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Physicochemical parameters, phytochemical screening and mineral composition of trunk bark of *Cynometra ananta*

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Abstract: Traditional medicine uses the bark of the *Cynometra ananta* trunk to treat a variety of illnesses. This study involved examining the physicochemical characteristics, phytochemical profile, and mineral content of the bark of the trunk of *C. ananta*. These findings were based on the documented correlations between the chemical composition of plants and their biological or therapeutic effects. Standard protocols were used to assess the physicochemical characteristics, phytochemical composition, and mineral composition of the methods. The findings indicate a 13.38% (w/w) moisture content, 6.95% total ash, 1.03% insoluble ash in acid, 1.30 water soluble ash, and pH values of 5.8 at 1% and 5.5 at 10%. Significant levels of bioactive substances, including phenolic compounds, terpenoids, alkaloids, and saponins, as well as important minerals, such calcium (5968.62 mg/100g) and potassium (1071.46 mg/100g), are present in the bark of the *C. ananta* trunk. The results obtained will provide important clues for the quality control criteria of *C. ananta* bark, as well as for knowledge of its pharmacological potential.

Keywords: *Cynometra ananta; Physicochemical; Phytochemical; Minerals; Pharmacological*

1. Introduction

Therapeutic plants, are assets of conventional medications, have played a critical part in human culture all through history. The interface of conventional information with modern logical discoveries, show the potential of these plants for dietary and pharmaceutical applications (Wanyo *et al.*, 2024).

It is possible that medicinal plants have been used by humans for up to 30,000 years, at least from 2600 BCE. Furthermore, paleolithic hominins probably employed a variety of plants for hundreds of thousands to millions of years to either cure or at least lessen the symptoms of various ailments. Tens of millions of people rely on traditional herbal medicines as their first line of defense against illness; today, an estimated 80% of people use them worldwide (Davis & Choisy, 2024).

Medicinal plants contain active ingredients that make them of interest to the pharmaceutical, food and beauty care industries (Elmsellem *et al.*, 2019; Kalyniukova *et al.*, 2021; Cherriet *et al.*, 2023; Haddou *et al.*, 2023; Taibi *et al.*, 2024).

Polyphenols are a group of secondary metabolites containing one or more aromatic rings carrying one or more hydroxyl groups. In later a long time, particular interest has been given to polyphenols due to their potential impacts on human wellbeing, such as anti-free radical, anti-inflammatory, neuroprotective, antitumor, cardioprotective, hypoglycemic, antibacterial properties (Zhang *et al.*, 2022).

There are two essential categories of polyphenols: firstly, flavonoids and furthermore non-flavonoids (for case lignans, stilbenes, phenolic acids, non-phenolic metabolites, and other polyphenols). Also, flavonoids have been appeared to decrease the protein action of cyclooxygenase, lipoxygenase, lipid peroxidation, platelet accumulation, capillary porousness, and fragility (Hasnat *et al.*, 2024). Tannins are polyphenols that are partitioned into two main groups: hydrolysable tanins and condensed tanins called proanthocyanidins. Diverse biological and pharmacological properties have been related with the composition and function of tanins (Melo *et al.*, 2023).

The Fabaceae family includes the massive tree *Cynometra ananta*, which has a straight trunk and thin root buttresses at the base of the tree. It has reddish-brown bark and can reach a height of 36 meters. The fruit is rectangular to obovate with a smooth brown pod, and the leaves are paripinnate compound with two leaflets. This species is indigenous to tropical Africa, where it is frequently found in deep, deciduous woods in nations like Ghana, Liberia, and the Ivory Coast. Its bark and leaves offer therapeutic qualities, and its lumber, known as Apome in Ivory Coast and Ananta in Ghana, is used in building (Cynometra Ananta in Genus Cynometra | PlantaeDB, n.d.).

The physicochemical traits and phytochemical screening of the species *Cynometra ananta* remain mostly unknown, even with the abundance of scholarly papers on the genus *Cynometra*. Thus, the aim of this study was to investigate the physicochemical parameters, phytochemical profile and mineral composition of *Cynometra ananta* trunk bark from southern Côte d'Ivoire. This would advance our understanding of the potential uses of African medicinal herbs.

2. Methodology

2.1 Collection of Cynometra ananta and Preparation of Samples

100 grams (g) of *Cynometra ananta* trunk bark was collected in Moapé (Geographical coordinates : 6.196797709754418, -3.791959685801558) in the Mé region of southern Côte d'Ivoire. The botanical species was authenticated at the Centre National Floristics and was registered in the herbarium under number UCJ009272. The properly cleaned collected organs were air dried for a week. After being ground into powder using a mortar, the pulverized barks were sieved in a stainless steel sieve. Then, the fine powder was stored in an airtight amber bottle for later analysis.

