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Olax dissitiflora Oliv. (small-fruited olax): Current status and future prospects as medicinal plant

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Abstract

Olax dissitiflora Oliv. (*O. dissitiflora*) has several medicinal uses, some of them known since prehistoric times. The present review compiles existing knowledge of the chemical and pharmacological properties, current medicinal uses, and further use potential and applications of *O. dissitiflora.* Multiple searches on existing literature on the medicinal, phytochemistry and pharmacological properties of *O. dissitiflora* were conducted in online databases such as Scopus, JSTOR, PubMed, Google Scholar and Science Direct as well as using pre-electronic literature sources obtained from the university library. This study showed that the bark, leaves, roots and twigs of *O. dissitiflora* are used as aphrodisiac, emetic, mosquito repellent and purgative and as traditional medicine against dental problems, gonorrhoea, hernia, venereal diseases and wounds. The phytochemical evaluation of the plant revealed that it contains reducing sugars, alkaloids, flavonoids, phenolic compounds, quinones, saponins, steroids, tannins, terpenoids, 21-epimachaerinic acid, oleanolic acid, hederagenin, oleanolic acid 3-O-glucuronide, amphotericin, santalbic acid, exocarpic acid and octadic-9,11-diynoic acid. The pharmacological assessments showed that the crude extracts and phytochemical compounds isolated from the species have antibacterial, antifungal, antiplasmodial, larvicidal and adulticidal activities. The collected ethnomedicinal and ethnopharmacological properties of *O. dissitiflora* documented in this review will assist to understand the therapeutic relevance and potential of the species as well as providing baseline data required for ethnopharmacological assessments required in the discovery of novel plant-based health products. There is also need for more studies focusing on phytochemistry, pharmacological properties and toxicological evaluations, *in vivo* and clinical research on *O. dissitiflora* to complement and validate the ethnomedicinal properties of the species.

Keywords

Indigenous pharmacopeia; Olacaceae; *Olax dissitiflora*; Santalales; traditional medicine; tropical Africa

Introduction

Small-fruited olax (*Olax dissitiflora* Oliv.) (Fig. 1) is one of the most important species in the sour plum family, Olacaceae of the order Santalales. Over the years, the circumscription of the family Olacaceae has been extremely variable, consisting of morphologically diverse parasitic and non-parasitic genera (1). But recent phylogenetic studies recommended reclassification of the Olacaceae, splitting the taxon into seven segregate families, i.e., Aptandraceae, Coulaceae, Erythropalaceae, Octoknemaceae, Olacaceae,

Strombosiaceae and Ximeniaceae (2, 3). The family Olacaceae consists of three closely related genera, namely *Dulacia* Sleumer, *Olax* L. and *Ptychopetalum* Benth., and members of this family are mainly small trees, shrubs and rarely lianas (2). The genus *Olax* L. consist of 45 species and this is the largest genus in the family occurring in tropical Africa, southeast Asia, Australia and New Caledonia (2, 4, 5). The genus *Olax* consists of small trees, shrubs or rarely lianas, for example, *O. scandens* Roxb. recorded in southeast Asia (5). Traditionally, *Olax* species such as *O. gambecola* Baill., *O. imbricata* Roxb., *O. mannii* Oliv., *O. obtusifolia* De Wild., *O. psittacorum* (Lam.) Vahl, *O. scandens*, *O. subscorpioidea* Oliv. and *O. wildemanii* Engl. (6-16) have been used for the treatment of various human diseases including anaemia, diarrhoea, fever, liver diseases, malaria, respiratory infections, sexually transmitted infections and ulcers. These species also demonstrated a variety of biological activities including anthelmintic, anti-arthritic, anticancer, antidepressant, antihyperglycaemic, anti-inflammatory, antioxidant, antipyretic and antimicrobial (6-16).

