintaining shelf stability; pH can also influence the flavor and processing requirements of jam (Olatidoye *et al.*, 2025). After one-week storage, the pH values ranged from 6.72±0.02 to 7.06±0.03 with sample WES having the highest value and samples UYC and ZAS are having the lowest values. After 2 weeks storage, the pH value ranged from 6.10±0.01 to 6.82±0.04. Sample SPD was the lowest and samples DBS and IRS had the highest values with same values. Week three of storage showed that pH values ranged from 5.78±0.04 to 6.36±0.04 with sample SPD having the lowest value and sample WXA and ZAS having the highest values. While 4th week of storage showed that the pH value ranged from 5.40±0.04 to 6.08±0.02 with sample SPD having the lowest value and sample UYC had the highest value. All pH values obtained over the weeks were higher than the control sample CDA. As storage period increased, the pH of each samples decreased; this was due to increased acidity. Changes in pH are directly related to change in acidity of jam sample (Hussain *et al.*, 2008). A significant decrease in pH was reported in apple and pear-mixed jam for a storage period of 3 months by Shakir et al. (2007) and also in grape fruit marmalade as reported by Ehsan *et al.* (2003). The decrease in pH agreed with the findings in this study.

The decrease in pH may be attributed to formation of free acids and pectin hydrolysis (Muhammad *et al.*, 2008). The pH in the present study was slightly lower than that of jackfruit (Eke-Ejiofor and Owuno, 2013) and pineapple jam (Hanan, 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 could suggest the fact that the reduction of acidity during ripening plays a great part in the acid: sugar balance and consequently, influence the taste and flavour of the fruit. The pH values of jam products act as a flavor enhancer and as preservatives (Aktar *et al.*, 2010). The pH value is an important

factor to be monitored and controlled in jam processing. Pectin has no significant effect on the pH concentration of jam (Afoakwa *et al.*, 2006).

Table 3: Effect of storage time on pH of orange and watermelon jam blends

Samples	Week 1	Week 2	Week 3	Week 4
DBS	5.94±0.02^{c}	6.82±0.04^{d}	5.98±0.04^{a}	4.94±0.01^{ab}
SPD	6.74±0.02^{a}	6.10±0.01^{a}	5.78±0.04^{a}	4.40±0.04^{a}
IRS	6.86±0.04^{b}	6.82±0.04^{c}	6.04±0.04^{b}	4.99±0.04^{ab}
WXA	6.86±0.04^{b}	6.48±0.02^{b}	5.36±0.04^{d}	4.82±0.04^{a}
ZAS	6.72±0.02^{a}	6.56±0.02^{b}	5.36±0.04^{d}	4.99±0.04^{ab}
WES	7.06±0.03^{c}	6.42±0.04^{b}	6.28±0.03^{c}	4.05±0.01^{b}
UYC	6.72±0.02^{a}	6.60±0.03^{c}	5.22±0.02^{c}	4.08±0.02^{c}
DAA	6.80±0.04^{b}	6.27±0.03^{a}	6.04±0.02^{b}	4.04±0.01^{b}
XBD	6.82±0.02^{b}	6.22±0.01^{a}	6.02±0.03^{b}	4.02±0.02^{b}
CDA	6.89±0.01^{b}	6.78±0.04^{c}	5.96±0.03^{a}	4.57±0.02^{a}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange:watermelon),SPD=80:20(orange:watermelon),IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon),ZAS=50:50 (orange:watermelon),WES=10:90(orange:watermelon),UYC=20:80(orange:watermelon),XBD=40:60 (orange: watermelon), CDA=100% (Orange).