2.2 Reagents and Solutions

2,2-Diphenyl-1-picrylhydrazyle (DPPH), Dragendorff reagent, L-ascorbic acid (vitamin C) were purchased from Sigma-Aldrich (St. Louis, USA). Copper sulfate ($CuSO_4$) was purchased from Chem-Lab (Zedelgen, Belgium). Acetone and chloroform were purchased from Carlo Erba (Val-De-Reuil, France). Finaly, Sodium hydroxide (NaOH) was purchased from Fischer Chemical (Strasbourg, France). Every other chemical and solvent used was analytical grade.

2.2 Experiments

2.2.1 Physicochemical analyses

The plant powder samples were analyzed according to AOAC methods to determine moisture, total ash content, soluble ash content, insoluble ash content, pH at 10% and pH at 1% (*AOAC: Official*

Methods of Analysis (Volume 1) : AOAC International : Free Download, Borrow, and Streaming : Internet Archive, n.d.).

Determination of moisture content

In a clean crucible dried in an oven at 105 °C for 30 min and then weighed, a 1 g powder sample was transferred and dried in an oven at 105 °C for 20 min. The sample was then weighed to determine the moisture content.

Determination of ash content

The crucible containing the sample whose moisture content was determined was placed in a muffle heating system set at 550 °C for 20 min for incineration. After weighing, the total ash content was calculated.

Determination of insoluble ash content

To the crucible containing the total ash, 25 mL of 2N HCl was added. The mixture was boiled for 5 min. Insoluble materials were collected on ashless filter paper and washed with hot water until the filtrate was neutral.

The filter paper containing the insoluble matter was transferred to the crucible and dried in an oven until a constant mass was obtained. Subsequently, the residue was cooled and weighed immediately. The insoluble ash content was calculated relative to the air-dried plant material.

Determination of soluble ash content

The ash added to 25 mL of distilled water was boiled for 5 min. The difference between the mass of insoluble ash and the mass of total ash represented the soluble ash in water. The percentage of soluble ash was calculated relative to the air-dried plant material.

2.2.2 Detection of bioactive compounds

The qualitative chemical tests on *C. ananta* trunk bark were performed according to the methods described by *Bekro et al.* (Bekro *et al.*, 2007); *Muskan et al.* (Muskan *et al.*, 2023).

Detection of alkaloids

10 mL of 10% H_2SO_4 were added to 1 g of plant powder. After 2 min of stirring, the mixture was filtered. 2 drops of Dragendorff's reagent were added to the filtrate. The appearance of an orange-red precipitate indicates the presence of alkaloids.

Detection of terpenoids

The presence of terpenoids was determined by the formation of a reddish-brown color in a mixture comprising 0.5 mL of crude extract, 2 mL of $CHCl_3$, and 3 mL of H_2SO_4.

Detection of steroids

Approximately 1 mL of the crude extract was combined with 10 mL of $CHCl_3$ and 10 mL H_2SO_4, and the formation of the bilayer (red upper layer and greenish lower layer) revealed the presence of steroids.

Detection of polyphenolics

2 mL (1%) of extract were mixed with two to three drops of 1% $FeCl_3$ solution. When combined with ferric ions, phenolic compounds produce an intense violet color.

Detection of flavonoids

To 1 mL of crude ethanolic extract, 3 to 5 drops of concentrated HCl solution are added and a red color indicates a positive reaction.

Detection of tanins

A few drops of $Pb(C_2H_3O_2)_2$ were added to 1 mL of extract. The formation of a white-brown precipitate reveals a positive test.

Detection of Phlobatanins

5 mL of extract were dissolved in distilled water and filtered. The filtrate was boiled with 2% HCl solution. A red precipitate shows the presence of phlobatannins

Detection of Anthraquinones

1 mL of extract was boiled with 10% HCl for a few minutes in a water bath. An equal volume of $CHCl_3$ was added to the filtrate. A few drops of 10% NH_3 were added to the mixture and heated. The formation of a pink color indicates the presence of anthraquinones.

Detection of Saponins

Approximately 0.5 mL of extract and 5 mL of distilled water were combined and stirred. The formation of foam confirms the presence of saponins.

