



Original scientific paper

DOI: 10.17508/CJFST.2020.12.1.07

Physicochemical, microbiological and sensory quality of juice mix produced from watermelon fruit pulp and baobab fruit pulp powder

ISRAEL OKPUNYI ACHAM^{1*}, MIKE OJOTU EKE^{1,2}, JOSEPH EDAH²

¹Benue State University, Faculty of Science, Centre for Food Technology and Research, PMB 102119, Makurdi, Benue State, Nigeria

²University of Agriculture, College of Food Technology and Human Ecology, Department of Food Science and Technology, PMB 2373, Makurdi, Benue State, Nigeria

ARTICLE INFO

Article history:

Received: April 23, 2019

Accepted: December 4, 2019

Keywords:

baobab fruit pulp powder
mineral elements
physicochemical
sensory characteristics
watermelon fruit pulp juice

ABSTRACT

Juice blending is one of the methods that can improve the nutritional quality of juices. The aim of this study was to evaluate the quality of juice product produced from blends of watermelon fruit pulp juice and baobab fruit pulp powder. This study was also aimed at promoting the use of underutilized African baobab and leverage on the benefits that can be derived from blending these two wonderful plant resources. Four blend ratios and codes of 100:0 (W₁₀₀), 80:20 (W₈₀B₂₀), 60:40 (W₆₀B₄₀) and 50:50 (W₅₀B₅₀) were developed for watermelon fruit pulp juice and baobab fruit pulp powder, respectively. The physicochemical attributes, mineral composition, microbiological and sensory attributes of the samples were analyzed using standard methods. The increase in baobab fruit pulp powder concentration in watermelon fruit pulp juice increased the titratable acidity (0.24 to 0.48 %), total sugar content (6.0 to 7.85 °Brix), total solid (1.30 to 1.37 %), viscosity (473.67 to 730.30 cP), Vitamin C (126.25 to 236.70 mg/100 mL), Vitamin A (18.67 to 80.33 mg/100 mL), calcium (1.97 to 3.46 %), potassium (1.09 to 2.07 %) and iron (3.10 to 4.43 ppm) contents, while decreasing the pH (5.19 to 4.08), total viable count (4.0×10^4 to 2.0×10^2 cfu/mL), yeast and mould count (3.2×10^4 to 0.0×10^0 cfu/mL) as well as sensory attributes whose values ranged from 3.80 to 7.60 on a 9-point hedonic scale. Therefore, blending watermelon fruit pulp juice and baobab fruit pulp powder has the ability to enhance the physicochemical, micronutrient content, microbiological and sensory characteristics of the samples.

Introduction

Fruits are highly perishable, non-staple foods which make-up about 39% of the food intake (fresh state or processed form) of people living in developing countries of Africa (Akusu et al., 2016). Fruits and its juices constitute one of the most important foods for man and their regular consumption maintains health and makes up for the losses in the human diet (Okwori et al., 2017). Consuming fresh juices is increasing all over the world due to their freshness, high vitamin content, low caloric consumption and ability to reduce risk of many diseases (Rathnayaka, 2013), such as diabetes, heart diseases and cancer. Fruit juice contains antioxidants, vitamins and minerals that are

essential for human beings (Aneja et al., 2014). Watermelon originated in Africa and has been in cultivation for more than 4, 000 years in the drier parts of the continent and throughout India and parts of Asia (Alam et al., 2013). Watermelon (*Citrullus lanatus*) is a popular staple summer fruit consumed frequently as a dessert, fruit salad and used in garnishing drinks (Ijah et al., 2015). In Nigeria, it is mostly cultivated in commercial quantities in the northern part of the country. Watermelon fruit is considered as a rich source of vitamins A, B, C and E and minerals K, mg, Ca and Fe and antioxidants, e.g. phenolics and carotenoids (Abu-Hiamed, 2017). It contains large amounts of beta carotene, which are significant sources of lycopene (Ogodo et al., 2015). It can

*Corresponding author E-mail: israelokpunyiam@gmail.com

be viewed as a more nutritious alternative to having energy drinks or supplements prior to exercise (Alam et al., 2013). The fruit pulp serves as a thirst-quencher due to its high (92%) water content (Egbonu, 2015).

The Baobab (*Adansonia digitata*) is also known as the “upside down tree” (Aluko et al., 2016). Other common names for Africa baobab include; *Monkey bread tree*, *Ethiopian sour gourd*, *Cream of tartar tree* and *Senegal calabash* (fruit). In Nigeria, the Hausas and Fulanis in the northern part call it “*Kouka* or *Kuka*” and “*Boki* or *Bokki*”, respectively. The baobab fruit is used in the day-to-day diet of rural societies in Africa (Aluko et al., 2016). It was reported that baobab is a nutrient rich fruit which has ascorbic acid, riboflavin, niacin, pectin and citric, malic and succinic acids, while the oil also comprises the vitamins D, E and A (Besco et al., 2007; Donkor et al., 2014). The fruit pulp is high in vitamin C, calcium, phosphorus, carbohydrates, fibers, potassium, proteins and lipids content, which can be used in seasoning as an appetizer and making juices (Rahul et al., 2015). The pulp of *A. digitata* is also rich in dietary fibers (Cissé et al., 2013). The soluble fibers of baobab fruit pulp are prebiotics, non-digestible food components that beneficially affect the host by selectively stimulating the growth and/or activity of beneficial microflora, hence supporting probiotics (Aluko et al., 2016). The European Union (EU) commission allowed dried baobab fruit pulp as a novel food ingredient under Regulation (EC) No 258/97 of the European Parliament and of the Council (Parkouda et al., 2011).

