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NUTRIENT COMPOSITION OF SOME COMMONLY CONSUMED INDIGENOUS SPICES OF NIGERIA

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ABSTRACT

This study evaluated nutrient composition of four Nigerian spices, namely Ocimum viride (leaves), Monodora myristica (seeds), Monodora tenuifolia (seeds) and Tetrepleura tetrapetra (fruits) frequently used in traditional dishes. Proximate, mineral and vitamin contents of the spices were screened using standard methods. The spices were rich in most of the nutrients. Protein content ranged from 6.79 % in Tetrapleura tetrapetra to 22.77 % in M myristica, ash from 4.17 % in T. tetrapetra to 12.44 % in Ocimum viride and fat content from 3.44 % in T. tetrapetra to 8.66% in Momodora trifolia. Fibre content ranged from 5.25 % in M. myristica to 29.75 % in. T. tetrapetra. Mineral contents varied significantly ($p < 0.05$) in the spices. Among the spices, Ocimum viride had the highest and Tetrapleura tetrapetra the lowest mineral contents. Iron content (mg/100g) was significantly ($p < 0.05$) high, ranging from 10.7 in T. tetrapetra to 27.2 in M. tenuifolia, 31.83 in M. myristica and to 68.27 in O. viride. Prominent minerals in the spices were in the following order from high to low: iron > manganese > zinc > calcium > magnesium > phosphorus. Zinc content (mg/100g) ranged from 2.26 to 8.85 and phosphorus (mg/100g) from 0.88 to 4.34. The spices were good sources of the vitamins thiamin, riboflavin, niacin, folic and ascorbic acids and were in the following order from high to low: O. viride > M. tenuifolia > M. myristica > T. tetrapetra. Vitamin contents varied significantly ($p > 0.05$) among the spices. Thiamin, riboflavin and ascorbic acid contents were relatively low while folic acid and niacin were high. Folic acid (mg/100g) ranged from 13.6 in T.tetrapetra to 87.51 in O. viride and niacin (mg/100g) from 1.25 in T. tetrapetra to 5.47 in O. viride. These spices could serve as excellent sources of nutrients in diet if used regularly.

Keywords: Nutrient composition, *O. viride*, *M. myristica*, *M. tenuifolia*, *T. tetrapetra*

INTRODUCTION

Spices are indispensable components of cuisines used mainly for flavouring to improve palatability of food (OKigbo, 1977; Okafor, 1987). A spice is a dried seed, fruit, root, bark, flower, leave or any vegetative substance used in a very small quantity as food additive to colour, flavour or preserve food (Ravindran *et al*., 2002). The United States Food and Drug Administration (FDA) defined spices as aromatic vegetative substances used for seasoning of food and from which no portion of any volatile oil or flavouring principles have been removed, and are free from artificial colouring matters, adulterants and impurities (Farrel, 1990). Some well known spices of commerce include red pepper, onions, sage, ginger, nutmeg, clove, cinnamon, mustard, curry, turmeric, rosemary and garlic. Spices add flavour, relish and pungency to diets. Spices are Generally Recognized As safe (GRAS) by the FDA, at least at concentrations commonly found in foods. The bulk of the major components of spice materials consist of carbohydrate, protein and little minerals. Spices are used in a very small amount and contribute very minimal nutrients per meal but because they are used regularly contribute maximally in diets. Tannins, resins, pigments, volatile, essential and fixed oils which contribute to flavouring occur in traces and constitute only a small fraction of the dry matter (Cowan, 1999). Most spices are fragrant, aromatic and pleasant. Spices in food also exert such secondary effects as salt and sugar reduction, prevention of spoilage and improvement of texture (Ravindran *et al*., 2002).

Spices, because of many health-promoting phytochemicals they contain, are known to fight cancer and many heart diseases. Many spices have been in use in many traditional medicines. Many ethnic cuisines are highly recognized for their reliance due to some perculiar spices in them. The turmeric in Italian cuisine, basil, garlic, and oregano in Italian and Greek cuisine, and lemon grass, ginger and chili peppers in Thai foods represent some of the cultural uses of spices in food (Satia-Abouta *et al*., 2002). This study is therefore designed to evaluate nutrient composition of four commonly consumed Nigerian spices, namely *Monodora tenuifolia*, *Tetrapleura tetrapetr*a, *Monodora myristica* and *Ocimum viride*

MATERIALS AND METHODS

Proximate content determination

Proximate composition was determined using the method of AOAC (2000).Moisture content was determined as weight loss after 12 h of drying at 105^{O}C in a hot-air oven. Fat content was estimated by exhaustive extraction of subsamples (3 g) with petroleum ether (boiling point, 40-60 ^{O}C) using a soxhlet apparatus. Total Nitrogen content was determined using Kjeldhal apparatus. The protein content was calculated as N x 6.25. Total carbohydrates were estimated as the remainder after accounting for ash, crude fibre, crude protein and fat.

