African Journal of Pharmaceutical Research and Development
Available online at https://ajopred.com
Vol. 16 No.3; pp. 97-104 (2024)

Original Research Article

NUTRITIONAL COMPOSITION, VITAMIN AND MINERAL CONTENTS OF *PIPER GUINEENSE*, *XYLOPIA AETHIOPICA*, AND *MONODORA MYRISTICA*

JOSEPH CHINEDU NDEFO[1], CHIOMA OBIAGELI ONYESIFE[1]*, CHIMAOBI ODINAKA UGORJI[1]

1. Department of Science Laboratory Technology, Faculty of Physical Sciences, University of Nigeria, P.M.B 410001, Nsukka, Enugu State, Nigeria.

ABSTRACT
An extensive body of research has consistently shown that most plants utilized as herbs possess therapeutic properties and serve as reservoirs of both nutritional and non-nutritive compounds. A diverse array of these compounds demonstrates a broad spectrum of health advantages, encompassing antioxidant and antibacterial properties that help protect the human body against infections and cellular oxidative processes. This study examines the vitamin, mineral, and nutritional makeup of three well-known African spices: African nutmeg (*Monodora myristica*), African guinea pepper (*Xylopia aethiopica*), and West African black pepper (*Piper guineense*). Though their extensive nutritional profiles are less well-documented in scientific research, these spices are essential to traditional African medicine and food. The study adopted the experimental method, and the samples were analyzed in triplicates. The IBM SPSS (version 25) statistical package was used in analyzing the results. The results show that *P. guineense* has the highest Iron content (68.75 mg/dl), Sodium content (287 mmol/L), and Chromium content (8.5 mg/dl); *X. aethiopica* has the highest Manganese content (3.35 mg/dl), while *M. myristica* is very high in sodium (287 mmol/L), potassium (304.50 IU) and phosphorus (282.20 mg/dl). *P. guineense* is richest in vitamin A (1747. 52 IU), and vitamin B2 (0.12 mg/dl), while *M. myristica* gave the highest amount of vitamin D (65.0 IU) and vitamin E (5.70 mg/100g). All three spices have high fiber content and are rich in dietary lipids, proteins, and carbs, according to proximate study of the seeds. Mineral examination revealed that these spices are good suppliers of macro minerals including sodium, potassium, and phosphorus; significant amounts of trace minerals, including manganese and iron, were also found. According to the study's findings, *Piper guineense*, *Xylopia aethiopica*, and *Monodora myristica* are considered functional foods since they have significant nutritional and therapeutic value in addition to culinary advantages.

ARTICLE INFO
Received 07 September, 2024
Accepted 05 December, 2024
Published 20 December, 2024

KEYWORDS
Xylopia aethiopica,
Monodora myristica,
Piper guineense,
Proximate analysis,
Vitamins,
Minerals

INTRODUCTION
Elaborate documentation exists on the functional contributions of several plant components, including roots, stems, leaves, flowers, seeds, and others, to the maintenance of cellular health. The pathophysiology of several diseases, most notably cancer, has been connected to the effects of free radicals on DNA [1]. Therefore, the combination of dietary factors and oxidative metabolic changes may have a major impact on the progression of benign to malignant cancer [2].

***Corresponding author:** chioma.onyesife@unn.edu.ng; +234-806 839 6398

https://doi.org/10.59493/ajopred/2024.3.11 *ISSN: 0794-800X (print); 1596-2431 (online)*

Piper guineense, a well-known culinary and medicinal herb, is a member of the Piperaceae family and is found across West Africa. It is a staple spice in many traditional recipes and has a unique peppery taste. *Piper guineense* is mostly composed of carbs, proteins, and dietary fibre. Depending on the plant component being studied, studies have revealed different proportions (leaves, seeds, or fruits) [3,4]. According to research by [5], the amount of carbohydrates, proteins, and fibre in various plant components ranged from 30% to 50%, 10% to 20%, and 5% to 15%, respectively. Vitamin A (as β-carotene), vitamin C, riboflavin (B2), and niacin (B3) were identified in high amounts in *Piper guineense*, according to research by [6]. The leaves and seeds of *Piper guineense* contain significant levels of calcium and potassium, according to research by [7]. *Piper guineense* also contains trace minerals in varied amounts, including iron, zinc, and copper. These minerals are essential to many different metabolic processes. *Piper guineense*'s leaves and seeds exhibit significant concentrations of certain trace minerals [8]. Because these minerals are essential for bone health, muscle activity, and some metabolic functions, *Piper guineense* is a valuable dietary supplement.

