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RESEARCH ARTICLE

PHYTOCHEMICAL STUDY AND ANTIOXIDANT ACTIVITY OF COMMIPHORA AFRICANA (A. RICH) ENGEL, A PLANT HARVESTED IN MALI

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ABSTRACT

Commiphora africana (A. Rich) Eng., known as 'African myrrh', is a medicinal plant of the Burseraceae family, widely used in traditional Malian medicine. The aim of this study was to carry out phytochemical screening and to evaluate the antioxidant activity of the extracts. The plant material consisted of root bark and leaves. These parts were collected in Ségué, Bankass Prefecture, in the Mopti region of Mali. The extracts were prepared by reflux heating and Soxhlet extraction. Phytochemical groups were identified using tube colour reactions. The antioxidant activity was assessed using the DPPH free radical scavenging assay. Phytochemical analysis revealed the presence of various secondary metabolites, such as flavonoids, alkaloids, tannins, free quinones, terpenoids, sterols, triterpenes, anthraquinones and reducing sugars. The assessment of antioxidant activity indicated that the methanolic extract from both organs exhibited good antioxidant efficacy ($IC_{50} = 0.61$ mg/mL for the root bark extract and $IC_{50} = 0.73$ mg/mL for the leaf extract), which are higher than that of ascorbic acid ($IC_{50} = 0.05$ mg/mL). *Commiphora africana* could be a promising natural source of antioxidants.

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INTRODUCTION

Since time immemorial, people have treated themselves with the plants available to them (Tadhani *et al.*, 2007). What guided them to use one plant rather than another? Chance? Religion? Superstition? Experience, certainly. The use of synthetic antioxidant molecules is currently being called into question due to potential toxicological risks. Consequently, research is now focusing on new plant-based sources of natural antioxidants (Koechlin-Ramonatxo, 2006). Indeed, polyphenols are natural compounds widely found in the plant kingdom which are becoming increasingly important, particularly due to their beneficial effects on health (Vârban *et al.*, 2009). Their role as natural antioxidants is attracting increasing interest in the prevention and treatment of cancer, inflammatory and cardiovascular diseases (Vârban *et al.*, 2009). They are also used as additives in the food, pharmaceutical and cosmetics industries (Suhaj, 2006). It is against this backdrop that we have focused on *Commiphora africana*, a shrub () of the Burseraceae family. It can grow up to 5 metres tall, and in exceptional cases even 10 metres. Although it is widespread across the African continent, the exact distribution of this species remains uncertain due to persistent taxonomic confusion. It grows mainly in dry savannah areas and in the Sahel (Arbonnier, 2009). This plant is associated with numerous medico-magical and magico-religious uses. Therapeutically, it is recognised for its stomachic, calming and soporific properties (Archna *et al.*, 2016). Various parts of *Commiphora africana* are used to treat a range of conditions: typhoid, dysentery, snake bites, wound healing, heartburn and malaria (Bouakaz, 2006). Its bark is used to treat scorpion stings, rheumatism, conjunctivitis and skin conditions. The leaves, meanwhile, are used in the treatment of bovine pleuropneumonia and male infertility (Archna *et al.*, 2016). In Burkina Faso and Côte d'Ivoire, a macerate of crushed leaves in oil is consumed as a sedative and soporific (Goji, 2009). The seeds, for their part, are renowned for their vermifuge and purgative properties (Ahmed *et al.*, 2016). The aim of this study was to carry out phytochemical screening and to evaluate the antioxidant activity of *Commiphora africana* extracts.

MATERIAL AND METHODS

Material: The plant parts studied (leaves and roots) were collected in Ségué, Bankass Prefecture in the Mopti region, which has a fairly arid, Sahelian climate characterised by an annual rainfall of 500 to 750 mm. The rainy season lasts for a maximum of three months (from July to September) and the vegetation consists of thorny and herbaceous steppe on sandy soil. The plant was

identified by a botanical specialist under herbarium number 2639/DMT at the National Institute for Research into Traditional Medicine and Pharmacopoeia (INRMPT), formerly the Department of Traditional Medicine (DMT), in Mali. The plant parts were harvested in November 2018; the leaves were collected in the morning at around 7.00 am, whilst the roots were harvested after 10.00 am. The plant parts were dried for two weeks at room temperature in the laboratory, then ground using a traditional mortar.

