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journal homepage: <http://ees.elsevier.com/apjtm>Review <http://dx.doi.org/10.1016/j.apjtm.2017.01.014>Phytochemical and ethnopharmacological review of *Elephantorrhiza goetzei* (Harms) Harms

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ABSTRACT

Elephantorrhiza goetzei (*E. goetzei*) commonly known as Goetze's elephantorrhiza, is traditionally used as a decoction in the treatment of a variety of conditions such as pain, sores, sexually transmitted infections (STIs), gastro-intestinal disorders, microbial infections and genito-urinary system disorders. On the basis of its wide distribution in south central Africa, *E. goetzei* has a long history of applications among the different ethnic groups. A total of 23 ethnomedicinal uses of *E. goetzei* are documented in this study from 62.5% of the countries where the species is indigenous. Multiple classes of phytochemicals including phenolic compounds, coumarins, flavonoids, saponins, stilbenoids, tannins and triterpenoids have been identified from *E. goetzei* bark, leaves and roots in different investigations. Scientific validation of its diverse uses in traditional medicine has been demonstrated through antibacterial, antifungal, antiviral, anthelmintic, antioxidant and cytotoxicity assays of crude extracts as well as isolated compounds from the species. *E. goetzei* has been widely used as a source of herbal medicine for several years without any adverse effects. In light of its long traditional use and the modern phytochemical and pharmacological evaluations summarized in this study, *E. goetzei* has been demonstrated to show a strong potential for therapeutic and health-maintaining uses. However, there is need for additional studies on the isolated compounds to validate the traditional uses in human models as well as evaluating the possible mechanisms of action. The present review focussing on the biology, traditional uses, phytochemistry and pharmacological properties of *E. goetzei* has provided preliminary information for further studies on the species.

1. Introduction

Traditional medicines play an important role in primary health care of both rural and urban communities as well as the development of pharmaceutical drugs and health products. About 80% of people in rural communities in developing countries rely on traditional medicines [1] as an integral part of their culture and also because traditional medicines are affordable and easily accessible. The world market for herbal medicines including herbal products and raw materials is estimated to be growing at a rate of 15% per annum with large multinational companies interested in commercializing herbal drugs [2]. Pharmaceutical drugs and health products derived from plants are gaining popularity and use worldwide as complementary and alternative health products [1] as well as

nutraceuticals and cosmeceuticals. According to van Wyk *et al.* [3] natural products and their derivatives represent more than 50% of all drugs in clinical use in the world and well-known examples of such plant-derived medicines include quinine, morphine, codeine, aspirin, atropine, reserpine and cocaine. There is a growing realization worldwide that traditional medicines based on indigenous medical systems such as African Traditional Medicine, Ayurveda, Native American Medicine, Traditional Chinese Medicine and Unani are potential sources of natural products that can be developed into pharmaceutical drugs and products. Therefore, the traditional knowledge-inspired natural product drug discovery is re-emerging as an attractive option. But Mukherjee *et al.* [2] argued that the major challenge for the development and promotion of traditional medicine include the chemoprofiling, safety evaluations, quality control and effective regulatory guidelines for traditional medicines. It is within this context that the ethnomedicinal uses of *Elephantorrhiza goetzei* (*E. goetzei*) (Harms) Harms of the Fabaceae family were

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evaluated throughout its distributional range as well as ethnopharmacological evaluations done so far, emphasizing the correlations between the ethnomedicinal uses of the species and its phytochemistry and pharmacological properties.

2. Methodology of the review

The literature search was performed from March to December 2016 using electronic search engines such as Google, Google scholar, publishing sites such as Elsevier, scienceDirect, BioMed Central (BMC) and PubMed. The databases and literature sources were chosen based on the topic covered (*i.e.*, ethnobotany, ethnomedicinal uses, ethnopharmacology, pharmacology, phytochemistry and therapeutic value) and geographical coverage (*i.e.*, Africa). The following keywords were used to search literature sources: *Elephantorrhiza goetzei*, *Elephantorrhiza elongata*, *Elephantorrhiza rubescens*, *Piptadenia goetzei*, long-pod cassia, narrow-rod elephant root, Goetze's elephantorrhiza, narrow-pod elephant-root and false sumach bean. Other literature sources included papers published in international journals, reports from international, regional and national organizations, conference papers, books, theses, websites and other grey literature. References were also identified by searching the library collections of the National Herbarium and Botanic Gardens (SRGH), Harare, Zimbabwe and the University of Fort Hare, South Africa.

