

Boscia coriacea, *B. foetida* and *B. mossambicensis*: comparative analysis of their medicinal uses and ethnopharmacological properties

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Abstract

Boscia coriacea, *B. foetida* and *B. mossambicensis* have a long history of medicinal use in tropical Africa. There is need to evaluate the existence of any correlation between the ethnomedicinal uses, phytochemistry and pharmacological properties of the species. Therefore, in this review, an analytical analysis of the botanical, medicinal and phytochemical properties of *B. coriacea*, *B. foetida* and *B. mossambicensis* is presented. Information on the botany, medicinal uses and phytochemistry of *B. coriacea*, *B. foetida* and *B. mossambicensis* was assembled from several internet sources which included Scopus, Google Scholar, Elsevier, Science Direct, Web of Science, Pubmed, SciFinder and BMC. Additional information was gathered from journal articles, scientific reports, theses, books and book chapters obtained from the University library. This study showed that alkaloids, cardiac glycosides, flavonoids, tannins and tocopherols have been identified from the leaves, stems and twigs of *B. coriacea*, *B. foetida* and *B. mossambicensis*. The three species are used as primary sources of traditional medicines for gastro-intestinal problems, malaria, respiratory problems and as ethnoveterinary medicines. For local communities to use *B. coriacea*, *B. foetida* and *B. mossambicensis* extracts as herbal medicines with confidence there is need for extensive phytochemical and pharmacological evaluations of the species. Further research is required to establish the safety profiles of different *B. coriacea*, *B. foetida* and *B. mossambicensis* preparations.

Keywords: *Boscia coriacea*, *Boscia foetida*, *Boscia mossambicensis*, Capparaceae, ethnopharmacology, herbal medicine

INTRODUCTION

The genus *Boscia* Lam. is a member of the Capparaceae or Capparidaceae or caper family. The genus consists of shrubs or small trees of about 37 species, distributed in tropical and southern Africa, a few in Madagascar, one confined to Arabia, mostly in semi-arid or seasonally dry areas.¹⁻³ The genus name *Boscia* is in honour of a French naturalist, botanist, zoologist and horticulturist Louis Auguste Guillaume Bosc (1759-1828).⁴ Several *Boscia* species are used as herbal medicines in tropical Africa and these include *B. albitrunca* (Burch.) Gilg & Gilg-Ben., *B. angustifolia* A. Rich., *B. coriacea* Graells, *B. foetida* Schinz, *B. longifolia* Hadj-Moust., *B. madagascariensis* (DC.) Hadj-Moust., *B. mossambicensis* Klotzsch., *B. plantefolii* Hadj-Moust., *B. salicifolia* Oliv. and *B. senegalensis* Lam.^{5,6} Iwu⁷ argued that the medicinal properties of *Boscia* species could be attributed to alkaloids, flavonoids, sesquiterpenes and their glycosides, sulphur compounds and lipids that are associated with the genus. The present study is focusing on *B. coriacea*, *B. foetida* and *B. mossambicensis*, three species that are categorized as multipurpose species and regarded as good browse with palatable fruits.⁸ In Kenya, *B. coriacea* is categorized as a multipurpose plant species used as a source of firewood, construction materials, timber, edible fruits, ethnoveterinary medicine, herbal medicine, fodder, bee forage, shade, toothbrush and disinfecting agent.⁹⁻¹² In Ethiopia, the berries of *B. coriacea* are popular with children and usually boiled and water changes made to eliminate bitterness.¹³⁻¹⁶ In Namibia and South Africa, the berries and roots of *B. foetida* are edible.¹⁷⁻²² The fruits and roots of *B. foetida* are dried, roasted and pounded, and used as substitute for coffee.^{20,21,23,24} In Namibia, the roots of *B. foetida* are pounded and cooked into porridge.^{20,21}

The fruits of *B. foetida* are used to produce a sweet drink made by mixing the berries with water or milk or used as a food flavouring agent.²⁴ In Botswana and Namibia, *B. foetida* is regarded as a valuable browse and shade tree.^{25,26} *Boscia foetida* is regarded as a valuable traditional medicine in southern Africa, as roots of the species are sold as herbal medicines in informal herbal medicine markets in Mozambique²⁷ and South Africa.²⁸ In Ethiopia, *B. mossambicensis* is categorized as a multipurpose species, used as fodder, herbal medicine, ritual purposes, shade, source of construction materials and firewood.²⁹⁻³¹ The fruits and roots of *B. mossambicensis* are sold as herbal medicines in informal herbal medicine markets in Mozambique.²⁷ *Boscia coriacea*, *B. foetida* and *B. mossambicensis* appear to be important sources of traditional medicines within their distributional ranges in Africa, and therefore, there is need for formal documentation and systematic research which is beneficial to indigenous and traditional systems of herbal medicine. It is within this context that this review was undertaken aimed at reviewing the medicinal uses and ethnopharmacological properties *B. coriacea*, *B. foetida* and *B. mossambicensis* so as to provide baseline data required in evaluating the therapeutic potential of the species.

