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Haworthiopsis limifolia (Asphodelaceae): medicinal uses, phytochemistry and biological activities

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Abstract

Haworthiopsis limifolia is a succulent herbaceous perennial plant widely used as herbal medicine in southern Africa. This study reviewed medicinal uses, phytochemistry and pharmacological properties of *H. limifolia*. Relevant information on the uses, phytochemistry and pharmacological properties of *H. limifolia* was collected from electronic scientific databases such as ScienceDirect, SciFinder, PubMed, Google Scholar, Medline, and SCOPUS. Pre-electronic literature search of conference papers, scientific articles, books, book chapters, dissertations and theses was carried out at the University library. Literature search revealed that *H. limifolia* is used as a protective charm against enemies, evil spirits, lightning, snakes, storms, and bring good fortune or luck. The leaves, roots and whole plant parts of *H. limifolia* are used as herbal medicines for fertility problems, sores, purifying blood, cough, skin rashes, sun burns, burns and gastro-intestinal problems. Phytochemical compounds identified from the species include alkaloids, anthraquinones, carbohydrates, fatty acids, flavonoids, glycosides, lectins, phenolics, saponins, sterols and tannins. Pharmacological studies revealed that *H. limifolia* extracts and compounds isolated from the species have antibacterial, antifungal, anti-inflammatory, antioxidant, wound healing, hemagglutinating, agglutination and cytotoxicity activities. *Haworthiopsis limifolia* should be subjected to detailed phytochemical, pharmacological and toxicological evaluations aimed at correlating its medicinal uses with its phytochemistry and pharmacological properties.

Keywords: Asphodelaceae, ethnopharmacology, *Haworthiopsis limifolia*, Southern Africa, traditional knowledge

INTRODUCTION

Haworthiopsis limifolia (Marloth) G.D. Rowley is a succulent herbaceous perennial plant belonging to the Asphodelaceae or Aloe family. The family Asphodelaceae has had a complex history and at some stage referred to as Xanthorrhoeaceae[1-5] based on recommendations made by the Angiosperm Phylogeny Group.[6] The family name Asphodelaceae has been conserved over Xanthorrhoeaceae based on arguments presented by the Angiosperm Phylogeny Group.[7] The genus *Haworthiopsis* G.D. Rowley was previously included in genus *Haworthia* Duval and erected to its present status by Rowley.[8] The name *Haworthiopsis* alludes to the similar appearance of these species to those of *Haworthia* and also to the fact that these species were previously included in the latter genus. Recognition of genus *Haworthiopsis* is supported by evidence from molecular data and morphological characteristics.[4,9-11] In South Africa, *H. limifolia* is categorized as Vulnerable under the IUCN Red List Categories and Criteria[12-15] based on the threats the species is currently facing in the country. The species is popular in the medicinal plant trade in South Africa and collection of mature individuals from the wild by succulent collectors. Despite being substituted with other species and being cultivated by healers and traders, *H. limifolia* remains a popular medicinal plant species and the long term protection of the plants in the wild, even in protected areas is not guaranteed.[16] Research by Raimondo et al.[14] revealed that the area of occupancy and extent of occurrence of the species are less than 0.0025 km², and the total population size at its only known localities is estimated to be 4000 to 5000 mature individuals. *Haworthiopsis limifolia* is sold as herbal medicine in informal herbal medicine markets in South Africa and Swaziland.[17-27] *Haworthiopsis limifolia* is grown in home gardens in KwaZulu Natal province in South Africa as herbal medicine and spiritual plant species.[28-30] *Haworthiopsis limifolia* is not only cultivated for its medicinal applications, but the species is also grown and managed in home gardens for its aesthetic value as an ornamental plant.[31-33] *Haworthiopsis limifolia* has potential to be commercially produced as herbal medicine and ornamental species.[34-36] Micro propagation protocols for *H. limifolia* were developed by Mycock et al.[37] through somatic embryo genesis using leaf explants. Nichols[38] also propagated *H. limifolia* from stem and leaf cuttings in Silverglen Nursery, Chatsworth in KwaZulu-Natal province. *Haworthiopsis limifolia* is therefore, considered a priority species for propagation and conservation considering its importance as both source of traditional medicines and as an ornamental plant species.[39-41] It is within this context that this review was undertaken aimed at reviewing the medicinal uses, phytochemistry and biological activities of *H. limifolia* so as to provide baseline data required in evaluating the therapeutic potential of the species.

