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PRODUCTION AND ACCEPTABILITY OF FRUITS ENHANCED ZOBO DRINK

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Abstract- The nutritional characteristics of enriched zobo drinks produced from the extract of *Hibiscus sabdariffa* mixed with juices of some selected fruits was studied. The physiochemical, mineral, nutritional and sensory properties of the zobo samples were investigated. The addition of fruits increased the protein content of the drink with the Iyeye zobo having the lowest protein content of 2.00%; Pineapple pepper fruit zobo had the highest value of fat 19.85%. The moisture content of the enriched zobo, increased significantly with the addition of different fruits. The pineapple zobo had the highest moisture content of 86.95%. The phytate and tannin contents in all the samples were found to be less than one per cent. (<1%). The Iyeye zobo had the highest amount of vitamin C (34.88mg/100g), while the lowest value was found in pineapple ginger zobo (29.28%). The pepper fruit zobo had the highest Vitamin A content (141IU). There were significant differences in aroma, taste, appearance, flavor, mouth feel, color and overall acceptability between the zobo samples (p<0.05), but the zobo with the mixture of all the fruits had the highest overall acceptability.

Keywords- Production, zobo drink, fruits enrichment, sensory acceptability

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Introduction

Zobo drink (Sorrel, zoborodo) is a non alcoholic local beverage made from different varieties of dried petals, acid-succulent calyces of the flower *Hibiscus sabdariffa* by boiling and filtration [1,2]. In Nigeria a wide variety of foods are prepared through indigenous technology from many plant Products. Beverages are food items that are quite different and distinct from other foods. They are liquid state but have lower food values relative to food products, beverages may be liquid or thin gruel preparations with high water content which supplies the body with water necessary to maintain health. Zobo is mostly consumed by low class people but it is gaining wide acceptance, being consumed by several millions of people from different socio-economic classes and background in the West Africa sub-region. In order to increase its acceptability, its nutritional value must be enhanced as well as its organoleptic properties and keeping quality. This will provide consumers with varieties of Zobo that is highly nutritive and which will also keep longer than the conventional Zobo.

Zobo has a sour (vinegar) taste, consumed in various parts of the country. It is a hot water Extract of *Hibiscus sabdariffa* which is consumed as beverage to quench thirst under heat in the tropics. Consumed majorly by low class citizens of the society, it is a beverage produce on small scale by traditional women at minimal cost as its ingredients are cheap and readily available. Zobo drink if well prepared and packaged will compete favorably with most of the imported non alcoholic beverages available in the country, considering the increasing acceptance, socio-economic potentials and ready source of protein and Vitamin C and other minerals [3].

Zobo is made using the following ingredients; Dry Zobo leaves, glove of garlic, ginger, Water, artificial flavors can also be used. Water is the most abundant constituent of Zobo this acts as the medium in which all other constituents are dissolved. Zobo, however highly nutritious with low cost of production contains Vitamins, natural carbohydrate, protein and Vitamin C and other antioxidants [4,5].

Despite these obvious advantages, the leap from locally marketed product to commercial product is still relatively improbable due to its poor shelf life, which would require very little inventory and storage time.This study sought to enhance the organoleptic and storage properties of Zobo by adding fruits; Hog Plum also known as iyeye (*Spondias mombin*), pineapple (*Ananas cosmous*) and pepper fruit (*Denettia tripetala*).

Materials and Methods

Zobo leaves were purchased from Sango market; the fruits were sourced from Ota surroundings.

The glasswares and some of the equipments were provided by the Food science and Technology and the Central Research Laboratories of Bells University of Technology, Ota.

Raw Materials Preparation

Iyeye Fruit *(Spondias mombin)*

Iyeye juice was extracted by washing the fruits in clean water to remove dirts and other extraneous matter. After which was collected and weighed. After weighing, the thin skin (pericarp) was removed. Pulp was collected from the fleshy mesocarp after which it was blended, and filtered. The seeds were discarded. The filtered juice was then made up with water to required volume.

