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Review Article

BOSCIA ALBITRUNCA: REVIEW OF ITS BOTANY, MEDICINAL USES, PHYTOCHEMISTRY, AND BIOLOGICAL ACTIVITIES

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ABSTRACT

Boscia albitrunca is a medium-sized tree widely used as herbal medicine in Southern Africa. The current study critically reviewed the botany, medicinal uses, phytochemistry, and pharmacological activities of *B. albitrunca*. Literature on botany, medicinal uses, phytochemical, and biological activities of *B. albitrunca* was collected from multiple internet sources including Elsevier, Google Scholar, SciFinder, Web of Science, PubMed, BMC, Science Direct, and Scopus. Complementary information was gathered from pre-electronic sources such as books, book chapters, theses, scientific reports, and journal articles obtained from the university library. This study revealed that the species is used as herbal medicine in 75.0% of the countries in Southern Africa where the species is indigenous. The bark, leaves, and roots of *B. albitrunca* are mainly used as herbal medicines for constipation, epilepsy, hemorrhoids, headache, human immunodeficiency virus/acquired immune deficiency syndrome, skin diseases, syphilis, and as ethnoveterinary medicine. Ethnopharmacological research identified phenolic compounds, alkaloids, coumarins, flavonoids, saponins, steroids, tannins, and triterpernoids from leaves of *B. albitrunca.* The crude extracts of the species and the compound martynoside isolated from *B. albitrunca* exhibited antibacterial and antifungal activities. *B. albitrunca* should be subjected to detailed phytochemical, pharmacological, and toxicological evaluations aimed at correlating its medicinal uses with its phytochemistry and pharmacological activities.

Keywords: *Boscia albitrunca*, Capparaceae, Herbal medicine, Indigenous knowledge, Southern Africa.

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INTRODUCTION

Boscia albitrunca (Burch.) Gilg & Gilg-Ben. is a medium-sized evergreen tree belonging to the Capparaceae or caper family. *B. albitrunca* is regarded as a multipurpose tree species in Southern Africa [1-19] used as coffee or tea substitute, source of dye or tannin, fodder, ethnoveterinary medicine, herbal medicine, famine food, food additive, and shade. The leaves of *B. albitrunca* are browsed by livestock and game, especially at the time of flowering and toward the end of the dry season [20-26]. The roots of B. albitrunca are edible and sometimes pounded and cooked into porridge [27-29]. The fruits of *B. albitrunca* are edible or are used to produce a sweet drink made by mixing the berries with water or milk or used as a flavoring agent [30-33]. The roots, bark, or fruits of *B. albitrunca* are dried, roasted, and pounded and used as substitute for chicory, coffee, or tea [2,25,34]. However, Steyn [34] argued that drinking this tea or coffee prepared from *B. albitrunca* bark, fruits of leaves causes severe nausea and other gastrointestinal troubles, especially in the novice. In Botswana and Namibia, roots of *B.* albitrunca are used to preserve fermented milk and also serve as a flavoring agent [24,31,32]. In Botswana and Swaziland, bark of *B. albitrunca* is used as a dye or a tannin [13,17]. *B. albitrunca* is managed in home gardens as herbal medicine in the Limpopo Province in South Africa [35]. Roots of *B. albitrunca* are sold in informal herbal medicine markets in South Africa [36-38] and Zimbabwe [36] as herbal medicine. *B. albitrunca* appears to be an important source of herbal medicine within its distributional range in Southern Africa and therefore, there is need for formal documentation and systematic research which is beneficial to indigenous and traditional systems of herbal medicine [29,39,40]. It is within this context that this review was undertaken aimed at reviewing the botany, medicinal uses, and biological activities of *B. albitrunca* so as to provide baseline data required in evaluating the therapeutic potential of the species.

