Research Article
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Nutritional, Sensory and Microbial analysis of organically fortified zobo tea (*hibiscus sabdariffa*) powder

Abstract

Contributing to the health benefits associated with the consumption of organically fortified Zobo Tea (Hibiscus sabdariffa) powder as beverage, this research have sought to contribute to knowledge via the production process of spiced Zobo Tea (Hibiscus sabdariffa) powder and its proximate content. Data were subjected to analysis of variance (ANOVA). Comparison of means was carried out by Duncan's multiple range test Statistical analysis was performed using the statistical package for social sciences (SPSS 17.0) and the means ± SD were calculated from triplicate determinations. The result of the sensory revealed that the entire three sample have no significant differences ($p<0.05$) that is, they are similar in their characteristics in mean score and standard deviation in terms of all the sensory characteristics (taste, appearance, aroma, texture, overall acceptability). Meanwhile, the proximate content (ash, crude fiber, carbohydrate, protein, and moisture) of sample ZT3 (80g ZT+ 20g SP) was significantly different from ZT1 (100g ZT). Also The Microbial count (Bacillus spp, Proteus spp, Klebsiella spp and Ecoli) were conducted and the result obtained indicated that these samples may be good for beverage production. We thus recommend the consumption of organically fortified zobo tea (Hibiscus sabdariffa) powder which is an indigenous beverage product for a wide range of consumer owing to the numerous health benefits as reviewed.

Keywords: nutritional, sensory and microbial analysis of organically fortified zobo tea powder

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Introduction

Foods are classified based on the readiness to consumption including fully, minimally processed and ready-to-eat food. Zobo is among the instant nutritional drinks drunk by numerous families within Nigeria irrespective of the socioeconomic status especially in the Northern region.[1] Due to its attractiveness, constant and growing demand for zobo drink with improved shelf life to care for the increasing demand of zobo drink by its users in Nigeria, research concentrations should be redirected and route for new technology in the production if zobo Tea (ZT) from sorrel calyx. ZT is usually prepared at home by housewives or those on low income as a way of earning additional money to care for immediate and extended family members; and it is frequently sold at chilling temperatures in motor-parks, on school premises, and in restaurants and markets especially during the summer when the temperature goes above 37 °C.[2] It is also served during naming and marriage ceremonies and during festival periods.[3] It is usually consumed in the afternoon especially during the summer and the winter; it is rarely consumed in the spring. Most people consume moderately chilled Zobo drink and only a few people prefer warm Zobo drink, and it is consumed by all sectors of the Nigerian population above the age of 10.[2] ZD is usually prepared from the calyx of Sorrel. Studies have shown the medicinal potentialities of Sorrel calyces by managing patients suffering from Type II Diabetes because of the hypoglycemic and hypolipidemic properties of the calyces of Sorrel. Hence, calyces of Sorrel can recover the lipid profiles of the diabetics.[4]

Sorrel calyx is indigenous to the tropics and it is used to produce liquid zobo drink (LZD) in Nigeria. It is often described as sorrel by the English speaking people, it is refered by the French as Orselle; and Karkade by the Arab speaking nations. In Nigeria diverse people from diverse cultural background call it various names; meanwhile, the three major ethnic groups (i.e. Yoruba, Hausa and Igbo) in Nigeria call it Isapa, zobo and Aukan, correspondingly.[5] According to Muhammad FS,[3] Sorrel as an identity is given to any shrub of a large genus of low luscious plant or any of the various plants that have acid sap that gives a sour flavour in their leaves; and the acidity results from the existence of one or more nutritionally based acids; of which oxalic, malic, and citric acids are mostly common. Zobo originates from two botanical types of sorrel plant which are *Hibiscus sabdariffa (altissima)*, and *Hibiscus sabdariffa (sabdarriffa)*.[6]