Pepper Fruit (*Denettia tripetala*)

The fruits were washed to remove dirts, sand, stone and other unwanted materials. After washing, drying was done. In making the juice, the seeds of the fruit are important as this is the part of the fruit which has the highest concentration of the peppery sensation in it. The fruits were then blended (with the use of a milling machine) to fine consistent fluid. The juice was then filtered, collected and kept.

Pineapple Juice Processing (*Ananas comosus)*

Pineapple juice was made by washing the whole fruits, peeling the outer skin by first cutting of the green crown, using a handheld knife, standing the pineapple upright on the board and carefully following the contours from top to bottom. After peeling, slicing and dicing was done to make blending of whole fruits easier. Blending was then done and the resulting juice was very thick and pulpy. To get a clear juice, filtration was done. After which clear juice was collected [Fig-1].

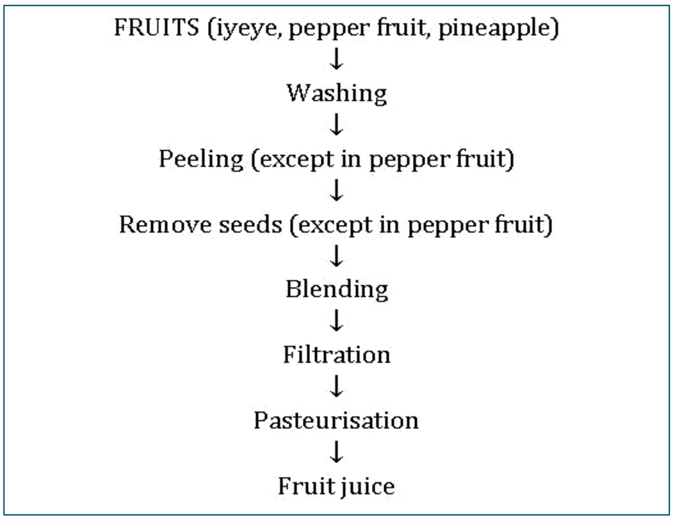

Fig. 1- Flow diagram of the production process of fruit juice.

Zobo Processing Procedures

Zobo is prepared conventionally by subjecting the calyces of *Hibiscus sabdariffa* leaves to two major processes; Boiling and Filtration [Fig-2].

The calyces are boiled in water for about 30 minutes at 80°C to extract the juice, alongside other ingredients such as ginger, lemon (optional) is added. After the juice is extracted, filtration is remove fibrous materials and the boiled leaves Zobo calyces to get a clear juice. After which it is cooled and packed in plastic containers.