Juice formulation is one of the methods that could be used to improve the nutritional quality of the juice (Hussein et al., 2017). Juice blends can also serve as an appetizer, aside acting as a nutrient enhancer. Watermelon juice and baobab fruit pulp powder contain dense nutrients that are capable of imparting tremendous health benefits on consumers. In Nigeria, watermelon juice drinks are not common and commercially available packaged watermelon juice drinks are virtually unknown. Unfortunately, an African baobab as a plant resource is still very much

underutilized. To the best of our knowledge, no research has been carried out to evaluate the blending of watermelon fruit pulp and baobab fruit pulp powder to produce an acceptable juice blend. Blending of these plant resources is quite significant in a number of ways: it will improve the vitamin and mineral contents, promote better sensory quality, create variety in the fruit juice market, promote the use of underutilized plant resources and help in curbing the incidence of postharvest food losses in Nigeria.

Materials and methods

Raw materials and preparation

Fresh and mature watermelon (*Citrullus lanatus*), the African baobab (*Adansonia digitata*) and packaging materials were purchased from the Railway, Wadata and Modern Markets, respectively, all in Benue State, North-Central Nigeria.

Watermelon was washed severally with distilled water to remove dirt and reduce microbial load and the flesh was separated into different bowl using a stainless steel knife, while the cleaned fork was used to remove the seeds. The flesh was blended with the aid of an electric blender (Model FP691 Series) and then homogenized in a blender and the juice was filtered with the use of ready-made double muslin cloth. They were packaged immediately and stored in airtight screw cap sterilized plastic containers prior to evaluation (Modified method of Okwori et al., 2017). Whole baobab fruits were weighed, and their hard woody shells were carefully crushed and the pulp was separated from the seeds, grounded using the pestle and mortar to separate the pulp from the seeds. The mixture was sieved using a 0.09 micron sieve to obtain a fine powder. The powder was weighed and instantly packed into polyethylene bags sealed and stored in a cool dry place (15 °C -30 °C) (modified method of Aluko et al., 2016).

Table 1. Blend formulations of watermelon fruit pulp juice and baobab fruit pulp powder

Sample	Watermelon fruit pulp juice (%)	Baobab fruit pulp powder (%)
W ₁₀₀	100	0
W ₈₀ B ₂₀	80	20
W ₆₀ B ₄₀	60	60
W ₅₀ B ₅₀	50	50

W₁₀₀ (control) = 100% Watermelon fruit pulp juice: 0% Baobab fruit pulp powder; W₈₀B₂₀= 80% Watermelon fruit pulp juice: 20% Baobab fruit pulp powder; W₆₀B₄₀= 60% Watermelon fruit pulp juice: 40% Baobab fruit pulp powder; W₅₀B₅₀= 50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder

Chemicals

All chemicals and equipment used were of analytical grade.

Physico-chemical analysis

Titrateable acidity (TTA)

The method of AOAC (2012) was used. Briefly, 10 mL of the juice was pipetted into a conical flask and 25 mL of distilled water added. 200 mL of 0.1 M NaOH was poured into a burette and was titrated against the sample in the flask using three drops of phenolphthalein as indicator. It was titrated until a pink colouration was observed and the corresponding burette reading taken using the following formula: titrateable acidity (%) = (Titre × blank × normality of base × mL equivalent of citric acid) / Weight of sample (1).

mL equivalent of citric acid (meq) = 0.06404

pH

The pH of the juice sample was determined using a digital pH meter (pHs-2F, Harris, England) according to AOAC (2012) method. 50 mL of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. Sufficient time was allowed for equilibration before readings were taken.

Total sugar content (°Brix)

Total Sugar Content (°Brix) was determined using Abbe refractometer. The prism of the refractometer was cleaned and a drop of the juice was placed on the prism and closed. The total sugar content (°Brix) was read off the scale of the refractometer when held close to the eye according to the method of AOAC (2012).

Total solid

The total solid content of the juice samples was determined using the air oven method (Akusu et al., 2016). Aluminium dishes were washed, dried in the oven for 10 min and kept in the desiccator to cool. Afterwards, their weights were taken. 3 mL of the juice samples were weighed into the dishes and weight of the dish and the samples were taken. The dishes were placed in the oven for 1 h at 105 °C. The dishes were removed after cooling. The total solid content was calculated.

Viscosity

The previous method of AOAC (2005) was used. The viscosity of the juice sample was evaluated using a Brookfield Viscometer (model LV-3) with spindle number at 60 rpm. Viscosity was determined in centipoises (cP) unit.

