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Full Length Research Paper

Studies on the chemical and antinutritional content of some Nigerian spices

Friday O. Uhegbu[1]*, Emeka E. J. Iweala[2] and Ijeoma Kanu[3]

[1]Department of Biochemistry, Faculty of Biological and Physical Science, Abia State University, P. M. B. 2000 Uturu, Nigeria.
[2]Department of Biological Sciences (Biochemistry and Molecular Biology Unit), College of Science and Technology, Covenant University, P. M. B. 1023 Ota, Ogun State, Nigeria.
[3]Department of Microbiology, Faculty of Biological and Physical Science, Abia State University, P. M. B. 2000 Uturu, Nigeria.

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Quantitative determination of chemical and anti-nutrient content of six spices commonly consumed in the South East of Nigeria was carried out using standard methods. Results reveal that the chemical and anti-nutritional composition of these edible Nigerian spices*, Gongronema latifolium, Piper guineense, Xylopia aethiopica , Monodora myristica, Allium sativum and Tetrapleura tetrapetra* are rich in protein, fat, fiber, and carbohydrate in the range of 1.17 to 11.90%, 1.06 to 14.66%, 0.33 to 38.60% and 13.18 to 76.16% respectively. The mineral and vitamin content is equally high: Ca^{2+} 122 to 279 mg/100 g, Na^{+} 19.34 to 60 mg/100 g, K^{+} 99.1 to 620 mg/100 g, P 96 to 723.8 mg/100 g, Mg^{2+} 0.065 – 82 mg/100 g. Vitamin A content ranged between 7.09 to 21.29 u/100 g, while vitamin C and E between 2740 to 88600 u/100 g and 1.64 to 16.4 u/100 g respectively. Antinutrients present include alkaloids 1.22 to 9.40%, flavonoids 0.038 to 0.36%, saponins 0.14 to 1.70%, Steroid 3×10^{-5} to 1.62%, HCN 5×10^{-4} -2.04%, Tannin 0.06 to 6.10%, anthocyanins 0.16 to 0.21%. In conclusion, this study has shown that these spices have high nutritional content and low anti-nutritional content. The possible nutritional implications of these findings are discussed.

Key words: Herbs, relative humidity, cultural practice, curative, phytomedicine.

INTRODUCTION

Plants constitute an important source of active natural products, which differ widely in terms of structure and biological properties. They have played a remarkable role in the traditional medicine of various countries. In recent years, the prevention of cancer and cardiovascular diseases has been associated with the ingestion of spices, fresh fruits, vegetables, or teas rich in natural antioxidants (Virgili et al., 2001). The protective effects of plant products are due to the presence of several components, which have distinct mechanisms of action; some are enzymes and proteins and others are low molecular weight compounds such as flavonoids (Zhang and Wang, 2002). Some preclinical studies suggest that phytochemicals can prevent colorectal cancer and othercancers (Birt et al., 2001).

The story of spices and other flavorings' materials is one of the most interesting chapters in the history of vegetable products (Obadoni and Ochuko, 2002). The cravings for spices have been one of the great factors in human progress and have done much to change the course of history and geography and to promote international relations (Akindahunsi and Salawu, 2005). Spices are used to season insipid foods and to add zest to an otherwise monotonous diet. They stimulate the appetite and increase the flow of gastric juice. For this reason they are often referred to as food accessories or adjuncts. They also play a role in many of the industries, and are used in perfumery, soaps, incense, as dyes in histology and in various acts (Onyesom and Okoh, 2006).

Studies on spices have been mostly on their exciting flavors and aromas, medicinal values and as flavorings

*Corresponding author. E-mail: fouhegbu@yahoo.com Tel: +234(0)8035426500.

agents. These spices are said to be therapeutically useful in the management of convulsion, leprosy, stomachache, inflammation and/or rheumatoid pains, cough and loss of appetite (Valko et al., 2007). The spices are used for preparing soups for mothers from the first day of delivery to prevent postpartum contraction and aid lactation. They are also used as vegetables for spicing meat, oil bean salad, and foods. Most of these spices have been associated with abundant bitter principle which is claimed to reduce blood sugar levels, and their liquor taken as a purge for colic, stomach pains, and worm infections. It is also believed that newborn babies grow rapidly when they are fed with food made of these spices (Roger, 2002). The spices grow commonly in high forest areas of the South Eastern region of Nigeria, as climbers, perennial creepers, or slim shrubs and trees and are available all year round (Sofowora, 1993). Proximate and nutrient analysis of medicinal plants, edible fruits and vegetables plays a crucial role in assessing their nutritional significance (Pandey et al., 2006). As various medicinal plant species are also consumed as food along with their medicinal benefits, evaluating their nutritional significance can help to understand the worth of these plant species (Pandey et al., 2006).

