



Evaluation of Phytochemical and Mineral Constituents of *Piper guineense* Schum. & Thonn. and *Piper Umbellatum* Linn: Implications for Ethnomedicine

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Authors' contributions

This work was carried out in collaboration among all authors. Author EMI initiated the study, coordinated the field investigation, data/laboratory analyses and writing of the manuscript. Author BOO was involved in the field survey, laboratory/data analyses and writing of the manuscript. Author IUE conducted the laboratory analyses and took part in writing of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: A significant number of tropical rainforest shrubs and lianes are inextricably linked to human use as food, spices and/or medicine. This study evaluates phytochemical and mineral constituents and ethnomedicinal uses of *Piper guineense* Schum. & Thonn and *Piper umbellatum* Linn.

Methods: Two phased investigations – ethnomedicinal uses and phytochemical/mineral constituents of *P. guineense* and *P. umbellatum* – were carried out in Benin City, Edo State, Nigeria. Firstly, key informants' interview and questionnaire were used to elicit reactions from respondents (vendors and end users) on ethnomedicinal and sundry uses of *P. guineense*

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and *P. umbellatum* in nine purposively selected markets out of 27. Secondly, samples of leaves and stems of *P. guineense* and *P. umbellatum* were collected and analysed in the laboratory for selected phytochemicals (alkaloid, cyanogenic glycosides, tannin, flavonoid, tannins, anthraquinones, saponin and phenol), and minerals (Ca, Mg, Na, K, P, Fe, Zn).

Results: Market survey revealed that vendor/end users (85%) were well-informed on the uses of the plants for food (spices, condiments) and ethnomedicine. Most respondents (80%) affirmed that the leaves were frequently used for flavouring; and for preparing traditional medicinal soups when combined with assorted vegetables. Respondents (80%) averred that the leaf was the most frequently used followed by stems (10.9%), roots (5.5%) and seeds (3.6%). *P. guineense* was considered best for stomach disorder/ulcer, respiratory/urinary tract infections; *P. umbellatum* most preferred for arthritis, fever and fertility/womb cleansing. Phytochemical analysis revealed *P. umbellatum* stem had more alkaloids, flavonoids and phenol; and anthraquinone in the leaf while *P. guineense* stem had more saponins and tannins. However, mineral analyses revealed more Ca and Mg in *P. guineense* leaf; and K, Na, Zn and P in *P. umbellatum* stem while Fe was higher in the leaf.

Conclusion: *P. guineense* and *P. umbellatum* are aromatic liane and shrub used for flavouring and spicing of food, and medicine. These fairly ubiquitous and underutilized plants can contribute significantly to food and health needs of forest dependent people in Nigeria and elsewhere in West Africa. The study has revealed that these aromatic plants are rich sources of phytomedicines and important minerals. Further investigation on the phytochemical/pharmacological potentials and ecological idiosyncrasies of these underutilized aromatic rainforest liane and shrub is recommended.

Keywords: *Indigenous knowledge; minerals; phytochemicals; spices; underutilized species; market vendor.*

1. INTRODUCTION

Medicinal plants refer to plants with one or more organ(s) containing substances that can be used for therapeutic purposes or which can be used as precursors for the synthesis of diverse medications [1]. Herbs are generally valued for their virtues as food as well as medicine [2]. The utilization of plants as therapeutic medicines is an ancient tradition, far older than the contemporary sciences of medicine, pharmacology or chemistry; it is a tradition that has an attachment to both historical and prehistoric precedence, having its origins in an era when medicine, magic, religion, and pharmacology were aspects of a single empirical discipline [3]. Kareem et al. [4] reported that medicines developed from plants are comparably safer than their synthetic counterparts thus rendering enormous therapeutic benefits at an economical treatment rate. It is widely believed that traditional medicine sometimes called herbalism is the most ancient method of curing diseases [5]. Traditional medicinal plants are a therapeutic resource used by the population in Africa for health care which also serve as a starting materials for drugs [6].

The knowledge and use of plants as spices is as old as the history of mankind [7]; and plants used as spices are usually aromatic and pungent [8].