As a member of the Annonaceae family, *Xylopia aethiopica* is widely used as a spice in African cuisines and traditional medicine. This evergreen shrub is indigenous to Africa's tropical rainforests. The fruits, seeds, and bark of this plant are widely utilized in food preparation, medicine, and nutrition. The proximate composition of *X. aethiopica* fruits is known to be heavy in carbs, proteins, and lipids, while the precise ratios may differ. The fruit of *X. aethiopica* was found to have around 35% carbs, 12% protein, and 11% fat in research done by [9]. *Xylopia aethiopica*'s phytochemical complexity highlights both its importance in conventional medicine and its promise as a source of innovative therapeutic agents. Studies have indicated that *Xylopia aethiopica* has essential minerals, contributing to the plant's nutritional value and potential health benefits. Significant amounts of minerals including calcium, potassium, magnesium, and zinc have been discovered in some plant parts [10,11]. *X. aethiopica* is a useful dietary supplement because these minerals are necessary for strong bones, the growth of muscles, and other metabolic processes. According to studies, *X. aethiopica* has vitamins A, C, and E, which increase its nutritional value and antioxidant capacity [12-14]. The vital roles these vitamins play in cellular metabolism, oxidative defence, and immunological function further augment the nutritional value of *X. aethiopica*.

Calcium, magnesium, potassium, and phosphorus are among the important minerals that *X. aethiopica* is an excellent source of. According to a study by [15], the fruit has significant calcium and potassium content, both of which are necessary for healthy bones and muscles. The immune system, antioxidant defence, and metabolic processes all depend on these trace minerals. The iron-rich *X. aethiopica* seeds have been shown by research [16] to be beneficial in treating iron-deficiency anemia. *X. aethiopica* is a significant spice that has significant nutritional advantages in addition to improving food flavour.

West African *Monodora myristica* is a tropical plant that belongs to the Annonaceae family. Since it tastes and is used similarly to nutmeg spice, it is also often called African nutmeg. The seeds' rich flavour and supposed health advantages have led to their extensive use in traditional African medicine and cuisine. *Monodora myristica*, a plant with deep roots in the region's cuisine, medicinal, and cultural practices, has garnered a lot of attention from scientists because of its wide range of bioactive chemicals and possible health advantages.

M. myristica seeds are renowned for having a high-fat content along with modest amounts of carbs and protein. According to research by [17], *M. myristica*'s proximate composition is 40.5% fat, 19.6% protein, and 34.7% carbs. Moisture, fibre, and ash content make up the remaining part. In addition, *M. myristica* is valued for its mineral content, which acts as a natural storehouse of vital elements required for bodily processes. Significant amounts of minerals like calcium, potassium, magnesium, and phosphorus have been found in various plant sections by studies, highlighting the plant's potential as a dietary supplement to treat mineral deficiencies and improve general health [18,19].

Apart from its mineral and phytochemical components, *M. myristica* has a wide range of vitamins, such as vitamin C, vitamin E, and several B-complex vitamins. The nutritional value of *M. myristica* is further enhanced by these vitamins, which are essential for immune system function, cellular metabolism, and antioxidant defence [20,21]. The seeds have a very high concentration of heart-healthy essential fatty acids, such as oleic and linoleic acids. *Monodora myristica* is a healthy source of lipids since its lipid component mostly consists of unsaturated fatty acids, according to research by [22]. The high dietary fibre content of the seeds promotes digestive health and gastrointestinal wellness. The results of [23] show that fibre content might vary from 5% to 15% depending on the preparation. Studies by [24] highlighted that it had moderate levels of ascorbic acid (vitamin C), thiamine (B1), niacin (B3), and riboflavin (B2). These vitamins help the spice's ability to enhance metabolic processes, increase energy levels, and offer antioxidant effects.

Additionally, the seeds include β-carotene, which is a precursor to vitamin A and essential for healthy skin, immune system, and vision. Research by [25] and [26], has verified that the seeds of *M. myristica* are a good source of calcium, magnesium, potassium, and phosphorus, among other important minerals. These minerals are necessary for strong bones, healthy muscles, and a healthy heart. Trace minerals including iron, zinc, and copper are present in *M. myristica* in addition to macrominerals, according to recent research by [27]. These minerals are essential for enzyme activity, immune system performance, and oxygen transport. *M. myristica* is not just a culinary spice but also a functional food component with the potential for wider uses in health and wellness because of its rich nutritional profile and possible health benefits.