Vitamin C

The ascorbic acid (vitamin C) content was estimated through the use of indophenols method (AOAC, 2005). 50 mL of the juice was pipetted into a 100 mL volumetric flask and 25 mL of 20% metaphosphoric acid was added as a stabilizing agent. About 10 mL of the solution was then pipetted into a conical flask and 2.5 mL of acetone was added and titrated with indophenols solution (2, 6- dichlorophenolindophenol), until a faint pink colour persists for 15 seconds. The Vitamin C content in the juice sample was calculated as mg/100 mL. S.I Unit was given as 50 µg ascorbic acid.

Vitamin C was calculated as = $\frac{\text{Dye concentration} \times \text{titre value} \times 100}{\text{vol. of sample}}$

Vitamin A

Reversed phase High Performance Liquid Chromatography (HPLC) was used for the estimation of provitamin A content in the juice samples (Ijah et al., 2015). Homogenized juice of 120 µL was extracted with 500 µL of hexane. The mixture was vigorously shaken on an electronic shaker for 4 min, centrifuged for 2 min at 10,000 rpm and the supernatant pooled. The extraction process was repeated. The pooled supernatant was evaporated to dryness under nitrogen gas and redissolved in 120 µL mobile phase (1% tetrahydrofuran in methanol). The resulting aliquot (120 µL) was then injected into the HPLC (C-R6A Chromatopaa, Shimadzu Cooperation, Japan) column with ultraviolet detection (UV-VIS) spectrophotometric detector, Shimadzu, Japan at 450 nm. A standard was prepared and chromatographed. Areas corresponding to the standard retention time were identified and used in the estimation of vitamin A content in the beverages samples.

Mineral composition

Potassium (K) was determined by flame photometry, while calcium (Ca) and iron (Fe) determinations were done using the Atomic Absorption Spectrophotometer (AAS Model 707, 11TA) (Akubor, 2017).

Microbiological analysis

Total bacterial, yeast and mold counts were determined using the pour plate method as outlined by Adegoke (2000). 1 mL of the samples was transferred to each test tube containing 10 mL of distilled water. Serial dilutions were made by transferring 1 mL of the first dilution into another test tube containing 9 mL of distilled water. This was repeated up to six times (10^{-6}). From each dilution, 1 mL was transferred to the Petri dish in duplicate. About 15 mL of the molten Nutrient agar at 45 °C was poured in each of the Petri dishes. The plates were allowed to set, then inverted and incubated at 30 ± 2 °C. For yeast and mold growth, potato dextrose agar with 10% tartaric acid was used. The microbial loads were calculated as number of colonies multiplied by dilution factor and were reported as colony forming unit per mL (cfu/ mL).

Sensory evaluation

The formulated watermelon fruit pulp juice and baobab fruit pulp powder blends were evaluated for appearance, flavour, texture, taste and overall acceptability by a 30-member panel comprising male and female subjects who were undergraduate students. The assessment was conducted under fluorescent illumination inside isolated booths within Sensory evaluation laboratory of the Department of Food Science and Technology, University of Agriculture, Makurdi, North-Central Nigeria. A 9-point hedonic scale (where 9 = like extremely and 1 = dislike extremely) was used for the assessment (Akeem et al., 2018). The panelists were given a questionnaire. The order of presentation of samples to the panel was randomized. Tap water was provided for each panelist to rinse their mouth between evaluations.

Statistical Analysis

The data obtained were subjected to Analysis of Variance (ANOVA) and Duncan Multiple range test was used to separate means where significant differences existed and data analyses were achieved using the Statistical Package for Social Statistics (SPSS) software version 20.0.

Results and discussion

Physico-chemical analysis

The results of the physico-chemical properties of the formulated watermelon fruit pulp juice and baobab fruit pulp powder blends are presented in Table 2. There was an increase in the TTA with increasing incorporation of the baobab fruit pulp powder to the juice with W_{100}