Botanical profiles of *B. coriacea*, *B. foetida* and *B. mossambicensis*

Boscia coriacea is associated with the following synonyms: *B. flavescens* Mattei, *B. paolii* Chiov., *B. pungens* Gilg, *B. somalensis* Gilg, *B. teitensis* Gilg and *B. xylophylla* Gilg.³²⁻³⁵ *Boscia coriacea* is an evergreen multi-stemmed shrub or small tree with twiggy branches growing up to 8 metres in height.³²⁻³⁵ The leaves of the

species are lanceolate to ovate in shape, hard and leathery, dark green in colour, the tip sharply pointed and the edge pale and thick and midrib clear below. The flowers are small, occurring in dense clusters on short terminal lateral shoots and yellow-green in colour. The fruit is a berry, which is spherical in shape, hairy, light green when young and becoming brown when ripe. *Boscia coriacea* has been recorded in Djibouti, Ethiopia, Somalia, South Sudan, Sudan, Tanzania and Uganda.³²⁻³⁵ The species has been recorded in deciduous bushland, semi-desert scrub and grassland and arid coastal lowlands in loose red clay or sandy soils with 300 mm to 500 mm of annual rainfall at an altitude of up to 1600 m above sea level.³²⁻³⁵

Boscia foetida is commonly known as the “stink shepherd’s tree” or the “evil-smelling boscia” as the scientific name suggests, that is, “foetida” as the name is derived from “foetid” which means “bad smelling”. *Boscia foetida* is divided into five subspecies, separated on the basis of their geographical distribution and the number of stamens in the flower. *Boscia foetida* subsp. *filipes* (Gilg) M.C. Lötter has been recorded in Mozambique, South Africa and Swaziland, subsp. *foetida* (Namibia and South Africa), subsp. *longipedicellata* (Gilg) Toelken (South Africa), subsp. *minima* (Gilg) M.C. Lötter (South Africa) and subsp. *rehmanniana* (Pestal.) Toelken (Botswana, South Africa and Zimbabwe).^{32,36,37} *Boscia foetida* is a shrub or small tree growing up to 10 metres in height and stems unpleasantly scented when cut.^{32,36-38} The leaves are linear to oblanceolate in shape, leathery, dark green to grey-green in colour on both surfaces. The flowers are small, unpleasantly scented and yellowish green in colour, occurring in dense clusters on short terminal lateral shoots. The fruit is a berry, which is spherical in shape, densely covered with hairs and velvety yellowish in colour. *Boscia foetida* has been recorded on stony or rocky ridges in karroid, semi-desert areas, dry bushveld and on termite mounds at an altitude ranging from 50 m to 1400 m above sea level.^{32,36-38}

The specific name of *B. mossambicensis* means “of Mozambique” where the tree species was first collected.²³ *Boscia mossambicensis* is commonly known as the “broad-leaved shepherds tree”. Synonyms associated with *B. mossambicensis* include *B. carsonii* Baker, *B. elegans* Gilg, *B. grandiflora* Gilg, *B. gymnosporiifolia* Chiov., *B. hildebrandtii* Gilg, *B. holzii* Gilg & Gilg-Ben., *B. pachyandra* Gilg, *B. uhligii* Gilg & Gilg-Ben., *B.*

viridiflava Gilg & Gilg-Ben. and *B. zimmereri* Gilg & Winkl. *Boscia mossambicensis* is a dense deciduous shrub or small tree with several rigid stems arising from the base which can grow to a height of 6 metres.^{32,37} The bole and branches have rough and flaking grey-brown bark characterized by an unpleasant smell when broken. The leaves occur in clusters, are broadly elliptic to obovate in shape, leathery, dark green above and paler green below. The flowers are small and whitish-green in colour, occurring in dense clusters on short terminal lateral shoots. The fruit is a berry, which is spherical in shape, hairless and yellowish to red in colour. *Boscia mossambicensis* has been recorded in Botswana, Democratic Republic of Congo, Ethiopia, Kenya, Mozambique, Namibia, Somalia, South Africa, Tanzania, Zambia and Zimbabwe.^{32,37,38} The species has been recorded in dry low-altitude bushveld, deciduous woodland, thicket and grassland at an altitude ranging from 305 m to 1500 m above sea level.^{32,37,38}

