***Original Research Article***

**ETHNOBOTANICAL, PHYTOCHEMICAL STUDIES AND DETERMINATION OF MINERAL ELEMENTS OF *COMMIPHORA AFRICANA* (A. RICH) ENGEL. HAVERSTED IN MALI**

**ABSTRACT**

 Since ancient times, people have treated themselves with the plants they had at their disposal. *Commiphora africana* (A. Rich) Engel., known as "African myrrh," is a medicinal plant belonging to the Burseraceae family, widely used in traditional Malian medicine. The objective of this study is to conduct an ethnobotanical survey, perform phytochemical screening of the plant powder, and determine the mineral content. A questionnaire was used to collect information from respondents regarding knowledge about the plant and the recommended preparation methods. The plant material consisted of root bark and leaves. These plant parts were harvested in November 2018 in Ségué, Bankass prefecture in the Mopti region of Mali. The extracts were prepared by aqueous decoction using reflux heating. The phytochemical families of the different extracts were identified using test tube reactions. Mineral elements were determined by Atomic Absorption Spectrometry (AAS). During the ethnobotanical Survey, the recorded ailment included headaches, evil spirits and Children nighttime fear. Phytochemical analysis revealed the presence of various secondary metabolites, such as flavonoids, alkaloids, tannins, free quinones, terpenoids, sterols, triterpenes, anthraquinones, and reducing sugars. Furthermore, the studied plant parts (leaves and roots) showed varied concentrations of minerals, including Na (1.14; 1.55 mg/L), K (28.12; 22.88 mg/L), Mg (12.79; 11.35 mg/L), Ca (62.96; 38.93 mg/L), Fe (0.57; 2.23 mg/L), Pb (1.48; 1.21 mg/mL). Some elements were present in trace amounts: Zn (-1.29; 0.38 mg/mL) and Cu (0.28; 0.08 mg/mL).

***Keywords:*** *Commiphora africana (A. Rich) Engel.; ethnobotanical survey; phytochemical screening; mineral elements.*

1. **INTRODUCTION**

Traditional medicine remains the primary recourse for a significant portion of populations in addressing health problems. This phenomenon is explained not only by its central role as part of cultural heritage but also by its financial accessibility, particularly in contexts where conventional medicines are costly. Transmitted orally from generation to generation, traditional medicine risks losing valuable knowledge in the absence of proper documentation. In this context, ethnobotanical surveys are essential to inventory medicinal plants and understand their uses. These studies help leverage local knowledge about the therapeutic properties of plants, especially in regions where they still play a crucial role in combating various diseases (Koné, 2009). Medicinal plants are the richest bio-resources for medicines. It is necessary to validate research findings on medicinal and aromatic plants through an organized database (Ahmed *at al.,* 2016).

*Commiphora africana*, a shrub of the Burseraceae family, can reach up to 5 meters in height, sometimes exceptionally 10 meters. Although it is widely distributed across Africa, its exact distribution remains uncertain due to persistent taxonomic confusions. It thrives mainly in dry savanna and Sahel regions.

This plant is associated with numerous medico-magical and magico-religious uses. Therapeutically, it is known for its stomachic, calming, and soporific properties (Archna *at al.,* 2016). Various parts of *Commiphora africana* are used to treat multiple ailments: typhoid, dysentery, snake bites, wound healing, heartburn, and malaria (Bouakaz, 2006). Its bark is used to treat scorpion stings, rheumatism, conjunctivitis, and dermatoses. The leaves are used for treating bovine pleuropneumonia and male infertility (Archna *at al.,* 2016). In Burkina Faso and Côte d'Ivoire, a maceration of crushed leaves in oil is consumed as a sedative and soporific (Goji, 2009). The seeds are known for their vermifuge and purgative properties (Archna *at al.,* 2016).

The objective of this study is to identify the traditional medicinal uses associated with *Commiphora africana* and document local knowledge about this plant in collaboration with traditional healers, the custodians of this intangible heritage. The results will provide a comprehensive view of the curative properties attributed to this species as perceived by traditional healers.

