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Evaluation of the Bioactive Compounds in Leaves and Stem-Bark of *Piptadeniastrum africanum* (Hook.f.) Brenan (Family Fabaceae)

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Abstract: *This study evaluated the bioactive compounds in leaves and stem-bark extracts of Piptadeniastrum africanum (Hook.f.) Brenan. Specimens of the plant were obtained from the tropical rain forest in several communities in the eight local government areas of Bayelsa State, Nigeria. The samples were extracted using water, and the bioactive constituents were analyzed using qualitative and quantitative techniques. The quantitative results revealed that Alkaloids, Saponins, Flavonoids, Glycosides, Phytate, Tannins, Oxalate and Phenols concentrations were 5.08%, 17.60%, 5.72%, 0.90mg/kg, 0.0917%, 2.684%, 36.55 mg/g and 376.08 mg/kg, respectively in the leaves and 3.00%, 13.60%, 7.34%, 0.50mg/kg, 0.0917%, 2.732%, 61.02 mg/g and 376.08 mg/kg, respectively in the stem-bark. The qualitative results showed that saponins, and terpenes were very high and tannins, steroids, phenol and flavonoids were fairly present in the leaves of P. africanum. While in the stem bark saponins was very high, phenol was high, and tannins, terpenes, steroids and flavonoids were fairly present. The concentrations of the bioactive ingredients varied based on plant parts for some bioactive compounds. Both the qualitative analysis and quantitative determination of the metabolites showed that the plant under study is rich in phytochemicals. Therefore, there is need for further research to focus on other medicinal properties of the plant parts.*

Keywords: *Medicinal plant, Metabolites, Phytochemicals, Traditional medicine*

1. INTRODUCTION

Piptadeniastrum africanum is a forest tree that belongs to the family Fabaceae, Subfamily Mimosoideae (Airy Shaw, 1985). The plant can grow up to 45-50 m high and 3-5 m in girth with conspicuous plank-like buttresses, straight bole, with fine fern-like foliage. The plant has compound leaves with the basal pinnae low down on the common stalk which is usually 10-12 cm and grooved on the adaxial surface. The plant bears fruits which are usually 15-35 cm long and 15 – 35 mm wide. The fruits have seeds which are about 20-25 mm attached to the margin of the pod by a slender thread running from the middle and each is provided with wings that are papery, dark brown, and elongated. These wings are about 4-8 cm long and 10-25 mm wide (Hutchinson and Dalziel, 1958; Nyananyo, 2006).

Piptadeniastrum africanum (Hook.f.) Brenan is endemic to tropical Africa. It is found in Angola, Central African Republic, Gabon, Ghana, Ivory Coast, Liberia, Nigeria, Sierra Leone, Sudan, Togo, Uganda, Zaire, Congo, Equatorial Guinea (Brenan, 1955; Richard, 2013). The plant is found in the Niger Delta region of Nigeria especially on river banks in the riverine areas of the rain forest (Nyananyo, 2006). The plant is a valuable tree that is used as timber and for construction works.

Like many medicinal plants, *P. africanum* is used by traditional medicine practitioners for the treatment of several disease conditions especially in the region where the plant is endemic. Scientific validations have been made with regards to the medicinal potentials of the plant about some specific diseases. The plant parts such as the leaves, stem and root are used by traditional medicine practitioners. Authors have reported that medicinal plants are plants in which one or more parts

(leaves, root, stem, flower, fruit, seed) have therapeutic properties (Kigigha *et al*., 2015; Epidi *et al*., 2018; Izah and Aseibai, 2018; Izah *et al*., 2018a –e; Kigigha *et al*., 2018a,b).

Specifically, Ateufack *et al*. (2015) reported that aqueous and methanol extracts of the stem bark of *P. africanum* could stimulate essential cellular mechanisms (such as migration and proliferation of epithelial cells that may have cytoprotective activity by stimulating the release of prostaglandins that have gastroprotective and ulcer healing effects). Line-Edwige *et al*. (2009) reported that alcoholic extracts of the roots of *P. africanum* have antiproliferative activity on human colon cancer cell line. Other authors have indicated that the plant has analgesic, anti-inflammatory, and anti- gastric ulcer activity (Jiofack, 2008; Diffoum, 2012; Ateufack *et al*., 2015). Neuwinger (2000), Jiofack *et al*. (2008) and Owoeye *et al*. (2018), reported that the bark of the plant is used to prepare decoctions for the treatment of cough, bronchitis, headache, mental disorders, stomach-ache, dysmenorrhea and male impotence (internal) and treatment of fever, toothache, pneumonia, oedema, skin complaints and even leprosy (external). The authors further reported that the leaves can be used for the treatment of gonorrhea and abdominal pains. Owoeye *et al*. (2018) reported that the root can be used as abortifacient, aphrodisiac and for the treatment of mental disorder.