Zobo drink is a traditional beverage usually produced into liquid form by either boiling or steeping sorrel calyx/petals (Zobo flower) in drinkable water, sweetener is added before chilling and serving to consumers.[5] The red and/or purple luscious calyces/petals are simmered, filtered, sweetened with sweetner of choice, and then flavoured/spiced with pineapple juice, ginger and lemon to produce sorrel drink.[7] The calyx/petals could likewise be simmered with pineapple peelings during the extraction process to amplify the taste of the extracted Zobo drink before sweetening with sugar or other sweeteners such as Honey. A study reports that the dry red calyces/petals are frequently used as tea, guzzled hot or cold after sweetening with nourishing sweeteners such as sucrose, which have a tart flavor, and they are as well used as food coloring agent.[3]

Poor hygienic practices during the production process with the use of contaminated water might place consumers of these products into health risk. The quality of zobo drink hinge mainly on the physicochemical elements of the raw materials, water used during the production process and the hygienic environment and practices of the processors.[8] Water is a chief resource utilized in the production of these drink from their raw materials. Poor quality with respect to physicochemical (Color, pH, Electrical Conductivity, Total Alkalinity

Salinity, Turbidity, Total Suspended Solids (TSS), Total Hardness (TH)), Heavy metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, nickel, Zinc,) and Microbial (Total Heterotrophic Bacteria (THB), Total Coliform and Fecal Coliforms, Total Fungi) could also impact on the overall quality of the drink. The environment from which the zobo drinks are produced from could also impact the quality specifically in the microbial perspectives. Zobo drink is a nourishing drink consumed often by Nigerians. However, the consumption of local beverages produced in unhygienic environment could be a probable source of transference of zoonotic and food-borne pathogens which includes staphylococcosis, Salmonellosis, Brucellosis, Tuberculosis, Shigellosis, Listeriosis, E. coli, infections etc.[9]

Materials and method

Materials

The following spices: (1) Garlic (2) ginger (3) Dates, (4) West Africa black pepper (5) Cloves (6) Grain of selium (7) Nut Meg (8) West Africa black pepper were purchased from the Auchi market Auchi, Edo State, Nigeria. The spices were cleaned, mixed together, ground and sieved into fine zobo drink (*Hibiscus sabdariffa*) powder using a standard (fine) kitchen sieve. The samples were divided into three portions, the first portion was adopted as control for the production of pure zobo powder while the remaining portion were added to the spices for an organically fortified zobo drink (*Hibiscus sabdariffa*) powder as variation. The remaining samples were kept into the refrigerator for further analysis.

Chemicals and reagents

All chemicals and reagents used in this study were of analytical grade and water was glass distilled.

Methods

Determination of proximate composition of organically fortified zobo tea (*hibiscus sabdariffa*) powder. This was determined following the method described by Association of Official Analytical Chemist.[10]

Microbial analyses of organically fortified zobo tea (*hibiscus sabdariffa*) powder

Preparation of culture media

The media used in this research work were: Nutrient Agar (NA), MacConkey Agar (MCA), Mannitol Salt Agar (MSA) and Potato Dextrose Agar (PDA). They were prepared according to the manufacturer's specification as directed on the containers.

Sterilization of materials and culture media

Glass ware such as conical flask, measuring cylinders, Petri-dishes, McCartney bottles, cork borer and other glass container were washed, drained and dried. They were then autoclaved (121^{0}C for 15 min) for sterilization, and were allowed to cool to 40 ^{0}C before used. Nutrient Agar (NA), Maconkey Agar (MCA), Monitor Salt Agar (MSA) and Potato Dextrose Agar (PDA) were also sterilized by autoclaving. Work surfaces were sterilized by swabbing with 95% ethanol. Aseptic working environment was achieved with the use of spirit lamp.

Preparation of diluent

For every 100 ml of distilled water, 0.85 g of NaCl was weighed into it and dissolved by shaking. And 9 ml of the diluent was dispensed into serial dilution bottles and sterilized for serial dillutions.

