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Anatomical, Proximate, Vitamin and Mineral Studies on *Piper guineense* (Piperaceae)

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Authors' contributions

This work was carried out in collaboration between all authors. Author CVI designed the study. Authors CVI and AJC wrote the protocol and wrote the first draft of the manuscript. Author AJC managed the literature searches, analyses of the study and managed the experimental process. Author CVI identified the species of plant. All authors read and approved the final manuscript.

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ABSTRACT

Anatomical, proximate, vitamin and mineral studies were carried out on the leaf, petiole, stem and root of *Piper guineense* using standard techniques. Analysis of Variance (ANOVA) was employed for data analysis. Anatomical result revealed similar features in their epidermis and cortex and differences in their vascular bundles arrangement. Moisture was highest in the stem (16.91±0.00%), crude protein and Fat were highest in the leaf (16.41±0.10% and 9.43±0.01% respectively) crude fibre and Ash were highest in the root (5.91±0.06% and 10.30±0.63% respectively). Vitamin A and vitamin C, phosphorus, zinc and iron were highest in the leaf (66.24±0.04 µg/g, 201.05±0.00 mg/100 g, 34.13±0.22 mg / 100 g, 0.45±0.00 mg / 100 g and 14.62±0.01 mg / 100 g respectively. The work has demonstrated that the plant is really a power house of nutrients. Apart from the leaf eaten by our people, other parts of the plant could also be used as food to supplement our daily nutrient needs, animal feed and in the manufacture of drugs. Also the anatomical result is an additional aid to the taxonomic characterization of the plant.

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1. INTRODUCTION

Plants are important source of medicines, lumber, spices, paper and fibers, they produce the food and oxygen on which humans and animals depend on [1]. Plants contain many nutrients which are important for proper functioning of human body system. These nutrients are protein, ash, fat and oil, moisture, minerals, vitamins [2]. Medicinal plants have been used since medieval time as a source of medicine for the treatment of all kinds of ailments. Traditional medicine and medicinal plants continue to play a role in the system of most cultures [3].

Piper guineense, also known as West African, ashanti pepper, benin pepper, false cubebs, guinea cubebs, uziza pepper or (ambiguously) ''Guinea pepper'' [4]. *P. guineense* belongs to the plant family called piperaceae [5,6,7]. *P. guineense* is native to tropical regions of Central and Western African and are semi-cultivated in countries such as Nigeria where the leaves are known as uziza. *P. guineense* is used as spice and for medicinal purposes [8]. In China, *P. guineense* fruit extract is used for the treatment of epilepsy [9]. In Nigeria, *P. guineense* leaves have shown to exhibit molluscidal and antibacterial activity amongst inhabitants of the rain forest belt of Western Nigeria [10]. *P. guineense* is used as surf in streams and also in cleansing fresh wounds and old sores [11]. Besides, it is used to spice varied dishes for a woman in post-natal, hence this plant is vegetatively propagated along the banks of streams and the ripe fruits fall inside the streams [12].

Anatomy of plants revealed the internal organization of cells, organelles, tissues, and their functions [13]. The anatomy of plants has enabled man to make choice in timber production. The shape, size and arrangement of most cells in the plant like epidermis, sclerenchyma amongst other features have aided the studying of wood formations in plants [14].

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life [15]. Minerals are chemical constituents used by the body in many ways. Although they yield no energy, they have important roles to play in many activities in the body [16,17]. Every form of living matter requires these inorganic elements or minerals for their normal life processes [18,19].

Vitamins are a heterogeneous group of organic compounds that are very vital for life. They are organic compounds which are needed in small quantities to sustain life. We get vitamins from food, because the human body either does not produce enough of them or none at all. Vegetables and fruits are valuable components of the daily diet contributing carbohydrate in form of dietary fibre, vitamins and minerals to the body.

P. guineense is a species with high nutritional and medicinal values, however no comprehensive survey has been done which covers anatomy, minerals and vitamins studies, hence the need for the present study. The problem and focus of the researcher is to ascertain the gross internal structures of the plant organs as seen in a section and its nutritional information.