There is a need for a more thorough investigation of native spices such as *Piper guineense*, *Xylopia aethiopica*, and *Monodora myristica* due to the growing interest in plant-based diets and nutrient-dense meals worldwide. These spices may provide a host of nutritional advantages, such as vital vitamins, minerals, proteins, carbs, and fats that may help maintain a balanced diet and enhance overall health. Although these spices are frequently used, much is not known or recorded about their complete nutritional and therapeutic potential. Without examining their possible health benefits or contribution to micronutrient consumption, the majority of study focuses on their traditional use. To help determine their significance in correcting micronutrient deficiencies, this study attempts to offer accurate measurements of the vitamins and minerals they contain. To close this information gap, a thorough and objective assessment of the nutritional makeup, vitamin content, and mineral content of *P. guineense, X. aethiopica, and M. myristica* is provided in this work. This work was aimed to ascertain the macronutrient, vitamin, and mineral contents of Piper guineense, Xylopia aethiopica, and Monodora myristica together with their complete nutritional makeup and to determine whether these spices can help with micronutrient shortages, improving nutritional status and reducing malnutrition, especially in developing countries where malnutrition is common. Knowing their nutritional profiles will benefit public health nutrition, especially in areas where these spices are widely used. It will also assist market these spices as possible functional foods or dietary supplements, adding to the body of scientific research. Furthermore, this study's examination of the vitamin and mineral composition of these spices may offer important insights into how well they might treat micronutrient deficiencies, a problem that affects the whole world but is particularly acute in impoverished nations. As a result, by promoting local, nutrient-rich food sources, this research may aid in the mitigation of nutritional deficits.

MATERIALS AND METHODS

Sample Collection and Preparation

The seeds of *Piper guineense, Xylopia aethiopica,* and *Monodora myristica* were purchased from the Ogige market, Nsukka L.G.A., Enugu state of Nigeria. The seeds were identified by a plant taxonomist from the Department of Plant Science and Biotechnology, University of Nigeria, Nsukka; and a voucher specimen was deposited in their Herbarium with the voucher number UNH/ 04/0223 for *P. guineense*, UNH/04/0227 for *X. aethiopica*, and UNH/04/0228 for *M. myristica*. After collecting the samples of *Piper guineense*, *Xylopia aethiopica*, and *Monodora myristica*, the spices were cleaned thoroughly to remove any dirt or impurities. The cleaned samples were then air-dried at room temperature for 3 days to ensure complete moisture removal. Once dried, the samples were ground into a fine powder using a mechanical grinder (Retsch ZM200, Germany), ensuring a consistent particle size of approximately 0.5 mm. This particle size ensures uniformity in analysis and better accuracy during the nutrient composition tests. The samples were then kept at 4°C until additional examination.

Homogenization of the Sample

Homogenization for AAS and Flame Photometry: To guarantee uniform distribution of the elements to be examined, the samples were dried and powdered into fine powders. The powders were then thoroughly homogenized by agitating at a moderate speed in a mechanical shaker for ten minutes. This procedure made sure that there was no clumping or uneven particle distribution and that the material was well-mixed. Preparation for AAS and Flame Photometry: The homogenized samples were acid-digested using a solution of nitric acid and perchloric acid to break down the organic materials and release the minerals into solution before performing AAS and flame photometry. Following digestion, the materials were filtered and diluted to the proper quantities for examination and the clear solutions from the digested samples were examined.

Determination of the Mineral Contents of the Seeds.

Atomic absorption spectrophotometry (AAS) and flame photometry were used to assess the mineral content following the protocols outlined by [28].
Macro Minerals (Sodium, Potassium): Flame photometry was used to determine the amounts of sodium and potassium.
Trace Minerals (Iron, chromium, manganese): Following an acid digestion process employing a nitric and perchloric acid combination, the samples were examined for iron, chromium and manganese using AAS.
Phosphorus: A UV-Vis spectrophotometer was used to measure the absorbance at 660 nm and quantify the phosphorus concentration using the colourimetric technique with ammonium molybdate.

Determination of the Vitamin Contents of the Seeds.

High-performance liquid chromatography (HPLC) was used to assess the vitamin content, including vitamin E, β-carotene, and the B-complex vitamins (thiamine, riboflavin, and niacin) following modified [29] procedures.
B-Complex Vitamins: Following extraction with 0.1 N hydrochloric acid and separation using a reverse-phase C18 column, thiamine (B1), riboflavin (B2), and niacin (B3) were quantified using HPLC.
β-Carotene: A UV detector set at 450 nm was used to quantify β-Carotene using HPLC. Hexane was used for extraction, while potassium hydroxide was used for saponification [30].

Proximate Analysis

Using proximate analysis and the standard operating procedures of [30], the moisture, crude protein, crude fat, carbohydrate, fibre, and ash content of each sample were ascertained.
Moisture Content: To ascertain the moisture content, 5g of each sample was oven-dried at 105°C until a consistent weight was reached.
Crude Protein: The protein content was determined using the Kjeldahl technique, which involved converting the nitrogen content to protein using a conversion factor of 6.25.

Crude Fat: Petroleum ether was used as the solvent in a Soxhlet device to extract crude fat [30].
Ash Content: Using the [30] Method, the sample was burned at 550°C in a muffle furnace until a consistent weight was reached.
Crude Fiber: The Weende technique was used to determine the amount of crude fibre.
Carbohydrate Content: By deducting the total moisture, protein, fat, fibre, and ash from 100%, the carbohydrate content was determined by difference.