The results of the total titratable acidity of jam are represented in Table 4 above. This ranged from 0.10±0.04-0.46±0.04%. In week one, the total titratable acidity ranged from 0.23±0.04%-0.46±0.04% with sample WES having the lowest value and sample DBS had the highest value. The control sample CDA had value which was within range of experimental samples. In week two, total titratable acidity ranged from 0.18±0.04%-0.36±0.04 with sample WES having the lowest mean value and sample DBS having the highest mean value. The control sample CDA had the highest value of 0.42±0.04%. In week three, the values ranged from 0.15±0.04%-0.31±0.04% with sample WES having the lowest value and sample DBS having the highest value. The control sample (CDA) had a value 0.40%±0.04% which is in close range with the highest sample. In week four, the values ranged from 0.10±0.04%-0.29±0.04% with sample WES having the lowest value and sample SPD having the highest value. The total titratable acid increased as storage period progressed. The control sample had a higher total titratable acidity value than the experimental samples. It was observed that the acidity of control sample (CDA) was high from week one to four which shows that it has good gel formation without weeping. It helps to determine the micro-organisms that will grow. The values obtained are similar to the values reported by Chikku and Estherlydia (2014). Rao *et al*. (1972) attributed a decrease in TTA in pineapple as a chemical indicator for fixing maturity. Garcia-Martinez *et al*. (2002) stated that high acidity preserve quality and destroys fruit enzymes that can cause spoilage. The result of the vitamin C content of jam is represented in Table 5 above. It was observed that there was significant difference between samples in vitamin C content. In week one, values ranged from 6.37±0.01mg/100g to 17.48±0.02mg/100g with sample WES having the lowest value and sample WXA having the highest value. The control sample CDA had a high value of 13.41±0.01. In week two, the vitamin C content ranged from 6.30±3.51mg/100g to 13.38±0.02mg/100g with sample WES having the lowest value and sample XBD having the highest value. The control sample had a vitamin C content value of 12.01±0.01 1 which was the second highest. In week three, values ranged from 4.16±0.04mg/100g to 7.98±0.01mg/100g with sample IRS having the lowest value and sample DBS having the highest value. The control sample CDA had a value of 9.58±0.02mg/100g which was higher than the other jam samples. In week four, values ranged from 3.16±0.02mg/100g to 8.89±0.01mg /100g with sample WES having the lowest value and sample SPD having the highest value. Microorganisms have optimal pH requirements for their growth however; the storage or shelf life of a fruit juice is dependent on its pH (Olatidoye *et al.*, 2025; Olagunju and Sandewa, 2018). The addition of sugar may have caused a decrease in acidity as sugar has the ability to reduce acidity (Olatidoye *et al.*, 2025; Olatidoye *et al.*, 2019). There is a correlation between pH (low) and TTA (high) which may have led to the increase in acidity levels while the low amount of acid in it was neutralized by a strong alkali in the formulated jam.

Table 4: Effect of storage time on titratable acidity (%) of orange and water- melon jam blends

Sample	Week 1	Week 2	Week 3	Week 4
DBS	0.46±0.04^{c}	0.36±0.04^{b}	0.31±0.04^{b}	0.16±0.04^{a}
SPD	0.34±0.04^{ab}	0.30±0.05^{ab}	0.29±0.04^{b}	0.20±0.04^{b}
IRS	0.38±0.04^{ab}	0.32±0.04^{b}	0.24±0.04^{ab}	0.15±0.04^{a}
WXA	0.36±0.04^{ab}	0.26±0.04^{a}	0.26±0.04^{ab}	0.22±0.04^{b}
ZAS	0.40±0.04^{b}	0.28±0.04^{ab}	0.26±0.04^{ab}	0.22±0.04^{b}
WES	0.23±0.04^{a}	0.18±0.04^{a}	0.15±0.04^{a}	0.10±0.04^{a}
UYC	0.40±0.04^{b}	0.29±0.01^{ab}	0.16±0.04^{a}	0.16±0.04^{a}
DAA	0.24±0.04^{a}	0.22±0.04^{a}	0.18±0.04^{a}	0.16±0.04^{a}
XBD	0.24±0.04^{a}	0.22±0.04^{a}	0.18±0.04^{a}	0.16±0.04^{a}
CDA	0.44±0.04^{c}	0.42±0.04^{c}	0.40±0.04^{c}	0.21±0.01^{c}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange: watermelon), SPD=80:20(orange: watermelon), IRS=60:40(orange: watermelon), WXA=70:30(orange: watermelon), ZAS=50:50(orange: watermelon), WES=10:90(orange: watermelon), UYC=20:80(orange: watermelon), XBD=40:60 (orange: watermelon), CDA=100% (Orange).