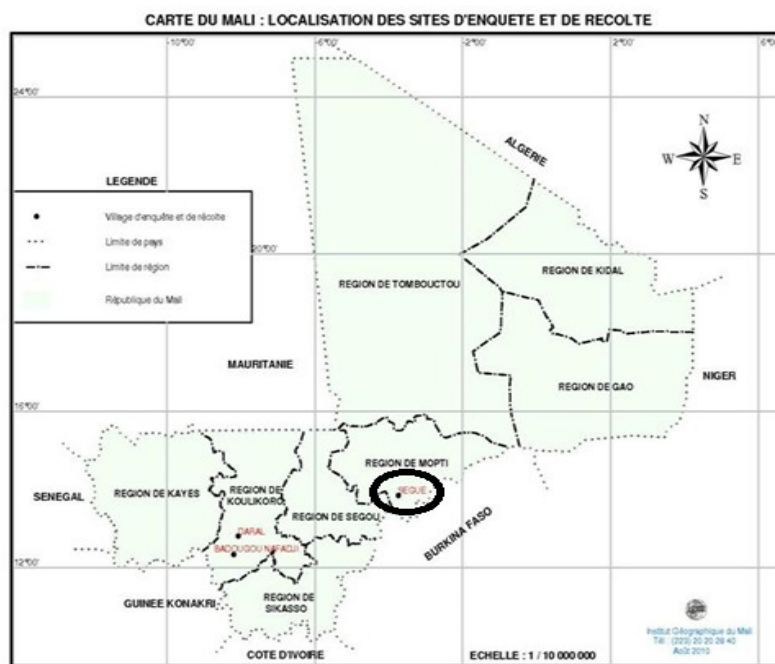


Figure 1: Map of Mali showing the collection site (Geographical Institute of Mali)

Methods:

Preparation of extracts:

- Aqueous decoction: Prepared by refluxing 10 g of plant powder in 100 mL of distilled water for 15 minutes.
- Soxhlet extraction: Prepared by Soxhlet extraction using 40 g of plant powder in 400 mL of methanol.

Phytochemical screening:

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

- The formation of insoluble complexes, using precipitation reactions.
- The formation of coloured complexes, based on colour reactions.

This analysis enables the qualitative identification of the main families of chemical compounds present. Colour reactions in test tubes with specific reagents were carried out to identify the main chemical groups in the aqueous extracts of the leaves and root bark (Cissé, 2019).

Characterisation of flavonoids: 1 mL of each extract (leaves and roots of *Commiphora africana*) is treated with a few drops of concentrated HCl; a few milligrams of magnesium shavings are then added. The presence of flavonoids is confirmed by the appearance of an orange-red and pink colour.

Characterisation of tannins: To 1 mL of each extract, 2 to 3 drops of a 1% FeCl₃ solution are added. After a few minutes' incubation, a positive test is indicated by the appearance of a blue or dark green colour.

Characterisation of alkaloid:

The presence or absence of alkaloids is confirmed by two tests: To 2 mL of each extract, 5 mL of 1% HCl is added. After incubation in a water bath, each extract is divided into two parts. Mayer's reagent is added to the first part and Wagner's reagent to the second. The formation of a white or brown precipitate indicates the presence of alkaloids.

Characterisation of sterols and triterpenes 'Libermann–Burchard reaction' : To 1 mL of each extract, 1 mL of acetic anhydride and a few drops of concentrated H₂SO₄ are added. In this reaction, steroids produce a violet to green colouration, whilst a reddish-brown colour in the interface layer indicates the presence of triterpene saponins.

Characterisation of terpenoids: 1 mL of each extract is treated with 0.4 mL of chloroform and 0.6 mL of concentrated H₂SO₄. The presence of terpenoids is indicated by the formation of two phases and a brown colour at the interface in the case of roots; however, for leaves, we did not observe any brown colouration at the interface.