There are also various claims about the usefulness of these spices, especially their use in fattening homes, and remarkable growth of new born babies whose mothers use these spices. This study therefore focuses on the phyto-chemical, proximate composition, and mineral analysis of these spices. Our results would aid in assessing their nutritional potential in relation to their ethnomedicinal uses by the people of South East of Nigeria. The spices include *Gongronema latifolium* [Utazi], *Piper guineenses* [Uziza*], Xylopia aethiopica* [Uda], *Monodora myristica* [Ehiri], *Tetrapleura tetrapetra* [Oghokirigho], and *Allium sativum* [Garlic]. These spices have been described variously by (Smith et al., 1996). The results of this study will aid in appreciating the acclaimed medicinal properties of these spices and their age long usage by the people.

MATERIALS AND METHODS

Spices

The spices were bought as sold from the Eke Okigwe market, Imo State of Nigeria, by the traders, and identified taxonomically at the Department of Plant Science and Biotechnology, Abia State University Uturu, on the 15th of May, 2010.The samples were washed with distilled water and stored in polyethene bags to avoid contamination.

Processing of samples

The leaves of *G. latifolium*, scaly outer leaves of *A. sativum*, and the seeds of *P. guineense, X. aethiopica, M. myristica* and fruits of *T. tetrapetra* were all dried in the oven at 65°C. The dried samples were milled in an Arthur Thomas coated milling machine and screened through 1 mm sieve to obtain a fine powder of processed sample of each.

Determination of chemical composition

The proximate analysis (carbohydrate, fats, protein, moisture and ash) of spices sample was determined by using AOAC (1995) methods. Carbohydrate was determined by difference method (100 – (protein + fat + moisture + ash)). The nitrogen value, which is the precursor for protein of a substance, was determined by micro–Kjeldahl method (Guebel et al., 1991). The nitrogen value was converted to protein by multiplying to a factor of 6.25. The moisture and ash were determined using weight difference method while determination of crude lipid content of the spices sample was done using Soxhlet type of the direct solvent extraction method. The solvent used was petroleum ether (boiling range 40 to 60°C). All the proximate values were reported in percentage (AOCS, 2000; Okwu and Morah, 2004).

Determination of mineral composition

The spices sample was investigated for elemental composition by using atomic absorption spectrophotometer (AAS), Bulk Scientific model AVG 210. Appropriate working standard solution was prepared for each element. The calibration curves were obtained for concentration versus absorbance. The data were statistically analyzed by using fitting of straight line by least square method. All elements were determined in the spices under this investigation procedure. Laboratory procedures for the preparation and determination of macro and micronutrients were used as outlined by Shah et al. (2009) for plant samples.

Vitamin determination

Vitamins were determined by the Meyer Spectrophotometric method of Morton (1942) as described by the Association of Vitamin Chemists AOAC (1990).

Determination of antinutrients

Preparation of fat free samples

2 g of each sample were defatted with 100 ml of diethyl ether using a soxhlet apparatus for 2 h, and then used for the determination of antinutrients. Alkaloids and cyanogenic glycosides were determined by the gravimetric precipitation method as described by (Harbone, 1973). Flavonoids and anthocyanins were determined following the method of Boham and Kocipai –Abyazan (1994). While tannin was determined by the Folin-Dennis spectrophotometric method as described by Makka (1989). Spectrophotometric methods as described by Obadoni and Ochuko (2002) were used to determine the phytosterol and Saponin content.

Statistical analysis

Data were expressed as Mean ± SEM. The data were subjected to one-way analysis of variance {ANOVA}, and Scheffe's post test: (Scheffe, 1959). SPSS software was used to analyze data. $p<0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

Table 1 shows the antinutrient content of the spices. The

Table 1. Antinutrient content of spices.

