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# Proximate, phytochemical and sensory evaluations of African Black Pepper (*Piper guineense*), Guinea Pepper (*Xylopia aethiopica*) and Aidan Fruit (*Tetrapleura tetraptera*)spiced drinks

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**Abstract:** This study evaluated the proximate and phytochemical properties of African black pepper (*Piper guineense*), Guinea pepper (*Xylopia aethiopica*) and Aidan fruit (*Tetrapleura tetraptera)* spices and also assessed the level of acceptability of the drinks prepared using these spices. Pineapple, zobo and kunuzaki drinks enriched with African black pepper, guinea pepper and aidan fruitandginger/garlic (control) were produced. Proximate and phytochemical properties of the spices and sensory evaluations of the spiced drinks were determined. The results of the proximate compositions of the spices showed that aidan fruit recorded the highest values in moisture (11.33%), ash (8.53%) and protein (9.78%). African black pepper recorded highest values in fat (9.32%) and carbohydrate (58.95%) while Guinea pepper recorded highest values in fibre (19.60%). African black pepper recorded the lowest values in moisture (9.45%), ash (6.83%), Fibre (8.64%) and protein (6.82%). The phytochemical properties of the spices showed that African black pepper recorded the highest values in alkaloids (1.77%), tannins (1.85%), saponins (0.21%) and flavonoids (0.47%) while Guinea pepper recorded the highest values in cyanide (0.05%) and phenol (3.81%) and Aidan fruit recorded the lowest values for all the phytochemical determined. The sensory evaluation showed that sample B (stimulating pineapple drink enriched with uziza, uda and oshosho) was most preferred by the panelists. Findings from this study have clearly shown that these spices can be used in production of various drinks with comparable nutritional qualities and general acceptability to the already existing drinks.

**Keywords:** African black pepper; Guinea pepper; Aidan fruit; zobo; kunuzaki. 

## 1. Introduction

Spices are a large group of natural ingredients which include dried seeds, fruits, roots, rhizomes, barks and flowers plants which are used in very small quantities as food additives to improve colour, flavour, aroma and other organoleptic qualities of food and also serve in food preservation [1]. The bulk of the major components of spice materials consist of carbohydrate, proteins, minerals and

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phytochemicals. The phytochemicals present in spices such as alkaloids, steroids, tannins, flavonoids and phenolic compounds are responsible for their flavouring, colouring, preservative and health promoting characteristics [2]. Essential oils (EOs), usually obtained from several parts of plants contain volatile aromatic compounds which are predominantly secondary metabolites [3]. They have potent antibacterial and antifungal activity and have also been known to have antioxidant properties and cancer suppressive activity against human malignant (cancer) cell lines [4].

African black pepper (*Piper guineense*) belongs to piperacea family, like all true pepper seeds. They are prolate spheroids, small and smooth in appearance and generally bear a reddish tinge. They are native to tropical regions of Central and Western Africa and are cultivated in Nigeria where the leaves are used as a flavouring for stews [5]. *Piper guineense*contains nutritional and non nutritional factors which are responsible for its aroma, flavour and preservative properties [6]. It is rich in protein, fat, fiber and carbohydrate. On dry weight basis *Piper guineense*contains crude protein from (4.6 to 22.1 %), fat (ether extract) ranged from 7.5 to 36.0 %, while total carbohydrate content ranged from 34.6 to 71.9 % [7]. Nwankwo *et al.* [6] also studied *Piper guineense* and found that in addition to the above mentioned, it also contains a high amount of ash. This implies high mineral content such as calcium, zinc, magnesium, copper and potassium [8]. Juliani *et al.* [9] reported that *Piper guineense*is an important plant used in traditional medicine and as spice. The fruits of *Piper guineense*(which is the part of the plant that is traditionally used) are rich in a wide range of natural products including volatile oils, lignans, amides, alkaloids, flavonoids and polyphenols.

Guinea pepper (*Xylopia aethiopica*) also known as Uda belongs to the annoneceae family. It is an ever green aromatic dicotyledenous plant commonly found in West Africa, South Africa and Brazil. The fruits are cylindrically thick, about 5 cm long and are green when unripe, reddish when ripe and black when dried. The fruits contain 3-9 seeds which are used as substitute for pepper. Chemical compositions of the seeds consist of flavonoids, alkaloids, cineol, phytosterols, tannins, saponins, glycosides, carbohydrates, terpenes, paradol, cryptone, limonene, myrtenol etc. and have been shown to have antioxidizing, laxative and antimicrobial properties [10]. Zaragozá [11] reported proximate composition of 9.59% moisture, 6.97% ash, 13.89% protein, 9.28% fibre, 7.81% fat and 52.94% carbohydrate for *Xylopia aethiopica*. It has anti-microbial effects against gram positive and negative bacteria and their phytochemicals have antioxidant properties. These properties are exploited in hot pepper soups (postpartum tonic) prepared for postnatal and lactating mothers as anti-infection and lactation aid in the traditional set ups [12]. The seed extract of *Xylopia aethiopica* is also an important plant used in traditional medicine to assist in the contraction of the uterus in post-partum women [13].