Spices are known as products of plants, which are mostly used for seasoning, flavouring and thus enhancing the taste of foods, beverages and drugs [9]. Over the years, plant extracts and plant-derived medicines have made an immense contribution to the overall health and wellbeing of man [10]. Plants have the ability to synthesize a wide variety of chemical compounds that are used to perform important biological functions and to defend against attack from predators such as microbes [3]. Phytochemical compounds in plants mediate their effect in the human body through processes identical to those already well understood for the chemical compounds in orthodox drugs; thus herbal medicines do not differ greatly from conventional drugs in terms of how they work [11]. Phytochemicals are not vitamins or minerals but are bioactive compounds found in plant foods that work with nutrient and dietary fibers to protect against disease [12].

The importance of plants in medicine remains even of greater relevance with the current global shift to obtain drugs from plants sources as a result of which attention has been given to the medicinal value of herbal remedies for safety, efficacy and economy [13]. The literature is replete with relevant information on the vital roles that secondary metabolites (e.g. alkaloids, flavonoids, tannins, saponins, cardiac

glycoside, etc.), which are components of traditional herbal preparations, play in managing various ailments [14]. Alkaloids are natural products made up of heterocyclic nitrogen that has antimalarial, antihypertensive, antiarrhythmic and anticancer properties [15]. While they are capable of reducing headache associated with hypertension, management of cold, fever and chronic catarrh [16]; they also act as CNS stimulant, pain relievers, etc. [17].

Flavonoids possess antioxidant, anti-inflammatory, anti-tumor, anti-allergic and antiplatelet properties [18]; and have cholesterol lowering ability [19]. The antioxidant activity helps to protect the body against cancer and other degenerative disease such as Arthritis [20]. Saponins in plants have anti-carcinogenic and anti-malaria properties [21,22]. Tannins are compounds with proline-rich proteins which inhibit the absorption of iron when present in the gastrointestinal lumen thus reducing the bioavailability of iron due to the presence of compounds that help in the treatment of diseases like enteritis, gastritis, and esophagitis [3]. Plants that contain tannins as their primary component are astringent; they are beneficial for the management of diarrhea, dysentery, inflammation of the mucous membrane [9]. The presence of high amount of anthraquinone in a leaf makes it suitable for the treatment of ailments like constipation, malaria and cancer [23].

Piper guineense Schum. & Thonn. (Family: Piperaceae), known locally as Uziza in Igbo and Ehiendo in Benin (Nigeria), is commonly called "Black pepper". The plant is native to tropical regions of Central & Western Africa and is semi-cultivated in countries like Nigeria and commonly found in the southern part [24]. It is a perennial vine that grows up to 12 m high, climbing up bole of trees by means of adventitious roots; leaves are pale greenish color when fresh and darker green when frozen or dried; fruits are red or red-brown when ripe, black when dry [25]. *P. guineense* is used for preparation of soups and treatment of diverse ailments in southern Nigeria, including intestinal diseases, cough, bronchitis and rheumatism [13,26,27]. It is also used for restoring fertility in women and low sperm count in men [28].

Piper umbellatum Linn. (Family: Piperaceae) is a shrub, 1.2 m – 1.8 m in height with white narrow catkins in most shady places [25]. Commonly called cow-foot, *P. umbellatum* is known locally as 'Ebewieha' among the Benin speaking people

of Edo State, Nigeria. It originated from tropical America, but now found in tropical rainforest in Africa, Japan and the Indian Ocean Islands [29]. In Southern Nigeria, the leaves of *P. guineense* and *P. umbellatum* are commonly used for making "Black and Pepper soups" or spicing, seasoning and/or flavoring agents for foods and soups. They could be used singly, combined or mixed with other leafy vegetables to prepare traditional soups and medicines.

The Nigeria rainforest is endowed with large collections of diverse aromatic and medicinal flora; many of which are yet to be explored and/or characterized for their bioactive, ethnomedicinal and food values. Majority of these plants are largely under-explored for their flavoring, perfumery and spicing qualities [30]. Most aromatic medicinal shrubs and lianes used by the local populations as flavouring and spicing condiments/vegetables for preparing soups/foods also have invaluable ethnomedicinal properties. For example, several scientists have reiterated the antibacterial, anticonvulant, antifungal, antihyperlipidemic, antimicrobial, antioxidant, antiparasitic and antitumor, hermatological, insecticidal, sedative properties contained in the leaves, fruits, seeds and roots of *P. guineensis* and *P. umbellatum* [3,31]. Despite the foregoing, there is paucity of empirical and indigenous information on the ethnomedicinal values of the stems of these two conspecific species; besides, most important organs, including leaves and roots have remained largely unexplored and therefore underutilized. The study evaluates the phytochemical and mineral constituents as well as indigenous knowledge and ethnomedicinal uses of the leaves and stems of *P. guineensis* and *P. umbellatum*.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Benin City, Edo State Nigeria. Benin City, the cosmopolitan headquarters of Edo State, spans three Local Government Areas, namely Oredo, Egor and Ikpoba Okha. It is located in the rainforest region of Nigeria and receives average annual rainfall of 2500 mm. Rainfall pattern is bi-modal and there are two distinct wet and dry seasons. Humidity in Benin City is about 75% at noon and 95% in the morning while average maximum and minimum temperatures are 35°C and 22°C respectively [32]. Edo State (located between latitude 6°11' and 6°29'N longitude 5°33' and 5°47'E) has a land area of about 19,701 km² [33]. The state

