



REVIEW ARTICLE

***Piper guineense* Schum. & Thonn. (Piperaceae) - a review of its pharmacognostic, phytochemical, ethnomedicinal and pharmacological properties**

 Temitayo Lucia OHEMU^{1*}, Hidayat Oyiza BELLO¹, Tongret DATOK², Dalen Gwatau DAFAM¹

¹Department of Pharmacognosy, Faculty of Pharmaceutical Sciences, University of Jos, Jos, Nigeria.

²Department of Pharmacognosy, Bingham University, Karu, Nasarawa State, Nigeria.

Received 6th March 2024; Accepted 15th April 2024

Abstract

Piper guineense Schum. & Thonn. (Piperaceae) is a spice plant cultivated in West Africa for its aromatic, pungent, or otherwise desirable qualities. The leaves of *P. guineense* are used as a leafy vegetable, while its fruits are favoured for imparting flavour to a wide range of African soups. This study aimed to review available scientific literature on the pharmacognostic, ethnomedicinal, phytochemical, and pharmacological studies of *P. guineense* Schum. & Thonn. in Africa, from the year 2000 till date. Pharmacognostic studies have identified various macroscopic, organoleptic, microscopic, and physicochemical characteristics have been identified, providing valuable tools for the accurate identification and authentication of *P. guineense*. The phytochemical studies of the plant revealed the presence of alkaloids, steroids, glycosides, saponins, flavonoids, tannins, and terpenoids. Several studies have explored various plant parts of *P. guineense*, to elucidate its pharmacological effects, including its potential as an antimalarial, anticancer, antioxidant, aphrodisiac, antiplatelet, hepatoprotective, and antimicrobial agent. This review has shown that beyond its traditional role as a spice, *P. guineense* offers significant nutritional and biological benefits.

Keywords: *Piper guineense*; Pharmacognostic; Ethnomedicinal; Phytochemical; Pharmacological

INTRODUCTION

Traditional Medicine (TM) serves as the primary source of healthcare for many people in developing countries, where access to modern healthcare services and medicine is limited due to economic and cultural reasons [1]. Traditional Medicine holds significance not only in developing nations but also in developed countries, where there has been an

increase in the demand for herbal medicines in recent years. Additionally, many pharmaceutical products in developed countries are derived from or contain biological substances.

In Africa, herbal medicine is the most common Traditional Medicine practice, because plants have shown to serve as an

*Correspondence. E-mail: ohemut@unijos.edu.ng

essential reservoir of medicines [2]. Traditional medicine was the primary healthcare system for millions of people across rural and urban communities in Africa before the introduction of modern medicine [3]. African traditional medicine encompasses a system of healing rooted in the beliefs and customs of the African people. This system involves the utilization of medicinal plants and other natural materials, along with the practices of diviners, medicine men, witch doctors, and sorcerers [4].

Piper guineense, belonging to the family Piperaceae and genus piper, is a spice plant native to West Africa. Popularly known as Ashanti pepper, it is cultivated for its aromatic, pungent, and other desirable properties [5]. *Piper guineense* is native to Nigeria, Guinea, Ghana and Uganda, thriving in closed forests, forest edges, and moist environments within forest clearings. Known by local names are Uziza (in Igbo), Iyere (in Yoruba), Masoro (in Hausa), Urie (in Urhobo), this plant's leaves are commonly used as a leafy vegetable, while its fruits serve as a flavouring agent in many African soups (Figure 1). Traditional beliefs attribute medicinal properties to this plant [5]. This study aims to conduct a comprehensive review of scientific literature published from the year 2000 to the present, focusing on pharmacognostic, ethnomedicinal, phytochemical, and pharmacological studies of *Piper guineense* Schum & Thonn in Africa.

METHODS

In this review, scientific databases such as PubMed, ScienceDirect and Google Scholar were searched for available literature on the pharmacognostic, ethnomedicinal, phytochemical and pharmacological uses of *Piper guineense*. While some of the publications were directly accessed, others were obtained through citations from other sources.