Aidan Fruit(*Tetrapleura*tetraptera) also known as oshosho is a flowering-medicinal plant belonging to the Leguminosae family. It is a deciduous tree mostly found in the western part of Africa and is usually referred to as Aidan fruit in English [14]. *T. tetraptera* has a variety of chemical compositions that translate into its nutritive value. Significant amounts of various nutrients such as ash, fiber, proteins, carbohydrates, vitamins, and fats are present in *T. tetraptera* [14]. The chemical composition of the plant may vary at different parts of its fruit. For example, the carbohydrate and mineral contents of *T. tetraptera* fruit among the seeds, pulp, and woody coats are significantly different [15]. Similar to the nutritional composition, *T. tetraptera* possesses an essential concentration of phytochemicals such as tannins, alkaloids, steroids, flavonoids, triterpenoids, and phytate [16]. These bioactive naturally occurring organic compounds induce health benefits in humans compared to micronutrients and macronutrients [16]. The rich source of the aforementioned phytochemicals in *T. tetraptera* confers its pharmacological activities such as antimicrobial, hypoglycaemic, neuromuscular, molluscicidal, trypanocidal, and anti-ulcerative [17]. These pharmacological activities have proven its use in traditional medicine

Spices have been in existence for years and some of these local spices were consumed without knowing the actual nutritional composition of them. The ability of consumers to accept drinks prepared with these spices are uncertain. Also, foreign spices are available, most of them are priced beyond the reach of the majority of population in Nigeria. Some of these spices are manufactured using high technology and expensive packaging. There is need for an alternative that is cheaper and has more health benefits. Therefore, this study was carried out to determine the proximate and phytochemical properties of African black pepper (*Piper guineense*), Guinea pepper (*Xylopia aethiopica*) and Aidan fruit

(*Tetrapleura tetraptera)* spices and to assess the level of acceptability of the drinks prepared using these spices.

## 2. Materials and Methods

### *2.1. Source of Raw Materials*

Freshly dried seeds of African Black Pepper *(Piper guineense)* also known as uziza, Guinea Pepper *(Xylopia aethiopica)* also known as Uda and the dried pods of Aidan Fruit *(Tetrapleura tetraptera)* also known as oshosho, ginger, garlic and clove were bought from Ubani main market in Umuahia North Local Government Area of Abia State, Nigeria between 20th - 24th January, 2025 and were identified at Project Development Institute PRODA, Enugu Nigeria.

### *2.2. Sample Preparation*

Samples were sorted to remove dirt and unwholesome ones and then washed in water, oven dried at 80ºC, milled using a blender (model: 220V/50Hz/200W) and sieved. The samples were packaged in an air tight container until needed for analysis.

**Figure 1.** Dried African black pepper **Figure 2.** Dried fruits Guinea pepper **Figure 3.** Dried pods of Aidan Fruit

#### *2.2.1. Production of Pineapple Drink*

Pineapple drink enriched with African black pepper (*Piper guineense*), guinea pepper (*Xylopia aethiopica*) and aidan fruit (*Tetrapleura tetraptera*)andginger/garlic (control) were produced according to the method described by Akujobi*et al.* [18] with slight modifications. The pineapple fruit was washed thoroughly in running tap water and peeled using a stainless steel knife. The pineapple fruit was sliced into small chunks and the juice was extracted using a fruit juice extractor (model: HA-9801, 220-240V). The pineapple extract was boiled with 1 g each of uziza, uda and oshosho and for the control, 20 g each of ginger/garlic for 5 minutes at temperature of 70ºC and was allowed to cool before packing and kept refrigerated.

#### *2.2.2. Production of Kunu Zaki Drink*

Kunu zaki drink enriched with African black pepper (*Piper guineense*), guinea pepper (*Xylopia aethiopica*) and aidan fruit (*Tetrapleura tetraptera*)andginger/clove (control) were produced according to the method described by Islamiyat*et al.* [19]. Millet (1 kg) and the spices (20 g of each spice) were soaked in water separately for 72 hr. Wet milled using hammer mill and wet sieved with muslin cloth. The slurry was fermented for 48 hr. at ambient temperature (28ºC), during which it was allowed to sediment. The supernatant was decanted and the slurry residue was mixed with water (1 L) and divided into two equal parts. One part of the slurry was boiled (100ºC) for 2 minutes and the uncooked slurry (second part) was mixed with the boiled one. Water (500 ml) and sugar (200 g) were added to obtain the desired thickness and taste.