The genus name *Olax* is derived from the Latin word "*olax*", meaning "odorous" or "ill-smelling", in reference to the unpleasant scent produced by some of the *Olax* species (17). For example, *O. zeylanica* L. is said to have a disagreeable smell (4) while the roots and stems of *O. subscorpioidea* are said to smell like gallic (18-20). However, Palmer and Pitman (21) and Quattrocchi (22) argued that the genus name *Olax* is derived from the Greek word "*aulax*", meaning "furrow", in reference to the ridged bark and branches of some members of the genus. The specific name "*dissitiflora*" is derived from the Latin word "*dissitus*" which means "lying apart" or "well-spaced" in reference to the scattered flowers (17, 21). The synonyms of *O. dissitiflora* include *O. andronensis* Baker, *O. emirnensis* Baker and *O. stuhlmannii* Engl. (5, 18, 23-26). Common names of *O. dissitiflora* in English include "bastard sour plum", "olax", "small false sour plum", "small-fruited olax" and "small sour plum" (5, 21, 22, 25).

Olax dissitiflora is a deciduous scrambling shrub or medium sized tree, growing to 12 metres in height (27). The crown of the species is rounded, low, spreading and young shoots are rust-coloured. The bark is light to dark grey in colour, sometimes smooth, finely wrinkled to rather rough with zigzag young branches. The leaves of *O. dissitiflora* are simple and alternate, glabrous, lanceolate or elliptic in shape, round, cuneate, acuminate and obtuse with entire margins. The leaf blade is light, glossy green above and paler green below, thinly textured and hairless, usually folded upwards along midrib. The flowers occur in short axillary racemes, sweet-scented, small, shortly stalked, occasionally solitary and white in colour (25). The fruit is a drupe, ellipsoid or ovoid in shape, reddish in colour when mature (Fig. 1) and crowned with the persistent remains of the style-base. *Olax dissitiflora* occurs in Malawi, Zimbabwe, Botswana, South Africa, Eswatini, Tanzania, Madagascar, Namibia, Mozambique and Zambia (Fig. 2) at an altitude ranging from 40 m to 1280 metres above sea level (5, 24). *Olax dissitiflora* has been recorded in dry, hot type of deciduous woodland, bushveld, rocky hillsides, riverine and dry lowland forest (24-27). In Zimbabwe, *O. dissitiflora* has been recorded in copper bearing soils (28).

Although *O. dissitiflora* is a shrub or small tree, the species is widely used as an important source of timber and general purpose wood and other non-timber products. For example, in Tanzania, *O. dissitiflora* is used for firewood, poles, tool handles and ornamental purposes (27). In Mozambique, *O. dissitiflora* is used as source of wood (29) and in Madagascar, the wood of this species is used to make boxes and as source of construction material (5). The game and livestock eat young shoots and leaves of *O. dissitiflora* (17, 21). Research by Van Wyk and Van Wyk (30) showed that *O. dissitiflora* is also larval food for the butterfly, *Hypolycaena caeculus caeculus*. In Malawi, the species is considered to be an important medicinal plant species (31) while in Mozambique *O. dissitiflora* is widely used for cosmetics purposes (32). Research by Assane et al. (32) showed that when *O. dissitiflora* is used as beauty cream or in commercial cosmetic mixtures, the species is often mixed with *Aloe vera* (L.) Burm.f., coconut oil and black clay. In South Africa, the leaves of *O. dissitiflora* are cooked as leafy vegetables (33, 34) and in Mozambique, the fruits of the species are used as snacks (29). In southern Africa, *O. dissitiflora* is regarded as an important source of traditional medicines and therefore, included in the monograph "Medicinal and magical plants of southern Africa: An annotated checklist" (35). The therapeutic value

Fig. 1: *Olax dissitiflora*: A: a branch showing leaves and a fruit and B: branch showing a flower (Photos: BT Wursten)

Fig. 2: Distribution of *Olax dissitiflora* in eastern and southern Africa (map drawn using mapchart.net)

of *O. dissitiflora* as traditional medicine and its phytochemical and pharmacological properties are evident from the reports published in recent scientific publications. This review attempts to compile this scattered information on *O. dissitiflora* in order to generate more scientific attention. Therefore, the present review of *O. dissitiflora* compiles information on its chemical and pharmacological properties, traditional and present uses and further use potential. This is a comprehensive scientific review aimed at providing baseline information and additional views that can enhance further research and use of this plant species.