Botanical profile of *Haworthiopsis limifolia*

Haworthiopsis limifolia is divided into five varieties, namely *H. limifolia* var. *arcana* (G.F. Smith & N.R. Crouch) G.D. Rowley, *H. limifolia* var. *gigantea* (M.B. Bayer) G.D. Rowley, H. *limifolia* var. *glaucophylla* (M.B. Bayer) G.D. Rowley, *H. limifolia* var. *limifolia* and *H. limifolia* var. *ubomboensis* (I.Verd.) G.D. Rowley.[8,42,43] *Haworthiopsis limifolia* is an acaulescent perennial herb, suckering from the base to form dense clusters. The leaves occur in rosettes, tapering to a sharp point, thick and stiff, uniformly bright green, ridged or smooth on both surfaces but obscurely keeled towards the apex on the lower surface. The inflorescence is simple, erect and not showy

with white flowers. *Haworthiopsis limifolia* has been recorded in Mozambique, South Africa and Swaziland at an altitude ranging from 300 m to 1500 m above sea level.[42-45]

Medicinal uses of *Haworthiopsis limifolia*

The leaves, roots and whole plant parts of *H. limifolia* are mainly used as herbal medicines for fertility problems, sores, purifying blood, cough, skin rashes, sun burns, burns, gastro-intestinal problems and as a protective charm (Table 1, Figure 1). Research by Nemudzudzanyi et al.[30] conducted in KwaZulu Natal province showed that *H. limifolia* is grown in old containers or pots and suspended from the roof adjacent to the kitchen door or placed on poles at the front door as protection against evil spirits.

Table 1: Medicinal uses of *Haworthiopsis limifolia*

Medicinal use	Parts used	Country	References
Blood purifiers	Leaves and whole plant	India and South Africa	Naidoo and Coopoosamy[26]; Coopoosamy and Naidoo[27]; Coopoosamy and Naidoo[46]; Ghulan et al.[47]
Boils	Whole plant	South Africa	Ghulan et al.[47]
Burns	Leaves and whole plant	India and South Africa	Naidoo and Coopoosamy[26]; Coopoosamy and Naidoo[27]; Coopoosamy and Naidoo[46]; Ghulan et al.[47]; Coopoosamy and Naidoo[48]; Sharma et al.[49]
Cough	Leaves and whole plant	India and South Africa	Coopoosamy and Naidoo[27]; Coopoosamy and Naidoo[46]; Coopoosamy and Naidoo[48]; Sharma et al.[49]
Fertility problems (women and cattle)	Leaves and whole plant	South Africa	Naidoo and Coopoosamy[26]; Ghulan et al.[47]; Coopoosamy and Naidoo[48]
Fractures	Whole plant	South Africa	Ghulan et al.[47]
Gastro-intestinal problems (cleansing digestive system, constipation, diarrhoea, dysentery and indigestion and stomach problems)	Leaves, roots and whole plant	South Africa and Swaziland	Ndawonde et al.[25]; Naidoo and Coopoosamy[26]; Ghulan et al.[47]; Coopoosamy and Naidoo[48]; Hutchings[50]; Hannweg[51]; Hutchings et al.[52]; Long[53]; Fawole et al.[54]; Fawole et al.[55]
Haemorrhoids	Leaves	South Africa	Hutchings[50]; Hannweg[51]
Internal tumours	Whole plant	South Africa	Ghulan et al.[47]
Nausea	Leaves	South Africa	Hutchings[50]; Hannweg[51]
Protective charm (repels enemies, evil spirits, lightning, snakes and storms and bring luck)	Roots and whole plant	South Africa and Swaziland	Ndawonde[24]; Ndawonde et al.[25]; Naidoo and Coopoosamy[26]; Zobolo and Mkabela[29]; Coopoosamy and Naidoo[46]; Coopoosamy and Naidoo[48]; Hutchings[50]; Hannweg[51]; Long[53]; Koopman[56]
Skin rashes	Leaves and whole plant	India and South Africa	Coopoosamy and Naidoo[27]; Coopoosamy and Naidoo[46]; Coopoosamy and Naidoo[48]; Sharma et al.[49]
Sores	Leaves and whole plant	South Africa	Naidoo and Coopoosamy[26]; Coopoosamy and Naidoo[46]; Ghulan et al.[47]; Coopoosamy and Naidoo[48]
Sprains	Whole plant	South Africa	Ghulan et al.[47]
Sun burns	Leaves and whole plant	India and South Africa	Naidoo and Coopoosamy[26]; Coopoosamy and Naidoo[27]; Coopoosamy and Naidoo[46]; Coopoosamy and Naidoo[48]; Sharma et al.[49]
Worms	Leaves	South Africa	Hutchings[50]; Hannweg[51]