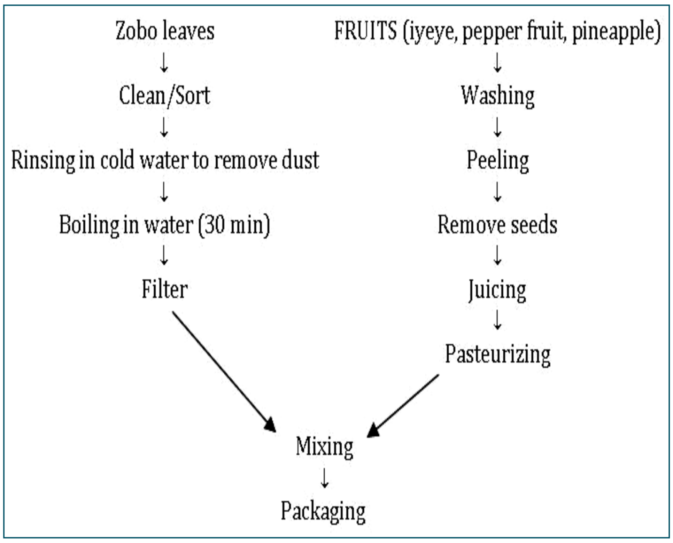

Fig. 2- Flow chart for the processing of fruity zobo

Production Formulation for the Fruity Zobo Drink

Pineapple flavored Zobo = 300g of the pineapple juice + 1 liter Zobo

Pepper fruit flavored Zobo = 300g of the Pepper fruit + 1 liter Zobo

Iyeye flavored Zobo = 300g of the Iyeye juice + 1 liter Zobo

Pineapple, Pepper fruit Zobo = 300g Pepper fruit + 300g pineapple + 1 liter Zobo

Iyeye, Pepper fruit flavored Zobo = 300g Iyeye + 300g Pepper fruit +1 liter Zobo

Pineapple, Pepper fruit, Iyeye flavored Zobo = 300g pineapple + 300 g pepperfruit +300g iyeye + 1 liter Zobo

Proximate Analyses of the Samples

The proximate analyses were carried out according to the standard procedures of AOAC [6].

Determination of Nutritional Composition

Mineral Content Determination

The dry ashing procedure was used for mineral content determination with five (5) grams of each of the samples which will be accurately weighed into porcelain crucibles and pre-ashed until the sample was completely charred on a hot plate. The pre-shed samples were thereafter ashed in the muffle furnace at 500 degrees Celsius till the ash was white for about 2 hours. After ashing, the crucibles were transferred into the desicator to cool and then reweighed. Each sample was quantitatively transferred into volumetric flasks by carefully washing the crucibles with 1ml nitric acid, then with portions of the dilute nitric acid. All washings were transferred to individual volumetric flasks, repeating the washing procedure twice. The solutions were diluted to volume with deionised water and used for individual mineral determination using the appropriate standards and blank. The content of the minerals; calcium, Magnesium, Copper, and iron were determined with the Atomic absorption spectrophotometer (Buck scientific, model210).

Calculation

% Mineral Element concentration = ppm/1000.

Where parts per million (ppm) of any element = Meter reading × slope × dilution factor.

Vitamin Content Determination

Vitamin A

This was determined using the method described by Capel and Dorrell [7]. Each sample was weighed (2g) into a flat bottom reflux flask and 10ml of distilled water was added followed by careful shaking form a paste. This was followed by the addition of 25ml of alcoholic potassium hydroxide solution and the attachment of reflux condenser. The mixture was then heated in boiling water bath for 1 hour with frequent shaking and rapidly cooked with 30mls of distilled water added. The hydrolysate obtained was transferred into a separating funnel and the solution was extracted three times with 250ml quantities of chloroform. Two grams of Anhydrous Sodium tetraoxosulphate (Na_2SO_4) was thereafter added to the extract to remove any traces of water. The mixture was then filtered into a 100ml volumetric flask and made up to mark with chloroform. Standard solutions (within the range of 0 to 50 micron gram/ml) prepared were determined with reference to their absorbance from which average gradients were taken to calculate Vitamin A (Beta-Carotene in micron gram/100 gram). Absorbance of each sample and standards was read on the spectrophotometer (Spectronic 21D, Milton Roy Model) at a wavelength of 328nm.

Calculation

Vitamin A (micron gram/100g) = [(Absorbance × dilution Factor) / (weight of sample)] × 100/1

Vitamin C

Equal weights of each of the samples and 3% metaphosphoric acid were individually, mechanically blended and each portion mixed to obtain homogenous mix. Five (5) grams of the mixture was then transferred using a pipette into a 100ml volumetric flask and made up to mark with 3% metaphosphoric acid. Each mixture was then filtered; discarding the first portion of the filtrate and 10ml of the aliquot which was pipetted into a 50ml volumetric flask and titrated immediately with the standard dye solution of 2, 6- dichlorophenolindophenol to a faint pink color which persisted for 15 seconds.

Calculation

Mg vitamin C per 100g = $[(W_1 + W_2) / (W_1 \times W_3)] \times [100(V \times F)]$

Where W_1 = weight of sample (grams)

W_2 = weight of extracting acid (grams)

W_3 = weight of mixture removed for analysis

V_1 = volume to which mixture sample is diluted (ml)

V_2 = volume of filtrate taken for titration (ml)

V = volume of dye solution used for titration.

