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Development and comparative evaluation of spice-mix seasonings from functional leaves of Utazi (*Gongronema latifolium*), Uda (*Xylopia aethiopica*), Nchanwu (*Ocimum gratissimum*) and Uziza (*Piper guineense*).

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Abstract

Spices are esoteric food adjuncts that are used to enhance the sensory quality of foods. Some local spices are currently in use for their health benefits in culinary. This study was on the development of seasonings from spice-leaves of Utazi (*Gongronema latifolium*), Uziza (*Piper guineense*), Uda (*Xylopia aethiopica*) and Nchuanwu (*Ocimum gratissimum*) which were formulated in ratios of 15:15:15:15 (ES); 24:12:12:12 (TS); 12:24:12:12 (ZS); 12:12:24:12 (US) and 12:12:12:24 (NS) with other ingredients. Local seasoning (Yaji) was used as control (CS) for comparison. The spice-leaves were evaluated for their phytochemical contents and the seasonings were evaluated for their chemical, antioxidant and sensory properties. The result of the phytochemical analysis of the spice-leaves showed that flavonoid, anthocyanin, alkaloid, saponin and tannin ranged from 0.20 - 4.32%, 0 - 0.16%, 1.49 - 7.91%, 0.18 - 5.68% and 0.22 - 8.63% respectively. The proximate analysis showed that the moisture content of the seasonings ranged from 7.42-12.62%. Samples TS and ZS had the lowest values for fat (3.20%) and fibre (5.39%). NS had lowest oil absorption capacity (7.75%) and highest water absorption capacity (10.70%). The produced seasonings were higher in vitamins A (10.4 - 17.90 µg/100g), C (55.05 – 62.50 mg/100g), and E (1.23 – 6.31 mg/100g) while commercial sample CS was higher in B-vitamins (0.16 – 0.20 mg/100g). The seasonings with spice-leaves exhibited higher DPPH and FRAP antioxidant activities. In overall sensory acceptability, control sample CS was preferred. However, the developed seasonings had higher nutritional, functional and antioxidant potentials and would serve as functional ingredient.

Keywords: Antioxidant, Functional ingredients, Phytochemical, Proximate, Sensory

1. Introduction

Spices are esoteric food adjuncts that are used to enhance the sensory quality of foods (Ndife, 2016). They have been used as flavourings since ancient times and as medicine and food preservatives in recent decades (Nabavi *et al.,* 2016). They impart characteristic flavor, aroma or piquancy and color to foods, stimulate appetite as well as modify the texture of foods. Recent research reveal that dietary spices in their minute quantities have immense effect on human health by their antioxidant, chemo preventive, anti-mutagenic, anti-inflammatory, immune modulatory effects on cells (Okwu *et al*., 2006; Ndife, 2016). Spices occur in variety of flavor, colour and aroma, they contribute a wide range of nutrient to foods (Mann, 2011; Okonkwo and Ogu, 2014).

Variety of local seasonings exists for different purposes. The most commonly used in Northern Nigeria for dried meat products (suya) is called “Yaji” (Nwaopara et al., 2009). It can also be used in different recipes such as soups, stews, jollof rice, salad dressing etc. Other spice-mixes are also produced in different regions of Nigeria, from numerous indigenous plants such as red pepper, Utazi, Uda, Nchanwu, Uziza and many more in different formulations for specific purposes (Okonkwo et al., 2014).

Utazi (*Gongronema latifolium*) is an edible nutritional/medicinal plant mostly found in the rain forest zones in Nigeria and other tropical African countries (Eleyinmi, 2007). Medicinally, utazi is used in West African communities to treat cough, intestinal worms, dysentery, dyspepsia and malaria. It is a good source of protein, minerals and vitamins. Previous researches have shown that the leaves are suitable for use in food production due to their high amino acid contents (Osuagwu *et al.,* 2013). The leaves can be eaten fresh, dried and used as local powdery spice or as vegetable for food preparations such as unripe plantain porridge, white soup, sauces and salads in which they add a bittersweet flavor. They are also used to spice locally brewed beer (Adenuga *et al.,* 2010). Utazi leaves are rich in fats, proteins, vitamins, minerals and essential amino acids (Eleyinmi, 2007). It also contains minerals such as calcium, phosphorus, potassium and magnesium as well as iron and zinc in minute quantities.