Determination of minerals

The minerals calcium, iron, magnesium, manganese, zinc, potassium and selenium were determined according to the method of Association of Official Analytical Chemists (AOAC) (2000). Ground spice samples were sieved with a 2 mm rubber sieve and 2 g of each of the spice spices were weighed and subjected to dry ashing in well-cleaned Petri dishes at 550^{O}C in a muffle furnace. The resultant ash was dissolved in 5 ml of $HNO_3/HCl/H_20$ (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining mineral in each of the Petri dishes was added 5 ml of deonised water and heated until a colourless solution resulted. The mineral solution in each of the crucible was transferred into a 100 ml volumetric flask by filtration through a man no. 5 filter paper and the volume was made to the mark with deionised water. The solution was used for elemental analysis by atomic absorption spectrophotometer. The concentrations of the minerals Ca, Mg, Mn, K, Zn, Fe and Se in each of the resulting solution was determined using Perkin Elner 8650 atomic absorption spectrophotometer. Calibration curves of absorbance values versus concentration of each element at appropriate concentrations were constructed using their respective standards of 100 mg /litre. A 10 cm long cell was used and concentration of each element in the sample was calculated as the percentage of the dry matter.

Vitamin content determination

Ascorbic acid content

The ascorbic acid content of the samples was determined by the method of AOAC (2000). Ground spice (1g each) was homogenized with 50ml of distilled water (3min), rested for 3h, re-homogenized for another 2min and then filtered through cheese cloths.

Extracts were boiled for 5min. to inactivate inherent enzymes (Effraim *et al.,* 2000), cooled and filtered through what man no 5 filter papers into sterile bottles. A 10 ml of each spice filtrate or ascorbic acid solution used as standard was mixed with 25ml of 20% glacial acetic acid and titrated against standardised 2, 6–dichloro indophenol (0.05g/100 ml) solution. Ascorbic acid was calculated and expressed as mg/100g of dry spice sample using the expression

C x V x (F/W), with

C= mg ascorbic acid/ml 2,6-dichloroindophenol used,,

V= volume of 2,6-dichloroindophenol used against spice extract,,

F= dilution factor and W= weight of spice used.

Niacin content

Niacin content was determined according to the method of Eitenmiller and DeSouza (1985). Ground spice sample (50g) was admixed with 200 ml of 1N H_2SO_4 to extract niacin. This was autoclaved at $121^{O}C$ for 30 min, cooled and the pH adjusted to 4.5 before diluting to 250ml mark. This was filtered and 40 ml of filtrate purified with 17g of $(NH_4)_2SO4$ in a 50 ml volumetric flask and further filtered. To 1ml of each of filtrate and niacin standard solution in separate text tubes was added 0.5ml of 2 % aqueous NH_4OH, 2.0 ml of 2 % H_2SO_4 solution and 0.5% of dilute HCl. Next, 5.0 ml of H_2O was added to the spice filtrates while 5.0ml of CNBr was added to the niacin standard solution; and each shaken vigorously. There were allowed to stand for 2 min after which absorbance was read against a standard at 430 nm.

Riboflavin content

Riboflavin content was determined according to the method of AOAC (2000). Ground spice (5 g) was extracted with 100 ml of 50 % of ethanol solution, shaken for 1 h and filtered into 100 ml conical flask. Ten ml of the extract was pipette into 50 ml volumetric flask. Ten ml each of potassium permanganate and 30 % H_2O_2 were added and allowed to stand over hot water bath for 30 min. Two ml of 40 % sodium sulphate was added. This was made up to the mark and absorbance measured at 510 nm in a spectrophotometer.