2. MATERIALS AND METHODS

2.1 Area of Study and Sources of Plant Materials

This research work was carried out at the Botany laboratory of University of Nigeria, Nsukka (UNN). The plant used in this work was collected from Uruagu, Nnewi North Local Government Area, Anambra State. The plant was identified by a taxonomist in the Department of Botany Nnamdi Azikiwe University Awka. The voucher specimens were deposited in the herbarium of Nnamdi Azikiwe University, Awka.

2.2 Anatomical Study

Anatomical study was carried out at the Anatomy Laboratory of the Department of Plant Science and Biotechnology, University of Nigeria, Nsukka using Reichert sledge microtome. Transverse sections were made from middle part of fully grown leaves, midpoint of petiole, centre of an internode of young and mature stem and mature root. This was done using standard procedure as described by [20,21]. Photomicrographs of the specimens were taken with Zeiss light microscope with MC'35 Camera for 53 mm film.

2.3 Proximate, Mineral and Vitamin Studies

Proximate (ash, crude protein, crude fat, crude fibre and moisture), minerals (zinc, iron and phosphorus) and vitamins (vitamin A and C) contents were carried out to ascertain the nutrient compositions present in the plant extracts. These were done using the standard methods described by [22,23,24,25].

2.4 Statistical Analysis

Results were presented in mean±standard deviation and were subjected to analysis of variance (ANOVA) using Duncans Multiple Range Test (DMRT) at 5% probability to separate the treatments. Difference in mean value were considered significant.

3. RESULTS AND DISCUSSION

The results of the study were shown in Fig. 1, Tables 1-3 and Plates 1-6.

The result revealed that all the parts contained the nutrients investigated but in varied compositions (Tables 1-3). The leaf contained the highest percentage of crude protein (16.41±0.10), and fat (9.43±0.01). The root contained the highest percentage of crude fibre (5.91±0.06) and Ash (10.30±0.63). The stem contained the highest percentage of variance showed a significant difference in the percentage of crude protein, crude fibre, fat and moisture between the stem, leaf and root of *P. guineense* ($p<.05$) (Table 1). The result has indicated that these parts are a good source of the nutrients investigated when compared to some other vegetables. Fat is high energy nutrient and does not add to the bulk of the diet [26]. Fat provides a source of concentrated energy, transports vital nutrients around the body, protects the internal organs and prevents excessive body heat [27].

Proteins are used for building and repairing of body tissues, regulation of body processes and formation of enzymes and hormones. Ash content of any given food materials is a measure of food quality and identity, it represents the foodstuff that is carbon free as a result of burning away of organic portion [28].

The higher fibre content in the root showed that they can help in keeping the digestive system healthy and functioning properly. Fibre aids and speeds up the excretion of waste and toxins from the body, preventing them from sitting in the intestine or bowel for too long, which could cause a build-up and lead to several diseases [28]. Higher moisture content of stem showed that it will be less preferred to leaf and root in processed food products. [26] have reported that high moisture increase spoilage and enzymatic deterioration in food products.

Fig. 1. *Piper guineense* in its natural habitat
Source: Self collection

Result in Table 2 indicated that the leaf contained the highest percentage of all the minerals investigated (.45±0.00), (34.13±0.22) and (14.62±0.01) for zinc, phosphorus and iron respectively (Table 2). Analysis of variance showed a significant difference in the composition of zinc, phosphorus and iron between stem, root and leaf ($P< .05$) (Table 2). The higher composition of these minerals in the leaf indicated that it will serve as a better source of zinc, phosphorus and iron than other parts of the plant. According to [28] the recommended daily allowance of iron is between 8-18 mg/day. Iron is an important constituent of haemoglobin found in blood. Iron serves as a carrier of oxygen to the tissues from the lungs by the red blood cell haemoglobin as a transport medium for electrons within cells and as integrated part of important enzyme systems in various tissues [29]. Phosphorus is essential for the process of bone mineralization as well as a role in the structure of cellular membranes, nucleic acids and nucleotides, including adenosine triphosphate while zinc is an essential trace element needed in the body for boosting the immune system and preventing lower respiratory infections [28].