Studies have suggested that plants are able to confer therapeutic properties because of the bioactive compounds they contain (Kigigha *et al*., 2015; Epidi *et al*., 2018; Izah and Aseibai, 2018; Izah *et al*., 2018a –e; Kigigha *et al*., 2018a,b). To this effect, a previous study by Owoeye *et al*. (2018) assessed the phytochemical properties of the bark of the plant. This present study is aimed at assessing the phytochemical and anti-nutritional compounds in leaves and stem-bark of *P. africanum.*

2. MATERIALS AND METHODS

2.1. Plant Collection and Identification

The leaves and stem of *P. africanum* were collected from several communities in the eight local government area of Bayelsa State, Nigeria. The plant specimens were identified at the Forest Herbarium Ibadan of the Forestry Research Institute of Nigeria (FRIN) and the Herbarium of the Department of Plant Science and Biotechnology, University of Port Harcourt, Rivers State. Voucher Specimens of the plant were deposited in these herbaria for reference and further studies.

2.2. Phytochemical Analysis

Phytochemical analysis included both the screening of plant samples for the presence of phytochemicals (qualitative analysis) and the determination of the specific amounts of the various phytochemicals present in the plant samples (quantitative analysis) using standard procedures by Lambert and Muir (1973), Stewarte *et al.* (1974), Sofowora (1993), Edeoga *et al*. (2005), Okwu (2005), Doherty *et al.* (2010), Kanife *et al.* (2012)

Specifically, the quantitative determination of the bioactive compounds was carried out according to methods previously established in literature viz: alkaloids (Harborne, 1973), flavonoids (Boham and Kocipal-Abyazan, 1994), Phenol (King and Armstrong, 1934), phytic acid (Kent-Jones and Amos, 1967), Tannic acid (AOAC, 1970). Saponins determination was carried out by Soxhlet extraction/Gravimetric method (Harborne, 1973), cyanogenic glycoside by Alkaline Titration Method (AOAC, 1984) and oxalate by standardization of potassium permanganate solution by sodium oxalate (Lambert and Muir, 1973).

3. RESULTS AND DISCUSSION

Table 1 presents results of the qualitative analysis of crude phytochemical constituents of *P. africanum*. The result showed that saponins and terpenes were very high while tannins, steroids, phenol and flavonoids were fairly present in the leaf of *P. africanum.* In the stem bark, saponins is very high; phenol is high, while tannins, terpenes, steroids and flavonoids are fairly present.

The quantitative crude bioactive compounds present in *P. africanum* are presented in Table 2. The amounts of Alkaloids, Saponins, Flavonoids, Glycosides, Phytate, Tannins, Oxalate and Phenols are 5.08%, 17.60%, 5.72%, 0.90mg/kg, 0.0917%, 2.684%, 36.55 mg/g and 376.08 mg/kg, respectively in the leaf and 3.00%, 13.60%, 7.34%, 0.50mg/kg, 0.0917%, 2.732%, 61.02 mg/g and 376.08 mg/kg, respectively in the stem-bark. The study showed that alkaloids, saponins, glycosides were apparently

higher in the leaf compared to the stem-bark. Phenols and phytate concentrations were same in both plant parts. While flavonoids, tannins, oxalate were apparently higher in the stem-bark when compared to the leaf. Both the qualitative analysis and quantitative determination of metabolites showed that the plant under study is rich in phytochemicals.

The phytochemicals of *P. africanum* appeared to be the aspect of the plant that has been most studied. This is possibly so because plants have been shown to contain secondary metabolites that can also protect humans against diseases (Doughari *et al*., 2009). To these effects most of the phytochemicals have been reported by several authors for specific functions. For instance, Agu and Thomas (2012) reported that alkaloids have defense mechanisms through which plants ward off pests. This suggests the medicinal properties (such as analgesic, antispasmodic and bactericidal effects) of alkaloids from plants (Kigigha *et al*., 2015; Epidi *et al*., 2016a, b; Doherty *et al*., 2010; Osuntokun and Oluwafoise, 2015). Alkaloids are also essential for the treatment of ulcer (Ateufack *et al*., 2015). The values of alkaloids observed in this study are lower than the values reported by Owoeye *et al*. (2018).

Saponins in the leaf and stem-bark is an indication that the plant could be used as expectorant, cough suppressant and it also has hemolytic activity (Sofowora, 1993; Kigigha *et al*., 2015; Okwu, 2005; Osuntokun and Oluwafoise, 2015; Epidi *et al*., 2016a,b). Bark decoctions of *P. africanum* are useful in the treatment of cough, bronchitis, and genito-urinary infections (Jiofack, 2008; Fern, 2014). Brusotti *et al*. (2013) reported that the saponin fraction of the methanolic extract of the stem bark of *P. africanum* has been demonstrated to be a good candidate for the control of a pathogen of rice blast disease, *Pyricularia* grisea. These may be linked to the biological activities of saponins contained in the extracts of these plants. The values were high and are comparable to values reported by Owoeye *et al*. (2018).

