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Ethnopharmacological characteristics of *Piper umbellatum* L. (Piperaceae), a plant used in the traditional treatment of three neglected tropical diseases in Côte d'Ivoire

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Abstract

A recent ethnomedicinal survey, conducted in ten Health Districts of Côte d'Ivoire, revealed *Piper umbellatum* L. (Piperaceae) as a plant used in the traditional treatment of lymphatic filariasis, onchocerciasis and schistosomiasis. The present study aims to highlight the distinctive ethnopharmacological characteristics of *Piper umbellatum*. The aim was to identify some groups of chemical compounds by thin layer chromatography, to assay some minerals and finally to characterise the specific anatomical and micrographic features of the plant. Terpenes and sterols, saponosides, flavonoids and tannins are the main phytocompounds revealed. Magnesium with 748.3 mg/100 g dry matter is the most abundant mineral. Anatomical sections and plant powder revealed starch grains, secretory pockets and tectorial hairs that are responsible for the formation of various biological substances in the plant. These results add to the data on *Piper umbellatum*, a taxon much used in traditional Ivorian medicine for the treatment of three filarial NTDs (lymphatic filariasis, onchocerciasis and schistosomiasis).

Keywords: Ethnopharmacological characteristics*; Piper umbellatum*; neglected tropical disease; Côte d'Ivoire

1. Introduction

Neglected tropical diseases (NTDs) are still prevalent in several West African countries and hamper the socio-economic development of affected communities. In Côte d'Ivoire, three of these NTDs are co-endemic in ten Health Districts with prevalence ranging from 1 to 60%. These are lymphatic filariasis, onchocerciasis and schistosomiasis, which are all filarial.

The chemoprevention recommended by the WHO [1] remains the main way to fight against these NTDs despite many limitations including the recrudescence of drug resistance, serious side effects, prolonged treatment duration [2].

To overcome all these constraints, medicinal plants offer a promising alternative to be explored and an asset for poor communities affected by NTDs. It is in this context that a recent study revealed *Piper umbellatum* L. (Piperaceae) as a plant for the traditional treatment of lymphatic filariasis, onchocerciasis and schistosomiasis, three neglected tropical diseases [3].

Amorim *et al* [4] showed the anti-parasitic effect of *Piper umbellatum* while Perazzo *et al* [5] revealed Anti-inflammatory and analgesic properties of its water-ethanolic extract.

The present study aims to highlight the distinctive ethnopharmacological characteristics of *Piper umbellatum*.

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In addition, several studies have been carried out on *Piper umbellatum*. Some of them were based on morphological and nutritive characteristics of *P. umbellatum* from Malaysia [6] and others on comparative cross-cultural analysis of its medicinal uses and an ethnopharmacological evaluation [7].

It is important to compare all these data obtained from the plant with that found in Côte d'Ivoire.

2. Material and methods

2.1. Material

The parts of *Piper umbellatum* used were the leaves and the stem. These organs were harvested in Agboville (south of Côte d'Ivoire). The geographic coordinates are 5° 55′ 41″ N, 4° 13′ 01″ W.

2.2. Methods

2.2.1. Phytochemistry

This phase started with the extraction of the different phytochemicals. The plant powder was introduced into a 50 mL Falcon tube and cold macerated for 24 hours in the extraction solvent (96% ethanol). The filtrate obtained was used for phytochemical screening.

Phytochemical screening of the extracts was performed on HPTLC plates (20 cm × 10 cm) silica gel〖60 F〗_254 (Merck, Darmstadt, Germany).

10 µL of extract were deposited in a 1 cm strip with a semi-automatic sample dispenser (CAMAG, Linomat 5, Switzerland) along the baseline 8 mm from the bottom edge of the plate. The distance between the spots is 3.4 mm. The distance between the first spot and the left edge of the plate and between the last spot and the right edge of the plate is 20 mm. A constant application rate of 100 nL/s was used. Linear upward development with 10 mL mobile phase was performed in a CAMAG double-trough glass chamber lined with filter paper and previously saturated with mobile phase vapour for 20 minutes. The development distance was approximately 70 mm. The plates were dried after development using a hair dryer. In the double trough chamber, the mobile phases were:

- Terpenoids, eluted with hexane/ethyl acetate system 20:4, v/v and revealed by Liebermann Bürchard reagent;
- Saponosides, eluted with ethyl acetate/petroleum ether 2:1, v/v revealed with sulphuric anisaldehyde;
- Flavonoids and tannins: ethyl acetate/formic acid/acetic acid/water 100:11:11:26, v/v/v. Flavonoids were revealed by Neu's reagent, tannins by $FeCl_3$ (2 %).