Thiamin content

Thiamin content was determined using the method of AOAC (2000). Ground spice (5 g) was homogenised with ethanolic sodium hydroxide (50 ml) and filtered into a 100 ml flask. A 10 ml of the filtrate or blank solvent was pipetted into a test tube to which 10 ml of potassium dichromate was added to develop colour. Absorbance of samples or blank was read at 360 nm. A standard solution was prepared using thiamic acid to get 100 ppm and serial dilutions of 0.0, 0.2, 0.4 and 0.8 ppm was made. This was used to plot a calibration curve from which thiamin contents of the spices were extrapolated using the absorbance values.

RESULTS AND DISCUSSION

Proximate compositions and energy value of spices

Proximate compositions of dried leaves of *Ocimum viride*, dried seeds of *Monodora myristica* and *Monodora tenuifolia*, and dried fruits of *Tetrapleura tetrapetra* are shown in Table 1. Moisture contents of the spices were 9.82% in *O. viride*, 9.61% in *T. tetrapetra*, 8.96% in *M. tenuifolia* and 8.68% in *M. myristica*. The values showed that the four spices were relatively dry (moisture contents less than 12%) and would store for a long period of time without undue microbial and biochemical spoilage. Moisture content of any food can be used as an index of its keeping quality. Water is an important medium for most biochemical reactions. Food samples with water content of 12% or more are more prone to high biochemical activities and usually have short shelf life (Joslyn, 1970).

Crude protein content was highest in *M. myristica* (22.77%) and was followed by *M. tenuifolia* (21.65%), *O. viride* (17.85%) and then *T. tetrapetra* (6.79%). Thus, *M. myristica, M. tenuifolia* and *O. viride* could serve as excellent sources of protein in the diet if consumed regularly. Protein is the building block and essential structural component of cells. It provides the body's required essential amino acids (Shills and Young, 1988). Protein content in food varies widely. The spices were also good sources of fat. Fat content was significantly ($p < 0.05$) lowest (3.44%) in *T. tetrapetra* but highest (8.66%) in *M. tenuifolia*. *M. myristica* had 6.34% and was followed by *O. viride w*hich had 4.43% fat .High fat content implies high calorific value and possible presence of fat-soluble vitamins, namely vitamins A, D, E and K. Spices are known to be rich sources of essential oils which account for the peculiar aroma characteristics of the spices (Madsen and Grypa, 2000).

Crude fibre ranged from 5.25 in *M. myristica* to 13.84% in *O. viride* but was observed to be relatively high in *T. tetrapetra* (29.73%). *Monodora myristica* had relatively low fibre content (5.25%) compared to 13.8% content in *O. viride* and 29.73% in *T. tetrapetra*. The high fibre content in *T. tetrapetra* is not fully exploited because only hot water extract of the fruit is utilized as spice in most African dishes unlike *M. myristica, M. tenuifolia* and *O viride* that are prepared and consumed alongside the main food items as meals. They could be therefore good sources of crude fibre in the diet. Crude fibres are generally plant polysaccharides that cannot be digested by human digestive enzymes. Fibres are either soluble or insoluble, both of which may or may not be present in the same plant material but work better in combinations to modulate physiological functioning and prevent some degenerative diseases in human. Fibre in the diet causes variations in the faecal water content, faecal bulk, transit time and elimination of bile acids and neutral sterols; which lowers the body's cholesterol pool. Fibres have been shown to reduce the incidence of coronary and breast cancer (Lintas, 1992; *Effiong et al.*, 2005).

The spices showed high ash contents (4.17 – 11.75%). The ash contents of *M. tenuifolia* (11.75%), *O. viride* (12.44%) and *M. myristica* (8.61%) were significantly higher (P<0.01) than that of *T. tetrapetra* (4.17%). Ash content refers to the inorganic residues remaining after either ignition or complete oxidation of organic matter in the sample, and gives an overview of mineral content of the material (Joslyn, 1970). High ash content implies high mineral contents in the spices. *Monodora tenuifolia*, *M. myristica* and *O. viride* are likely to be good sources of minerals in the diet. Nutritionally, ash aids in the metabolism of protein, carbohydrate and fat (Okaka, 2005)

Carbohydrate content ranged from 41.6 to 47.8% in the spices. There was no significant difference (p >0.05) in carbohydrate contents of the spices. Carbohydrate provides energy to cells in the body, particularly the brain, the only carbohydrate dependent organ in the body (Effiong *et al*., 2005). These spices could be supplementary for carbohydrate need in the diet.