Statistical Analysis
The statistical analysis was carried out with IBM Corp.'s SPSS program (Version 25). All analyses were carried out in triplicate, and the means ± standard deviation (SD) of the findings was reported. One-way analysis of variance (ANOVA) was used to evaluate the data, and Tukey's post hoc test was used to compare means to observe if significant differences ($p < 0.05$) were found

RESULTS

The mineral composition of *X.aethiopica, P.guineense and M. myristica* seeds are shown in Table 1. It shows the presence of macro minerals like Sodium, Potassium, and Phosphorus, and trace elements like Iron, Manganese and Chromium (Figure 1). The highest concentrations of sodium (287.20 mg/100 g), potassium (304.50 mg/100 g), and phosphorus (282.20 mg/100 g) were found in *Monodora myristica*. The highest concentrations of iron (68.75 mg/100 g) and chromium (8.50 mg/100 g) were found in *Piper guineense*; *Xylopia aethiopica* showed a higher manganese content (3.35 mg/100 g) than the other spices, and it had no measurable levels of chromium despite having substantial levels of sodium, potassium, phosphorus, and iron.

Table 2 shows the presence of the different vitamins in all three seeds, with *X.aethiopica* and *P.guineense* showing significantly ($p < 0.05$) higher levels of vitamin A and B3 compared with *M. myristica*, while *M. myristica* gave a significantly higher level of vitamin D compared to the other two. *Piper guineense* has the highest concentration of vitamin B2 (0.12 mg/100 g) and vitamin A (1747.52 IU), *Xylopia aethiopica* exhibited significant vitamin E levels (5.21 mg/100 g), the highest vitamin B3 content (0.58 mg/100 g), and high amounts of vitamin A (1550.36 IU). The highest concentrations of vitamin B1 (0.32 mg/100 g) and vitamin D (65 IU) were found in *Monodora myristica*.

Table 3 shows the proximate composition of the three seeds. The macronutrient content of *Xylopia aethiopica*, *Monodora myristica*, and *Piper guineense* varied significantly, according to the proximate composition analysis. Xylopia aethiopica exhibited the greatest crude protein (13.17%). High crude fat content (21.37%) and crude fibre (15.39%) was obtained in *Monodora myristica*. *Piper guineense* contained the largest percentage of carbohydrates (64.54%), and the highest percentage of ash (5.78%). Crude fat and carbohydrate contents of *X.aethiopica* and *P. guineense* are significantly ($p < 0.05$) higher than that of *M. myristica*. *M. myristica* has the highest level of crude fibre, and the moisture content is significantly ($p < 0.05$) higher in *P. guineense* than in *X. aethiopica* and *M. myristica*.

Table 1: Mineral composition of *X.aethiopica, P.guineense and M. myristica* seeds

Samples	Sodium (Na)	Potassium (K)	Phosphorus (P)	Iron (Fe)	Manganese (M)	Chromium (Cr)
X. aethiopica	266.80 ± 2.89	203.00 ± 50.12	218.40 ± 0.28	17.81 ± 3.62	3.35 ± 0.98*	0.00 ± 0.00
M. myristica	287.20 ± 0.38*	304.50 ± 11.37*	282.20 ± 0.28*	25.45 ± 0.00*	0.00 ± 0.00	1.21 ± 1.70
P. guineense	287.80 ± 1.71*	220.70 ± 6.84	226.40 ± 0.21	68.75 ± 3.60*	0.67 ± 0.94	8.50 ± 1.70*

Key: Values are expressed as mean ± SD (n = 3). Values with different superscripts in a row are significant at $p < 0.05$.