Uziza *(Piper guineense)* belong to the family *Piperaceae*. It is a West African spice plant commonly called “Ashanti pepper” (Elizabeth *et al.,* 2016). It is known as “Uziza” in Igbo and “Iyere” in Yoruba. Other common names are black pepper, Benin pepper, Guinea pepper and false cubeb (Elizabeth *et al.,* 2016). It has high commercial, economical, and medicinal value. Extracts from its leaves, roots and seeds are used for the treatment of bronchitis, gastrointestinal disorders and rheumatism (Okon *et al*., 2014). Uziza has high mineral content such as calcium, zinc, magnesium, copper and potassium in the vegetable (Idris *et al*., 2011) with appreciable protein and carbohydrate contents (Okonkwo and Ogu, 2014). More so, Uziza contains vitamin C, vitamin A and traces of vitamin B_1 and B_2, vitamin E (Chibuzor and Assumpta, 2014).

Uda *(Xylopia aethiopica)* belongs to the family *Annonaceae*. The plant contains significant amount of major active principles of therapeutic benefits suitable for the treatment of bronchitis, dysentery, rheumatism, malaria, uterine fibroid and amenorrhea (Okonkwo and Ogu, 2014). The fruits can also be crushed and mixed with Shea butter and used as body creams, cosmetic products. The mature fruit of green color take a brown-black coloration after drying and they are commonly used as spices (Okonkwo and Ogu, 2014).

Nchanwu *(Ocimum gratissimum)* of the family *Lamiceae*. It is known by various names in different parts of the world such as “effinrin-nla” by the Yoruba speaking tribe. It is called “Ahuji” or "Nchuanwu" by the Igbos, while in the Northern part of Nigeria, the Hausas call it

"Daidoya" (Effraim *et al*., 2003). This spice is used in the preparation of foods and medicines. It is used in the treatment of fungal infections, fever, cold, and catarrh.

The use of artificial seasonings which is common in commercial brands is fraught with some health hazards. The need for people to make food their medicine is rapidly increasing, hence the need to consume functional foods or ingredients. The addition of these functional spices; Utazi, Uziza, Nchuanwu and Uda in seasonings will not only enhance it nutritionally but also functionally, providing a wide range of health benefits to its consumers. Thus, this work is an attempt to develop functional seasonings from some local medicinal spices that would have positive impact on human health when consumed

2. Materials and methods

2.1. Source of raw material

Groundnut cake, salt, seasoning (maggi), ginger, red pepper, Utazi (*Gongronema latifolium)*, Nchuanwu (*Ocimum gratissimum)*, Uziza (*Piper guineense)*, and Uda (*Xylopia aethiopica)* were purchased from Ubani market in Umuahia, Abia State of Nigeria.

2.2. Sample preparation

2.2.1. Production of spice powders

The utazi, uda, uziza and nchuanwu leaves were sorted to remove the unwholesome leaves and washed properly to remove dirt and debris. The washed leaves were also destalked to remove the stems attached to the leaves and chopped to facilitate faster drying. The leaves were dried at 60°C in a hot air oven (Bionics scientific BST/HAO-1122, India) for 5 hours (*Utazi* leaves), 30 minutes (*Uda* leaves), 30 minutes (*Uziza* leaves) and for 4 hours (*Nchuanwu* leaves) respectively. The dried leaves were milled with an electric grinder (Tower spice grinder T12009, China) and sieved with a 2 µm sieve to obtain fine and uniform particles of the powders.

2.2.2. Production of seasonings

The spice-leaves powders were weighed according to the formulation in Table 1 and mixed together with the other ingredients to produce the spice-mix seasonings (Table 2). The seasonings were then ground and sieved with a 2µm sieve to obtain a uniform fine particle sizes. Local seasoning (Yaji) was used as the control sample for comparison.

Table 1: Spice-leaves formulation (%)

Samples	Utazi	Uziza	Uda	Nchuanwu
ES	15	15	15	15
TS	24	12	12	12
ZS	12	24	12	12
US	12	12	24	12
NS	12	12	12	24

Table 2: Seasoning recipe

Ingredients	Quantity (%)
Spice-leaves	60
Groundnut	15
Ginger	5
Maggi	6
Salt	6
Pepper	8
Total	100

2.3. Methods of Analysis

2.3.1. Proximate analysis

The determination of the chemical composition of the samples for moisture, ash, protein, fat, and fiber contents were determined by methods described by AOAC (2010). The carbohydrate content of the samples was determined by estimation using the arithmetic difference method of Onwuka, (2018).

2.3.2. Functional properties analysis

The method described by Onwuka (2018), was used in determination of bulk density, water absorption capacity, oil absorption capacity, wettability and emulsion capacity of the samples

2.3.3. Vitamin analysis

The spectrophotometric method described by Jacobs (1999) was used; the absorbance of the sample and the standard solutions were measured with a UV-Spectrophotometer at their respective wavelengths. The concentrations of the vitamins in the prepared samples were run against known standards calibrated curve.

