A synthesis and review of medicinal uses, phytochemistry and pharmacological properties of *Scheflera umbellifera* (Sond.) Baill. (Araliaceae)

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**ABSTRACT**

*Schefflera umbellifera* (Sond.) Baill. is an evergreen tree widely used as traditional medicine throughout its distributional range in southern Africa. *Schefflera umbellifera* is indigenous to Eswatini, Malawi, Mozambique, South Africa and Zimbabwe. This study was aimed at providing a critical review of medicinal uses, phytochemical and pharmacological properties of *S. umbellifera*. Documented information on medicinal uses, phytochemical and pharmacological properties of *S. umbellifera* was collected from several online sources such as Scopus, Google Scholar, PubMed, Francis and Taylor and Science Direct, and pre-electronic sources such as book chapters, books, journal articles and scientific publications obtained from the University library. This study revealed that the bark, leaf and root decoction or infusion of *S. umbellifera* are mainly used as diuretic, laxative, colic and protective charm, and traditional medicine for stomach ulcers, weaning infants, insanity, inflammation, rheumatism and malaria. Phytochemical compounds identified from the species include 3-hydroxy-20(29)-lupen-28-ol, 7-hydroxy-6-methoxycoumarin, betulin, ent-kaur-16-en-19-oic acid and oleanolic acid. Pharmacological research revealed that *S. umbellifera* extracts and compounds isolated from the species have antibacterial, anti-HIV, anti-inflammatory, antimalarial, antiprotozoal, larvicidal and cytotoxicity activities. *Schefflera umbellifera* should be subjected to detailed phytochemical, pharmacological and toxicological evaluations aimed at correlating its medicinal uses with its phytochemistry and pharmacological activities.

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**INTRODUCTION**

*Schefflera umbellifera* (Sond.) Baill. is an evergreen tree belonging to the Araliaceae family. The Araliaceae family consists of approximately 55 genera and 1500 species, which are mainly woody plants with a few herbaceous plants (Kim et al., 2017). The genus name *Schefflera* J.R. Forst. & G. Forst. is in honour of Johann Peter Ernst von Scheffler, an 18th century German physician and botanist (Palmer and Pitman, 1972). *Schefflera* is a genus of between 600 to 900 species, mainly trees, shrubs and lianas with several species grown as garden ornamental and house plants (Plunkett et al., 2005; Fiaschi and Plunkett, 2011). The specific name “*umbellifera*” refers to the umbellate arrangement of the flowers in which the flower stalks spring from the same point like the ribs of an umbrella (Palmer and Pitman, 1972). The English common name of *S. umbellifera* is “false-cabbage tree” and “for-
est cabbage tree”. The synonyms associated with the name *S. umbellifera* include *Cassonia chartacea* Schinz, *C. umbellifera* Sond. and *Neocussonia umbellifera* (Sond.) Hutch (Strey, 1973). *Schefflera umbellifera* is a medium to large evergreen tree with a tall trunk and much-branched and rounded crown, reaching a height of 20 metres (Strey, 1973; Venter and Venter, 2015). The bark on young stems is smooth with raised cork dots, resinous and rough to longitudinally fissured on older branches and stems. The leaves of *S. umbellifera* are clustered at ends of branches, alternate, compound and hand-shaped. The leaves are glossy dark green above, paler below with toothed and waxy margins in the upper half of the leaf. The flowers are large, branched and terminal and pale yellow to white in colour. The fruit is a cone-shaped drupe, fleshy and dark red in colour when ripe. *Schefflera umbellifera* is widely distributed in Eswatini, Malawi, Mozambique and Zimbabwe as well as in South Africa at an altitude ranging from 60 m to 1980 m above sea level (Strey, 1973; Venter and Venter, 2015). *Schefflera umbellifera* has been recorded in well-drained and humus-rich soil in coastal forest, evergreen forest, afro-montane forest and forest margins. *Schefflera umbellifera* is widely used as traditional medicine throughout its distributional range with the minimum inhibitory concentrations (MIC) values ranging from 0.2 mg/mL to 20.0 mg/mL with the exception of *Enterococcus faecalis* which exhibited activities against all the tested pathogens with the exception of *Enterococcus faecalis* with MIC values ranging from 0.2 mg/mL to 20.0 mg/mL while both extracts exhibited activities against *Neisseria gonorrhoeae* with MIC values ranging from 0.2 mg/mL to 20.0 mg/mL. Other medicinal applications of *S. umbellifera* supported by at least two literature records include the use of the leaf and root decoction or infusion of the species as traditional medicine for nausea, stomach ache and venereal diseases (Palmer and Pitman, 1972; Mthembu et al., 2010).