Table1. *Results of qualitative analysis of crude phytochemical constituents of P. africanum*

Phytochemical	Leaf of *P. africanum*	Bark of *P. africanum*
Saponins	+ + +	+ + +
Tannins	+	+
Terpenes	+ + +	+
Steroids	+	+
Phenols	+	+ +
Flavonoids	+	+

KEY

+ + + = very highly present

+ + = highly present

Table2. *Quantities of crude phytochemicals present in plants studied*

Phytochemicals	Leaf of *P. africanum*	Bark of *P. africanum*
Alkaloids (%)	5.08	3.00
Saponins (%)	17.60	13.60
Flavonoids (%)	5.72	7.34
Glycosides (mg/kg)	0.900	0.50
Phytate (%)	0.0917	0.0917
Tannins (%)	2.684	2.732
Oxalate (mg/g)	36.55	61.02
Phenols (mg/kg)	376.08	376.08

Flavonoids have been reported to have antioxidant, anticarcinogenic, antimicrobial and antitumor properties (Kigigha *et al*., 2015; Osuntokun and Oluwafoise, 2015). Flavonoids are also essential for the treatment of ulcer (Ateufack *et al*., 2015). As such the values obtained from this study suggest the biological activity of flavonoids. Glycosides are known for several biological activities including analgesic, antipyretic, and anti-inflammatory effects. Some types of glycosides such as the cyanogenic is found in several plants and they aid to defend the plant against herbivores and pathogens due to their bitterness and release of poisonous hydrogen cyanide once the plant tissue is wounded (Zagrobelny *et al*. 2004).

Tannins are known to occur abundantly in the bark of trees where they act as a barrier to micro-organisms. Tannin is astringent in nature and has the ability to bind or precipitate proteins and various other organic compounds making them unavailable for absorption. Plants rich in Tannin are said to have several medical applications (Okuda, 2005; Doughari *et al*, 2009). Tannins have health importance such as wound healing, varicose ulcers, hemorrhoids, frostbite and burns, and it has the ability to regenerate skin, as well as anti-inflammatory and anti-diuretics activity (Okwu and Okwu, 2004; Doherty *et al.*, 2010; Kigigha *et al*., 2015; Osuntokun and Oluwafoise, 2015).

In this study steroids and terpenes were detected through qualitative approach. Okeke *et al*. (2015) suggested that the occurrence of steroids in plants could be helpful in the classification of closely related species. Furthermore, plant steroids are known to possess medicinal, pharmaceutical and agrochemical activities (Patel and Savjani, 2015). Plant steroids are classified into phytosterols and brassinosteroids. Authors have reported that phytosterols lower plasma cholesterol by preventing the absorption of cholesterol and cancer prevention potentials (Ogbe *et al.*, 2015; Sultan and Raza, 2015). Brassinosteroids also help plants resist biotic and abiotic stress by protecting plants from the toxicity of herbicides, fungicides and insecticides (Xia *et al*, 2009).

The results of qualitative screening of phytochemicals in this study is contrary to that reported by Owoeye *et al* (2018) in which both steroids and terpenoids were not detected in the stem bark of *P. africanum*. In this study, both compounds were present. The variations could be as a result of differences in the environment of the plants, the manner of collection of the plant samples, the process of extraction or the status of the chemicals used for the extraction of the phytochemicals from the samples.

Phytate is a phosphorylated form of Inositol and its major storage of phosphorus in all leafy vegetables (Harland and Oberleas, 1987; Horner, *et al*., 2005; Habtamu and Negussie, 2018). Phytic acid is found in plant tissues as salts of cations such as potassium, magnesium and calcium (Natesh *et al*., 2017) and has both beneficial and detrimental effects on human. Therefore, the presence of phytate in plants used for medicinal purpose is worth considering as a result of the well-known anti-nutritional activities of phytic acid. Phytic acid has the tendency to reduce the bioavailability of essential metals such as zinc and iron, and binds with proteins and negatively affects the action of digestive enzymes (Aberoumand, 2012**;** Natesh *et al*., 2017). However, phytic acid can also inhibit the formation of calcium oxalate and calcium phosphate crystals that could cause kidney stone disease. Oxalates have been reported in flowering plants (Natesh, 2017). In humans, oxalates could be harmful. The ingestion of high levels of oxalate through herbal medicine could cause hyperoxaluria (Horner *et al*., 2005; Radek and Savage, 2008). Phenolic compounds are among the most abundant secondary metabolites in plants. Some phenolic compounds have powerful antioxidant properties and they aid to prevent oxidative stress that could cause degenerative diseases conditions such as cancer (Dai and Mumper, 2010).

4. CONCLUSION

This study investigated the phytochemical and anti-nutritional compounds in leaf and stem-bark of *P. africanum.* The result revealed varying concentrations of Alkaloids, Saponins, Flavonoids, Glycosides, Phytate, Tannins, Oxalate and Phenols through quantitative approach and saponins, terpenes, tannins, steroids, phenol and flavonoids through qualitative approach. The presence of phytochemicals like tannins, phytate and oxalate suggest the possible adverse effects of the continuous use of herbal preparations from leaf and stem bark of this plant on human health. However, the rich presence of other phytochemicals in this plant suggests its vast pharmacological potentials. Therefore, there is need for further research to be carried out on the anti-nutritional characteristics to reveal the concentrations that could be toxic to human health as well as other medicinal properties of the plant that have not been documented.

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