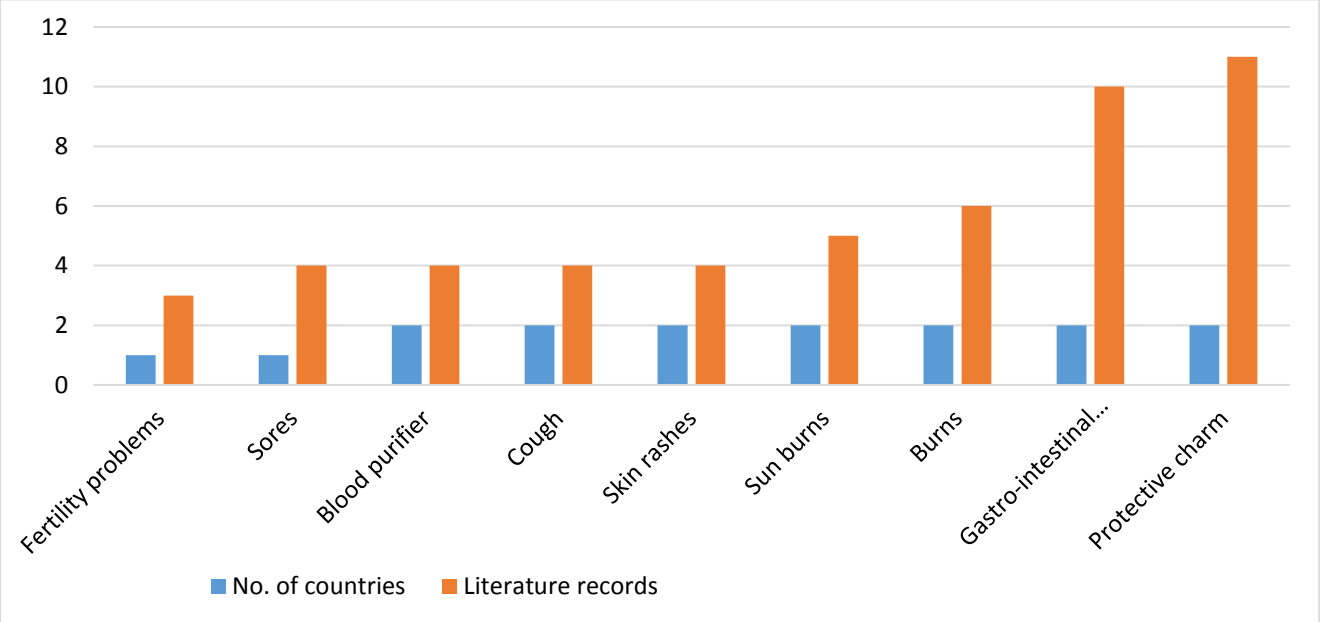

Figure 1. Medicinal applications of *Haworthiopsis limifolia* derived from literature records

Phytochemistry of *Haworthiopsis limifolia*

Fawole et al.[55] identified alkaloids and saponins from the leaves of *H. limifolia*. El Shamy et al.[33] identified carbohydrates, glycosides, flavonoids, polyphenols, sterols, tannins and anthraquinones from the aerial parts of *H. limifolia* (Table 2). Fahmy[57] identified carbohydrates, fatty acids, flavonoids, polyphenols and sterols from the aerial parts of *H. limifolia* (Table 2). Some of the pharmacological activities associated with *H. limifolia* could be attributed to the documented phytochemical compounds.