(0.24 %) and $W_{50B_{50}}$ (0.48 %) showing the least and highest values, respectively. Significant difference was observed in all the samples studied. Titratable acidity is a measure of the predominant acid present in the juice of fruits. Food acids dictate the dominant microflora in foods and to a large extent will determine the shelf stability of the juice; the more acidic the juice, the less susceptible to bacterial action (Ndife et al., 2013). The pH decreased with increasing levels of the baobab fruit pulp powder with W_{100} (5.19) and $W_{50B_{50}}$ (4.08) showing the highest and least values respectively. This falls within the range of 3 – 5 for fruit and vegetable juices (Akusu et al., 2016; Owolade et al., 2017). This result is also in agreement with those obtained by Ijah et al. (2015) who reported the pH values of water melon juice and water melon/orange juice mix to range from 5.1-5.3 and 4.3-4.4, respectively. Other reports from several researches conducted revealed fruit juices with different pH values as well. The pH range for cocktail juices was reported to be 4.82 – 4.99 (Adubofuor et al., 2010), 3.23 – 4.08 for different brands of orange juices was observed (Ndife et al., 2013), 4.36 – 4.41 for spiced cucumber and pineapple drinks were determined (Babajide et al., 2013), 4.1 for fresh cashew apple juice was reported (Emelike & Eber, 2015a) and pineapple has been revealed to contain a pH range of 3.7 – 4.5 (Frazier & Westhof, 1995). The pH value gives a measure of the acidity or alkalinity of the juice samples. Fruit juices have a low pH because they are comparatively rich in organic acid (Tasnim et al., 2010). The observed decreasing trend seen in the pH in the samples was attributable to the increase in titratable acidity which had an influence on the organoleptic quality of the juice samples. Quite a number of researchers have reported an inverse correlation that exists between acidity and the pH (Islam et al., 2015; George & Moiloa, 2015; Jan & Masih, 2012). This implies that the higher the pH, the lower will be the acidity and the lower the pH, the higher will be the acidity. The total sugar content increased from 6.0 °Brix in the control sample (W_{100}) to 7.85 °Brix in the sample blend, $W_{50B_{50}}$ with increasing levels of the baobab fruit pulp powder. Akusu & Emelike (2018) reported the total sugar content in watermelon and pineapple blends to be 4.50 – 5.00 % and 6.90 – 7.70 %, respectively. These are quite similar to results obtained in the current study. It may be suggested that the increase in the sugar present may be ascribed to the amount of sugar present in the watermelon fruit pulp juice and baobab fruit pulp powder. Brix is a measure of the total soluble solids contained in a juice. Soluble solids content is one of the most important quality parameters in fruit processing (Akubor, 2017). The total reducing and non-reducing sugars could be used for masking the astringency derived from organic acids

(Ndife et al., 2013). The values for total solid ranged from 1.30% for sample W₁₀₀ (Control sample) to 1.37% for sample W₅₀B₅₀ (50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder). There was significant difference between samples, W₁₀₀ (Control) and W₈₀B₂₀, except for W₆₀B₄₀ and W₅₀B₅₀ samples. The total (soluble and non-soluble) solids are used as indicators of the fruit juice content (Ndife et al., 2013). The total solids and juice content are used in characterizing the quality of juice and other beverage products (Ndife et al., 2013). The viscosity of all the studied juice blends ranged between 473.67- 730.30 cP with samples, W₁₀₀ and W₅₀B₅₀ showing a significant variation, except for W₈₀B₂₀ and W₆₀B₄₀ samples. It is a property that describes the resistance of the fluid to flow. The values obtained were higher than those reported by Hussein et al. (2017) who observed the viscosity of their juice product to be between 210-300 cP. It may be suggested that the observed high viscosity values reported in this study could be the result of the addition of the baobab fruit pulp powder to the watermelon fruit pulp juice. The Vitamin C contents of the formulated blends (172.05-236.70 mg/100 mL) were higher than the control (126.25 mg/100 mL). This may be attributed to the natural rich reserve of ascorbic acid in the baobab fruit pulp powder. Pulp obtained from baobab fruit in different locations of Tanzania have been reported by Aluko et al. (2016) to have ascorbic acid contents of 231.57±140.41 mg/100g, 211.99±84.82 mg/100 g and 169.74±85.43 mg/100 g, respectively. Similar reports have also revealed high ascorbic acid contents of 300 mg/100 g (Gebauer et al., 2002) and 34-200 mg/100 g (Sidibe & Williams, 2002) in the pulp of the baobab fruit. The vitamin C content (126.25-236.70 mg/100 mL) obtained in this study is comparable to the research findings of Hussein et al. (2017) (19.50- 270 mg/100 g) for different juice blend formulations. The recommended daily intake (RDI) of

ascorbic acid is about 30 mg/day for adults and 17 mg/day for children (Othman et al., 2014). The rich repository of vitamin C in the formulated juice blends of watermelon fruit pulp juice and baobab fruit pulp powder should be able to address vitamin C related deficiency known as scurvy. Vitamin C is involved in protein metabolism, collagen synthesis and an important physiological antioxidant (Adedeji, 2017). All the formulated juice blends (W₈₀B₂₀- W₅₀B₅₀) showed a better vitamin A profile than the control, W₁₀₀ with significant difference observed among all the samples. Fruit juices are important in the delivery of body fluids and essential micronutrients such as vitamins, and the nutritional significance of food nutrients is related to their contribution to the Recommended Dietary Allowance (RDA) (Ijah et al., 2015).

Mineral composition

Some of the mineral composition of the formulated watermelon fruit pulp juice and baobab fruit pulp powder blends are presented in Table 3. The mineral content increased with the increase in the proportion of the baobab fruit pulp powder. This may be due to the fact that the raw baobab fruit pulp is highly rich in minerals Sidibé et al. (1996). The samples contained between 1.97-3.46% calcium with the samples showing significant variation among one another. Calcium is helpful in the formation of strong bones and teeth, preventing osteoporosis and osteomalacia (Akubor, 2017). All the formulated blends (W₈₀B₂₀-W₅₀B₅₀) had higher potassium content than the Control, W₁₀₀. Samples, W₆₀B₄₀ and W₅₀B₅₀ do not differ significantly, except for W₁₀₀ and W₈₀B₂₀ samples. Potassium is useful in the prevention of hypertension (Akubor, 2017).