Methods

Literature search on medicinal uses, phytochemistry and pharmacological properties of *Olax dissitiflora* was conducted using online databases such as Scopus, JSTOR, Google Scholar, PubMed and Science Direct. In addition to this, pre-electronic sources such as books, journal articles, dissertation, book chapters, thesis and other scientific articles obtained from the University library were used. Keywords used in the search included "biological activities of *Olax dissitiflora*", "pharmacological properties of *Olax dissitiflora*", "ethnobotany of *Olax dissitiflora"*, "medicinal uses of *Olax dissitiflora*", "phytochemistry of *Olax dissitiflora*" and "traditional uses of *Olax dissitiflora".*

Medicinal uses of *Olax dissitiflora*

For several generations, the bark, leaf, root and twig extracts of *O. dissitiflora* have been used in folklore medication in Zimbabwe, Madagascar, Mozambique, Malawi, Tanzania and South Africa, that is, 60.0% of the countries where the species is indigenous (Table 1). The herbal concoctions prepared from the bark, leaves, roots and twigs of *O. dissitiflora* are used as aphrodisiac, emetic, mosquito repellent and purgative, and as traditional medicines against dental problems, gonorrhoea, hernia, venereal diseases and wounds (Table 1, Fig. 3). In Mozambique, the bark, leaf or root extracts of *O. dissitiflora* are used against bronchitis, evil spirits, fever, nausea and stomachache (32, 36-38). Research by Quattrocchi (22) showed that roots of *O. dissitiflora* are often mixed with other medicinal plant species as remedy for infertility in women. Therefore, the importance of *O. dissitiflora* as an ethnomedicinal plant species in addressing the health problems in communities in eastern and southern Africa cannot be denied. Literature research showed that more and more scientific articles are reporting on ethnomedicinal and ethnopharmacological potential of this species.

Table 1: Medicinal uses of *Olax dissitiflora*

Disease or ailment	Plant parts used	Country	Reference
Aphrodisiac	Root infusion taken orally	Zimbabwe	(39-42)
Bronchitis	Bark, leaf or root infusion taken orally	Mozambique	(32)
Dental problems	Bark and twig infusion used topically	Tanzania	(40, 41, 43)
Emetic	Leaves crushed and liquid strained and mixed with coconut oil	Malawi, Mozambique and Tanzania	(40-42, 44-47)
Evil spirits	Bathing using leaf decoction	Mozambique	(37)
Fever	Leaves mixed with bathing water	Mozambique	(36)
Gonorrhoea	Bark and root decoction taken orally	Not specified	(40-42)
Hernia	Root decoction taken orally	Not specified	(40-42)
Infertility in women	Roots mixed with other species and taken orally	Not specified	(22)
Mosquito repellent	Bark is burnt to make smoke	South Africa	(41, 42, 48)
Nausea	Leaf and root infusion taken orally	Mozambique	(38)
Purgative	Leaf decoction taken orally	Madagascar	(5, 41, 42)
Stomach-ache	Leaf and root infusion taken orally	Mozambique	(38)
Venereal diseases	Root infusion taken orally	Zimbabwe	(39, 40-42)
Wounds	Ground leaves applied topically	Mozambique	(29, 40-42, 49)