Keywords, such as “traditional medicine”, “medicinal plants”, “*Piper guineense*”, “traditional medicine in Africa”, “ethno medicinal uses of *Piper guineense*”, “*Piper guineense* phytochemicals” and “pharmacological activity of *Piper guineense*” were used for the search. The literature utilized in this study encompassed publications available from the year 2000 to the present day. The research aimed to highlight ethnomedicinal use, pharmacological activity and phytochemical properties of *Piper guineense* in various African countries. Subsequently, the plant's parts were categorized according to their ethnomedicinal use, pharmacological activity and phytochemical characteristics

RESULTS

Macroscopic features of the plant parts of *Piper guineense*. The macroscopical features such as type, colour, shape, and size of the leaf, fruits and flowers of *Piper guineense* Schum & Thonn are presented in Table 1.

Organoleptic properties of the leaf of *Piper guineense*. The organoleptic properties of the leaf of *Piper guineense* are presented in Table 2. The odour is aromatic, taste is hot and very pungent, the colour is green and texture is powdery and soft.

Microscopical properties of the lant parts of *Piper guineense*. The microscopical properties of the leaf of *Piper guineense* are presented in Table 3. The epidermal cell is dorsiventral with straight anticlinal walls. The stomata type is diacytic, the mesophyll consists of spongy and palisade. The vascular bundle consists of xylem and phloem tissues, surrounded by layers of fibres.

Physicochemical Properties of *Piper Guineense* Schum & Thonn. The physicochemical properties of the leaf and seed of *Piper guineense* such as the moisture content, Total ash value, extractive values,

crude fat, crude proteins and crude fibre are presented in Table 4. The leaf has a moisture content of $11.70 \pm 0.03\%$, total ash value of $7.73 \pm 0.04\%$, water-soluble extractive of 5.80 ± 0.16 , alcohol-soluble extractive of 8.00 ± 0.08 , crude protein of $16.67 \pm 0.02\%$ and carbohydrate of $48.21 \pm 0.00\%$. The seed has a moisture content of $12.35 \pm 0.01\%$, total ash value of $6.33 \pm 0.02\%$, crude protein of $5.86 \pm 0.04\%$ and carbohydrate of $57.32 \pm 0.78\%$.

Phytochemical properties of the plant parts of *Piper guineense*. The phytochemical constituents present in the leaf, seed, root and fruit of *Piper guineense* are presented in Table 5. The leaf and seed contain mainly alkaloids, tannins, flavonoids, Saponins, steroids and terpenes. The root contains mainly alkaloids such piperine, trichostachine and wisanine. Terpenes and phenylpropanoids are the major phytochemicals found in the fruit of *Piper guineense*.

Ethnomedicinal uses of the plant parts of *Piper guineense*. The leaf, seed, root and fruit

of *Piper guineense* is used in ethno medicine in the treatment of different diseases such as infections, male and female infertility, weight control, stomach discomfort, abortifacient and so on (Table 6). The seed (31%) is the part mostly used in ethnomedicine, followed by the leaves (27%), fruit (21%) and root (21%) (Figure 2).

Pharmacological activity of the plant parts of *Piper guineense*. Table 7 shows the pharmacological activity of the leaf, seed, root, fruit and essential oil of *Piper guineense*. These morphological parts and oil of *Piper guineense* have shown to possess antimalarial, antihypertensive, anticancer, antidiabetic, aphrodisiac, antioxidant, anticonvulsant, antipsychotic, sedative, antimicrobial and molluscidal activities. This review revealed that the leaf (46%) is the most studied part of the plant for pharmacological activity, followed by the root (15%) and seed (15%) while the fruit (12%) and essential oil (12%) being the least studied (Figure 3).

