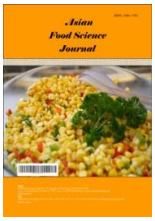

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Production and Quality Evaluation of Mixed Juice Blend from Soursop (*Annona muricata*), Mango (*Mangifera indica*) and Watermelon (*Citrullus lanatus*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author CA designed the study, performed the statistical analysis, managed the analyses of the study, wrote the protocol and wrote the first draft of the manuscript. Author JCA managed some of the literature searches and supervised the work. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the chemical, microbiological, physico-chemical and sensory properties of fruit juice produced from blends of soursop, mango and watermelon.
Study Design: The data obtained were analyzed using statistical package for social science (SPSS) version 20. The mean and standard deviation were calculated using analysis of variance. Means were separated by Duncan's new multiple range test.
Place and Duration of Study: The study took place at the Department of Food Science and Technology, University of Nigeria, Nsukka between January and July, 2016.
Methodology Juices extracted from Soursop Mango and Watermelon (designated as S, M and W respectively) were blended to give samples containing soursop, mango and watermelon juices in the ratio of 60:25:15, 15:60:25, 25:15:60 and 33.3:33.3:33.3, respectively. The samples were processed, bottled and analyzed for proximate, phytochemical and micronutrients composition, physico-chemical, microbial and sensory qualities using standard methods.
Results: There were significant ($p < 0.05$) differences in the proximate composition, micro-nutrient

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and phytochemical composition of the mixed fruit juice blend. The moisture content, ash content, crude fiber, crude fat, crude protein and carbohydrate ranged from 85.0 to 90.03%, 0.14 to 0.6%, 0.95 to 2.94%, 0.19 to 0.44%, 0.75 to 1.72% and 7.23 to 11.48% respectively. pH, brix and Titratable acidity of samples varied significantly ($p < 0.05$) and ranged from 5.92 to 6.11%, 8.85 to 12.80% and 0.38 to 0.69% respectively. The flavonoid, total phenol and pro-vitamin A contents of the blends ranged from 9.14 to11.04%, 0.3 to 0.5% and 13.01 to 72.9% respectively. Vitamin C, potassium and calcium contents ranged from 28.25 to 41.75 mg/100ml, 108.32 to 168.92 mg/100 ml and 7.05 to 12.69 mg/100 ml respectively. The microbial results showed that total viable count found present in the mixed fruit juice blended samples ranged from 3.0 x 101 to 9.0 x 101. The sensory scores showed that all the samples were generally accepted while sample which had equal proportions of the individual juices had the highest overall acceptability due to the homogeneity, luscious taste, appearance and consistency of the blend. The overall results showed that improving the quality and availability of fruit and fruit products through processing will raise consumer awareness, boost fruit consumption and improve health, check post-harvest losses and harness the therapeutic advantages of fruits. Blending of soursop, mango and watermelon juices in varying proportions produced acceptable juice that compared favorably with a commercial mixed juice blend in terms of vitamins C and pro-vitamin A content, total sugar, brix content and acidity.

Keywords: Soursop; mango; watermelon; fruits; juice blend.

1. INTRODUCTION

Fruits are known to be seasonal in nature. They could be abundant in one season or scarce (or limited in supply) in others. Even when they are available, they are only restricted to some regions that favor their growth and are lacking in others that do not. In the quest to make them available to other regions, they might deteriorate on transit due to their highly perishable nature. Fruits are vulnerable to softening and spoilage when adequate processing, preservation and storage techniques are not applied [1]

Some cancer and cardiovascular diseases have been reported to be caused by low fruit consumption. These two diseases are the leading causes of death worldwide [2]. The International Agency for Research on Cancer (IARC) concluded that 5–12% of cancer could be attributed to low fruit consumption [3]. Australian data suggests that 2% of cancers were attributable to low consumption of fruit [4], while 21% of the cause of lung cancer and 4% of the cause of breast cancer has been attributed to lower fruit intake [5]. These numbers give some indication of what proportion of cancers could be prevented by increased fruit consumption. This then calls for the identification and processing of certain fruits whose therapeutic and phytochemical constituents are necessary for the prevention of these diseases.

Fruits are important sources of energy for human-beings. Fruits are delicious, nutritious and desirable components of human diet but they suffer the problem of being regional commodities, extremely perishable and seasonal. For this reason, it is often advantageous to preserve and extend the shelf-life of fruits, thus, ease transport to locations distant from their site of production. Processing of fruits also transforms the raw material into a nutritive, convenient and perhaps value added product [6]. Processing fruits can enhance consumption and hence help to reduce the prevalence of non-communicable diseases. WHO [7], recommended increased fruit consumption as a key component to a healthy diet.

Soursop is the fruit of *Annona muricata* in the *Annonaceae* family, a broadleaf, flowering, evergreen tree native to Mexico and produced in all tropical parts of Africa, especially in Eastern Nigeria [8]. The flesh of the fruit consists of an edible, white pulp, some fiber and a core of indigestible black seeds. It contains 80.6% water, 1.62% fiber, 0.73% ash, 0.31% fat, 1.22% protein, 1.62% starch, 0.021% vitamin C, 15.63% sugar, other micronutrients, amino acids and phytochemicals. The specie is the only member of its genus suitable for processing and preservation. The pulp is also used to make fruits nectar, smoothies, fruit juice drinks, as well as candies, sorbets, and ice cream flavoring [8]. It is excellent for the endocrine system, normalizing hormone production in the different glands in the body. It also helps recover the heart muscle after heart attack, combat hypertension and cardiovascular problems, prevent accumulation of body fat and thus contributes to weight loss.

Mango is the fruit of *Mangifera indica* tree which is grown in practically every tropical and subtropical country but India has by far the largest area. The fruit is a big fleshy drupe with edible pulp and a stony layer around the seed. The edible portion takes up 60-75% of the fruit weight. Edible flesh of the ripe mango contains about 83% water, 15% sugar (mostly sucrose), and ascorbic acid. The main acid constituent is citric acid although glycolic, oxalic, malic and tartaric acids are also present. The amino acid, which have been identified are alanine, aspartic acid, glycine, serine and alpha-aminobutyric acid. Ripe mangoes are eaten for dessert, juice and all kinds of preserves can be made from it, while pickles and chutney are prepared from unripe fruits. Mango has high level of vitamin C, pectin and fibers that help to lower serum cholesterol levels. Fresh mango is a rich source of potassium, which is an important component of cell and body fluids that helps to control heart rate and blood pressure. It also contains enzyme that breakdown protein. Its fibrous nature helps in digestion and elimination; it is rich in pre-biotic dietary fiber, vitamin and minerals.