The spices showed high energy values which ranged from 3.11Kcal in *T. tetrapetra* to 3.53Kcal in *O. viride*. The high energy values of the spices may be of little or no practical importance in real life situation since the quantity of these spices used in menu is relatively very small. These spices are consumed in very small amount as food ingredients, and their contribution to nutrition in menu may not be as high as is the case with staple food items.

However, among many rural consumers who use these spices copiously in various local dishes, the spices can make meaningful nutritional contribution in menu. Also the high carbohydrate, protein and energy values of *T. tetrapetr*a may not impart meaningfully to the nutrition of the users because only the hot water extract of the fruits of this spice is utilized. Generally, the spices contribute nutritionally to menu and impart many health benefits through the phytochemicals.

Table 1: Proximate composition and energy value of *Monodora tenuifolia*, *Tetrapleura tetrapetr*a, *Monodora myristica* and *Ocimum viride*

Spices	Protein (%)	Fat (%)	Ash (%)	Water (%)	Fibre (%)	Carbo-hydrate (%)	Dry matter (%/)	Energy (kJ/kg)
M. myristica	22.77[a]	6.34[b]	8.61[b]	8.68[b]	5.25[d]	46.9[a]	91.33[a]	26.62[a]
M. tenuifolia	21.65[b]	8.66[a]	11.75[a]	8.96[b]	7.35[c]	41.6[a]	91.07[b]	18.74[b]
O. viridi	17.85[c]	4.43[c]	12.44[a]	9.82[a]	13.84[b]	42.4[a]	90.18[c]	18.93[b]
T. tetrapetra	6.79[d]	3.44[d]	4.17[c]	9.61[a]	29.73[a]	47.81[a]	90.11[c]	16.88[b]

Data are means ± standard deviations (n = 3); values marked by the same letter within the same column are not significantly different (p < 0.05).

Mineral composition of the spices

Table 2 shows the mineral composition of the four spices. The spices had high contents of most of the minerals investigated in this study. The most abundant mineral in the spices was iron which ranged from 10.70mg/100m in *T. tetrapetra*, 27.20mg/100g in *M. tenuifolia*, and 31.83mg/100g in *M. myristica* to 68.27mg/100g in *O. viride*. Iron is a major component of hemoglobin which transports the respiratory gases, namely oxygen (O_2) and carbondioxide (CO_2) (Schauss, 1995). Recommended dietary allowance (RDA) for iron is 15mg per day (Food and Nutrition Board, 2001).

The four spices were also good sources of manganese. *Manganese* content was approximately 12.0mg/100g in both *M. myristica* and *M. tenuifolia*, and 16.75mg/100g in *O.viride*. It was significantly (p < 0.05) low in *T. tetrepetra* which had 4.72mg/100g.

Zinc ranged from 6.42 to 8.85mg/100g in *M. myristica, M. tenuifolia* and *O. viride* but was relatively low (2.26mg/100g) in *T. tetrapetra*. The body contains only a small quantity of biologically active pool of zinc. Therefore, dietary supply of zinc is continually needed (Schauss, 1995). Zinc is involved in ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) synthesis needed for cell division, repair and growth (Food and Nutrition Board, 2001). Zinc may help to prevent growth of abnormal cells associated with cancer. Zinc as food supplement has been used to enhance wound healing and improve impaired acuity of taste, smell and night vision. Lack of zinc in the body causes rapid egestion on the surface of wound and may delay quick healing.

The spices *O. viride* and *M. myristica* were significantly (p < 0.05) higher sources of calcium than *M. tenuifolia* which also was comparatively a higher source than *T. tetrapetra*. *Ocimum viride* had about twice (9.67mg/100g) the amount of calcium content (4.84mg/100g) in *M. myristica*. The Ca (4.84mg/100g) content in *M. myristica* was about two and half times the amount (1.81mg/100g) in *M. tenuifolia*. Thus, T. tetrapetra is relatively a poor source of calcium in the diet. Calcium is the most important and most common mineral needed in the body. Calcium is needed for regulating most internal organs, including the heart and liver. It is needed for most physiological functional integrity, involving normal functioning of heart muscles, the skeletal system and cell membrane, blood clotting, nerve signal transmission and regulation of enzymes and hormones (Food and Nutrition Board, 2001). Deficiency of Ca in the body leads to malfunctioning of organ systems.