1. **MATERIAL AND METHODS**
	1. **Plant Material**

The studied plant parts (leaves and roots) were harvested in Ségué, Bankass prefecture, Mopti region, which has a fairly arid Sahelian climate characterized by a rainfall index of 500 to 750 mm. The rainy season lasts a maximum of 3 months (July to September), and the vegetation is mainly thorny steppe and grasses on sandy soil.

The plant organs were harvested in November 2018; leaves in the morning around 7 AM and roots after 10 AM. The plant was identified by a botanical specialist at the Department of Medicinal Plants on the herbal number 2639/DMT. The plant materials were dried for two weeks at room temperature in the laboratory and then pulverized using a traditional mortar.



**Fig.1:** Map of Mali with the collection site (Geographic Institute of Mali)

**2.2 Ethnobotanical Survey**

Ethnobotanical surveys were conducted in December 2019 among herbalists and traditional healers in the Bamako district, particularly in Commune V (17 respondents at the Sabalibougou market and 7 at Kalaban Coura ACI). A structured interview guide with questionnaires was used to collect information on respondents' knowledge of the plants and their recommended preparation methods.

**2.3 Phytochemical Screening**

 Phytochemical screening is a method used to detect the presence of specific chemical groups in a given substance. This study relied on:

* Formation of insoluble complexes using precipitation reactions;
* Formation of colored complexes based on color reactions. This analysis helps to qualitatively identify the main chemical families present.

Mineral Analysis of plants extracts and powder

 The mineralization process aims to detect and quantify essential mineral elements for human health, such as sodium (Na), calcium (Ca), magnesium (Mg), and iron (Fe). The analysis was performed using Atomic Absorption Spectrometry (AAS).

To do this, 0.5 g of plant powder or extract (aqueous decoction) was weighed and dissolved in a 150 mL Erlenmeyer flask containing:

• 10 mL of concentrated acids (sulfuric and nitric);
• 5 mL of hydrogen peroxide.

The obtained solution was filtered into a 100 mL flask and then brought to volume with distilled water. The mixture was then placed in a mineralizer (BUCHI-K-436) for 30 minutes.

Before analysis, the decoctions (aqueous and hydro-alcoholic) were dissolved in hot distilled water to facilitate dissolution. Calibrated standards for each mineral element (ranging from 2 to 8 ppm) were used, along with appropriate detectors.

Finally, the analysis was performed using an atomic absorption spectrometer (AAS), allowing the measurement of the mineral element concentrations present in the samples. Test tube reactions were performed to identify chemical groups (Cissé, 2019)

**Detection of Flavonoids**

1 mL of each extract (leaves and roots of *Commiphora africana*) was treated with a few drops of concentrated HCl, adding a few milligrams of magnesium chips. The presence of flavonoids was reported by the appearance of a red, orange or pink color.

**Detection of alkaloids**

The presence or absence of alkaloids was confirmed by two tests.

To 2 mL of the aqueous extract, 5 mL of 1% HCl were added, and incubation at 35°C in a water bath for 15 min, before dividing the extract into two equal parts. The first part was supplemented with 5drops of Mayer’s reagent (1.36% w/v mercuric chloride and 5% w/v in water) leading to a white precipitate in presence of alkaloids. The second part was supplemented with 5 drops of Wagner’s reagent (2% w/v of iodine and 6% w/v of KI in water), yielding a brown precipitate, if alkaloids are present. The presence of alkaloids is confirmed by the formation of white or brown precipitate.

**Characterization of Tannins**

One milliliter of the aqueous extract was complemented with 2 to 3 drops of 1% w/v FeCl3. After a few minutes of incubations at room temperature, tannins were reported by the appearance of a strong blue or green.

**Characterization of Sterols and triterpenes**

To one milliliter of the aqueous extract, 1 mL of acetic anhydride and a few drops of concentrated H2SO4 were added. The appearance of a purplish to green or brownish coloration of the interface layer indicates the presence of triterpene saponosides

**Free Quinones** **characterization**

To one milliliter of the aqueous extract, a few drops of 1% NaOH are added. Free quinones will cause the appearance of a colour that turns yellow, red or purple.