Table 2: Phytochemical composition of *Haworthiopsis limifolia*

Phytochemical and nutritional composition	Value	Plant part	Reference
3,4,5-methoxy-cinnamic acid (mg/100g)	45.0	Aerial parts	El Shamy et al.[33]
3-OH tyrosol (mg/100g)	53.8	Aerial parts	El Shamy et al.[33]
4-amino-benzoic acid (mg/100g)	3.8	Aerial parts	El Shamy et al.[33]
4,6,9-trihydroxy,2,8-dimethyl-3,4-dihydroanthracene-1(2H)-one	-	Aerial parts	Fahmy[57]
5-hydroxyaloin A-2′-*O*-sinapoyl-6′- *O*-acetate	-	Aerial parts	Fahmy[57]
5-hydroxyaloin A 6`-*O*-acetate	-	Aerial parts	Fahmy[57]
5-hydroxyaloin A 6`-*O*-sinapoyl	-	Aerial parts	Fahmy[57]
α-coumaric acid (mg/100g)	161.6	Aerial parts	El Shamy et al.[33]
β-sitosterol	-	Aerial parts	Fahmy[57]
p-coumaric acid (mg/100g)	83.1	Aerial parts	El Shamy et al.[33]
p-OH-benzoic acid (mg/100g)	62.7	Aerial parts	El Shamy et al.[33]
Aloctin A	-	Leaves	Coopoosamy and Naidoo[46]
Aloctin B	-	Leaves	Coopoosamy and Naidoo[46]
Apigenin (mg/100g)	69.7	Aerial parts	El Shamy et al.[33]
Arabinose	-	Aerial parts	Fahmy[57]
Benzene-1-butylheptyl (%)	16.7	Aerial parts	Fahmy[57]
Benzene-1-butyloctyl (%)	8.8	Aerial parts	Fahmy[57]
Benzene-1-pentylheptyl (%)	9.6	Aerial parts	Fahmy[57]
Caffeic acid (mg/100g)	12.7	Aerial parts	El Shamy et al.[33]
Catechin (mg/100g)	153.1	Aerial parts	El Shamy et al.[33]
Catechol (mg/100g)	47.0	Aerial parts	El Shamy et al.[33]
Chlorogenic acid (mg/100g)	80.0	Aerial parts	El Shamy et al.[33]
Cinnamic acid (mg/100g)	40.0	Aerial parts	El Shamy et al.[33]
Condensed tannin (%)	0.1	Leaves	Fawole et al.[55]
Diheptyl phthalate	-	Aerial parts	Fahmy[57]
Dihydroanthracenone	-	Aerial parts	Fahmy[57]
Ellagic acid (mg/100g)	34.7	Aerial parts	El Shamy et al.[33]
Ferulic acid (mg/100g)	26.5	Aerial parts	El Shamy et al.[33]
Flavonoid (mg catechin equivalent/ g dry weight)	0.4 – 3.1	Leaves	Ghuman et al.[47]; Fawole et al.[55]
Galactose	-	Aerial parts	Fahmy[57]
Galacturonic acid (%)	1.4	Aerial parts	El Shamy et al.[33]
Gallic acid (mg/100g)	17.3	Aerial parts	El Shamy et al.[33]
Gallotannin (μg GAE/ g dry weight)	0.3	Leaves	Fawole et al.[55]
Glucose (%)	0.02	Aerial parts	El Shamy et al.[33]; Fahmy[57]
Glucuronic acid (%)	0.9	Aerial parts	El Shamy et al.[33]
Hesperetin (mg/100g)	646.5	Aerial parts	El Shamy et al.[33]
Hesperidin (mg/100g)	95.5	Aerial parts	El Shamy et al.[33]
Iso-ferulic acid (mg/100g)	14.1	Aerial parts	El Shamy et al.[33]
Kaempferol (mg/100g)	246.1	Aerial parts	El Shamy et al.[33]
Linoleic acid	-	Aerial parts	Fahmy[57]
Luteolin (mg/100g)	29.6	Aerial parts	El Shamy et al.[33]
Methyl palmitate	-	Aerial parts	Fahmy[57]
Naringin (mg/100g)	80.0	Aerial parts	El Shamy et al.[33]
Oleic acid	-	Aerial parts	Fahmy[57]
Proanthocyanidin (μg LCE/g dry weight)	3.0	Leaves	Ghuman et al.[47]
Protocatechuic acid (mg/100g)	39.9	Aerial parts	El Shamy et al.[33]
Pyrogallol (mg/100g)	67.3	Aerial parts	El Shamy et al.[33]

