

## MEDICINAL USES, BIOLOGICAL AND CHEMICAL PROPERTIES OF WILD GRAPE (*LANNEA EDULIS*): AN INDIGENOUS FRUIT PLANT OF TROPICAL AFRICA

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### ABSTRACT

*Lannea edulis* is a fruit plant widely used as herbal medicine throughout its distributional range in tropical Africa. This study was aimed at providing a critical review of the biological activities, phytochemistry, and medicinal uses of *L. edulis*. Documented information on the botany, biological activities, medicinal uses, and phytochemistry of *L. edulis* was collected from several online sources which included BMC, Scopus, SciFinder, Google Scholar, Science Direct, Elsevier, PubMed, and Web of Science. Additional information on the botany, biological activities, phytochemistry, and medicinal uses of *L. edulis* was gathered from pre-electronic sources such as book chapters, books, journal articles, and scientific publications sourced from the University library. This study showed that the bark, leaves, rootbark, and roots of *L. edulis* are used as antiabortifacient and herbal medicine to dilate birth canal, dizziness, sore eyes, sexually transmitted diseases, amenorrhea and dysmenorrhea, malaria, bilharzia, and gastrointestinal problems. Ethnopharmacological research revealed that *L. edulis* extracts and compounds have anthelmintic, anti-human immunodeficiency virus, antihyperglycemic, antihyperlipidemic, antimalarial, antimicrobial, antioxidant, and cytotoxicity activities. Future studies should focus on conducting detailed phytochemical, pharmacological, and toxicological evaluations of *L. edulis* crude extracts as well as compounds isolated from the species.

**Keywords:** *Anacardiaceae*, Ethnopharmacology, Herbal medicine, Indigenous pharmacopeia, *Lannea edulis*.

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### INTRODUCTION

Several plant species with edible fruits, leaves, or seeds in tropical Africa are also valued as herbal medicines [1-6]. In recent years, there has been a resurgence of interest in wild edible fruits and vegetables as their consumption has been associated with lowered risk of stroke, heart diseases, cancer, aging, diabetes, and hypertension. Research by Marco *et al.* [7], Vinson *et al.* [8], and Wolfe and Liu [9] showed that phytochemicals associated with edible plants are responsible for the protection of human health against chronic degenerative diseases. Synthetic and natural antioxidants have been targeted as potential agents for preventing and treating chronic degenerative diseases [10-13]. Previous research showed that edible fruits, spices, microalgae, vegetables, and medicinal plants could be important sources of natural antioxidants required for preventing and treating oxidative stress-related diseases [13-20]. In tropical Africa, wild grape, *Lannea edulis* (Sond.) Engl. is one of the indigenous fruit plants [21-34] that are widely used as herbal medicines. According to FAO [25], the fruits can be dried for later use, and the dried fruits are made into a fermented drink. In Zimbabwe, the underground rhizomes of *L. edulis* are consumed, particularly by children [29], and in South Africa, the rhizome is edible after cooking. Research by Van Wyk [35] showed that the fruits of *L. edulis* have commercial potential in the development of new food and beverage products which include jam, jelly, dried fruits, and other processed products that can be used as food additives. Research by Van Wyk *et al.* [36] and Van Wyk and Gericke [28] showed that *L. edulis* is among the species widely used as herbal medicines in South Africa. Research by Cunningham [37] showed that roots of *L. edulis* are sold as herbal medicines in Malawi. It is against this background that this study was undertaken aimed at appraising the medicinal uses and phytochemistry and biological activities of *L. edulis*.

### TAXONOMY AND DESCRIPTION OF *L. EDULIS*

*L. edulis* is a member of the *Anacardiaceae* family, which includes economically important genera such as cashew (*Anacardium L.*), mango (*Mangifera L.*), marula (*Sclerocarya Hochst.*), and sumac (*Rhus L.*) [38].