**Terpenoids Characterization**

One milliliter of the aqueous extract is complemented with 0.4 mL of CHCl3 and 0.6 mL of concentrated H2SO4, which will in the presence of terpenoids produce two phases and a brown colour at the interphase.

**Anthraquinones characterization**

To one milliliter aqueous of extract, 0.5 mL of 10% NH4OH are added, and the mixture is shaken. The appearance of a purple colour indicates the presence of anthraquinones

**Reducing sugars characterization**

To five milliliter of extract, 1 mL of Fehling’s liquor (Fehling, 1849) is added. Then the mixture is heated in a water bath at 70°C for 5 min. The appearance of a brick- red coloured precipitate reports the presence of reducing sugars.

**Sterol and Triterpene Characterization – "Liebermann-Burchard Reaction"**

To 1 mL of each extract, 1 mL of acetic anhydride and a few drops of concentrated H₂SO₄ were added. Steroids reacted to produce a violet to green coloration, while a brownish-red interface layer indicated the presence of triterpenoid saponins.

**Amines characterization**

A drop of extract on a filter paper is dried at 80°C in the oven, and then complemented by a drop of ninhydrin (0.5% w/v of ninhydrin in 65% ethanol), drying again in the oven at 110°C for 5 min. The appearance of a purple spot indicates the presence of amines

**Saponosides characterization**

To one milliliter of extract, 2 mL of hot distilled water are added, and the mixtures is then shaken for a few seconds and then left to stand for 15 min. A foam height of more than 1 cm persisting over this time indicates the presence of saponosides.

1. **RESULTS AND DISCUSSION**

The results obtained in this study are summarized in the following tables:

**Table I: Results of the Ethnobotanical Survey**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Diseases Treated** | Used Parts | Preparations | Mode of Use | **Number of Citations** |
| Headaches | Resin | Resin on hot embers | Head fumigation |  24 |
| Evil spirits | Resin | Resin on hot embers | Fumigation morning and evening until delivrance  |  21 |
| Children's nighttime fear | Resin | Resin on embers | Fumigation |  4 |

The ethnobotanical data highlighted traditional uses of the resin in treating various conditions, including headaches, bad spirits, and children's nighttime fear.

Table II: Results of phytochemical screening

|  |  |  |
| --- | --- | --- |
| Chemical Compounds | Roots | Leaves |
| Flavonoids | + | + |
| Tannins | + | + |
| Alkaloids (Mayer)Alkaloids (Wagner) | + | + | + |
| + | + | + |
| Sterols and Triterpenes | + | + |
| Quinones | + | + |
| Terpenoids | + | – |
| Anthraquinones | + | + |
| Reducing Sugars | + | + |
| Amines | – | + |
| Saponosides | – | – |

Legend :

+: Positive reaction; -: Negative reaction

Phytochemical screening revealed the presence of sterols, triterpenes, flavonoids, tannins, alkaloids, quinones, and anthraquinones, suggesting potential anti-inflammatory, antimicrobial, and antioxidant properties.

The results show a significant distribution of chemical compounds in the roots and leaves. The main observations include the presence of:

• Sterols and triterpenes: indicating possible anti-inflammatory or antimicrobial activity;

• Flavonoids and tannins: known for their antioxidant and astringent properties;

• Alkaloids: potentially responsible for various pharmacological effects;

• Quinones and anthraquinones: which could explain antibacterial or laxative properties.

Table III: Results of Mineral Elements

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Mass (g) | Pb | Cd | Cr | Fe | Mg | Cu | Ca | Zn | K | Na |
| Root | 1.013 | 1.21 | 0.22 | -1.23 | 2.23 | 11.35 | 0.08 | 38.93 | 0.38 | 22.88 | 1.55 |
| Leaves  | 1.001 | 1.48 | 1.13 | -1.81 | 0.57 | 12.79 | 0.28 | 62.96 | -1.29 | 28.12 | 1.14 |
| Authorized Standard | 0.1 mg/L | 5µg/L | 50µg/L | 200µg/L | 50mg/L | 2000µg/L | 270µg/L | 5000µg/L | 200mg/L | 150mg/L |

Mineral analysis showed significant variations between roots and leaves, with notable levels of calcium, potassium, and iron.