2.3.4. Phytochemical analysis

The method of AOAC (2010) was used to determine tannin content of the spice-leaves powder. The alkaloid and flavonoid contents was determined by the method described by Abdulmalik *et al.* (2009). Saponin was determined by the double solvent extraction gravimetric method described by Harbourne (1973). Anthocyanin content was determined by the method described by Flores-Martinez *et al.* (2018).

2.3.5. Antioxidant assay

The antioxidant capacities of the seasonings were measured by comparing two different antioxidant assays as described by Thaipong *et al.* (2006). The radical scavenging capacity was measured using DPPH solution (2,2-diphenyl-1-picrylhydrazyl) and Ferric reducing antioxidant power (FRAP) was determined by using potassium ferricyanide-ferric chloride solution.

2.3.6. Sensory evaluation

The protocol described by Iwe (2010) was adopted. The organoleptic properties of the seasoning samples were evaluated by 20-member semi-trained panelists, randomly selected from the staff and students of Michael Okpara University of Agriculture, Umudike. Sensory attributes including appearance, aroma, texture, taste, and general acceptability of the seasonings were scored in a 9-point hedonic scale. The degree of likeness was expressed as: Like extremely 9, like very much 8, like moderately 7, like slightly 6, neither like nor dislike 5, dislike slightly 4, dislike moderately 3, dislike very much 2, dislike extremely 1.

2.3.7. Experimental design and statistical analysis

The experimental set-up was a completely randomized design (Hinklemann and Kempthrone, 2008). All determinations were done in triplicates and the results are presented as mean ± standard deviations. The data obtained from the various analyses were subjected to analysis of variance (ANOVA) for comparison of the means. Differences between means were considered to be significant at $p<0.05$. The statistical package for social sciences version 16.0 was used (SPSS, 2011).

3. Results and discussion

3.1. Proximate composition of seasonings

The result of the proximate composition of the seasonings is presented in Table 3.
The moisture content of seasons ranged from 7.42 to 12.62%. Values obtained were significantly different ($p<0.05$) from each other. The commercial sample (CS) had lower moisture content (7.42%) compared to the composite seasoning samples (10.58-12.62%). The values obtained in this study are higher than the value (8.85%) reported by Keswet and Abia (2015). Moisture content can be used as an index of stability of foods (Ezeama, 2007). It could be presumed that the composite seasonings would have a lower shelf stability compared to the commercial sample.

The ash content of the samples ranged from 4.97 to 9.72%. The composite seasonings had higher ash content than the commercial sample (CS; 4.97%). This observation might be due to the proportions of multiple leaf powders in the formulation. Notably, ES with equal proportion of leaf powders had the highest ash content (9.72%) followed by NS (9.22%) then ZS (7.20%). Although, the ash content obtained in this study was higher than the value obtained for pepper soup seasoning (2.75%) reported by Keswet and Abia, (2015). Ash content represents total minerals content in foods and thus, serves as a viable tool for nutritional evaluation of mineral (Ndife et al., 2019; Mamiro *et al.,* 2011). The increased ash content of the composite seasoning samples might indicate improved mineral content than in the commercial sample (CS).

Equal proportion of the leaf powders in ES resulted in higher fat content (10.64%), this was followed by control CS (10.27%). The lowest fat value was observed in TS (3.28%). The values are considerably lower than the values obtained for a similar seasoning which had an ash content of 22.8% (Keswet and Abia., 2015). Dietary fat increases the palatability of food by absorbing and retaining flavor although excess of fat is also implicated in certain cardiovascular diseases. The low fat content (3.28 to 10.64%) in the composite seasonings, might result to increased keeping quality as a result of decreased susceptibility to rancidity (Ezeama, 2007).

The protein content in the composite seasonings (12.18 – 13.59%) were higher than the value (11.14%) in the commercial sample CS. ES (15.12%) had the highest value while CS (11.14%) had the lowest value. The leaf-spices in the seasonings must have made the difference. The protein content of the samples is appreciably high compared to the values reported by Keswet and Abia (2015), for pepper soup seasoning (9.29%). The composite seasonings will contribute to the protein requirement of the human body.