The name of the genus, "*Lannea*," is derived from a Latin word "*lana*" which translates to "wool" in reference to young plant parts which are densely hairy or possibly to the wool on the roots of some *Lannea* species [21,27]. The specific name "*edulis*" is a Latin word meaning "edible", in reference to edible fruits of the species [27]. Two varieties of *L. edulis* are recognized, that is *L. edulis* var. *edulis* and *L. edulis* var. *glabrescens* (Engl.) Burt Davy. Synonyms associated with *L. edulis* include *L. nana* Engl. and *Odina edulis* Sond. [39-41]. Other *Lanneas* species which include *L. acida* A. Rich., *L. discolor* (Sond.) Engl., *L. microcarpa* Engl. and K. Krause, *L. schimperii* (Hochst. ex A. Rich.) Engl., and *L. schweinfurthii* (Engl.) Engl. are widely used as herbal medicines in tropical Africa [42-46].

*L. edulis* is a small deciduous, perennial shrublet of up to a meter in height, with short, leafy branches developing from a woody, underground rootstock. *L. edulis* has a robust underground, branching stem, which may be up to 12.5 cm thick and anchored by a deep root system [25]. The stem is purple-brown in color, and the leaves are compound, densely covered with silvery hairs when young. The flowers are small, yellowish, tinged with red and occur in erect spikes near the ground. The fruits are red, fleshy drupe when ripe and together with flowers normally appear before the leaves and are conspicuous on burnt ground. *L. edulis* has been recorded in Angola, Botswana, Burundi, the Democratic Republic of Congo (DRC), Ethiopia, Ivory Coast, Kenya, KwaZulu-Natal, Malawi, Mozambique, Namibia, Northern Provinces, Rwanda, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe [32,39-41,47-51]. The species has been recorded in grassland, vleis, open woodland, on rocks, swamps, and termite mounds at an altitude ranging from 305 m to 1740 m above sea level [32,39-41,47-50].

### MEDICINAL USES OF *L. EDULIS*

The bark, leaves, rootbark, and roots of *L. edulis* are used as herbal medicines against 39 human diseases in tropical Africa (Table 1). *L. edulis* is mainly used as an antiabortifacient, herbal medicine to dilate birth canal, dizziness, sore eyes, sexually transmitted diseases, amenorrhea and dysmenorrhea, malaria, bilharzia, and gastrointestinal problems (Fig. 1). In South Africa and Malawi, the roots of *L. edulis*

Table 1: Medicinal uses of *Lannea edulis*

Medicinal use	Plant parts	Country	References
Abdominal pains	Roots	Zimbabwe	[52]
Abscesses	Bark	South Africa	[36,57-62]
Amenorrhoea and dysmenorrhoea	Roots	Malawi and South Africa and Zimbabwe	[28,52,63,64]
Angina pectoris	Roots	Namibia	[65,66]
Antiabortifacient	Roots	South Africa and Zimbabwe	[28,52]
Bilharzia	Roots	Malawi and Zimbabwe	[52,67-75]
Bilharzia and blood in urine	Roots mixed with seeds of <i>Vigna unguiculata</i> (L.) Walp.	Malawi and South Africa	[28,52,53]
Bilharzia	Bark mixed with <i>Bauhinia thonningii</i> Schum.	Malawi	[54,55]
Black water fever	Rootbark	South Africa	[25,28,57]
Boils	Bark	South Africa	[36,57-62]
Bronchitis	Roots	Zimbabwe	[52]
Gastrointestinal problems (cholera, constipation, diarrhea, and dysentery)	Bark, leaves and roots	Angola, Kenya, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe	[24,25,28,30,32,36,52,55,57,59,71-88]
Convulsions	Roots	Zimbabwe	[52]
Cough	Roots	Zimbabwe	[52]
Depression	Roots	Malawi	[55]
Diabetes	Leaves	South Africa	[59,62]
Dilate birth canal	Roots	Malawi and South Africa	[28,52]
Dizziness	Roots	Malawi and Zimbabwe	[52,55]
Erectile dysfunction	Roots	Angola	[87]
Expulsion of placenta	Roots	Kenya	[78]
Heart problem	Roots	Namibia	[65,66]
Hematuria	Roots	Zimbabwe	[52]
Human immunodeficiency virus	Roots	South Africa	[62,89,90]
Inflammation	Roots	Zimbabwe	[52]
Intercostal myalgia	Roots	DRC	[24]
Leprosy	Roots	Mozambique	[85]
Malaria	Roots	Mozambique, South Africa and Tanzania	[24,57,91-93]
Painful uterus	Roots	Zimbabwe	[52]
Pre-hepatic jaundice	Roots	Uganda	[94]
Rheumatism	Roots	Zimbabwe	[52]
Sexually transmitted infections (gonorrhoea, syphilis, and venereal disease)	Leaves and roots	Namibia and Zimbabwe	[52,73,74,82,95-97]
Sore eyes	Leaves	South Africa and Zimbabwe	[36,52,59]
Sterility	Roots	South Africa	[36]
Wounds	Leaves	Zimbabwe	[83]
Ethnoveterinary medicine			
Fever	Leaves	Tanzania	[56]

