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Erythrophleum lasianthum: A review of its botany, medicinal uses, phytochemistry and pharmacological properties

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Abstract

Erythrophleum lasianthum is a medium-sized to large tree widely used to treat various animal and human ailments in southern Africa. The present review aims to provide a comprehensive report on the botany, medicinal uses, phytochemical and pharmacological properties of *E. lasianthum*. Diverse electronic search engines and specialized reference tools such as Google, Google Scholar, Scopus, Web of Science, scientific literature, publishing sites and electronic databases (Pubmed, Springer, Wiley and Science Direct) were used for data retrieval. The leaves and bark of *E. lasianthum* are mainly used as anthelmintic, emetic, enema, insecticide and pesticide, and traditional medicine for abdominal pains, body pains, colds, hallucinations and hysteria, headache, intestinal spasms and stomachache, mental disorder, snakebite and as ethnoveterinary medicine. The bark and seeds of *E. lasianthum* contain toxic cardiac alkaloids, cassaine and erythrophleine and biological activities reported from the leaf, stem and stem bark extracts of the species include anthelmintic, antibacterial, antimycobacterial, antifungal, anti-inflammatory, antioxidant, cardiac and cytotoxicity activities. There is need for clinical and toxicological evaluations of crude extracts and compounds isolated from the species since *E. lasianthum* contains potentially toxic compounds.

Keywords: Caesalpinioideae, ethnopharmacology, *Erythrophleum lasianthum*, Fabaceae, herbal medicine, indigenous pharmacopeia

INTRODUCTION

Erythrophleum lasianthum Corbishley is a medium-sized to large tree belonging to the subfamily Caesalpinioideae of the Fabaceae family. *Erythrophleum lasianthum* is included in the Red List of South African Plants and categorized as Near Threatened in the country as the population, area of occupancy and extent of occurrence of the species are decreasing.[1] The species is threatened due to bark harvesting for the medicinal plant trade and habitat loss outside of protected areas as a result of continuing decline of forest habitat due to deforestation and subsistence crop cultivation.[1-5] The bark of *E. lasianthum* is sold in informal herbal medicine markets as traditional medicine in Gauteng and KwaZulu-Natal provinces in South Africa.[5-11] The bark of *E. lasianthum* is used as a fish poison, to kill rats, to poison water where game drinks and the leaves are used to protect grain against insects.[6,12-14] Therefore, the leaves of *E. lasianthum* are known to have killed stock, particularly sheep in South Africa.[6,13,14] Closely related species such as *E. africanum* (Welw. ex Benth.) Harms, *E. chlorostachys* (F. Muell.) Baillon, *E. couminga* Baill., *E. ivorense* A. Chev. and *E. suaveolens* (Guill. & Perr.) Brenan are also known to be poisonous.[14-24] *Erythrophleum lasianthum* is widely used as an ordeal poison throughout its distributional range in southern Africa for executing capital punishment.[5,6,14,15] In spite of literature reports emphasizing toxicological properties of the various plant parts and compounds isolated from the species, *E. lasianthum* is a popular traditional medicine in southern Africa. For example, in South Africa, *E. lasianthum* is included in the book "medicinal plants of South Africa", a photographic guide to the most commonly used plant medicines in the country, including their botany, main traditional uses and active ingredients.[5] It is therefore, within this context that this review was undertaken aimed at reviewing the botany, medicinal uses, phytochemical and pharmacological properties of *E. lasianthum* so as to provide baseline data required in evaluating the therapeutic potential of the species.

Botanical profile of *Erythrophleum lasianthum*

The genus *Erythrophleum* Afzel. ex G. Don consists of about 10 species distributed in continental Africa, Madagascar, eastern Asia and Australia.[23] The genus name is derived from the Greek words "*erythros*" meaning "red" and "*phloios*" meaning "bark of trees", that is, red bark in reference to red sap produced by some African tree species.[25] Several species of the genus are often called "redwater trees" because a red sap is exuded when the bark is cut and this colours water red.[6] The specific name "*lasianthum*" means "with woolly flowers" from the Greek words "*lasios*" and "*anthos*".[25] The English common names of *E. lasianthum* include "Maputaland ordeal tree", "ordeal tree", "red water tree", "sasswood" and "Swazi ordeal tree", since the bark of the tree has been used as an ordeal poison in southern Africa since time immemorial.[6,13] Synonyms associated with this species include *E. guineense* G. Don var. *swaziense* Burtt Davy, *E. suaveolens sensu* Compton, *E. suaveolens non* (Guill. & Perr.) Brenan.[26] *Erythrophleum lasianthum* is a medium-sized to large tree, growing to a height of 23 metres.[6,13,26,27] The bark is grey in colour and smooth in young trees and becoming red-brown, rough and fissured with age. The leaves are alternate, leaflets are ovate to ovate-elliptic in shape, dark green in colour, smooth, glossy and hairless. The apex of the leaf is narrowly tapering to a point with a notch at the tip, the base is asymmetric with waxy entire margins. Flowers are cream to yellow in colour, occurring in more or less dense spikes and often grouped together in large heads. The fruit is a flat pod, which is dark brown in colour, straight, leathery, thinly woody, dehiscing simultaneously along both margins.[27] The species has been