*2.2.3. Production of Zobo Drink*

Zobo drink enriched with African black pepper (*Piper guineense*), guinea pepper (*Xylopia aethiopica*) and aidan fruit (*Tetrapleura tetraptera*)andginger/garlic (control) were produced according to the method described by Ezekiel *et al.* [20] with slight modifications. About 1.2 liter of water was heated in a pot (100ºC) and the 30 g zobo leaves were added to the boiling water and were boiled for 5 minutes. Twenty (20) g each of uziza, uda and oshosho and for the control, (20) g each of ginger/garlic were added into the mixture and was boiled (100ºC) for 2 minute. The pot was then removed from heat and the zobo drink was allowed to cool and was filtered using a muslin cloth before packaging.

*2.3. Determination of Proximate Composition of the Spices*

Moisture, crude protein, fat, ash, crude fiber and carbohydrate contents of the grounded spices were all determined using the method described by AOAC [21].

$$\%\text{Moisture} = \frac{\text{W2} - \text{W3}}{W2 - W1} \times \frac{100}{1}$$

Where:
$W_1$ = weight of empty dish
$W_2$ = weight of dish and sample before drying
$W_3$ = weight of dish and sample after drying

$$\%\text{Ash} = \frac{\text{W3} - \text{W1}}{W2 - W1} \times \frac{100}{1}$$

Where:
$W_1$ = weight of empty crucible
$W_2$ = weight of crucible+sample before ashing
$W_3$ = weight of crucible + sample after ashing

$$\%\text{Fat} = \frac{\text{W2} - \text{W1}}{W} \times \frac{100}{1}$$

Where:
W = weight of sample
$W_1$ = weight of flask
$W_2$ = weight of flask and oil extracted

$$\%\text{Crude fibre} = \frac{\text{W1} - \text{W2}}{W} \times \frac{100}{1}$$

Where:
W = weight of sample
$W_1$ = weight of crucible + residue after drying
$W_2$ = weight of crucible + sample after ashing

% Total Nitrogen = Titre Value x Atomic mass of nitrogen x Normality of HCl used x 4. Therefore, the crude protein content w determined by multiplying percentage Nitrogen by a conversion factor of 6.25 i.e. % crude protein = % N x 6.25.

The percentage of carbohydrate content was obtained by differential method as follows:

Carbohydrate (%) = 100 - [%Moisture + % Ash + %Protein + %Crude fiber + %Fat]

*2.4. Determination of Phytochemical Properties of the Spices*

Test for the presence of alkaloids and saponin were carried out following the method of Herborne [22]. Alkaloid was done by the alkaline precipitation gravimetric method. One (1) mg of the sample was dispersed in 10 ml of 10 % acetic acid solution in ethanol to form a ratio of 1:10 (10%). The mixture was allowed to stand for 4hours at 28 °C. It was later filtered with a Whatman No 42 grade filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation and treated with drop wise addition of concentrated aqueous $NH_4OH$ until the alkaloid was precipitated. The alkaloid precipitated was filtered, received in a weighed filter paper, washed with 1% ammonia solution dried in the oven at 80ºC for 30 minutes. Alkaloid content was calculated as:

$$\% \text{ Alkaloid} = \frac{W2-W1}{W} \times \frac{100}{1}$$

W = weight of sample
W1 = weight of empty filter paper
W2 = weight of paper + alkaloid precipate

Saponin content of the samples was determined by the double solvent extraction gravimetric method. Five (5) grams of the powdered sample was weighed and mixed with 50 ml of 20 % aqueous ethanol solution. The mixture was heated with periodic agitation on a water bath for 90 minutes at 55℃. It was filtered through Whatman No. 42 filter paper and the residue re-extracted with 50 ml of 20 % ethanol, both extracts were combined together. The combined extracts were reduced to 40 ml over a water bath at 90 ℃ and the concentration transferred into 250 ml separating funnel and 40 ml of diethyl ether added and shaken vigorously. Separation was by partition during which the aqueous layer recovered and the ether layer discarded. Re-extraction by partition was done repeatedly until the aqueous layer became clear in colour. The saponins was extracted with 60 ml of normal butanol and the combined n-butanol extract washed with 5 % aqueous NaCl (sodium chloride) solution and evaporated to dryness in a pre-weighed evaporating dish. It was further dried at 60℃ in the oven and weighed. The saponin content was determined and expressed as percentage of the weight analyzed using the formula:

$$\% \text{ Saponin} = \frac{W2-W1}{W} \times \frac{100}{1}$$

W = weight of sample
W1 = weight of empty evaporating dish
W2 = weight of dish + saponin extract

Flavonoids was carried out following the method of Meda *et al.* [23]. F1ive (5) grams weight of each sample was boiled in 50 ml of 2M HCl solution for 30 minutes under reflux. It was allowed to cool and then filtered using Whatman No 42 filter paper. A known volume (5 ml) of the extract was treated drop wise with equal volume of ethyl acetate. The flavonoid precipitated was recovered by filtration using weighed filter paper. The weight difference gave the weight of flavonoid in the sample.