Table 1: Macroscopical features of the plant parts of *Piper guineense*

Plant part	Characters	Features	References
Leaf	Type	Simple, Alternate Petioles	[7, 8, 9, 10]
	Colour	Green	
	Apex	Acuminate	
	Venation	Pinnate	
	Shape	Elliptical	
	Size	Length: $10.3\text{cm} \pm 0.5$; Breadth: $6.0\text{cm} \pm 0.2$	
Fruit	Type	Drupe mesocarp or fleshy	[9, 10, 11, 12]
	Occurrence	Clusters	
	Colour	Red or reddish brown when ripe; Black when dry	
	Shape	Oval	
Flower	Colour	Greenish yellow	[9]
	Peduncle	5 mm long	

Table 2: Organoleptic properties of the plant parts of *Piper guineense*

Plant Part	Characters	Features	References
Leaf	Odour	Aromatic	[7, 8]
	Taste	Hot and very pungent	
	Colour	Green	
	Texture	Powdery & Soft	

Table 3: Microscopical properties of the plant parts of *Piper guineense*

Plant Part	Characters	Features	References
Leaf	Anticlinal Walls	Straight	[7, 13]
	Calcium Oxalate Crystals	Cluster scattered on surface of lamina	
	Stomata	Diacytic arrangement	
	Transverse Section	Upper and lower epidermis	
	Surface	Bifacial	
	Arrangement	Dorsiventral	
	Mesophyll	Spongy & Palisade	
	Vascular Bundle	Xylem & Phloem tissues, surrounded by layers of fibres	

Table 4: Physicochemical properties of the plant parts *Piper guineense*

Plant Part	Parameters	Values	References
Leaf	Moisture content	11.70±0.03%	[7, 9, 14, 15, 16, 17, 18, 19]
	Total Ash value	7.73±0.04%	
	Acid– insoluble ash	0.89 ± 0.01	
	Water– soluble ash	4.10 ± 0.25	
	Alcohol– soluble extractive	8.00 ± 0.08	
	Water– soluble extractive	5.80 ± 0.16	
	Crude fibre	9.26±0.03%	
	Crude fat	2.24±0.02%	
	Crude protein	16.67±0.02%	
	Carbohydrate	48.21±0.00%	
Seed	Moisture content	12.35±0.01%	[9, 14, 15, 16, 17, 19]
	Dry matter	87.65±0.01%	
	Ash value	6.33±0.02%	
	Crude fibre	8.79±0.01%	
	Crude fat	9.89±0.07%	
	Crude protein	5.86±0.04%	
	Carbohydrate	57.32±0.78%	

Table 5: Phytochemical properties of the plant parts of *Piper guineense*

Plant part	Phytochemical constituents	Continent/Country	References
Leaf	Tannins, Flavonoids, Alkaloids, Saponins, Cardiac glycosides	Africa	[7, 8, 9, 10]
	Dihydrocubebin	Africa	[20]
Seed	Piperine, Capsaicin, Cubebin, Caryophyllene, Carotenoids, Alkaloids, Tannins, Saponins, Anthraquinones, Steroids, Phenols, Flavonoids, Terpenes	Africa (Nigeria, Ghana)	[21, 22]
Root	Piperine, Trichostachine, Lignans, Wisanine	Africa	[20]
Fruit	Monoterpenes, Sesquiterpenes, Phenylpropanoids	Africa (Cameroon, Nigeria, Congo)	[23,24,25,26]
	Phellandrene	Africa	[20]
	Pinene, Limonene, β-sesquiphellandrene,		[26]
	Linalool, Limonene, Z-β-bisabolene, α-pinene		

Table 6: Ethnomedicinal uses of the plant parts of *Piper guineense*

Plant Part	Ethnomedicinal Uses	Continent	References
Leaf	To treat respiratory infections, rheumatism, syphilis, flatulence	Africa (Nigeria)	[9, 26, 27]
	To treat female infertility		[27, 28, 29]
	To treat low sperm count in males;	Africa	[30]
	To stabilise womb after birth		[31]
	For urinary tract infections; As an antipyretic		
Seed	For stomach discomfort; Adjuvant in rheumatic pains; As an anti-asthmatic agent; As an aphrodisiac; To control weight;	Africa (Nigeria)	[32].
	To improve uterine contraction; As an abortifacient.	Africa	[20]
	To treat bronchial infections.		
Root	As an aphrodisiac, as chewing stick	Africa (Nigeria)	[9]
	To treat gonorrhoea, bronchitis, syphilis, and colds.	Africa	[20]
Fruit	As an aphrodisiac	Africa (Nigeria)	[9]
	Fresh fruits are used as a cough remedy.	Africa	[20]

