



Antioxidant Potential of *Boscia senegalensis* (Pers.) Lam. Ex Poir. (Capparaceae) Collected In Mali

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Abstract: For millennia, humanity has exploited various plants from its environment to treat many diseases. These plants contain numerous chemical compounds endowed with biological activities. *Boscia senegalensis*, a wild fruit-bearing shrub well adapted to the arid conditions of the Sahel, is highly valued by rural populations for its numerous food and pharmacological uses. The objective of this study was to investigate the phytochemistry and evaluate the antioxidant activity of leaf and stem extracts of the plant. The study material consisted of leaves and stems of *Boscia senegalensis* collected in April 2023 in Niono, Ségou region, Mali. Extracts were prepared by reflux heating and Soxhlet extraction. Colorimetric reactions were used to determine the chemical constituents of the plant powder and extracts. Total polyphenol and flavonoid contents of the extracts were determined using the Folin–Ciocalteu method and a colorimetric assay, respectively. Antioxidant potential was assessed using the DPPH free radical scavenging method. Alkaloids, saponins, tannins, and terpenoids were identified in the powders and extracts. Methanolic leaf extracts and aqueous stem extracts contained 17.26 EG/g of polyphenols and 3.03 ± 0.25 ECt/g of total flavonoids, respectively. The antioxidant activity of methanolic and aqueous leaf extracts as well as aqueous stem extracts was significant, with IC_{50} values of 808.93 ± 37.75 μ g/mL, 864.03 ± 82.4 μ g/mL, and 905.66 ± 90.8 μ g/mL, respectively, comparable to ascorbic acid (1092.4 ± 32.82 μ g/mL). *Boscia senegalensis* could represent a promising natural source of antioxidants.

Keywords: *Boscia senegalensis*, phytochemistry, antioxidant activity, Mali.

I. INTRODUCTION

Plants in the human environment have always offered an enormous potential for nourishment and self-care (Awa *et al.*, 2020). Natural substances derived from plants have, for over a decade, attracted increasing interest from nutritionists, food manufacturers, and consumers. One of the many reasons for this growing interest is the recognition of their antioxidant properties and their probable role in the prevention of various oxidative stress-related pathologies (Somboro *et al.*, 2025). These substances, called secondary metabolites, are present in all parts of plants (fruits, roots, stems, leaves, flowers, etc.). Secondary metabolites mainly include alkaloids, phenolic compounds (phenolic acids, flavonoids, tannins, and coumarins), glycosides, etc. Some of these substances cause fewer side effects and are more easily assimilated by the body compared to synthetic compounds, most of which are questioned due to their potential toxicological risks (Awa *et al.*, 2020). For this reason, new sources of natural antioxidants are actively sought (Suhaj, 2006).

In recent years, the fields of biological and medical sciences have been increasingly influenced by a new concept: "oxidative stress", a condition in which the cell can no longer control the excessive presence of toxic oxygen-derived radicals (Tadhani *at al.*, 2007). The evaluation of antioxidant activity is becoming increasingly relevant in the field of nutrition as it provides useful information on the quality of raw materials (Vougat *at al.*, 2015). This parameter considers the presence of effective oxygen radical scavengers, such as vitamin C and phenolic compounds, as well as their synergistic and/or antagonistic effects (Somboro *at al.*, 2025). Indeed, it has been established that antioxidants can prevent oxidative stress involved in the onset of several cardiovascular diseases (Scalfi *at al.*, 2000). This oxidative stress, resulting from an imbalance between pro-oxidants and antioxidants in the body, is now recognized as a key phenomenon in the development of chronic diseases. In this context, the search for plant sources rich in phenolic compounds could be beneficial in preventing oxidative stress-related diseases such as cardiovascular and neurodegenerative disorders.

It is within this framework that we focused on *Boscia senegalensis*, a shrub belonging to the family *Capparaceae*. *Boscia senegalensis* is listed among the food and medicinal plants used by rural populations in Mali (Niang *at al.*, 2014). The greenish pulp of the immature fruits is cooked before being eaten like peas or crushed to prepare cakes and couscous. The fruits of this species remain a common and highly valued food, particularly in the Sahel. As for the leaves, they are used to feed livestock, especially cattle (Diop, 2016).

