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Research Paper

Survey for the composition of some common spices cultivated in Nigeria

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Abstract. The samples of four spices (*Zingiber officinale, Piper nigrum, Monodora myristica and Piper guineense*) were analyzed for their proximate composition, minerals, antinutrients and vitamins constituents. The results revealed the presence of all food fractions (crude protein, crude fibre, moisture, ash, fat and carbohydrate) in these spices. The percentage of each food fraction differed significantly (P = 0.05) in the four spices. The results suggest that these spices are good sources of the various food fractions. Elemental analysis showed that minerals such as Na, Ca, K, P, N, Zn and Fe were present in these spices, indicating that they are good sources of these minerals. The concentration of these minerals differed significantly (P = 0.05) in each of the four spices. Antinutrients such as tannins, oxalate, phytate, alkaloids, saponins and hydrogen cyanide were found to be present in these spices. The concentration of these antinutrients in these spices was low. Therefore, consumption of these spices will not pose any danger to human health, since none of their concentration is above the lethal dosage. The concentration of each antinutrient differed significantly (P = 0.05) in these four spices. Vitamins A, B_1, B_2, C and E were observed in these spices. The concentration of each of these vitamins differed significantly (P = 0.05) in these four spices. These spices are therefore good sources of the various vitamins. This study has therefore shown and compared the proximate, mineral, antinutrient and vitamin composition of these studied species.

Keywords: Proximate composition, minerals, antinutrients, vitamins, spices.

INTRODUCTION

Aromatic food substances which enhance flavour are classified into spices, which are usually dried roots, barks or seeds used as whole or crushed powder. They add a glorious touch to food with their flavour and fragrance. In addition, spices add colour to food making it palatable, and also stimulates salivation and acid secretion of digestive enzymes like amylase (Okwu, 2005). According to Kochhar (2008), spices possess anti-inflammatory, antibacterial and antioxidant properties, and it also reduces cholesterol levels which help to prevent heart diseases. Even though spices are not eaten as real functional foods but as supplements, its nutritional capacity should not be neglected. They are important sources of proteins, carbohydrates, vitamins, minerals, fats and oils, and therefore contribute to the nutritional enrichment of food in their own little way.

The beneficial health effects of spices have been documented (Okwu, 2005). These beneficial effects can be obtained through the utilization of the seeds, leaves or rhizomes of these spices which can be used as either fresh, dry or ground for medicinal purposes. Thompson and Al-Quattan (2002) showed that consumption of ginger led to the reduction of blood cholesterol and also served as a potential anti-inflammatory and anti-thrombotic agent. Nose (2009) reported the importance of pepper as nutritional antioxidant therapy and the fight against respiratory diseases. Nutmeg and West African pepper alongside some other spices are therapeutically useful in the management of convulsion, leprosy, stomach ache, inflammation, rheumatoid pains, cough and loss of appetite (Valko and Tesler, 2007)

This study investigates the scientific background for the use of these spices by determining the chemical constituents as well as quantifying the concentrations of proximates, minerals, antinutrients and vitamins present in these four spices.

MATERIALS AND METHODS

Collection and identification of plant materials

The seeds of Nutmeg (*Monodora myristica*), Black nigrum (*Piper nigrum*), West African pepper (*Piper guineense*) and rhizome of ginger (*Zingiber officinale)* were purchased from Nsukka Main Market in Enugu State and identified at the Taxonomy Division of the Bioresource Development and Conservation Programme (BDCP), Nsukka, Enugu State, Nigeria.

Preparation of plant materials

The plant materials were aid-dried for 5 days under shade and each of them milled separately into powdered form using Thomas–Wiley milling machine, and stored in an airtight plastic container at room temperature until further handling.

Proximate analysis

The proximate analyses for the samples of these four common spices were carried out using the official methods of analysis of the Association of Official Analytical Chemists (AOAC, 1990) and replicated five times.

Mineral composition

The major elements comprising sodium (Na), calcium (Ca) potassium (K), phosphorus (P), magnesium (Mg), nitrogen (N), and trace elements such as zinc (Zn) and iron (Fe) were determined according to the procedure described by Pearson (1976).Each analysis was replicated five times.

Two grammes of each dried sample of the spices were ground to pass through a 1 mm mesh sieve and transferred into a crucible and ashed in a muffle furnace at 500˚C for 3 h. The crucible was removed after completing the ashing. After cooling, 10 ml of 2 M hydrochloric acid was added and heated directly until boiling. The content of the crucible was thereafter transferred into 50 ml volumetric flask and then diluted to 50 ml with deionized water.