recorded in Mozambique, South Africa and Swaziland in hot, dry bushveld, sand forest, forest margins, stream banks usually on deep sand at an altitude ranging from 20 m to 600 m above sea level.[26-31]

Medicinal uses of *Erythrophleum lasianthum*

The leaves and bark of *E. lasianthum* are mainly used as anthelmintic, emetic, enema, insecticide and pesticide, and traditional medicine for abdominal pains, body pains, colds, hallucinations and hysteria, headache, intestinal spasms and stomachache, mental disorder, snakebite and as ethnoveterinary medicine (Table 1). In South Africa, the bark of *E. lasianthum* is mixed with that of *Warburgia salutaris* (Bertol. f.) Chiov. as traditional medicine for headache.[32-35]

Phytochemistry and biological activities of *Erythrophleum lasianthum*

The bark and seeds of *E. lasianthum* contain toxic cardiac alkaloids,[15] cassaine and erythrophleine are noted among these (Table 2), and some of these compounds have exhibited cardiotonic, analgesic and vasoconstrictor effects.[5,14,33] The following biological activities have been reported from the leaf, stem and stem bark extracts of *E. lasianthum*: anthelmintic,[36] antibacterial,[36,49] antimycobacterial,[49] antifungal,[49] anti-inflammatory,[39,40,50,55] antioxidant,[39] cardiac,[56] cytotoxicity[39,57] and toxicity[14,44] activities.

Table 1: Medicinal uses of *Erythrophleum lasianthum*

Medicinal use	Parts used	References
Abdominal pains	Bark	Watt and Breyer-Brandwijk[15]; Hutchings et al.[33]; McGaw et al.[36]; Grace et al.[37]; Stark et al.[38]
Anthelmintic	Bark	Palmer and Pitman[6]; Hutchings et al.[33]; McGaw et al.[36]
Arthritis	Bark	Netshiluvhi[9]
Blood cleansing	Bark	Twilley et al.[39]
Body pains	Bark	Van Wyk et al.[5]; Netshiluvhi[9]; Hutchings et al.[33]; McGaw et al.[40]; Scot[41]; Iwalewa et al.[42]; Adebayo and Amoo[43]
Colds	Bark	Palmer and Pitman[6]; Netshiluvhi[9]; Palgrave[13]; Watt and Breyer-Brandwijk[15]; Hutchings et al.[33]; Grace et al.[37]; Lewis[44]; Long[45]
Emetic	Bark	Palmer and Pitman[6]; Watt and Breyer-Brandwijk[15]; Hutchings et al.[33]; Grace et al.[37]
Enema	Bark	Palmer and Pitman[6]; Hutchings et al.[33]; Grace et al.[37]
Fever	Bark	Van Wyk et al.[5]
Hallucinations and hysteria	Bark	Palmer and Pitman[6]; Hutchings et al.[33]; Grace et al.[37]; Sobiecki[46]
Headache	Bark	Van Wyk et al.[5]; Palmer and Pitman[6]; Netshiluvhi[9]; Palgrave[13]; Watt and Breyer-Brandwijk[15]; Quattrocchi[25]; Hutchings et al.[33]; Grace et al.[37]; McGaw et al.[40]; Scot[41]; Lewis[44]; Long[45]; Hutchings and Van Staden[47]; Jäger and Van Staden[48]; Nielsen et al.[49]; Adebayo et al.[50]
Headache	Bark mixed with that of *Warburgia salutaris* (Bertol. f.) Chiov.	Gerster[32]; Hutchings et al.[33]; Maroyi[34]; Maroyi[35]
Insecticide and pesticide	Leaves and bark	Palmer and Pitman[6]; Van Wyk and Van Wyk[12]; Palgrave[13]; Long[45]
Intestinal spasms and stomachache	Bark	Van Wyk et al.[5]; Netshiluvhi[9]; Hutchings et al.[33]; Grace et al.[37]; Stark et al.[38]; Scot[41]; Iwalewa et al.[42]; Long[45]; Pujol[51]; Sarasan et al.[52]
Mental disorder	Bark	Sobiecki[46]; Masondo et al.[53]
Snakebite	Bark	Palmer and Pitman[6]; Hutchings et al.[33]; Lewis[44]
Ethnoveterinary medicine (abortion in dogs and bovine lung sickness)	Bark	Palmer and Pitman[6]; Netshiluvhi[9]; Palgrave[13]; Watt and Breyer-Brandwijk[15]; Quattrocchi[25]; Hutchings et al.[33]; Grace et al.[37]; McGaw and Eloff[54]