The fruits, leaves, roots, and stems of *Boscia senegalensis* are mainly used as traditional remedies for cough, malaria, swellings, cancer, rheumatism, ulcers, jaundice, and sexually transmitted infections (Maroyi, 2019). Considering its various medicinal and dietary uses, it is relevant to review the biological activities of some families of compounds it contains. The present study aims to carry out the phytochemical characterization and evaluate the antioxidant activity of extracts from the leaves and stems.

II. MATERIALS AND METHODS

2.1 Plant material

The plant material consisted of leaves and stems of *Boscia senegalensis*. They were collected on April 17, 2023, in Niono, Cercle of the Ségou region, Mali, and identified by a botanical specialist under the herbarium number 0735/DMT at the Institute National of Research on Traditional Medicine and Pharmacopoeia (INRMPT), formerly the Department of Traditional Medicine (DMT) of Mali. After air-drying for two weeks, the samples were pulverized into a fine powder used for extractions.

2.2 Preparation of extracts

2.2.1 Aqueous decoction

Prepared by reflux heating 10 g of plant powder in 100 mL of distilled water for 15 minutes.

2.2.2 Methanolic extract

Prepared by Soxhlet extraction with 40 g of plant powder in 400 mL of methanol.

2.3 Phytochemical tests

Specific colorimetric reactions in test tubes were performed to identify the main chemical groups in the powders, as well as in aqueous leaf and stem extracts.

Plant powder

- **Total polyphenols characterization**

2 g of plant powder were added to 50 mL of boiling distilled water. After cooling, the solution was filtered, and 2 mL of filtrate were mixed with 1 to 2 drops of 2% ferric chloride (FeCl_3). The presence of polyphenols was confirmed by the appearance of an intense blackish coloration or a blackish-green precipitate (Cissé, 2019).

- **Flavonoids characterization**

The Shibata (cyanidin) reaction was used. 10 g of powder were boiled in 50 mL of distilled water for 30 minutes. The hot mixture was filtered and 2 mL of filtrate were mixed with 2 mL of hydrochloric alcohol and magnesium chips. A pink-orange or pink-violet coloration indicated flavonoids (Cissé, 2019).

- **Tannins characterization**

5 g of powder were boiled in 50 mL of distilled water, allowed to cool, and filtered. To 5 mL of this infusion, 4 mL of Stiasny reagent were added and heated in a water bath for 30 minutes. Precipitate formation indicated

condensed tannins. After filtration, the filtrate was saturated with sodium acetate and treated with FeCl_3 (2%). A blue-black coloration confirmed hydrolyzable tannins. For catechic tannins, 1 mL of concentrated HCl was added to 5 mL of infusion and boiled for 15 minutes. A red precipitate insoluble in amyl alcohol indicated catechic tannins (Cissé, 2019).

- **Alkaloids characterization**

1 g of powder was macerated in 15 mL of 10% sulfuric acid for 30 minutes, filtered, and divided into three test tubes:

- Tube n° 01: two to three drops of Dragendorff reagent;
- Tube n° 02: two to three drops of Bouchardat reagent;
- Tube n° 03: two to three drops Valser-Mayer reagent.

The apparition of an orange to vermillion red precipitate in the first tube, a brown precipitate in the second and a yellowish-white precipitate indicated the presence of alkaloids (Cissé, 2019).

- **Cardiotonic glycosides**

1 g of plant powder was macerated in 5 mL of chloroform/ethanol (4:1 v/v) for 30 min. The filtrate was distributed in three test tubes:

- 0,5 mL of Baljet reagent was added in the first tube;
- 0,5 mL of Kedde reagent was added in the second tube;
- 0,5 mL of Raymond-Marthoud reagent, in the third tube.

In each tube, 2 drops of sodium hydroxide diluted in absolute ethanol at 90°C were added, the pH was checked. The appearance of an orange color in the first tube, a stable purple-red color in the second and a fleeting purple color in the third indicates the presence of cardiotonic heterosides (Cissé, 2019).