Microbial counts of organically fortified zobo tea (*hibiscus sabdariffa*) powder

Twenty five millilitres of each cookies samples was added to 225ml of sterile saline water. This was thoroughly mixed in the bottle and pour plate method was used. Each sample (1ml) was transferred into sterile petri dishes and individual sterilized agar was poured and swirled to cover the surface of the petri dish. The coliform count and total viable count plates were incubated at 32^{0}C for 24h and the microbial growths were counted using colony counter. The total count plates were incubated at room temperature for 72h

Sensory evaluation of zobo drink (Hibiscus sabdariffa) powder

A sensory panel consisting of 15 semi-trained staff members and students from the Department of Hospitality Management, Auchi Poly. Edo state and familiar with sensory attributes of local zobo drink was employed to evaluate the products. Sensory evaluation was performed using the modified method of [11] The samples were checked for Appearance, Aroma, Taste, Texture, and General Suitability. The participants evaluated the samples using a 9 point hedonic scale quality analysis with 9 = Extremely desirable, 8 = Very much desirable, 7 = Moderately desirable, 6 = Slightly desirable, 5 = Neither desirable nor undesirable, 4 = Slightly undesirable 3 = Moderately undesirable, 2 = very much undesirable 1 = Extremely undesirable. Table 1, Figure 1

Table 1 shows the formulation for composite of Spiced Zobo Tea Drink

Ingredients	ZT 1	ZT2	ZT3
Zobo Tea (ZT) (g)	100	90	80
Spices (SP) (g)	0	10	20
Sugar (g)	120	120	120
Water (cl)	250	250	250

Control Sample 1; ZT_1 = 100 g of Zobo Tea with 0g of Spices

Sample 2; ZT_2 = 90g of Zobo Tea with 10 g of Spices

Sample 3; ZT_3 = 80g of Zobo Tea with 20 g of Spices

Source; Hospitality Management, Auchi Polytechnic 2022

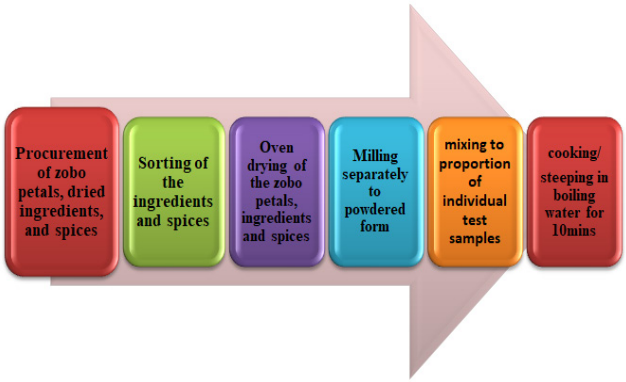

Figure 1 Flow Diagram of the Production Process of Powdered Zobo Drink.

Statistical Analysis

Data were to analysis of variance (ANOVA). Comparison of means was carried out by Duncan's multiple range test.[12] Statistical study was made using the statistical platform for social sciences (SPSS 17.0) and the means ± SD were calculated from triplicate determinations.

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Results and discussion

Consumer acceptability of organically fortified Zobo Tea drink (*Hibiscus sabdariffa*) powder.

The sensory attributes evaluated in the nutritional composition of zobo tea drink fortified with cloves, Garlic, ginger, Dates, West Africa black pepper, nut Meg, grain of selim is shown in Table 5. The results of the appearance shows that the value is ranged between (7.35-7.95) with the highest value in sample (3) and the lowest value in Sample (1). It was revealed from the result that the appearance of the sample (S3) was preferred by the panelist which could be as attributed to further addition of spices and mixed fruits. Appearance has been a fundamental sensory attribute which has the ability to influence consumer acceptability.[13]

Aroma recorded the highest value in sample 3 (7.40) followed by sample 2 (7.32) and the control sample 1 (7.33) which has the lowest value. Also the taste of the samples has the highest value in sample 1 (7.76) while the lowest value was recorded in sample 3 (6.80). The gradual changes from both the taste and the aroma could be as a result of gradual fortification of spices and mixed fruits into zobo tea respectively, as taste and aroma refers to the sweet sensation caused in the mouth and nostrils by contact or perceiving the product due to its sweeting effect.