BOTANICAL PROFILE OF *B. ALBITRUNCA*

The genus name *Boscia* Lam. is in honor of a French naturalist, botanist, zoologist, and horticulturist Louis Auguste Guillaume Bosc (1759–1828) [41]. The species name "*albitrunca*" is a contraction of two Latin words "*albi*" which means "white" and "*trunca*" which means "trunk" in reference to the whitish trunk of the young branches of the species [42,43]. *B. albitrunca* is commonly referred to as "shepherd tree" in English because the evergreen crown of the species cast a small but deep shadow in which for centuries shepherds and their flocks have rested [44]. Synonyms of *B. albitrunca* include *Boscia puberula Pax*., *Boscia pechuelii Kuntze*, *Boscia transvaalensis* Pestal., *Capparis albitrunca* Burch., and *Capparis punctata* Burch. [22,43-54]. *B. albitrunca* is a stocky, small evergreen tree, growing up to 9 m in height with a round, much-branched crown, and rigid branchlets [14,55,56]. The bark is smooth, gray to whitish-gray in color. The leaves are often clustered on reduced shoots, oblanceolate to elliptic in shape, leathery, and gray-green to green in color above and below. The flowers are small, sweetly scented, and yellowish-green in color, occurring in dense clusters on short lateral shoots. The fruit is a berry, which is spherical in shape, hairless and yellowish in color. This species has been recorded in Angola, Botswana, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe [45-54]. The species has been recorded in dry, open woodland, bushveld, semi-desert areas and often on termitaria in sandy, and loamy and calcrete soils [6] at an altitude ranging from 5 m to 1850 m above sea level [48].

MEDICINAL USES OF *B. ALBITRUNCA*

Ethnomedicinal information on *B. albitrunca* has been found in Botswana, Namibia, South Africa, Swaziland, and Zambia, representing 75.0% of the countries where the species is indigenous. The country with the highest ethnomedicinal uses is South Africa with 11 literature records, followed by Namibia with nine literature records, Mozambique with four literature records, Botswana, Swaziland and Zambia with three literature records each (Table 1). The bark, leaves, and roots of *B. albitrunca* are mainly used as herbal medicines for constipation, epilepsy, hemorrhoids, headache, human immunodeficiency virus/acquired immune deficiency syndrome

Table 1: Medicinal applications of *Boscia albitrunca*

Medicinal use	Parts used	Country	References
Constipation	Leaves and roots	Mozambique and Namibia	[32,60]
Diarrhea	Leaves	Mozambique	[61]
Ear problems	Leaves	Namibia	[62]
Emetic	Leaves and roots	Swaziland	[17,63]
Epilepsy	Bark, fruits, leaves, and roots	Namibia, South Africa, and Swaziland	[17,24,29,30,63-67]
Eye problems	Leaves	South Africa	[65]
Galactagogue	Fruits	Namibia	[24]
Haemorrhoids	Fruits, leaves and roots	Botswana, Mozambique, Namibia, South Africa, and Swaziland	[17,30,42,52,55,61,63,65]
Headache	Roots	Namibia and South Africa	[32,68,69]
HIV/AIDS	Mixed with roots of *Elephantorrhiza elephantina* (Burch.) Skeels, *Plectranthus ciliatus* E.Mey., and *Peltophorum africanum* Sond.	South Africa	[57-59]
HIV/AIDS	Roots	South Africa and Zambia	[18,35,70,71]
Hypertension	Roots	South Africa	[72]
Magical purposes	Roots	South Africa	[64]
Muscular pain	Roots	Mozambique	[60]
Respiratory infections	Roots	South Africa	[73]
Skin diseases (chickenpox and rash)	Leaves and roots	Botswana and Namibia	[25,74]
Snakebite	Bark	South Africa	[66]
Syphilis	Leaves, roots, and stems	Namibia and Zambia	[71,74-76]
Ethnoveterinary medicine (anthrax, chicken diseases, fertility, retained placenta, eye, liver, and lung infections)	Bark, leaves, and roots	Botswana, Namibia, South Africa, and Zambia	[42,52,55,77-85]

HIV/AIDS: Human immunodeficiency virus/acquired immune deficiency syndrome

(HIV/AIDS), skin diseases, syphilis, and as ethnoveterinary medicine (Table 1 and Fig. 1). Other minor medicinal uses recorded in a single country or based on a single literature record include ear problems, emetic, eye problems, galactagogue, hypertension, magical purposes, muscular pain, respiratory infections, and snakebite (Table 1). The roots of *B. albitrunca* are mixed with roots of *Elephantorrhiza elephantine* (Burch.) Skeels, *Plectranthus ciliatus* E.Mey., and *Peltophorum africanum* Sond. as herbal medicine for HIV/AIDS [57-59].