Table 7: Pharmacological activity of the plant parts of *Piper guineense*

Plant part	Pharmacological Activities	Continent/ Country	References
Leaf	Antimalarial; Antihypertensive	Africa (Nigeria)	[33]
	Antiarrhythmic	Africa	[34]
	Anticancer		
	Antioxidant	Africa	[31]
	Anti-inflammatory; Antitumor;	Africa	[35, 36]
	Ant allergic; Antiplatelet		
	Antidiabetic		
	Aphrodisiac		
Seed	Hepatoprotective	Africa	[38]
	Anticancer activity	Africa	[39, 40]
	Antioxidant; Haematological effects		[12]
Root	Anti-aggressive; Sedative; -	Africa (Nigeria, Cameroon)	[10, 24, 26]
	Tranquilizing agent; Anticonvulsant		
Fruit	Molluscidal activity	Africa	[41]
	Antifungal agent	Africa (Togo)	[42]
	Aphrodisiac agent	Africa (Nigeria)	[28, 43, 44]
Essential oils	CNS-depressant, Antipsychotic	Africa (Nigeria)	[26, 45]
	Bactericidal & Antimicrobial;	Africa	[46,47,48,49]
	Antifungal		



Fig 1: (A) *Piper guineense* leaf and unripe seeds (B) *Piper guineense* leaf and ripe seeds (C) *Piper guineense* dried seeds [6]

DISCUSSION

Piper guineense (African black pepper) is widely used traditionally in the treatment of different diseases because of its medicinal properties [9]. The pharmacognostic properties of this plant highlighted in this review are crucial for accurate identification of the plant. The macroscopic and microscopic characteristics outlined in tables 1, 2 and 3 will aid in standardising the plant and safeguarding against adulteration and substitution. *P. guineense* is characterized by a simple aromatic leaf with alternate petioles, green in colour with an acuminate apex and pinnate venation, and elliptical in shape. Its fruit is a drupe monocarp that occurs in clusters, red or reddish brown when ripe, and black when dry.

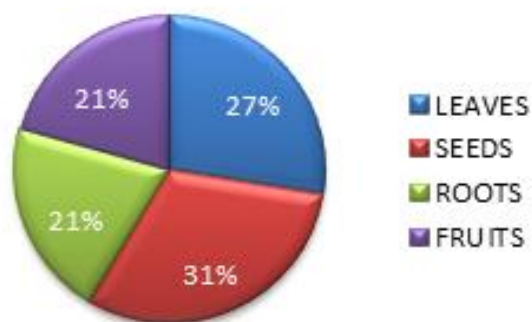


Fig 2: Percentage of Plant Parts of *Piper guineense* used in Ethnomedicine

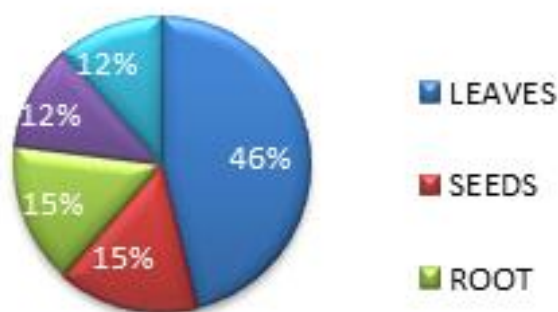


Fig 3: Percentage of Plant Parts of *Piper guineense* used in Pharmacological studies

Its flowers are greenish yellow in colour with a 5 mm long peduncle (Table 1).