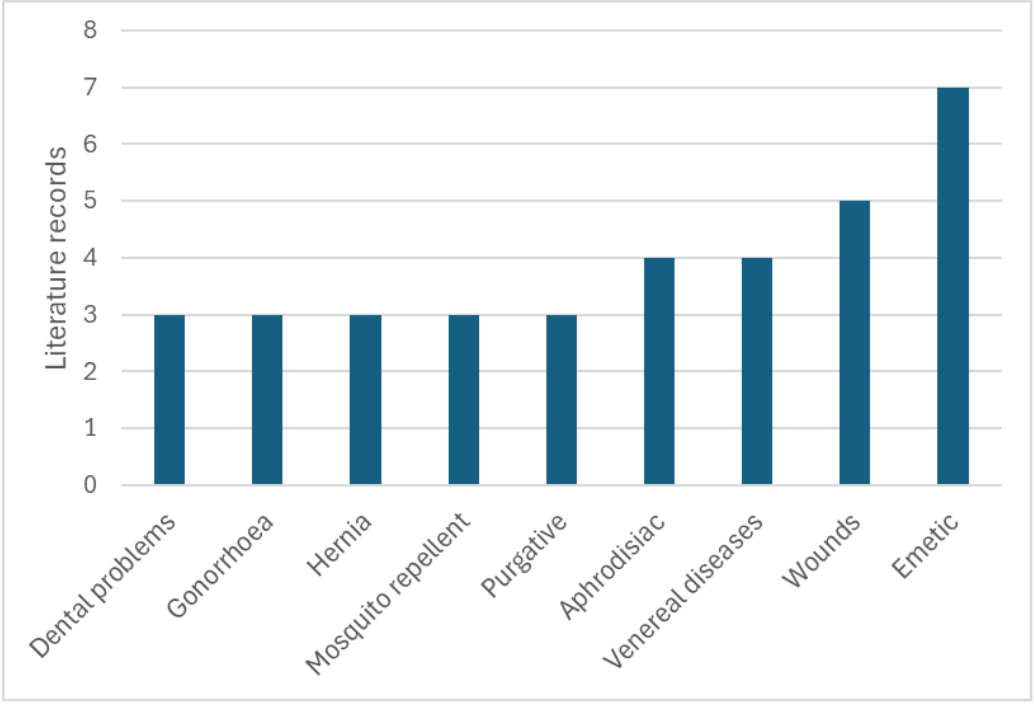

Fig. 3: Main diseases and ailments treated and managed using *Olax dissitiflora* extracts

Phytochemical and pharmacological properties of *Olax dissitiflora*

The leaves, roots and stems of *O. dissitiflora* are rich in different classes of primary and secondary metabolites such as reducing sugars, alkaloids, flavonoids, phenolic compounds, quinones, saponins, steroids, tannins and terpenoids (32, 50). Prunasin-like cyanogenic glycosides have been reported in *O. dissitiflora* (4). Roots of *O. dissitiflora* yielded a mixture of saponins, three triterpenoid sapogenins, 21-epimachaerinic acid, oleanolic acid and hederagenin and a prosapogenin oleanolic acid 3 -O-glucuronide (51) and these compounds are shown in Fig. 4.

The traditional uses of *O. dissitiflora* inspired Mavundza (41) and Mavundza et al. (42, 52, 53) to assess the medicinal value of the species through pharmacological screening of both the crude extracts and phytochemical compounds isolated from the species. Traditionally used medicinal plants represent an indispensable source of novel and effective health promoting products and pharmaceutical drugs (54-56). Since plants have long been used as folk herbal medicines to treat various human diseases and ailments, and their different natural products have inspired the design, discovery, and development of new pharmaceutical drugs and products over the years (55, 57). Literature studies