- **Sterols and triterpenes**

In a test tube containing 20 mL of diethyl ether, 1 g of plant powder was added. The mixture was macerated for 24 hours and then filtered. The filtrate was collected in another test tube and the volume was made up to 20 mL. 10 mL of this filtrate was evaporated to dryness at room temperature. The dry extract was then taken up in a mixture consisting of 1 mL of acetic anhydride and 1 mL of chloroform. The solution was divided between two tubes: one serving as a control and in the other, 1 to 2 mL of concentrated sulfuric acid (H_2SO_4) were added. The appearance at the contact zone between the two solvents of a reddish-brown or purple ring followed by the green coloration of the supernatant layer confirms the presence of sterols and triterpenes (Cissé, 2019).

- **Carotenoids**

Five milliliters of the previously prepared macerate were evaporated to dryness in a water bath. Then, 2–3 drops of a saturated solution of antimony trichloride (prepared by dissolving 2–3 pieces of antimony in 5 mL of chloroform) were added to the dry extract. The appearance of a blue coloration followed by a turbid opalescence indicated the presence of carotenoids (Cissé, 2019).

- **Reducing Compounds**

Five milliliters of the aqueous decoction (10%) were evaporated to dryness in a water bath. Two to four drops of Fehling's reagent were added to the dry extract. The formation of an intense red coloration indicated the presence of reducing compounds (Cissé, 2019).

- **Saponosides**

A 1% aqueous decoction was prepared and filtered. The filtrate was adjusted to 100 mL and allowed to cool. Ten test tubes, numbered from 1 to 10, were filled with increasing volumes of the decoction (1 mL to 10 mL). With the exception of tube 10, the remaining tubes were completed to 10 mL with distilled water. The tubes were shaken longitudinally for 15 seconds (at a rate of two shakes per second). After a 15-minute rest, the foam height in each tube was measured. The tube with a foam height of 1 cm was used as a reference for calculations.

Foam index = $100/X$, where X is the foam height in cm (Cissé, 2019).

- **Anthracene Derivatives**

A hydro-acid solution was prepared by mixing 250 mg of plant powder, 20 mL of distilled water and 1 mL of concentrated hydrochloric acid in a 150 mL Erlenmeyer flask. The mixture was placed in a boiling water bath for 15 minutes, cooled and filtered. The filtrate was transferred to a separating funnel and 10 mL of chloroform

were added. The chloroform phase was collected and evaporated to dryness at room temperature. The residue was redissolved in 2 mL of diluted ammonia (1/2). The appearance of a yellow coloration turning to red after slight heating in a water bath confirmed the presence of anthracene derivatives (Cissé, 2019).

Extracts

- **Flavonoids**

One milliliter of each extract was treated with a few drops of concentrated HCl, followed by the addition of a few milligrams of magnesium turnings. The appearance of a red to pink coloration confirmed the presence of flavonoids (Chaibou, 2022).

- **Tannins**

Two to three drops of 1% FeCl₃ solution were added to 1 mL of each extract. After a few minutes of incubation, the appearance of a blue or dark green coloration indicated the presence of tannins (Somboro *et al.*, 2025).

- **Alkaloids**

Two milliliters of each extract were mixed with 5 mL of 1% HCl and incubated in a water bath. Each extract was divided into two portions: Mayer's reagent was added to the first, and Wagner's reagent to the second. The formation of white and brown precipitates, respectively, indicated the presence of alkaloids (Cissé, 2019).

- **Sterols and Triterpenes**

One milliliter of each extract was mixed with 1 mL of acetic anhydride and a few drops of concentrated H₂SO₄. The presence of steroids was confirmed by the appearance of a violet to green coloration or a red-brown color at the interface (Chaibou, 2022).

- **Terpenoids**

One milliliter of each extract was treated with 0.4 mL of concentrated H₂SO₄. The formation of two phases and a brown coloration at the interface revealed the presence of terpenoids (Chaibou, 2022).

- **Anthraquinones**

One milliliter of each extract was mixed with 0.5 mL of 10% NH₄OH and shaken. The appearance of a violet coloration indicated a positive test for anthraquinones (Chaibou, 2022).

- **Reducing Sugars**

Five milliliters of each extract were treated with 1 mL of Fehling's solution (A + B) and heated in a water bath for 5 minutes. The appearance of a brick-red precipitate indicated the presence of reducing sugars (Chaibou, 2022).