F= Ascorbic acid equivalent of dye in milligrams/milliliters.

Determination of Antinutritional Factors

Determination of Phytate

The method described by AOAC [6] was used for Phytate determination. Sample (2g) was weighed into 250ml conical flask. 100ml of 2% concentrated hydrochloric acid was used to soak each of the samples in conical flasks for 3 hours and then filtered through a double layer filter paper. 50ml of each of the .sample filtrates was placed in 250ml beakers and 107ml of distilled water was added to each of the samples to improve proper acidity. 10ml of 0.3% ammonium Thiocyanate solution was added to each of the sample solutions as indicator and titrated with standard iron (III) chloride solution which contains 0.00195 g iron per ml. The end point was signified by brownish-yellow coloration that persisted for 5 minutes.

Calculation

Phytic acid (%) = (Titre value × 0.00195) × 1.19 × 100) /2.

Determination of Tannins

The method of Kirk and Sawyer [8] was used. One (1) gram of each sample was weighed into a beaker and individually soaked with a solvent mixture (made up of 80ml of acetone and 20ml of glacial acetic acid) for five hours to extract the tannins. Samples were thereafter filtered through a double layer filter paper to obtain the filtrate. This was followed by the preparation of a set of standard Tannic acid solution ranging from 10ppm to 50ppm. The absorbance of the standard solution and that of the filtrates were read at 500nm on a Spectronic 21D (Milton Roy model spectrophotometer.

Calculation

Tannin (%) = (Absorbance x Average gradient x Dilution factor)/100.

Physico Chemical Analyses

Determination of Potential Hydrogen (pH) of Zobo samples

The pH meter was switched on and allowed to warm up for about five minutes and then standardized with a pH buffer solution to ensure the sensitivity and accuracy of the meter. This was done by dipping the electrode of the meter into each buffer solution with thorough rinsing with distilled water. The pH values of samples (initially prepared by measuring 10ml of samples into beaker were taken individually by dipping the ph meter electrode into the samples followed by thorough rinsing with distilled water after each dip. The pH values were consequently read out from the display unit of the meter.

Specific Gravity Determination

This was determined using a density bottle. The samples was poured into a 50ml density bottle and weighed. This is known as the mass. The mass was divided by the volume of the density bottle, to get the density.

Calculation

Density of sample = x (g/ml) / density of water

Where $x = \frac{W_1(g)}{W_2 - V(ml)}$

Where W_2 = weight sample in the density bottle

W_1 = weight of density bottle

V = volume of the density bottle (50ml)

Total Acidity Determination

To 200ml of boiling distilled water in a 500ml Erlenmeyer flask 1ml of 1% phenolphthalein indicator was added. The solution was titrated with 0.1M sodium hydroxide solution to a faint but definite pink color; 5mls of the sample was titrated to a pink color with the 0.1m NaOH, using 3 drops of 1% phenolphthalein as indicator.

Calculation

$$\text{Total Acidity} = (\text{g/ml}) = \frac{0.075 \times M_1 \times W_2}{V_1 M_1}$$

Where M_1 = Molarity of N_aOH

V_2 = Titre volume

V_1 = volume of sample (5ml)

0.075 = Equivalent weight for Tartaric acid

Fixed Acidity Determination

Samples (25ml) were placed in boiling tubes and evaporated carefully on the hot plate until the volume reduced to 5mls. Then, 25ml of hot distilled water was added and the solution again evaporated to a final volume of 5ml. this process was repeated once more. The residue was allowed to cool, and then diluted to 50ml with distilled water. 3 drops of 1% phenolphthalein was added and finally the samples were titrated with a standardized concentrated 0.1M NaOH until color change was observed.

Calculation

$$\text{Fixed acidity (g/100ml)} = \frac{V_1 \times M_1 \times 0.075 \times 100}{V_2}$$

Where V_1 = Volume of NaOH used

V_2 = Molarity of NaOH

0.075 = Equivalent weight for tartaric acid.