The microscopical examination help in the identification of diagnostic characters that useful in the proper standardisation of the plant. The leaf possess straight anticlinal walls, with cluster type of calcium oxalate crystals scattered on the surface of the lamina, its stomata is diacytic and it possesses spongy and palisade mesophyll with upper and lower epidermal layers [7, 13].

The nutritional and anti-nutritional properties of *Piper guineense* can be seen in the reports of the physicochemical and proximate analysis (table 4). These nutritional and anti-nutritional factors confer on *Piper guineense* its flavour, aroma, and preservative

properties [49, 50]. *Piper guineense* is an important source of various phytochemicals, responsible for its medicinal potential. Phytochemicals such as alkaloids, steroids, glycosides, saponins, flavonoids, tannins, and terpenoids [7, 10, 9, 8, 20] (table 5). This review has also revealed that the majority of the ethnomedicinal uses of *Piper guineense* have been proven by scientific research both in vitro and in vivo. The plant parts of *P. guineense* have been employed traditionally for the treatment of various ailments [9]. The leaves are being used to treat respiratory and urinary tract infections, flatulence, low sperm count in males, and female infertility. The seeds, roots, and fruits are used as an aphrodisiac (Table 6). The oil distilled from the fruit is used in soap making and perfumery [33].

Numerous studies have been carried out on most of the plant parts of *P. guineense*, to determine its pharmacological actions on the system (table 7). The leaf and seed are seen to have antimalarial, antihypertensive, anti-inflammatory, anticancer, and hepatoprotective properties, to name but a few [33, 31, 38, 39, 40]. The fruits possess molluscidal and antifungal activities [41, 42]. The root possesses sedative and tranquilizing activity [10, 23], while the essential oils expressed have been seen to possess antipsychotic, antimicrobial, and antifungal activities [26, 45, 46, 47].

This review went further to compare the plant part mostly used in Africa, where the plant is widely used for its nutritional and medicinal properties. It was revealed that the plant part mostly used in ethnomedicine is the seed, closely followed by the leaves (figure 2). Also, the plant part that has been researched the most, in Africa is the leaves as shown in Figure 3.

Conclusion. *Piper guineense* Schum & Thonn is a West African spice plant popularly used as a spice in traditional foods. It is known for its aromatic odour and peppery taste. This review

has shown that other than its use as a spice, *Piper guineense* possesses many nutritional and biological benefits. Extensive studies have been carried out to determine the pharmacological activities of the different parts of the plant. However, there is a need for more research to determine the specific compounds responsible for each therapeutic activity.

REFERENCES

1. Van Andel T, Carvalherio GL. Why Urban Citizens in developing countries use traditional medicines: The Case of Suriname, Evid Based Complement Alternat Med. 2013; 1-13.
2. Patel D. Plants as a Source of Medicine. Med. & Arom. Plants Editorial Open Access. 2015; 10.4172/2167-0412.S3-e001.
3. Abdullahi AA. Trends and challenges of traditional medicine in Africa. Afr J Tradit Complement Altern Med. 2011; 8(5 Suppl):115-123. doi:10.4314/ajtcam.v8i5S.5
4. Kasilo OM, Dikassa L., Samson P., Ngenda M., Trapsida C. Marie J. An Overview of The Traditional Medicine Situation In The African Region, Afr. Health Monit. (Online). 2010; 14: 7-15.
5. Kabiru AY, Ibikunle GF, Innalegwu DA, Bola BM, Madaki FM. In vivo antiplasmodial and analgesic effect of crude ethanol extract of *Piper guineense* leaf extract in Albino mice. Scientifica (Cairo). 2016; 86: 87-93.
6. Brunken, U., Schmidt, M., Dressler, S., Janssen, T., Thiombiano, A. & Zizka, G. West African plants - A Photo Guide. http://www.westafricanplants.senckenberg.de/root/index.php?page_id=14&id=2392 - Forschungsinstitut Senckenberg, Frankfurt/Main, Germany. 2008.
7. Tavs AA, Mumuni S, Obi IS. Pharmacognostic and toxicological evaluation of the leaves of *Piper guineense* Schum. and Thonn (Piperaceae). African Journal of Pharmacy and Pharmacology. 2020; 14(7): 229-239.
8. Mgbeahuruike EE, Fyhrquist P, Vuorela H, Julkunen-Tiitto R, Holm Y. Alkaloid-Rich Crude Extracts, Fractions and Piperamide Alkaloids of *Piper guineense* Possess Promising Antibacterial Effects. Antibiotics. 2018; 7(4):98. <https://doi.org/10.3390/antibiotics7040098>