Medicinal uses of *B. coriacea*, *B. foetida* and *B. mossambicensis*

The medicinal uses of *B. coriacea*, *B. foetida* and *B. mossambicensis* are referred to in many folkloric and ethnobotanical studies carried out in tropical Africa where the species are used as primary sources of traditional medicines (Table 1). In Ethiopia and Kenya, the fruits, leaves and roots of *B. coriacea* are used as herbal medicines for diarrhoea, dyspepsia and stomachache³⁹⁻⁴¹ while bark and roots of the same species are used as herbal medicines for malaria.^{39,42,43} In Ethiopia and Kenya, the leaves, roots and seeds of *B. coriacea* are used as ethnoveterinary medicines for anthrax, babesiosis, bile problems, blackleg, eye problems and retained placenta.^{41,44-47} The leaves and twigs of *B. foetida* are used as herbal medicines for back pain in Namibia and South Africa^{20,21,48,49} while leaves, roots and twigs of the same species are used as herbal medicine for stomach problems in Mozambique, Namibia and South Africa.^{20,21,48-51} The hypogenous organs and roots of *B. mossambicensis* are used as herbal medicines for diarrhoea and stomachache in Angola and Zambia^{52,53} while the leaves and roots of the same species are used as herbal medicines for chest pains and sinusitis in Ethiopia and Zambia.^{52,54}

Table 1: Medicinal applications of *B. coriacea*, *B. foetida* and *B. mossambicensis*

Medicinal use	Parts used	Country	References
<i>B. coriacea</i>			
Body pains	Bark	Kenya	Wanzala et al. ⁴³
Burns	Roots	Kenya	Fratkin ⁴²
Controlling appetite	Roots	Ethiopia	Quattrocchi ⁴
Gastro-intestinal problems (diarrhoea, dyspepsia and stomachache)	Fruits, leaves and roots	Ethiopia and Kenya	Teklehaymanot and Giday ³⁹ ; Kaigongi and Musila ⁴⁰ ; Teklehaymanot ⁴¹
Ear problems	Roots	Ethiopia	Teklehaymanot and Giday ³⁹
Ectoparasites (fleas and mites)	Tubers	Kenya	Kaigongi and Musila ⁴⁰
Gonorrhoea	Roots	Ethiopia	Quattrocchi ⁴
Headache	Roots	Ethiopia	Quattrocchi ⁴