The crude fiber content of the samples ranged from 5.39 to 13.31%. The highest value was reported in ES (13.31%) followed by NS (9.13%) while ZS (5.39%) had the lowest value. The variations in the results could be linked to fibre content of the leaf powders. The values obtained in this study are lower than the values reported for pepper soup seasoning (26.80%) (Keswet and Abia, 2015). Crude fibre offers a variety of health benefits and is essential in reducing the risk of chronic disease such as diabetes, obesity, cardiovascular disease and diverticulitis (Ndife, 2016). The carbohydrate content of the composite seasonings were quite high (39.71 – 58.43%) which compares favourably with that of the commercial sample CS (59.71%). Considering the fat and carbohydrate contents, the composite seasonings will be good sources of energy to the body.

Table 3: Proximate composition of seasoning samples (%).

Samples	Moisture	Ash	Fat	Crude fiber	Protein	Carbohydrate
CS	$7.42^{f}\pm0.02$	$4.97^{f}\pm0.06$	$10.27^{b}\pm0.02$	$6.51^{d}\pm0.02$	$11.14^{f}\pm0.01$	$59.71^{a}\pm0.10$
ES	$11.51^{b}\pm0.01$	$9.72^{a}\pm0.02$	$10.64^{a}\pm0.01$	$13.31^{a}\pm0.01$	$15.12^{a}\pm0.03$	$39.71^{f}\pm0.06$
TS	$12.62^{a}\pm0.02$	$6.44^{d}\pm0.02$	$3.28^{f}\pm0.04$	$6.51^{d}\pm0.01$	$13.27^{c}\pm0.02$	$57.90^{c}\pm0.00$
ZS	$11.35^{c}\pm0.03$	$7.20^{c}\pm0.01$	$4.04^{e}\pm0.01$	$5.39^{e}\pm0.01$	$13.59^{b}\pm0.01$	$58.43^{b}\pm0.09$
US	$10.58^{e}\pm0.01$	$5.60^{e}\pm0.01$	$6.27^{d}\pm0.01$	$7.02^{c}\pm0.01$	$13.13^{d}\pm0.01$	$57.43^{d}\pm0.00$
NS	$11.04^{d}\pm0.01$	$9.22^{b}\pm0.01$	$6.43^{c}\pm0.01$	$9.13^{b}\pm0.02$	$12.18^{e}\pm0.01$	$52.02^{e}\pm0.04$

Values are mean±SD. Mean values in the same column with different superscript are significantly different (p<0.05). CS: Control sample (Commercial Yaji). ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12% Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

3.2. Functional properties of seasonings

The results of functional properties of the seasonings are presented in Table 4.

The bulk density of the composite seasonings ranged from 0.65 to 0.68 g/ml. The commercial sample had the lowest bulk density (0.59 g/ml). There was significant difference (p<0.05) between the bulk densities of the composite seasonings and the control CS. Bulk density reveals the porosity of a product, which is important in packaging designs (Onwuka, 2018), since it reveals the load carrying capacity of a food material when allowed to rest on its weight. The bulk density values were quite low, this may be advantageous when used in food formulation-mix which may require compact packing (Ndife et al., 2019).

The control sample CS had the lowest oil absorption capacity (OAC) (6.81%) compared to the composite seasonings (7.21 to 7.75%). The values of OAC obtained in this study was higher than the values (1.72 - 3.32%) reported by Nguyen and Nguyen (2018). The presence of hydrophobic protein shows superior binding of lipids (Lawal and Adebowale, 2014), the higher OAC of the composite seasonings could be attributed to their high protein content (Table 3). The high OAC indicate that these seasonings might have improved mouth-feel and better flavor retention (Onwuka, 2018).

Similar to the OAC, NS had the highest WAC (10.70%) followed by US (10.62%) while CS had the lowest value (5.11%). The different leaf powders did not significantly influence the WAC of the seasonings. The observed variation in the different seasoning may be due to different protein concentrations, their degree of interaction with water and conformational characteristics (Butt and Batool, 2010). The high WAC of the composite seasonings suggest that they could be used in formulation of some foods such as sausage, dough processed cheese and even in some bakery products (Onwuka, 2018).

The emulsion capacity (EC) of the seasoning samples ranged from 37.9 to 42.10%. The highest EC was recorded in NS (42.10%) and ES (42.05%), while CS had the lowest emulsion capacity (37.90%). Proteins as surface active agents can form and stabilize the emulsion by creating electrostatic repulsion on oil droplet surface (Lawal, and Adebowale, 2014). The results showed that, the emulsion capacity might have greatly increased in the composite seasonings due to their protein contents. However, the variations in the emulsion capacities of the samples might be attributed to the different spice-leaf powders.