9. Besong EE, Balogun ME, Djobissie SFA, Mbamalu OS, Obinna JN. A Review of Piper guineense (African Black Pepper). *Int. J. Pharm Pharm Res.* 2016; 6: 368–384.
10. Ohiagu FO, Chikezie PC, Maduka T, Enyoh CE, Chikezie CM. Bioactive compounds and medicinal usefulness of edible leaves of Vernonia amygdalina, Ocimum gratissimum, Piper guineense and Gongronema latifolium. *SAJ Pharma Pharmacology.* 2021; 7: 101
11. Effiong OO, Ochagu SI. Chemical composition and growth promoting effect of Piper guineense leaf and seed meals on broiler chicks at starter phase. *Anim. Res. Int.* 2019; 16(2): 3285 – 3294
12. Ogbonna AC, Abuajah CI, Hart EB. Preliminary evaluation of physical and chemical properties of Piper guineense and Xylopia aethiopica seed oils. *Int. Food Res J.* 2015; 22(4): 1404-1409.
13. Ibtisam A, Hannis FM, Zolkapli E. Styloid-shaped calcium oxalate crystals from Piper Species, *Journal Intelek.* 2016; 10(2): 41-43.
14. Adesokan AA, Akanji MA. Antimalarial bioactivity of Enantia chlorantha Stem bark. *Pharmacol. Ther.* 2010; 4 (1): 441 – 447.
15. Nwankwo CS., Ebenezer IA., Ikpeama AI, Asuzu FO. The Nutritional and anti-nutritional values of two culinary herbs – Uziza Leaf (Piper guineense) and Scent Leaf (Ocimum gratissimum) Popularly used in Nigeria, *Int. J. Sci. Eng.* 2014; 5 (12): 1160-1163.
16. Okonkwo C, Ogu A. Nutritional evaluation of some selected spices commonly used in South Eastern part of Nigeria, *J. Biol. Agric. Healthcare.* 2014; 4(15): 45 -51.
17. Udousoro I, Ekanem P. Assessment of Proximate Compositions of twelve edible vegetables in Nigeria, *Int. J. Mod. Chem.* 2013; 4(2): 79 – 89.
18. Dibulo CC, Madu KC, Ogbu PN, Onyeachu BI, Njoku DI. Proximate and Phytochemical Analysis of Ethanolic Extracts of Leaves of Piper guineense from South-eastern Nigeria. *IOSR J. Appl. Chem. (IOSR-JAC).* 2017; 8(10): 46-50.
19. Ojinnaka MC, Odimegwu EN, Chidiebere FE. Comparative Study on the Nutrient and Antinutrient Composition of the Seeds and Leaves of Uziza (Piper Guineense), *IOSR J. Environ. Sci.Toxicol. Food Technol. (IOSR-JESTFT).* 2016; 8(10): 42-48.
20. Iwu MM. Pharmacognostical Profile of Selected Medicinal Plants from: *Handbook of African Medicinal Plants (2nd ed.). CRC Press.* 2014 <https://doi.org/10.1201/b16292>.2014