are mixed with seeds of *Vigna unguiculata* (L.) Walp. as remedies for bilharzia and blood in urine [28,52,53]. In Malawi, the bark of *L. edulis* is mixed with the bark of *Bauhinia thonningii* Schum. as herbal medicine for bilharzia [54,55]. The leaves of *L. edulis* are also used as ethnoveterinary medicine in Tanzania [56].

#### PHYTOCHEMISTRY OF *L. EDULIS*

Amusan *et al.* [80], Banda [86], and Banda *et al.* [98] identified alkaloids, cardiac glycosides, flavonoids, polyphenols, saponins, steroids, and tannins from the bark, leaves, and roots of *L. edulis*. Munodawafa [83] found the total phenolic content of leaf extracts of *L. edulis* to be 0.3 mg of tannic acid equivalent per 100 mg. Queiroz *et al.* [99] identified two alkylphenols, 3-[14'-nonadecenyl]phenol and 3-[16'-heptadecenyl]phenol and three dihydroalkylhexenones, 5-[14-heptadecenyl]-4,5-dihydroxy-2-cyclohexenone, 5-[16'-nonadecenyl]-4,5,5S-dihydroxy-2-cyclohexenone, and 5-[16-nonadecenyl]-4,5-dihydroxy-2-cyclohexenone from the rootbark of *L. edulis* (Fig. 2).

#### BIOLOGICAL ACTIVITIES OF *L. EDULIS*

Biological activities of *L. edulis* extracts and compounds isolated from the species include anthelmintic [100], antihuman immunodeficiency virus (HIV) [89], antihyperglycemic [86,98], antihyperlipidemic [86,98], antimalarial [91], antimicrobial [83,101,102], antioxidant [86,99], and cytotoxicity [89,103] activities.

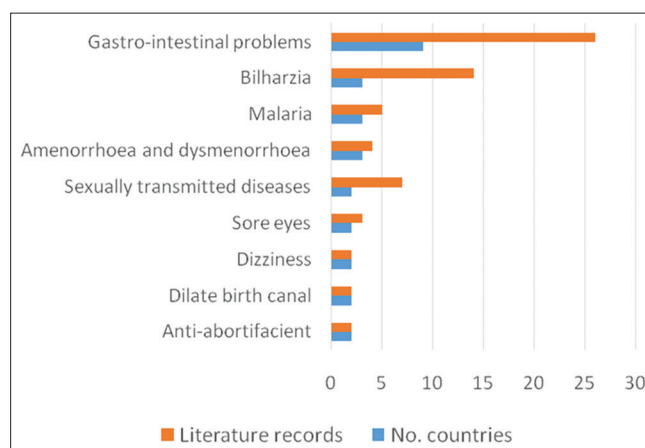


Fig. 1: Medicinal uses of *Lannea edulis* derived from literature records

#### Anthelmintic activities

Mølgaard *et al.* [100] evaluated the anthelmintic activities of *L. edulis* leaf and stem extracts against schistosomules of the trematode *Schistosoma mansoni* and cysticercoids of the cestode of *Hymenolepis*