Medicinal use	Parts used	Country	References
Impotence	Roots	Kenya	Kipkorir and Wandibba ¹²
Jaundice		Ethiopia	Abdoul-Latif et al. ⁵⁵
Leprosy	Roots	Ethiopia	Teklehaymanot ⁴¹
Respiratory problems (colds and lung infections)	Leaves and roots	Ethiopia	Teklehaymanot ⁴¹ ; Meragiaw ⁵⁶
Magical purposes (evil spirits)	Leaves	Ethiopia	Meragiaw ⁵⁶
Malaria	Bark and roots	Ethiopia and Kenya	Teklehaymanot and Giday ³⁹ ; Fratkin ⁴² ; Wanzala et al. ⁴³
Obesity	Seeds	Kenya	Kipkore et al. ⁵⁷
Snake bite	Fruits and leaves	Ethiopia	Teklehaymanot ⁴¹
Yellow fever	Bark	Ethiopia	Quattrocchi ⁴
Ethnoveterinary medicine (anthrax, babesiosis, bile problems, blackleg, eye problems and retained placenta)	Leaves, roots and seeds	Ethiopia and Kenya	Teklehaymanot ⁴¹ ; Njoroge et al. ⁴⁴ ; Giday and Teklehaymanot ⁴⁵ ; Dharani et al. ⁴⁶ ; Asmare et al. ⁴⁷
Anthrax	Leaves mixed with fruits of <i>Solanum incanum</i> L.	Ethiopia	Quattrocchi ⁴
<i>B. foetida</i>			
Back pain	Leaves and Twigs	Namibia and South Africa	Van Damme et al. ²⁰ ; Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸ ; Philander ⁴⁹
Colds	Leaves and twigs	Namibia	Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸ ; Philander ⁴⁹ ; Van den Eynden and Van Dammen ⁵⁰
Ear problems	Leaves and twigs	Namibia	Van Damme et al. ²⁰ ; Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸ ; Van den Eynden and Van Dammen ⁵⁰
Eye problems	Leaves and twigs	Namibia	Van Damme et al. ²⁰ ; Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸ ; Van den Eynden and Van Dammen ⁵⁰
Galactagogue	Leaves	Namibia	Van Damme et al. ²⁰ ; Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸
Impotence (aphrodisiac)	Roots	Nigeria	Kokwaro ⁵⁸
Impotence (dysfunction)	Roots mixed with those of <i>Uvaria leptopoda</i> (King) R.E. Fr. and <i>Combretum hereroense</i> Schinz	Kenya	Kaingu et al. ⁵⁹
Kidney problems	Roots	Mozambique	Ribeiro et al. ⁵¹
Magical purposes (used against lightning)	Flowers	South Africa	Koopman ⁶⁰
Menstrual problems	Roots	South Africa	Van Wyk and Gericke ⁶¹
Stomach problems	Leaves, roots and twigs	Mozambique, Namibia and South Africa	Van Damme et al. ²⁰ ; Van Damme and Van Den Eynden ²¹ ; Du Pisani ⁴⁸ ; Van den Eynden and Van Dammen ⁵⁰ ; Philander ⁴⁹ ; Ribeiro et al. ⁵¹
Womb problems	Leaves	South Africa	Philander ⁴⁹
Ethnoveterinary medicine (eye problems)	Leaves	Botswana	Gabalebatse et al. ⁶² ; Madibela ⁶³
<i>B. mossambicensis</i>			
Anthelmintic	Hypogenous organs	Angola	Urso et al. ⁵³
Gastro-intestinal problems (diarrhoea and stomachache)	Hypogenous organs and roots	Angola and Zambia	Reynolds ⁵² ; Urso et al. ⁵³
Epilepsy	Roots	Ethiopia	Mekuanent et al. ⁵⁴
Evil eye	Roots	Ethiopia	Mekuanent et al. ⁵⁴
Eye problems	Roots	Mozambique	Ribeiro et al. ⁵¹
Haematuria	Leaves	Zambia	Fowler ⁶⁴ ; Fowler ⁶⁵
Joint pain	Roots	Ethiopia	Mekuanent et al. ⁵⁴
Magical purposes (bad dreams)	Leaves	Zambia	Reynolds ⁵²
Respiratory problems (chest pains and sinusitis)	Leaves and roots	Ethiopia and Zambia	Reynolds ⁵² ; Mekuanent et al. ⁵⁴
Sexual stimulant	Hypogenous organs	Angola	Urso et al. ⁵³
Swelling	Roots	Ethiopia	Gidey et al. ³¹
Toothache	Leaves	Zambia	Fowler ⁶⁴ ; Fowler ⁶⁵

Phytochemistry of *B. coriacea*, *B. foetida* and *B. mossambicensis*

Some phytochemical constituents including alkaloids, cardiac glycosides, flavonoids and tannins have been identified from the leaves, stems and twigs of *B. coriacea*, *B. foetida* and *B. mossambicensis*⁶⁶⁻⁷¹ (Table 2). There appear to be similarities in terms of the content of acid detergent fibre, crude protein and neutral detergent fibre of *B. coriacea*, *B. foetida* and *B. mossambicensis* (Table 2). Further phytochemical evaluations of *B. coriacea*, *B. foetida* and *B. mossambicensis* are required as some of the pharmacological activities associated with the species could be attributed to the phytochemical compounds of the species.

Antifungal activities of *B. coriacea*

Kiswii et al.⁷¹ evaluated antifungal activities of methanol leaf and bark extracts of *B. coriacea* against *Aspergillus flavus* using micro-dilution method with meconazole (10 mg/ml) as a positive control. The extracts exhibited activities with zone of inhibition ranging from 13.2 mm to 24.4 mm which was comparable to 17.4 mm to 19.4 mm exhibited by the positive control. The minimum inhibition concentrations (MIC) values ranged from 6.3 mg/ml to 12.5 mg/ml while the minimum fungicidal concentrations (MFC) exhibited by the extracts was 12.5 mg/ml and the control exhibited MIC and MFC value of 10.0 mg/ml.⁷¹

Table 2: Phytochemical composition of *B. coriacea*, *B. foetida* and *B. mossambicensis*