straddles three main ecological regions – humid in the south senatorial district, sub-humid in the central and semi-dry conditions in the north.

2.2 Ethnomedicinal Survey

Two phased investigations were carried out on phytochemical and mineral composition as well as ethnomedicinal uses of *P. guineense* and *P. umbellatum*. In the first phase, preliminary/reconnaissance visits were made to all 17 markets (seven in Oredo and five each in Ikpoba Okha and Egor Local Government Areas respectively) that constitute the Benin municipality (headquarters of Edo State, Nigeria). Nine markets (three each from a local government area) were purposively selected based on population of vendors, bulk of products sold and accessibility (Table 1). Overall, there were 121 vendors and end users of *P. guineense* and *P. umbellatum* in the markets. Using 60% sampling intensity, 72 respondents comprising traders/vendors and end users of *P. guineense* and *P. umbellatum* were engaged in the survey. Thus, information was elicited from respondents through key informants' interview and administration of semi-structured questionnaire.

2.3 Species Identification

Identification of *P. guineense* and *P. umbellatum* followed Hutchinson and Dalziel [34]. Authentication/validation of scientific and vernacular names of the two species was carried out at the Forest Research Institute of Nigeria (FRIN) FHI, Ibadan, Nigeria.

2.3.1 Laboratory investigation

The second phase consisted of phytochemical and mineral analyses of *P. guineense* (Fig. 1a) and *P. Umbellatum* (Fig. 1b) at the Faculty of Agriculture Central Laboratory, University of

Benin, Benin City, Nigeria. Prior to analyses, samples were cleansed with distilled water; air dried at room temperature and ground into fine powder using mortar and pestle. Alkaloid, tannin, flavonoid and saponin contents were quantitatively evaluated using methods described by Akerle et al. [35] while the analysis of phenol, anthraquinone and cyanogenic glycosoides followed Krishnaiah et al., Soladoye and Chekwuma, Piero et al. [36,37,38].

Alkaloid: 1 g of each sample was weighed and macerated with 20 ml of 2% H₂SO₄ in ethanol (1:1). The mixture was filtered and 1 ml of filtrate pipetted into test tubes. 5 ml of 0.5% formaldehyde in 60% H₂SO₄ were added and the content mixed properly. The mixture was allowed to stand for 3 h and absorbance was measured at 568 nm. The standard curve was prepared using different concentrations of Atropine and alkaloid content was expressed as Atropine equivalent (AE) per 100 g of dry weight.

Tannin: 1 g of each sample was macerated with 50 ml distilled water. The mixture was filtered and 1 ml of filtrate pipetted into test tubes and 2 ml of saturated picric acid added. Absorbance was read at 530 nm. The standard curve was prepared using different concentrations of Tannic Acid. The Tannic content was expressed as g Tannin equivalent (TAE) per 100 g of dry weight.

Flavonoid: 1 g of each sample was measured and macerated with 20 ml of ethyl alcohol. The mixture was filtered and 5 ml of the filtrate measured into test tubes. To each test tube, 5 ml of dilute ammonia was added and the mixture was shaken. The supernatant was collected and absorbance measured at 490 nm. The standard curve was prepared using different concentrations of Catechin and flavonoid content was expressed as g Catechin equivalent (CE) per 100 g of dry weight.