The control sample CDA had constant vitamin C content for week three and week four. Over the four weeks of analysis, vitamin C content ranged from

3.16±0.02mg/100g to 17.48±002mg/100g. This shows that the formulated jam has high vitamin C content and will prevent scurvy, which is a Vitamin C-related disease (Edem and Miranda, 2011). There was loss in vitamin C content of some samples due to high amount of heat used for cooking of jam. It has also been reported that 46% loss of ascorbic acid can occur at ambient temperature. This may also be due to residual oxygen present within the container headspace assisted by degrading activities of light (Jawaheer *et al.,* 2003). Vitamins C are some of the major non-enzymatic antioxidants in the body that produce health beneficial effects by scavenging free radicals (Xu et al., 2008, Olatidoye *et al.,* 2019, Olatidoye et al., 2025). The application of prolonged heat treatments on fruits, such as in the case of jams, can lead to important losses of the beneficial properties of these citrus fruits (Igual *et al.,* 2011). Also, the fruit type and the degree of fruit exposure to sun could influence variation (Askar *et al.,* 1972). The values obtained from this study agree with the findings of Jawaheer *et al.* (2003) and Mohd Naeem *et al.,* 2017). Despite the processing and storage conditions in jam production, some level of vitamin C were retained in this study. Exposure of food items to high temperature has been identified as a factor that can destroy ascorbic acid (Johnson *et al.,* 2013, Olatidoye *et al.,* 2020, Olatidoye *et al.,* 2025). Over ripening of fruits can also affect the ascorbic acid of plantain and fruits. Vitamin C functions as a water-soluble antioxidant, and it is also an effective antioxidant that readily scavenges reactive oxygen species (ROS) and reactive nitrogen species (RNS). The Recommended Dietary Allowance for vitamin C is 75 mg per day for women and 90 mg for men, for nonsmokers (Annette, 2002).

Table 5: Effect of storage time on vitamin C (mg/100g) content of orange and watermelon jam blends

Samples	Week 1	Week 2	Week 3	Week 4
DBS	11.43±0.02^{b}	8.32±0.04^{ab}	7.98±0.04^{b}	7.66±0.04^{b}
SPD	9.84±0.04^{ab}	9.53±0.03^{b}	9.25±0.04^{c}	8.89±0.01^{c}
IRS	12.75±0.04^{b}	6.41±0.01^{a}	4.16±0.04^{a}	3.51±0.02^{a}
WXA	17.48±0.02^{c}	8.62±0.04^{ab}	7.46±0.02^{b}	6.70±0.02^{b}
ZAS	8.30±0.04^{ab}	7.98±0.04^{ab}	5.74±0.02^{ab}	4.79±0.01^{ab}
WES	6.37±0.01^{a}	6.30±3.51^{a}	5.43±0.04^{ab}	3.16±0.02^{a}
UYC	9.25±0.04^{ab}	6.38±0.04^{a}	5.72±0.02^{ab}	4.78±0.02^{ab}
DAA	15.86±0.01^{c}	13.38±0.04^{c}	6.43±0.03^{b}	4.18±0.02^{ab}
XBD	15.89±0.02^{c}	13.39±0.01^{c}	6.41±0.04^{b}	4.16±0.04^{ab}
CDA	13.41±0.01^{b}	12.01±0.01^{c}	9.58±0.02^{c}	9.58±0.04^{c}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange: watermelon), SPD=80:20 (orange: watermelon), IRS=60:40 (orange: watermelon), WXA =70:30(orange;watermelon),ZAS=50:50(orange:watermelon),WES =10:90(orange: watermelon), UYC=20:80 (orange: watermelon), XBD=40:60 (orange: watermelon), CDA=100% (Orange).