PHYTOCHEMICAL AND MINERAL COMPOSITION OF *B. ALBITRUNCA*

Table 2 provides values of macro- and micro-elements, rare earth, and trace elements and nutritional composition of leaves, roots, stems, and twigs of *B. albitrunca* (Table 2). Pendota *et al*. [65] identified a phenolic compound martynoside (3-hydroxy-4-methoxyphenethyl 3-O-α-L-rhamnopyranosyl-4-O-(3-methoxy-4-hydroxy-trans-cinnamoyl)-β-D-glucopyranoside) from leaves of *B. albitrunca*. Iikasha [86] and Iikasha *et al.* [87] isolated alkaloids, coumarins, flavonoids, saponins, steroids, tannins, and triterpernoids from leaves of *B. albitrunca*. Future research should focus on evaluating the biological activities of the isolated compounds.

BIOLOGICAL ACTIVITIES OF *B. ALBITRUNCA*

The following biological activities have been reported from leaf and fruit extracts of *B. albitrunca* and the compound martynoside isolated from the species: Antibacterial [65,86,87,94,95] and antifungal [65,94] activities.

Antibacterial activities

Pendota *et al*. [65] evaluated antibacterial activities of crude, dichloromethane, ethyl acetate, and butanol leaf extracts of *B. albitrunca* and the compound martynoside isolated from the species against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* using the microdilution technique with neomycin (0.1 mg/mL) as a positive control. The extracts exhibited

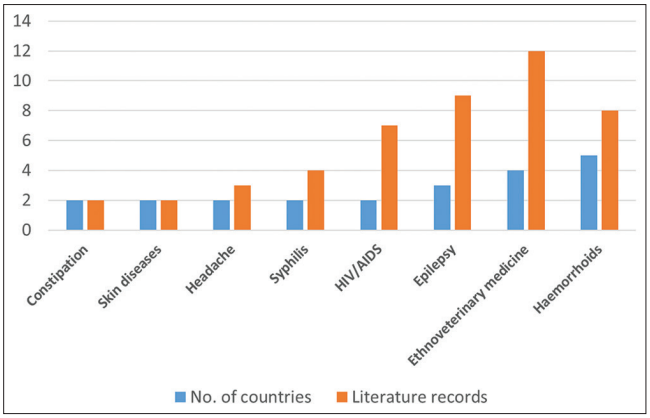

Fig. 1: Medicinal applications of Boscia albitrunca derived from literature records

activities with minimum inhibitory concentration (MIC) values ranging from 390.0 µg/mL to 6250.0 µg/mL, while the compound martynoside exhibited MIC values ranging from 7.8 µg/mL to 125.0 µg/mL and the positive control exhibited MIC values ranging from 0.4 µg/mL to 1.6 µg/mL [65]. Pendota *et al*. [94] evaluated antibacterial activities of 80% ethanol extracts of *B. albitrunca* seedlings grown under different environmental conditions such as smoke, water, nutrient levels, and nutrient deficiency treatments. The antibacterial activities were evaluated against *B. subtilis*, *S. aureus*, *E. coli*, and *K. pneumoniae* using the microdilution assay with neomycin (0.1 mg/ml) as a positive control. The extracts exhibited activities with MIC values ranging from 0.4 mg/ml to 6.3 mg/ml, while the control exhibited MIC values ranging from 0.4 µg/ml to 1.6 µg/ml [94]. Iikasha [86] and Iikasha *et al*. [87] evaluated antibacterial activities of aqueous and organic leaf extracts of *B. albitrunca* against *E. coli*, *Shigella boydii*, *S. aureus*, *Salmonella typhi*, and *Listeria monocytogenes* using the disc and broth dilution methods with vancomycin (10 µg), gentamycin (30 µg), tetracycline (35 µg),