Table 1. List of markets and number of respondents

Market	Local Govt. Area	Vendors/Buyers	Selected Respondents
Oba	Oredo	14	8
New Benin	Oredo	12	7
Oliha	Oredo	16	10
Egor	Egor	8	5
Ogida	Egor	10	6
Urelu	Egor	15	9
Oregbeni	Ikpoba Okha	19	11
Ekiosa	Ikpoba Okha	10	6
Oka	Ikpoba Okha	17	10
Total		121	72



(a)

(b)

Fig. 1. (a). Whole plant of *Piper guineense* and (b) *Piper umbellatum*

Saponin: 1 g of each sample was macerated with 10 ml of petroleum ether. The supernatant was decanted into a beaker and another 10 ml of petroleum ether added. The supernatant was decanted and mixed with the first, the mixture was evaporated to dryness and 6ml of ethanol added. 2 ml of the mixture was pipetted into a test tube. 2 ml of colour reagent was added and the mixture allowed to stand for 30 min and absorbance was read at 550 nm. The standard curve was prepared using Diosgenin and saponin content was expressed as g Diosgenin equivalent (DE) per 100 g of dry weight.

Phenol: 10 g of each sample was defected into petroleum ether for 4 h the residue extracted with 80% methanol using saponification for 2 h. The crude extract was separated by simple filtration. The filtrate was evaporated and residue re-extracted with chloroform and water. The filtered residue was evaporated to dryness using an oven at 60°C for 2 h and weigh to constant weight.

$$\% \text{ phenol} = \frac{\text{weight of residue}}{\text{weight of sample taken}} \times 100$$

Anthraquinone: 1 g of each sample was soaked in 50 ml of distilled water for 16 h. The suspension was heated in a water bath at 70°C for 1 hr and allowed to cool. Few drops of 80% methanol were added and then filtered. The concentrate was then weighed and anthraquinone content calculated.

Cyanogenic Glycoside: 1 g of each sample was dispersed in 200 ml of warm water and the suspension heated for 3 h while stirring continuously. The filtrate and residue were then re-extracted with 100 ml acetone and reduced to 10 ml on heating. The concentrate was then weighed and Cyanogenic glycoside content calculated.

2.3.2 Mineral element determination

The determination of mineral contents of *P. guineense* and *P. umbellatum* was carried out using Atomic Absorption Spectrophotometer (AAS model: SOLAAR 968 Unicam Series) for Ca, Fe, Mg and Zn; Flame Photometer for Na, K and Spectrophotometer (model: Spectronic 20D+) for P followed methods described by AOAC [39]. For wet digestion of samples, 1.0 g of the powdered sample was weighed in digestion flask. 12 ml of concentrated HNO₃ was added and kept overnight at room temperature. 4.0 ml of HClO₄ was added to the mixture and heated in digestion block; starting at 50°C and gradually increasing to 250°C. The appearance of fumes at 70 – 80 min signaled completion of digestion. The mixture was allowed to cool before transferring into 100 ml volumetric flask and thereafter made to mark with distilled water. The wet digested solution was stored in plastic reagent bottle for use in determination of minerals following the principles and procedures expounded by Gul and Safdar [40].

2.4 Data Analysis

Data obtained from traders/vendors and end users in the markets were analyzed using descriptive statistics. The Use Value (UV) index was used to determine the level of use of the organs of each species in the study area. UV was calculated using the formula:

$$UV = U_i/N_i;$$

where U_i = Number of use reports cited by each informant for a given species' organ; and N_i = Total number of informants [41]. Use values are high when there are many use reports for a plant, implying that the plant is important; and approach zero (0) when there are few reports related to its use [42,43,44]. Harmonic mean was used to synchronize results of respondents' deposition in connection with the two medicinal plants which are congeners. The results of secondary metabolites and minerals were arranged in three replicates and subjected to one-way Analysis of Variance (ANOVA) and means separated using Duncan Multiple Range test (DMRT) ($p= 0.05$).

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Socio-demographic information of participants

Majority of the respondents who participated in the study were female (90%) who were married adults (53%) within the age range of 41 to 55

years (49%) (Table 2). The educational qualification of most respondents (57%) was primary school leaving certificate. While the highest population of respondents (47%) whose indigenous knowledge of sale and medicinal use values of the species span 5 to 10 years; (51%) of the of participants acquired their knowledge of the medicinal uses of *P. guineense* and *P. umbellatum* through inheritance (Table 2).