Table 2. Physico-chemical properties of the formulated watermelon fruit pulp juice-baobab fruit pulp powder blends

Parameter	Sample			
	W ₁₀₀	W ₈₀ B ₂₀	W ₆₀ B ₄₀	W ₅₀ B ₅₀
TTA (%)	0.24±0.01 ^d	0.39±0.01 ^c	0.42±0.01 ^b	0.48±0.00 ^a
pH	5.19±0.01 ^a	4.25±0.01 ^b	4.18±0.01 ^c	4.08±0.02 ^d
°Brix	6.0±0.07 ^d	7.48±0.03 ^c	7.69±0.03 ^b	7.5±0.01 ^a
Total solid (%)	1.30±0.00 ^c	1.32±0.00 ^b	1.36±0.00 ^a	1.37±0.00 ^a
Viscosity (cP)	473.67±0.50 ^c	532.63± 0.60 ^b	546.67±0.33 ^b	730.30±0.36 ^a
Vitamin C (mg/100 mL)	126.25±0.25 ^d	172.05±0.05 ^c	186.65±0.15 ^b	236.70±0.10 ^a
Vitamin A (mg/100 mL)	18.67±0.6 ^d	55.33±0.54 ^c	57.23±0.0 ^b	80.33±0.6 ^a

Values are means of duplicate determinations. Means in the same column with different superscripts differ significantly (P<0.05).

W₁₀₀ (control) = 100% Watermelon fruit pulp juice: 0% Baobab fruit pulp powder, W₈₀B₂₀= 80% Watermelon fruit pulp juice: 20% Baobab fruit pulp powder, W₆₀B₄₀= 60% Watermelon fruit pulp juice: 40% Baobab fruit pulp powder, W₅₀B₅₀= 50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder, TTA= Titratable acidity

The study also revealed that the iron content in W₅₀B₅₀ was the highest among all the samples evaluated with the least being W₁₀₀ (Control). Iron is said to be important element in the diet of pregnant women, nursing mothers and infants to prevent anaemia (Olayinka and Etejere, 2018). Inadequate intake of micronutrients (minerals) has been associated with severe malnutrition, increased disease conditions and mental impairment ((Ijah et al., 2015).

Table 3. Some mineral composition of formulated watermelon fruit pulp juice-baobab fruit pulp powder blends

Parameter	Sample			
	W ₁₀₀	W ₈₀ B ₂₀	W ₆₀ B ₄₀	W ₅₀ B ₅₀
Calcium (%)	1.97±0.01 ^d	2.82±0.02 ^c	3.02±0.02 ^b	3.46±0.01 ^a
Potassium (%)	1.09±0.06 ^c	2.06±0.06 ^b	2.07±0.01 ^a	2.07±0.05 ^a
Iron(ppm)	3.10±0.01 ^c	3.75±0.01 ^b	3.79±0.06 ^b	4.43±0.01 ^a

Values are means of duplicate determinations. Means in the same column with different superscripts differ significantly (P<0.05). W₁₀₀ (control) = 100% Watermelon fruit pulp juice: 0% Baobab fruit pulp powder, W₈₀B₂₀= 80% Watermelon fruit pulp juice: 20% Baobab fruit pulp powder, W₆₀B₄₀= 60% Watermelon fruit pulp juice: 40% Baobab fruit pulp powder, W₅₀B₅₀= 50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder

Microbiological analysis

Microbial examinations are usually used as monitoring indices of food spoilage (Dauda et al., 2017). The results of the microbial analyses of the blends of watermelon fruit pulp juice and baobab fruit pulp powder are shown in Table 4. The results showed that the total viable count of 2.0×10^2 - 3.5×10^3 cfu/ mL for samples with the inclusion of baobab fruit pulp powder were lower than that of 4.0×10^4 cfu/ mL for the Control sample, W₁₀₀. Likewise, that of yeast and mould counts of 0.0×10^0 - 2.4×10^3 cfu/ mL for samples with the incorporation of baobab fruit pulp powder were lower than that of 3.2×10^4 cfu/ mL for the control. The results revealed that all the samples were microbiologically safe for human consumption, since the microbial loads do not exceed the acceptable limits of $>10^5$ recommended by the International Commission of Microbiology Specifications of Foods, ICMSF (2005).