Table 2: Phytochemical and mineral composition of *Boscia albitrunca*

Phytochemical and mineral composition	Values	Plant parts	References
Acid detergent fiber (g/kg of dry matter)	281.6–292.2	Leaves and stems	[88,89]
Acid detergent lignin (g/kg of dry matter)	128.5–140.0	Leaves and stems	[88,89]
Aluminium (ppm)	3481.9	Leaves	[90]
Antimony (ppm)	0.1	Leaves	[90]
Arsenic (ppm)	1.2	Leaves	[90]
Ash (g/100 g)	1.8	Roots	[91,92]
Barium (ppm)	357.0	Leaves	[90]
Beryllium (ppm)	0.1	Leaves	[90]
Bismuth (ppm)	0.04	Leaves	[90]
Boron (ppm)	406.0	Leaves	[90]
Caesium (ppm)	1.9	Leaves	[90]
Calcium (mg/100 g)	63.6	Roots	[91,92]
Carbohydrates (g/100 g)	19.8	Roots	[91,92]
Cerium (ppm)	5.7	Leaves	[90]
Chromium (ppm)	59.0	Leaves	[90]
Cobalt (ppm)	2.8	Leaves	[90]
Copper (mg/100 g)	0.08	Roots	[91,92]
Crude fiber (g/100 g)	3.6	Roots	[91,92]
Crude protein (g/kg of dry matter)	195.8–253.3	Leaves and stems	[88,89]
Dry matter digestibility (%)	68.9	Leaves and twigs	[93]
Dysprosium (ppm)	0.4	Leaves	[90]
Energy (kj/100 g)	449.0	Roots	[91,92]
Erbium (ppm)	0.2	Leaves	[90]
Europium (ppm)	0.3	Leaves	[90]
Fat (g/100 g)	0.2	Roots	[91,92]
Gadolinium (ppm)	0.5	Leaves	[90]
Gallium (ppm)	1.9	Leaves	[90]
Germanium (ppm)	0.02	Leaves	[90]
Gold (ppb)	5.4	Leaves	[90]
Hafnium (ppm)	0.02	Leaves	[90]
Holmium (ppm)	0.1	Leaves	[90]
Indium (ppm)	0.1	Leaves	[90]
In vitro dry matter digestibility (g/kg of dry matter)	558.4±21.4	Leaves and stems	[88]
Iron (mg/100 g)	0.4	Roots	[91,92]
Lanthanum (ppm)	4.2	Leaves	[90]
Lead (ppm)	12.1	Leaves	[90]
Lithium (ppm)	5.6	Leaves	[90]
Lutetium (ppm)	0.02	Leaves	[90]
Magnesium (mg/100 g)	75.8	Roots	[91,92]
Manganese (ppm)	879.5	Leaves	[90]
Mercury (ppm)	1.3	Leaves	[90]
Moisture (g/100 g)	68.1	Roots	[91,92]
Neodymium (ppm)	2.7	Leaves	[90]
Neutral detergent fiber (g/kg of dry matter)	369.2–428.8	Leaves and stems	[88,89]
Neutral detergent insoluble (g/kg of dry matter)	8.3±1.2	Leaves and stems	[88]
Nickel (ppm)	75.7	Leaves	[90]
Nicotinic acid (mg/100 g)	0.2	Roots	[91,92]
Niobium (ppm)	0.4	Leaves	[90]
Organic matter (g/kg of dry matter)	924.4	Leaves	[89]
Palladium (ppm)	0.04	Leaves	[90]
Phosphorus (mg/100 g)	14.4	Roots	[91,92]
Potassium (mg/100 g)	504.0	Roots	[91,92]
Praseodymium (ppm)	0.8	Leaves	[90]
Protein (g/100 g)	6.5	Roots	[91,92]
Riboflavin (mg/100 g)	0.03	Roots	[91,92]
Rubidium (ppm)	31.5	Leaves	[90]
Scandium (ppm)	0.9	Leaves	[90]
Selenium (ppm)	2.8	Leaves	[90]
Silver (ppm)	0.2	Leaves	[90]
Sodium (mg/100 g)	37.2	Roots	[91,92]
Strontium (ppm)	627.8	Leaves	[90]
Sulphur (%)	1.0	Leaves	[90]
Tannin (%)	68.9	Leaves and twigs	[93]
Tantalum (ppm)	0.003	Leaves	[90]
Tellurium (ppm)	0.1	Leaves	[90]
Terbium (ppm)	0.1	Leaves	[90]
Thallium (ppm)	0.01	Leaves	[90]
Thiamin (mg/100 g)	0.02	Roots	[91,92]
Thorium (ppm)	0.7	Leaves	[90]
Thulium (ppm)	0.03	Leaves	[90]
Tin (ppm)	0.3	Leaves	[90]

(Contd...)