Volatile Acidity

The volatile acidity was calculated by subtracting the fixed acidity from the total acidity expressed on the same scale.

Calculation

$T_A - F_A = V_A$ (g/100ml)

F_A = Fixed acidity

Where T_A = Total acidity

V_A = volatile acidity

Sensory Evaluation

The sensory evaluation was carried out using the multiple comparison tests. The 6 samples of fruit enhanced Zobo were served to 15 semi-trained panelists made up of a population of staff and students of Bells University of technology, who are familiar with the sensory attributes-taste, aroma, flavor, color, mouth feel. A 9 point hedonic scale was designed to measure the degree of preference of the samples.

Results and Discussions

Effect of Enrichment on the Nutritive Value of Zobo

The Proximate Analysis of the Conventional Zobo Product and fruit enriched zobo product is presented in [Table-1]. The enriched zobo with Iyeye product had the lowest protein content 2.00%, followed by the zobo product enriched with pepper fruit (3.75%), and conventional zobo product with protein content of 4.13%. The enriched zobo with combination of all fruits had 4.75%. The highest protein content (6.2%) was found in the zobo enriched with pineapple and pepper fruit.

The lowest ash content was found in the zobo product enriched with pepper fruit (1.75%) and the highest ash content was found in the zobo product which had all the fruits present in it. This simply signifies that the ash content of the zobo increased with the addition of more fruits to it. The conventional zobo had the lowest carbohydrate content (1.67%) this can be attributed to the fact that only pineapple fruit was added to the product, and pineapple is relatively low in carbohydrate. The highest carbohydrate was found in the enriched zobo sample with mixture of all the fruits. The product with the highest fat content was the enriched zobo product containing all the fruits having as much as 19.89% fat, nine times more than that contained in the conventional zobo. The highest dry matter was present in the sample which had the pepper fruit 14% due to the seeds of the pepper fruit which were blended into the peeper fruit juice before adding to the zobo product during processing.

Table 1- Effect of fruit enrichment on the nutritive value of the zobo sample

Samples	Protein	Ash	Fat	Carbohydrate	Dry Matter	Moisture
ZGP	4.13^c	2.51^b	1.92^c	21.60^b	3.70^c	86.01^a
ZPP	6.20^f	3.24^c	7.25^d	21.68^b	9.00^e	81.61^a
ZP	3.75^b	1.75^a	1.71^b	29.52^c	$1\,4.85^f$	86.95^a
ZI	2.00^a	3.58^c	1.50^a	51.41^e	4.16^d	85.90^a
ZIP	5.23^e	4.01^d	1.40^a	35.10^d	2.11^a	85.50^a
ZGIPP	4.75^d	4.75^e	19.89^e	19.85^a	2.75^b	86.27^a

Values with different superscripts are significantly different
LEGEND:
ZGB: zobo + ginger + pineapple
ZPP: zobo + pineapple + pepper fruit
ZP: zobo + pepper fruit
ZI: zobo + iyeye
ZIP: zobo + iyeye + pepper fruit
ZGIP: zobo +Ginger + Iyeye + pepper fruit

The moisture content of the samples was between 80.13% and 87.63%, this findings was similar to the result of Fasoyiro and Owosibo [8]. The conventional zobo had the highest moisture content of 86.01% while the lowest was found in the zobo product enriched with pepper fruit. There was significant difference between the entire sample analyzed ($p<0.05$).

Effects of Fruits Enrichment on the Physiochemical Properties of Zobo

[Table-2] shows the effect of enrichment on the physio-chemical properties of Zobo. The conventional zobo product had the highest pH (4.58), and the zobo product containing iyeye and pepper fruit had the lowest pH (4.04). This explains why the conventional zobo had the lowest Total and Fixed acidity contents. Because the lower the pH of a substance, the higher the acidity, the effects of the acidic value of the products can be seen in the value of its Total and Fixed acidity, this might be responsible for the highest content of fixed and total acidity (0.80%) in the Zobo with mixture of fruits.