The optical density of the elements except phosphorus was determined using the Atomic Absorption Spectrophotometer. For phosphorus determination, 2 ml Ammonium Molybdate vanadate and 5 ml of 5 M hydrochloric acid were added to 2 ml of the stock solution. The concentration of phosphorus was determined through the measurement of the yellow phospho-vando-molybdate complex using Cecil Carating Digital Spectrophotometer Series 2 (Made in Germany). The concentration of each element contained in the sample was calculated as follows:

$$\text{Conc. of each element} = \frac{\text{Microgram/ml of sample} \times \text{dilution} \times \text{original volume}}{\text{Weight of sample} \times 10^6}$$

Conc. × 10000 = concentration in part per million (PPM)
PPM × 100 = mg/100 g
mg/100 g × 100 = microgram/100 g

Antinutritional constituents

Antinutrient analyses include the determination of tannins, oxalate, phytate, alkaloids, saponins and hydrogen cyanide. Tannins, oxalate, phytate and hydrogen cyanide were determined using the methods of Onwuka (2005) while alkaloids and saponins were determined based on methods of analyses described by AOAC (1990). Each of the analysis was replicated five times.

Vitamin composition

The vitamins determined include vitamin A (Retinol), vitamin B (Thiamine), vitamin B_2 (Riboflavin), vitamin C (Ascorbic acid) and vitamin E (Tocopherol). These were analyzed according to Onwuka (2005). Each analysis was replicated five times.

Data analysis

All the data collected were subjected to analysis of variance (ANOVA) according to the procedure for a randomized complete block design (RCBD) using Genstat statistical package. Treatment means were tested using standard error (S.E) of the means at 5% probability level.

RESULTS

Proximate analysis

The results of the proximate analyses of these spices

Table 1. Proximate analysis of studied spices.

Spice	Protein (%)	Crude fibre (%)	Moisture (%)	Ash (%)	Fat (%)	Total carbohydrate (%)
Z. officinale	0.61 ± 0.07[d]	1.46 ± 0.11[d]	89.71 ± 0.0 [a]	0.75 ± 0.01[d]	0.10 ± 0.01[c]	6.31 ± 0.03[c]
P. nignum	3.54 ± 0.07[c]	48.95 ± 0.01[a]	16.93 ± 0.06[d]	1.65 ± 0.01[b]	16.30 ± 0.01 [a]	12.65 ± 0.02[b]
M. myristica	6.87 ± 0.10[a]	14.58 ± 0.08[b]	32.45 ± 0.02[c]	1.35 ± 0.01[/c]	11.00 ± 0.05[b]	33.79 ± 0.04[a]
P. guineense	3.63 ± 0.01[b]	3.20 ± 0.01[c]	84.64 ± 0.02[b]	2.01 ± 0.02[a]	0.20 ± 0.01[c]	6.31 ± 0.01[c]

Values are means ± SE. Mean values not followed by the same letter in super script in the same column are significantly different (P = 0.05).

Table 2. Mineral composition of studied spices.

Mineral	*Z. officinale*	*M. myristica*	*P. nigrum*	*P. guineense*
Sodium (ppm)	62.25 ± 0.06[b]	9.41 ± 0.06[a]	9.43 ± 0.06[a]	9.43 ± 0.07 [a]
Calcium (ppm)	14.54 ± 0.70[b]	15.92± 0.36[b]	6.44 ± 0.26[c]	56.12 ± 0.39[a]
Potassium (ppm)	37.17 ± 0.08[c]	50.22 ± 0.07[b]	58.60 ± 0.10[a]	33.70 ±0.07[d]
Phosphorus (mg/100 g)	0.80 ± 0.06[d]	1.62 ± 0.05[a]	1.45 ± 0.07[b]	0.94 ± 0.07[c]
Magnesium (ppm)	56.32 ± 0.33[d]	456.34 ± 0.49[b]	546.8 ± 0.63[a]	206.88 ±0.55[c]
Nitrogen (%)	0.86 ± 0.03[b]	1.75 ± 0.30[a]	0.28 ± 0.02[b]	0.54 ± 0.08[b]
Zinc (mg/100 g)	214.27 ± 0.09[a]	192.85 ± 0.34[a]	173.54 ± 0.19[d]	183.24 ± 0.41[c]
Iron (%)	1.28 ± 0.05[b]	1.90 ± 0.07[a]	1.85 ± 0.10[a]	1.26 ± 0.07[b]

Values are means ± SE. Mean values not followed by the same letter in super script in the same column are significantly different (P = 0.05).

