A Review of Medicinal Uses, Phytochemistry and Biological Activities of *Bolusanthus speciosus* (Bolus) Harms (Fabaceae)

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Abstract: *Bolusanthus speciosus* (Bolus) Harms is a deciduous and ornamental tree with its different parts used traditionally to treat various diseases. The main aim of this review is to provide an overview and critical analysis of the medicinal uses, phytochemistry, and biological activities of *B. speciosus*. The information presented in this study was gathered using various databases such as PubMed, Taylor and Francis imprints, Springer, NCBI, Google scholar and Science direct, and review of books, journal articles and other scientific publications kept in the university library. The articles published between 1933 and 2020 were used in this study. The bark, leaf and stem infusion of *B. speciosus* are mainly used for cleansing blood and as an emetic, and a traditional medicine for abdominal pains, kidney problems, sexually transmitted infections and stomach problems. Phytochemical compounds identified from the leaves, root bark, root wood, seeds and stem bark of *B. speciosus* include alkaloids, essential oils, flavonoids, phenolics, saponins and tannins. The biological activities exhibited by *B. speciosus* and the phytochemical compounds isolated from the species include anti-arthritic, antibacterial, antigonococcal, antimycobacterial, antifungal, anti-HIV, anti-inflammatory and antioxidant activities. Future research should focus on toxicological screening, *in vivo* studies and clinical trials involving the crude extracts and phytochemical compounds isolated from the species.

Keywords: *Bolusanthus speciosus*, Fabaceae, indigenous knowledge, southern Africa, traditional medicine.

INTRODUCTION

Bolusanthus speciosus (Bolus) Harms is a deciduous tree indigenous to Botswana, Eswatini, South Africa, Malawi, Botswana, Zimbabwe, Mozambique and Zambia [1-7]. The species has also been introduced in Uganda, Australia, India, Kenya and several other countries throughout the world as an ornamental plant [8]. The genus *Bolusanthus* Harms comprises of a single species and the genus name is in the honour of Dr Harry Bolus (1834-1911), a South African businessman, botanist, botanical artist and founder of the Bolus Herbarium in Cape Town, South Africa [9]. The specific name "*speciosus*" is the Latin word for "beautiful" or "splendid" as the species is horticulturally attractive and showy [10]. The synonym of *B. speciosus* is *Lonchocarpus speciosus* Bolus while the English common names of the species include "elephant wood", "Rhodesian wistaria", "South African wistaria", "tree wistaria" and "wild wistaria". *Bolusanthus speciosus* is a small deciduous tree, usually multi-stemmed with narrow crown and drooping foliage. The bark of *B. speciosus* on young branches is smooth and grey, but dark grey to black, rough and deeply fissured longitudinally on older branches and stems. The leaves are spirally arranged and imparipinnate with lanceolate leaflets, which are greyish green in colour with minute silvery hairs above and dull green below. The flowers of *B. speciosus* occur in loose, hanging racemes and are pale blue to deep mauve in colour. The fruit is a narrow, thin and flat non-splitting pod, which is straw-coloured to grey-brown when ripe. *Bolusanthus speciosus* has been recorded in granite basaltic, heavy alkaline clay, limestone and calcareous soils in bushveld, thicket and open woodland and wooded grassland at an altitude ranging from 15 m to 1400 m above sea level [11-15]. Apart from being used as medicinal plant, *B. speciosus* is also an important forage plant throughout its distributional range in southern Africa [16]. Moreover, there is a patent registered in 1996 highlighting the potential clinical applications of a dihydro-isoflavonone compound isolated from the leaves, roots and stem bark of *B. speciosus,* which exhibited anti-HIV and anti-cancer activities [17]. It is this background that formed the basis of this study aimed at providing an overview of the medicinal uses, phytochemistry and biological activities of *B. speciosus*.

Medicinal Uses

The bark, leaf and stem infusion of *B. speciosus* are mainly used for cleansing blood and as an emetic, and a traditional medicine for abdominal pains, kidney problems, sexually transmitted infections (including venereal diseases) and stomach problems (Table **1**; Figure **1**). Other minor medicinal uses of *B. speciosus* supported by at least one literature report include the use of the bark, leaf and stem infusion to induce sleeping [18] and vomiting [8], an ethnoveterinary

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Table 1: Medicinal Uses of *Bolusanthus speciosus*