The overall acceptability expresses how the consumers or panelist accept the product by considering all the other parameters of sensory evaluation. The overall acceptability of the control sample S1 (7.81) has the highest values compare to sample 2 (7.58) and sample 3 (7.45) respectively, which is an indication that the consumer acceptability of organically fortified Zobo drink (*Hibiscus sabdariffa*) powder were favorably considered and acceptable above average among end users Table 2.

Table 2 Shows the consumer acceptability of organically fortified Zobo Tea drink (*Hibiscus sabdariffa*)

Sample	Appearance	Aroma	Taste	Overall Acceptability
ZT1	7.95 ± 1.32a	7.33 ± 1.87a	7.76 ± 1.55a	7.81 ± 1.33a
ZT2	7.36 ± 1.57a	7.32 ± 1.70a	7.00 ± 1.45ab	7.58 ± 1.12ab
ZT3	7.35 ±1.35a	7.40 ± 1.43a	6.80 ±1.79ab	7.45 ±1.47a

Value are means ± standard deviation of three determinations. Values with different superscripts along the columns are significantly different ($p<0.05$)

Where; ZT1, ZT2, ZT3, represents sample (1, 2, 3, respectively)

Control ZT1 = 100 g of Zobo + 0g of spices

ZT2 = 90 g of Zobo + 10 g of spices

ZT3 = 80 g of zobo + 20 g of spices

Source; (Hospitality Management, Auchi Polytechnic 2022)

The proximate composition of organically fortified Zobo Tea (*Hibiscus sabdariffa*) powder.

The proximate composition of zobo drink dried (*H. sabdariffa calyces)* i.e. active ingredients used for the preparation of Zobo drink, prepared Zobo drink and spiced zobo drink are represented in Table 3 below.

The moisture content ranged between (5.53 % - 13.07%), with the highest value in ZT1 (13.07%) and the lowest value in ZT3 (5.53%). These result indicated that the shelf life of these zobo samples are high while dried, and the dried sample justifies the practice of storage in dry form by users. Moisture content is one of the most important and widely used measurements in the processing, preservation and storage of foods.[14]

Table 3 Shows the proximate composition of organically fortified zobo drink (*Hibiscus sabdariffa*) powder

Sample	ZT1	ZT2	ZT3
Moisture	13.07 ± 2.00b	7.75 ± 1.99c	5.53 ± 8.85a
Ash	25.49 ± 2.00a	18.97±1.54b	17.60 ± 1.93b
Fibre	9.40 ± 1.95b	7.88 ± 2.00a	5.93±1.69a
Fat	3.19 ± 2.06a	3.38 ± 1.92a	3.66 ± 2.21a
Protein	5.09 ± 2.52a	6.74 ± 2.00a	8.49 ± 2.52b
Carbohydrate	43.71 ± 1.97a	47.31 ± 2.52a	50.16 ± 2.14b

Value are means ± standard deviation of three determinations. Values with different superscripts along the columns are significantly different ($p<0.05$)

Where; ZT1, ZT2, ZT3, Stands for sample (1, 2, 3, respectively)

Control ZT1 = 100 g of Zobo + 0g of spices

ZT2 = 90 g of Zobo + 10 g of spices

ZT3 = 80 g of zobo + 20 g of spices

Source; Hospitality Management, Auchi Polytechnic 2022

The crude protein obtained from the samples show that the value ranged from (5.09% - 8.49%) with the highest value in ZT3 (8.49%) and the lowest value in ZT1 (5.09%). The crude protein obtained from these plant based beverage without the addition of spices (ZT1) showed that the plant has a lower source of protein. Pamela et al.,[15] (2005) suggested that protein from plant sources are of lower quantity, but their combination with many other sources of protein such as animal protein, legumes or spices may result in additional nutritional value.