presented in Table 1 indicated that *M. myristica* contains the highest percentage protein (6.87 ± 0.10[a]) while *Z. officinale* showed the lowest percentage protein (0.61 ± 0.07[d]).The Highest percentage of crude fibre was recorded in *P. nigrum* (48.95 ± 0.01[a]). On the other hand, *Z. officinale had the lowest percentage* (1.46 ± 0.11[d]).The highest percentage of moisture was observed for *Z. officinale* (89.71 ± 0.02[a]) while *P. nigrum* recorded the lowest percentage (16.93 ± 0.06 [d]). *P. guineense* showed the highest percentage of ash content (2.01[a]± 0.02) and the lowest percentage was recorded for *Z. officinale* (0.75 ± 0.01 [d]). For fat content, it was observed that *P. nigrum* contains the highest percentage fat (16.30 ± 0.01[a]) while fat found in Z*. officinale* showed the lowest percentage (0.10 ± 0.01[c]). The percentage carbohydrate was very high in *M. myristica* (33.79 ± 0.04[a]) while the lowest percentages were recorded in both *P. guineense* and *Z. officinale* (6.31 ± 0.01[c]). The percentage of each food fractions differed significantly in these four spices. These spices are good sources of the various food fractions.

Mineral composition

The elemental analysis results are shown in Table 2. Sodium recorded the highest concentration in *Z. officinale* (62.25 ± 0.06[b]) while the lowest concentration was observed for *M. myristica* (9.41 ± 0.06[a]). The concentration of Calcium was very high in *P. guineense* (56.12 ± 0.39[a]) while the lowest concentration was recorded in *P. nigrum* (6.44 ± 0.26[c]). The highest concentration of Potassium was recorded in *P. nigrum* (58.60 ±0.10[a]). On the other hand, the lowest concentration was found in *P. guineense* (33.70 ± 0.07[d]). *M. myristica* showed the highest concentration of Phosphorus (1.62[a] ± 0.05) and the lowest was recorded for *Z. officinale* (0.80 ± 0.06[d]). Magnesium concentration was very high in *P. nigrum* (546.80 ± 0.63[a]) while *Z. officinale* (56.32 ± 0.33[d]) recorded the lowest concentration. Nitrogen showed the highest percentage in *M. myristica* (1.75 ± 0.30[a]) and the lowest percentage was recorded in *P. nigrum* (0.28 ± 0.02[b]). The concentration of Zinc was very high in *Z. officinale* (214.27 ± 0.09[a]) while *P. nigrum* (173.54 ± 0.19[d]) showed the lowest concentration. The highest concentration of Iron was recorded in *M. myristica* (1.90 ± 0.07[a]) and *P. guineense* showed the lowest concentration of Iron (1.26 ± 0.07[b]). The concentration of each mineral differed significantly among these spices (P = 0.05).

Antinutritional constituents

Table 3 showed the results of the antinutritional composition of the four spices. Antinutrients such as tannins, oxalate, phytate, alkaloids, saponins and hydrogen cyanide were found to be present in various concentrations in all the spices. The concentration of each antinutrient differed significantly (P = 0.05) among these spices. The highest concentration of both tannins

Table 3. Antinutritional content for the studied spices.

Antinutrient	*Z. officinale*	*M. myristica*	*P. nigrum*	*P. guineense*
Tannin (%)	0.83 ± 0.02[d]	0.46 ± 0.04[c]	0.81 ± 0.02[a]	0.64 ± 0.01[b]
Oxalate (ppm)	236.07 ± 0.85[a]	67.07 ± 0.51[b]	33.40 ± 0.10[c]	33.93 ±0.40[c]
Phytate (%)	1.24 ± 0.01[d]	2.67 ± 0.07[b]	3.41 ± 0.07[a]	1.59 ± 0.03[c]
Alkaloid (%)	2.90 ± 0.10[b]	1.25 ± 0.50[c]	4.92 ± 0.20[a]	2.93 ± 0.03[b]
Saponin (%)	1.80 ± 0.01[d]	9.77 ± 0.06[b]	17.32 ± 0.03[a]	2.84 ± 0.01[c]
Hydrogen cyanide (%)	0.35 ± 0.01[b]	0.44 ± 0.01[b]	0.13 ± 0.06[c]	1.37 ± 0.15[a]

Values are means ± SE. Mean values not followed by the same letter in super script in the same column are significantly different (P = 0.05).

Table 4. Vitamin contents of the studied spices.