21. Ameh SJ, Obodozie OO, Inyang US, Abubakar MS, Garba M. Climbing black pepper (Piper guineense) seeds as an antisickling remedy. In: Preed VR, Watson RR, Patel VB, editors. *Nuts and Seeds in Health and Disease Prevention.* Academic Press; 2011. P. 333-343. <https://doi.org/10.1016/B978-0-12-375688-6.10040-4>.
22. Ogunmefun O, Akharaiyi F, Adegunle S, Ogunmefun O. Phytochemical and Antimicrobial Properties of Piper guineense (Shumach and Thonn) on Selected Human Pathogens. *J. Chem. Pharma. Res.* 2020; 9:180-186.
23. Benitez NP, Melendez Leon EM, Stashenko EE. Essential oil composition from two species of Piperaceae family grown in Colombia. *J. Chromatogr. Sci.* 2009; 47: 804–807.
24. Tankam JM, Ito M. Inhalation of the essential oil of Piper guineense from Cameroon shows sedative and anxiolytic-like effects in mice. *Biol. Pharm.* 2013; 36: 1608–1614.
25. Oyedeji OA, Adeniyi BA, Ajayi O, König WA. Essential oil composition of Piper guineense and its antimicrobial activity. Another chemotype from Nigeria. *Phytother. Res.* 2005; 19: 362-364. [10.1002/ptr.1679](https://doi.org/10.1002/ptr.1679).
26. Oyemitan IA, Olayera OA, Alabi A, Abass LA, Elusiyan CA, Oyedeji AO, Akanmu MA. Psychoneuropharmacological activities and chemical composition of essential oil of fresh fruits of Piper guineense (Piperaceae) in mice. *J. Ethnopharmacol.* 2015; 166: 240–249. <https://doi.org/10.1016/j.jep.2015.03.004>.
27. Ekanem AP, Udoh FV, Oku EE. Effects of ethanol extract of Piper guineense seeds (Schum. and Thonn) on the conception of mice (Mus Musculus). *Afr. J. Pharm. and Pharmacol.* 2010; 4(6): 362-367.
28. Memudu AE, Akinrinade ID, Ogundele OM, Dare BJ. Effects of crude extract of dry fruits of Piper guineense on male fertility parameters of adult Sprague Dawley rats. *Eur. J. Med. Plants.* 2015; 5(3):297-303.
29. Nwachukwu CU, Ume NC, Obasi MN, Nzewuihe GU, Onyirioha C. The qualitative uses of some medicinal plants in Ikeduru LGA of Imo state, Nigeria. *N Y Sci J.* 2010; 3(11):132-134.
30. Ajuru MG. Ethnobotanical Inventory of Oguru-ama Town, Degema Local Government Area, Rivers State, Nigeria, *J. Adv. Biol. Biotechnol.* 2018; 19(2): 1-13.
31. Isikhuemen EM, Ogbomwan BO, Efenudu IU. (2020). Evaluation of Phytochemical and Mineral