Phytochemical and nutritional composition	Value	Plant part	Reference
Quercitrin (mg/100g)	887.6	Aerial parts	El Shamy et al.[33]
Quercetin (mg/100g)	173.5	Aerial parts	El Shamy et al.[33]
Resveratrol (mg/100g)	48.9	Aerial parts	El Shamy et al.[33]
Rhamnose	-	Aerial parts	Fahmy[57]
Rosmarinic acid (mg/100g)	98.2	Aerial parts	El Shamy et al.[33]
Rutin (mg/100g)	165.1	Aerial parts	El Shamy et al.[33]
Salicylic acid (mg/100g)	5666.7	Aerial parts	El Shamy et al.[33]
Stachyose (%)	2.8	Aerial parts	El Shamy et al.[33]
Sucrose (%)	0.01	Aerial parts	El Shamy et al.[33]
Tannin (%)	8.0	Aerial parts	El Shamy et al.[33]; Fahmy[57]
Total phenolics (mg GAE/ g dry weight)	4.5 – 7.0	Leaves	Ghuman et al.[47]; Fawole et al.[55]
Vanillic acid (mg/100g)	1730.8	Aerial parts	El Shamy et al.[33]

Biological activities of *Haworthiopsis limifolia*

The following biological activities have been reported from the aerial parts and leaf extracts of *H. limifolia* and compounds isolated from the species: antibacterial,[47,48,54,55,57] antifungal,[26,47,48,54,55,57] anti-inflammatory,[55,57,58] antioxidant,[33,58] wound healing,[46,58] hemagglutinating and agglutination[46] and cytotoxicity[47,57,58] activities.

Antibacterial activities

Fawole et al.[54] and Fawole et al.[55] evaluated antibacterial activities of petroleum ether, dichloromethane, 70% ethanol and aqueous leaf extracts of *H. limifolia* against *Bacillus subtilis, Staphylococcus aureus* and *Escherichia coli* using the microdilution assay with neomycin (100 µg/ml) as a positive control. All extracts with the exception of aqueous extracts exhibited activities against tested pathogens with minimal inhibitory concentration (MIC) values ranging from 0.1 mg/ml to 3.1 mg/ml.[54,55] Coopoosamy and Naidoo[48] evaluated antibacterial activities of aqueous, acetone and ethyl acetate leaf extracts of *H. limifolia* against *Bacillus subtilis, Micrococcus kristinae, Bacillus cereus, Staphylococcus aereus, Staphylococcus epidermidis, Escherichia coli, Proteus vulgaris, Enterobacter aerogenes* and *Shigella sonnei* using micro dilution method with chloramphenicol and streptomycin sulphate as positive controls. The extracts exhibited activities against most of the tested pathogens with the exception of *Proteus vulgaris, Enterobacter aerogenes* and *Shigella sonnei* which exhibited the MIC values ranging from 3.0 mg/ml to 8.5 mg/ml.[48] Ghuman et al.[47] evaluated antibacterial activities of hexane, chloroform, dichloromethane, acetone and methanol leaf extracts of *H. limifolia* against *Actinomycetes brasielensis, Bacillus subtilus, Micrococcus* spp., *Staphylococcus aureus, Staphylococcus epidermidis, Streptococcus pneumonia, Streptococcus pyogenes, Enterobacter aerogenes, Klebsiella pneumoniae, Pseudomonas aeruginosa, Shigella sonnei, Proteus mirabilis* and *Proteus vulgaris* using the disc diffusion method with neomycin (0.1µg/mL) as a positive control. Only chloroform and hexane extracts exhibited activities with MIC values ranging from 0.6 mg/mL to 2.5 mg/mL.[47] Fahmy[57] evaluated antibacterial activities of methanolic extract of the aerial parts of *H. limifolia* exhibiting potent antibacterial effect against *Klebsiella pneumoniae*, where its effect exceeded that of the positive control gentamycin at 100.5%. The effect of the extract was close to that of gentamycin at 94.1% against *Enterobacter cloacae* and 72.5% against *Escherichia coli*. The antibacterial activities of the extract was very close to that of the positive control, ampicillin at 90.2% against *Bacillus subtilus,* 87.8% and 74.1% against *Enterococcus faecalis* and *Staphylococcus aureus*, respectively.[57]