Table 2: Phytochemical compounds identified from *Erythrophleum lasianthum*

Phytochemical compound	Value	Plant part	Reference
nor-cassamide	-	Bark	Kamerman[58]; Sandberg et al.[59]; Loder et al.[60]; Cronlund[61]
3β-hydroxy-nor-erythrosuamine	-	Seeds	Verotta et al.[56]
3β-hydroxy-nor-erythrosuamine-3-O-β-D-glucopyranoside	-	Seeds	Verotta et al.[56]
Resveratrol 3-O-β-D-glucopyranoside	-	Seeds	Orsini et al.[62]
Total flavonoid content (mg/g QE)	0.05	Leaves	Adebayo et al.[50]
Total phenolic content (mg/g QE)	48.5	Leaves	Adebayo et al.[50]

Anthelmintic activities

McGaw et al.[36] evaluated the anthelmintic activities of hexane, ethanol and water leaf extracts of *E. lasianthum* on the mortality and reproductive ability of the free-living nematode *Caenorhabditis elegans* in two different assays. Ethanol and water extracts exhibited activities at a concentration of 1.0 mg/ml and 2.0 mg/ml after the two and seven days incubation period.[36]

Antibacterial activities

McGaw et al.[36] evaluated the antibacterial activities of aqueous, ethanol and hexane leaf extracts of *E. lasianthum* against *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus* using the disc diffusion assay with neomycin (5 µg) as the positive control. Ethanol extract was active against *Bacillus subtilis* with minimum inhibitory concentration (MIC) value of 0.8 mg/ml.[36] Nielsen et al.[49] evaluated antibacterial activities of methanol leaf and stem extracts of *E. lasianthum* against *Citrobacter* spp., *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* using the micro-broth dilution method with gentamicin and ciprofloxacin as positive controls. The extracts exhibited weak activities against tested pathogens with MIC values ranging from 39.1 µg/ml to 1250 µg/ml which were much higher than MIC values of 0.3 µg/ml to 19.5 µg/ml exhibited by the controls.[49]

Antimycobacterial activities

Nielsen et al.[49] evaluated antimycobacterial activities of the stem methanol extract of *E. lasianthum* against *Mycobacterium smegmatis* and *Mycobacterium tuberculosis* using the radiometric respiratory techniques with dimethylsulfoxide (DMSO) as control. Both extracts demonstrated weak activities against tested pathogens with MIC values ranging from 625 µg/ml to >2500 µg/ml.[49]

Antifungal activities

Nielsen et al.[49] evaluated antifungal activities of methanol leaf and stem extracts of *E. lasianthum* against *Candida albicans* and *Microsporum audouinii* using the micro-broth dilution method with nystatin as a positive control. The extracts exhibited weak activities with MIC values ranging from 78.1 µg/ml to 312.5 µg/ml which were much higher than MIC value of 19.5 µg/ml exhibited by the control.[49]

Anti-inflammatory activities

McGaw et al.[40] evaluated the anti-inflammatory activities of the aqueous and ethanol stem bark extracts of *E. lasianthum* by assessing the inhibition of prostaglandin biosynthesis using the cyclooxygenase assay with indomethacin (0.5 µg) as a positive control. The extracts exhibited percentage inhibition ranging from 58% to 94% which was comparable to 75% exhibited by the positive control.[40] Adebayo et al.[55] evaluated the anti-inflammatory activities of the crude leaf extract of *E. lasianthum* by assessing the ability of extract to inhibit 15-lipoxygenase (15-LOX) enzyme with quercetin as a positive control. The extract inhibited the enzymatic activities of 15-LOX by 49.3% better than quercertin (57.2%) which was used as a positive control.[55] Adebayo et al.[50] evaluated the anti-inflammatory activities of acetone leaf extracts of *E. lasianthum* by assessing the ability of extracts to inhibit 15-LOX enzyme with quercetin as a positive control. The extract exhibited weak activities with half maximal inhibitory concentration (IC_{50}) value of 100.0 µg/mL which was higher than IC_{50} value of 8.8 µg/mL exhibited by the positive control.[50] Twilley et al.[39] evaluated anti-inflammatory activities of ethanol leaf extracts of *E. lasianthum* using the cyclooxygenase-2 (COX-2) assay. At 10 µg/ml, the extract exhibited COX-2 inhibition of 75.0%.[39]