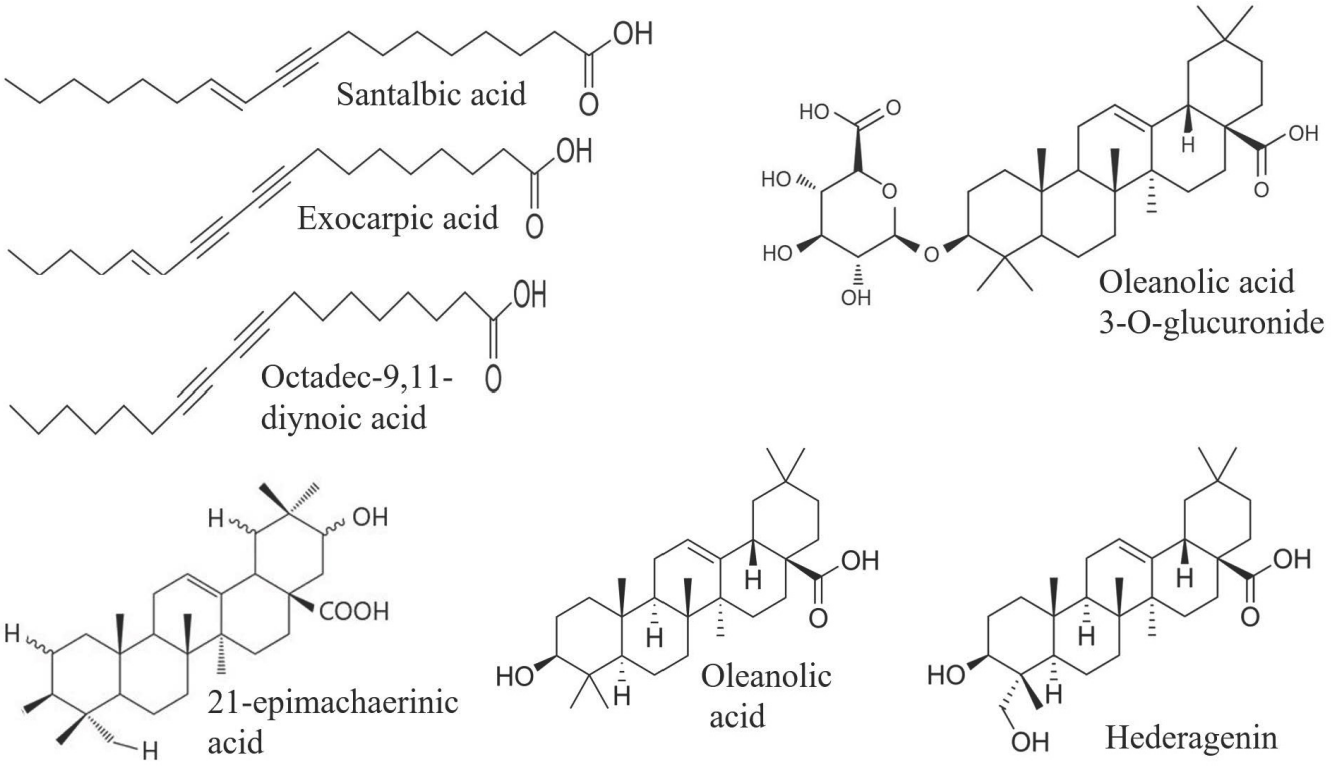

Fig. 4: Chemical structures of phytochemical compounds isolated from *Olax dissitiflora*

show that the capacity to use active phytochemical compounds derived from medicinal plants or their synthetic equivalents has improved with the development of ethnopharmacological research (54, 58, 59).

The crude extracts and phytochemical compounds isolated from the species have been evaluated for different biological activities such as antibacterial, antifungal, antiplasmodial, larvicidal and adulticidal. Now, the emerging ethnopharmacological investigations are validating some of the ethnomedicinal applications of the species and there is need for more studies to compliment and validate the *in vitro* and *in vivo* antibacterial, antifungal, antiplasmodial, larvicidal and adulticidal potential of the plant extracts and the phytochemical compounds isolated from the species. Similarly, Bombardelli et al. (60, 61) registered patents with novel pharmaceutical and cosmetic properties. The formulation comprised of an anti-inflammatory saponin isolated from *O. dissitiflora* used in amounts ranging from 0.1% to 1.0% by weight (60, 61). This information may provide opportunities for researchers around the world to investigate the unexplored potentials of *O. dissitiflora* by isolating new bioactive phytoconstituents and assessing their pharmacological properties.