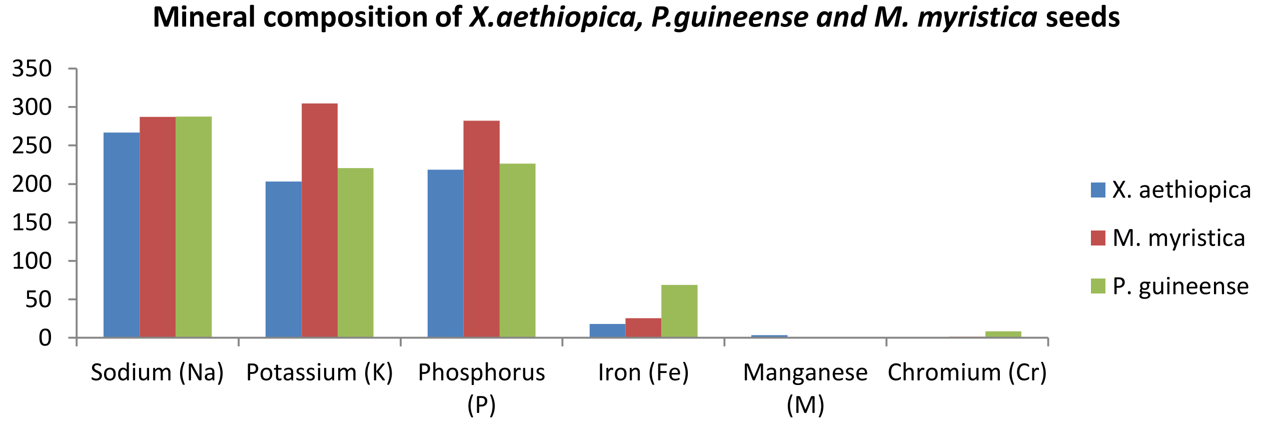

Figure 1: Mineral composition of *X.aethiopica, P.guineense and M. myristica* seeds

Table 2: Vitamin contents of *X.aethiopica, P.guineense and M. myristica* seeds

Samples	Vitamin A (IU)	Vitamin B1 (mg/100g)	Vitamin B2 (mg/100g)	Vitamin B3 (mg/100g)	Vitamin D (IU)	Vitamin E (mg/100g)
X. aethiopica	1550.36±4.01*	0.15±0.00	0.05±0.00	0.58±0.10*	48.00±1.41	5.21±1.01*
M. myristica	478.06±4.07	0.32±0.02*	0.03±0.00	0.11±0.03	65.00±1.41*	5.70±1.01*
P. guineense	1747.52±10.03*	0.04±0.01	0.12±0.00*	0.40±0.01*	44.00±1.41	4.22±1.04

Key: Values are expressed as mean ± SD (n = 3). Values with different superscripts in a row are significant at $p < 0.05$.

Table 3: Proximate composition of *X.aethiopica, P.guineense and M. myristica* seeds

Samples	Crude Protein (%)	Ash content (%)	Crude Fat (%)	Moisture Content (%)	Crude fibre (%)	Carbohydrate (%)
X.aethiopica	13.17 ± 0.05*	3.06 ± 0.01*	4.69 ± 0.01	11.81 ± 0.03	8.51 ± 0.04*	58.80 ± 0.05*
M. myristica	9.75 ± 0.05	1.36 ± 0.01	21.37 ± 0.04*	11.53 ± 0.01	15.39 ± 0.01*	40.62 ± 0.12
P. guineense	8.60 ± 0.03	5.78 ± 0.03*	3.57 ± 0.03	14.62 ± 0.01	2.90 ± 0.01	64.54 ± 0.03*

Key: Values are expressed as mean ± SD (n = 3). Values with different superscripts in a row are significant at $p < 0.05$.

DISCUSSION

Significant information about the possible functions of *Piper guineense*, *Xylopia aethiopica*, and *Monodora myristica* as functional foods may be gleaned from their nutritional makeup, and vitamin, and mineral levels. The findings demonstrate how the three spices' respective macro- and micronutrient profiles differ significantly, which attests to their distinct nutritional worth.

Although the quantities of the three spices differ greatly, the mineral analysis showed that they are all good suppliers of critical minerals. With an iron (Fe) concentration of 68.75 ± 3.60 mg/100g, *Piper guineense* showed the greatest level, much greater than that of *Xylopia aethiopica* (17.81 ± 3.62 mg/100g) and *Monodora myristica* (25.45 ± 0.00 mg/100g). These iron levels are greater than those found by [31], suggesting that these spices may play a major role in helping people reach their dietary iron needs, especially in areas where iron deficiency anaemia is common. *P. guineense*'s historic usage in postpartum recovery, where it is said to help restore blood loss, may also be attributed to its high iron concentration [4].

P. guineense (287.80 mg/100g) and *M. myristica* (287.20 mg/100g) had the greatest sodium contents, both of which were much more than *X. aethiopica* (266.80 mg/100g). These research findings support past research by [18] and [32], which suggested that these spices may increase salt consumption. They did, however, have comparatively lower potassium contents, with *M. myristica* having the greatest quantity (304.50 mg/100g). The potassium-to-sodium ratio suggests that these spices, particularly *M. myristica*, may aid in maintaining electrolyte balance. Blood pressure regulation and cardiovascular health are significantly influenced by this ratio.

Compared to the other spices, *Xylopia aethiopica* had a greater manganese (Mn) concentration (3.35 ± 0.98 mg/100g), whereas *P. guineense* and *M. myristica* had lower amounts. This is consistent with the work of [19]. For the synthesis of bones, energy metabolism, and antioxidant defence, manganese is necessary. Notably, *P. guineense* has a high level of chromium (Cr) (8.50 ± 1.70 mg/100g), a mineral crucial for controlling insulin and glucose metabolism. On the other hand, no chromium was found in *Xylopia aethiopica*, indicating that *P. guineense* would have more advantages for controlling blood sugar.