3.1.2 Significance and uses of *P. guineense* and *P. umbellatum*

The outcome of the investigations conducted in the different markets revealed that majority of the vendor/end users (85%) had wealth of indigenous knowledge on the uses of both plants for food (spices, condiments and vegetables) and ethnomedicine (prevention/cure of diverse ailments). Most respondents (80%) affirmed that the leaves of both plants were most frequently used for spicing and flavouring; and when used in combination with leaves of assorted medicinal vegetables – in the following order of significance *Ocimum gratissimum* (46.4%) > *Vernonia amygdalina* (33%) > *Telfairia occidentalis* (11%) > others (9%) – they present substantial medicinal efficacy, particularly when used in preparing traditional foods and soups. But when respondents were prompted to categorize the most frequently used plant parts for ethnomedicine on a scale of 0 to 100%, the 'leaf' was selected as the most preferred organ (80%) followed by stems (10%), roots (6%) and seeds (4%).

Table 2. Respondents' socio-demographic characteristics, experience and knowledge

Variable		Frequency	Percentage (%)
Sex	Male	7	9.72
	Female	65	90.28
Marital status	Single	15	20.83
	Married	38	52.78
	Widow	19	26.39
Age	≤30	5	6.94
	31 – 45	24	33.33
	41 – 55	35	48.61
	≥55	8	11.11
Educational attainment	Informal	19	26.39
	Primary	41	56.94
	Secondary	12	16.67
Years of experience	≤5	9	12.5
	5 - 10	34	47.22
	≥10	29	40.28
Source of knowledge	Hereditary	37	51.39
	Formation	23	31.94
	Voluntary transfer	12	16.67

Table 3 shows type of ailment, plant species and parts (organ), frequency and deposition of informants on use values of the two underutilized aromatic and medicinal plants. The type of ailment/disease, plant organ with the most important/efficient use values following respondents' deposition were fertility/ womb cleansing with the leaf of *P. guineense* and pile/diarrhea /dysentery using *P. umbellatum* leaf (Table 3).

There were more vendors and buyers/end users of *P. guineense* and *P. umbellatum* in markets that were fairly peri-urban in status though

remotely located and far-flung from the city center (Fig. 2). But when data were pooled for markets using harmonic mean, there was convergence of opinions on the broad uses of the two plants particularly among respondents in the larger and cosmopolitan markets (e.g. Oregbeni, Ekiosa, New Benin and Oka which serve as major depots, have high population of traders/vendors and buyers owing to huge volume of trade in medicinal herbal products); and the smaller markets (e.g. Ekiosa, Oba, etc.) which serve as retail outlets for vendors and buyers/end users dealing on smaller trade volumes (Fig. 2).

Table 3. List of ailments treated and/or cured using *P. guineense* and *P. umbellatum* organs

Ailments	Plant species	Part used	Number of informants	UV
Stomach disorder/ Ulcer	<i>P. guineense</i>	Leaf	31	0.4
	<i>P. umbellatum</i>	Leaf	25	0.4
Fever (Antipyretic)	<i>P. guineense</i>	Leaf	22	0.3
	<i>P. umbellatum</i>	Leaf and stem	32	0.4
Fertility/Womb Cleansing	<i>P. guineense</i>	Leaf	54	0.8
Arthritis	<i>P. guineense</i>	Leaf	36	0.5
	<i>P. umbellatum</i>	Stem	20	0.3
Respiratory/Urinary tract infection	<i>P. guineense</i>	Leaf	19	0.3
	<i>P. umbellatum</i>	Stem	22	0.3
Pile/Diarrhea/Dysentery	<i>P. umbellatum</i>	Leaf and stem	50	0.7