ES had the highest wettability value (242.50 sec), followed by TS (231.50 sec) while the control sample CS had the lowest wettability value (25.50 sec). There was significant difference ($p<0.05$) between the values obtained. It took more time (176.50 - 242.50 sec) for the composite seasonings to become wet than the control CS, as a result of poor water absorption. Wettability improves with less oil containment and smaller particle size (Onwuka, 2018). Also, higher value of wettability indicates lower reconstitution properties (Ndife *et al*., 2019).

Table 4: Functional properties of seasoning samples.

Samples	BD (g/ml)	OAC (%)	WAC (%)	EC (%)	WET (seconds)
CS	0.59^{c}±0.01	6.81^{e}±0.01	5.11^{c}±0.01	37.90^{d}±0.14	25.50^{f}±2.12
ES	0.67^{a}±0.01	7.21^{d}±0.01	10.50^{a}±0.14	42.05^{a}±0.07	242.50^{a}±0.71
TS	0.65^{b}±0.01	7.43^{c}±0.01	10.60^{a}±0.14	41.55^{b}±0.07	231.50^{b}±0.71
ZS	0.68^{a}±0.01	7.50^{c}±0.01	10.34^{b}±0.02	41.10^{b}±0.14	226.00^{c}±0.00
US	0.68^{a}±0.01	7.61^{b}±0.01	10.62^{a}±0.02	40.60^{c}±0.14	212.50^{d}±3.54
NS	0.67^{a}±0.01	7.75^{a}±0.07	10.70^{a}±0.14	42.10^{a}±0.14	176.50^{e}±2.12

Values are mean ± SD. Mean values on the same column with different superscript are significantly different ($p<0.05$).
BD-Bulk density; OAC-Oil absorbtion capacity; WAC-Water absorption capacity; EC-Emulsion capacity; WET-Wettability; CS: Control sample (Commercial Yaji); ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12%, Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

3.3. Vitamin content of seasonings

The results of the vitamin content of the seasoning samples is shown in Table 5.
The Vitamin A content ranged from 8.85-17.90 µg/100g. Values obtained were significantly different ($p<0.05$) from each other. The result obtained showed that ES with equal proportion of leaf powders had the highest value (17.90 µg/100g), followed by TS (12.60 µg/100g. The higher vitamin A content in ES and TS could be attributed to the presence of Utazi, since its reduced content in other composite seasonings resulted in reduced vitamin A content. The values obtained in this study were higher than the value obtained for *Piper guineense* (7.08 µg/100g) by Elizabeth *et al*. (2016). Vitamin A is a fat-soluble vitamin and a powerful antioxidant. It plays a critical role in maintaining healthy vision and skin.

The thiamin B content of the composite seasonings was low (0.01 – 0.08 mg/100g) compared to the commercial sample (0.16 – 0.20 mg/100g). Values obtained were significantly different ($p<0.05$) from each other. The low vitamin B values could be attributed to processing conditions and spice-leaves used. The values obtained were similar to those obtained for *Piper guineense* (0.029 mg/100g) as reported by (Elizabeth *et al.,* 2016). Also, the values obtained in this study for vitamin B_1 and B_2 in all the seasonings were low.

The vitamin C content was highest in US (62.50 mg/100g) followed by NS (60.20 mg/100g) while the control sample CS (50.45 mg/100g) had the lowest value. These results suggested that the use spice-leaves must have improved the vitamin C content of the composite seasonings. Vitamin C is beneficial in treatment of flu and act as antioxidant. However, the values obtained are considerably lower than the values for *Piper guineense* (292.62 mg/100g) reported by Elizabeth *et al*. (2016).

The vitamin E content of the samples ranged from 0.14-8.31 mg/100g. The results obtained were significantly different ($p<0.05$) from each other. NS (8.31 mg/100g) had the highest value followed by ES (6.31 mg/100g) while the commercial sample (CS) (0.14 mg/100g) had the lowest value. The higher vitamin E content recorded in NS could be attributed to the higher proportion of Nchuanwu in the spice-mix. The obtained values are lower than the value reported by Elizabeth *et al.* (2016) for *Piper guineense* (32.26 mg/100g). Vitamin E is a strong antioxidant that potentially prevents damage caused by free radicals (Ndife et al., 2019).

