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Review Article

BERCHEMIA ZEYHERI (SOND.) GRUBOV: MEDICINAL USES, PHYTOCHEMISTRY, AND PHARMACOLOGICAL PROPERTIES

ALFRED MAROYI*

Department of Botany, Medicinal Plants and Economic Development Research Centre, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa. Email: amaroyi@ufh.ac.za

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ABSTRACT

Berchemia zeyheri is a small-to-medium-sized deciduous fruit tree widely used as herbal medicine. This study was aimed at providing a critical review of the medicinal uses, phytochemistry, and biological activities of *B. zeyheri*. Documented information on the biological activities, medicinal uses, and phytochemistry of *B. zeyheri* was collected from several online sources which included BMC, Scopus, SciFinder, Google Scholar, ScienceDirect, Elsevier, PubMed, and Web of Science. Additional information on the biological activities, phytochemistry, and medicinal uses of *B. zeyheri* was gathered from pre-electronic sources such as book chapters, books, journal articles, and scientific publications obtained from the university library. This study showed that the bark and roots of *B. zeyheri* are used for magical purposes and as herbal medicine for anemia, backache, baby's navel problems, cough, dysentery, headache, rectal ulcers, stomach problems, tonic, and vomiting and ethnoveterinary medicine for infectious diseases in cattle. Phytochemical analyses revealed that the aerial parts, bark, and heartwood of *B. zeyheri* are characterized by alkaloids, flavonoids, glycosides, polyphenols, and steroids. Pharmacological research revealed that *B. zeyheri* crude extracts have anthelmintic, antibacterial, antioxidant, and toxicity activities. Future ethnopharmacological research should focus on conducting detailed phytochemical, pharmacological, and toxicological studies.

Keywords: *Berchemia zeyheri*, Ethnopharmacology, Herbal medicine, Indigenous pharmacopeia, *Rhamnaceae*.

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INTRODUCTION

Berchemia zeyheri (Sond.) Grubov is a small-to-medium-sized deciduous tree belonging to the *Rhamnaceae* or buckthorn or buffalo-thorn family [1,2]. Koekemoer *et al*. [2] argued that the *Rhamnaceae* family is a large cosmopolitan family of 52 genera and 925 species of mostly trees and shrubs with inconspicuous white or green flowers with their stipules often modified into tendrils or hooked spines. *Rhamnaceae* is an important family for the edible fruits of *Ziziphus* Mill., *Berchemia* Necker ex DC., and *Scutia* Comm. ex Brongn. and the ornamental shrubs *Ceanothus* L. and *Colletia* Comm. ex Juss. [3-11]. *B. zeyheri* is an indigenous African fruit tree species with commercial potential as fresh or dried fruits are used as food additives, jam, and sweets [12]. *B. zeyheri* is categorized as a multipurpose species throughout its distributional range in Southern Africa [13-19] characterized by edible fruits, used as famine food, sweet preserve, fuelwood, charcoal, building materials, fences, commercial source of timber, source of dye, herbal medicine, and as an ornamental plant. The small drupe fruits of *B. zeyheri* have a delicious sweet taste and popular throughout the distributional range of the species [19-54] and also used to make juice and beer [42,46]. In South Africa, the fruits of *B. zeyheri* are stored in baskets until they form a sweet sticky mass that is enjoyed as a sweetmeat [35]. The fruits and leaves of *B. zeyheri* are also used as feed for cattle, goats, and sheep in South Africa [18,25,55-58]. The fruits, craftwork, and ornaments made from *B. zeyheri* are an important source of income for local communities in Southern Africa [19,35]. It is within this context that the current study was undertaken aimed at reviewing the medicinal uses, phytochemistry, and biological activities of *B. zeyheri*.