The result of the total soluble solids of the jam formulation is represented in Table 7 above. Sugar content of fruits is of importance because it acts as natural food preservative (Ayub *et al*., 2010). In week one, the total soluble solid ranged from 69.00±1.41°Brix-74.00±1.41°Brix with sample IRS having the lowest value and sample WXA having the highest value. The control sample CDA was within this range. In week two, total soluble solid ranged from 67.00±2.83°Brix-72.50±3.54°Brix with sample WES having the lowest value and sample WXA having the highest value. In week three, total soluble solid ranged from 66.50±2.12°Brix-71.50±2.12°Brix with sample WES having the lowest value and sample WXA having the highest value. The control sample CDA had similar values with sample WES. In week four, total soluble solid ranged from 66.00±4.24°Brix-71.00±1.41°Brix with sample WES and DBS having the lowest value with a tie and sample WXA having the highest value. For week three and four, the control sample CDA was within an acceptable range and had a constant value. The overall ºBrix value ranged from 63.00±1.41°Brix-74.00±1.41°Brix. The values obtained are similar to that obtained by Nwosu *et al., (*2014). The brix contents of freshly prepared jam obtained for all samples ranged from 68° to 71° brix (Table 1) similar to the value reported by Nour *et al*. (2011). A decrease in brix was observed in all the samples prepared which could be as a result of increased acidity during storage. There is a decrease in sugar content as the number of storage period increases. Nour *et al*. (2011) also reported decrease in sugar contents of Sudanese mango jam during storage. Sugar present in jam comprises of natural and added sugar which serves as a good agent for preservation of jam (Eke-Ejiofor and Owuno, 2013). The decrease could be attributed to the metabolism of the polysaccharides in the cell-wall accompanied with the significant external colour and taste changes (Biale, 1975). However, in fruits which contain starch, this is hydrolyzed and contributes to the reduction in sugars as found in climacteric fruits (Biale and Young, 1962). Lakshminarayana (1975) also reported that fruits harvested at a physiologically mature stage showed higher quantities of sugars during ripening. This suggests that the total sugar and total soluble solids could be used as a chemical parameter to determine the harvest maturity of the fruit. The decrease in the TSS of the fruit could have been greatly influenced by the soil and its fertility (Lakshminarayana, 1975).The results of the viscosity determination of jam samples are represented in Table 8 below. The viscosity of jam sample produced from orange and watermelon has significant differences across the weeks. The viscosity value of

samples stored in week one ranged from 20,475±106.07m.pa.s to 90,575±176.78mpa.s with sample SPD having the lowest value and sample XBD having the highest value. The control sample CDA had a value of 58,050±212.13mpa.s which was within the range of values obtained for other samples. From week two to week four, the values obtained shows that viscosity of jam samples had similar values with week one. Sample SPD had the lowest viscosity as the week progressed with sample XBD having the highest viscosity value. The viscosity values ranged from 17,090±14.14m.pa.s to 80,675±247.49m.pa.s, 16,775 ±35.36m.pa.s to 80,435±21.21mpa.s, 26,252.50±3.54 m. pa.s to 80,230±14.142m.pa.s for week two, week three and week four respectively. The viscosity values obtained for control sample CDA was constant except for week two where there was a decrease in viscosity. Some factors such as pH, sugar and pectin are responsible for the formation of tough gel which affects the rheological properties of jam (Swapnil *et al.,* 2015). Change in viscosity of the jam samples may be due to presence of sugar (Javanmard and Endan, 2010).Viscosity may be reduced by high concentration of enzymes (Sin *et al.,* 2006). Studies have shown viscosity increases gradually with an increase in sugar concentration, meaning that sugar plays important role in maintaining the viscosity of jam (Aftab *et al*., 2016). The addition and heating up of sugar during processing may have led to a reduction in the free flow of the jam and consequently, increased viscosity. Higher viscosities were observed in the samples which could be attributed to the addition of sugar and the addition of pineapple (almost ripened) which is higher in pectin (Olatidoye *et al.,* 2020, Olatidoye *et al.,* 2025).

Table 7: Effect of storage time on total soluble solids (ºBrix) content of orange and watermelon jam blends

Sample	Week 1	Week 2	Week 3	Week 4
DBS	73.50±3.54^{c}	71.50±0.71^{c}	71.00±1.41^{c}	66.00±7.07^{a}
SPD	71.00±1.41^{b}	69.50±2.12^{b}	68.50±2.12^{b}	67.50±3.54^{ab}
IRS	69.00±1.41^{a}	67.50±2.12^{a}	67.50±2.12^{a}	67.50±2.12^{ab}
WXA	74.00±1.41^{c}	72.50±3.54^{c}	71.50±2.12^{c}	71.00±1.41^{c}
ZAS	70.00±1.41^{b}	69.50±2.12^{b}	67.00±2.83^{a}	67.00±2.83^{a}
WES	68.00±1.41^{a}	67.00±2.83^{a}	66.50±2.12^{a}	66.00±4.24^{a}
UYC	71.00±1.41^{b}	68.50±2.12^{ab}	68.50±2.12^{b}	68.00±2.83^{b}
DAA	69.50±2.12^{ab}	69.50±2.12^{b}	68.50±3.54^{b} 68.51±3.54^{b}	68.50±3.54^{b}
XBD	69.50±2.12^{ab}	69.50±2.12^{b}		68.50±3.54^{b}
CDA	69.00±1.41^{a}	68.00±4.24^{ab}	66.50±2.12^{a}	66.50±3.54^{a}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange:watermelon),SPD=80:20(orange:watermelon),IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon),ZAS=50:50(orange:watermelon),WES=10:90(orange:watermelon), UYC=20:80 (orange:watermelon), XBD=40:60 (orang:watermelon), CDA=100% (Orange).