Next in the hierarchy of mineral contents in the spices was magnesium. *Ocimum viride* had the highest amount of magnesium (4.40mg/100g), followed by *M. tenuifolia* (3.27mg/100g), *M. myristica* (2.67mg/100g) and finally by *T. tetrapetra* (2.03mg/100g). Magnesium is needed for normal functioning of the body. It activates the enzymes necessary for carbohydrate metabolism (Merki and Merki, 1987; Food and Nutrition Board, 2001).

Sodium contents (0.13mg/100g in *M. myristica* and *M. tenuifolia* to 0.99mg/100g in *O. viride*) were comparatively lower than potassium contents (1.17 in *M. myristica* to 6.88mg/100g in *T. tetrepetra*) in the spices. Such low sodium and high potassium ratio is ideal for normal cell functioning. Both regulate water balance, heart rhythm, muscles contraction and nerve-signal conduction. Sodium/potassium ratio less than one (1) is recommended to regulate normal body pH for muscle movement. Such ratio controls glucose absorption and enhances normal retention of protein during growth (NRC, 1989). It also influences glucose and lipid metabolism. Increased potassium intake can lower blood pressure and prevent strokes whereas high sodium intake leads to fluid retention, causing hypertension, heart failure and instant death (Talwari *et al*., 1989; Food and Nutrition Board, 200. Phosphorus, the only nonmetallic micromineral analysed for in this study, occured from 2.00mg/100g to 4.00mg/100g in *M. myristica*, *O. viride* and *M. tenuifolia*. Phosphorus was relatively low in *T. tetrapetra* which had as low as 0.86mg/100g of it. Phosphorus is needed in the diet for good nervous system, strong bone and teeth formation.

All the four spices were poor in selenium content which ranged from approximately 0.4mg/100g to 0.6mg/100g in the spices. While only *M. myristica* had about 0.4mg/100g, the other three spces had approximately 0.6mg/100g. Selenium is, however, a micromineral needed in a very small amount in the body but must be supplied regularly from the diet

It is known that iron, selenium, zinc, magnessium and manganese strengthen the immune system as antioxidants (Talwari *et al*., 1989). Also magnesium, zinc and selenium are known to prevent cadiomyopathy, muscle degeneration, growth retardation, alopecia, dermatitis, immunologic disfunctioning, gonadial athrophy, impaired spermatogenesis, congenital malfunctioning and bleading disorder (Chaturvedi *et al*., 2004). Minerals play important metabolic and physiological functions in living cells (Enechi and Odonwodo, 2003).

Table 2: Mineral composition (mg/100g) of spices

Spices	Ca	Fe	Mg	Mn	Zn	Na	K	P	Se
M. yristica	4.84^{b}+0.02	31.83^{b}+0.31	2.67^{c}+0.25	11.57^{c}+0.03	6.42^{c}+0.04	0.13^{c}+0.01	1.17^{d}+0.01	2.02^{c}+0.05	0.37^{c}+0.01
M. enuifolia	1.81^{c}+0.03	27.20^{c}+0.36	3.27^{b}+0.20	11.91^{b}+0.02	7.17^{b}+0.02	0.13^{c}+0.00	2.80c+0.00	4.34^{a}+0.03	0.56^{a}+0.01
O. viridi	9.67^{a}+0.02	68.27^{a}+0.51	4.40^{a}+0.26	16.75^{a}+0.03	8.85^{a}+0.02	0.99^{a}+0.01	8.05^{a}+0.01	3.31^{b}+0.03	0.54^{b}+0.01
T. etrapetra	0.19^{d}+0.02	10.70^{d}+0.17	2.03^{d}+0.17	4.72^{d}+0..04	2.26^{d}+0.03	0.39^{b}+0.02	6.88^{b}+0.01	0.86^{d}+0.02	0.57^{a}+0.00

Data are means ± standard deviations (n = 3); values marked by the same letter within the same column are not significantly different ($p < 0.05$)