Mineral Element Results

The mineral element contents vary between the roots and leaves, compared to the authorized standards.

• Toxic elements:

Lead (Pb): Exceeds acceptable thresholds (0.1 mg/L), posing a significant health risk.

Cadmium (Cd): Present in concerning amounts, especially in the leaves, exceeding the authorized limits (5 µg/L).

Chromium (Cr): Negative values reported, requiring methodological or instrumental verification.

• Essential elements:

Iron (Fe) and magnesium (Mg): Significant concentrations in roots and leaves, supporting their nutritional or therapeutic properties.

Calcium (Ca) and potassium (K): Particularly abundant in leaves, enhancing their value in dietary formulations.

Zinc (Zn): Variable concentrations but generally below regulatory limits.

1. **DISCUSSION**

The study on *Commiphora africana* is a significant contribution to the ethnobotanical and phytochemical documentation of a plant widely used in Malian traditional medicine. It highlights the bioactive compounds present in the plant and its therapeutic potential while emphasizing the limitations of current ethnobotanical knowledge.

The ethnobotanical survey did not yield conclusive results, as the traditional healers interviewed only mentioned the use of the plant’s resin for treating various ailments such as headaches, malevolent spirits, and children's nocturnal fears.

Several studies have addressed the use of *Commiphora africana* in African traditional medicine for treating various conditions, including digestive disorders (stomach aches, diarrhea, etc.), respiratory ailments (cough, bronchitis, etc.), skin problems (wounds, infections, etc.), pain (toothaches, muscle pain, etc.), as well as kidney and bladder conditions (Adjanohoun, 1989; Kokwaro, 1993; Gadir and Ahmed, 2014; Amare, 2019).

Phytochemical screening results reveal the presence of sterols, triterpenes, flavonoids, tannins, alkaloids, quinones, and anthraquinones. Studies conducted by Baser and Demirci (2007) and Sánchez-Morgado (2000) have identified various bioactive compounds in *Commiphora africana*, such as: Terpenoids (Compounds with anti-inflammatory, antimicrobial, and antioxidant properties), Flavonoids(Known for their antioxidant and anti-inflammatory properties), Alkaloids (Compounds with analgesic and anti-inflammatory properties). These studies suggest that the medicinal properties of *Commiphora africana* may be attributed to the presence of these bioactive compounds.

The determination of mineral elements in *Commiphora africana* is crucial for understanding its nutritional value and health impact. The analysis revealed the presence of essential elements such as iron (Fe), magnesium (Mg), calcium (Ca), potassium (K), and zinc (Zn). Studies have confirmed the presence of key minerals in this plant, including: Calcium (Essential for bone and dental health), Iron (Crucial for red blood cell formation and oxygen transport), Potassium (Important for muscle and nerve function), Magnesium: Essential for muscle and nerve function, as well as blood sugar and blood pressure regulation (Orwa *at al.,* 2009). The variability in mineral content between the roots and leaves is a natural phenomenon linked to the specific functions of the organs and the mobility of elements. A negative value for chromium indicates a measurement error that requires deepened verification.

The presence of potentially hazardous minerals (lead, cadmium, chromium) in *Commiphora africana* could be attributed to the variable uptake of minerals by the plant and the different agroecological conditions of different regions. Research on these minerals is essential to ensure user safety. It will help to better understand the risks and benefits of this plant, as well as to develop safer and more effective applications (Ashok et al., 2022).

These findings suggest that *Commiphora africana* could serve as a valuable source of essential minerals for the body.

1. **Conclusion**

Ethnobotanical, phytochemical, and mineral element studies on *Commiphora africana* reveal its potential as a medicinal plant and a source of bioactive compounds and essential minerals. The presence of hazardous elements such as lead, cadmium, mercury and Chromium in the plant may be due to absorption from the soil. These heavy metals are toxic and can accumulate in the body, leading to serious health issues. A multidisciplinary approach combining chemical analyses, toxicological studies and ethnobotanical research is necessary to assess and manage the risks associated with potentially dangerous minerals in *commiphora africana.* However, further in-depth research is needed to explore its chemical constituents for the development of promising natural pharmaceutical products.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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