The three spices' respective vitamin contents varied significantly, according to the vitamin study. The species *Piper guineense* had the greatest vitamin A content (1747.52 ± 10.03 IU/100g), with *Xylopia aethiopica* (1550.36 ± 4.01 IU/100g) and *Monodora myristica* (478.06 ± 4.07 IU/100g) following closely behind, which is consistent with research by [29]. Vitamin A is essential for healthy skin, immune system, and eyesight. *P. guineense* and *X. aethiopica* have high vitamin A contents, which indicates that they may be valuable providers of this fat-soluble vitamin in diets that could otherwise be lacking in it.

When it came to B-complex vitamins, *Piper guineense* had the greatest amounts of riboflavin (B2) (0.12 ± 0.00 mg/100g), whereas *Monodora myristica* had the highest quantities of thiamine (B1) (0.32 ± 0.02 mg/100g). This agrees with the work of [33]. This implies that these spices could help promote brain function and energy metabolism. All three of these spices include some B vitamins, but because they are low in niacin (B3), it may be necessary to eat them with other foods high in niacin to achieve optimal consumption.

The samples showed variable levels of vitamin D and vitamin E. All samples had comparable amounts of vitamin D; however, *Monodora myristica* had somewhat greater quantities (65.00 IU) than did *X. aethiopica* and *P. guineense*. As noted by [31], this implies that these spices may support bone health and calcium absorption, particularly in areas with little solar exposure. Concurrently, *M. myristica* demonstrated the maximum concentrations of vitamin E (5.70 ± 1.01 mg/100g), a strong antioxidant that promotes skin health and immune system performance [34]. The use of these spices in nutraceuticals and dietary supplements meant to increase antioxidant consumption is further supported by the antioxidant qualities of vitamin E, which can aid in the reduction of oxidative stress.

The macronutrient composition of the spices varied significantly, according to the proximate analysis. With the greatest protein content (13.17 ± 0.05%), *Xylopia aethiopica* may play a role in the amount of protein consumed through food. These results are consistent with previous research by [32], which concluded that *X. aethiopica* is high in protein, probably because of its function as a nutrient-dense seed.

On the other hand, *M. myristica* had a higher crude fat content (21.37 ± 0.04%) than the other spices. The results of [17], which emphasized *M. myristica* as a rich source of oils with potential uses in the food and pharmaceutical industries, are in line with this outcome. *M. myristica*'s high-fat content adds to its potential as an energy-dense spice and may increase its usefulness in dietary formulations intended to support energy levels. *M. myristica* is traditionally used in soup preparations where its high-fat content—especially its unsaturated fatty acids—contributes to the dish's taste and energy content.

Comparing *Piper guineense* (64.54%) to *X. aethiopica* (58.80%) and *M. myristica* (40.62%), the latter two have much lower carbohydrate contents. This suggests that *P. guineense* may represent a significant dietary energy source, a feature that [10], [29] and [32] also support. *P. guineense*'s high carbohydrate content may account for its frequent usage in traditional recipes that favour meals high in energy.

Due to its high carbohydrate content, it is also commonly used in meals high in energy that are ingested after childbirth or during periods of intense activity. Notable was the fibre content of these spices, with *Xylopia aethiopica* exhibiting the greatest crude fibre content (8.51 ± 0.04%), which may aid in blood sugar regulation and promote digestive health [11].

Although each of these spices has nutritional advantages, when compared, they offer a broad range of vital elements. Because *P. guineense* has high levels of iron, vitamin A, and carbohydrates, it can help with energy provision and micronutrient deficits. *X. aethiopica* stands out for its protein and fibre content, supporting both muscle maintenance and digestive health, while *M. myristica*, with its greater fat content and vitamins D and E, may give cardiovascular and antioxidant advantages. The idea that using all three spices together in traditional dishes not only improves flavour but also results in a more balanced intake of macro and micronutrients is further supported by the range of nutrients found in each spice.

CONCLUSION

The potential of *Piper guineense*, *Xylopia aethiopica*, and *Monodora myristica* as functional foods is confirmed by their nutritional profiles. They are important nutritional components because of their high mineral, vitamin, and macronutrient concentrations, especially in areas with little food diversity. Subsequent investigations may go deeper into the bioactive components of these nutrients and their role in particular health consequences. These spices have promise for usage in modern diets and nutraceutical formulations due to their traditional use and promising nutritional advantages.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Because the study only examined samples from certain sites, it might not accurately reflect the differences in nutrient content that could result from different harvest periods, geographic locations, or growing circumstances. This restricts the findings' applicability to other areas where these spices are cultivated. The study doesn't discuss how the nutrients in these spices might interact to change how bioavailable they are when eaten. Antinutritional elements (such as tannins and phytates) that could affect the absorption of nutrients were not investigated.