3. Species description

E. goetzei, commonly known as Goetze's elephantorrhiza is a small, deciduous tree or shrub growing in Botswana, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. Synonyms of *E. goetzei* include *Elephantorrhiza elongata* Burt Davy, *Elephantorrhiza rubescens* Gibbs and *Piptadenia goetzei* Harms. The generic name 'Elephantorrhiza' means 'elephant root' in reference to large underground stem common to some members of this genus [4]. The specific name '*goetzei*' honours Walter Goetze (1872–1899), a German naturalist, explorer, photographer and collector of botanical and zoological specimens in East Africa who died there in 1899 [4]. *E. goetzei* is multi-stemmed with brown or reddish bark and smooth dark twigs with conspicuous lenticels. The annual stems of nearly one metre in height grow from an enormous underground rhizome of up to seven metres long [5]. The finely divided leaves have numerous small, narrow leaflets with clusters of small, cream-coloured flowers produced along the lower half of the aerial stem [4]. The characteristic pods are up to 30 cm long, with the inner parts breaking free and peeling off from the persistent margins [5]. The species is divided into two subspecies based on distribution and leaf characteristics. *E. goetzei* subsp. *goetzei* is the most widespread species recorded from Tanzania to South Africa and has 14–41 pairs of pinnae, each bearing 20–48 pairs of leaflets measuring up to 1.2 cm long [5]. *E. goetzei* subsp. *lata* Brenan & Brummit has been recorded in the north and west of Zimbabwe, is characterized by 4–15 pairs of pinnae, each bearing 9–28 pairs of leaflets of up to 2.2 cm long [5]. Most published literature, ethnobotany researchers, traditional healers and local communities do not separate *E. goetzei* into subspecies, but rather to *E. goetzei sensu lato*, and the same approach has been adopted in this study. *E. goetzei* is recorded in the

Red Data List of Namibia as data deficient by Craven and Loots [6] and Klaassen, and Kwembeya [7] because there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status. These authors argued that listing of *E. goetzei* in this category in Namibia indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

4. Vernacular names and ethnomedicinal uses of *E. goetzei*

E. goetzei is known by several vernacular names in its geographical areas of occurrence (Table 1). Literature survey showed no fewer than 17 common or vernacular names for *E. goetzei* (Table 1). Zimbabwe has the highest number of common or vernacular names (eight in total) followed by Botswana with seven and South Africa with three names, and the rest of the countries have either one or two names (Table 1). A vernacular name often describes the history, some characteristic feature of the plant species or the plant parts, for example 'Goetze's elephantorrhiza', 'narrow-pod elephant-root', 'narrow-rod elephant root', 'bastard sumach bean' or 'false sumach bean' (Table 1). This English name 'Goetze's elephantorrhiza' is in honour of Walter Goetze, a German plant collector who first collected this species on his journey from Dar es Salaam in Tanzania to Lake Malawi where he died of blackwater fever [18]. The other English common names, 'narrow-pod elephant-root' and 'narrow-rod elephant root' are in reference to long and flat pods, sometimes measuring 30 cm long and up to 4 cm broad and also large and long roots up to 8 m long [4]. The common names 'bastard sumach bean' and 'false sumach bean' translate into 'false sumach bean', because *E. goetzei* superficially resembles a closely related species 'sumach bean' (*Elephantorrhiza burkei* Benth.). The common Afrikaans names 'basterbasboontjie' and 'smalpeulbasboontjie' are based on the use of this species in tanning [4]. *E. goetzei* roots are traded in informal medicinal markets in Zimbabwe [19]. More research needs to be carried out in Tanzania, where documentation of vernacular names and ethnomedicinal uses of *E. goetzei* are missing.

Table 1

Vernacular names of *Elephantorrhiza goetzei*.

Vernacular (ethnic group or geographical region)	Country	Refs
Bastard sumach bean, large bean elephant root (English), mereko, mosidi, mosidigodimo, mositsane, mudamba (Setswana)	Botswana	[8,9]
Chiteta (Ngoni), thetha (Sena)	Malawi	[10,11]
Churai, mussambanhanga (ChiTewe/chiNdau)	Mozambique	[12]
Basterbasboontjie (Afrikaans), narrow-pod elephant-root (English)	Namibia	[13]
Smalpeulbasboontjie (Afrikaans), Goetze's elephantorrhiza, narrow-pod elephant-root, false sumach bean (English)	South Africa	[4,5]
Long-pod cassia, narrow-rod elephant root (English), ililamba, intolwane (Ndebele), chiurayi, mugudzuru, muzezepasi, ntorani (Shona)	Zimbabwe	[14–17]

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