- Constituents of Piper guineense Schum. & Thonn. and Piper umbellatum Linn: Implications for Ethnomedicine, *Eur. J. Med. Plants.* 2020; 31(1): 84-97.
32. Uhegbu, F, Imo C, Ugbogu A. Effect of aqueous extract of Piper guineense seeds on some liver enzymes, antioxidant enzymes and some hematological parameters in albino rats. *Int. J. Plant Sci.* 2016; 1: 167–171.
33. Ogbunugafor HA, Ugochukwu CG, Kyrian-Ogbonna AE. The role of spices in nutrition and health: a review of three popular spices used in Southern Nigeria; *Food Qual. Saf.* 2017; 1(3): 171–185
34. Iweala EEJ, Liu FF, Cheng RR, Li Y, Ononhinmin CA, Zhand YJ. Anticancer and free radical scavenging activity of some Nigerian food plants in vitro. *Int. J. Cancer Res.* 2015; 11: 41–51.
35. Wodu CO, Iwuji SC, Adienbo OM. Antihyperglycaemic Activity of Piper Guineense in Diabetic Female Albino Wistar Rats. *Int. J. Pharm. Phytopharmacol. Res. (eIJPPR).* 2017; 7: 1-4.
36. Sulaimon LA, Anise EO, Obuotor EM, Samuel TA, Moshood AI, Olajide, Fatoke MT. In vitro antidiabetic potentials, antioxidant activities and phytochemical profile of african black pepper (Piper guineense). *Clin. Phytosci.* 2020; 6:90. <https://doi.org/10.1186/s40816-020-00236-2>
37. Ochei JO, Enitan SS, Effedua HI, Omodiale PE, Giwa O. Libido Enhancement Potential of Piper guineense in Male Wistar Rats. *Asian J. Biol.* 2017; 4(4): 1-9.
38. Wasswa JN, Omorodion TN, Avwioro GO, Asimiyu OS. Histological Effect of Piper Guineense (UZIZA) Leaves on the Liver of Wistar Rats. *Int. J. Res. Rev.* 2017; 4(3):36-41.
39. Kuete V, Krusche B, Youns M, Voukeng I, Fankam AG, Tankeo S, et al. Cytotoxicity of some Cameroonian spices and selected medicinal plant extracts. *J. Ethnopharmacol.* 2011; 134: 803–812.
40. Soladoye MO, Amusa NA., Raji-Esan SO, Chukwuma EC, Taiwo AA. Ethnobotanical survey of anti-cancer plants in Ogun State, Nigeria. *Ann. Biol. Res.* 2010; 1: 261–273.
41. Ukwandu N; Odaibo A; Okorie T; Nmorsi O (2011) Molluscicidal effect of piper guineense. *Afr. J. Tradit. Complement. Altern. Med.* 8: 447–451.
42. Mgbeahuruike EE, Holm Y, Vuorela H, Amandikwa C, Fyhrquist P. An ethnobotanical survey and antifungal activity of Piper guineense used for the treatment of fungal infections in West-African traditional medicine. *J Ethnopharmacol.* 2019; 30;229:157-166. doi: 10.1016/j.jep.2018.10.005. Epub 2018 Oct 15. PMID: 30336302.
43. Mbongue FGY, Kantchouing P, Essame OJL, Yewah PM. Effect of the aqueous extract of dry fruits of Piper guineense on the reproductive function of adult male rats. *Indian J. Pharmacol.* 2005; 37(1):30-32.
44. Kpomah ED, Uwakwe AA, Abbey BW. Aphrodisiac studies of diherbal mixture of Zanthoxylum leprieurii Guill and Piper guineense on male wistar rats. *Global J. Med. Plants.* 2012; 1: 381-390.
45. Abubakar AR, Haque M. Medicinal plants with reported anxiolytic and sedative activities in Nigeria: A systematic review. *Istanbul J. Pharm.* 2019; 49(2): 92-104.
46. Nwinyi OC, Chinedu NS, Ajani OO, Ikpo CO, Ogunniran KO. Antibacterial effects of extracts of Ocimum gratissimum and Piper guineense on Escherichia coli and Staphylococcus aureus, *Afr. J. Food Sci.* 2009; 3(3): 077-081
47. Anyawu CU, Nwosu GC. Assessment of the antimicrobial activity of aqueous and ethanolic extract of Piper guineense leaves. *J. Med. Res.* 2014; 8: 337–439.
48. Omonigbehin EA. Piper guineense: a possible alternative treatment for multidrug resistant EHEC. *Int. J. Appl. Sci. Technol.* 2013; 2: 55–60.
49. Klin-Kabari BB, Barimalaa IS, Achenwu SC. Effect of three indigenous spices on the chemical stability of smoked dried catfish (Clarias lazera) during storage. *Afr. J. Agric. Nutr. Dev.* 2011; 11: 5–9.
50. Alagbe OA, Alagbe GO, Adekunle EA, Ayodele OO, Olorode EM, Oyediran RI, et al. Ethnomedicinal Uses and Therapeutic Activities of Piper Guineense: A Review. *J. Appl. Sci. Environ. Manage.* 2021; 25(6): 927-937.
51. Ogbunugafor HA, Ugochukwu CG, Kyrian-Ogbonna AE. The role of spices in nutrition and health: A review of three popular spices used in Southern Nigeria, *Food Qual. Saf.* 2017; 1(3): 171–185. <https://doi.org/10.1093/fqsafe/fyx020>