$$\% \text{ Flavonoids} = \frac{W2-W1}{W} \times \frac{100}{1}$$

W = weight of sample
W1 = weight of empty crucible
W2 = weight of paper + flavonoid precipate

Phenols was carried out following the method of Singleton *et al.* [24]. A quantity of 0.2 g of the sample was treated with 10ml of concentrated methanol to extract the phenol and filtrate. This was mixed for 30 minutes at room temperature. The mixture was centrifuged at 500rpm for 15 minutes and the supernatant was used for the analysis. One ml portion of the extant from each sample was treated with equal volume of folin- ciocalteu's reagent followed by the addition of 2 ml of 2 % $Na_2CO_3$ solution. The standard phenol solution was prepared and diluted to a desired concentration. One ml of the standard solution was also treated with F-D reagent and $Na_2CO_3$solution. The intensity of the resulting blue coloration was in a spectrophotometer at 560 nm wavelength. Measurements were made with a reagent blank at zero.

Tannins was carried out following the method of Pearson [25]. Five (5) grams weight of each sample was dispersed in 50 ml of distilled water, shaken and allowed to stand for 30 minutes at 28 °C before it was filtered through whatman No.42 grade filter paper. Two ml volume of each sample extract was dispensed into a 50 ml volumetric flask and mixed with 2 ml standard reagent and 2.5 ml of saturated $Na_2CO_3$ solution. After mixing, the content of each flask was made up to 50 ml with distilled water and allowed to incubate at 28 ℃ for 90 minutes. The respective absorbance was measured in a spectrophotometer at wave length of 260 nm. The reagent blank was used to calibrate the instrument while the absorbance values of the samples was plotted to determine tannin content against the weight of the sample. Tannin content was calculated as:

$$\% \text{ Tannin} = \frac{100}{w} \times AU \times \frac{\text{C}}{AS} \times C \times \frac{\text{Vf}}{1000} \times D/Va$$

W = weight of sample analyzed
AU = Absorbance of the test sample
AS = Absorbance of the standard solution in mg/ml
C = Concentration of standard solution in mg/ml
Vf = Total volume of extract
Va= Volume of extract analyzed
D = Dilution factor

Hydrogen cyanide content was determined using the method described by Onwuka [26]. Five (5) grams of the ground plant sample was dissolved in 50 ml distilled water in a conical flask and allowed to stay overnight and filtered after. 2 millimetres of the filtrate was poured into a conical flask and 4ml alkaline picrate solution was added and incubated in water bath for 5miuntes for colour development (reddish brown) and absorbance was taken at 490 nm. Also blank was prepared using 2 ml distilled water. The cyanide content was extrapolated using a cyanide standard curve.

$$\% \text{ hydrogen cyanide} = \frac{100}{w} \times \frac{An}{As} \times \text{C} \times \frac{Vf}{Va} \times \frac{1}{10^6}$$

An = absorbance of test sample
As = absorbance of standard solution
C = concentration of standard solution
W = weight of sample used
$V_f$ = total volume of extract
$V_a$ = volume of extract analyzed

*2.5. Sensory Evaluation*

The sensory evaluation was carried out using 20 panelists made who are familiar with the sensory attributes taste, texture, mouth feel and color. Their preference was rated on a nine (9) point hedonic scale. Where 9 = extremely liked, 8 = liked very much, 7 = liked moderately, 6 = like much, 5 = neither like nor dislike, 4 = dislike, 3 = dislike moderately, 2 = dislike very much, 1 = disliked extremely. They samples were served simultaneously with clean white disposable cups. Drinking water was provided for rinsing of mouth between samples.

*2.6 Statistical Analysis*

The replicated experimental data was analyzed for Analysis of Variance (ANOVA) at 0.05 level of significance and Pearson correlation coefficient at 0.05 level of significance using one- way ANOVA. All the data was presented in mean± standard error of mean and alphabetic mean ranking in case of significant difference observed based on Duncan Multiple Range Test.

## 3. Results and Discussion

*3.1. Proximate Compositions*

The proximate compositions of the different spices are shown in Table 1. The moisture content of the spices ranged from 9.45 – 11.33%. African black pepper (*Piper guineense*) had the least value (9.45%) while aidan fruit (*Tetrapleura tetraptera*) had the highest value (11.33%). There were significant ($p<0.05$) differences among samples. The moisture contents of the spices were within the range values 6.90 – 11.90% reported by Dodo *et al.* [27] for *Piper guineense, Xylopia aethiopica, Ocimum gratissimum, Ricinus communis and Pergulariadeamia* spices but lower than the values 14.15 – 21.13% reported by Ebana*et al.* [28] for *Tetrapleura tetraptera and Piper guineense*. These values indicate that the spices are relatively dry owing to their low moisture content. The low moisture contents allow them to be stored for a longer duration without spoiling. Higher moisture contents lead to food spoilage through increasing microbial activity [29]. The higher moisture content recorded in aidan fruit (*Tetrapleura tetraptera*) when compared with the other spices from this study could be due to reduced transpiration in the seeds, since they are contained within the pod.