Spice	Vitamin A (IU)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin C (mg)	Vitamin E (mg)
Z. officinale	297.51 ± 0.62[b]	5.23 ± 0.25[b]	0.16 ± 0.02[b]	0.29 ± 0.01[d]	13.57 ± 0.40[b]
M. myristica	14.20 ± 0.04[d]	2.90 ± 0.10[c]	0.44 ± 0.04[b]	9.80 ± 0.17[a]	17.77 ± 0.23[a]
P. nignum	42.69 ± 0.27[c]	6.97 ± 0.15[a]	0.05 ±0.01[c]	3.83 ± 0.03[b]	10.67 ± 0.21[d]
P. guineense	1446.51 ± 0.30[a]	1.23 ± 0.25[d]	0.15 ± 0.01[b]	0.83 ± 0.01[c]	17.50 ± 0.10[a]

Values are means ± SE. Mean values not followed by the same letter in super script in the same column are significantly different (P = 0.05).

(0.83 ± 0.2[a]) and oxalate (236.07 ± 0.85[a]) occurred in *Z. officinale. P. nigrum* recorded the highest percentage of phytate (3.41 ± 0.07[a]) and alkaloids (4.92 ± 0.20[a]). The highest percentage of saponins (2.84 ± 0.01[c]), and hydrogen cyanide (1.37 ± 0.15[a]) were recorded in *P. guineense*. The measured antinutrient concentrations in these spices were below the lethal dosage and so their consumption has no harmful effect on human health.

Vitamin composition

The results for vitamins constituents in the four studied spices are presented in Table 4. *P. guineense* recorded the highest concentration of vitamin A (1446.51 ± 0.30[d]) while *M. myristica* showed the lowest concentration (14.20 ± 0.04[d]). The highest concentration of vitamin B_1 was shown in *P. nigrum* (6.97 ± 0.15[a]) and the lowest concentration was observed in *P. guineense* (1.23 ± 0.25[d]). *M. myristica* showed the highest concentration of vitamin B_2 (0.44 ± 0.04[b]) while *P. nigrum* recorded the lowest concentration (0.05 ± 0.01[c]). The highest percentage of vitamin C was recorded for *M. myristica* (9.80 ± 0.17[a]). On the other hand, *Z. officinale* (0.29 ± 0.01[d]) showed the lowest concentration. The highest concentration of vitamin E was recorded in *M. myristica* (17.77 ± 0.23[a]) while the lowest concentration was shown in *P. nigrum* (10.67 ± 0.21[d]). The concentrations for these vitamins differed significantly in these four spices. These results showed that these spices are sources for these vitamins.

DISCUSSION

Proximate analysis studies revealed that the studied spices are rich sources for the various food fractions. Protein has been proved to be an essential ingredient for the survival of human beings and animals (Hunel et al., 1992). The amount of proteins obtained in these spices are considerable even though their percentages are low compared to the protein levels in some oil seeds consumed in Nigeria (Enujiugha and Agbede, 2000). The low protein levels obtained in this study is an indication for the potential usage of these spices for food and feed formulation. The samples of the spices possess considerable amount of moisture in powdered form. The moisture content of any food is an indication of its water activity and it is important as a number of biochemical and physiological changes in food depends on it (Onwuka, 2005). The highest moisture contents recorded in *Z. officinale* (89.71 ± 0.02[a]) and *P. nigrum* (84.62 ± 0.02[b]) could mean that they have a low shelf life. Food sample with much moisture content is susceptible to microbial growth (Guisseppe and Baratta, 2000).

Carbohydrates are the most abundant biological molecules and play important roles in the body as sources of energy as well as provision of structural materials (Hunel et al., 1992). The results of this study indicate that the spices possess moderate amounts of carbohydrate and these can provide accessible fuel for physical performance and regulate nerve tissues (Onwuka, 2005). The results of this study showed that *Z. officinale* (1.46 ± 0.01[d]) and *P. guineese* (3.20 ± 0.01[c]) had low fibre contents. The highest fibre content obtained in *P. nigrum* (48.95 ± 0.01[a]) and *M. myristica* (14.58 ± 0.08[b]) suggest that they could be useful in preparation of animal feeds (Abigbor et al., 1997). The ash content of these spices was low and as a result, they may be considered unsuitable for compounding animal feeds. The low ash content may enhance the quality control for oil extraction (Ibanga and Ekpa, 2009). The fat content of *Z. officinale* (0.10 ± 0.01[c]) and *P. guineense* (0.20 ± 0.01[c]) were negligible while those of *P. nigrum* (16.30 ± 0.01[a]) and *M. myristica* (11.00 ± 0.05[b]) were moderate. This could mean that fat in both spices has domestic and industrial potentials (Gunstone and Norris, 1982).