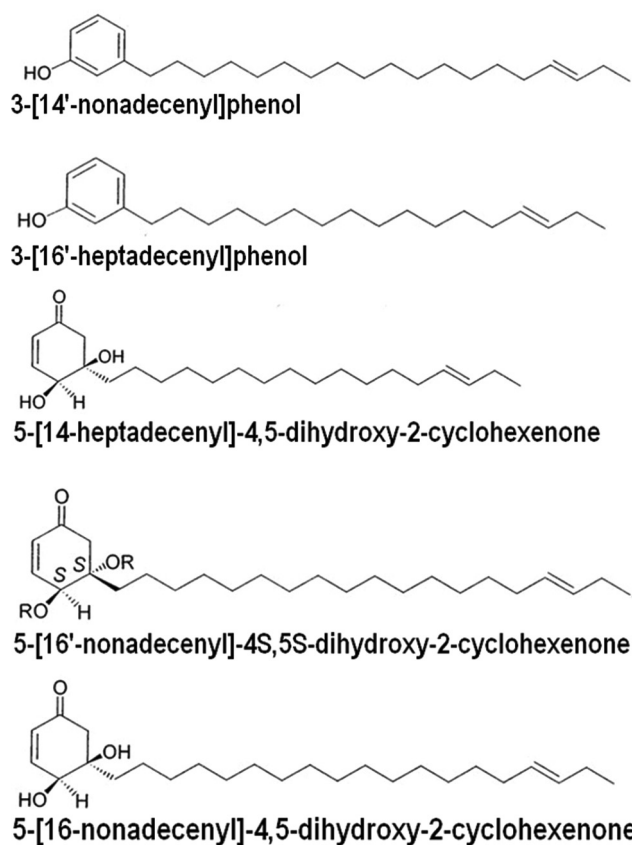


Fig. 2: Alkylphenols and dihydroxyalkyl hexanones that have been identified from the rootbark of *L. edulis*

*diminuta* with praziquantel as a positive control. The extracts killed the newly excysted cysticercoids within an hour, when incubated in a culture medium. The lethal concentrations ( $LC_{50}$ ) of *L. edulis* were 4.0 mg/ml and 3.0 mg/ml after 1 h and 24 h, respectively [100].

#### Anti-HIV activities

Sigidi *et al.* [89] evaluated the anti-HIV activities of aqueous root extract of *L. edulis* using the reverse transcriptase assay. The extract at a concentration of 50  $\mu$ g/ml and 100  $\mu$ g/ml showed inhibition of 20% and 30%, respectively [89].

#### Antihyperglycemic activities

Banda [86] and Banda *et al.* [98] evaluated the antihyperglycemic activities of the aqueous leaf extracts of *L. edulis* in alloxan-induced diabetic male albino rats. The extract exhibited dose-dependent antihyperglycemic effects [86,98].

#### Antihyperlipidemic activities

Banda [86] and Banda *et al.* [98] evaluated the antihyperlipidemic activities of the aqueous leaf extracts of *L. edulis* in alloxan-induced diabetic male albino rats. The extract exhibited dose-dependent antihyperlipidemic effects [86,98].

#### Antimalarial activities

Gessler *et al.* [91] evaluated the antimalarial activities of crude ethanol, petroleum ether, ethyl acetate, and water root extracts of *L. edulis* using the ( $^3H$ ) hypoxanthine incorporation assay against multidrug-resistant *Plasmodium falciparum* strain K1 and the chloroquine-sensitive strain NF54. The ethyl acetate, petroleum ether, and ethanol extracts exhibited activities against *P. falciparum* strain K1 with half maximal inhibitory concentration ( $IC_{50}$ ) values of 17.0  $\mu$ g/ml, 18.0  $\mu$ g/ml, and 40.0  $\mu$ g/ml, respectively, while water extracts were inactive [91].

#### Antimicrobial activities

Munodawafa [83] and Munodawafa *et al.* [101] evaluated the antimicrobial activities of leaf methanol extracts of *L. edulis* against *Aspergillus niger*, *Candida albicans*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Staphylococcus* Group A using the agar well-diffusion method with 10  $\mu$ g each of ampicillin, amoxicillin, gentamicin, tetracycline, and amphotericin B as positive controls. The extracts showed activities against *A. niger*, *C. albicans*, *P. aeruginosa*, *S. aureus*, and *Staphylococcus* Group A with zone of inhibition ranging from 1.0 mm to 5.0 mm against 4.0 mm to 13.0 mm exhibited by the positive controls. The minimum inhibitory concentration (MIC) values against *A. niger*, *C. albicans*, *P. aeruginosa*, *S. aureus*, and *Staphylococcus* Group A ranged from 2.5 mg/ml to 5.0 mg/ml [83,101]. Munodawafa [83] found the minimum bactericidal or fungicidal concentration of the extracts against *A. niger*, *C. albicans*, *P. aeruginosa*, *S. aureus*, and *Staphylococcus* Group A to range from 10.0 mg/ml to >10.0 mg/ml. Chivengwa *et al.* [102] evaluated the antimicrobial activities of the leaf ethanol and aqueous extracts of *L. edulis* against *E. coli* and *Salmonella* spp. using the microdilution method. The extracts exhibited activities against tested pathogens with MIC value of 10  $\mu$ m/mL [102].