Detection of glycosides

The extract was hydrolyzed with HCl solution, then it was neutralized with NaOH solution. After that, a few drops of Fehling's solution were added. A red precipitate indicates the presence of glycosides.

Detection of cardiac glycosides

1 mL of acetic acid and 2 drops of $FeCl_3$ were added to 2 mL of extract, then 2 mL of concentrated H_2SO_4. The color change was observed. The formation of a reddish-brown color was considered a positive test.

Detection of reducing sugars

In a test tube, 5 mL of crude alcoholic extract are added to 5 mL of Fehling's solution. The formation of a brick-red precipitate after 2 to 3 min of heating in a water bath at 70 ° C indicates a positive reaction.

Detection of mucilages

Mucilages are heterogeneous molecules based on polysaccharides. In contact with water, mucilages become viscous and swell. Mucilages always contain a glucose molecule. 5 ml of absolute ethanol were added to 1 ml of infusion. Obtaining a flocculent precipitate indicates the presence of mucilage

Detection of protein

An aliquot of crude extract is diluted in 2 mL of 20% NaOH. 5 drops of a 1% $CuSO_4$ solution are added to the mixture obtained. The appearance of a purple color sometimes with a reddish tint indicates a positive reaction.

2.2.3 Analysis of Minerals

Using an X-ray fluorescence spectrometer (HORIBA MESA-50), the mineral content of *Cynometra ananta* stem bark was examined.

3. Results and Discussion

3.1 Physico-chemical parameters of Cynometra ananta trunk bark

Table 1 presents the findings from the physicochemical analyses of the plant under evaluation. The amount of minerals and earthy materials associated to the plant material was indicated by the total ash value, which was calculated to be 6.95% p/p. The evaluation of the total ash value is significant for assessment of purity and quality of drugs (Logamadevi & Menaka, 2023). The plant had 1.03% p/p of acid-insoluble siliceous materials. The extractive value that dissolved in water revealed the existence of inorganic chemicals, sugar, and acids. The existence of polar components was revealed by the water-soluble extractive values, which showed a value of 1.30% w/w. The 1% and 10% solutions have pH values of 5.8 and 5.5, respectively. 13.38% w/w was discovered to be the drying value loss. A comparative investigation revealed that the moisture content of *C. ananta* trunk bark was higher to that reported for *Abies marocana* Trab. needles (Zirari *et al.*, 2024). The low moisture content is profitable because it contributes to the amplified shelf life of the drug (Akinsola *et al.*, 2021).

Table 1: Physicochemical parameters of *Cynometra ananta*

Test parameters	Results
Moisture	13,38±0,34
Total ash	6,95±0,01
Acid insoluble ash	1,03±0,14
Water soluble ash	1,30±0,14
pH of 1.00% w/v	5,8±0,01
pH of 10.00% w/v	5,5±0,01

3.2 Phytochemical profile of Cynometra ananta trunk bark

The pharmacological or therapeutic actions generated by plant materials have been linked to phytochemicals (Camilleri & Blundell, 2024; Ntemafack *et al.*, 2023). In this experiment, *Cynometra ananta* trunk bark were shown to contain substantial levels of alkaloids, terpenoids, steroids, phenolics, flavonoids, tanins, pholobatanins, anthraquinone, saponin, glycosides, cardiac glycosides and reducing sugars (**Table 2**). Flavonoids and terpenoids are the main chemical classes reported from the genus *Cynometra*, in addition to fatty acids, alkaloids, esters and other polyphenols (Sabiha *et al.*, 2022). The class of compounds known as polyphenols, which includes flavonoids, tanins (**Figure 1**), phlobatanins and anthraquinones, is well known for its potency as an antioxidant. They might control internal processes and defend the body from illnesses brought on by oxidative damage, such as diabetes, cancer, heart disease, and inflammation (Lang *et al.*, 2024). Alkaloid is one of the bioactive compounds in plants that show restorative pain relieving, antiplasmodial and bactericidal properties (Sodamade *et al.*, 2024). The presence of a variety of phytocompounds in a plant can be utilized as prove for the potential presence of pharmacological activities. Many authors have reported the significance of plants as a

source of bioactive compounds, including alkaloids, terpenoids and polyphenols with wide pharmacological impacts (Barbouchi *et al.*, 2024). This confirms the diverse employments of *Cynometra ananta* within the Ivorian pharmacopoeia, as well as its biological and pharmacological properties.