Table 1. Proximate composition of the stem, leaf and root of *P. guineense*

Plant part	Percentage proximate composition (%)				
	Crude protein	Crude fibre	Ash	Fat	Moisture
Stem	4.60±0.02[b]	5.32±0.04[b]	10.12±0.36[b]	9.12±0.01[a]	16.91±0.00[c]
Leaf	16.41±0.10[c]	4.85±0.06[a]	8.92±0.04[a]	9.43±0.01[b]	11.30±0.04[b]
Root	4.11±0.00[a]	5.91±0.06[c]	10.30±0.63[b]	9.12±0.00[a]	5.88±0.00[a]

Results are in Mean±Std. Column followed by the same letters is not significantly different at p< .05

Table 2. Mineral composition of the stem, leaf and root of *P. guineense* (mg/100 g)

Plant part	Mineral composition (mg/100 g)		
	Zinc	Phosphorus	Iron
Stem	0.09±0.01[a]	19.37±0.03[b]	3.42±0.00[a]
Leaf	0.45±0.00[c]	34.13±0.22[c]	14.62±0.01[c]
Root	0.28±.065[b]	5.52±0.00[a]	3.89±0.02[b]

Results are in Mean±Std. Columns followed by the same letter are not significantly different at P< .05

Table 3. Vitamin compositions of the stem, leaf and root of *P. guineense*

Plant part	Percentage vitamin composition	
	Vitamin A (µg/g)	Vitamin C (mg/100 g)
Stem	13.62±0.01[a]	11.32±0.00[b]
Leaf	66.24±0.04[c]	201.05±0.00[c]
Root	13.20±0.02[b]	11.05±0.00[a]

Results are in Mean±Std. Columns followed by the same letter are not significantly different p< .05

Result in Table 3 showed that the leaf contained the highest level of the Vitamins investigated (66.24±0.04) and (201.05±0.00) for vitamin A and vitamin C respectively (Table 3). Analysis of variance showed a significant difference in the compositions of vitamin A and vitamin C between the stem, root and leaf (P< .05). The higher composition of these vitamins in the leaf indicated that it will serve as a better source of vitamin A and vitamin C when compared to other parts. Vitamin A enhances vision while vitamin C activates the cell functions. Vitamin C is a powerful antioxidant. It favours the absorption of iron in the intestine, protects against infections. It neutralizes blood toxins and intervenes in the healing of wounds [28].

4. ANATOMICAL RESULTS

The transverse section of the leaf showed that the leaf is dorsiventrally flattened with the midrib and the mesophyll is composed of one layer of palisade cells adaxially and occupies one third the width of the mesophyll and several layers of spongy tissue abaxially. Vascular bundles are not well laid out (Plate 1).

Transverse section of the petiole showed that the outline is circular, no wings found but trichomes are present and are mainly non-glandular. There were presence of uniserate epidermis followed by 2-3 layers of collenchymas and parenchyma. Vascular bundle was well arranged and pronounced (Plate 2).