Table 8: Effect of storage time on viscosity of orange and watermelon jam blends

Sample	Week 1	Week 2	Week 3	Week 4
DBS	47,175.00±35.36^{c}	46,992.50±10.61^{c}	46,225.00±35.36^{c}	45,870.00±28.28^{c}
SPD	20,475.00±106.07^{a}	17,090.00±14.14^{a}	16,775.00±35.36^{a}	16,252.50±3.54^{a}
IRS	64,980.00±28.28^{e}	60,085.00±21.21^{f}	59,815.00±21.21^{f}	59,310.00±14.14^{f}
WXA	68,035.00±21.21^{f}	65,380.00±28.28^{g}	65,065.00±21.21^{g}	64,735.00±7.07^{g}
ZAS	72,200.00±212.13^{e}	50,379.50±28.99^{e}	50,040.00±14.14^{d}	49,645.00±21.21^{d}
WES	34,975.00±35.36^{b}	32,325.00±106.07^{b}	31,990.00±14.14^{b}	31,615.00±21.21^{b}
UYC	72,825.00±35.36^{h}	69,025.00±35.36^{h}	68,775.00±36.36^{h}	68,470.00±28.28^{h}
XBD	90,575.00±176.78^{i}	80,675.00±247.49^{i}	80,435.00±21.21^{i}	80,230.00±14.142^{i}
CDA	58,050.00±212.13^{d}	49,250.00±353.55^{d}	57,985.00±21.21^{e}	57,490.00±28.28^{e}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p \leq 0.05$). DBS=90:10 (orange: watermelon),SPD=80:20(orange:watermelon),IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon),ZAS=50:50(orange:watermelon),WES=10:90(orange:watermelon),UYC=20:80(orange:watermelon),XBD=40:60(orange:watermelon), CDA=100% (Orange).

Table 9: Effect of storage time on total plate count (Cfu/ml) of orange-watermelon jam blends

SAMPLES	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
DBS	7.6×10^{5}	5.5×10^{5}	4.7×10^{5}	4.0×10^{5}	3.7×10^{5}	2.6×10^{5}
SPD	7.5×10^{5}	5.8×10^{5}	5.4×10^{5}	4.6×10^{5}	4.2×10^{4}	2.2×10^{5}
IRS	6.8×10^{5}	4.95×10^{5}	4.2×10^{5}	4.2×10^{5}	3.1×10^{5}	1.7×10^{5}
WXA	13.5×10^{5}	9.5×10^{4}	6.0×10^{5}	5.2×10^{5}	4.4×10^{5}	2.3×10^{5}
ZAS	6.0×10^{4}	5.6×10^{5}	5.5×10^{5}	5.5×10^{5}	5.3×10^{5}	4.5×10^{5}
WES	8.0×10^{4}	7.6×10^{5}	3.2×10^{5}	3.0×10^{4}	2.6×10^{5}	1.8×10^{5}
UYC	5.8×10^{5}	5.1×10^{5}	4.0×10^{5}	3.7×10^{5}	2.2×10^{5}	1.8×10^{5}

XBD	8.5×10^4	7.2×10^5	5.0×10^5	4.8×10^5	4.7×10^5	2.1×10^5
CDA	6.1×10^5	5.2×10^5	4.0×10^5	3.6×10^5	3.3×10^5	2.7×10^5

Values are mean of two counts. DBS=90:10 (orange: watermelon), SPD=80:20 (orange:watermelon),IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon),ZAS=50:50(orange:watermelon),WES=10:90(orange:watermelon),UYC=20:80(orange:watermelon), XBD=40:60 (orange:watermelon), CDA=100% (Orange).