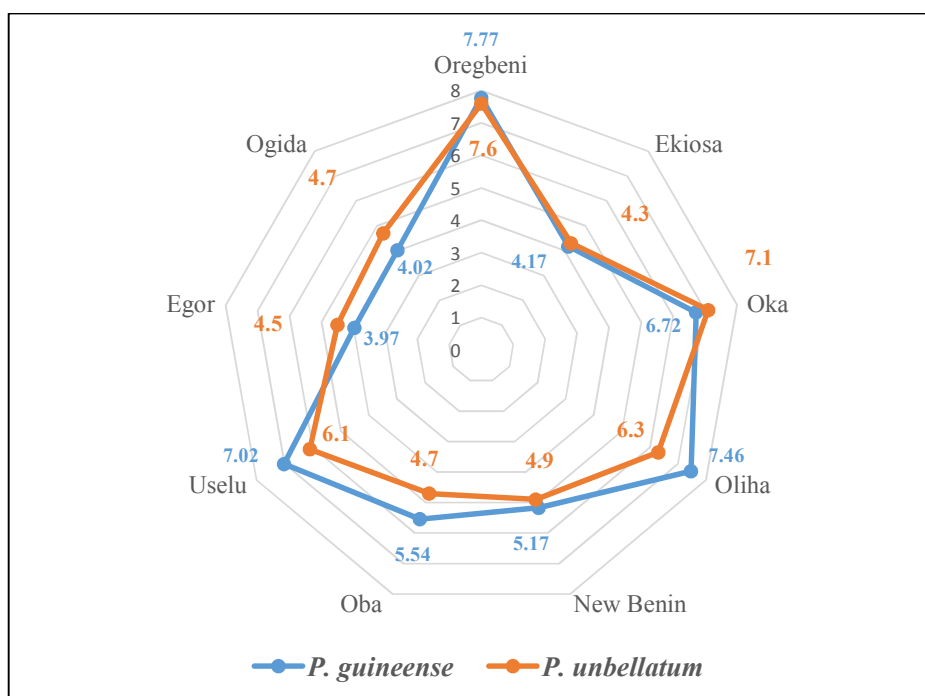


Fig. 2. Respondents' opinions on the uses of *P. guineense* and *P. umbellatum*

However, when species' data were pooled using harmonic means, the outcome of respondents' opinions on the efficacy of the plants to treat/cure ailments did not differ significantly. On juxtaposition, significant differences were recorded among variables measured with *P. guineense* ranking as most suitable for the treatment of 'stomach disorder/ulcer' followed by 'respiratory and urinary tract infections' while *P. umbellatum* was best suited for the treatment of arthritis followed by fever and then fertility/womb cleansing (Fig. 3).

The results of phytochemicals obtain from *P. guineense* and *P. umbellatum* were relatively low. *P. umbellatum* stem was richest in alkaloids, flavonoids and phenol and were significantly different ($P \leq .05$) from the rest phytochemicals. Anthraquinone was greatest in the leaf of *P. umbellatum*. *P. guineense* had more saponins and tannins in the stem than leaf and were significant ($P \leq .05$) (Table 4). The outcome of mineral analyses revealed that the leaf of *P. guineense* recorded more Ca and Mg while *P. umbellatum* stem had more Na, K, Zn and P and were significantly different from the rest minerals ($P \leq .05$). However, Fe was richer than other minerals in the leaf (Table 5).

3.2 Discussion

Of the total number of participants involved in the study, a greater majority were female adults whose primary source of indigenous information on the uses of *Piper guineense* and *Piper umbellatum* for ethnomedicine was through inheritance from parental and family sources. Historically, ethnobotanists have been predominantly male; this has tended to hamper access to women's indigenous knowledge repository in societies where men command greater public supremacy and access than women [45]. The literature is replete with information that indigenous knowledge gathering in ethnobotanical research was hitherto at the command and control of the male specialists, thus implying that the wealth of information held by lay female ethnomedicinal experts was inconsequential and mostly ignored [44,46]. Several authors have argued that women were often more knowledgeable in the collection and characterization of therapeutic information on, and, the uses of plants for ethnomedicine than men [41].

The study has demonstrated that both *Piper guineense* and *Piper umbellatum* belong to the rainforest aromatic medicinal plants

commonly used for flavouring and spicing. These plants can either be used singly or in combination with other leafy vegetables for medicines or as taste enhancer in foods/soups. Tapsell et al. [11] have attributed the general use of most vegetable herbal plants (particularly *P. guineense* and *P. umbellatum*) for food and ethnomedicine to the presence of significant quantities of secondary metabolites, e.g. phenols, flavonoids, tannins and alkaloids, etc. in their leaves, seeds, stems or roots. The leaves as the most exploited organs of plants are basically the 'power house' of photochemical reactions; and being the store of organic materials; they contain the majority of secondary metabolites, including alkaloids, flavonoid, glycosides, etc. [47,48]. In this study, the leaf of *P. guineense* presented better results for cyanogenic glycosides while the stem was richer in saponins and tannin. *P. umbellatum* leaf was richer in anthraquinones while the stem had more alkaloids, flavonoids and phenol. The overall outcomes of the study, in which a significant number of the bioactive compounds were recorded in the stem than leaf of *P. guineense* and *P. umbellatum* appear to contrast with the findings of Chinmwendu et al. [49].