Vitamin contents of the spices

Vitamin contents of the spices are as shown in Table.3. Thiamin, riboflavin and ascorbic acid (vitamin C) contents were relatively low and ranged from 0.05mg/100g in *T. tetrapetra* to 0.16mg/100g in *M. tenuifolia*. Folic acid occurred at the highest level compared to other vitamins in the spices; it was highest in *O. viride* (87.51mg/100g) and lowest in *T. tetrapetra* (13.60mg/100g). It was about three times or more in *M. myristica* (38.73mg/100g) and *M. tenuifolia* (46.10mg/100g) as it was in *T. tetrapetra*. Niacin content was highest in O. viride (5.47mg/100g), followed by *M. tenuifolia* (3.63mg/100g), *M. myristica* (2.95mg/100g) and then *T. tetrapetra* (1.25mg/100g). Vitamin C content ranged from 0.34mg in *T. tetrapetra* to 0.74mg in *M. myristica*. Vitamin contents of the spices were generally low when compared to vitamin contents of some commonly consumed green leafy vegetables and fruits which are established dietary sources of vitamins (Oboh, 2006). For example, vitamin C content usually ranged from 43.5 to 148.0 mg/100 in green leafy vegetables and from 20 to 29mg/100g in fruits (Oboh, 2006).

The likely basis for low vitamin contents in these spices could be attributed to heating effect during drying of the spices. Sun drying, at least, had been reported to cause a marked decrease in vitamin contents of food materials (Enechi and Odonwodo, 2003). Also, it is evident from this study that of the four spices, *T. tetrapetra* had the least content of each of the vitamins, the least content of crude fat (Table 1) and the least content of most macrominerals (Table 2) investigated. This low nutrient content could be the main reason why the natives, even without any scientific knowledge but with long experience in food and nutrition use only the hot water extract of *T. tetrapetra* in their diet.

Vitamins are generally needed daily in small amounts from foods. They yield no energy directly but may contribute to energy yielding chemical reactions in the body and promote growth and development (Murray, 1998). Thiamin, riboflavin, and niacin play key roles as co-enzymes in energy yielding processes. The recommended dietary allowance (RDA), that is adequate intake is 1.1 to 1.2mg for thiamin, 1.1 to 1.3mg for riboflavin, and 14 to 16mg for niacin. Only niacin has upper limit of toxicity at 35mg or more. They help metabolize carbohydrates, fats and oils.

Deficiency of these three vitamins may cause brain damage, poor nervous coordination, skins and gastro-intestinal (GI) tracts disorders (Schauss, 1995; Enechi and Odonwodo, 2003).

Folate plays an important role in DNA synthesis and homocysteine metabolism. The RDA for folate is 400mg. Excess folate intake can mask vitamin B-12 deficiency. Its deficiency could cause poor cell division, megaloplastic anaemia, tongue inflammation, diarrhea and poor growth.

Vitamin C assists in synthesizing collagen for building connective tissues. As an antioxidant, it enhances iron absorption, and helps in synthesizing hormones and neurotransmitters (Food and Nutrition Board, 2001). Vitamin C maintains blood vessel flexibility and improves circulation in the arteries of smokers. It acts as antioxidant and scavenges oxygen-free radicals produced from normal metabolic processes in the body (Murray, 1998). Its deficiency results in scurvy with poor wound healing, skin hemorrhages and bleeding of gum. Vitamin C is lost during cooking. Fresh or lightly cooked vegetables should be added in the diet.

Table 3: Vitamin contents of spices

Spices	Thiamin (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	Folic acid (mg/100g)	Ascorbic acid (mg/100g)
M. myristica	0.13^{c}+0.01	0.06^{c}+0.00	2.95^{c}+0.03	38.73^{c}+0.21	0.74^{a}+0.00
M. tenuifolia	0.16^{b}+0.01	0.11^{b}+0.00	3.63^{b}+0.02	46.10^{b}+0.61	0.54^{a}+0.01
O. viridi	0.36^{a}+0.00	0.21^{a}+0.01	5.47^{a}+0.03	87.51^{a}+0.99	0.39^{a}+0.01
T. tetrapetra	0.05^{d}+0.00	0.03^{c}+0.00	1.25^{d}+0.01	13.60^{d}+0.06	0.34^{a}+0.00

Data are means ± standard deviations (n = 3); values marked by the same letter within the same column are not significantly different ($p < 0.05$).

CONCLUSION

Nutrient compositions of these spices indicate that they are excellent sources of most food nutrients, including fibre, fats and oil, protein, vitamins and minerals. However, as spices they are consumed in small quantities at meals and would be maximally exploited if consumed regularly. These spices are therefore recommended for broader application in foods and food related materials for greater health benefits. More bioactive constituents of these spices should also be characterized for medicinal application.

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