Phytochemical compound	Plant part	<i>B. coriacea</i>	<i>B. foetida</i>	<i>B. mossambicensis</i>	Reference
α -tocopherols ($\mu\text{g/g}$ dry matter)	Leaves and twigs	-	-	13.9 – 29.4	Dierenfeld et al. ⁶⁶
γ -tocopherols ($\mu\text{g/g}$ dry matter)	Leaves and twigs	-	-	0.4 – 1.5	Dierenfeld et al. ⁶⁶
Acid detergent crude protein (%)	Leaves and twigs	-	-	1.3 – 3.6	Dierenfeld et al. ⁶⁶
Acid detergent fibre (%)	Leaves and twigs	34.7	37.1 – 45.5	40.0 – 45.4	Dierenfeld et al. ⁶⁶ ; Aganga et al. ⁶⁹ ; Kuria et al. ⁷⁰
Acidic detergent lignin (g/kg dry matter)	Leaves and stems	129.0	136.0 – 222.0	-	Havenga et al. ⁶⁸ ; Kuria et al. ⁷⁰
Ash (%)	Leaves and twigs	18.1	5.3 - 6.4	5.6 – 9.3	Dierenfeld et al. ⁶⁶ ; Aganga et al. ⁶⁹ ; Kuria et al. ⁷⁰
Calcium (g/kg dry matter)	Leaves, stems and twigs	-	3.2 – 6.3	6.0	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸
Crude protein (%)	Leaves, stems and twigs	14.5	7.8 – 40.5	14.6 - 18.4	Dierenfeld et al. ⁶⁶ ; Aganga-Bessa ⁶⁷ ; Havenga et al. ⁶⁸ ; Aganga et al. ⁶⁹ ; Kuria et al. ⁷⁰
Condensed tannin (%)	Leaves and twigs	-	0.3	-	Aganga-Bessa, 1999
Copper (g/kg dry matter)	Leaves, stems and twigs	-	3.0 – 9.8	4.6	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸
Dry matter (%)	Leaves and twigs	68.7	36.3 – 63.4	-	Aganga et al. ⁶⁹ ; Kuria et al. ⁷⁰
Dry matter digestibility (%)	Leaves and twigs	-	44.4	-	Aganga-Bessa, 1999
In vitro digestible organic matter (g/kg dry matter)	Leaves and stems	-	215.0 – 479.0	-	Havenga et al. ⁶⁸
Iron (% dry matter)	Leaves and twigs	-	-	104.0	Dierenfeld et al. ⁶⁶
Magnesium (g/kg dry matter)	Leaves, stems and twigs	-	0.9 – 3.8	3.0	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸
Manganese (g/kg dry matter)	Leaves, stems and twigs	-	22.0 – 133.0	191.0	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸
Neutral detergent fibre (g/kg dry matter)	Leaves, stems and twigs	547.0	507.0 – 760.0	489.0 – 719.0	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸ ; Aganga et al. ⁶⁹ ; Kuria et al. ⁷⁰
Phosphorus (g/kg dry matter)	Leaves, stems and twigs	-	0.6 – 0.9	1.0	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸
Potassium (% dry matter)	Leaves and twigs	-	-	1.6	Dierenfeld et al. ⁶⁶
Sodium (% dry matter)	Leaves and twigs	-	-	0.002	Dierenfeld et al. ⁶⁶
Sulfuric acid lignin (%)	Leaves and twigs	-	-	9.5 – 18.5	Dierenfeld et al. ⁶⁶
Total tannin (%)	Leaves and twigs	-	0.4	-	Aganga-Bessa, 1999
Vitamin E (IU/kg dry matter)	Leaves and twigs	-	-	33.8	Dierenfeld et al. ⁶⁶
Water (%)	Leaves and twigs	-	-	38.8 – 41.1	Dierenfeld et al. ⁶⁶
Zinc (g/kg dry matter)	Leaves, stems and twigs	-	13.0 – 42.0	10.6	Dierenfeld et al. ⁶⁶ ; Havenga et al. ⁶⁸

Toxicity activities of *B. foetida* extracts

Van Der Walt and Steyn⁷² evaluated toxicity activities of flowers, fruits and leaves of *B. foetida* in sheep. Oral administration of 400 g of leaves and flowers resulted in the death of sheep after 24 hours and death of sheep occurred after receiving 900 g of leaves, flowers and unripe fruits. Postmortem findings revealed haemorrhagic diarrhoea, cyanosis, hydrothorax, hyperaemia, oedema of the lungs, nuclear degeneration of the liver and inactivity in the rumen.⁷²

CONCLUSION

The present review summarizes the botanical, medicinal and phytochemical properties of *B. coriacea*, *B. foetida* and *B. mossambicensis*. Based on presented information, the three species are closely related and deemed as highly potent traditional medicines for gastro-intestinal problems, malaria, respiratory problems and used as ethnoveterinary medicines. *Boscia coriacea*, *B. foetida* and *B. mossambicensis* have overlapping distributional range in tropical Africa and preliminary studies revealed similarities in the phytochemistry of the species. Therefore, these preliminary findings call for advanced phytochemical and pharmacological studies aimed at evaluating variation of these aspects in the three species.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

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