- **Saponosides**

One milliliter of each extract was mixed with 2 mL of hot distilled water, shaken for 15 seconds, and allowed to rest for 15 minutes. The persistence of foam with a height greater than 1 cm confirmed the presence of saponosides (Cissé, 2019).

2.4 Antioxidant activity

Antiradical activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method following Sanchez *et al.*, (1998). DPPH is a stable free radical with a violet color and maximum absorbance at 517 nm. In the presence of antioxidant compounds, DPPH is reduced, turning yellow, forming 2,2-diphenylhydrazine.

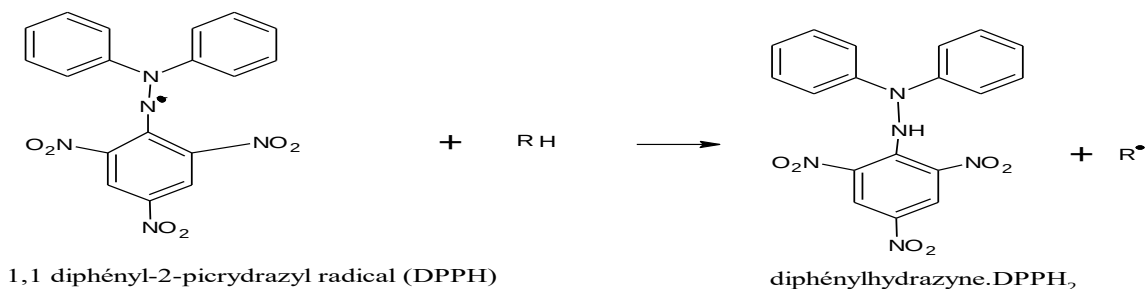


Figure 1: Structure of the DPPH radical and its reduction by an antioxidant

The inhibition percentage was calculated using the formula:

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

- AC = absorbance of the control
- At = absorbance of the tested extract

Antiradical power (ARP) was determined as the inverse of the IC₅₀ value (Maisuthisakul *et al.*, 2007):

$$\text{ARP} = 1/\text{IC}_{50}$$

- ARP = Antiradical Power
- IC₅₀ = concentration of extract required to reduce 50% of the initial DPPH radical concentration (Keita, 2022).
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III. RESULTS

3.1 Phytochemical Composition

The results of phytochemical characterization are summarized in Table 1, which revealed the presence of several bioactive metabolites in *Boscia senegalensis*.

Table 1: Phytochemical composition of *Boscia senegalensis*

Phytochemical constituents	Powder		Aqueous extract	
	Leaves	Stems	Leaves	Stems
Total polyphenols	+	+	+	+
Flavonoids	-	+	-	-
Alkaloids	+	+	+	+
Tannins	+	+	+	+
Saponosides	+	+	+	+
Sterols and triterpenes	+	-	+	-
Carotenoids	-	+	-	-
Anthracenic derivatives	-	-	-	-
Reducing compounds	-	-	-	-
Terpenoids	+	+	+	+

+: positive reaction; -: negative reaction

Phytochemical analysis revealed the presence of flavonoids, tannins, alkaloids, saponosides and terpenoids.

3.2 Antioxydant activity

The quantification of total polyphenols and flavonoids is presented in Table 2.

Table 2: Total polyphenols and flavonoids in *Boscia senegalensis*

Extracts	Total Polyphénols (mg EGa/g)	Total Flavonoids (mg ECt/g)
H ₂ O (Leaves)	6.54 ± 0.45	2.5 ± 0.16
H ₂ O (Stems)	10.59 ± 1.03	3.03 ± 0.25
MeOH (Leaves)	17.26 ± 2.03	2.5 ± 0.16

The DPPH radical scavenging activity is summarized in Table 3.