Watermelon (*Citrullus lanatus*) is a vine-like flowering plant originally from Southern Africa. Watermelon fruit supplies 30 calories and low amounts of essential nutrients. Only vitamin C is present in and appreciable amount (10%). It contains 91% water, 6% sugar and low in fat. Its pulp contains carotenoids, including lycopene. Watermelon contains amino acids, such as *L-citrulline*, which help the blood vessels dilate naturally, countermanding endothelia dysfunction and reducing blood pressure [9]. In addition, they contain antioxidants and phytochemicals which are known to fight cancer and other cardiovascular diseases.

Juice is the liquid that is naturally contained in fruit or vegetable tissues which is prepared by mechanical squeezing or macerating fresh fruit or vegetable without the application of heat or solvent [10]. Fruit juice can be made from all types of fruits and can be made from mixtures of different types of juice, to produce assorted mixed fruit juice combination [11]. Fruit juices are consumed for their thirst quenching qualities and more importantly the nutritional quality. The vitamin C content of juice is usually an important parameter used in characterizing the nutritional value of juices. Regular consumption of fruits juice is still one of the best ways of replenishing the body's essential nutrients and it's a natural source of ready energy. A ½ - ¾ cup of pure fruit juice is equivalent to a single fruit such as an apple or orange, and it is rich in natural fruit sugars such as fructose and glucose [12]. Fruit juice is popular today because of their pleasing organoleptic and health benefits.

Despite the strong appeal and tradition that many pure fruit juices have, overcoming scarcity and/or seasonal availability of certain juice components, balancing out excessively strong flavors, primarily high acidity, astringency, or bitterness, improving poor color or color stability of otherwise desirable juices attributes and emphasizing unique nutritional or phytochemical properties are some of the logical reasons for producing single fruit and mixed pure juice blends and juice products containing less than 100 percent juice.

Blending offers the opportunity to adjust sugar/acid ratios and compensate for other imbalances in juice from a single harvest or cultivar, since many factors influence the composition and quality of juice. By blending several batches of juice with complementary compositions a uniform, standard juice is practical. Adjusting 100 percent juices is much more of a challenge than manipulating acid and sugar in juice beverage blends.

In a similar sense defects in many juice quality or nutritional attributes can be overcome by proper combination of juices. Further adjustments call for additional ingredients. Extremely acidic and/or strong flavored juices completely mask subtler juices. In which case, non-juice sweeteners can greatly extend the juice.

Hence, the broad objective of the work was to produce and evaluate the quality of mixed juice from blends of soursop, mango and watermelon as well as evaluate the chemical, microbiological, physico-chemical and sensory properties of the juice blends.

2. MATERIALS AND METHODS

2.1 Materials

Soursop, Mango Watermelon, citric acid and other reagents for juice production were procured from Ogige market in Nsukka and some villages around the University of Nigeria, Nsukka in Enugu state, Nigeria. Some of the equipment used include blender, trays, stainless steel knife, small sized bowls and plastic containers for packaging of the products.

2.2 Production of Soursop, Mango and Watermelon Juice Blend

The fruits were sorted for wholesomeness. Fully ripened ones were selected while under-ripened and defective ones were removed to avoid contaminating the entire juice and reducing the quality of the juice. The sorted fruits were washed with clean tap water to remove all dirt and contaminants. Peeling and cutting were done with clean stainless knives and seed removed. Edible pulp was macerated with a blender (Binatone Blender - BLG-450 – 1500 ml) and the juice of each fruit extracted using electric juice extractor (Waring Pro JEX328 Health Juice extractor). The extracted juices were filtered using muslin cloth. The pasteurized and bottled single juice was blended in the ratios 60:25:15, 15:60:25, 25:15:60 and 33.3:33.3:33.3 as shown in Table 1. Each juice blend was pasteurized (boiled for 3 minutes), hot filled into sterilized glass bottles and sealed/corked. The flow diagram for the production of the mixed fruit juice blend is as shown in Fig. 1.

2.3 Proximate Composition Analysis

2.3.1 Determination of moisture content

The moisture content of the formulated mixed fruit juice from blends of soursop, mango and watermelon were determined using the hot oven method described by AOAC [13].

Table 1. Formulation of Mixed Fruit Juices

Juices samples	Proportions		
Samples	**Soursop (ml)**	**Mango (ml)**	**Watermelon (ml)**
MPOx	-	unknown	-
MSW_a	60	25	15
MSW_b	15	60	25
MSW_c	25	15	60
MSW_d	33.3	33.3	33.3

Key: MSWa = 60% soursop, 25% mango and 15% watermelon, MSWb = 15% soursop, 60% mango and 25% watermelon; MSWc = 25% soursop, 15% mango and 60 % watermelon; MSWd = 33.3% of individual juices and MPO = Control juice sample (mango, pineapple and orange)

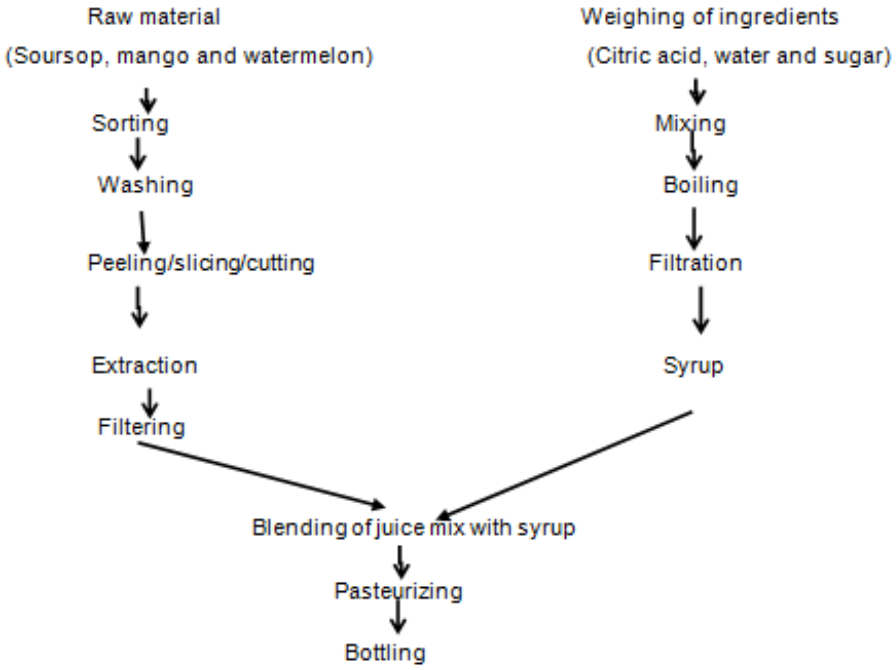

Fig. 1. Flow chart for the Production of mixed fruit juice blend

2.3.2 Determination of ash content

The ash content of the formulated mixed fruit juice from blends of soursop, mango and watermelon were determined using the hot oven method described by [13]. The ash content of the fruit bar samples was determined by the method. Two grams of the samples were placed in weighed crucible (W_1) and weighed again with the sample as W_2. The crucibles containing the samples were transferred to the muffle furnace and heated to 550^{o}C for 4 hours in the furnace. At the end, the furnace was put off and allowed to cool. The crucibles were cooled in a desiccator and then weighed as W_3. The percentage ash content was then calculated using the expression;

Percentage (%) ash content = (W_2 – W_3 / W_2– W_1) X 100

2.3.3 Determination of crude protein content

The crude protein content (percentage of nitrogen X 6025) was determined by the micro Kjeldahl method as described by [13].