Table 4. Microbiological analysis of formulated watermelon fruit pulp juice-baobab fruit pulp powder blends

Parameter	Sample			
	W ₁₀₀	W ₈₀ B ₂₀	W ₆₀ B ₄₀	W ₅₀ B ₅₀
TVC (cfu/ mL)	4.0×10^4	3.5×10^3	3.3×10^3	2.0×10^2
YMC (cfu/ mL)	3.2×10^4	2.4×10^3	2.1×10^2	0.0×10^0

Values are means of duplicate determinations. W₁₀₀ (control) = 100% Watermelon fruit pulp juice: 0% Baobab fruit pulp powder, W₈₀B₂₀= 80% Watermelon fruit pulp juice: 20% Baobab fruit pulp powder, W₆₀B₄₀= 60% Watermelon fruit pulp juice: 40% Baobab fruit pulp powder, W₅₀B₅₀= 50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder, TVC=Total Viable Count, YMC=Yeast and Mould Count

Sensory evaluation

The mean sensory scores of the mixed watermelon fruit pulp juice-baobab fruit pulp powder samples are presented in Table 5. There was no significant difference in all the sensory parameters evaluated among samples, W₁₀₀, W₈₀B₂₀ and W₆₀B₄₀. Generally, there was a decrease in the scores of each parameter with increasing levels of baobab fruit pulp powder. The appearance decreased from 7.53(control) to 4.33(W₅₀B₅₀). The other sensory attributes followed the same trend from 7.07 to 4.20 (for flavour), 7.60 to 4.07 (for texture), 7.00 to 3.80 (for taste) and 7.40 to 3.87 (for overall acceptability) on a 9-point hedonic scale, respectively. Sample W₅₀B₅₀ scored the least in taste, compared to the other samples. It could be suggested that this could be due to the relative sour and astringent taste that may be associated with the baobab fruit pulp powder.

Table 5. Sensory scores of formulated watermelon fruit pulp juice-baobab fruit pulp powder blends

Parameter	Sample			
	W ₁₀₀	W ₈₀ B ₂₀	W ₆₀ B ₄₀	W ₅₀ B ₅₀
Appearance	7.53 ^a	6.07 ^a	5.53 ^a	4.33 ^b
Flavour	7.07 ^a	5.60 ^a	5.27 ^a	4.20 ^{a,b}
Texture	7.60 ^a	6.07 ^a	5.27 ^a	4.07 ^b
Taste	7.00 ^a	5.53 ^a	4.67 ^a	3.80 ^b
Overall acceptability	7.40 ^a	5.80 ^a	5.00 ^a	3.87 ^b

Values are means of duplicate determinations. Means in the same column with different superscripts differ significantly (P<0.05).

W₁₀₀ (control) = 100% Watermelon fruit pulp juice: 0% Baobab fruit pulp powder; W₈₀B₂₀= 80% Watermelon fruit pulp juice: 20% Baobab fruit pulp powder; W₆₀B₄₀= 60% Watermelon fruit pulp juice: 40% Baobab fruit pulp powder; W₅₀B₅₀= 50% Watermelon fruit pulp juice: 50% Baobab fruit pulp powder

Conclusion

This work has revealed that it is possible to produce a juice product made from blends of watermelon fruit pulp juice and baobab fruit pulp powder. Blending watermelon fruit pulp juice and baobab fruit pulp powder has the ability to enhance the physicochemical and micronutrient content, microbiological and sensory characteristics of the product. Generally, the increase in baobab fruit pulp powder concentration increased the TTA, total sugar content, total solid, viscosity, Vitamin C, Vitamin A, calcium, potassium and iron contents, while decreasing the pH, total viable count, yeast and mould count as well as sensory attributes of appearance, flavour, texture, taste and overall acceptability. All the blend formulations were microbiologically safe, since they fell within the permissible limit required by the standard. Sensory evaluation showed that the most preferred blend formulation was W₈₀B₂₀ containing 80% watermelon

fruit pulp juice and 20% Baobab fruit pulp powder. However, in order to make the formulated juice product more acceptable to consumers, natural health friendly sweeteners should be added in the right amount. There is also a need to pasteurize and add preservatives, in order to guarantee a safer and longer shelf life of the formulated watermelon fruit pulp juice-baobab fruit pulp powder mix.