Antioxidant activities

Twilley et al.[39] evaluated antioxidant activities of ethanol leaf extracts of *E. lasianthum* using the 2,2'-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging and nitric oxide (NO) radical scavenging assays with ascorbic acid as a positive control. The extract exhibited good DPPH scavenging activities with an IC_{50} value of 5.3 µg/ml while NO scavenging activities exhibited IC_{50} value of >1000.0 µg/ml.[39]

Cardiac activities

Verrota et al.[56] evaluated the cardiac activities of the compounds 3β-hydroxynorerythrosuamine and 3-O-β-D-glucopyranoside isolated from the seeds of *E. lasianthum*. In spontaneously beating atria, the compound 3β-hydroxynorerythrosuamine and 3-O-β-D-glucopyranoside as well as the reference compound ouabain, exhibited a positive concentration-dependent inotropic activities with the half maximal effective concentration (EC_{50}) values of 0.5 µM, 0.7 µM and 0.7 µM, respectively.[56] On the other hand, both compounds, 3β-hydroxynorerythrosuamine and 3-O-β-D-glucopyranoside were active in repressing the Na^+/K^+-ATPase activity (an electrogenic trans-membrane ATPase enzyme isolated from bovine cardiac sarcolemmal vesicles) with the IC_{50} values of 2.0 µM and 20.0 µM, respectively which were comparable with IC_{50} value of 10.0 µM exhibited by the reference compound, ouabain.[56]

Cytotoxicity activities

Adebayo et al.[57] evaluated the cytotoxicity activities of the leaf extracts of *E. lasianthum* against isolated mononuclear leucocytes, U937 macrophage, Vero kidney and liver cell lines using (3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide (MTT) and Excelligence RTCA assays with hydrogen peroxide (1 mM) and doxorubicin hydrochloride (2 mg/ml) as positive controls. The extract was not cytotoxic to the cell lines used when compared with hydrogen peroxide and doxorubicin hydrochloride.[57] Twilley et al.[39] evaluated cytotoxicity activities of ethanol leaf extracts of *E. lasianthum* against human melanoma (A375), epidermoid carcinoma (A431), cervical epithelial carcinoma (HeLa) and human embryonic kidney cells (HEK-293) using the XTT (sodium 3'-[1-(phenyl amino-carbonyl)-3,4-tetrazolium]-bis-[4-methoxy-6-nitro] benzene sulfonic acid hydrate)

colorimetric assay with actinomycin D as a positive control. The extract exhibited low toxicity with IC_{50} values ranging from 58.6 µg/ml to >200.0 µg/ml.[39]

Toxicity activities

Lewis[44] evaluated the toxicity activities of methanol and water extracts of the bark, leaves and pods with seeds of *E. lasianthum* using the brine shrimp (*Anemia salina*) lethality assay. All the extracts exhibited weak activities with the median lethal concentration (LC_{50}) value of 2000 ppm.[44] Van Wyk et al.[14] argued that the alkaloids of *E. lasianthum* are highly toxic, and the seeds are more poisonous than the bark with 0.5 g of the seed sufficient to kill a rabbit while 60.0 g of the bark and leaves may kill a sheep.

CONCLUSION

Erythrophleum lasianthum is a known poisonous plant[5,14] and there is need for detailed clinical and toxicological evaluations of crude extracts and compounds isolated from the species. Much work is required on aspects of quality control to ensure safety and ensure that potentially toxic components of *E. lasianthum* herbal products are kept below tolerance levels. Future studies should investigate any side effects and/or toxicity associated with intake of *E. lasianthum* herbal products. Therefore, the use of *E. lasianthum* for the treatment and management of human diseases and ailments should be treated with caution and rigorous toxicological and clinical studies on the different plant parts and compounds isolated from the species are necessary before they are widely prescribed for use as traditional medicine.

Conflict of interest

The author declares that he has no conflict of interest.

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