2.3.4 Determination of crude fiber content

The crude fiber content of the sample was determined by the method described by [13]. 2 g of each sample was weighed (W_1) into a 600 ml beaker and 150 ml of preheated 0.128 M H_2SO_4 was added to it. This was heated for 30 minutes and filtered under suction and washed with hot distilled water until the washings were no longer acidic. The residue was then transferred to a beaker and boiled for 30 minutes with 150 ml of preheated NaOH (0.223 M). It was filtered and washed with hot water until the washings are no longer acidic. The residue was washed three times with acetone and dried in an oven at 100°C for 2 hours. It was cooled in a desiccator, weighed (W_2) and ashed in a muffle furnace (make: Vecstar, model LF3, U.K) at 600°C for 5 hours. The ash obtained was cooled in a desiccator and weighed (W_3). The crude fiber content was calculated using the expression:

Percentage (%) crude fiber = (W_2 -W_3)/W_1 * 100

Where: W_1 = Weight of sample
W_2 = Weight of dry residue
W_3 = Weight of ash

2.3.5 Determination of crude fat in the mixed fruit juice

The crude fat content of the sample was determined using the Rose-Gottlieb method. The sample (10 g) was weighed into the tube. One (1) ml of ammonia and 10 ml of ethanol (95%) was added and mixed thoroughly. Peroxide free diethyl ether (25 ml) was added and the tube stoppered and shaken vigorously for 1 minute. Petroleum ether (25 ml) was added and shaken vigorously for 30 second. A 100 ml flat bottom glass flask was weighed and dried and the extraction left to stand until the layers were clearly separated. The fat was transferred into the flask. To the tube, 2 successive lots of 5 ml of mixed ethers was added and transferred to the flask. The extraction was repeated with 15 ml of ether and 15 ml of petroleum ether and the subsequent operation repeated two times. The solvent was distilled off from the flask and the flask dried for 1 hour at 100°C in an oven, cooled and weighed. The fat content was calculated using the expression:

$$\text{Percentage crude fat} = \frac{\text{weight of fat} \times 100}{\text{Weight of sample}}$$

2.3.6 Determination of carbohydrate content

This was determined by difference as described by [13].

Carbohydrate content (%) = 100 – (% protein + % fat + % ash + % crude fiber + % moisture).

2.3.7 Determination of pH

The pH of the samples was determined using a pH meter. The electrode was dipped in an already weighed 5 ml of the sample solution. The pH of the sample was displayed on the screen and the reading was taken.

2.3.8 Determination of titratable acidity

This was determined by [13]. 10 g of the samples were titrated against 0.1 M NaOH solution using 0.3 ml phenolphthalein as indicator. The volume of NaOH (ml) that neutralized the sample was recorded. The titratable acidity expressed as citric acid per 100 ml of each sample was calculated using the expression:

$$\text{Percentage}(\%) = \frac{\text{molar weight of citric acid x titer value x normality x 100}}{\text{1000 x weight of sample}}$$

2.3.9 Determination of total soluble solid (O Brix)

The brix level of the samples was determined using digital hand refractometer. 5 g of the mixed juice samples were dissolved in 15 ml of warm distilled water and mixed properly. A disposable pipette was dipped into the solution and a drop of the solution was released into the silver plate of the refractometer to touch the prism. The enter button was pressed and the value was displayed on the screen. The total soluble solid was expressed as percent sucrose by weight (O Brix).

2.3.10 Determination of reducing sugar

The reducing sugar was determined using the method described by [14]. 1 ml of the samples was pipetted into a volumetric flask and 5 ml of the ferricyanide was added and immersed in a boiling water bath for 10 minutes. After heating, the flask was cooled quickly in running water and the content partially neutralized with 10 ml of H_2SO_4. The content of the flask was mixed thoroughly until no more gas evolved. Four (4 ml) of the arsenomolybdate solution was added, mixed, and diluted to volume. The absorbance of the solution was read at 515 nm using a reagent blank and the reducing sugar content calculated thus:

The k value for the total reducing sugar was calculated from the standard curve using the formula

$$k = c/a$$

Where c = concentration in grams reducing sugars per 100 ml
a = absorbance of solution at that concentration
k = factor for unit absorbance, or slope of curve
.
The reducing sugar content, S, of the sample was calculated from the formula:

$$S = K \times A \times D$$

Where: S = total reducing sugar concentration of sample (mg/100 ml)
K = average slope of curve
A = absorbance of sample
D = dilution factor

2.3.11 Determination of total solids

This was carried out in accordance with the method described by AOAC [13]. The sample (10 grams) was weighed into a dish and dried at 130°C. The dish was allowed to cool in a desiccator and weight of the solid (content) was determined using the expression:

$$\text{Percentage}(\%)\text{Total Solid} = \frac{W3 - W1 \times 100}{W2 - W1}$$

W1 = weight of empty dish,
W2 = weight of dish + sample before drying
W3 = weight of solid + dish after drying.

2.3.12 Determination of density

The density of the fruit juice samples was determined using specific gravity bottle (of volume (V) 50 ml) method described by [14]. The specific gravity bottle was cleaned by shaking with acetone and then with ether. The bottle was dried and tare weight noted. The bottle was carefully filled with juice sample and cover inserted. The excess liquid was cleaned off and sample placed on the weighing balance and weight (W) determined.

$$\text{Density} = W/V$$

Where; W = mass
V = volume

2.3.13 Determination of viscosity

The viscosity was determined using the Ostwald viscometer at room temperature. The time taken for distilled water and the sample to flow from the top of the viscometer bulb to the bottom was determined and relative viscosity calculated using the expression:

$$\text{Viscosity} = \frac{\rho 1 \times t2 \times \square}{\square 1 \times t1}$$

Where, ρ1 = viscosity of water (1.005)
t2 = time of flow of sample
□2 = density of sample
□1 = density of water
t1= time of flow of water

2.3.14 Stability test of samples

Each sample was placed in a 50 centimeter bottle immediately after preparation to measure the volume of separation thus determining the

stability to sedimentation of the mixed juice blend. The analyses were carried out in triplicate at room temperature, and the volume was evaluated for a period of one month. Separation was observed visually, and the sedimentation index **(IS%)** was calculated using the expression:

$$IS = \frac{\text{Height of sediment (cm)}}{\text{Initial height of juice (cm)}} \times 100$$