Characterisation of anthraquinones: To 1 mL of each extract, 0.5 mL of 10% NH₄OH is added and the mixture is shaken. The appearance of a violet colour indicates a positive test.

Characterisation of reducing sugars: To 5 mL of each extract, 1 mL of Fehling's solution (A+B) is added, and the mixture is then heated in a water bath for 5 minutes. The appearance of a brick-red precipitate indicates a positive test.

Characterisation of amines: A drop of each extract is applied to filter paper; after drying in an oven at 80 ° C, a drop of ninhydrin is added. The paper is dried in an oven at 110 ° C for 5 minutes. The appearance of a purple stain indicates a positive test.

Characterisation of saponosides : To 1 mL of each sample, 2 mL of hot distilled water is added, followed by shaking for 15 seconds and leaving to stand for 15 minutes. A persistent foam forms.

Antioxidant activity: Antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method according to the protocol described by (Sanchez *et al.*, 1998). DPPH is a stable, purplish-coloured free radical that absorbs at 517 nm. In the presence of free radical-scavenging compounds, the DPPH radical is reduced and changes colour, turning yellow. DPPH reacts with an antioxidant by losing a hydrogen atom, thereby forming 2,2-diphenylhydrazine. DPPH (Keita, 2022).

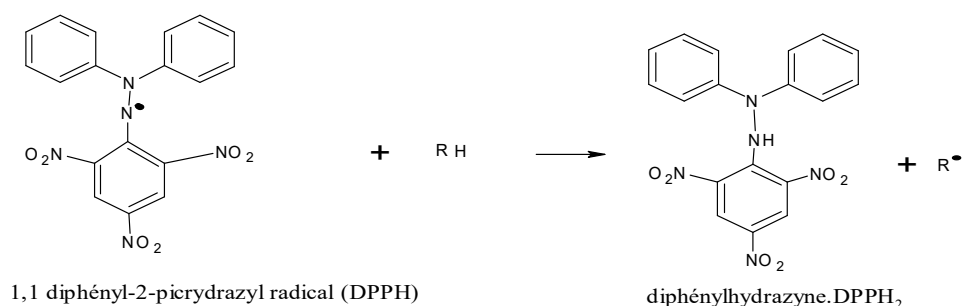


Figure 2: The structure of the DPPH radical and its reduction by an antioxidant

The percentage of inhibition is calculated using the following formula:

$$I\% = (AC - At) / AC \times 100$$

AC: absorbance of the control;

At: absorbance of the test extract.

Antiradical activity is determined by calculating the inverse of the IC₅₀ values (Maisuthisakul *et al.*, 2007):

$$PAR = 1 / IC_{50}$$

PAR: Antiradical activity;

IC₅₀ : concentration of the extract required to reduce the initial concentration of the DPPH radical by 50 per cent.

RESULTS

Phytochemical composition: Table I shows the results of the characterisation tests, which revealed the presence of numerous bioactive metabolites in the aqueous extracts of the bark, roots and leaves of *Commiphora africana*.

Table I: Results of characterisation tests

Chemical compounds		Aqueous extract	
		Root bark	Leaves
Flavonoids		+	+
Tannins		+	+
Alkaloids	Mayer	+	+
	Wagner	+	+
Sterols and triterpenes		+	+
Quinones		+	+
Terpenoids		+	-
Anthraquinones		+	+
Reducing sugars		+	+
Amines		-	+
Saponins		-	-

+: Positive reaction;

-: Negative reaction

The results show a significant distribution of chemical compounds in the bark, roots and leaves. The main findings are 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.