The study on minerals revealed that the leaf of *P. guineense* was richest in Ca and Mg while that of *P. umbellatum* had more Fe. However, Na, K, P and Zn were found to be richest in the stem of *P. umbellatum*. These findings are in harmony with Nwauzoma and Dawar [31] who asserted that the leaves of *P. guineense* and *P. umbellatum* were very rich in nutrients and chemical substances which offer great potential for food and pharmaceutical products. Generally, the mineral elements contained in medicinal plants contribute immensely to the health care needs and wellbeing of users both as medicines and as food. For example, K is an essential nutrient that maintains fluid and electrolyte balance in the body; Ca is the most common mineral in the human body which helps in strengthening bones and teeth, apart from regulation of muscle and heart functions; Mg functions as enzyme cofactors in energy metabolism, protein synthesis, RNA and DNA synthesis and maintenance of electrical potential of nervous tissues and cell membrane [50]. Additionally, Fe serves as a carrier of oxygen to the tissues from the lungs by red blood cells hemoglobin and act as transport medium for electrons within the cells while Zn is a natural constituent in all plant and animal tissues and functions as an integral part of several enzyme systems [51].

Table 4. Phytochemical constituents of *Piper guineense* and *Piper umbellatum*

Sample	Alkaloids	Cyanogenic glycosides	Saponin	Tannin	Flavinoids	Anthraquinone	Phenol
<i>P. guineense</i> (leaf)	0.029±0.004 ^d	0.614±0.001 ^a	1.353±0.001 ^b	1.219±0.004 ^b	0.835±0.001 ^d	0.414±0.001 ^b	0.035±0.001 ^d
<i>P. guineense</i> (stem)	0.053±0.001 ^c	0.398±0.013 ^b	1.379±0.004 ^a	1.421±0.002 ^a	0.849±0.004 ^c	0.235±0.001 ^d	0.063±0.001 ^c
<i>P. umbellatum</i> (leaf)	0.315±0.001 ^b	0.102±0.001 ^c	0.421±0.005 ^d	0.474±0.001 ^d	1.123±0.001 ^b	0.726±0.004 ^a	0.422±0.003 ^b
<i>P. umbellatum</i> (stem)	0.413±0.001 ^a	0.116±0.001 ^c	1.214±0.002 ^c	0.764±0.001 ^c	1.326±0.002 ^a	0.366±0.007 ^c	0.613±0.001 ^a

Means along columns are significantly different ($P \leq .05$). \pm = Standard error of mean (S.E.M)

Table 5. Mineral composition of *Piper guineense* and *Piper umbellatum*

Samples	Calcium	Magnesium	Sodium	Potassium	Iron	Zinc	Phosphorus
<i>P. guineense</i> (leaf)	43.70±1.027 ^a	33.61±0.950 ^a	15.95±0.712 ^b	13.54±0.283 ^c	13.08±0.165 ^b	0.326±0.012 ^b	33.06±0.396 ^c
<i>P. guineense</i> (stem)	23.24±0.552 ^c	17.29±0.041 ^c	13.18±0.026 ^{bc}	11.24±0.006 ^d	9.12±0.402 ^c	0.253±0.021 ^c	19.17±0.970 ^d
<i>P. umbellatum</i> (leaf)	25.36±1.027 ^c	17.90±0.275 ^c	12.08±1.591 ^c	18.13±0.008 ^d	17.53±0.410 ^a	0.333±0.008 ^b	39.32±0.965 ^b
<i>P. umbellatum</i> (stem)	34.04±0.714 ^b	22.40±0.393 ^b	23.89±0.975 ^a	24.03±0.560 ^a	9.33±0.623 ^c	0.456±0.006 ^a	45.96±0.681 ^a

N.B. Means along same columns are significantly different ($P \leq .05$); \pm = Standard error of mean (S.E.M)