Medicinal use	Part used	Country	Reference
Abdominal pains	Bark and root decoction taken orally	Eswatini, Malawi and South Africa	[8,10,21-27]
Ascites	Root infusion taken orally	Eswatini	[20]
Bile emesis (vomiting bile)	Leaf decoction taken orally	Zimbabwe	[21]
Cleansing blood	Bark, leaf and stem infusion applied as an enema	South Africa	[28-30]
Emetic	Root decoction taken orally	South Africa and Zimbabwe	[21,26]
Induce sleeping	Root infusion taken orally	South Africa	[18]
Kidney problems	Bark, leaf and stem infusion applied as an enema	South Africa	[28-30]
Sexually transmitted infections (including venereal diseases)	Bark, leaf and stem infusion applied as an enema	South Africa	[28-30]
Sterility	Roots mixed with the latex of *Tabernaemontana elegans* Stapf	Zimbabwe	[21]
Stomach problems	Bark and root decoction taken orally	Eswatini and South Africa	[8,23,24,26,31]
Vomiting	Leaf infusion taken orally	Zimbabwe	[8]
Ethnoveterinary medicine (retained placenta)	Roots	South Africa	[19]

medicine to expel retained placenta [19], and as a traditional medicine against ascites [20] and bile emesis [21]. In Zimbabwe, the roots of *B. speciosus* are mixed with the latex of *Tabernaemontana elegans* Stapf as a traditional medicine for sterility [21].

Nutritional and Phytochemical Composition

Researchers such as Aganga *et al.* [15], Mulaudzi *et al*. [29] and Vambe *et al.* [30] investigated the nutritional properties of *B. speciosus* bark, leaves and stems (Table **2**). This wide variety of nutrients such as calcium, copper, crude fibre, fat, iron, magnesium, manganese, phosphorus, proteins and zinc imply that the species could be a source of health promoting nutrients to animals that consume the species as fodder. Phytochemical compounds identified from the leaves, root bark, root wood, seeds and stem bark of *B. speciosus* include alkaloids, essential oils, flavonoids, phenolics, saponins and tannins [29,30,32-38].

Pharmacological Properties

The following pharmacological activities have been documented from bark, leaves and stems, and phytochemical compounds isolated from *B. speciosus*: anti-arthritic, antibacterial, antigonococcal, antimycobacterial, antifungal, anti-HIV, anti-inflammatory and antioxidant activities.

Anti-Arthritic Activities

Elisha *et al.* [39] evaluated the anti-arthritic activities of acetone extract of *B. speciosus* leaves using an

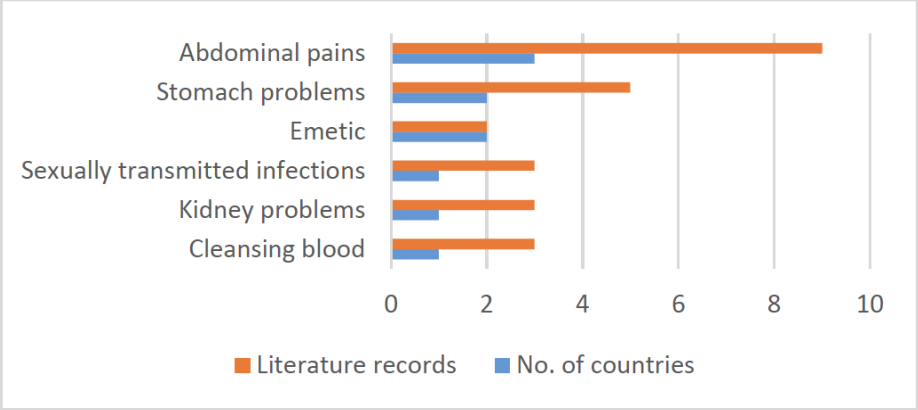

Figure 1: Major medicinal uses of *Bolusanthus speciosus* in southern Africa.