2.3.15 Determination of pro-vitamin a content

The pro-vitamin A content was determined using the method described by [15]. 10 ml of 95% ethanol and an equivalent volume of hexane were added into a test-tube containing 1 ml of sample, followed by the addition of 10 ml of normal saline to dilute it. The test-tube was stoppered and the contents mixed vigorously on a vortex mixer for 2 minutes to ensure complete extraction of carotene before centrifugation for 10 minutes at 3000 X G to obtain a clean phase separation. Thereafter, 100 µm of hexane extract was transferred from the micro cuvette and the absorbance due to carotene read at 450 nm against hexane blank. The sample was then transferred from the micro cuvette to a test tube and the cuvette rinsed with 50 µL of hexane. The solution was added to the sample in the test tube. The extract was evaporated to dryness under gentle stream of nitrogen in a water bath at 60^{o}C while avoiding splashing on the test tube wall. The residue was immediately re-dissolved in 10 µL of chloroform-acetic anhydride (1:1 v/v) reagent and 100 µL of freshly prepared Trifloroacetic acid-chloroform chromagen reagent was added. The solution was rapidly transferred to the micro-cuvette using a micro-transfer pipette. The blank consisted of chloroform acetic anhydride mixture and trifluroacetic acid-chloroform chromagen (1:1 v/v) reagent. An ultraviolent spectrophotometer was used to read the absorbance of the sample at 620 nm after 15 seconds and again at 30 seconds after addition of chromagen. The concentration of pro-vitamin A was extrapolated from a standard curve prepared by diluting vitamin A standard with hexane and the calculation processed thus:

$$\text{Vitamin A (as µg RE/dl)} = \frac{\text{A 620} - 2 \text{ X 420 FC 450 X FC 620}}{\text{FC 620}}$$

Where, A 620 = absorbance reading taken at 620 nm

A 450 = absorbance reading taken at 620 nm

FC 450 = calibration factor for carotene at 450 nm = $\frac{\text{µg carotene/ml}}{\text{A 450}}$

FC 620 = beta carotene A 620 correction factor = $\frac{\text{µg carotene/ml}}{\text{A 620}}$

2 x A 450 FC 450 in which the factor 2 is derived from the difference in dilution of carotenoids FC 620 and Vitamin A in their respective assays.

2.3.16 Determination of vitamin C

The vitamin C content of the sample was determined according to the method described by [16]. One gram of the sample was measured into a conical flask. Ten millimeters (10 ml) of 20% metaphosphoric acid and 5 ml of acetone were added to the sample. The sample was then filtered and absorbance read in a spectrophotometer at 520 nm wavelength. The vitamin C was calculated using the expression:

$$\text{Vitamin C in mg/100 ml} = \frac{\text{Absorbance of test sample x concentration of standard}}{\text{Absorbance of sample x wavelength of sample}}$$

2.4 Mineral Analysis

2.4.1 Determination of calcium

Calcium content was determined using method described by [13]. 2 g of the samples was diluted with 3 ml of distilled water and 1 ml of 50% ammonium oxalate. One drop of methyl red indicator was made alkaline with ammonia drops and drops of glacial acetic acid until color changes to pink. This was allowed to stand for 4 hours and centrifuged for 5 minutes, followed by decantation of the supernatant. 1 ml of hydrogen sulphate was added to the residues which were diluted with 4 ml of distilled water. The solution was boiled with 0.2 N potassium permanganate. Calcium content was calculated using the expression:

$$\text{Calcium content} = \frac{\text{volume of EDTA x molar mass of calcium x DF/100}}{\text{Weight of sample x 10}}$$

Where DF = Dilution factor

2.4.2 Determination of potassium

The potassium content of the sample was determined using AOAC (2010) method. Twelve

millimeters (12 ml) of trioxonitric acid (HNO_3) was added to the sample in a digestion tube and the mixture was kept overnight at room temperature. Then, 4 ml of perchloric acid was added to the mixture and was kept in a fume chamber for digestion. The temperature was increased gradually starting at 50°C and increasing up to 250 – 300°C. The digestion completed in about 70 minutes as indicated by the appearance of white fumes. The mixture was left to cool and the content of the tube was transferred to 100 ml volumetric flask and the volume was made up to 100 ml with distilled water. Standard solution of 0.2, 0.4, 0.6, 0.8 and 1 ml in different test tubes was prepared and aspirated into a flame photometer followed by the sample solution and the concentration of potassium was calculated thus:

$$\text{Potassium (mg/100 ml)} = \frac{\text{absorbance of the test sample x diluted factor}}{\text{Slope (from standard curve) x weight of the sample}}$$

2.5 Phytochemical Analysis

2.5.1 Determination of flavonoid

Flavonoid was determined by the method described by [17]. 10 g of each sample was extracted repeatedly with 100 ml of 80% aqueous methanol at room temperature. The whole solution was filtered through Whatman filter paper No. 42 (125 mm). The filtrate was transferred to a crucible and evaporated to dryness over a water bath and weighed to a constant weight.

The percentage flavonoid was calculated using the expression:

$$\text{Percentage flavonoid} = \frac{\text{weight of flavonoid}}{\text{Weight of sample used}} \times 100$$

2.5.2 Determination of total Phenol by spectrophotometric method

The total phenolic content (TPC) was determined by spectrophotometry, using gallic acid as a standard, according to the method described by [18]. Briefly, 0.2 mL of the diluted sample was transferred into tubes containing 1.0 mL of a 1/10 dilution of Folin-Ciocalteu's reagent in water. After waiting for 10 minutes, 0.8 mL of a sodium carbonate solution (7.5% w/v) was added to the sample. The tubes were then allowed to stand at room temperature for 30 min before absorbance at 743 nm was measured. The TPC was expressed as gallic acid equivalents (GAE) in mg/100 mL of fruit juice. The concentration of polyphenols in samples was derived from a standard curve of gallic acid ranging from 0.2 to 4 mg/L.

$$\text{Total phenol (mg/100 g)} = \frac{\text{absorbance of sample x concentration of standard}}{\text{Absorbance of standard}}$$

2.6 Microbial Analysis

1 ml of sample was dissolved into 9 ml of ¼ strength Ringer's solution in a test tube and mixed thoroughly to give it a 10^{-1} dilution. Then I ml from this test tube was pipetted into another 9 ml of ringer's solution to give 10^{-2} dilution. The petri dishes were duplicated for each sample and in each plate, 15 ml of sterile nutrient agar medium was added and I ml of each sample dilution was pipetted into each plate containing the medium. This was followed by shaking and circular movement for about 10 seconds. The plates were then allowed to set and incubated (inverted) in VWR1530 incubator for 24 hours at 38°C. The colonies formed were counted after 24 hours and recorded as colony forming unit (CFU) per millimeters.