Table 2: Phytochemical and mineral composition of *Boscia albitrunca(Continued)*

Phytochemical and mineral composition	Values	Plant parts	References
Titanium (ppm)	144.0	Leaves	[90]
Total phenol (g/kg of dry matter)	24.7	Leaves	[89]
Total tannin (g/kg of dry matter)	9.1	Leaves	[89]
Tungsten (ppm)	0.6	Leaves	[90]
Uranium (ppm)	0.1	Leaves	[90]
Vanadium (ppm)	8.2	Leaves	[90]
Vitamin C (mg/100 g)	6.6	Roots	[91,92]
Ytterbium (ppm)	0.1	Leaves	[90]
Yttrium (ppm)	2.2	Leaves	[90]
Zinc (mg/100 g)	0.8	Roots	[91,92]
Zirconium (ppm)	0.6	Leaves	[90]

and ampicillin (15 µg/ml) as positive controls. The extracts exhibited activities with MIC values ranging from 125.0 µg/ml to >1000.0 µg/ml against the tested pathogens [86,87]. Tshikalange *et al*. [95] evaluated antibacterial activities of crude fruit extracts of *B. albitrunca* against *Salmonella typhimurium*, *Streptococcus pyogenes*, *Bacillus cereus*, *K. pneumonia*, and *Privotella intermedia* using microdilution technique. The extract exhibited activities with MIC values ranging from 6.3 mg/mL to >25.0 mg/mL and minimum bactericidal concentration (MBC) values ranging from 12.5 mg/mL to >25.0 mg/mL against the tested pathogens [95].

Antifungal activities

Pendota *et al*. [65] evaluated antifungal activities of crude, dichloromethane, ethyl acetate, and butanol leaf extracts of *B. albitrunca* and the compound martynoside isolated from the species against *Candida albicans* using the microdilution technique with amphotericin B (0.1 mg/ml) as a positive control. The extracts exhibited activities with MIC and minimum fungicidal concentration (MFC) values ranging from 390.0 µg/mL to 6250.0 µg/mL and 780.0 µg/mL to 6250.0 µg/mL, respectively, while the compound martynoside exhibited MIC and MFC values ranging from 62.5 µg/mL to 250.0 µg/mL and the positive control exhibited MIC and MFC values of 0.2 µg/mL and 9.8 µg/mL, respectively [65]. Pendota *et al*. [94] evaluated antifungal activities of 80% ethanol extracts of *B. albitrunca* seedlings grown under different environmental conditions such as smoke, water, nutrient levels, and nutrient deficiency treatments. The antifungal activities were evaluated against *C. albicans* using the microdilution assay with amphotericin B (0.1 mg/ml) as a positive control. The extracts exhibited activities with MIC values ranging from 0.4 mg/ml to 6.3 mg/ml, MFC values ranged from 0.4 mg/ml to 6.3 mg/ml, while the control exhibited MIC and MFC values of 0.2 µg/ml and 9.8 µg/ml, respectively [94].

CONCLUSION

The present review summarizes the ethnomedicinal uses, phytochemistry, and biological activities of the bark, leaves, root bark, and roots extracts of *B. albitrunca.* The historical traditional usage of *B. albitrunca* as herbal medicine in Southern Africa calls for detailed phytochemical and pharmacological studies aimed at correlating its documented ethnomedicinal uses with the phytochemical and pharmacological properties of the species. There is need for clinical and toxicological evaluations of both crude extracts and phytochemical compounds associated with *B. albitrunca*.

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AUTHOR'S CONTRIBUTIONS

The author declares that this work was done by the author named in this article.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest regarding the publication of this paper.

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