BOTANICAL PROFILE OF *B. ZEYHERI*

The genus *Berchemia* include about 32 taxa that are distributed mainly in temperate and tropical regions of East to Southeast Asia, Southern Africa, and North America [59-61]. The genus name is in honor of a 17th century Dutch or French botanist, Jacob Pierre Berthoud van Berchem [55,62-67], while the specific epithet is in honor of a German botanist and collector, Carl (Karl) Ludwig Philipp Zeyher [55,63,68-70]. The synonyms of *B. zeyheri* are *Phyllogeiton zeyheri* (Sond.) Suesseng and *Rhamnus zeyheri* Sond. *B. zeyheri* has been recorded in Bushveld, open woodland, often on termite mounds, rocky ridges, or near watercourses in Botswana, Mozambique, South Africa, Swaziland, and Zimbabwe at an altitude ranging from 60 m to 1980 m above sea level [47,71-78].

B. zeyheri has a spreading crown and can reach a height of 13 m with a stem diameter of up to 36 cm [47,71,73,74]. The bark of the tree is gray, and young branchlets are smooth often purplish in color but becoming dark gray and rough and cracked into longitudinal segments in older trees. The leaves are opposite to subopposite, elliptic to ovate in shape, grayish green above, and paler green below. The leaves are hairless with principal lateral veins prominently raised below, ending at the leaf margin. The leaf margins are entire or sometimes finely scalloped between the lateral veins. Flowers of *B. zeyheri* are small, inconspicuous, occurring in a few-flowered axillary clusters and greenish yellowish in color. The fruit is a drupe, ovoid in shape, fleshy, and yellow to brownish-red in color with a single stone [47,71,73,74].

MEDICINAL USES OF *B. ZEYHERI*

The bark and roots of *B. zeyheri* are used as lucky charm and protection against evil spirits [79,80] and as herbal medicine for anemia, backache, baby's navel problems, cough, dysentery, headache, rectal ulcers, stomach problems, tonic, and vomiting and ethnoveterinary medicine for infectious diseases in cattle (Table 1) [19,30,52,55,69,80-94]. In South Africa, the bark of *B. zeyheri* is mixed with that of *Ozoroa paniculosa* (Sond.) R. Fern. and A. Fern. var. *paniculosa* as herbal medicine for dysentery [81,83,84,86,92].

PHYTOCHEMISTRY OF *B. ZEYHERI*

The macronutrients, essential nutrients, and trace elements identified from the fruits of *B. zeyheri* include calcium (Ca), carbohydrates, copper (Cu), fat, fiber, iron (Fe), magnesium (Mg), phosphorus (P), potassium (K),

Table 1: Medicinal uses of *Berchemia zeyheri*

Medicinal use	Parts used	Country	References
Anemia	Roots	Swaziland	[85,89]
Backache	Stembark	Swaziland	[19,52,69,80-85,87,88,91,93]
Baby's navel problems	Roots	Swaziland	[85]
Cough	Stembark	Swaziland	[82]
Dysentery	Bark mixed with that of *Ozoroa paniculosa* (Sond.) R. Fern. and A. Fern. var. *paniculosa*	South Africa	[81,83,84,86,92]
Headache	Roots	South Africa	[55,69]
Lucky charm and protection against evil spirits	Roots	South Africa and Zimbabwe	[79,80]
Rectal ulcers	Stembark	South Africa	[19,81,83,84,88]
Stomach problems	Stembark	South Africa	[80,82]
Tonic		South Africa	[94]
Vomiting	Bark	South Africa	[30]
Ethnoveterinary medicine			
Infectious diseases in cattle	Bark	South Africa	[90]