Sample	Antinutrient content (%)							
	Alkaloid	Flavonoid	Saponin	Steroid	HCN	Tannin	Starch	Anthocyanin
G. latifolium	9.40±0.01	0.042±0.02	2.70±0.01	$4\times10^{-}$±0.03	5×10^{-4} ±0.04	6.10±0.03	ND	ND
P. guineense	1.54±0.02	0.038±0.04	0.16±0.03	3×10^{-5}±0.04	0.126±0.05	2.33±0.03	1.52 ±0.03	ND
X. aethiopica	1.44±0.03	0.22±0.02	0.18±0.03	1.62±0.04	ND	0.24±0.04	ND	0.18±0.04
M. myristica	1.32±0.01	0.18±0.04	0.16±0.05	1.08 ±0.03	2.04±0.04	0.18±0.02	ND	0.21±0.03
T. tetrapetra	1.46±0.05	0.24±0.02	0.18±0.06	1.14±0.03	ND	0.22±0.04	6.40 ±0.02	0.20±0.01
A. sativum	1.22±0.03	0.36±0.03	0.14±0.05	0.08 ±0.05	ND	0.06±0.02	13.50±0.01	0.16±0.05

ND = Not detected; HCN: Hydrogen cyanide.*Values are mean ±SD of triplicate determinations.

Table 2. Mineral and vitamin content of test samples.

Sample	Mineral (µg/100 g)					Vitamin (u/100 g)		
	Ca	Mg	K	Na	P	A	C	E
G. latifolium	297±0.01	0.065±0.01	133.3±0.01	19.34±0.03	723.8±0.03	21.29±0.01	2740±0.03	3.19±0.03
P. guineense	194±0.02	0.116±0.03	99.1±0.02	20.18±0.01	215.8±0.06	7.09±0.02	5120±0.02	1.64±0.02
X. aethiopica	186±0.04	76±0.03	412±0.06	56±0.03	248±0.02	12.0±0.01	38400±0.02	1.64±0.04
M. myristica	194±0.06	64±0.01	508±0.03	42±0.01	233±0.03	9.8±0.03	66800±0.06	12.0±0.03
T. tetrapetra	136±0.03	82±0.03	486±0.04	38±0.02	268±0.06	12.6±0.02	46000±0.03	10.4±0.03
A. sativum	122±0.01	54±0.02	620±0.03	60±0.03	96±0.01	ND	88600±0.04	ND

ND = Not detected.* Values are mean± SD of triplicate determinations.

results showed that the spices are rich in phytochemicals. *G. latifolium* is rich in alkaloids 9.40±0.01% which is significantly ($p<0.05$) higher compared to the other spices, *P. guineense* 1.54±0.02% and *A. sativum* 1.22±0.03 as the least. *A. sativum* had significantly ($p<0.05$) higher flavonoid content 0.36±0.03%, compared to *X. aethopica* 0.22±0.02%, while *G. latifolium* had the least 0.042±0.02%. Saponin content was significantly ($p<0.05$) higher for *G. latifolium* 1.70±0.01%, compared to 0.14±0.05% *for A. sativum. X. aethiopica* had significantly ($p<0.05$) higher steroids content 1.62±0.04% compared to *P. guineense* which had the least 3×10^{-5}±0.05%. Cyanogenic glycoside [HCN] appears to be significantly ($p<0.05$) high in *M. myristica* 2.04±0.04%. *G. latifolium* had significantly ($p<0.05$) higher tannin content 6.10±0.03% compared to 0.06±0.02% for *A. sativum. A. sativum* had significantly ($p<0.05$) higher content of starch (carbohydrate) 13.50±0.01, compared to *T. tetrapleura* 6.40±0.02% and *P. guineense* 1.52±0.01%, while *M. myristica* had significantly $p<0.05$) higher anthocyanin content 0.21±0.03% compared to the other spices.

Table 2 shows the mineral and vitamin content of the spices. The spices are all rich in minerals. Calcium is present in all the test samples, with *G. latifolium* being the highest 297±0.01 µg/100 g sample and *A. sativum* the least 122±0.01 µg/100 g sample. *T. tetrapetra* had a high Mg content 82±0.03 µg/100 g, while *G. latifolium* had the least 0.065± 0.01µg/100g Potassium content of *sativum* is high 620±0.02 µg/100 g sample, while it is low in *P. guineense* 99.1±0.02 µg/100 g. Sodium content of *A. sativum* 60±0.03 µg/100 g is high and *G. latifolium* 19.34±0.03 µg/100 g is the lowest. *G. latifolium* had a high content of phosphorus 723.8±0.03 µg/100 g, and *A. sativum* 96±0.01 µg/100 g was the least. All the samples are rich in vitamins A, C, and E. *G. latifolium* contains 21.29±0.01 u/100 g of vitamin A while *A.*

Table 3. Proximate composition of the spices.