Table 2- Effect of fruit enrichment on the physiochemical properties of the zobo sample

Samples	Specific Gravity	pH	Total Acidity	Fixed Acidity	Volatile Acidity
ZGP	0.71^a	4.58^b	0.76^b	0.15^b	3.70^a
ZPP	0.74^a	4.53^b	0.83^b	0.18^b	9.00^a
ZP	0.74^a	4.04^a	0.41^a	0.42^a	14.85^a
ZI	0.72^a	4.04^a	0.76^b	0.12^a	4.16^a
ZIP	0.74^a	4.04^a	0.80^b	0.80^b	2.11^a
ZGIPP	0.73^a	4.04^a	0.80^b	0.80^b	2.75^a

Values with different superscripts are significantly different.
LEGEND:
ZGB: zobo + Ginger + Pineapple
ZPP: zobo + pineapple + pepper fruit
ZP: zobo + pepper fruit
ZI: zobo + Iyeye
ZIP: zobo + Iyeye + Pepper fruit
ZGIP: zobo +Ginger + Iyeye + Pepper fruit

There was significant difference between the pH of the samples (P>0.05) when compared with the work of Fasoyiro and Owosibo, [8] where the pH of the zobo product was between 3.12-3.42, it can be seen that the effects of the fruits addition reduced the acidity of the enriched zobo products by increasing its pH. The specific gravity of the products also ranged between 0.70-0.75g/mol.

Effect of Fruit Enrichment on the Vitamin Composition of Zobo

[Table-3] shows the vitamin A and C composition of the Zobo samples. Vitamins are organic compounds necessary for good health and vitality. Vitamin A is a fat soluble vitamin essential for the building and growth of all cells and maintenance of normal vision in dim light. Vitamin C is a water soluble vitamin which acts as an anti oxidant. Although, vitamins are required in minute amounts. The resulting vitamins after enrichment in this study were significantly different (P<0.05). Zobo with the iyeye fruit had the highest vitamin C content (34.88mg), the conventional zobo had the lowest vitamin C content (29.28mg). The vitamin A content of the samples was also significantly different with zobo containing iyeye and pepper fruit having the highest vitamin A content. The conventional zobo enriched with pineapple had the lowest vitamin A. The high pH of the zobo with pineapple sample can be attributed to the low vitamin content which it has compared with other fruit added to the zobo samples.

Table 3- Effect of fruit enrichment on vitamin composition of the zobo sample

Samples	Vitamin A (RE/L)	Vitamin C (mg/100)
ZGP	28	29.28
ZPP	68	33.24
ZP	141	31.96
ZI	42	34.88
ZIP	87	32.76
ZGIPP	54	32.85

Values are results of triplicate determinations.
LEGEND:
ZGB: zobo + ginger + pineapple
ZPP: zobo + pineapple + pepper fruit
ZP: zobo + pepper fruit
ZI: zobo + Iyeye
ZIP: zobo + iyeye + pepper fruit
ZGIP: zobo + ginger + iyeye + pepper fruit

Effect of Fruit Enrichment on the Mineral Composition of Zobo

[Table-4] shows the mineral composition of zobo samples. Minerals are inorganic substances necessary for maintaining good health. Water balance, regulation of fluids and acid base balance in the body depending to a great extent on certain mineral balance in the body [9]. Magnesium plays an important role in normal calcium and phosphorus metabolism in man. Iron forms a constituent of heamoglobin which takes part in the transportation of oxygen from the lungs to the tissues [9]. Copper stimulates the absorption of iron and it is a constituent of the elastic connective tissue protein elastin. Calcium is necessary for the ossification of bones and for normal nerve impulse transmission [9].