Table 2: Nutritional composition of *Berchemia zeyheri*

Nutritional composition	Values	Plant parts	References
Ash (g/100 g)	1.1	Fruits	[95]
Calcium (mg/100 g)	75.8	Fruits	[95]
Carbohydrates (g/100 g)	20.7	Fruits	[95]
Carotene (mg/100 g)	0.1	Fruits	[95]
Condensed tannins (%)	5.4	Foliage and fruits	[58]
Copper (mg/100 g)	0.2	Fruits	[95]
Crude fiber (g/100 g)	0.7	Fruits	[95]
Crude protein (%)	15.4	Foliage and fruits	[58]
Energy (kj/100 g)	370	Fruits	[95]
Fat (g/100 g)	0.1	Fruits	[95]
Iron (mg/100 g)	1.0	Fruits	[95]
Magnesium (mg/100 g)	39.2	Fruits	[95]
Moisture (g/100 g)	76.3	Fruits	[95]
Neutral detergent fiber (%)	33.3	Foliage and fruits	[58]
Nicotinic acid (mg/100 g)	0.3	Fruits	[95]
Phosphorus (mg/100 g)	25.0	Fruits	[95]
Potassium (mg/100 g)	313	Fruits	[95]
Protein (g/100 g)	1.1	Fruits	[95]
Riboflavin (mg/100 g)	0.1	Fruits	[95]
Sodium (mg/100 g)	1.3	Fruits	[95]
Thiamin (mg/100 g)	0.1	Fruits	[95]
Vitamin C (mg/100 g)	6.5	Fruits	[95]
Zinc (mg/100 g)	0.2	Fruits	[95]

protein, and zinc (Zn) [58,95] (Table 2). Volsteedt and Roux [96] identified zeyherin from the heartwood of *B. zeyheri.* Bekker [97], Bekker *et al*. [98-104] identified (2R,3S)-4',5,7-tri-O-methylnaringenin-(3α→7)-(2R)-2,4,4',6-tetra-O-methylmaesopsin, (2R,3S)-4',5,7-tri-O-methylnaringenin-(3α→7)-(2S)-2,4,4',6-tetra-O-methylmaesopsin, (2R,3S)-4',5,7-tri-O-methylnaringenin-(3α→5)-(2R)-2,4,4',6-tetra-O-methylmaesopsin, (2R,3S)-4'5,7-tri-O-methylnaringenin-(3α→5)-(2S)-2,4,4',6-tetra-O-methylmaesopsin, (2S,3R)-dihydrogenistein-(2β→7)-(2R)-maesopsin, (2S,3R)-dihydrogenistein-(2β→7)-(2S)-maesopsin, (2S,3R)-4',5,7-tri-O-methyldihydrogenistein-(2α→7)-(2R)-2,4,4',6-tetra-O-methylmaesopsin, (2S,3R)-4',5,7-tri- O-methylnaringenin-(2α→7)-(2S)-2,4,4',6-tetra-O-methylmaesopsin, 2-(4-hydroxybenzyl)-2,4,6-trihydroxybenzo[b] furan-3(2H)-one, 4,4',6-tri-O-methyl-2-deoxymaesopsin-(2→7)-2,4,4',6-tetra-O-methylrnaesopsin, 4,4',6-tri-O-methyl-2-deoxymaesopsin-(2→7)-2,4,4',6-tetra-O-methylmaesopsin, 2,4,4',6-tetra-O-methylmaesopsin, 4,6-dimethoxy-3-(4-methoxybenzyl)benzo[b] furan-2(3H)-one-(2→5)-2,4,4',6-tetra-O-methylmaesopsin, 4,6-dime thoxy-3-(4-methoxybenzyl) benzo[b]furan-2(3H)-one-(2→7)-2,4,4',6-tetra-O-methylmae sopsin, 2-hydroxy-4 ,4',6-tri-O- methylmaesopsin, (R)-2,4,4',6- tetra -O-methylmaesopsin, (S)-2,4,4',6-tetra-O-methyl maesopsin, (2S)-4,4',6-tri-O-methyl -2-deoxymaesopsin-(2→7)-(2R)-2,4,4',6-tetra-O-methylmaesopsin, (2R)-4,4',6-tri-O-methyl-2-deoxymaesopsin-(2→7)-(2S)-2,4,4',6-tetra-O-methylmaesopsin, (2R)-4,4',6-tri-O-methyl-2-deoxymaesopsin-(2→7)-(2R)-2,4,4',6-tetra-O-methylmaesopsin, (2S)-4,4',6-tri-O-methyl-2-deoxymaesopsin-(2→7)-(2S)-2,4,4',6-tetra-O-methylmaesopsin, (2R)-7-[2-(4-methoxyphenyl)ethyl]-2,4,4',6-tetra-O-methylmaesopsin, and (2S)-7-[2-(4-methoxyphenyl)ethyl]-2,4,4',6-tetra-O-methylmaesopsin from the heartwood of *B. zeyheri*. Blunden *et al*. [105,106] identified trans-4-hydroxy-N-methylproline from aerial parts of *B. zeyheri*. Amusan *et al*. [87] identified alkaloids, flavonoids, glycosides, polyphenols, and steroids from the stem bark of *B. zeyheri.*

