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

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Received: 24 June 2019, Revised and Accepted: 08 August 2019

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, Ethnopharmacology, Herbal medicine, Indigenous pharacoepeia, 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 Miller, 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 distributary 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 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 [47,71-73].

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, oval 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                                  | Stem bark                   | Swaziland                | [19,52,69,80,85,87,88,91,93] |
| Baby’s navel problems                     | Roots                       | Swaziland                | [85]       |
| Cough                                     | Stem bark                   | Swaziland                | [82]       |
| Dysentery                                 | Bark mixed with that of Ozoroa paniculosa (Sonnd. 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                             | Stem bark                   | South Africa             | [19,81,83,88] |
| Stomach problems                          | Stembark                    | South Africa             | [80,82]    |
| Tonic                                     | Stembark                    | South Africa             | [94]       |
| Ethnoveterinary medicine                  | Bark                        | South Africa             | [30]       |
| 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)        | 31.3   | 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]       |

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
Ndala 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 assay.
mortality assay against the larva of Artemia salina with podophytoxine as a positive control. Only hexane extract showed activities with median lethal concentration (LC₅₀) value of 3.8 mg/mL while the positive control exhibited LC₅₀ 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.

ACKNOWLEDGMENTS

The author would like to express his gratitude to Govan Mbeki Research and Development Centre, University of Fort Hare, for financial support to conduct this study.

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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