Table 5: Vitamin content of seasoning samples

Sample	Vitamin A (µg/100g)	Vitamin B1 (mg/100g)	Vitamin B2 (mg/100g)	Vitamin C (mg/100g)	Vitamin E (mg/100g)
CS	$10.40^{c}\pm0.14$	$0.16^{a}\pm0.14$	$0.20^{a}\pm0.03$	$50.45^{d}\pm0.21$	$0.14^{f}\pm0.01$
ES	$17.90^{a}\pm0.14$	$0.01^{b}\pm0.00$	$0.02^{b}\pm0.00$	$58.55^{c}\pm0.21$	$6.31^{b}\pm0.01$
TS	$12.60^{b}\pm0.14$	$0.01^{b}\pm0.00$	$0.01^{b}\pm0.00$	$55.05^{e}\pm0.07$	$1.23^{e}\pm0.01$
ZS	$10.75^{c}\pm0.07$	$0.02^{b}\pm0.00$	$0.02^{b}\pm0.00$	$56.40^{d}\pm0.14$	$3.16^{e}\pm0.01$
US	$10.40^{c}\pm0.14$	$0.02^{b}\pm0.00$	$0.02^{b}\pm0.00$	$62.50^{a}\pm0.14$	$2.93^{d}\pm0.01$
NS	$8.85^{d}\pm3.07$	$0.01^{b}\pm0.00$	$0.08^{a}\pm0.01$	$60.20^{b}\pm0.14$	$8.31^{a}\pm0.01$

Values are mean ± SD. Mean values on the same column with different superscripts are significantly different ($p<0.05$)

CS: Control sample (Commercial Yaji); ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12%, Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

3.4. Phytochemical content of the leaf powders

The results of the phytochemical analysis of the seasonings are presented in Table 6.

The flavonoid content of the leaf powders ranged from 0.20-4.32%. Nchuanwu had the highest value (4.32%) followed by Uziza (1.59%) while Uda (0.20%) has the lowest value. Flavonoids are one of the major polyphenols present in plants and are strong antioxidants and effective antimicrobials (Ndife, 2016), Flavonoids have been reported to possess substantial anti-carcinogenic and anti-mutagenic activities (Okwu *et al.,* 2006). The flavonoid content of Nchuanwu (4.32%) is lower than the values reported by Okerulu *et al.* (2019).

Anthocyanin content of spice-leaves ranged from 0.00 - 0.16%. Uda (0.16%) had the highest value followed by Uziza (0.13%) while the content in Utazi was very negligible. The values obtained in this study were lower than the value (0.70%) reported by Arnnok *et al.* (2012). Anthocyanin are phenolic compounds with help benefits (Ndife, 2016)

The alkaloid content ranged from 1.49-7.91%. Nchuanwu had the highest value (7.91%) of alkaloid content followed by Utazi (4.90%). Uda (1.49%) and Utazi (1.59%) had low values.

Some alkaloids exert a stimulating role on the central nervous system (Kaur and Aurora, 2015). Prolonged consumption of these spice-leaves may generally increase metabolic activity in the body, endure stress and develop resistance against diseases (Kaur and Aurora, 2015).

Table 6: Phytochemical content of the leaf powders (%).

Samples	Flavonoid	Anthocyanin	Alkaloid	Saponin	Tannin
Uda	$0.20^{d}\pm0.00$	$0.16^{a}\pm0.01$	$1.49^{d}\pm0.00$	$0.18^{d}\pm0.01$	$0.22^{c}\pm0.01$
Uziza	$1.59^{b}\pm0.02$	$0.13^{b}\pm0.01$	$1.59^{c}\pm0.01$	$0.27^{c}\pm0.01$	$1.77^{b}\pm0.02$
Nchuanwu	$4.32^{a}\pm0.01$	$0.03^{c}\pm0.01$	$7.91^{a}\pm0.02$	$4.51^{b}\pm0.01$	$8.60^{a}\pm0.07$
Utazi	$0.76^{b}\pm0.01$	$0.00^{d}\pm0.00$	$4.90^{b}\pm0.01$	$5.68^{a}\pm0.01$	$8.63^{a}\pm0.04$

Values are mean ± SD. Mean values on the same column with different superscript are significantly different ($p<0.05$).

Utazi had the highest tannin content (8.63%) followed by Nchuanwu (8.60%) while Uda had the lowest value (0.22%). There was significant difference ($p<0.05$) in the values obtained. These values (0.22-8.63%) were higher than the values reported by Itoro *et al.* (2015). Tannins are astringent plant polyphenolic compounds that either binds or precipitates proteins and alkaloids, thereby making proteins partially unavailable. They also inhibit digestive enzymes and increase fecal nitrogen (Ndife, 2016).. Tannin concentration in Nchuanwu and Utazi are above the value (0.50 – 5.00%) reported by Chung et al., (1998). The higher values obtained could attest to the heat stability of tannins. Tannins are good antioxidants and catechin, a type of tannin mostly present in leaves has been found to decrease total cholesterol, lower blood pressure and minimizes the risk of cancer (Chung *et al.,* 1998).