Antibacterial activities

Mavundza (41) evaluated the antibacterial activities of dichloromethane and ethanol extracts of O. dissitiflora bark against *Staphylococcus aureus* ATCC 12600, *Klebsiella pneumoniae* ATCC 13883, *Bacillus subtilis* ATCC 6051 and *Escherichia coli* ATCC 11775 using the microdilution assay with neomycin as a positive control. Both extracts exhibited activities against tested pathogens with minimum inhibitory concentration (MIC) values ranging from 0.20 mg/ml to 0.78 mg/ml (41).

Antifungal activities

Mavundza (41) evaluated the antifungal activities of dichloromethane and ethanol extracts of *O. dissitiflora* bark against *Candida albicans* ATCC 10231 using the microdilution assay with amphotericin B as a positive control. Both extracts exhibited activities against *Candida albicans* with MIC and minimum fungicidal concentration (MFC) values ranging from 0.20 mg/ml to 0.78 mg/ml (41).

Antiplasmodial activities

Mavundza (41) evaluated the antiplasmodial activities of dichloromethane and ethanol extracts of *O. dissitiflora* bark against a chloroquine-sensitive strain of *Plasmodium falciparum* (D10) using the modified parasite lactate dehydrogenase assay with chloroquine diphosphate and artesunate as positive controls. The ethanol and dichloromethane extracts exhibited activities with half maximal inhibitory concentrations (IC_{50}) values of 15.6 µg/ml and 45.6 µg/ml, respectively (41).

Larvicidal activities

Mavundza et al. (52) evaluated the larvicidal activities of ethanol extracts of *O. dissitiflora* bark against *Anopheles arabiensis* mosquitoes by observing larval mortality after 24 hours of exposure. The extract exhibited activities with the median lethal concentration (LC_{50}) value of 25.24 µg/ml (52). Similarly, Mavundza et al. (42) evaluated the larvicidal activities of the phytochemical compounds santalbic acid, exocarpic acid and octadec-9,11-diynoic acid isolated from *O. dissitiflora* bark against laboratory-reared larvae of *Anopheles arabiensis* mosquitoes, a potent malaria vector. The compound santalbic acid and a mixture of compounds exocarpic acid and octadec-9,11-diynoic acid exhibited activities with half maximal effective concentration (EC_{50}) values of 62.17 µg/ml and 17.31 µg/

ml, respectively (42).

Adulticidal activities

Mavundza et al. (53) evaluated the adulticidal activities of dichloromethane and ethanol extracts of *O. dissitiflora* bark by observing adult mortality of *Anopheles arabiensis* mosquitoes after 24 hours of exposure. Both extracts showed weak adulticidal activities exhibiting <20% mosquito mortality (53).

Conclusion

The present review provides a summary of the medicinal uses and applications, chemical and pharmacological properties of *O. dissitiflora*. The importance of *O. dissitiflora* as a medicinal plant species in addressing primary health issues of communities in eastern and southern Africa cannot be denied. The current review testifies that *O. dissitiflora* is an integral part of the primary health care in Madagascar, Zimbabwe, Malawi, South Africa, Mozambique and Tanzania, that is, 60.0% of the countries where the species is indigenous. The preliminary ethnopharmacological research focusing on the phytochemistry and pharmacological properties conducted so far, appear to show *O. dissitiflora* as crucial and promising in addressing primary health care issues. But detailed studies focusing on toxicity and safety, mechanisms of action *in vivo* and clinical research aimed at corroborating the traditional medical applications of *O. dissitiflora* are required.

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