Assessment of free radical scavenging activity

Table II: Inhibition percentages of methanolic leaf extracts at 517 nm

C (mg/mL)	1	0.1	0.01	0.001	0.0001
Abs (nm)	0.360	1.732	1.827	1.841	1.854
I %	80.6	6.78	1.67	0.91	0.021

Table III: Inhibition percentages of methanolic extracts from root bark at 517 nm

C (mg/mL)	1	0.1	0.01	0.001	0.0001
Abs (nm)	0.583	1.739	1.820	1.840	1.856
I %	68.62	6.40	2.04	0.54	0.11

Table IV: Percentages of ascorbic acid inhibition at 517 nm

C (mg/mL)	1	0.1	0.01	0.001	0.0001
I %	76.53	63.68	34.64	31.28	22.91

The IC₅₀ value, or 50 per cent inhibition concentration, is the concentration of the substrate that results in a 50 per cent reduction in DPPH activity; it was determined graphically. The antioxidant activity (PAR) is the inverse of the IC₅₀ values. The results are shown in the table below:

Table V: IC₅₀ and PAR values

Methanolic extracts	IC ₅₀ value (mg/mL)	PAR value
Root bark	0.61	1.64
Leaves	0.73	1.37
Ascorbic acid	0.05	20

DISCUSSION

The results of the phytochemical screening reveal the presence of sterols, triterpenes, flavonoids, tannins, alkaloids, quinones and anthraquinones. Studies carried out by Baser and Demirci (2007) and Sánchez-Morgado (2000) have revealed the presence of various bioactive compounds in *Commiphora africana*, such as terpenoids (compounds with anti-inflammatory, antimicrobial and antioxidant properties), flavonoids (compounds with antioxidant and anti-inflammatory properties), and 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 results of the free radical scavenging activity of the methanolic extracts of the root bark and leaves show an IC₅₀ (concentration inhibiting 50 per cent of the reaction) of 0.61 mg/mL and 0.73 mg/mL respectively, which is higher than that recorded for ascorbic acid, which is 0.05 mg/mL. The antioxidant activity of ascorbic acid is greater than that of the two extracts studied; this may be due to the fact that we used total extracts. Further study (fractionation, isolation) could yield more conclusive results. Studies have shown that the antioxidant activity of *Commiphora africana* is attributed to the presence of several secondary metabolites identified in the root bark, leaves and resin (Mallam *et al.*, 2020). HPLC analyses revealed the presence of quercetin (approximately 60 per cent of the flavonoids in some extracts), rutin and gallic acid (Amanabo *et al.*, 2016). The resin is rich in triterpenes, notably commafric A, α -amyrin and sesquiterpenes such as D-oxobisabolene. These compounds possess anti-inflammatory properties that complement the antioxidant action by reducing the production of pro-inflammatory cytokines. They contribute to the resin's aroma and possess antimicrobial properties as well as properties that protect against lipid oxidation (Aliyu *et al.*, 2015). Resveratrol, found in the stem bark, is a rare polyphenol renowned for its anti-ageing properties. In *C. africana*, it acts as a shield against environmental stress on the plant, transferring these benefits to human consumption. Tannins and saponins play a supporting role by precipitating certain oxidised proteins and facilitating the absorption of other antioxidants (Ibrahim *et al.*, 2025). The efficacy of *Commiphora africana* does not stem from a single molecule, but from a synergistic effect: flavonoids protect the hydrophilic parts of cells, whilst terpenes protect fatty membranes (lipids) against rancidity (peroxidation) (Ashok, 2022).

CONCLUSION AND OUTLOOK

The phytochemical study of the plant revealed the presence of secondary metabolites such as flavonoids, alkaloids, tannins, quinones, terpenoids, sterols and triterpenes, anthraquinones and reducing sugars. These findings may explain the traditional use

of this plant in medicine. The study of the antioxidant activity of methanolic extracts from the leaves and root bark of *Commiphora africana*, carried out using the DPPH free radical scavenging assay, showed that these extracts possess significant antioxidant activity. These extracts could therefore provide an alternative to certain synthetic additives. It should be noted that these results were obtained *in vitro* only. Their significance lies in the fact that they enable the antioxidant activity of these extracts to be investigated directly *in vivo*, in order to correlate the results observed in both cases.

Following this work, and to complement the present study, it would be important:

- to carry out further work (fractionation) to isolate and identify the bioactive compounds using a range of more sophisticated techniques (GC, HPLC, etc.);
- to conduct more in-depth research into the pharmacological properties of *Commiphora africana* to carry out *in vitro* and *in vivo* studies to evaluate other properties: antioxidant, biological (namely anti-inflammatory), antimicrobial, anti-cancer, etc.

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