The mineral content of the zobo with pepper fruit had the highest iron content 1.68mg/100g followed by the zobo sample with pineapple and pepper fruit 1.26mg/100g. The sample which had the combination of all fruits was lowest (0.26mg/100g). The calcium content of the samples were also different with zobo, pineapple pepper fruit combination having the highest concentration of 7.1mg/100g, zobo with pineapple fruit had the least calcium content of 0.90mg/100g. Zobo with pineapple and pepper fruit sample had a corresponding high value in magnesium content. This can be attributed to the fact that pepper fruit is high in vitamins and minerals [10] similar trend was observed in the values of their copper content (0,75mg/100g) when compared with zobo with pineapple sample.

Table 4- Effect of fruit enrichment on the mineral composition of the zobo samples

Samples	Iron	Magnesium	Calcium	Copper
ZGP	0.54^{a}	1.77^{bc}	0.90^{a}	0.15^{a}
ZPP	1.25^{b}	1.78^{b}	7.10e	0.18^{b}
ZP	1.68^{c}	1.74^{a}	1.90^{c}	0.42^{b}
ZI	0.26^{a}	1.58^{a}	0.93^{a}	0.12^{ab}
ZIP	1.03^{b}	1.74^{a}	1.40^{b}	0.80^{a}
ZGIPP	0.25^{a}	1.76^{ab}	6.60d	0.80^{a}

Values with different superscripts are significantly different.
LEGEND:
ZGB: zobo + Ginger + Pineapple
ZPP: zobo + pineapple + pepper fruit
ZP: zobo + pepper fruit
ZI: zobo + Iyeye
ZIP: zobo + iyeye + pepper fruit
ZGIP: zobo + ginger + iyeye + pepper fruit

Effect of Enrichment on Anti Nutritional Composition of Zobo

[Table-5] shows the anti nutritional composition of the zobo samples. Tannins cause decreased feed consumption in animals, bind dietary proteins and digestive enzymes to form complexes that are not readily digestible. Tannins can also interact with dietary iron by preventing its absorption and they have the capability of decreasing the digestibility and palatability of proteins because they form insoluble complexes with protein. Tannin content of the Zobo samples ranged between 0-0.003% to 0.006%.

Table 5- Effect of fruit enrichment on the anti-nutritional composition of the zobo

Samples	Tannins (%)	Phytate (%)
ZGP	0.0026	0.0038
ZPP	0.0043	0.0064
ZP	0.0033	0.0049
ZI	0.0056	0.0078
ZIP	0.0039	0.0057
ZGIPP	0.0031	0.0052

Values are results of triplicate determination.
LEGEND:
ZGB: zobo + ginger + pineapple
ZPP : zobo + pineapple + pepper fruit
ZP: zobo + pepper fruit
ZI: zobo + iyeye
ZIP: zobo + iyeye + pepper fruit
ZGIP: zobo + ginger + iyeye + pepper fruit

Phytate have twelve replaceable hydrogen atoms and therefore could form insoluble salts with many metals like calcium, iron, zinc, magnesium thereby preventing the proper utilization of these minerals and making them unavailable. The phytate content ranged between 0.00%4 to 0.009%. The content of tannins and phytate in the samples were found to be minute. The zobo sample which had iyeye was found to be highest in both tannin 0.0056% and phytate 0.0078% while the zobo with pineapple sample was found to have the lowest tannins 0.0026% and phytate content 0.0.0038%.

Effect of Fruit Enrichment on the Sensory Characteristics of Zobo

Fifteen judges sensory panel was used for this sensory evaluation and the statistical analysis of their response is shown in [Table-6] below, and it explains that there is a significant difference in the appearance, flavor, aroma, color, taste, mouth feel and overall acceptability of the zobo samples (P<0.05). However, the zobo sample which had combination of all the fruits had the highest overall acceptability followed by the pineapple pepper fruit zobo, then the conventional ginger pineapple zobo, the pepper fruit zobo, the iyeye zobo and the iyeye pepper fruit zobo which had the least overall acceptability.