Number of colonies per ml = average count x dilution factor.

2.7 Sensory Evaluation

Sensory properties of the samples were evaluated by 20 semi-trained panelists consisting of students of university of Nigeria, Nsukka for various sensory attributes (flavor, color, aroma, taste, aftertaste, mouth feel and overall acceptability). The samples were scored on a nine-point Hedonic scale, where "9" represented extremely liked and "1" represented extremely disliked [1]

2.8 Experimental Design and Statistical Analysis

The experimental design used was the complete randomized design (CRD) and the data obtained from the analyses were analyzed using one – way analysis of variance (ANOVA). Also means were separated by Ducan's multiple range test method and the level of significance was

accepted at ($p < 0.05$) according to Steel and Torrie [19].

3. RESULTS AND DISCUSSION

Table 2 shows the material balance for juice production from mango, soursop and watermelon. It indicates the weight of fruit used, the juice yield, the volume of water added to the fruit during blending and the actual juice yield i.e. volume of yield gotten when the volume of water added was subtracted from the total juice yield.

In the percentage juice yield tabulated, the yield of watermelon is higher (63%) than that of mango (52%) and soursop (34%). The low yield of mango juice could be due to the variety used. The mango variety used for the study had strong endocarp and relatively large kernel which may have contributed appreciably to the weight of the fruit. This high yield of watermelon could be attributed to high moisture composition of the fruit [9].

3.1 Proximate Composition of Mixed Fruit Juice Blend

Table 3 shows the proximate composition of the mixed juice blend. The mean moisture content of the samples did not differ significantly ($p > 0.05$). MSWc had the highest moisture which differed significantly ($p < 0.05$) from sample MPOx with the lowest moisture content. Samples MSWa, MSWb and MSWd had comparable ($p > 0.05$) moisture content. The high moisture content of MSWc could be due to the high proportion of watermelon (60%) in the sample and this result agrees with [20] who noted that watermelon has about 91% moisture content. The result equally corresponds with the report of [21], on the biochemical properties of watermelon rinds subjected to solid media fermentation.

As the level of watermelon increased in the blends, the moisture content increased and vice versa. The variation observed in the moisture content of the samples could be as a result of the variation in composition of individual fruits, variety of fruit selected and climatic conditions at the time of the fruits development.

The high moisture content observed in these samples because of high moisture is in agreement with high perishability associated with fruits reported by [12] and other workers. The moisture content of the samples was within the acceptable range of 80 – 90% moisture for fruit and vegetable juices [22]. The solid content of food products is related to their food values. The greater the solid content (lower moisture content) of the fruits, the greater is its nutritional value. Moisture content is of profound importance in determination of shelf-life of unprocessed and processed fruits and vegetables since it affects physico-chemical properties, microbiological spoilage and enzymatic change. Furthermore, the high moisture of the juices makes them

Table 2. Material balance of juice production from soursop, watermelon and mango

Fruit	Weight of whole fruit (kg)	Total juice yield (T)ml	Volume of water added (Q)ml	Actual juice yield (T-Q)ml	Waste from fruit (kg)	Residue after sieving (g)	Percentage yield (%)
Mango	8.54	4150	1250	2900	4.78	860	34
Soursop	4.89	3800	1250	2550	2.15	193.3	52
watermelon	4.73	3100	100	3000	1.2	530	63

M = mango, S = soursop, W = watermelon

Table 3. Proximate composition of mixed fruit juice blend

Sample	Moisture	Ash	Crude fiber	Crude fat	Crude protein	Carbohydrate
MSWa	87.76^{ab}±1.32	0.14^{a}±0.05	1.65^{c}±0.05	0.44^{d}±0.01	1.44^{d}±0.04	8.56^{ab}±1.28
MSWb	86.43^{ab}±0.88	0.6^{a}±0.31	2.94^{e}±0.45	0.29^{b}±0.01	1.00^{b}±0.04	8.72^{ab}±0.56
MSWc	90.03^{b}±1.14	0.15^{a}±0.50	1.15^{b}±0.05	0.19^{a}±0.01	0.75^{a}±0.04	7.23^{a}±0.60
MSWd	88.91^{ab}±0.96	0.15^{a}±0.50	1.94^{d}±0.05	0.34^{c}±0.01	1.18^{c}±0.04	7.46^{a}±0.90
MPOx	85^{a}±1.29	0.15^{a}±0.50	0.95^{a}±0.05	0.19^{a}±0.01	1.72^{e}±0.02	11.48^{b}±1.22

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

Key: MSWa = 60% S, 25% M and 15% W, MSWb = 15% S, 60% M and 25% W; MSWc = 25% S, 15% M and 60% W; MSWd = 33.3% of M, S and W and MPOx = Control juice sample. M = mango, S = soursop, W = watermelon, P = pineapple, O = orange

suitable for spoilage organisms and agents to grow and multiply. Therefore, all juices are classified as highly perishable and cannot be preserved or stored at ambient conditions. In order to preserve these fruits and their juices, their moisture contents have to be reduced to the level that will make moisture unavailable for microbial growths.

The ash content of the mixed blend juice ranged from 0.14% in sample MSWa to 0.6% in sample MSWb. There was no significant difference ($p > 0.05$) in the ash content of the samples. The ash content of the sample was lower than the ash content of watermelon reported by [21], this could be attributed to varietal differences in the fruits.

The crude fiber content of the mixed blend juice ranged from 0.95% in sample MPOx to 2.94% in sample MSWb. The crude fiber content of the samples was significantly different ($p < 0.05$). It is evident from the result that as the proportion of mango juice in the blend increased the fiber content of the sample increased and vice versa.

The crude fat content of the mixed blend juice ranged from 0.19% in sample MPOx and MSWa to 0.44% in sample MSWa. The mean crude fat of the samples were significantly different at $p < 0.05$. Except samples MSWc and MPOx which had comparable ether extract, other samples differed significantly ($p < 0.05$) in ether extract content. Sample MSWa had the highest fat which could be due the composition of the fruit. The ash content of samples in the present study was lower than the value reported by [21], but compares with the value reported by [23], for the composition of soursop, watermelon and bush mango.

The samples showed significant difference ($p < 0.05$) in crude protein content. Sample MSWc had the lowest protein content (0.72%) while MPOx had the highest mean value of 1.72%. The protein content of sample MSWa with 60% soursop was second to the control sample. The variation in the protein contents could be attributed to the different types of fruits used, probably due to the variable nitrogen-containing compounds in the fruits. [23], reported the protein contents of soursop and watermelon to be 0.51% and 1.05%, respectively which is lower than the values observed in the present study.