Samples from different regions and times of year could be gathered for future studies to take seasonal and environmental influences on nutrient composition into consideration. Data on the nutritional characteristics of these spices would become more broadly applicable as a result. Studies could look at the other bioactive substances found in these spices, such as polyphenols, flavonoids, and essential oils. Such research would aid in comprehending the entire spectrum of potential health advantages these spices may provide.

Investigating the bioavailability of these nutrients in human or animal models may shed light on their real absorption and metabolic effects. Clinical research could also look into the medicinal uses and possible health advantages of these spices in treating nutritional deficits.

ACKNOWLEDGMENT

The authors wish to thank Mr Austin Okorie of the Department of Pharmacology and Toxicology, UNN, for running the proximate analysis and Dr Offormata of Energy Research Centre UNN for running the flame photometry.

AUTHORS' CONTRIBUTION

Joseph Chinedu Ndefo: Investigation, Resources, Visualization, Software, Formal Analysis, Chioma Obiageli Onyesife: Methodology, Analysis and interpretation, Writing - original draft, Chimaobi Odinaka Ugorji: Visualization, editing the original draft.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

Funding was not received either externally or internally during and after the study.

REFERENCES

1. Jomova K, Raptova R, Alomar SY, Alwasel SH, Nepovimova E, Kuca K, Valko M. Reactive oxygen

species, toxicity, oxidative stress, and antioxidants: Chronic diseases and aging. Archives of Toxicology, 97(10), 2023:2499-2574.

2. Sadiq IZ. Free radicals and oxidative stress: Signaling mechanisms, redox basis for human diseases, and cell cycle regulation. Current Molecular Medicine, 23(1), 2023:13-35.
3. Uzoekwe NM, Ezenwajiugo CE. Phytochemicals, elemental and proximate analyses of *Piper guineense* leaves. Journal of Applied Sciences and Environmental Management, 27(4), 2023:657-663.
4. Ojimelukwe PC. *Piper guineense*-an underutilized aromatic spice with medicinal value. Advanced Traditional Medicine, 23(2), 2023:381-392.
5. Oyewole OB, Onyenike NO, Adesola OA. Nutritional and anti-nutritional composition of *Piper guineense*: Implications for its use in food and medicine. Journal of Ethnopharmacology, 261, 2020:113067.
6. Alagbe OA, Alagbe GO, Adekunle EA, Ayodele OO, Olorode EM, Oyediran RI, et al. Ethnomedicinal uses and therapeutic activities of *Piper guineense*: A review. Journal of Applied Sciences and Environmental Management, 25(6), 2021:927-937.
7. Dingtsen DJ, Bartholomew O, John SS, Eyitayo EA, Ekirigwe O. Evaluation of the antinutritional and nutritional composition of five Nigerian spices. American Journal of Quantum Chemistry and Molecular Spectroscopy, 4(2), 2021:22-27.
8. Ajibola O, Akinpelu BA, Adeyemo SO. Comparative study of proximate, minerals, and vitamin composition of West African black pepper (*Piper guineense*) seeds and leaves. Food Science and Nutrition, 9(4), 2021:2164-2170.
9. Okeke CE, Nwachukwu UP, Uzodimma GC. Nutritional composition and functional properties of *Xylopia aethiopica* fruit. Journal of Nutrition and Food Science, 10(4), 2020:12-17.
10. Ibe C, Irondi EA, Ugbogu EA, Anyamele T. A review of the nutritional and antimicrobial properties of *Xylopia aethiopica* A. Rich. Food and Humanity, 31(6), 2023: 56-69.
11. Adewuyi A, Oyeleye SI, Akanbi OB, Osundahunsi OF. Nutritional composition and antioxidant properties of selected underutilized tropical fruits in Nigeria. Journal of Food Measurement and Characterization, 15, 2021:327-335.
12. Fategbe MA, Avwioroko OJ, Ibukun EO. Comparative biochemical evaluation of the proximate, mineral, and phytochemical constituents of *Xylopia aethiopica* whole fruit, seed, and pericarp. Preventive Nutrition and Food Science, 26(2), 2021:219-234.
13. Solomon FE, Essien CA, Eyoh GD. Determination of nutrient and phytochemical profile of *Xylopia aethiopica*. Nigerian Journal of Animal Production, 12, 2024:1667-1670.
14. Bada SO, Nafiu AO, Eze IJ. Phytochemical composition, antioxidant activity, and nutritional evaluation of selected Nigerian medicinal plants. Journal of Food Biochemistry, 44(11), 2020:e13417.
15. Odebiyi AO, Alabi TI, Ibitoye EA. Mineral and proximate composition of *Xylopia aethiopica*: Nutritional evaluation of an African spice. International Journal of Food Sciences and Nutrition, 72(3), 2021:324-331.
16. Kone M, Diallo D, Traore N. Evaluation of mineral composition of *Xylopia aethiopica* seeds and leaves. Journal of Agricultural and Food Chemistry, 68(1), 2020:45-52.
17. Ugbogu OC, Emecheta RO, Igwe IO. Nutritional and functional potential of African spices: Implications for health and wellness. Journal of Food Science and Nutrition, 8(4), 2020:2251-2264.
18. Afolabi KD, Eko PM, Etukudoh EN. The nutritional value of African nutmeg (*Monodora myristica*) seed meal. Asian Journal of Research in Biosciences, 6(1), 2024:71-78.
19. John CH. Proximate and phytochemical composition of some *Monodora myristica* fruits consumed in Nigerian states. Journal of Agriculture and Food Research, 1(1), 2022:1-9.
20. Etukudoh EN, Afolabi KD. Proximate composition of *Monodora myristica* seed. In: Ayandele IA, (editor),Contemporary Discourse on Nigeria's Economic Profile, A Festschrift in honour of Prof Nyaudoh, U. Ndaeyo. A Publication of University of Uyo, Uyo, Akwa Ibom State, 2023, p. 410-414.
21. Oko OE, Okwute SK, Achinewhu SC. Antioxidant potential and bioactive properties of *Monodora myristica* seed extract. Journal of Medicinal Food, 23(11), 2020:1145-1153.
22. Adeleke AE, Adegbite SA, Amoo IA, Onifade AP. Composition, nutritional valuable minerals and functional properties of *Monodora myristica* seed flour for domestic consumption and industrial utilization. Journal of Scientific and Industrial Research, 15(1), 2020: 35-42.
23. Okiki PA, Nwobi CP, Akpor OB, Adewole E, Agbana RD. Assessment of nutritional and medicinal properties of nutmeg. Scientific African, 19, 2023:e01548.
24. Akinduko AA, Nwonuma CO. Nutritional and safety assessment of aqueous extract of nutmeg seeds, *Myristica fragrans*. African Journal of Food, Agriculture, Nutrition and Development, 24(8), 2024: 218-225.
25. Okechukwu QN, Ugwuona FU, Ofoedu CE, Juchniewicz S, Okpala CO. Chemical composition, antibacterial efficacy, and antioxidant capacity of essential oil and oleoresin from *Monodora myristica* and *Tetrapleura tetraptera* in Southeast Nigeria.