The ash content of the spices ranged from 6.83 – 8.53%. African black pepper (*Piper guineense*) had the least value (6.83%) while aidan fruit (*Tetrapleura tetraptera*) had the highest value (8.53%). There were significant ($p<0.05$) differences among samples. The ash contents of the spices were higher than the values 1.12 – 3.23% reported by Dodo *et al.* [27] for *Piper guineense, Xylopia aethiopica, Ocimum gratissimum, Ricinus communis and Pergulariadeamia* spices but vary from the values 6.22 – 7.43% reported by Evuen*et al.* [30] for three culinary spices *Xylopia aethiopica* (fruits), *Piper guineense*(seeds), and *Rhaphiostylisbeninensis* (roots). Ash content determines the mineral composition of the spices. These minerals are essential for the proper functioning of the human immune system. The high ash content recorded in aidan fruit (*Tetrapleura tetraptera*) is an indication of higher composition of vital mineral elements compared to other spices.

The crude fibre of the spices ranged from 8.64 – 19.60%. African black pepper (*Piper guineense*) had the least value (8.64%) while guinea pepper (*Xylopia aethiopica*) had the highest value (19.60%). There were significant ($p<0.05$) differences among samples. The crude fibre content of guinea pepper (*Xylopia aethiopica*) was within the RDA for children 19-20% reported by National Research Council. The crude fibre contents of the spices vary from the values 7.75 – 11.38% reported by Fategbe*et al.* [31] for *Xylopia aethiopica* whole fruit, seed, and pericarpand 4.61 – 18.39% reported by Ebana*et al.* [28] for*Tetrapleura tetraptera and Piper guineense*. According to Igile*et al.* [32] consumption of plants which contain fiber could aid digestion, absorption of water from the body and prevent constipation. Fibre cleanses the digestive tract by removing potential carcinogens from the body, therefore preventing absorption of excess cholesterol [33]. In addition, fibre adds calories to food and lessens intake of excess starchy food, thereby helping to prevent metabolic conditions such as hypertension and diabetes mellitus [34].

The fat content of the spices ranged from 6.81 – 9.32%. Guinea pepper (*Xylopia aethiopica*) had the least value (6.81%) while African black pepper (*Piper guineense*) had the highest value (9.32%). Guinea pepper (*Xylopia aethiopica*) differ significantly ($p<0.05$) from other samples. The fat contents of the spices vary from the values 0.39 – 13.82% reported by Evuen*et al.* [30] for three culinary spices *Xylopia aethiopica* (fruits), *Piper guineense*(seeds), and *Rhaphiostylisbeninensis* (roots) and 4.06 and 1.91% reported by Imo *et al.* [35] for *Piper guineense* seeds and leaves. The fat contents of the spices were below the range described by acceptable macronutrient distribution ranges (AMDRs) for adults (20-35%) [36]. Therefore, could be recommended as part of weight reducing diets since low fatty foods are said to reduce the level of cholesterol and obesity. However, African black pepper (*Piper guineense*) may support the production of hormones of lipid origin owing to its higher amount of fat.

The protein content of the spices ranged from 6.82 – 9.78%. African black pepper (*Piper guineense*) had the least value (6.82%) while aidan fruit (*Tetrapleura tetraptera*) had the highest value (9.78%). There were significant ($p<0.05$) differences among samples. The protein contents of the spices vary from the values 3.45 – 7.80% reported by Fategbe*et al.* [31] for *Xylopia aethiopica* whole fruit, seed, and pericarp and 12.99 and 15.17% reported by Imo *et al.* [35] for *Piper guineense* seeds and leaves. The proteins present in the three spices could impact the proteins required by humans for certain biochemical activities or processes such as replacement and repair of worn-out tissues, growth, provision of hormones, and amino acids. Hence, crude protein values obtained for spices in this study make them good sources of plant protein.