2.2.2. Mineralogy

For the determination of mineral elements, the Analist Pinaacle 900T air-acetylene flame atomic adsorption spectrometer (Perkin Elmer) was used. The wavelengths of the elements to be analysed were first defined on the instrument (324.75 nm for copper, 213.86 nm for zinc, 248.33 nm for iron, 285.2 nm for magnesium, 766.49 nm for potassium, 279.48 nm for manganese and 589.0 nm for sodium). Then, the different readings of the calibration ranges were used to establish the calibration curve translating absorbance as a function of concentration. Finally, the samples to be analysed were presented to the apparatus in order to determine their absorbances. A blank is necessarily passed between the passage of two different solutions.

2.2.3. Anatomo-histology

It consisted of making thin cross-sections of a portion of *Piper umbellatum* stem using a new razor blade. The stem was inserted into sorghum or polystyrene pith. The whole set of sections was soaked in diluted bleach for 20 min followed by rinsing with plain water. The sections were then soaked in acetic water for 15 minutes to neutralise the excess bleach, which is chemically basic and makes the cell walls receptive to the dye. After this step, the sections obtained were stained with carmino-green (a mixture of carmine alumina and iodine green) and then rinsed one last time with water. Thus, the cell walls were stained according to their chemical nature (cellulosic walls in pink and lignified walls in green). The stained sections were then mounted between slides and coverslips in a drop of glycerine water for observation under a photonic microscope connected to a computer. After observation, the different sections were photographed.

2.2.4. Micrography

On an object slide, a drop of 10% potash was placed. This preparation was sprinkled with a pinch of fine plant drug powder obtained using a 500 µm mesh sieve. This was covered with a slide without leaving any air bubbles. The powder thus treated was observed with an Optika Microscopes Italy photonic microscope, connected to a tablet. Observations were made at x40 and x100 magnification in order to look for characteristic elements or organ fragments. These observed elements were then photographed.

3. Results and discussion

3.1. Systematic position

Kingdom: Plantae
Clade: Angiosperms
Clade: Dicotyledons
Order: Piperales
Family: Piperaceae
Genus: Piper
Species: *Piper umbellatum* L.
Synonymes

- *Heckeria subpeltata (Wild.) Kunth*
- *Pothomorphe umbellata (L.) Miq.*
- *Piper subpeltatum Willd.*
- *Pothomorphe subpeltata (Willd.) Miq.*

Common names: Umbelliferae pepper, anisette wood, great balsam

Local names: Kou-baté (Attié), M'blala (Guéré), Mondê (Yacouba), Ahonhévê (Abey), Amoumougna (Baoulé)

Herbarium specimen number:

CSRS: N°104-CSRS005276-A4-C92-R2-E10-F2-P1

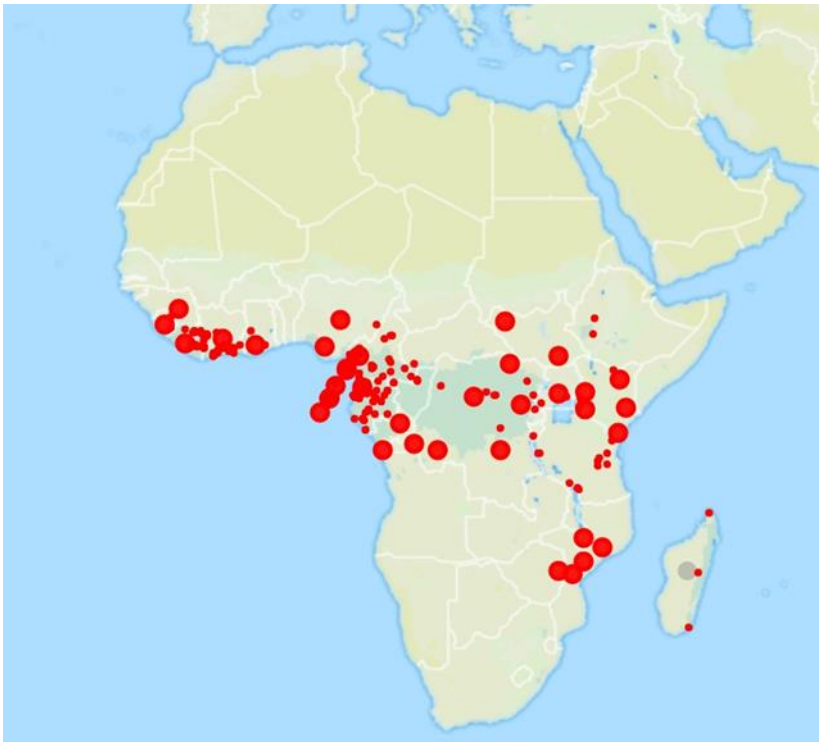
3.2. Botanical description

Figure 1 A. *Piper umbellatum*; B. Inflorescence

Piper umbellatum is a perennial herb or climbing shrub reaching 4 m high, much branched near the base; originates from a woody, succulent, ribbed rootstock, rooting at the nodes. The leaves are alternate, simple and entire. The leaf blade is almost circular to kidney-shaped, the base deeply cordate (Figure 1A) with a short acuminate to rounded, rather thin apex. The inflorescence, axillary (Figure 1B) or opposite the leaves, is a spike 5.5-15 cm long; the peduncle is 3-12 cm long. The flowers are tiny, bisexual and sessile; the perianth is absent; the stamens are 2; the ovary is superect, unilocular and ends with 3 stigmas. The fruit is a brownish, 3-angled fleshy drupe containing 1 tiny globose seed [7, 8].

3.3. Habitat and geographical distribution

Piper umbellatum grows in cool places. It is found in tropical evergreen forests, clearings, swamp forests, riverbanks, old plantations (rubber and oil palm), and always in humid places at an altitude of (0-)150-1800 (-2100) m. In vegetation, it is present all year round in shaded areas [10, 9]. Figure 2 shows the geographical distribution of *Piper umbellatum* L. in Africa.



Source : https://africanplantdatabase.ch/en/nomen/114950

Figure 2 Geographical distribution of *Piper umbellatum* in Africa

3.4. Traditional uses against NTDs

The leaves are eaten in sauce to treat Schistosomiasis. The roots are crushed and diluted in water for oral and anal administration against Onchocerciasis and Schistosomiasis. For lymphatic filariasis, the decoction of the roots and leaves is taken as a drink, enema and bath.

The work of Amorim *et al* [4] and Roersch [7] showed that hydroethanolic extracts of *Piper umbellatum* had an antiparasitic activity.

3.5. Other therapeutic uses

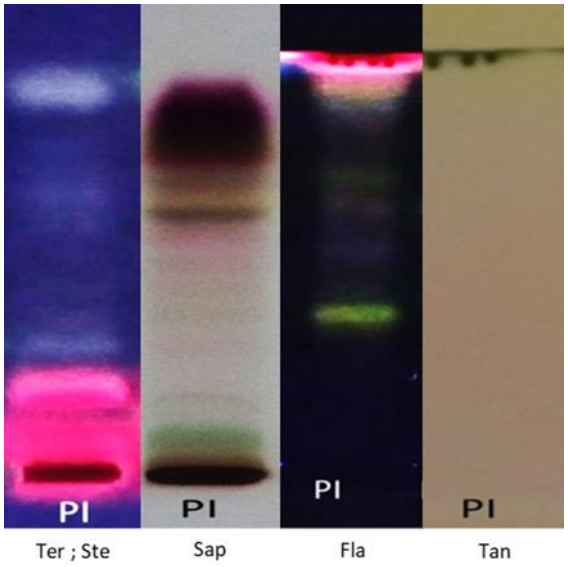
Piper umbellatum (whole plant) is used in the treatment of coughs and also painful periods. The leaves treat urogenital infections. The leaves are vermifuge while the roots are anthelmintic. The inflorescences are used against haemorrhoids, female sterility and various infantile treatments.

The importance of *P. umbellatum* as a medicinal plant has been described in various studies. The extract from its leaves and other parts of the plant have been used for the treatment of infectious and inflammatory diseases [7] snake venom [11] and as an anti-cancer remedy [12]. The plants also been used by witchdoctors in Cameroon [13, 7], as a fragrance in Ecuador [14], and as fish bait in Ghana [7].

In many countries, the leaves of *P. umbellatum* is consumed as a leafy vegetable and condiment as was reported by Mensah et al. [15]. In Malaysia, *P. umbellatum* is also used as a leafy vegetable by locals especially by the Kenyah ethnic group residing in Sungai Asap, Belaga, Sarawak. The plant can occasionally be found growing on the forest floor within the Belaga area. It is a perennial or woody herb that commonly grows up to 1.0 – 2.5 m tall [7].

3.6. Phytochemistry

The chromatogram (Figure 3) presents the phytochemical composition of *Piper umbellatum* leaves. It shows the presence of phytochemical groups such as terpenes and sterols, saponosides, flavonoids and tannins. Sacoman et al. [16] characterised sterols and Isobe *et al* [17] identified uvangoletin and wogonin in the aerial parts. Other works have identified essential oils that justify the characteristic odour of Piperaceae [18, 19].