Antifungal activities

Fawole et al.[54] and Fawole et al.[55] evaluated antifungal activities of petroleum ether, dichloromethane, 70% ethanol and aqueous leaf extracts of *H. limifolia* against *Candida albicans* using the micro dilution assay with amphotericin B as a positive control. All extracts with the exception of aqueous extract exhibited activities against tested pathogens with MIC values ranging from 4.7 mg/ml to 6.3 mg/ml and minimum fungicidal concentration (MFC) value of 6.3 mg/ml.[54,55] Coopoosamy and Naidoo[49] and Naidoo and Coopoosamy[26] evaluated antifungal activities of aqueous and ethanol leaf extracts of *H. limifolia* against *Aspergillus flavus, Aspergillus glaucus, Candida albicans, Candida tropicalis, Trichophyton mentagrophytes* and *Trichophyton rubrum*. The extracts exhibited activities against the tested fungal species.[26,48] Ghuman et al.[47] evaluated antifungal activities of hexane, chloroform, dichloromethane, acetone and methanol leaf extracts of *H. limifolia* against *Trichophyton rubrum, Trichophyton mentagrophytes, Candida albicans* and *Candida tropicalis* using the disc diffusion method with amphotericin B (0.1µg/mL) as a positive control. Only chloroform and hexane extracts exhibited activities with MIC value of 0.6 mg/mL.[47] Fahmy[57] evaluated antifungal activities of methanolic extract of the aerial parts of *H. limifolia* exhibiting potent antifungal effects against *Aspergillus fumigatus,* where its effect was comparable to that of the positive control amphotericin B. at 86.9%. The antifungal activities of the extract were very close to that of amphotericin B at 76.6% against *Syncephalastrum racemosum* and 63.7% against *Geotricum candidum* and extract showed no activities against *Candida albicans.*

Anti-inflammatory activities

Fawole et al.[55] evaluated anti-inflammatory activities of *H. limifolia* by assessing the ability of dichloromethane, ethanol, petroleum ether and water leaf extracts of the species to inhibit cyclooxygenase 1 and 2 (COX 1 and COX 2) enzymes. All dichloromethane and petroleum ether extracts showed good activities against both COX 1 and COX 2 enzymes with inhibition of prostaglandin synthesis of 72.3% to 88.3% at the highest test concentration of 250 µg/mL.[55] Fahmy[57] evaluated anti-inflammatory activities of *H. limifolia* by assessing the ability of methanol aerial parts extract of the species to inhibit COX 2 enzymes with ibuprofen as a positive control. The COX 2 inhibitory activities of the extract was very potent with a very close half maximal inhibitory concentration (IC_{50}) value of 19.15 µg/ml to that of ibuprofen which exhibited 18.5 µg/ml. Ghuman et al.[58] evaluated the anti-inflammatory activities of methanol leaf extracts of *H. limifolia* using the nitric oxide release and lipoxygenase inhibition assays with quercetin as a positive control. The extract exhibited IC_{50} value >100.0 µg/mL which was much higher than IC_{50} value of 6.30 µg/mL exhibited by the positive control. The extract exhibited weak activities for lipoxygenase with IC_{50} value of >100.0 µg/mL in comparison to 15.9 µg/mL exhibited by the positive control.[58]