Carbohydrate content had the highest nutritional composition of all the spices evaluated in this study. It ranged from 42.52 – 58.95%. Aidan fruit (*Tetrapleura tetraptera*) had the least value (42.52%) while African black pepper (*Piper guineense*)had the highest value (58.95%). There were significant ($p<0.05$) differences among samples. The carbohydrate contents of the spices vary from the values 19.38 – 67.10% reported by Dodo *et al.* [27] for *Piper guineense, Xylopia aethiopica, Ocimum gratissimum, Ricinus communis and Pergulariadeamia* spices, 30.39 – 56.77% reported by Fategbe*et al.* [31] for *Xylopia aethiopica* whole fruit, seed, and pericarp and 70.08 – 81.24% reported by Evuen*et al.* [30] for three culinary spices *Xylopia aethiopica* (fruits), *Piper guineense*(seeds) and *Rhaphiostylisbeninensis* (roots). Carbohydrate content of Guinea pepper (*Xylopia aethiopica*)and African black pepper (*Piper guineense*) were within the range for adult provided by AMDRs (45-60%) [36]. Carbohydrates such as glucose provide energy to cells in the body, especially the brain, which solely depends on glucose for energy. Therefore, the carbohydrate contents observed for Guinea pepper (*Xylopia aethiopica*)and African black pepper (*Piper guineense*) indicate that they are good sources of fuel and energy for the body's daily activities.

The observed differences in the proximate compositions recorded in this study when compared with the findings of other studies may be due to differences like the soil and climatic conditions in the areas of cultivation, genetic variations, and differences in analytical procedures.

**Table 1.** Proximate composition of the local spices

| **Sample (%)** | **Moisture content** | **Ash** | **Crude fibre** | **Fat** | **Crude protein** | **Carbohydrate** |
|---|---|---|---|---|---|---|
| XO | $10.72^{b}\pm0.09$ | $7.85^{b}\pm0.01$ | $19.60^{a}\pm0.08$ | $6.81^{b}\pm0.04$ | $7.53^{b}\pm0.11$ | $47.51^{b}\pm0.14$ |
| UO | $9.45^{c}\pm0.13$ | $6.83^{c}\pm0.10$ | $8.64^{c}\pm0.01$ | $9.32^{a}\pm0.03$ | $6.82^{c}\pm0.05$ | $58.95^{a}\pm0.19$ |
| TO | $11.33^{a}\pm0.13$ | $8.53^{a}\pm0.18$ | $18.78^{b}\pm0.03$ | $9.07^{a}\pm0.16$ | $9.78^{a}\pm0.03$ | $42.52^{c}\pm0.21$ |

Values show the mean of duplicate analysis and ± standard deviation. Figures with different superscript down the column are significantly different ($p<0.05$).
XO = Guinea pepper (*Xylopia aethiopica*), UO = African black pepper (*Piper guineense*), TO = Aidan fruit (*Tetrapleura tetraptera*)

*3.2. Phytochemical Properties*

The phytochemical properties of the different spices are shown in Table 2. The results indicate the presences of alkaloids, saponin, flavonoids, tannins, phenols and hydrogen cyanide in all of the plant extracts. African black pepper (*Piper guineense*) recorded the highest values in alkaloid (1.77%), tannin (1.85%), saponin (0.21%) and flavonoid (0.47%) and Guinea pepper (*Xylopia aethiopica*) recorded the highest values in cyanide (0.05%) and phenol (3.81%), while aidan fruit (*Tetrapleura tetraptera*) recorded the lowest values for all the phytochemical determined. There were significant

($p<0.05$)differences among the samples for alkaloid, tannin and phenol. No significant ($p>0.05$) differences were observed between Guinea pepper (*Xylopia aethiopica*)and African black pepper (*Piper guineense*), African black pepper (*Piper guineense*)and aidan fruit (*Tetrapleura tetraptera*) and Guinea pepper (*Xylopia aethiopica*) and aidan fruit (*Tetrapleura tetraptera*) for saponin, cyanide and flavonoid respectively. These values vary from flavonoids (2.73 – 4.04%), tannins (0.17 – 0.78%), alkaloids (1.57 – 2.23%), phenols (0.33 – 2.92%) and saponins (0.23 – 0.36%) reported by Evuen*et al.* [30] for three culinary spices *Xylopia aethiopica* (fruits), *Piper guineense*(seeds) and *Rhaphiostylisbeninensis* (roots) and flavonoids (1.26 – 10.30%), tannins (0.36%), alkaloids (1.80 – 2.26%), phenols (4.50 – 9.83%) and saponins (1.20 – 1.40%) % reported by Ebana*et al.* [28] for *Tetrapleura tetraptera and Piper guineense*. The observed differences may be due to the method of analysis, genetic, variety, harvesting time, climatic conditions of the growing area, method of processing, and variation in solvent for extraction. This is in line with the findings of Onyeka and Nwambekwe [37] who reported that method of processing affect the phytochemical properties of vegetables. Also, According to Müller and Heindl [38], post-harvest processes like drying take authoritative impact on the quality of the product influencing its value which is mostly shown on its appearance.