BIOLOGICAL ACTIVITIES OF *B. ZEYHERI*

The following biological activities have been reported from the bark, fruit, and leaf extracts of *B. zeyheri*: Anthelmintic [106], antibacterial [106], antioxidant [33], and toxicity [107] activities.

Anthelmintic activities

McGaw *et al*. [107] evaluated the anthelmintic activities of aqueous, hexane, and methanol bark extracts of *B. zeyheri* against the free-living nematode *Caenorhabditis elegans*. The hexane and methanol extracts exhibited weak-to-moderate activities by killing 20%–40% of nematodes at a concentration of 0.5 mg/mL and 2.0 mg/mL [107].

Antibacterial activities

McGaw *et al*. [107] evaluated the antibacterial activities of aqueous, methanol, and hexane bark extracts of *B. zeyheri* against *Enterococcus faecalis*, *Escherichia coli, Pseudomonas aeruginosa,* and *Staphylococcus aureus* using the serial microplate dilution method with neomycin as the positive control. The extracts exhibited activities with minimum inhibitory concentration (MIC) values ranging from 0.2 mg/mL to >12.5 mg/mL while the positive control exhibited activities with MIC values ranging from 0.8 mg/mL to 25.0 mg/mL [107].

Antioxidant activities

Ndlala *et al*. [33] evaluated the antioxidant activities of aqueous and methanolic fruit extracts of *B. zeyheri* using the reducing power, superoxide anion radical scavenging effect, 1,1-diphenyl-2-picrylhydrazyl free radical scavenging assay, and the inhibition of phospholipid peroxidation by applying the colorimetric techniques. The extracts of pulps and peels of the species demonstrated high antioxidant activities. At concentrations of 40 mg and 60 mg sample equivalent/µl, the fruit extracts showed a high anion scavenging capacity. The degree of polymerization was 13.0 monomer units of catechin per polymer of phenolic acid compounds in the peels and pulps of the species [33].

Toxicity activities

McGaw *et al*. [107] evaluated toxicity activities of aqueous, methanol, and hexane bark extracts of *B. zeyheri* using the brine shrimp lethality

mortality assay against the larvae of *Artemia salina* with podophyllotoxin as a positive control. Only hexane extract showed activities with median lethal concentration (LC_{50}) value of 3.8 mg/mL while the positive control exhibited LC_{50} value of 7 µg/mL [107]. *B. zeyheri* is potentially unsafe as herbal medicine due to its toxic effects [108,109], but detailed toxicological evaluations are required.

CONCLUSION

The present review summarizes the medicinal uses, phytochemistry, and biological activities of *B. zeyheri*. From a chemical, pharmacological, and toxicological point of view, *B. zeyheri* has not received any major emphasis. Currently, there are not yet enough data on ethnopharmacological evaluations on the species that can be correlated with its medicinal applications. Therefore, detailed phytochemical, pharmacological, and toxicological studies of *B. zeyheri* are recommended.

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AUTHOR'S CONTRIBUTIONS

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

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this paper.

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