Similar to the observations on tannin content, Utazi had the highest saponin value (5.68%) followed by Nchanwu (4.51%) while Uda had the lowest value. Saponins are absorbed only in small amounts, they decrease enzyme activity and can form complexes with zinc and iron, thus, limiting their bioavailability (Liener, 2003).

3.5. DPPH Antioxidant activity of seasonings

The results of the antioxidant activity of the seasonings using DPPH are presented in Table 7. The result for DPPH antioxidant activity is shown in Table 7. The result showed that the various concentrations yielded and their varying values. Among the samples, TS (with highest *Utazi* leaf) had the highest antioxidant activity (14.77 – 30.25%) at all levels of extract concentration followed by ES (12.18- 28.73%). The commercial sample CS had higher value (10.98%) than ZS (10.46%) and NS (10.00%) at 25% concentration of extracts. The values obtained in this study were lower than the values reported by (Rohan *et al.,* 2015) for cinnamon and cumin (42.55 and 14.75%) respectively. Antioxidants have the potential capacity to stabilize the cell membrane by scavenging free radicals and counteract the ageing process in the body (Ndife, 2016).

Table 7: DPPH activity for the seasoning samples (%)

Samples	Concentration of extracts (µmol)				
	25	50	100	200	400
CS	10.98^{d}±0.01	11.41^{a}±0.02	13.42^{e}±0.02	14.24^{f}±0.02	20.20^{e}±0.02
ES	12.18^{b}±0.04	15.39^{a}±0.17	21.72^{b}±0.03	25.62^{b}±0.02	28.73^{b}±0.04
TS	14.77^{a}±0.03	16.29^{a}±0.02	24.12^{a}±0.01	26.16^{a}±0.03	30.25^{a}±0.02
ZS	10.46^{e}±0.01	11.51^{a}±0.01	13.55^{d}±0.02	20.16^{d}±0.02	22.13^{d}±0.02
US	11.26^{c}±0.01	13.22^{a}±0.03	17.24^{c}±0.02	21.44^{c}±0.02	23.10^{c}±0.03
NS	10.00^{f}±0.02	12.16^{a}±0.01	13.04^{f}±0.02	16.17^{e}±0.02	20.19^{e}±0.02

Values are mean ± SD. Values on the same column with different superscript are significantly different ($p<0.05$).

DPPH (2,2-diphenyl-1-picrylhydrazyl). CS: Control sample (Commercial Yaji); ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12%, Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

3.6. FRAP Antioxidant activity of seasonings

The result of FRAP antioxidant activity showed various extract concentrations yielded varying values (Table 8). The FRAP values followed similar pattern as the DPPH. Sample ES had the highest FRAP values (14.55 – 28.22%) while NS had the least (10.44 -23.13%). The FRAP values of the seasonings with spice-leaves (10.44 – 28.22%) were higher than that of the control CS (10.22 – 24.12%). The composite seasonings had higher values than was reported by Rohan *et al.* (2015) for cinnamon and cumin (0.07% and 0.08%) respectively. It could be inferred that the seasonings with higher antioxidant activities will possess greater potential to scavenging free radicals that causes oxidative degradation of cells.

Table 8: FRAP activity for seasoning samples (%)

Samples	Concentration of extract (µmol)				
	20	40	80	160	320
CS	10.22^{b}±0.03	15.34^{b}±0.02	18.16^{a}±0.02	22.03^{a}±0.03	24.12^{a}±0.02
ES	14.55^{e}±0.01	17.23^{d}±0.02	22.38^{b}±0.04	24.13^{c}±0.04	28.22^{c}±0.02
TS	15.17^{a}±0.01	18.04^{a}±0.03	21.16^{a}±0.02	23.17^{b}±0.02	25.18^{b}±0.01
ZS	12.34^{d}±0.02	15.13^{e}±0.02	16.23^{c}±1.39	20.24^{e}±0.02	23.92^{d}±0.03
US	12.56^{c}±0.02	16.04^{c}±0.04	17.21^{c}±0.02	21.08^{d}±0.01	23.82^{e}±0.03
NS	10.44^{f}±0.02	13.52^{f}±0.01	14.28^{d}±0.01	15.33^{f}±0.01	23.13^{f}±0.04

Values are mean ± SD. Values on the same column with different superscript are significantly different ($p<0.05$).