Qiu [39] have shown that alkaloids have a wide range of pharmacological activities. Hence, the presence of alkaloids in the spices could account for their use as antimicrobial agents. Alkaloids work on the nervous system and are used as analgesic because they are capable of relieving pains [40], and it plays some metabolic roles and control development in living organisms [41]. A growing interest exists in the flavonoids and phenol contents of plants owing to their roles against pathogenic organisms and in the scavenging of free radicals. Flavonoids and phenols are known antioxidants in plants and humans. Hence, African black pepper (*Piper guineense*) and Guinea pepper (*Xylopia aethiopica*) will have a greater antioxidant potential in comparison with the other two spices owing to their higher constituent of favonoids and phenols respectively. Tannins are aromatic compounds containing phenolic groups. They are one of the principal active ingredients found in plant-based medicines possessing antiviral, antibacterial, and antitumor activities [42]. Tannins significantly predominate ($p< 0.05$) in African black pepper (*Piper guineense*). Consequently, African black pepper (*Piper guineense*) may serve a better potential as a major active ingredient in drug production compared to the other two spices [43]. Roa *et al.* [44] have shown that saponins possess antioxidant, antitumor, and anti-mutagenic activities and may also reduce the incidence of human cancers by inhibiting the growth of cancer cells. The saponin content of the spices ranged from 0.13 to 0.21%. Interestingly, toxicological studies of saponin using relevant experimental models have established that even at a higher concentration of 3.5%, saponin was safe and did not cause any systemic side effects [45]. Thus, it can be deduced from the above that the levels of saponin in the three spices are safe for human consumption.

**Table 2.** Phytochemical properties of the local spices

| **Sample (%)** | **Alkaloid** | **Tannin** | **Saponin** | **HCN** | **Flavonoid** | **Phenol** |
|---|---|---|---|---|---|---|
| XO | $1.64^{b}\pm0.02$ | $1.25^{b}\pm0.01$ | $0.17^{a}\pm0.01$ | $0.05^{a}\pm0.00$ | $0.29^{b}\pm0.01$ | $3.81^{a}\pm0.04$ |
| UO | $1.77^{a}\pm0.04$ | $1.85^{a}\pm0.01$ | $0.21^{a}\pm0.02$ | $0.04^{b}\pm0.00$ | $0.47^{a}\pm0.03$ | $1.60^{b}\pm0.05$ |
| TO | $1.47^{c}\pm0.02$ | $0.79^{c}\pm0.01$ | $0.13^{b}\pm0.01$ | $0.03^{b}\pm0.00$ | $0.25^{b}\pm0.02$ | $0.87^{c}\pm0.05$ |

Values show the mean of duplicate analysis and ± standard deviation. Figures with different superscript down the column are significantly different ($p<0.05$).
HCN = Hydrogen cyanide, XO = Guinea pepper (*Xylopia aethiopica*), UO = African black pepper (*Piper guineense*), TO = Aidan fruit (*Tetrapleura tetraptera*)

*3.3. Sensory characteristics*

The sensory characteristics of the drinks prepared from the three local spices are shown in Table 3. The appearance of the drinks ranged from 6.65 – 7.60. Sample C (Kunu drink enriched with uziza, uda and oshosho) had the least value (6.65) while sample B (Stimulating pineapple drink enriched with uziza, uda and oshosho) had the highest value (7.60). Sample C (Kunu drink enriched with uziza, uda and oshosho) differ ($p< 0.05$) significantly from other samples. The values for the appearance varied from the values (7.45-8.00) reported by Akujobi *et al.* [18] for zobo (*Hibiscus sabdariffa*) drinks substituted with pineapple (*Ananas comosus*) and orange (*Citrus sinensis*) juices.

The mouth feel of the drinks ranged from 6.00 – 7.45. Sample E (Zobo drink enriched with uziza, uda and oshosho) had the least value (6.00) while samples B (Stimulating pineapple drink enriched with uziza, uda and oshosho) and $B_1$ (Stimulating Pineapple drink enriched with ginger/garlic) had the highest values (7.45). There were significant ($p< 0.05$) differences in the mouth feel of the drinks enriched with the three local spices. The values for the mouth feel were lower than the values (7.75-8.13) reported by Olufunke *et al.* [46] for mixed spices from selected local spices retailed in Ede, Nigeria.

The texture of the drinks ranged from 6.10 – 7.55. Sample E (Zobo drink enriched with uziza, uda and oshosho) had the least value (6.10) while sample B (Stimulating pineapple drink enriched with uziza) had the highest value (7.55). There were no significant ($p>0.05$) differences in the texture of sample B (Stimulating pineapple drink enriched with uziza, uda and oshosho), sample C (Kunu drink enriched with uziza, uda and oshosho), sample $B_1$ (Stimulating Pineapple drink enriched with ginger/garlic) and sample $C_1$ (Kunu enriched with ginger and clove). . The values for the texture were lower than the values (7.67-8.13) reported by Olufunke *et al.* [46] for mixed spices from selected local spices retailed in Ede, Nigeria.