**Phytochemistry of Schefflera umbellifera**

Mthembu (2007) and Mthembu et al. (2010) isolated coumarin, krauran diterpene and triterpenes compounds such as 3-hydroxy-20(29)-lupen-28-ol, 7-hydroxy-6-methoxy coumarin, betulin, ent-kaur-16-en-19-oic acid and oleanolic acid (Figure 2) from the leaves of *S. umbellifera*. The coumarin compounds are characterized by pharmacological properties such as antioxidant, anti-depressant, anti-convulsant, anti-coagulant, anti-inflammatory, antimicrobial and anticancer properties (Rivero et al., 2010; Stefanachi et al., 2018). Similarly, diterpenes are associated with antitumor, antitussive, antimalarial, anti-peptic ulcer, antiplasmodial, anti-inflammatory, antidiagnosticin, hypoglycemic, antihypertensive, neuroprotective and anti-throm bin inhibitory activities (Li et al., 2016; Roncero et al., 2018). The triterpenes compounds are also associated with antioxidant, antimicrobial, antimalarial, anti-inflammatory, anticancer, α-glucosidase inhibitors and antidiabetic properties (Tan et al., 2008; Zhang et al., 2016). Some of these phytochemical compounds may be responsible for the pharmacological properties of the species.

**Materials and Methods**

Results of the current study are based on literature search on the phytochemistry, pharmacological properties and medicinal uses of *S. umbellifera* using information derived from several internet databases. The databases included Scopus, Google Scholar, PubMed and Science Direct. Other sources of information used included pre-electronic sources such as journal articles, theses, books, book chapters and other scientific articles obtained from the University library.

**Results and Discussion**

**Medicinal uses of Schefflera umbellifera**

The bark, leaf and root decoction or infusion of *S. umbellifera* are mainly used as diuretic, laxative, colic and protective charm, and traditional medicine for stomach ulcers, weaning infants, insanity, inflammation, rheumatism and malaria (Table 1; Figure 1). Other medicinal applications of *S. umbellifera* supported by at least two literature records include the use of the leaf and root decoction or infusion of the species as traditional medicine for nausea, stomach ache and venereal diseases (Palmer and Pitman, 1972; Mthembu et al., 2010).
Table 1: Medicinal uses of *Scheflera umbellifera*

<table>
<thead>
<tr>
<th>Medicinal use</th>
<th>Part used</th>
<th>Country</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colic</td>
<td>Leaf decoction or infusion taken orally</td>
<td>South Africa</td>
<td>Hutchings <em>et al.</em> (1996); Tetyana <em>et al.</em> (2002)</td>
</tr>
<tr>
<td>Diuretic</td>
<td>Root infusion taken orally</td>
<td>South Africa</td>
<td>Shai (2007); Mthembu <em>et al.</em> (2010)</td>
</tr>
<tr>
<td>Inflammation</td>
<td>Bark, leaf and root infusion applied</td>
<td>South Africa</td>
<td>Jäger and van Staden (2005); Venter and Venter (2015)</td>
</tr>
<tr>
<td>Inflammation of navel</td>
<td>Root infusion applied topically</td>
<td>Zimbabwe</td>
<td>Gelfand <em>et al.</em> (1985); Hutchings <em>et al.</em> (1996)</td>
</tr>
<tr>
<td>Insanity</td>
<td>Leaf decoction or infusion taken orally</td>
<td>South Africa</td>
<td>Palmer and Pitman (1972); Wyk and Gericke (2018)</td>
</tr>
<tr>
<td>Laxative</td>
<td>Root infusion taken orally</td>
<td>South Africa</td>
<td>Shai (2007); Mthembu <em>et al.</em> (2010)</td>
</tr>
<tr>
<td>Malaria</td>
<td>Bark and leaf decoction or infusion</td>
<td>Eswatini, South Africa and Zimbabwe</td>
<td>Gelfand <em>et al.</em> (1985); Netshiluvhi (1996)</td>
</tr>
<tr>
<td>Nausea</td>
<td>Root infusion taken orally</td>
<td>South Africa</td>
<td>Mthembu (2007); Mthembu <em>et al.</em> (2010)</td>
</tr>
<tr>
<td>Protective charm (good luck and magical)</td>
<td>Bark</td>
<td>Eswatini and South Africa</td>
<td>Watt and Breyer-Brandwijk (1962); Long (2005)</td>
</tr>
<tr>
<td>Rheumatism</td>
<td>Leaf decoction or infusion taken orally</td>
<td>Eswatini and South Africa</td>
<td>Long (2005); Venter and Venter (2015)</td>
</tr>
<tr>
<td>Stomach ache</td>
<td>Leaf infusion taken orally</td>
<td>South Africa</td>
<td>Palmer and Pitman (1972); Mbambezeli <em>et al.</em> (2006)</td>
</tr>
<tr>
<td>Stomach ulcers</td>
<td>Bark decoction or infusion taken orally</td>
<td>South Africa</td>
<td>Watt and Breyer-Brandwijk (1962); Mthembu <em>et al.</em> (2010)</td>
</tr>
<tr>
<td>Venereal diseases</td>
<td>Root infusion taken orally</td>
<td>South Africa</td>
<td>Mthembu (2007); Mthembu <em>et al.</em> (2010)</td>
</tr>
<tr>
<td>Weaning infants</td>
<td>Root infusion applied topically</td>
<td>South Africa</td>
<td>Shai (2007); Mthembu <em>et al.</em> (2010)</td>
</tr>
</tbody>
</table>