Table 2: Nutritional and Phytochemical Composition of *Bolusanthus speciosus*

Nutritional and phytochemical composition	Value	Plant part	Reference
Nutritional component			
Acid detergent fibre (%)	19.3	Leaves	[15]
Ash (g/kg dry matter)	2.1	Leaves	[15]
Calcium (%)	0.1	Leaves	[15]
Condensed tannins (% LCE)	0.04	Leaves	[29]
Copper (ppm)	13.0	Leaves	[15]
Crude fat (g/kg dry matter)	10.2	Leaves	[15]
Crude protein (g/kg dry matter)	13.6	Leaves	[15]
Dry matter (%)	98.3	Leaves	[15]
Flavonoids (µg CAE/g)	0.04 – 0.3	Bark, leaves and stems	[29]
Gallotannin (µg GAE/g)	3.1 – 5.8	Bark, leaves and stems	[29]
In vitro true dry matter digestibility (%)	97.0	Leaves	[15]
Iron (ppm)	29.0	Leaves	[15]
Magnesium (%)	0.09	Leaves	[15]
Manganese (ppm)	27.0	Leaves	[15]
Neutral detergent fibre (%)	6.7	Leaves	[15]
Phosphorus (%)	0.3	Leaves	[15]
Tannins (%)	1.4	Leaves	[15]
Total flavonoids (mg CE/g)	5.0	Bark	[30]
Zinc (ppm)	0.3	Leaves	[15]
Phytochemical compounds			
1-ethyl-3-methylbenzene (%)	1.6	Stem bark	[38]
1,2,3-trimethylbenzene (%)	0.9	Stem bark	[38]
1,2,3,4-tetrahydro-1,6-dimethyl-4-(1-methylethyl)-,(1S-cis)-naphthalene (%)	4.3	Stem bark	[38]
1,3-dimethylbenzene (%)	39.2	Stem bark	[38]
1-methyl-3-(1-methylethyl)-benzene (%)	0.2	Stem bark	[38]
2-Naphthalenemethanol, decahydro-α,α,4a-trimethyl-8-methylene-, [2R-(2α,4α,8β] (%)	1.0	Stem bark	[38]
3'-O-methylorobol	-	Seeds	[32]
3'-O-methylpratensein	-	Seeds	[32]
3-hydroxyisoflavanone bolusanthin	-	Seeds	[32]
5,6-dehydrolupanine	-	Leaves, seeds and stem bark	[33]
3,5,7,3',4'-pentahydroxy-6-γ,γ-dimethylallylflavone	-	Stem bark	[34]
4,2',3',4'-tetrahydroxy-6,7-methylenedioxyisoflavonol	-	Root bark	[36]
4,7,2'-trihydroxy-4'-methoxyisoflavanol	-	Root bark and stem bark	[35,36]
5,7,2'-trihydroxy-4'-methoxy-6,5'-diprenylisoflavanone	-	Root bark	[36]
5,7,2'-trihydroxy-4'-methoxy-6,5'-di(γ,γ-dimethylallyl)isoflavanone	-	Root bark and stem bark	[34-36]
5,7,2',4'-tetrahydroxy-8,3'-diprenylisoflavanone	-	Root bark	[36]
5,7,2',4'-tetrahydroxy-8,3'-di(γ,γ-dimethylallyl)isoflavanone	-	Root bark and stem bark	[34-36]
5,7,2',4'-tetrahydroxy-8,5'-di(γ,γ-dimethylallyl)flavavone	-	Stem bark	[35]
5,7,3'-trihydroxy-4'-methoxy-5'-γ,γ-dimethylallylisoflavanone	-	Root bark and stem bark	[34-36]
5,7,3'-trihydroxy-4'-methoxy-5'-prenylisoflavanone	-	Root bark	[36]

(Table 2). Continued.

Nutritional and phytochemical composition	Value	Plant part	Reference
5,7,3',4'-tetrahydroxy-5'-(2-epoxy-3-methylbutyl)isoflavanone	-	Stem bark	[35]
5,7,3',4'-tetrahydroxy-5'-(2,3-epoxy-3-methylbutyl)isoflavanone	-	Root bark	[36]
5,7,3',4'-tetrahydroxy-5'-γ,γ-dimethylallyl-isoflavanone	-	Root bark	[36]
5,7,4'-trihydroxy-6,3'-di(γ,γ-dimethylallyl)isoflavanone	-	Root bark	[36]
6β-hydroxylupanine	-	Leaves	[33]
7-hydroxy-4'-methoxyisoflavone	-	Root wood	[37]
7,3'-dihydroxy-4'-methoxyisoflavone	-	Root wood	[37]
11α-allylcytisine	-	Leaves, seeds and stem bark	[33]
13-hydroxyanagyrine	-	Leaves, seeds and stem bark	[33]
Acetic acid, butyl ester (%)	5.7	Stem bark	[38]
Anagyrine	-	Leaves, seeds and stem bark	[33]
Azulene (%)	0.1	Stem bark	[38]
Biochanin A	-	Seeds	[32]
Bolucarpan A - D	-	Root bark	[36]
Bolusanthin II - IV	-	Root bark	[36,37]
Bolusanthols A - C	-	Stem bark	[34]
Caryophyllene (%)	16.3	Stem bark	[38]
α-caryophylene (%)	1.0	Stem bark	[38]
α-cubebene (%)	0.1	Stem bark	[38]
Cytisine	-	Leaves, seeds and stem bark	[33]
Derrone	-	Root bark, root wood and stem bark	[35-37]
Ethylbenzene (%)	8.3	Stem bark	[38]
Gancaonin C	-	Root wood	[37]
Genistein	-	Root wood and seeds	[32,37]
β-isosparteine	-	Leaves and seeds	[33]
Isogancaonin C	-	Root wood	[37]
Lupanine	-	Leaves and seeds	[33]
Lupiwighteone	-	Root wood	[37]
Medicarpan	-	Root wood	[37]
N-methylcytisine	-	Leaves, seeds and stem bark	[33]
Orobol	-	Seeds	[32]
Pratensein	-	Seeds	[32]
p-Xylene (%)	9.1	Stem bark	[38]
Sparteine	-	Leaves, seeds and stem bark	[33]
Total phenolics (mg GAE/g)	8.7 – 15.0	Bark, leaves and stems	[29,30]
Wighteone	-	Root wood	[37]

anti-protein denaturation assay with diclofenac sodium as a positive control. The extract exhibited dose dependent activities and exhibited the half maximal inhibitory concentration (IC_{50}) value of 110.0 µg/ml, which was higher than the IC_{50} value of 32.4 µg/ml exhibited by the positive control [39].