The carbohydrate content of the samples was high. MPOx had the highest mean carbohydrate value but differs from MSWc and MSWd which showed the least mean carbohydrate value which did not differ ($p > 0.05$) from MSWa and MSWb. As the proportion of watermelon in the sample increased, the carbohydrate content decreased and vice versa. The carbohydrate content of watermelon (7.25%) reported by [23], was similar to the values observed in the present study but his value for soursop (16%) was higher than the values for soursop in the present study.

The proximate composition of the samples compares with the values reported by [21] for watermelon. However, [24] noted that fruit juices do not constitute a significant source of such nutritional components as protein, fat and calories.

3.2 Physico-Chemical Properties of Mixed Fruit Juice Blends

Table 4 shows that there were significant ($p < 0.05$) differences in the pH of the juice samples. Samples MSWa and MSWb showed comparable pH values that differed from the pH values of MSWc and MPOx. The high pH levels of the juice blend disagree with the pH range (3 - 5) of fruit and vegetable juices reported by [25]. pH plays a dual role in fruit juice by acting as a flavor promoter and preservative. The high pH level may not ensure good storage stability.

The Brix level of the juice samples varied significantly ($p < 0.05$). MSWc and MSWa were similar with values of 8.85^{O} and 9.01^{O}, respectively. The Brix level of sample MSWb, MSWd, and MSWx was above the minimum Brix level of fruit juices as stated by [26]. The Brix values were observed to increase with increase in the proportion of mango. The result could be as a result of the high mango juice in the blend.

The total solids of the samples did not differ significantly ($p > 0.05$). Sample MSWa showed the lowest total solid content which is significantly ($p < 0.05$) different from the total solid content of MPOx (12.92%) with the highest value. The high pulp content and thick consistency of mango in the blend may have contributed to the observed high total solid content of sample MSWd. The total solid content of the samples which ranged from 7.77 - 12.54% compares with the values (5.9 – 15. 7%) reported by [27], for Roselle-mango juice blends.

The titratable acidity of MPOx was the highest and this could be as a result of high concentration of ascorbic acid in the sample. This was followed by sample MSWd, this could be due to the combination of different juices.

Table 4. Physico-chemical properties of mixed fruit juice blends

Sample	pH	°Brix	Total solids (%)	Reducing sugar (%)	Titrable acidity (%)	Density	Viscosity (Pa.s)	Sedimentation (5th day) (%)	Sedimentation (10th day) (%)	Vitamin C(g/100ml)
MSWa	6.06^{b} ±0.01	9.01^{a} ± 0.1	7.77^{a}± 1.18	3.9^{a} ±0.30	0.41^{b}±0.00	1.020^{c}±0.00	3.06^{d}±0.01	73.33^{c}±0.88	63.33^{c}±0.88	35.50^{b}±0.05
MSWb	6.07^{b} ± 0.01	10.90^{c} ± 0.10	9.39^{ab}±0.86	2.4^{a}± 0.60	0.43^{b}±0.01	1.014^{b}±0.00	8.51^{e}±0.01	72.00^{c}±0.00	69.00^{d}±0.57	41.75^{c}±2.25
MSWc	6.11^{c} ± 0.01	8.85^{a} ± 0.05	9.89^{ab}±0.79	4.5^{a}± 1.50	0.38^{a}±0.01	1.014^{b}±0.00	2.31^{b}±0.01	39.33^{b}±9.21	44.00^{b}±1.15	28.25^{a}±2.75
MSWd	6.08^{bc} ±0.01	10.05^{b}± 0.05	12.54^{bc} ±0.82	3.0^{a}± 0.00	0.42^{b}±0.00	1.004^{a}±0.00	2.39^{c}±0.01	68.67^{c}±0.88	64.33^{c}±1.20	38.05^{bc}±0.25
MPOx	5.92^{a} ± 0.01	12.80^{d}± 0.10	12.92^{c} ± 0.81	14.7^{b}±0.30	0.69^{c}±0.00	1.0367^{d}±0.00	0.53^{a}±0.00	20.67^{a}±2.23	17.33^{a}±1.76	75.45^{d}±0.15

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

Key: MSWa = 60% S, 25% M and 15% W, MSWb = 15% S, 60% M and 25% W; MSWc = 25% S, 15% M and 60% W; MSWd = 33.3% of M, S and W and MPOx = Control juice sample. M = mango, S = soursop, W = watermelon, P = pineapple, O = orange

Samples MSWa, MSWb, MSWc and MSWd showed comparable reducing sugar content that differed significantly ($p < 0.05$) from the reducing sugar content of MPOx (control). The control juice sample (MPOx) had the highest value of reducing sugar, followed by sample MSWc which contain the highest proportion of watermelon. The reducing sugar values (2.4 – 4.5%) observed in the present study is similar to the values (2.5 – 4.4%) reported by Beatrice et al. [27], for Roselle-mango juice blends.

There were significant ($p < 0.05$) differences in the density of samples except sample MSWb and MSWc that showed comparable density values. The density of the samples ranged from 1.004 to 1.036 and sample MPOx (control sample) had the highest density (1.036). Among the blends, sample MSWa had the highest density (1.020) while sample MSWd had the least (1.004). The hollowness and soluble solid contents of intact fruits is related to their specific and solid densities. The variation in the density and relative density of the fruits and their juices might have been influenced by the structure of polymers which will result in low density. This imply that the lower the density, the higher the flotation of the fruit samples on top of water and as a result may not be of a high quality and may in turn be rejected by consumers. Nwanekezi and Ukagu [28] found that density as an engineering property is used for quality assessment especially during separation of intact quality fruits and vegetables (damaged or rotten ones). Kato [29] reported that the quality of Water melon is related to its relative and solid densities.

All the samples showed significantly ($p < 0.05$) differing viscosities. The mean viscosity of MSWb was the highest (8.51) and this could be attributed to the pulpy and high consistency nature of mango juice which was highest in MSWb. Sample MPOx had the least viscosity due probably to the effect of clarification being a commercial juice sample. It was observed that the higher the proportion of mango in the blend, the higher the viscosity values of the blend. The viscosities of the samples may also have been affected by heat due to pasteurization. There may have been degradation of pectic polysaccharides during heating and this affects the structure of heat sensitive fruits [27].

Sedimentation was observed in all the blends from the 5th day of storage. From the first day to the fourth day, there was no observable sedimentation in all the blends. On the fifth day of storage at ambient conditions samples MSWa, MSWb and MSWd had sedimentation values of 73.3%, 72% and 68.67%, respectively which differed significantly ($p < 0.05$) from the sedimentation values of MSWc (39.33%) and MPOx (20.67%). The low sedimentation observed in the control sample may have been due to the presence of hydrocolloid normally added to commercial juices to check sedimentation. Sample MSWa had the highest sedimentation (73.3%). The observed reduction in sedimentation values was due to "packing effect'' influenced by gravity.