Scientific Reports, 12(1), 2022:1-12. https://doi.org/10.1038/s41598-022-23161-5.
26. Alawode TT, Ogundele DT, Adeola TO. Vitamin A and carotenoid content of *Monodora myristica* seeds and their potential role in improving eye health. Food Chemistry, 312, 2020:125820.
27. Okafor OE, Agbede JO, Olorunfemi M. Determination of trace element composition in *Monodora myristica* and its potential health benefits. Journal of Trace Elements in Medicine and Biology, 66, 2021:126771.
28. Onyeike EN, Omubo-Dede T. Evaluation of the effect of heat processing on proximate composition, energy values, and levels of some toxicants in African yam bean (*Sphenostylis stenocarpa*) seeds. Plant Foods for Human Nutrition, 57(3), 2002:223-231.
29. Onyeike EN, Nwankwo JO, Ifemeje JC. Comprehensive analysis of the vitamin and mineral composition of indigenous African spices. Journal of Food Composition and Analysis, 72, 2018:12-22.
30. AOAC. Official methods of analysis of Analysis of Official and Analytical Chemists. 21st Ed. Rockville (MD). Association of Official and Analytical Chemists. Washington DC; 2020:123-130.
31. Adepoju OT, Olawuyi BA, Afolabi WAO. Mineral and anti-nutrient composition of commonly consumed traditional spices in Nigeria. African Journal of Food, Agriculture, Nutrition and Development, 20(2), 2020:15521-15536.
32. Orji VU, Appah J, Abdulsalami MS, Ejike OJ. Antimicrobial and biochemical properties of three Nigerian food spices: *Piper guineense, Xylopia aethiopica* and *Monodora myristica*. International Journal of Medical Science and Clinical Research Studies, 3(4), 2023:742-750. https://doi.org/10.47191/ijmscrs/v3-i4-31.
33. Dodo JD, Okugo B, Salami SJ, Eseyin AE, Ogar E. Evaluation of the antinutritional and nutritional composition of five Nigerian spices. American Journal of Quantum Chemistry and Molecular Spectroscopy, 5(1), 2020:22-27.
34. Liu X, Yang G, Luo M, Lan Q, Shi X, Deng H. Serum vitamin E levels and chronic inflammatory skin diseases: A systematic review and meta-analysis. PLoS One, 16(12), 2021:e0261259.