Table 3: DPPH assay results

Extracts	IC ₅₀ (µg/mL)
H ₂ O (Leaves)	864.03 ± 82.4
H ₂ O (Stems)	905.66 ± 90.8
MeOH (Leaves)	808.93 ± 37.75
Vitamin C	1092.4 ± 32.82

The methanolic leaf extract contained the highest amount of phenolic compounds (17.26 mg GAE/g). The aqueous stem extract contained the highest flavonoid content (3.03 mg CE/g), followed by the aqueous and

methanolic leaf extracts (2.50 mg CE/g each). The methanolic leaf extract exhibited the strongest free radical scavenging activity ($IC_{50} = 808.93 \pm 37.75 \mu\text{g/mL}$), followed by aqueous leaf and stem extracts ($IC_{50} = 864.03 \pm 82.40$ and $905.66 \pm 90.80 \mu\text{g/mL}$) respectively. These findings confirm the antioxidant potential of the plant.

IV. DISCUSSION

The phytochemical screening of powdered material and aqueous extracts of leaves and stems revealed the presence of alkaloids, saponosides, tannins, and terpenoids. Flavonoids and carotenoids were detected only in stem powder. Our findings are consistent with those of Chaibou (2020), who reported the presence of tannins and alkaloids in *Boscia senegalensis*, confirming that these compounds are among the main phytochemical constituents of the plant. However, unlike our results, Osuala *et al.*, (2022) did not detect flavonoids in their extracts. Such discrepancies may be due to differences in extraction methods, environmental conditions influencing the biosynthesis of secondary metabolites, or geographical variations in plant material, which could alter phytochemical composition.

Further studies by Awa *et al.*, (2020) on the pulp and seeds of *B. senegalensis* confirmed the presence of saponosides, alkaloids, sterols, triterpenes and phenolic compounds, including flavonoids. Similarly, Adam *et al.*, (2011) identified saponosides and alkaloids in seed extracts from Chad, although flavonoids, triterpenes and sterols were absent.

The alkaloids in *Boscia senegalensis* may be associated with antimicrobial and antiparasitic activities, contributing to its traditional use in treating infections and digestive disorders (Elkhateeb *et al.*, 2019). Saponosides, known for their detergent and surfactant properties, are linked to anti-inflammatory, antimicrobial, and hemolytic activities (Chaibou, 2020), as well as digestive and immune-enhancing effects (Ka, 2020). Tannins, well known for their antioxidant, astringent and antimicrobial properties, contribute to tissue protection and wound healing (Cissé *et al.*, 2024). Terpenoids may explain the plant's traditional use as a tonic or stimulant.

The high concentrations of phenolic compounds observed in both leaves and stems likely contribute to the antioxidant activity demonstrated by the DPPH assay. The methanolic leaf extract showed the strongest free radical scavenging activity, followed by aqueous extracts, with IC_{50} values comparable to ascorbic acid. This activity can be attributed to the synergistic effects of flavonoids, tannins and other phenolics in neutralizing free radicals and reducing oxidative stress.

Comparable studies have reported similar antioxidant properties. For example, Deli *et al.*, (2019) found an IC_{50} of $86.16 \mu\text{g/mL}$ in seed extracts of *B. senegalensis*. Oumarou *et al.*, (2020) confirmed significant radical scavenging activity in ethanolic leaf extracts, attributed to their high flavonoid and antioxidant content. These results highlight the importance of flavonoids as potent antioxidants with wide-ranging health benefits, including antimicrobial, anti-inflammatory, antiviral, antitumor, vasculoprotective, hepatoprotective and anti-ulcer properties (Agrawal, 2011; Deli *et al.*, 2019). In African traditional medicine, *B. senegalensis* is also used to treat livestock diseases such as foot and mouth disease in northern Cameroon (Ghedira, 2005).

V. CONCLUSION

This study revealed the presence of flavonoids, tannins, alkaloids, saponosides, and terpenoids in the leaves and stems of *Boscia senegalensis*. Quantification showed a differential distribution of phenolic compounds: leaves were richer in polyphenols, while stems contained higher flavonoid levels. These phenolic compounds, known for their multifunctional properties, act as singlet oxygen quenchers and free radical scavengers. Both methanolic and aqueous extracts demonstrated significant radical scavenging activity, highlighting leaves and stems of *B. senegalensis* as potential sources of natural antioxidants. This supports its traditional use in treating various ailments. Nevertheless, further research is required to isolate, purify and characterize the specific compounds responsible for these biological activities.

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