Sedimentation is as a result of insoluble material which tends to precipitate and lead to phase separation when beverages are allowed to stand. It was expected that sample MSWb with the highest viscosity should exhibit the least sedimentation value but the contrary was observed.

The vitamin C content of the blends differed significantly ($p < 0.05$). Sample MPOx had the highest vitamin C value (75.4 g/100 ml) among the juice blends, samples MSWb containing 60% Mango, 25% Watermelon and 15% Soursop showed the highest vitamin C content (41.75 g/100 ml) followed by MSWd, MSWa and MSWc with vitamin C content of 38.05 g/100 ml, 35.50 g/100 ml and 28.25 g/100 ml, respectively. The result indicates that the juice blends could be good Vitamin C source. The variation in the blend could be due to the thermal effect on the heat sensitive Vitamin C of the juice samples during pasteurization [30].

Vitamin C is an essential nutrient for humans because it aids in the synthesis of collagen in addition to protective oxidative damage. It has antioxidative properties required for the normal metabolic function of the human body. Its consumption is known to help against cancers, improve cholesterol and prevent disorder associated with lack of collagen in the body [31].

3.3 Micronutrient and Phytochemical Composition of the Mixed Fruit Juice Blend from Soursop, Mango and Watermelon

Table 5 shows the selected mineral and phytochemical constituents of the mixed fruit juice blend. The potassium content of the samples ranged from 108.32-188.92 mg/100 ml. All the samples had significantly ($p < 0.05$) different potassium content. Sample MSWa had

the highest potassium content (168.92 mg/100 ml) while sample MSWc had the least (108.32 mg/100 ml). The potassium observed in this study is in agreement with the values reported by [23] for soursop, watermelon and bush mango. [23] noted that potassium is the most abundant mineral found in fruits. Potassium is a component of cell and body fluids that helps to control heart rate and blood pressure.

Calcium content of the samples ranged from 7.05 mg/100 ml in sample MSWc to 12.69 mg/100 ml. There was no significant ($p > 0.05$) difference in the calcium content of the blends except sample MSWc. Sample MSWc was significantly ($p < 0.05$) different from samples MSWa, MSWb and MSWd. Sample MSWd had the highest calcium content (12.69 mg/100 ml) while sample MSWc had the least (7.05 mg/100 ml). Ekpete et al. [23] reported that the calcium content of watermelon and banana fruits were 7.00 mg/100 ml and 7.24 mg/100 ml, respectively.

There was a significant ($p < 0.05$) difference in the mean value of flavonoid in the sample. Sample MSWc and MSWd had similar mean value which differed significantly ($p < 0.05$) from the flavonoid content of MSWa (10.08%), MSWb (11.04%) and MSWd (9.14%).

The flavonoid in sample MPOx (control) was higher than that in the prepared samples. MPOx had the highest flavonoid content (12.73%) that differed significantly ($p < 0.05$) from other blends. MSWb containing 60% mango, 25% watermelon and 15% soursop, had the highest flavonoid content (11.04). Flavonoid has been associated with protection against colon, breast, leukemia and prostate cancers [3]. This group of phytochemicals also inhibits inflammation and tumor growth, and boosts the production of detoxifying enzyme in the body. The best described property of almost every group of flavonoids is their capacity to act as antioxidant [32].

There is a significant ($p < 0.05$) difference in the total phenol content of the juice samples. Samples MSWa, MSWb and MSWd showed similar total phenol content that differed from that in sample MSWc and MSWx. As the proportion of mango increased in the sample blend the total phenol content increased. The polyphenol content of the samples was generally low. This could be attributed to the exclusion of the fruit peels which is a good source of high-quality pectin and polyphenols [33]. Differences in cultivars and genetic variation may have caused the disparity observed in these results relative to the findings of other workers [34]. Phenol has been associated with prevention of inflammation, antioxidant effect and prevention of cancer formation by reducing oxidative damage to cells that spark cancer [3].

Samples MSWc had the highest content (72.9 iu) of β-carotene among the blends. MSWc containing 60% watermelon, 25% soursop and 15% mango. This blend contains the highest proportion of watermelon and this suggests that watermelon may be a good source of β-carotene. β-carotene is known to fight against cancer and cardiovascular diseases. It inhibits cancer cell growth, work as antioxidants and improve immune response [35]. It works by anti-oxidative activity elicited either through direct free radical absorption or through induction of anti-oxidative enzyme via a variety of molecular mechanisms [36].

3.4 Microbial count (Cfu/g) of the formulated Mixed Fruit Juice Blend

The total viable count of the fruit juice samples was below the maximum allowable limit (10^3/ml of Cfu/g) total viable count by [37]. This result suggests the effectiveness of the sterilization and pasteurization steps adopted in the processing on the bottle and juice blend, respectively in reducing the microbial load of the sample and packaging container.

Table 5. Micronutrient and phytochemical content of the mixed fruit juice blend

Samples	Flavonoids (%)	Total Phenol (%)	Pro-vitamin A(β-carotene)mg/100 ml	Potassium (mg/100 ml)	Calcium (mg/100 ml)
MSWa	$10.08^{b} \pm 0.22$	$0.3^{ab} \pm 0.1$	$31.2^{d} \pm 0.1$	$168.92^{e} \pm 0.05$	$10.77^{ab} \pm 0.04$
MSWb	$11.04^{c} \pm 0.08$	$0.4^{ab} \pm 0.1$	$13.01^{b} \pm 2.61$	$120.34^{c} \pm 0.20$	$7.69^{a} \pm 0.02$
MSWc	$9.21^{a} \pm 0.09$	$0.5^{b} \pm 0.1$	$72. 9^{e} \pm 0.0$	$108.32^{a} \pm 0.05$	$7.05^{a} \pm 0.05$
MSWd	$9.14^{a} \pm 0.13$	$0.4^{ab} \pm 0.0$	$20.80^{c} \pm 0.0$	$112.73^{b} \pm 0.05$	$12.69^{b} \pm 0.02$
MPOx	$12.73^{d} \pm 0.45$	$0.2^{a} \pm 0.00$	$5.21^{a} \pm 7.0$	$126.59^{d} \pm 0.02$	$7.59^{a} \pm 0.01$

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

Key: MSWa = 60% S, 25% M and 15% W, MSWb = 15% S, 60% M and 25% W; MSWc = 25% S, 15% M and 60% W; MSWd = 33.3% of M, S and W and MPOx = Control juice sample. M = mango, S = soursop, W = watermelon, P = pineapple, O = orange

Table 6. Total viable count of mixed fruit juice blend

Sample	Total viable count (Cfu/ml)
MSWa	7×10^1
MSWb	5×10^1
MSWc	8×10^1
MSWd	9×10^1
MPOx	3×10^1

Key: MSWa = 60% S, 25% M and 15% W, MSWb = 15% S, 60% M and 25% W; MSWc = 25% S, 15% M and 60% W; MSWd = 33.3% of M, S and W and MPO = Control juice sample. M = mango, S = soursop, W = watermelon, P = pineapple, O = orange

3.5 Sensory Qualities of the Mixed Fruit Juice Blend

Table 7 shows the sensory scores of the mixed fruit juice blends from soursop, mango and watermelon. There was no significant ($p > 0.05$) difference in color of the samples with mean scores ranging from 6.45 to 6.75. Samples MSWb and MSWd containing the highest (60%) and equal proportion of mango juice among the blend were equally most preferred while MPOx was least preferred in terms of color. This preference could be due to the bright color of mango juice which [38], noted that it affects consumer acceptability of juice product.