However, the use of spices in the preparation of Zobo Tea powder enhances the protein content. For instance, a study has reported significant increase in the protein content of zobo drink when spiced with ginger, garlic and mixture of ginger and garlic.[16] The pH level of Zobo Tea powder also improves when all the spices (ginger and garlic, Dates, West Africa black pepper, nut Meg etc.) were mixed and blended together. Apart from crude protein content, the use of spices increases the ascorbic acid content, zinc, calcium, potassium, total sugar, pH (toward alkalinity) of zobo drink and reduces the iron concentration. This trend suggests improvement in the nutritional content. This could be due to the fact the spices including ginger, garlic and some other spices are rich in nutrients also in the production processes.[16]

The ash contents is between (17.60 % - 25.49%), sample ZT1 exhibited the highest ash contents of (25.49%) while ZT3 (17.60 %) had the lowest value. The result from this proximate composition of the Dried H. sabdariffa calyces indicates that it is high in dry matter and low compare to the value (5.92% – 6.77%) gotten by,[1] this could be as a result of the addition of spices in to the sabdariffa calyces, making it a good source of plant based minerals required by man for normal metabolic activity of body tissues as well as the proper assimilation of vitamins.[14]

The crude fiber of the powdered Zobo Tea ZT1 yielded the highest content of 9.40 % while ZT3 (5.93) % had the lowest value. The crude fibre contents of ZT1 and ZT3 were similar compared to the value (7.28 %–7.82%) reported by [1] for dried Dried *H. sabdariffa calyces*.

The low crude fiber content of this plant is advantageous in absorption of glucose and fat. Although crude fiber enhances digestibility, its presence in high levels can cause intestinal irritation, lower digestibility and decreased nutrient utilization [14]. Soluble fibre also lowers cholesterol levels and helps to maintain blood sugar.[17] This further justifies the use of the plant based beverage in the prevention and management of diseases such as coronary heart diseases, cancer and diabetes.[18]

The fat contents of the powdered Zobo Tea ZT3 yielded the highest value (3.66 %), while the lowest value was found in ZTI (3.19%). The fat contents were low compared to the value (8.51 – 9.26 %) reported by [1], which also suggested that this fat contents is considered appropriate, many body functions depend on lipids. Lipids provide excellent source of energy and enhance transport of fat soluble vitamins, insulate and protect internal tissues and contribute to vital cell processes.[19] It has been suggested that enough lipid (fat) be included in the diet to account for at least 20- 25% of the total caloric intake.

The carbohydrate contents of the spiced zobo powdered is ranged between (50.16 % - 43.71%) with the highest content in ZT3 (50.16 %) and the lowest contents in ZT1 (43.71%). These carbohydrate content of the leaves are low compared to the value (86.92%) reported by [1] which could be as a result of fluctuation between the different spices added to sample as reported by.[20] This results indicates that spiced zobo beverage are very good source of energy.

Mineral composition of organically fortified zobo drink (*Hibiscus sabdariffa*) powder

Table 4 represents the mineral and vitamin C composition of zobo drinks. The highest value (2.3 mg) of Phosphorus content was found in ZT3, followed by (2.0 mg) ZT3, and the least value (1.8 mg) was found in ZT1. Phosphorus, an essential mineral, is naturally present in many foods and available as a dietary supplement. Phosphorus is a component of bones, teeth, DNA, and RNA[21] In adults, normal phosphate concentration in serum or plasma is 2.5 to 4.5 mg/dL (0.81 to 1.45 mmol/L)[22]

Table 4 Mineral composition of organically fortified zobo drink (*Hibiscus sabdariffa*) powder