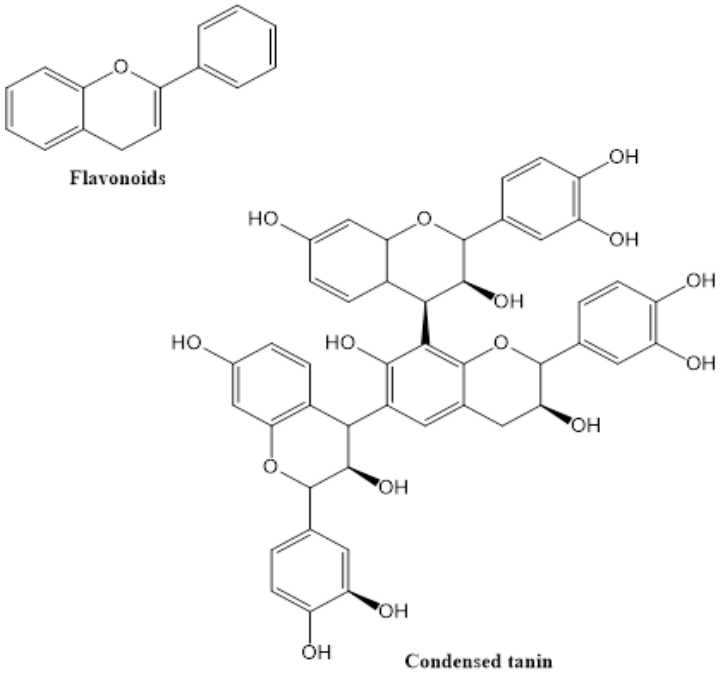

Figure 1 : Chemical structure of flavonoids and a condensed tanin

Table 2: Phytochemical analysis of extracts of *Cynometra ananta*

Constituents	Results
Alkaloids	+
Terpenoids	+
Steroids	+
Phenolics	+
Flavonoids	+
Tanins	+
Phlobatanins	+
Anthraquinones :	+
Saponins	+
Glycosides	+
Cardiac glycosides	+
Reducing sugars	+
Mucilages	-
Proteins	-

3.3 Mineral composition of Cynometra ananta trunk bark

This is the first study that we know of that shows the mineral composition of *Cynometra ananta* trunk bark. Three macrominerals (Ca, K and P) and five microminerals (Fe, Mo, Mn, Cu, and Zn) made up the total of eight minerals that were quantified in the powder. **Table 3** lists the concentrations of each mineral. Upon analysis, it is evident that Ca is the most prevalent element in the sample, accounting for about 5968.62 mg/100g.

Ca is the foremost abundant mineral within the human body which, as well as reinforcing the skeleton, is fundamental for blood clotting, muscle compression, and nerve transmission, decreasing the chance of hypertension, colon cancer, and stomach corpulence (Luz *et al.*, 2024). Potassium content was 1071.46 mg/100g, making it the second most abundant macromineral total. Potassium is an important nutrient that is necessary for numerous cellular processes, such as maintaining fluid equilibrium, contracting muscles, sending nerve impulses, and decreasing blood pressure (McLean & Wang, 2021). Iron was found to be 2901.37 mg/100 g and Molybdenum content was 2768.86 mg/100 g.

Certain macro- and micro-elements can be found within the composition of teeth, particularly calcium and phosphorus, as well as in bones, such as calcium, manganese and phosphorus. In expansion, a majority of micro-elements, counting copper, iron, manganese and zinc, serve as crucial components inside various proteins, satisfying a significant part in their basic composition (Zirari *et al.*, 2024).

Table 3: Mineral contents of *Cynometra ananta* stem bark

Minerals	Amounts (mg/100g)
Phosphorus (P)	1.02
Potassium (K)	1071.46
Calcium (Ca)	5968.62
Manganese (Mn)	154.70
Iron (Fe)	2901.37
Copper (Cu)	91.28
Zinc (Zn)	83.34
Molybdenum (Mo)	2768.86

Conclusion

One important plant species for medicine is *Cynometra ananta*. The trunk bark of this plant is traditionally used to treat several diseases in Côte d'Ivoire and West Africa. A few research have been conducted on the effectiveness, safety, and quality of *Cynometra* species. This study was carried out to determine the effectiveness of *C. ananta* bark as a medicinal plant for the first time. It was discovered that *C. ananta* bark was a good source of active components, especially alkaloids, phenolic compounds, and terpenoids, which are thought to be in charge of the plant's pharmacological qualities. In addition, our research indicates that *Cynometra ananta* extract is a great way to get important minerals like potassium and calcium.

Disclosure statement: *Conflict of Interest:* The authors declare that there are no conflicts of interest.
Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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