Table 11: mineral determination of jam produced from orange and watermelon

Sample	Calcium(mg/100g)	Iron(mg/100g)	Potassium(mg/100g)
DBS	575.42 ± 0.04^{bc}	18.08 ± 0.04^{g}	1.50 ± 0.04^{e}
SPD	493.12 ± 0.04^{bc}	17.24 ± 0.02^{f}	1.20 ± 0.01^{b}
IRS	168.16 ± 0.01^{a}	13.68 ± 0.04^{d}	1.50 ± 0.02^{e}
WXA	687.58 ± 0.02^{c}	13.72 ± 0.04^{d}	1.63 ± 0.02^{f}
ZAS	366.78 ± 0.04^{ab}	16.26 ± 0.01^{e}	1.54 ± 0.02^{e}
WES	317.72 ± 0.38^{ab}	6.07 ± 0.04^{a}	0.92 ± 0.04^{a}
UYC	520.66 ± 0.02^{bc}	23.78 ± 0.04^{h}	1.29 ± 0.02^{c}
XBD	391.21 ± 0.01^{ab}	9.22 ± 0.02^{c}	0.91 ± 0.04^{a}
CDA	333.47 ± 0.33^{ab}	8.62 ± 0.04^{b}	1.39 ± 0.04^{d}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are significantly different from each other at ($p\leq0.05$). DBS=90:10 (orange:watermelon), SPD=80:20(orange:watermelon),IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon), ZAS=50:50 (orange:watermelon), WES=10:90 (orange:watermelon), UYC=20:80 (orange:watermelon), XBD=40:60(orange:watermelon), CDA=100% (Orange).

Table 12: sensory evaluation of jam produced from orange and watermelon

Samples	Colour	Flavor	Texture	Sweetness	Taste	Overall acceptability
DBS	3.60 ± 1.4^{a}	3.67 ± 1.76^{a}	3.93 ± 1.44^{a}	2.93 ± 1.44^{a}	3.07 ± 1.3^{a}	3.33 ± 1.23^{a}
SPD	3.93 ± 0.96^{ab}	3.27 ± 1.03^{a}	4.00 ± 1.51^{a}	3.47 ± 1.96^{a}	3.20 ± 1.08^{a}	4.20 ± 1.52^{ab}
IRS	3.93 ± 1.26^{ab}	3.53 ± 1.13^{a}	3.93 ± 1.49^{a}	3.00 ± 1.46^{a}	3.13 ± 1.30^{a}	3.67 ± 1.29^{ab}
WXA	3.93 ± 1.03^{ab}	3.47 ± 1.19^{a}	3.47 ± 1.81^{a}	3.13 ± 1.19^{a}	3.20 ± 1.15^{a}	4.53 ± 1.88^{ab}
ZAS	3.93 ± 1.49^{ab}	3.67 ± 1.59^{a}	4.07 ± 1.44^{a}	3.67 ± 1.59^{a}	3.47 ± 1.51^{a}	4.93 ± 1.91^{ab}
WES	3.93 ± 0.96^{ab}	3.47 ± 1.13^{a}	3.93 ± 1.79^{a}	3.67 ± 1.25^{a}	3.87 ± 1.77^{a}	4.13 ± 1.60^{ab}
UYC	3.93 ± 2.00^{ab}	3.27 ± 1.16^{a}	3.60 ± 1.50^{a}	3.67 ± 1.65^{a}	3.87 ± 1.73^{a}	3.60 ± 1.35^{ab}
XBD	3.93 ± 1.81^{ab}	3.27 ± 1.58^{a}	3.33 ± 1.59^{a}	3.67 ± 1.80^{a}	3.20 ± 1.47^{a}	3.73 ± 1.79^{ab}
CDA	3.93 ± 2.29^{ab}	4.13 ± 2.03^{a}	4.33 ± 2.02^{a}	3.67 ± 2.29^{a}	3.73 ± 2.19^{a}	3.87 ± 2.17^{b}

Values are mean± standard deviation of two replicates. Values with different superscripts within the same column are Significantly different from each other at ($p\leq0.05$). DBS=90:10 (orange: watermelon), SPD=80:20 (orange: watermelon), IRS=60:40(orange:watermelon),WXA=70:30(orange:watermelon),ZAS=50:50(orange:watermelon),WES=10:90 (orange :watermelon), UYC=20:80(orange: watermelon), XBD=40:60(orange: watermelon),CDA=100%(Orange)