Sample	Phosphorus	Potassium	Copper	Manganese	Calcium	Vitamin C
ZT1	1.8 ± 1.7b	2.2 ± 0.1c	0.4 ± 0.2b	1.1 ± 0.2c	2.7 ± 0.8a	1.20 ±0.1b
ZT2	2.0 ± 0.1b	2.6 ± 0.1b	0.5± 0.1b	1.6 ±0.2b	3.5 ± 0.2ab	1.4 ±0.2ab
ZT3	2.3 ± 0.1a	3.03± 0.2a	0.8 ± 0.1a	2.0 ± 0.1a	3.8 ± 0.6a	1.6±0.6a

Value are means ± standard deviation of three determinations. Values with different superscripts along the columns are significantly different ($p<0.05$)

Where; ZT1, ZT2, ZT3, Stands for sample (1, 2, 3, respectively)

Control ZT1 = 100 g of Zobo + 0g of spices

ZT2 = 90 g of Zobo + 10 g of spices

ZT3 = 80 g of zobo + 20 g of spices

Source; Hospitality Management, Auchi Polytechnic 2022

On Potassium value, ZT3 had the highest Potassium concentration of (3.03 mg), followed by ZT2 (2.6 mg) and ZT2 had the least value of (2.2 mg). The values is a little bit similar to the values (2.6-2.2mg) reported by[23] Potassium plays a similar role with sodium in the biological system, but it is located in the intracellular fluid. Unlike sodium it associated with lower rather than higher blood pressure values.[24] The potassium level of the Zobo are far below the RDA (2000 mg/day). Deficiency in potassium leads to an irregular heartbeat, loss of appetite and muscle cramps.[25] This zobo drink is often not taking alone but with other spices/ beverages which could improve the potassium level.

Copper content of ZT3, ZT2 and ZT1 were (0.8 mg), (0.5 mg) and (0.4 mg) respectively. These values are also a little bit higher than the value (0.5–0.2 mg) reported by[23] Copper plays a fundamental role in the production of red blood cells and energy production. It also aids the body in the formation of collagen and absorption of iron. The value of the copper gotten is lower than the recommended daily allowance, the upper limit for adults is 10 mg/100g[26] and any intake above this could be toxic.

The result of Manganese content revealed that the highest value (2.0, mg) is in ZT3, followed by ZT3 (1.6, mg) while ZT3 had the least value (1.1, mg). Manganese is essential for bones, hormone production, nervous system function, energy metabolism and antioxidant. It is also crucial for blood clothing and connective tissue growth.[27] The recommended daily allowance for men is 2.3 mg/day and women 1.8mg/day. [26]

Calcium has been reported to be the most abundant mineral in the human body, with 99% of it contained within bones and teeth. The other 1% found in the cellular and extracellular fluid is important for biological functions.[24] Calcium content (3.8 mg) was found in ZT3, followed by ZT2 (3.5 mg) and the least value (2.7 mg) in ZT1. These value showed a lower level (3.8 mg – 2.7 mg) of calcium, but not sufficient to meet the Adequate Intake (AI) of calcium for adults (1000-1200 mg/day) and adolescence (1300 mg/day). Calcium deficiency is certainly a risk factor for osteoporosis in later life.[28] This makes supplementation very important.

Vitamin C content in ZT3 was the highest value (1.6 mg), followed by ZT2 with ascorbate value of (1.4 mg) and the least value 1.2 mg in ZT1 respectively. Vitamin C is a well-established regulator of neurotransmitter biosynthesis. It serves as a cofactor for dopamine β-hydroxylase in the conversion of dopamine to norpinephrine (NE), which plays an important role in the regulation of mood. Chronic lack of vitamin C leads to decreasing NE levels.[29] It is also useful in the production of white blood cells whose function is to enhance the body's immunity and protect it against infections.[30] The recommended daily intake of vitamin C is 75 mg and 90 mg for women and men respectively.[31]