Sample	Proximate composition (%)						
	Protein	Fat	Fiber	Ash	NFE	Moisture	Dry matter
G. latifolium	1.17±0.01	3.33±0.02	0.67±0.01	8.00±0.02	13.18±0.03	21.67±0.04	78.34±0.02
P. guineense	5.57±0.04	10.00±0.01	0.33±0.03	0.33±0.03	0.24.4±0.05	84.67±0.06	84.67±0.06
X. aethiopica	11.90±0.06	10.64±0.02	38.60±0.04	30.18±0.04	38.60±0.04	61.40±0.04	61.40±0.04
M. myristica	11.20±0.05	14.66±0.03	30.42±0.05	9.34±0.03	34.38±0.04	36.88±0.0	63.12±0.05
T. tetrapetra	8.75±0.02	8.98±0.03	36.88±0.01	10.36±0.03	35.03±0.06	34.24±0.04	65.76±0.05
A. sativum	7.70±0.02	1.06±0.01	12.44±0.02	2.64±0.01	76.16±0.02	72.56±0.05	27.44±0.03

NFE: Carbohydrate as "nitrogen free extractive.*Values are mean ± SD of triplicate determinations.

Sativum had 88600±0.04 u/100 g of vitamin C as the highest, and 16.4±0.04 u/100 g of vitamin E was found in *X. aethiopica* as the highest. The difference in these measured parameters were all significant at (p<0.05).

Table 3 shows the proximate composition of the spices *X. aethiopica* had a significantly higher (p<0.05) protein content than all samples analyzed 11.90±0.06%, while *G. latifolium* had the least 1.17±0.01%. *M. myristica* had a significantly (p<0.05) higher fat content 14.66±0.03% and *A. sativum* the least 1.06%. The samples are rich in fiber 38.60±0.04% for *X. aethiopica,* which was significantly (p<0.05) higher than 0.33±0.03% for *G. guineense* as the least. *T. tetrapetra* had a significantly (p<0.05) higher total ash content 10.36±0.05 compared to 2.64±0.01% which was the least for *A. sativum*. NFE [carbohydrate] content of *A. sativum* 76.16±0.02% was significantly (p<0.05) higher compared to 13.18±0.03% for *G. latifolium* as the least. *P. guineense* had a significantly (p<0.05) higher moisture content 84.67±0.06% compared to 21.67±0.04% as the lowest for *G. latifolium*. *G. latifolium* also had significantly (p<0.05) high dry matter content 78.34±0.02%, compared to *P. guineense which* had the least 15.34±0.03%.

All the provided reviews in this part are in support of the results of this study and the reasons why the people of South East Nigeria may have found these spices useful. The results showed that the spices are rich in nutrients (Table 3), minerals and vitamins (Table 2), but low in antinutrients (Table 1).The protein content of *X. aethiopica* 11.90±0.06% is significantly (p<0.05) higher compared to 1.17±0.01% and 5.57±0.04% for *G. latifolium* and *P. guineense* respectively (Table 3). Fat content of *M. myristica* 14.66±0.03% is significantly (p<0.05) higher compared to 1.06±0.01% and 3.33±0.02% for *A. sativum* and *G. latifolium* respectively. Fiber content is equally high (0.67±0.01) for *G. latifolium* as the least and *X. aethiopica* having a significantly (p<0.05) higher content of 38.60±0.04% compared to the others. Carbohydrate ranged between 13.18±0.03% to 76.16±0.02%, with *A. sativum* having a significantly (p<0.05) higher content of 76.16±0.02% compared to the others. Moisture content ranged between 21.67±0.04% to 84.67±0.06%, while dry matter ranged between 15.34±0.03% to 78.34±0.02% which are significantly (p<0.05) higher compared to the lower value of 15.34±0.03%. Regular use of plant foods rich in protein makes a valuable addition to a diet (Wardlaw and Kessel, 2002). Fats insulate and protect body organs and also transport fat-soluble vitamins. The minimal intake of carbohydrate is 50 to 100 g per day, 60% of total energy intake is a typical recommendation (Wardlaw and Kessel, 2002). High carbohydrate; low fat diet aids control of hypertension and prevent obesity. Fat and protein stimulate the release of the hormone –gastric inhibitory peptide (GIP) from the walls of the small intestine. GIP slows the release of stomach contents into the small intestine (Wardlaw and Kessel, 2002).The high chemical content of these spices tend to lend support for the benefits the consumer may derive. Rich macronutrients of food are beneficial to the body (Okaka and Okaka, 2001).