There was no significant ($p > 0.05$) difference in the appearance of the juice samples with mean values ranging from 6.20 to 6.60. The appearance of MSWb with 6.60 mean score was most preferred while MSWd with mean score of 6.20 was least preferred.

The flavor of the samples also showed no significant ($p > 0.05$) difference. The flavor mean score ranged from 4.75 to 7.25. The flavor of the control juice (MPOx) was most preferred. Among the prepared blends, the flavor of MSWb (5.45) was most preferred while that of MSWc (5.15) was least preferred. This preference could be due to luscious flavor of mango juice because MSWb contain the highest (60%) proportion of mango juice.

Significant ($p < 0.05$) differences were observed in the taste of the samples with mean taste score range of 4.75 to 7.3. Samples MSWa, MSWb, MSWc and MSWd showed comparable mean taste score which significantly ($p < 0.05$) differed from the taste score of MPOx. Among the prepared blends, the taste of MSWd was most preferred while MSWc was least preferred.

There was a significant ($p > 0.05$) difference in the mouthfeel of the juice blend. The mean mouthfeel score ranged from 5.15 to 7.10. The mouthfeel of the control sample (MPOx) was 7.05 and it was most preferred than other sample blends. Among the prepared blends sample MSWa had the highest preference with a mean score of 5. 58, while MSWb with a mean score of 5.15 was least preferred.

There was no significant ($p > 0.05$) difference in the homogeneity of the samples with a range of mean values from 5.8 to 7.05. The homogeneity of the control was most preferred. Among the blends, sample MSWd showed the highest homogeneity score of 6.50 and was most preferred while that of MSWc was lowest (5.80) and was least preferred. The homogeneity of the blends had a relationship with the sedimentation observed in the juice blends during storage. Sample MSWc with the least sedimentation value (44.00%) was least homogeneous. In other words, the more homogeneous the blend is the less its tendency to sediment.

The overall acceptability of the juice samples shows that there was a significant ($p < 0.05$) difference in the overall acceptability of the samples. The mean score ranged from 5.60 to

Table 7. Mean sensory scores of the mixed fruit juice blend from soursop, mango and watermelon

Sample	Color	Appearance	Flavor	Taste	Mouthfeel	Homogeneity	Overall acceptability
MSWa	$6.60^a \pm 0.35$	$6.45^a \pm 0.33$	$4.70^a \pm 0.48$	$5.45^a \pm 0.42$	$5.80^a \pm 0.42$	$6.25^a \pm 0.31$	$5.95^{ab} \pm 0.34$
MSWb	$6.75^a \pm 0.39$	$6.60^a \pm 0.34$	$5.45^a \pm 0.43$	$5.50^a \pm 0.53$	$5.15^a \pm 0.45$	$6.40^a \pm 0.45$	$5.60^a \pm 0/54$
MSWc	$6.5^a \pm 0.41$	$6.35^a \pm 0.41$	$5.15^a \pm 0.39$	$4.95^{a\pm} 0.41$	$5.55^a \pm 0.48$	$5.80^a \pm 0.45$	$5.70^a \pm 0.38$
MSWd	$6.75^a \pm 0.35$	$6.20^a \pm 0.34$	$5.25^a \pm 0.53$	$5.6^a \pm 0.44$	$5.60^a \pm 0.44$	$6.50^a \pm 0.44$	$6.05^{ab} \pm 0.48$
MPOx	$6.45^a \pm 0.43$	$6.45^a \pm 0.42$	$7.25^a \pm 0.33$	$7.30^b \pm 0.35$	$7.10^b \pm 0.34$	$7.05^a \pm 0.36$	$7.20^b \pm 0.34$

Values are means of 20 determinations ± standard error. Means with different superscript in the same column are significantly ($p < 0.05$) different

Key: MSWa = 60% S, 25% M and 15% W, MSWb = 15% S, 60% M and 25% W; MSWc = 25% S, 15% M and 60% W; MSWd = 33.3% of M, S and W and MPOx = Control juice sample. M = mango, S = soursop, W = watermelon, P = pineapple, O = orange

7.20. Samples MSWa and MSWd, MSWb and MSWc had comparable overall acceptability mean scores that differed significantly ($p < 0.05$) from the score of sample MPOx (7.20). Among the processed blends MSWd was most accepted while MSWb was least accepted by the panelists.

4. CONCLUSION AND RECOMMENDATIONS

From this study, blending of soursop, mango and watermelon juices in varying proportions produced acceptable juice that compared favorably with a commercial mixed juice blend in terms of vitamins C and pro-vitamin A content, total sugar, brix content and acidity.

MSWb had the highest composition of crude fiber, total ash and carbohydrate. MSWa showed high content of fat and crude protein while MSWc had the highest moisture content. From the results obtained, MSWb is rich in Flavonoids known to regulate cellular activity and fight off free radicals that cause oxidative stress and vitamin C, essential for growth and repair of tissue. MSWc is rich in total phenol and β-carotene, MSWd is a good source of calcium for maintaining strong bones and maximal nerve function while MSWa is rich in potassium which is essential for regulating blood pressure.

MSWb had the highest Brix, titrable acidity, viscosity and sedimentation values and high sedimentation index implies that the juice will be less stable to separation of the component during storage at ambient temperature. Sample MSWd which had equal proportions of the individual juices had the highest overall acceptability due to the homogeneity, luscious taste, appearance and consistency of the blend.

The study promises a solution for the seasonality, perishability and regional nature of fruits and the possibility for added value and expansion of varieties. There is also a way forward for the utilization of underutilized soursop fruits to avoid losses and conserve the nutritional qualities in stable products. Increased production means enhanced consumption and hence, prevention of chronic diseases.

There were challenges in procurement of fruits and storage till needed for processing and unsuitability of some varieties for processing, further studies on the most suitable variety for processing should be carried out. Due to high sedimentation index of some blends, further studies on the use of edible stabilizers to improve the juice stability and homogeneity should be carried out. It is also recommended that shelf stability and the best packaging materials for increased stability be studied.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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