Microbial analysis of organically fortified zobo drink (*Hibiscus sabdariffa*) powder

The microbial count from fortified (enriched) recipe for Zobo(Z) were evaluated against some foodborne pathogens namely : *Bacillus spp*, *Proteus spp*, *Klebsiella spp, Escherichia coli*, are presented in Table 5. The mean values of ZT1 is between (2.0×10^2 - 1.0×10^2 cfu/ml) with had high bacterial counts in ZT1 and the lowest bacterial counts (1.0×10^2 cfu/ml) in ZT3 of Klebsiella spp. The highest microbial count was also found in ZT1 (2.0×10^2 - 1.0×10^2 cfu/ml) and the lowest bacterial counts (1.0×10^2 cfu/ml) in ZT3 of E. coli respectively. No growth was recorded for both bacillus spp and proteus spp, which may be due to the temperature and hygienic conditions given to the laboratory zobo ZT1 and fortified zobo (ZT2) and ZT3 prepared for all the samples.[23] Figure 2

Table 5 Shows the Microbial analysis of organically fortified zobo drink (*Hibiscus sabdariffa*) powder

Sample	Bacillus spp	Proteus spp	Klebsiella spp	Ecoli
ZT1	Nil	Nil	2.0×102	2.0×102
ZT2	Nil	Nil	1.0×102	2.0×102
ZT3	Nil	Nil	1.0×102	1.0×102

Value are means ± standard deviation of three determinations. Values with different superscripts along the columns are significantly different ($p<0.05$)

Where; ZT1, ZT2, ZT3, Stands for sample (1, 2, 3, respectively)

Control ZT1 = 100 g of Zobo + 0g of spices

ZT2 = 90 g of Zobo + 10 g of spices

ZT3 = 80 g of zobo + 20 g of spices

Source; Hospitality Management, Auchi Polytechnic 2022

Figure 2 Dried Zobo flower petals used during the research.

The spices and ingredients represented in Figure 3 are:

i. Nutmeg
ii. Dried potato chip
iii. Dried garlic
iv. Dried Dates
v. Dried cloves
vi. Dried west African black pepper,
vii. Grain of selim

All the ingredients above were mixed in different proportions with the separately milled zobo petal powder.

Figure 3 Picture of Spices and ingredients used during the research.

Conclusion and recommendation

Conclusion

Contributing to the health benefits associated with the consumption of organically fortified Zobo Tea (*Hibiscus sabdariffa*) powder as beverage, this research have sought to contribute to knowledge via the production process of spiced Zobo Tea (*Hibiscus sabdariffa*) powder and its proximate content. This is aimed at improving the nutritional composition and health benefit of the plant based sample i.e. Zobo. Thus, organically fortified zobo drink (*Hibiscus sabdariffa*) powder, samples produced in the course of this research have passed the sensory panelist test which revealed variance in consumer acceptability amongst the three samples ZD1, ZD2, ZD3. From the result it was observed that all the three sample have no significant differences ($p<0.05$) that is, they are similar in their characteristics in mean score and standard deviation in terms of all the sensory characteristics (taste, appearance, aroma, texture, overall acceptability), which is an indication that the general acceptability of these samples is above average by the end users.

Recommendation

We hereby recommend based on the conclusions derived from the analytical results of this research that, indigenous drink produced from organically fortified zobo drink (*Hibiscus sabdariffa*) powder, should be encouraged for consumption in order to help spread the health benefits associated with the indigenous zobo drinks among consumers so as to achieve a wide range of consumer acceptability and profit. More so, further studies should be carried out in prospects of phytonutrients composition of the produced organically fortified Zobo Tea (*Hibiscus sabdariffa*) powder. This will help food nutritionists make recommendations on best indigenous zobo tea sample adaptable for consumption by different consumer and age profile.

Acknowledgments

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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