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

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Received: 14 June 2019; Revised and Accepted: 13 July 2019

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 anti-inflammatory, 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 [12-13]. 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. globescens (Engl.) Burtt 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. schimperi (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 [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...
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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]-4S,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.

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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] |
| Amenorrhea and dysmenorrhea                  | Roots                | Malawi and South Africa and Zambia | [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 *Vigna unguiculata* (L.) Walp. | Malawi and South Africa | [28,52,53] |
| Black water fever                            | Rootbark             | South Africa                     | [25,28,57] |
| Boils                                        | Bark                 | South Africa                     | [36,57-62] |
| Bronchitis                                   | Roots                | Zimbabwe                         | [52]       |
| Gastrointestinal problems (cholera, constipation, diarrhoea, 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 (gonorrhea, 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                     | Leaves               | Tanzania                         | [56]       |

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**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*

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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 µg each of amoxicillin, amikacin, gentamicin, tetracycin, 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. Chiwenga 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 µm/ml [102].

Antioxidant activities
Queiroz et al. [99] evaluated the antioxidant activities of methanol and dichloromethane root 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 b-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 LC₅₀ value of 971 ± 86 µg/ml which was higher than LC₅₀ value of 141.7 µg/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 (LD₅₀) 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 LD₅₀ 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

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diminuta* with praziquantel as a positive control. The extracts killed the newly excysted cystercoids within an hour, when incubated in a culture medium. The lethal concentrations (LC₅₀) 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 µg/ml and 100 µg/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 *P. 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 (IC₅₀) values of 17.0 µg/ml, 18.0 µg/ml, and 40.0 µg/ml respectively, while water extracts were inactive [91].
of *L. edulis* are used as herbal medicine for anti-atherosclerotic, 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.

**ACKNOWLEDGMENTS**

I would like to express my gratitude to the National Research Foundation, South Africa and 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.

**CONFLICTS OF INTEREST**

The author declares that they have no conflicts of interest.

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