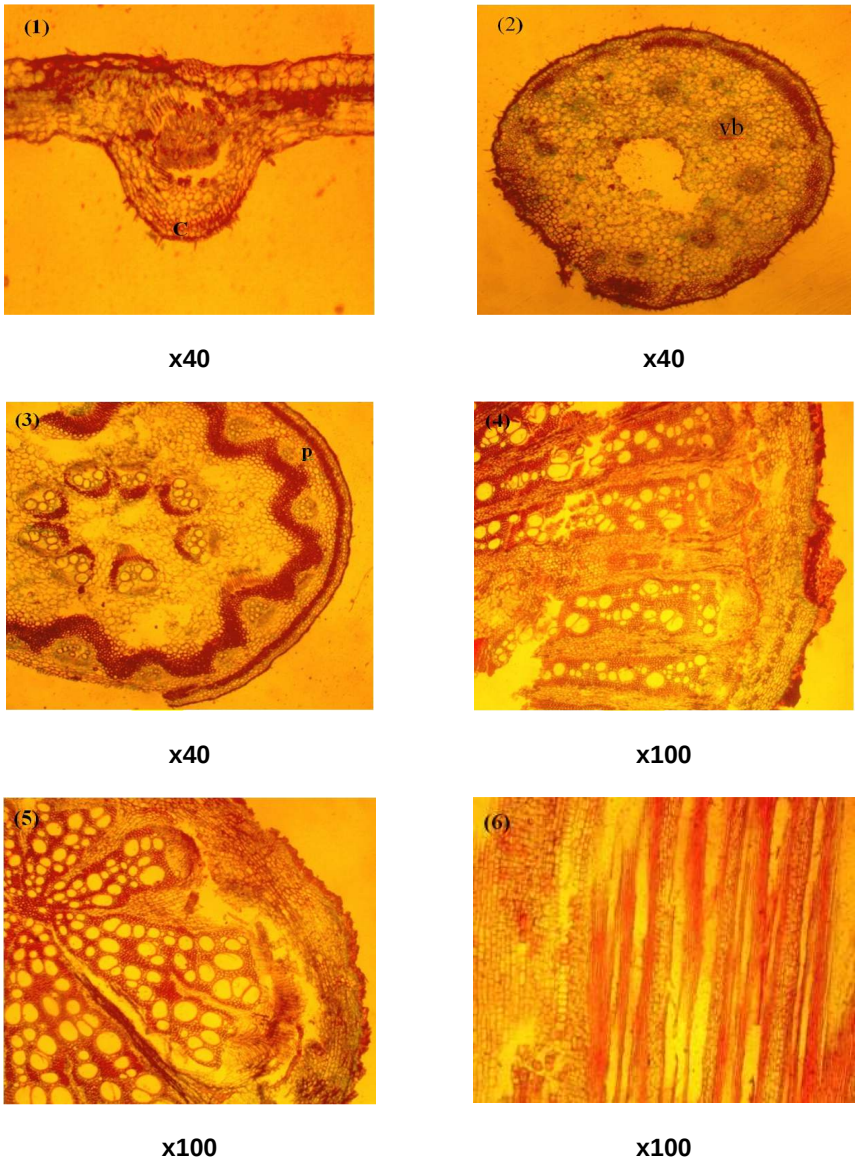
Transverse section of the primary stem showed that the outline was circular. Uniserate epidermis, 2-3 layers of collenchyma. Vascular bundle was collateral and medullary bundle also present (Plate 3).

Transverse section of secondary stem showed that the vascular bundle was interrupted by secondary rays and scattered sclereids (Plate 4).

Transverse section of root of *P. guineense* showed one layered epidermis, and well defined cortex. The vascular bundle was interrupted by secondary rays (Plate 5).

Tangential longitudinal section of the stem of *P. guineense* revealed the presence of xylem rays and phloem rays (Plate 6).

Result of the anatomical study of the various parts of *P. guineense* revealed similar features among the parts though the vascular bundles were differently arranged and distributed (Plates 1-6). The dissimilarity in arrangement of the vascular bundle could be attributed to the differences in their physiological functions as plant organs. The result is in line with the work of plant anatomist [30] who stated that the similarities and differences in features confirm their physiological functions as plant organs.



Plates 1-6. T/S of leaf, petiole, primary and secondary stem, root and TLS of stem respectively
C: Collenchyma, P: Parenchyma, VB: Vascular bundle

5. CONCLUSION

The results of the study revealed that these parts of the *P. guineense* investigated are very nutritious and can contribute significantly to the human health requirements. Anatomical study is an additional aid to the plant taxonomic characterization and identification.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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