Table 6- Effect of fruit enrichment on the organoleptic properties of zobo

Samples	Appearance	Color	Taste	Mouth Feel	Aroma	Overall Acceptability
ZGP	6.26^{bc}	5.93^{ab}	6.40^{bc}	6.4^{b}	6.40^{bc}	6.86^{bcd}
ZPP	7.73^{d}	7.66^{e}	6.93^{c}	6.4^{b}	6.40^{bc}	7.2^{bcd}
ZP	7.80^{d}	7.53^{de}	5.48^{ab}	5.06^{a}	5.06^{a}	6.53^{abc}
ZI	5.26^{a}	5.20^{a}	4.40^{a}	4.86^{a}	5.33^{ab}	5.60^{ab}
ZIP	5.80^{ab}	6.06^{bc}	5.06^{ab}	4.60^{a}	4.86^{a}	5.46^{a}
ZGIPP	7.06^{cd}	6.80^{cd}	7.26^{c}	7.00^{b}	7.00^{c}	7.5^{cd}

Values with different superscripts are significantly different.
LEGEND:
ZGB: zobo + Ginger + Pineapple
ZPP: zobo + pineapple + pepper fruit
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ZI: zobo + Iyeye
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ZGIP: zobo + ginger + iyeye + pepper fruit

The aroma properties of iyeye pepper fruit zobo, pepper fruit zobo, and iyeye zobo were statistically the same. In the same vein the aroma properties of iyeye zobo, pineapple pepper fruit zobo, and the ginger pineapple zobo were statistically the same. The zobo pineapple pepper fruit, zobo ginger pineapple, the combination of mixed fruits zobo samples were statistically the same. While the iyeye pepper fruit zobo, and the combination of all fruits zobo were significantly different.

Conclusion and Recommendations

The use of fruits in the enrichment of zobo had effect on the nutritional status of the zobo, the protein, fat and carbohydrate content of the Zobo increased significantly (P<0.05) with the addition of each fruits and more significantly in the Zobo with mixture of the fruits. Also, the physiochemical analyses results showed an increase in values of the parameters analysed with the addition of the fruits in all the Zobo samples. The mineral and vitamins content of zobo also followed a similar trend.

Some parameters of the sensory characteristics of the zobo samples such as color, appearance, aroma, taste and overall acceptability increased significantly (P<0.05), including the mouth feel and overall acceptability.

Recommendation

This study showed that the conventional zobo product is not shelf stable when compared with the enriched ones. This could be due to its high moisture content since water is the major ingredient in zobo, the water should be treated before use.

The addition of acidulants and preservatives (citric acid, sodium benzoate) can also improve the shelf stability of the zobo.

Conflicts of Interest: None declared.

References

[1] Ogiehor I.S. and Nwafor O.E. (2004) *Niger. Ann. Nat. Sci*., 1-10.

[2] Kolawole J.A. and Okeniyi S.O. (2007) *Research Journal of Pharmacology*, 1(1), 23-26.

[3] Bamgboye A.I. and Adejumo O.I. (2009) *Agricultural Engineering International: the CIGR Journal*, XI.

[4] Wong P.K., Yusof S., Ghazali H.M. and Man Y.C. (2002) *Nutrition & Food Science*, 32(2), 68-73.

[5] Babalola S.O, Babalola A.O. and Aworh O.C. (2000) *J. Food Technol. Africa,* 6, 133-134.

[6] AOAC (2004) *Association of Analytical Chemists Agric.*, Ottawa, Canada, 18-46.

[7] Capel I.D. and Dorrell H.M. (1984) *Biochem. J.*, 219, 41-49.

[8] Kirk, H, and Swayer, R. (1998). *Fruit Pearson Chemical Analysis of Food*, 8th ed., Longman Scientific and Technical. Edinburgh, 211-212.

[9] Raheena B.M. (2007) *A Textbook of Foods, Nutrition and Dietetics*, 2nd ed., Sterling Publishers Private Ltd., New Delhi.

[10] Okwu D.E. and Morah F.N.I. (2004) *Fruit Paris*, 59(6), 439-442.