Figure 1: Medicinal applications of *Scheflera umbellifera* derived from literature records
mg/mL to 6.7 mg/mL (Villiers et al., 2010).

**Anti-HIV activities**

Nthambeleni et al. (2010) evaluated the anti-HIV activities of aqueous extract of *S. umbellifera* leaves using EMF and InPheno bioassay screening against the cellular co-receptor types for human immunodeficiency virus (HIV), CCR5 and CXCR4 viruses. The extract exhibited moderate activities shown by inhibition of 50% viral replication (IC$_{50}$) and concentration of extract provoking 50% of cell death after a 4-day time-window (CD$_{50}$) (Nthambeleni et al., 2010).

**Anti-inflammatory activities**

Tetyana (2000) and Tetyana et al. (2002) evaluated the anti-inflammatory activities of the ethyl acetate, ethanol and aqueous extracts of *S. umbellifera* bark using the cyclooxygenase (COX-1) assay. The ethyl acetate and ethanol extracts inhibited cyclooxygenase in the cyclooxygenase-1 assay with inhibition percentage ranging between 80.0% and 93.0% (Tetyana, 2000; Tetyana et al., 2002).

**Antimalarial activities**

Tetyana (2000) and Tetyana et al. (2002) evaluated the antimalarial activities of the ethyl acetate, ethanol and aqueous extracts of *S. umbellifera* bark against *Plasmodium falciparum* (PFUP1) isolate using a parasite lactate dehydrogenase (pLDH) assay with chloroquine as positive control. The ethyl acetate and ethanol extracts exhibited activities with IC$_{50}$ values ranging from 3.2 g/ml to 5.0 g/ml in comparison to IC$_{50}$ value of 27.2 ng/ml exhibited by the reference compound (Mthembu, 2007; Mthembu et al., 2010). Mokoka (2013) and Mokoka et al. (2011) evaluated the antimalarial activities of dichloromethane, dichloromethane : methanol (1:1) and methanol extracts of *S. umbellifera* leaves, roots, stems and twigs against *Plasmodium falciparum* using a parasite lactate dehydrogenase (pLDH) assay. The extracts exhibited activities with half maximal inhibitory concentration (IC$_{50}$) values ranging from 3.2 g/ml to 100.0 g/ml (Clarkson et al., 2004). De Villiers et al. (2010) evaluated antimalarial activities of methanol and water extracts of *S. umbellifera* leaves using the [G-$^3$H] hypoxanthine incorporation assay using chloroquine-sensitive (3D7) strain of *Plasmodium falciparum* as the test organism. The extracts exhibited weak activities with IC$_{50}$ values >50.0 g/mL (Villiers et al., 2010). Mthembu et al. (2007) and Mthembu et al. (2010) evaluated the antimalarial activities of dichloromethane and dichloromethane: methanol (1:1) extracts of leaves of *S. umbellifera* and the compounds 7-hydroxy-6-methoxycoumarin, betulin and ent-kaur16-en-19-0ic acid isolated from the species against the chloroquine-susceptible *Plasmodium falciparum* D10 using a parasite lactate dehydrogenase (pLDH) assay with chloroquine used as a reference drug. The dichloromethane and dichloromethane: methanol (1:1) extracts and the compound betulin exhibited activities with IC$_{50}$ values ranging from 3.2 g/ml to 5.0 g/ml in comparison to IC$_{50}$ value of 27.2 ng/ml exhibited by the reference compound (Mthembu, 2007; Mthembu et al., 2010). Mokoka (2013) and Mokoka et al. (2011) evaluated the antimalarial activities of dichloromethane and dichloromethane: methanol (1:1) extracts of *S. umbellifera* roots against *Plasmodium falciparum* with benznidazole chloroquine (IC$_{50}$ = 0.05 μM)
as a positive control using the [G-3H]-hypoxanthine incorporation assay. The dichloromethane and dichloromethane: methanol (1:1) extracts exhibited weak activities with IC_{50} values of 2.7 μg/mL and 7.7 μg/mL, respectively (Mokoka, 2013; Mokoka et al., 2011).