FRAP (ferric reducing antioxidant power). CS: Control sample (Commercial Yaji); ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12%, Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

3.7. Sensory characteristics of seasonings

The result of the sensory evaluation of the seasoning samples is presented in Table 9. The appearance score ranged from 7.10 - 8.15. Commercial sample (CS) had the highest appearance score (8.15) while US had the least (7.10). The produced seasonings had no significant difference (p>0.05) in appearance among each other, which showed that, appearance of the seasonings were all liked moderately by the panelists. However, the panelist had better preference for the appearance of sample CS than the other samples and was liked very much. They complained of not been used to greenish colour of the produced seasonings

The aroma score of the samples ranged from 6.10 - 7.20. Control CS had the highest (7.20) aroma score followed by sample ES (7.00) while sample TS has the least (6.10). Although, there was no significant difference (p>0.05) in the aroma of the samples except for TS. The pungent aroma of Utazi used in the composite seasonings could have been responsible for the lower scores. The panelists had better preference for the aroma of CS than the other samples and was liked moderately as ES. Other seasoning samples were liked slightly by the panelist. The different spice-leaves used were associated with various aromas

The taste score of the seasoning samples ranged from 5.75-7.80. Sample CS had the highest taste score (7.80) followed by sample ES (6.75) while sample NS has the least value (5.75). The preferred the taste of sample CS when compared to the other samples. The results implied that, CS was liked moderately, TS was neither liked nor disliked while the rest of the seasonings were liked slightly. The higher Utazi used in composite seasonings conferred a pungent taste on them, especially in sample TS

The scores for texture ranged from 7.40 - 7.90. CS had the highest texture score (7.90) followed by sample US (7.75) while sample TS had the least value (7.40). However, the results revealed that, there was no significant difference in the texture of the samples and were all liked moderately.

The general acceptability of the seasoning samples ranged from 6.75-8.05. Sample CS had the highest general acceptability score (8.05) followed by sample ES (7.45) while sample TS had the least acceptance (6.75). The general acceptability rating implied that the commercial sample NS was liked very much than other samples. Apparently, the panelist were not used to the novel seasonings which could explain their low sensory scores.

Table 9: Sensory evaluation of seasoning samples.

Sample	Appearance	Aroma	Taste	Texture	Acceptability
CS	8.15^{a}±0.81	7.20^{a}±1.15	7.80^{a}±0.95	7.90^{a}±0.91	8.05^{a}±0.60
ES	7.15^{b}±0.75	7.00^{a}±1.12	6.75^{b}±1.89	7.60^{a}±1.23	7.45^{a}±1.00
TS	7.15^{b}±1.14	6.10^{b}±1.52	5.75^{b}±1.77	7.40^{a}±1.10	6.75^{b}±1.33
ZS	7.20^{b}±1.32	6.95^{a}±1.36	6.40^{b}±1.79	7.65^{a}±1.27	6.80^{b}±1.70
US	7.10^{b}±1.17	6.50^{a}±1.24	6.65^{b}±1.27	7.75^{a}±0.91	6.85^{b}±1.18
NS	7.15^{b}±0.81	6.85^{a}±1.09	6.70^{b}±1.23	7.65^{a}±1.04	6.95^{b}±1.19

Values are mean ± SD. Values on the same column with different superscript are significantly different ($p<0.05$).

CS: Control sample (Commercial Yaji); ES (15% Utazi, 15% Uziza, 15% Nchuanwu and 15% Uda); TS (24% Utazi, 12% Uziza, 12% Nchuanwu and 12% Uda); ZS (24% Uziza, 12% Utazi, 12% Nchuanwu and 12% Uda); US (24% Uda, 12%, Utazi, 12% Uziza, and 12% Nchuanwu); NS (24% Nchuanwu, 12% Utazi, 12% Uziza and 12% Uda).

4. Conclusion

In this study an attempt was made to develop seasonings from spice-leaves of Utazi (Gongronema latifolium), Uda (Xylopia aethiopica), Nchuanwu (Ocimum gratissimum) and Uziza (Piper guineense). The results of proximate analysis showed that, equal proportion of Utazi, Uziza, Nchuanwu and Uda (ES) had the best proximate composition. Vitamin analysis showed that composite seasonings were higher in vitamins A, C, and E than the commercial sample (CS) while control CS has higher vitamin B_1 and B_2. Also the produced seasonings exhibited higher DPPH and FRAP antioxidant activities than control CS. The results for the sensory evaluation showed that the commercial sample (control) CS was preferred by the panelists in all the sensory parameters than the produced seasonings due to lack of acquaintance to the novel seasonings.

This study have demonstrated that the production of composite seasoning from these spice-leaves would improve the nutritional and antioxidant potential of modified commercial seasonings.

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