The taste of the drinks ranged from 5.95 – 7.85. Sample $E_1$ (Zobo drink enriched with ginger and garlic) had the least value (5.95) while sample B (Stimulating pineapple drink enriched with uziza, uda and oshosho) had the highest value (7.85). There were significant ($p< 0.05$) differences in the taste of the drinks enriched with the three local spices. The values for the taste are similar to the values (5.63-7.87) reported by Akujobi *et al.* [18] for zobo (*Hibiscus sabdariffa*) drinks substituted with pineapple (*Ananas comosus*) and orange (*Citrus sinensis*) juices.

**Table 3.** Sensory characteristics of the drinks prepared from the three local spices

| SAMPLE | Appearance | Mouth feel | Texture | Taste | General acceptability |
|---|---|---|---|---|---|
| B | $7.60^{a}\pm1.67$ | $7.45^{a}\pm1.64$ | $7.55^{a}\pm1.23$ | $7.85^{a}\pm1.09$ | $7.90^{a}\pm0.79$ |
| C | $6.65^{b}\pm1.66$ | $6.35^{b}\pm1.81$ | $7.00^{a}\pm1.17$ | $6.20^{b}\pm1.51$ | $6.70^{b}\pm1.42$ |
| E | $7.25^{a}\pm1.62$ | $6.00^{c}\pm2.08$ | $6.10^{b}\pm2.13$ | $6.00^{c}\pm1.95$ | $6.35^{b}\pm1.98$ |
| $B_1$ | $7.55^{a}\pm1.36$ | $7.45^{a}\pm1.73$ | $7.50^{a}\pm1.40$ | $7.10^{a}\pm2.00$ | $7.85^{a}\pm1.14$ |
| $C_1$ | $7.45^{a}\pm1.36$ | $6.60^{b}\pm1.57$ | $6.95^{ab}\pm1.43$ | $6.80^{b}\pm1.44$ | $7.25^{ab}\pm1.65$ |
| $E_1$ | $7.15^{a}\pm1.84$ | $6.05^{c}\pm2.06$ | $6.50^{b}\pm1.47$ | $5.95^{c}\pm1.64$ | $6.65^{b}\pm1.73$ |

Values show the mean of duplicate analysis and ± standard deviation. Figures with different superscript down the column are significantly different ($p<0.05$).
B = Stimulating pineapple drink enriched with uziza, uda and oshosho, C = Kunu drink enriched with uziza, uda and oshosho,E = Zobo drink enriched with uziza, uda and oshosho, $B_1$ = Stimulating Pineapple drink enriched with ginger/garlic,$C_1$ = Kunu enriched with ginger and clove, $E_1$ = Zobo drink enriched with ginger and garlic

The general acceptability of the drinks ranged from 7.90 – 6.35. Sample E (Zobo drink enriched with uziza, uda and oshosho) had the least value (6.35) while sample B (Stimulating pineapple drink enriched with uziza, uda and oshosho) had the highest value (9.90). There were no significant ($p>0.05$) differences in the acceptability of sample C (kunu drink enriched with uziza, uda and oshosho), sample E (Zobo drink enriched with uziza, uda and oshosho), sample $C_1$ (Kunu enriched with ginger and clove) and sample $E_1$ (Zobo drink enriched with ginger and garlic). The values obtained from this study indicated that the samples were accepted by the panellists in all the attributes tested. However, sample B (stimulating pineapple drink enriched with uziza, uda and oshosho) was most preferred by the panellists. This was contrary to the findings of Obi [47] who reported that ginger flavoured drinks had the highest acceptability followed by African black pepper (*Piper guineense*) and Guinea pepper (*Xylopiaaethiopica*) and Ukwuru and Uzodinma [48] who reported that cloves (*Synygium aromaticum*) had the highest overall acceptability. These variations may have been due to the fact that different spice concentrations were used in the studies.

## 4. Conclusion

This study provides novel insights into the nutritional and phytochemical properties of three local spices - African black pepper (*Piper guineense*), Guinea pepper (*Xylopia aethiopica*), and aidan fruit (*Tetrapleura tetraptera*) and their potential applications in food product development. Our findings demonstrate significant variations in the proximate compositions and phytochemical profiles of these spices, highlighting their unique nutritional and bioactive properties. Notably, aidan fruit (*Tetrapleura tetraptera*) exhibited higher levels of moisture, ash, and crude protein compared to the other spices. The phytochemical analysis revealed the presence of alkaloids, tannins, saponins, flavonoids, and phenols, which are known for their antioxidant, antimicrobial, and anti-inflammatory properties. Furthermore, the sensory evaluation of drinks enriched with these spices showed that they were well-accepted by panelists, with the pineapple drink enriched with uziza, uda, and oshosho being the most preferred. These findings have implications for the development of novel food products with enhanced nutritional and sensory properties. Overall, this study contributes to the growing body of research on the nutritional and phytochemical properties of local spices and their potential applications in the food industry.

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