#### Antioxidant activities

Queiroz *et al.* [99] evaluated the antioxidant activities of methanol and dichloromethane rootbark extracts of *L. edulis* using the 0.2% diphenylpicrylhydrazyl (DPPH) free radical scavenging assay. The dichloromethane extract exhibited activities. Similarly, Queiroz *et al.* evaluated the antioxidant activities of the compounds 3-[14'-nonadecenyl]phenol, 3-[16'-heptadecenyl]phenol, 5-[14-heptadecenyl]-4,5-dihydroxy-2-cyclohexenone, 5-[16'-nonadecenyl]-4S,5S-dihydroxy-2-cyclohexenone, and 5-[16'-nonadecenyl]-4,5-dihydroxy-2-cyclohexenone isolated from the rootbark of *L. edulis* using the DPPH free radical scavenging assay with Quercetin and [2,6-di-(tert-butyl)-4-methylphenol] butylated hydroxytoluene (BHT) as positive controls. Only compounds 3-[14'-nonadecenyl]phenol and 3-[16'-heptadecenyl]phenol exhibited activities [99]. Munodawafa [83] evaluated the antioxidant activities of methanol leaf extracts of *L. edulis* using the DPPH free radical scavenging assay with  $\beta$ -carotene as the positive control. The antioxidant activity of the extract was 93.9% inhibition which was comparable to 98.6% inhibition exhibited by the positive control [83].

#### Cytotoxicity activities

Sohni *et al.* [103] evaluated mutagenicity activities of aqueous leaf extracts of *L. edulis* using the *Salmonella typhimurium* mutagenicity assay using the strains TA97a, TA98, and TA100. The extract-induced frameshift mutations in *S. typhimurium* display marginal mutagenicity in the strain TA97a [103]. Sigidi *et al.* [89] evaluated the cytotoxicity activities of aqueous root extract of *L. edulis* on U937, MeWo, and Vero cell lines, using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide cell proliferation assay. The extract exhibited activities in all the three human tumor cancer cell lines [89].

#### Toxicity activities

Munodawafa [83] and Munodawafa *et al.* [104] evaluated toxicity of leaf extract of *L. edulis* using the brine shrimp lethality test with *Nerium oleander* L. as a positive control. The extract exhibited median  $LC_{50}$  value of 971  $\pm$  86  $\mu$ g/mL which was higher than  $LC_{50}$  value of 141.7  $\mu$ g/mL exhibited by *N. oleander*, the positive control [83,104]. Banda [86] and Banda *et al.* [98] evaluated the toxicity activities of the aqueous leaf extracts of *L. edulis* aimed at establishing the median lethal dose ( $LD_{50}$ ) of the extract in male albino rats at doses of 10 mg/kg, 100 mg/kg, 300 mg/kg, 2000 mg/kg, 5000 mg/kg, and 6000 mg/kg. None of the doses caused death or caused rats to exhibit symptoms of toxicity. The  $LD_{50}$  value of the extract is, therefore, greater than 6000 mg/kg and falls within the nontoxic range [86,98].

#### CONCLUSION

*L. edulis* is a well-known medicinal plant in tropical Africa. In many cases, the different plant parts such as bark, leaves, rootbark, and roots



of *L. edulis* are used as herbal medicine for antiabortifacient, dilate birth canal, dizziness, sore eyes, sexually transmitted diseases, amenorrhea and dysmenorrhea, malaria, bilharzia, and gastrointestinal problems. Not much data are available on *in vivo* and toxicological properties of crude and compounds isolated from the species. Therefore, there is a need for further studies to focus on the toxicological and *in vivo* studies involving the crude extracts and chemical compounds isolated from the species.

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#### AUTHOR'S CONTRIBUTIONS

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

#### CONFLICTS OF INTEREST

The author declares that they have no conflicts of interest.

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