Microbiological analysis of jam produced from orange-watermelon blends: The total viable count of jam produced from orange and watermelon is represented in Table 9 above. The total plate count of microbial population is considered as an index of quality of food product. The total plate count for week one ranged from 5.8×10^5cfu/ml to 13.5×10^5cfu/ml with sample UYC having the lowest value and sample WXA having the highest value. The control sample CDA had value of 6.1×10^5cfu/ml which is higher than sample UYC. In week two, values ranged from 4.95×10^5cfu/ml to 9.5×10^4cfu/ml with sample IRS having the lowest value and sample WXA having the highest value. In week three, total plate count value ranged from 3.2×10^5cfu/ml to 6.0×10^5cfu/ml with sample WES lowest value and sample WXA had the highest value. In week four, sample WES had the lowest value while sample ZAS had the highest value. In week 5, sample UYC had the lowest value while sample ZAS had the highest value. In week six, total plate count of the jam samples ranged from 1.7×10^5cfu/ml to 4.5×10^5cfu/ml with sample IRS had the lowest value while sample ZAS had the highest value. It was observed from the result obtained that there was high microorganism growth between week one, week two and week three while there was reduction in growth between week four, five and six which may be due to reduced multiplication and death according to microorganism growth phase. According to values obtained by Adedeji (2017), the values obtained here are in close range. The yeast and mold count of the formulated jam samples from orange and watermelon are represented in Table 10 above. The yeast and mold count over the weeks ranged from 1.1×10^5cfu/ml to 19.5×10^5cfu/ml. In week one, yeast and mold count ranged from 4.6×10^5cfu/ml to 19.5×10^5cfu/ml with sample DBS had the lowest value and sample SPD had the highest value. In week two, values ranged from 3.8×10^4cfu/ml to 9.0×10^4cfu/ml with sample WES having the lowest value and sample SPD had the highest value. In week three, the values ranged from 1.3×10^5cfu/ml to 6.1×10^5cfu/ml with sample IRS having the lowest value and sample SPD having

the highest value. In week four, values ranged between 1.3×10^5cfu/ml to 3.1×10^4cfu/ml with sample DBS and IRS having the lowest values and sample SPD having the highest value at the end of last analysis. The control sample CDA had the lowest count of 1.1×10^5cfu/ml. This low microbial population may be attributed to the positive effect of pasteurization in destroying microorganisms in liquid foods. The addition of a high quantity of sugar is known to favor microbial stability. However, this high pH (low acid) is known to favor the growth. E. coli is commonly used as an indicator organism to reflect the hygienic quality of food. Its presence in food generally indicates direct or indirect faecal contamination with a substantial number suggesting a general lack of cleanliness in handling and improper storage.

Lawlor *et al.* (2009) opined that food-borne pathogens do not generally grow at pH 4.6 or below, which has been set as an official borderline between acid and low-acid foods. Low pH alone does not ensure the product safety and stability. However, the minimum pH for growth and the rate of inactivation depend on the nature of the acidulant, the presence of other inhibitors and the acid resistance mechanisms of an organism (Lücke, 2003).

Table 10: Effect of storage time on yeast and mold count (Cfu/ml) of orange-water-melon jam

Sample	Week 1	Week 2	Week 3	Week 4
DBS	4.6×10^5	4.1×10^5	3.9×10^5	1.3×10^5
SPD	19.5×10^5	9.0×10^4	6.1×10^5	3.1×10^4
IRS	6.5×10^5	6.3×10^5	1.3×10^5	1.3×10^5
WXA	6.4×10^5	5.5×10^5	2.6×10^5	2.2×10^5
ZAS	9.0×10^4	8.5×10^4	2.5×10^5	2.3×10^4
WES	6.0×10^5	3.8×10^4	3.6×10^5	2.5×10^4
UYC	9.0×10^4	5.5×10^5	5.5×10^4	1.5×10^5
XBD	6.4×10^5	4.3×10^5	3.2×10^5	1.6×10^5
CDA	5.0×10^5	4.9×10^5	1.5×10^5	1.1×10^5

Values are mean of two counts. DBS=90:10 (orange: watermelon), SPD=80:20 (orange: watermelon), IRS=60:40 (orange: watermelon), WXA=70:30 (orange: watermelon), ZAS=50:50(orange:watermelon),WES=10:90(orange:watermelon), UYC=20:80(orange: watermelon) , XBD=40:60 (orange: watermelon), CDA=100% (Orange).