Antioxidant activities

El Shamy et al.[33] evaluated the antioxidant activities of methanolic aerial parts extracts of *H. limifolia* using the 2,2-diphenyl-1-picryhydrazyl (DPPH) radical scavenging assay with ascorbic acid as a positive control. The extract at a concentration of 2560.0 µg exhibited DPPH scavenging activity of 81.2% which was comparable to 92.5% exhibited by the control at the same concentration. The IC_{50} value exhibited by the extract was 143.6 µg/ml which was higher than 14.2 µg/ml exhibited by the control.[33] Ghuman et al.[58] evaluated the antioxidant activities of methanol leaf extracts of *H. limifolia* using the DPPH free radical scavenging, ferric-reducing antioxidant power (FRAP) and β-carotene linoleic acid model system (CLAMS) assays with ascorbic acid, butylated hydroxytolulene and quercetin as positive controls. The extract exhibited DPPH scavenging activities with half maximal effective concentration (EC_{50}) value of 0.3 µg/mL which was higher than 0.07 µg/mL exhibited by the positive control. The percentage activity of antioxidants based on the average proportion of heat-induced β-carotene bleaching was 81.6% which was higher than 76.7% exhibited by the positive control. The extract showed some chelating ability at concentrations below 0.1 mg/mL comparable to that of the ascorbic acid control.[58]

Wound healing activities

Coopoosamy and Naidoo[46] evaluated the wound healing activities of lectins or lectin like derivatives isolated from *H. limifolia*. Superficial administration of aloctin A isolated from *H. limifolia* to the infected area of the rat effectively suppressed the swelling in the injured foot and on the inflamed lesions. Hind paw edema was induced by subcutaneous injection of carrageenin solution into the hind foot pads of rats. Administration of aloctin A markedly inhibited carrageenin induced edema. Studies by Coopoosamy and Naidoo[46] showed that administration of aloctin A at all dose levels effectively suppresses the swelling of adjuvant arthritis, with the optimal dose of 5 mg/kg/day of the extract. Ghuman et al.[58] evaluated the wound healing activities of methanol leaf extracts of *H. limifolia* using the protein precipitable phenolics capacity assay as a wound healing model. The protein-precipitating capacity as a wound healing model was significant for *H. limifolia* at 82.7%.[58]

Hemagglutinating and agglutination activities

Coopoosamy and Naidoo[46] evaluated the hemagglutinating and agglutination activities of lectins or lectin like derivatives isolated from *H. limifolia* against rat, rabbit and human serum. Aloctin A and aloctin B exhibited hemagglutinating and agglutination activities which increased proportionally when 0.1% trypsin was added to the treatment of rat serum as compared with that of untreated erythrocytes.[46]

Cytotoxicity activities

Ghuman et al.[47] evaluated the cytotoxicity activities of aqueous leaf extracts of *H. limifolia* using the brine shrimp (*Artemia salina*) assay with organophosphate as a positive control. The cytotoxicity results of the extract was in the range of 90% to 100% survival after 24 hours with the median lethal concentration (LC_{50}) value of >2.0 mg/mL indicating that the extract is not cytotoxic.[47] Ghuman et al.[47] also evaluated the cytotoxicity activities of aqueous leaf extracts of *H. limifolia* against African green monkey Vero kidney cells using the MTT colorimetric assay (3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide) assay with doxorubicin as a positive control. The extract exhibited LC_{50} value of >1.0 mg/mL indicating that the extract is not cytotoxic.[47] Fahmy[57] evaluated the cytotoxicity activities of methanolic extract of the aerial parts of *H. limifolia* against human hepatocellular carcinoma (HepG2), breast carcinoma (MCF-7) and colon carcinoma (HCT-116) cells. The extract exhibited IC_{50} values ranging from 72 µg/well to >100 µg/well. Ghuman et al.[58] evaluated the cytotoxicity activities of methanol leaf extracts of *H. limifolia* using the MTT colorimetric assay with quercetin as a positive control. The extract exhibited cell viability of 70.0% to 80.0%.[58]

CONCLUSION

The present review summarizes the ethnomedicinal uses, phytochemistry and biological activities of the leaves, roots and whole plant parts of *H. limifolia*. The historical traditional usage of *H. limifolia* as herbal medicine in southern Africa calls for detailed phytochemical and pharmacological studies aimed at correlating its documented ethnomedicinal uses with the phytochemical and pharmacological properties of the species. There is need for clinical and toxicological evaluations of both crude extracts and phytochemical compounds associated with *H. limifolia*.

Conflict of interest

The author declares that he has no conflict of interest.

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