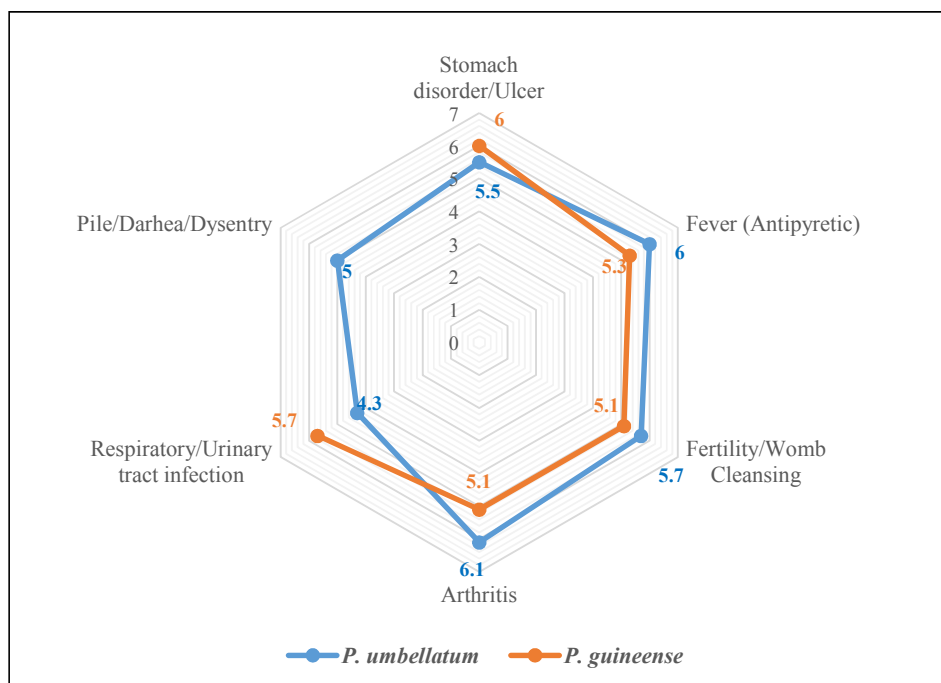


Fig. 3. List of ailments prevented or cured by *P. guineese* and *P. umbellatum*

Table 6. Medicinal efficacy of *P. guineense* and *P. umbellatum* and ailment cured

Scientific name	Part used	Type of ailment/infirmity	Validating Literature
<i>Piper Guineense</i>	Leaf	Respiratory and Urinary tract infections, rheumatism/ arthritis	[55]
		Relief of flatulence	[56]
		Intestinal disease, cough and bronchitis	[27]
		Anti-malaria, anti-hypertension, cancer arrhythmic	[57]
		Anti-oxidant; cures respiratory infections, rheumatism, syphilis	[3]
		Female infertility/ low sperm count in male	[58 59, 60]
<i>Piper umbellatum</i>	Leaf	Emollient for vulnerable and antiseptic disorders; jaundice, malaria, menstrual problems, hemorrhoids/pile, etc.	[61]
		Dysmenorrhea, anti-poison	[62]
	Stem	Oedema, malaria, urinary and kidney problem, Paralysis, epilepsy, convulsion, spasms and small pox	[63]
		Hemorrhoids (pile), arthritis, rheumatism, ear treatment, heart and kidney treatment	[31]
		Pulmonary disease, Diarrhea, and dysentery	[64]

Several empirical investigations [31,52] have revealed that the leaf and stem of *P. umbellatum* contain appreciable amounts of secondary metabolites; although alkaloid ranked highest as the most efficient, therapeutically [53]. But Besong et al. [3] reported that *P. guineense* possesses considerable quantities of alkaloids, flavonoids, saponin and tannin hence its

preference and frequent use in ethnomedicine. In modern times, there has been a substantial increase in the popularity and use of plant-based medicines for a variety of illnesses and symptoms as well as for preventive health practices and general self-care [54]. Table 6 shows some of the findings on the medicinal uses of *P. guineense* and *P. umbellatum* in this

study which are in agreement with the results of empirical investigations that have been published by authors.

4. CONCLUSION

This study has revealed that *P. guineense* and *P. umbellatum* are aromatic medicinal plants that play invaluable complementary roles in flavouring and spicing of foods/soups. The leaves and stems of *P. guineense* and *P. umbellatum* are very rich in phytochemicals and minerals which have great potentials for use in ethnomedicine as well as food and pharmaceutical industries. These fairly ubiquitous and underutilized rainforest liane and shrub can contribute significantly to the socio-economic and health care needs of most forest dependent communities in Nigeria and elsewhere in West Africa if the ecological idiosyncrasies are fully investigated and harnessed. Further investigation on the active ingredients in these medicinal plants, particularly when combined with other medicinal vegetables/spices for use in the treatment and cure of ailments/diseases, is recommended.

CONSENT

As per international standard, Respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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