Ter ; Ste : Terpenes and sterols; Sap : Saponosides ; Fla : Flavonoids; Tan : Tannins

Figure 3 Chromatogram of the ethanolic extract of *Piper umbellatum* leaves

3.7. Mineralogy

Table I shows the mineralogical composition of *Piper umbellatum* leaves. The amount of magnesium is 748.3 mg/100 g dry matter. This value is more than twice as high as the value determined by Saupi et al. [6] in their study of Malaysian *Piper umbellatum* (323.80 mg/100 g magnesium).

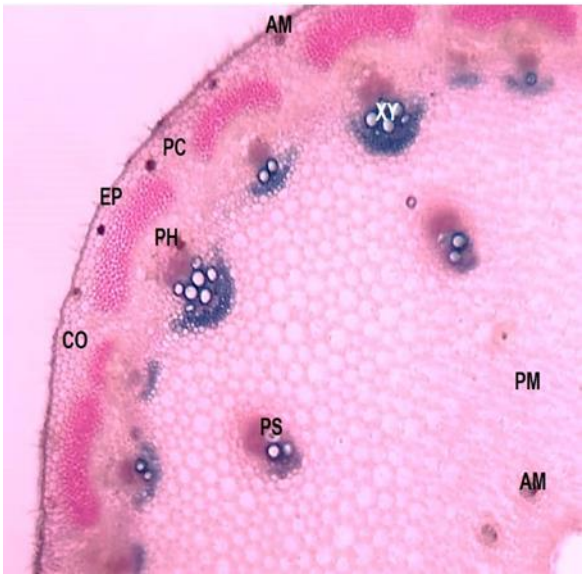
Table 1 Composition and mineral content of *Piper umbellatum* leaves

Samples	Mg	Cu	Fe	Mn	Zn
mg per 100 g dry matter	748.3	0.59	23.8	2.32	4.6

Mg: Magnesium; Cu: Copper; Fe: Iron; Mn: Manganese; Zn: Zinc

3.8. Anatomy

Figure 4 shows a cross-section of a *Piper umbellatum* stem. From the periphery to the centre of the organ, epidermis, collenchyma, cortical parenchyma, phloem, xylem and medullary parenchyma can be seen. Secretory pockets and starch grains are also observed. In their study on the morphological characterisation and nutrient evaluation of wild pepper, *Piper umbellatum* L. (Piperaceae) grown in Sarawak, Malaysia, secretory pockets and starch grains are also observed [6]. The secretory pockets are thought to be the basis for the synthesis of the plant's chemicals. As the plant is odorous, the work of Mattana et al. [20] revealed the presence of terpenoids in the leaves of the plant.

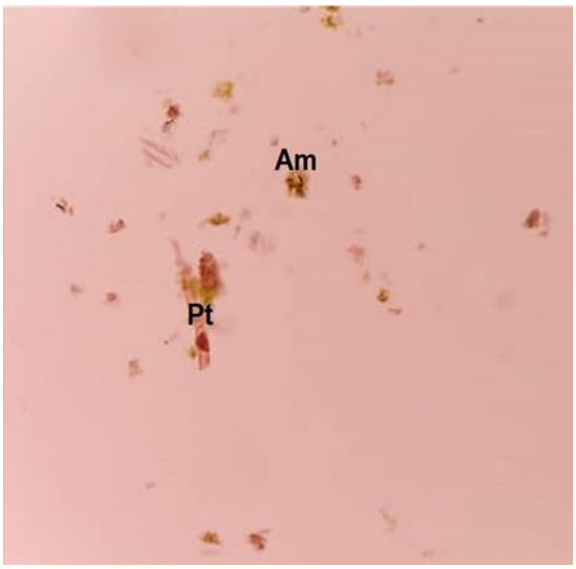


EP: epidermis; CO: collenchyma; AM: starch grain; PC: cortical parenchyma; PH: phloem; XY: xylem; PS: secretory hairs; PM: medullary parenchyma (G: x100)

Figure 4 Cross-sectional portion of *Piper umbellatum* stem

3.9. Micrography

Microscopic observation of *Piper umbellatum* leaf powder allowed the identification of starch grains and tector hairs (Figure 5).



Am: starch grain; Pt: tector hair (G: x100)

Figure 5 Microscopic elements observed in *Piper umbellatum* leaf powder

4. Conclusion

The study identified the distinctive ethnopharmacological features of *Piper umbellatum* L. (Piperaceae). Distinctive features such as starch grains, secretory pockets and tector hairs could be observed. In addition, the phytochemical composition justifies the traditional use of *Piper umbellatum* in the traditional treatment of lymphatic filariasis, onchocerciasis and schistosomiasis.

Compliance with ethical standards

Acknowledgements

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Disclosure of conflict of interest

None to declared conflict of interest.

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