Mineral composition of orange-watermelon jam blends: The results of calcium, iron and potassium determination of jam samples produced from orange and watermelon are represented in Table 11 above. The results showed that there are significant differences in the mineral content of the samples. The calcium content of the jam samples ranged 168.16±0.01mg/100g to 687.58±0.02mg/100g with sample IRS having the lowest value and sample WXA having the highest value. The control sample CDA had calcium content of 333.47±0.03mg/100g. Also, samples which had higher ratios of orange had more calcium content. The iron content of the jam sample ranged from 6.07±0.04mg/100g to 17.24±0.02mg /100g with sample WES having the lowest value and sample SPD having the highest value. The control sample CDA had very low iron content. The value of sample WES was similar to the value reported by Samaila *et al.* (2016). The potassium content of the jam samples ranged from 0.91±0.04mg/100g to 1.63±0.04mg/100g with sample WES having the lowest potassium content and sample WXA having the highest value. This is different from the values reported by Nawaz *et al.* (2010). Several authors have reported that potassium has the tendency to protect the body system against arterial hypertension, maintain osmotic balance of the body fluids, pH, regulates muscle and nerve irritability, control glucose absorption, and enhance normal retention of protein during growth (Wardlaw, 2004; Omoba *et al.*, 2013). However, significant differences were observed in all the samples ($p< 0.05$). Calcium is known to make up a large proportion of the bone: human blood and extracellular fluid in the body. It is therefore, important for the normal functioning of cardiac muscles, milk coagulation and blood clotting, and the regulation of cell permeability (Lopez-Martinez *et al*. 2009)

Sensory characteristics of Jam produced from orange-watermelon blends: The result of sensory evaluation of jam samples are represented in Table 12 above. There was no significant difference in most attributes measured in the samples except for colour and overall acceptability. The colour attributes ranged from 3.60±1.4 to 3.93±0.96 with sample DBS having the lowest value and sample UYC having the highest value which is similar to that obtained for samples IRS, WXA, ZAS, WES, XBD. It was observed that samples which had velvet-red colour of the watermelon were preferred by the panelists. The flavor attributes ranged from 3.27±1.03 to 3.67±1.59 with samples SPD, UYC, and XBD having the same value which are lower than that of samples DBS and ZAS respectively. The control sample CDA had the highest value for flavor attributes. Meanwhile, samples with higher ratios of orange fruit were preferred by panelists. The texture attributes ranged from 3.33±1.59 to 4.07±1.44. The sample which had the lowest value was sample XBD and the highest was sample ZAS followed by sample IRS, DBS and WES respectively. The control sample had a value of 4.33±2.02 which is higher than values obtained for other experimental samples. The sweetness attribute ranged from 2.93±1.44 to 3.67±1.25 with sample DBS having lowest while sample WES, XBD, UYC and ZAS had the highest value. The sweetness of the

jam increased with reduced substitution of orange fruit and increased substitution of watermelon fruit. Taste is a primary factor in the determination of acceptability of any product by consumers. Sample DBS has the lowest value while the highest value was in WES and UYC. The control sample CDA also had a high value of 3.73±2.19. The values obtained were different from the values reported by Adedeji (2017). The sample with highest overall acceptability was ZAS with mean score of 4.93±1.91 followed by samples WXA and SPD. The lowest value was found in sample DBS.

Conclusion: The results obtained from the study above show that jams produced from orange and watermelon are safe, nutritious and very good for human consumption and will provide basic nutrients for the body. The prepared mixed fruit jam samples with different fruit concentrations showed excellent taste, high nutritive values and good sensory acceptability. Hence, its consumption will improve nutrient intake and thus have the potential of reducing the prevalence of cardiovascular problem and improvement of eyesight. Jam production from local and existing resources can thus be used as a way of substituting imports and contributing to the protection of food and nutrition. The practical application, through the processing and promotion of fruit jam products, contributes to generating work opportunities for the community. It is an opportunity for exploring the possibility of producing other value-added food products to preserve the fruit during off seasons and also to reduce postharvest losses.

Declaration of Data Availability: Data are available upon request from the corresponding author.

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