References

- Abu-Hiamed, H. A. (2017): Chemical composition, flavonoids and β -sitosterol contents of pulp and rind of watermelon (*Citrullus lanatus*) Fruit. *Pak. J. Nutr.* 16, 502-507. <https://doi.org/10.3923/pjn.2017.502.507>
- Adedeji, T. (2017): Development and quality evaluation of Jam from Watermelon (*Citrullus lanatus*) and Pawpaw (*Carica papaya*) juice. *Archive Food Nutr. Sci.* 1 (2), 063-071. <https://doi.org/10.29328/journal.afns.1001010>
- Adegoke, G. O. (2000): Understanding Food Microbiology, Nigeria: Shalon Prints.
- Adubofuor, J., Amankwah, E., Arthur, B., Appiah, F. (2010): Comparative study related to physico-chemical properties and sensory qualities of tomato juice and cocktail juice produced from oranges, tomatoes and carrots. *Afr. J. Food Sci.* 4 (7), 427-433.
- Akeem, S. A., Yerumoh, O., Leigh, O., Bamgbala, K., Okeke, G., Sokunbi, F., Olayiwola, I. (2018): Physicochemical properties, colour characteristics, and sensory evaluation of full-cream cow-coconut milk yoghurts. *Croat. J. Food Sci. Technol.* 10 (2), 226-233. <https://doi.org/10.17508/cjfst.2018.10.2.13>
- Akubor, P. (2017): Evaluation of the Quality of Juice Prepared from African Bush Mango (*Irvingia garbonensis* Var. *garbonensis*) Fruit Pulp. *Asian Res. J. Agric.* 6 (4), 1-9. <https://doi.org/10.9734/arja.2017/36476>
- Akusu, O., Emelike, N. (2018): Physicochemical and organoleptic properties of flavored vegetable milk drinks made from tiger nuts (*Cyperus esculentus*) and Coconuts (*Cocos nucifera*) milk blends. *Int. J. Food Sci. Nutr.* 3 (2), 05-11.
- Akusu, O. M., Kiin-Kabari, D. B., Ebere, C. O. (2016): Quality Characteristics of Orange/Pineapple Fruit Juice Blends. *Am. J. Food Sci. Technol.* 4 (2), 43-47. <https://doi.org/10.12691/ajfst-4-2-3>
- Alam, M., Hoque, M., Morshed, S., Akter, F., Sharmin, K. (2013): Evaluation of watermelon (*Citrullus lanatus*) juice preserved with chemical preservatives at refrigeration temperature. *J. Scient. Res.* 5, 407-414. <https://doi.org/10.3329/jsr.v5i2.12181>
- Aluko, A. E., Kinyuru, J., Chove, L. M., Kahenya, P., Owino, W. (2016): Nutritional Quality and Functional Properties of Baobab (*Adansonia digitata*) Pulp from Tanzania. *J. Food Res.* 5 (5), 23-31. <https://doi.org/10.5539/jfr.v5n5p23>
- Aneja, K. R., Dhiman, R., Aggarwal, N. K., Kumar, V., Kaur, M. (2014): Microbes associated with freshly prepared juices of citrus and carrots. *Int. J. Food Sci.* 2014, 1-7. <https://doi.org/10.1155/2014/408085>
- AOAC. (2005): Official Methods of Analysis. Association of Official Analytical Chemist (18th ed.). Washington DC., USA
- AOAC. (2012): Official Methods of Analysis. Association of Official Analytical Chemist (20th ed.). Washington D.C., USA
- Babajide, J., Olaluwoye, A., Shittu, T. T., Adebisi, M. (2013): Physicochemical properties and phytochemical components of spiced cucumber-pineapple fruit drink. *Nig. Food J.* 31 (1), 40-52. [https://doi.org/10.1016/s0189-7241\(15\)30055-2](https://doi.org/10.1016/s0189-7241(15)30055-2)
- Besco, E., Braccioli, E., Vertuani, S., Ziosi, P., Brazzo, F., Bruni, R., Sacchetti, G., Manfredini, S. (2007): The use of photochemiluminescence for the measurement of the integral antioxidant capacity of baobab products. *Food Chem.* 102 (4), 1352-1356. <https://doi.org/10.1016/j.foodchem.2006.05.067>
- Cissé, I., Montet, D., Reynes, M., Danthu, P., Yao, B., Boulanger, R. (2013): Biochemical and nutritional properties of baobab pulp from endemic species of Madagascar and the African mainland. *Afr. J. Agric. Res.* 8 (47), 6046-6054. <https://doi.org/10.5897/AJAR12.123>
- Dauda, A., Abiodun, O., Maiyaki, T., Kayode, R. (2017): Microbiological evaluation of watermelon juice treated with serendipity berry (*Dioscoreophyllum cumminsii*) extract. *Croat. J. Food Sci. Technol.* 9 (1), 19-24. <https://doi.org/10.17508/cjfst.2017.9.1.03>
- Donkor, A.-M., Addae, D., Kpoanu, J. E., Kankam, F., Boaudi, A. N., Abanya, E. Y. M. (2014): Antioxidant enrichment of baobab fruit pulp treated with oil extracted from the seeds. *Food Nutr Sci.* 5 (4), 328-333. <https://doi.org/10.4236/fns.2014.54039>
- Egbuonu, A. C. C. (2015): Comparative assessment of some mineral, amino acid and vitamin compositions of watermelon (*Citrullus lanatus*) rind and seed. *Asian J. Biochem.* 10 (5), 230-236. <https://doi.org/10.3923/ajb.2015.230.236>
- Emelike N.J.T., Ebere C.O (2015a): Effect of packaging materials, storage conditions on the vitamin C and pH value of cashew-apple (*Anacardium occidentale* L.) juice. *J. Food Nutr. Sci.* 3 (4), 160-165. <https://doi.org/10.11648/j.jfns.20150304.14>
- Frazier, W. C., & Westhof, f. D. C. (1995): Food Microbiology (4th ed.), New Delhi: McGraw Hill, pp. 384-396.
- Gebauer, J., El-Siddig, K., Ebert, G. (2002): Baobab (*Adansonia digitata* L.): a review on a multipurpose tree with promising future in the Sudan. *Gartenbauwissenschaft* 67 (4), 155-160.
- George, M. J., Moilola, L. V. (2015): Determination and comparison of physico-chemical properties of home-made juices in Lesotho and commercial juice available in the local markets. *Am. Chem. Sci. J.* 5 (3), 247-252. <https://doi.org/10.9734/acsj/2015/14943>
- Hussein, A., Hegazy, N., Kamil, M., Ola, S. (2017): Formulation and Evaluation of Some Healthy Natural Juice Blends. *Asian J. Sci. Res.* 10, 160-168. <https://doi.org/10.3923/ajsr.2017.160.168>
- ICMSF. (2005): International Commission of Microbiology Specifications of Foods in Microbial Ecology of Food Commodities. 2, 522-532.