These spices have been shown to contain rich mineral elements. The significance of these minerals is noted when the usefulness of such elements like Sodium, Calcium, Potassium, Phosphorus, Magnesium, Nitrogen, Zinc and Iron is considered. The low sodium content of these spices could be an advantage because of the direct relationship between sodium intake and the hypertension in human beings (Dahl, 1972). Calcium is required for the formation of bones and supports the synthesis and functions of blood cells. The levels of calcium obtained in these spices are however lower in comparing with the levels reported for the seeds of *Sphenostylis sternocarpa* (Ameh, 2007). Magnesium and potassium support human biochemical processes by serving structural and functional roles as electrolytes (Nelson and Cox, 2008). Phosphorus is also an important mineral in bone formation. Zinc is important in the production of insulin and carbonic anhydrase in human body. The zinc content of these spices could be an indication that the plants can play a role in the management of diabetes that result from insulin malfunctioning (Okwu and Morah, 2004).

Iron is also present in these spices, with small amounts. It has a role in formation of heamoglobin. According to Okwu and Morah (2004), iron helps in oxygen transportation, and ferridoxin which plays important role in human metabolism. It is also necessary for the normal function of the central nervous system (Okwu, 2004).

Antinutritional analysis of these spices revealed the presence of tannins, oxalate, phytate, alkaloids, saponins and hydrogen cyanide. This is in line with the report of Akwaowo et al. (2000) on *Telferia occidentalis*. The distribution of antinutrients in some vegetable crops and their effects on other nutrients has been reported by Udosen and Ukpoma (1993). The concentrations of antinutrients in these spices were generally low and as such, they are below the lethal dosage approved by National Agency for Food and Drugs Administration and Control (NAFDAC) in Nigeria. Akwaowo et al. (2000) reported that a daily intake of 450 mg of oxalic acid interferes with metabolism. The authors also noted that high oxalate levels in food may reduce the bioavailability of calcium. According to Munro and Bassir (1969), the lethal level of oxalate in human is 2 to 5 g per day. The ability of soluble oxalates to inhibit calcium, potassium and sodium absorption as a result of their insolubility properties has been demonstrated (Pingle and Ramastin, 1978). In this study, the concentration of oxalate does not reach the level that could be injurious to human health. Hunel et al. (1992) reported that phytic acid intake at levels 4.00 to 9.00 mg/100 g reduces absorption by 4 to 5 fold in human.

Phytate and tannins concentrations obtained in this study were very low. According to Akwaowo et al. (2000), higher intake of tannic acid has been associated with carcinogenic effect in human, poor protein utilization, liver and kidney toxicity. Consumption of these spices will not pose any danger to health as their antinutrient levels do not reach to the lethal dosages. The hydrogen cyanide content of these spices (Table 4) indicates that it will not affect human nutrition if these spices are consumed in large quantities, since their concentrations are very low. Hydrogen cyanide is readily absorbed by the gastrointestinal and respiratory tracts (Hartung, 1982). A consequence of this absorption is distributed through the blood. Exposure to high concentration of cyanide causes respiratory track failure and death (United States Environmental Protection Agency, 1984).

The vitamin content of these spices was generally higher than those reported for *Dacryode edulis* fruit by Majesty et al. (2012). Vitamins are very important in the body and their deficiencies adversely affect the metabolism of the body. Normal formation of intercellular substances in the body including collagen, bone matrix and tooth dentine is greatly impaired by lack of ascorbic acid (Hunt et al. 1980). According to Okwu (2004), the scurvy hemorrhage from mucous membrane of the mouth and gastrointestinal tract, anemia, pains in the joints and defects in skeletal calcification can be related to the association of ascorbic acid (vit. C) and normal connective tissue metabolism. This function accounts for its requirement for normal wound healing (anti scurvy). The deficiency of riboflavine (vit. B_2) causes lesions of the mouth, eyes and skin while lack of thiamine (vit. B_1) in the diet causes beriberi disease (Okwu, 2004). Retinol (vit. A) is required for the photochemical reactions involved in light perception by the rods. Lack of vitamin A causes poor night vision and drying of cornea (xerophthalmia). Another important vitamin is tocopherol (vit. E). Its deficiency in the diet causes sterility in animals (Hunt et al., 1980).

Conclusion

This study has shown that these spices can be used as good sources of the various food fractions, vitamins and minerals necessary for body metabolism despite the trace amount of anti-nutrients.

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