**Antiprotozoal activities**

De Villiers et al. (2010) evaluated the antiprotozoal activities of methanol and water extracts of *S. umbellifera* leaves against the protozoan pathogen associated with urogenital or sexually transmitted infections, *Trichomonas vaginalis* using the microdilution method with ciprofloxacin (0.01 mg/mL) as positive control. The methanol and water extracts exhibited activities with MIC values of 1.5 mg/mL and 4.5 mg/mL, respectively which were higher than the MIC value of 0.001 mg/mL exhibited by the positive control (Villiers et al., 2010). Mokoka (2013) and Mokoka et al. (2011) evaluated the antiprotozoal activities of dichloromethane and dichloromethane: methanol (1:1) extracts of *S. umbellifera* roots against *Trypanosoma cruzi*, *Trypanosoma brucei rhodesiense* and *Leishmania donovani* with benznidazole (IC_{50} = 0.5 μg/mL), melarsoprol (IC_{50} = 0.03 μM) and milftosine (IC_{50} = 0.2 μg/mL) as reference drugs. Determination of the activities of the extracts against these pathogens was done using Almar Blue and resazurin assays. The extracts exhibited activities with IC_{50} values ranging from 5.0 μg/mL to 99.5 μg/mL (Mokoka, 2013; Mokoka et al., 2011).

**Larvicidal activities**

Maharaj et al. (2006) evaluated the larvicidal activities of water, dichloromethane, methanol and dichloromethane: methanol (1:1) extracts of *S. umbellifera* leaves against the 3rd instar larvae of *Anopheles arabiensis* using Temephos (Mostop; Agrivo) as positive control. The extract exhibited mortality between 40.0% and 59.0%, indicating limited toxicity (Maharaj et al., 2006).

**Cytotoxicity activities**

De Villiers et al. (2010) evaluated the cytotoxicity activities of methanol and water extracts of *S. umbellifera* leaves against the human T-cell leukemia (Jurkat) cell line using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) colorimetric assay with (S)-(−)-camptothecin as a positive control. The extracts exhibited weak cytotoxicity activities with IC_{50} values >50.0 μg/mL in comparison to IC_{50} value of 0.07 μg/mL exhibited by the positive control (Villiers et al., 2010). Mokoka (2013) and Mokoka et al. (2011) evaluated the cytotoxicity activities of dichloromethane and dichloromethane: methanol (1:1) extracts of *S. umbellifera* roots against the rat myoblast L6 cells with podophyllotoxin (IC_{50} = 0.05 μM) as a reference drug. The dichloromethane and dichloromethane: methanol (1:1) extracts exhibited activities with IC_{50} values of 13.9 μg/mL and 48.3 μg/mL, respectively (Mokoka, 2013; Mokoka et al., 2011).

**CONCLUSIONS**

The present review summarizes the medicinal uses, phytochemistry and pharmacological properties of *S. umbellifera*. Detailed studies on the pharmacokinetics, in vivo and clinical research involving both extracts and compounds isolated from the species are required. Therefore, future research should focus on the molecular modes or mechanisms of action, pharmacokinetics and physiological pathways for specific extracts of the species including identification of the bioactive compounds of the species and their associated pharmacological activities.

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**Conflict of Interest**

The authors declare that they have no conflict of interest for this study.

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