The spices are very rich in mineral and vitamin (Table 2). Calcium seems to be high in all the samples with *G. latifolium* 297 ±0.01 µg/100 g having a significantly (p<0.05) higher concentration compared to 122 ±0.01 µg/100 g for *A. sativum*. Phosphate content was also high in all the spices ranging between 96±0.01 µg/100 g to 723.8±0.03 µg/100 g. The value of 723.8±0.03 µg/100 g phosphate for *G. latifolium* is significantly (p<0.05) higher compared to 96±0.01 µg/100 g for *A. sativum*. Concentration of potassium in the spices is between 99.1±0.02 µg/100g for *P. guineense* to 620±0.02 µg/100 g for *A. sativum. A. sativum* contains significantly (p<0.05) higher concentration of potassium. The spices have low sodium and potassium content in the range of 19.34±0.03 µg/100 g to 60±0.03 µg/100 g 0.065±0.02 µg/100 g to 82±0.03 µg/100 g respectively. Minerals are absolutely necessary for most metabolic processes. They serve as cofactors, help in transmission of nerve impulses and water balance (Brown, 2007).

The vitamin content is rich (Table 2) for the spices, with vitamins A, C and E occurring in all the spices, excerpt A. *sativum* which did not show any trace of vitamin A and E. *G. latifolium* had a significantly (p<0.05) higher vitamin A content 21.29 ±0.01 u/100 g, while *A. sativum* content of vitamin C 88.6±0.04 mg/100 g was significantly (p<0.05) higher compared to the others. *X. aethiopica* had a significantly ($p<0.05$) higher content of vitamin E (16.4±0.04 u/100 g) compared to the others. The bio-chemical and physiological functions of vitamins include vision, growth, and differentiation of epithelial cells, nervous tissue activity, bone and immunity, non specific reducing agents as antioxidants (vitamin E) which may protect against some forms of cancer. Vitamin C has anti-infective properties, promotes wound healing, may boost the immune system and may help ward off infections (Wright, 2000). The rich micro-nutrient content of the spices makes them beneficial and useful to the physiological needs of man (Okaka and Okaka, 2001).

The antinutrient content (Table 1) shows that all the spices contain alkaloids, flavonoids, saponins, steroids and tannins. *G. latifolium* contains 9.40±0. 01% of alkaloid, which seems to be on the high side. The other spices contain between 1.22±0.03% to 1.54±0.02% which is probably on the low side. Flavonoids, saponins and steroids occur in the range of 0.038±0.04% to 0.36±0.03%; 0.14±0.05% to 17. 0±0.01% and 3×10^{-5}±0.04% to 1.62±0.04% respectively. Tannin content is low in all samples between 0.06±0.02% to 6.10±0.02%. *G. latifolium* does not contain starch and anthocyanin, while *X. aethiopica* and *M. myristica* does not contain starch. *G. latifolium, P. guineense* and *M. myristica* contains hydrogen cyanide 5×10^{-4}±0.01%, 0.126±0.05% and 2.04±0.04% respectively. The concentrations of these phytochemicals in these spices are not on the high side as to constitute a health hazard, as they are within the safe level (Brown, 2007).The low concentration of anti-nutrients makes the spices safe for use. Anti-nutrients are required in low concentrations to effect biochemical changes; hence the spices may be effective as ethno-medicine (Okaka and Okaka, 2001).

Nutritionally, *X. aethiopica* with 11.90±0.06% protein, 10.64±0.02% fat, 38.60±0.04% fiber, 8.68±0.02% ash, 30.18±0.04% NFE, 38.60±0.04 moisture, 61.40±0.04%; Ca 186±0.04 µg/100 g, Mg 76±0.05 µg/100 g, K 412±0.06 µg/100 g, Na 56±0.03 µg/100 g, P 248±0.02 µg/100 g and 12.0±0.01 u/100 g of vitamin A. seems to be of a higher nutritional value, since the antinutrient content is equally low.

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