- Ijah, U., Ayodele, H., Aransiola, S. (2015): Microbiological and some sensory attributes of water melon juice and watermelon-orange juice mix. *J. Food Resour. Sci.* 4 (3), 49-61. <https://doi.org/10.3923/jfrs.2015.49.61>
- Islam, M., Ahmad, I., Ahmed, S., Sarker, A. (2015): Biochemical composition and shelf life study of mixed fruit juice from orange & pineapple. *J. Environ. Sci. Nat. Resour.* 7 (1), 227-232. <https://doi.org/10.3329/jesnr.v7i1.22175>
- Jan, A., Masih, E. D. (2012): Development and quality evaluation of pineapple juice blend with carrot and orange juice. *Int. J. Sci. Res. Publications* 2 (8), 1-8.
- Ndife, J., Awogbenja, D., Zakari, U. (2013): Comparative evaluation of the nutritional and sensory quality of different brands of orange-juice in Nigerian market. *Afr. J. Food Sci.* 7 (12), 479-484. <https://doi.org/10.5897/ajfs2013.1060>
- Ogodo, A. C., Ugbogu, O. C., Ugbogu, A. E., Ezeonu, C. S. (2015): Production of mixed fruit (pawpaw, banana and watermelon) wine using *Saccharomyces cerevisiae* isolated from palm wine. *SpringerPlus* 4 (1), 683. <https://doi.org/10.1186/s40064-015-1475-8>
- Okwori, E., Onu, R. O., Adamu, M., Chindo, H., Dikko, H., Odunze, I. I., Baidu, A.L., Natala, C., Eze, P. (2017): Production and shelf life determination of fruit/vegetable juices using watermelon, cucumber, pineapple and carrot. *Afr. J. Food Sci. Technol.* 8 (3), 034-039. <https://doi.org/10.14303/ajfst.2017.015>
- Olayinka, B.U., Etejere, E.O. (2018): Proximate and Chemical Compositions of Watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai cv Red and Cucumber (*Cucumis sativus* L. cv Pipino). *Int. Food Res. J.* 25 (3), 1060-1066
- Othman, O. C., Fabian, C., Lugwisha, E. (2014): Post harvest physicochemical properties of soursop (*Annona muricata* L.) fruits of Coast region, Tanzania. *J. Food Nutr. Sci.* 2 (5), 220-226. <https://doi.org/10.11648/j.jfns.20140205.13>
- Owolade, S., Akinrinola, A., Popoola, F., Aderibigbe, O., Ademoyegun, O., Olabode, I. (2017): Study on physico-chemical properties, antioxidant activity and shelf stability of carrot (*Daucus carota*) and pineapple (*Ananas comosus*) juice blend. *Int. Food Res. J.* 24 (2).
- Parkouda, C., Sanou, H., Tougiani, A., Korbo, A., Nielsen, D. S., Tano-Debrah, K., Ræbild, A., Diawara, B., Jensen, J. S. (2012): Variability of Baobab (*Adansonia digitata* L.) fruits' physical characteristics and nutrient content in the West African Sahel. *Agroforest Syst.* 85 (3), 455-463. <https://doi.org/10.1007/s10457-011-9406-3>
- Rahul, J., Jain, M. K., Singh, S. P., Kamal, R. K., Naz, A., Gupta, A. K., Mrityunjay, S. K. (2015): *Adansonia digitata* L.(baobab): a review of traditional information and taxonomic description. *Asian Pac. J. Trop. Biomed.* 5 (1), 79-84. [https://doi.org/10.1016/s2221-1691\(15\)30174-x](https://doi.org/10.1016/s2221-1691(15)30174-x)
- Rathnayaka, R. (2013): Antibacterial effect of malic acid against *Listeria monocytogenes*, *Salmonella enteritidis* and *Escherichia coli* in Mango, Pineapple and Papaya juices. *Am. J. Food Technol.* 8 (1), 74-82. <https://doi.org/10.3923/ajft.2013.74.82>
- Sidibé, M., Scheuring, J., Tembely, D., Sidibé, M., Hofman, P., Frigg, M. (1996): Baobab-homegrown vitamin C for Africa. *Agroforestry Today* 8 (2), 13-15.
- Sidibe, M., Williams, J. T. (2002): Fruits for the future 4—Baobab—(*Adansonia digitata* L.) monograph: International Center for Underutilised Crops, Southampton.
- Tasnim, F., Hossain, M. A., Nusrath, S., Hossain, M. K., Lopa, D., Haque, K. (2010): Quality assessment of industrially processed fruit juices available in dhaka city, bangladesh. *Malays. J. Nutr.* 16 (3), 431-438