Antibacterial Activities

Bojase *et al.* [35] evaluated the antibacterial activities of the isoflavanoid compounds, 4,7,2'-trihydroxy-4'-methoxyisoflavanol and 5,7,3',4'-tetrahydroxy-5'-(2-epoxy-3-methylbutyl)isoflavanone

isolated from the stem bark of *B. speciosus* against *Escherichia coli, Bacillus subtilis* and *Staphylococcus aureus* using the TLC bioautography technique with chloramphenicol as a positive control. The compound 5,7,3',4'-tetrahydroxy-5'-(2-epoxy-3-methylbutyl)isoflavanone exhibited the best activities against the tested pathogens with minimum inhibitory concentration (MIC) values ranging from 1.0 µg to 10.0 µg [35]. Bojase *et al.* [36] evaluated the antibacterial activities of the compounds bolusanthin II, bolucarpan A, bolucarpan B, bolucarpan C, bolucarpan D, 5,7,3'-trihydroxy-4'-methoxy-5'-prenylisoflavanone, 5,7,2'-trihydroxy-4'-methoxy-6,5'-diprenylisoflavanone, 5,7,2',4'-tetrahydroxy-8,3'-diprenylisoflavanone, 4,2',3',4'-tetrahydroxy-6,7-methylenedioxyisoflavonol, 4,7,2'-trihydroxy-4'-methoxyisoflavanol, 5,7,3',4'-tetrahydroxy-5'-γ,γ-dimethylallyl-isoflavanone, 5,7,4'-trihydroxy-6,3'-di(γ,γ-dimethylallyl)isoflavanone and 5,7,3',4'-tetrahydroxy-5'-(2,3-epoxy-3-methylbutyl)isoflavanone isolated from the root bark of *B. speciosus* against *Escherichia coli, Bacillus subtilis* and *Staphylococcus aureus* using the TLC bioautography technique with chloramphenicol as a positive control. All compounds with the exception of bolucarpan C exhibited activities against the tested pathogens with MIC values ranging from 0.01 µg to 100.0 µg [36]. Erasto *et al.* [37] evaluated the antibacterial activities of the flavonoids, 7-hydroxy-4'-methoxyisoflavone, 7,3'-dihydroxy-4'-methoxyisoflavone, bolusanthin III, bolusanthin IV, derrone, gancaonin C, genistein, isogancaonin C, lupiwighteone, medicarpan and wighteone isolated from the root wood of *B. speciosus* against *Escherichia coli, Bacillus subtilis* and *Staphylococcus aureus* using the TLC bioautography technique with chloramphenicol as a positive control. The compounds exhibited activities against the tested pathogens with the MIC values ranging from 0.1 µg to 100.0 µg [37]. Mulaudzi *et al.* [29] investigated the antibacterial activities of acetone, aqueous, petroleum ether and dichloromethane extracts of *B. speciosus* bark, leaves and stems against *Staphylococcus aureus, Bacillus subtilis, Klebsiella pneumoniae* and *Escherichia coli* using the microdilution method with neomycin as a positive control. The extracts exhibited activities against the tested pathogens with the MIC values ranging from 0.01 mg/ml to >12.0 mg/ml [29]. Elisha *et al.* [40] evaluated the antibacterial activities of acetone extract of *B. speciosus* leaves against *Bacillus anthracis* using the microplate serial dilution method with gentamicin as a positive control. The extract exhibited activities with the MIC value of 0.04 mg/ml and total antibacterial activity of 576.0 ml/g [40]. Elisha *et al.* [41] evaluated the antibacterial activities of acetone extract of *B. speciosus* leaves against *Proteus mirabilis, Stenotrophomonas maltophilia, Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae* and *Salmonella typhimurium* using microdilution method with gentamicin as a positive control. The extract exhibited activities with MIC values ranging from 0.08 mg/ml to 0.6 mg/ml and total antibacterial activity values ranging from 36.6 ml/g to 287.9 ml/g [41]. Elisha *et al.* [42] evaluated the antibacterial activities of acetone extract of *B. speciosus* leaves against *Pseudomonas aeruginosa, Escherichia coli, Enterococcus faecalis, Staphylococcus aureus, Salmonella typhimurium* and *Bacillus cereus* using the microplate serial dilution method with gentamicin as a positive control. The extract exhibited activities with MIC values ranging from 0.08 mg/ml to 0.5 mg/ml and total antibacterial activity ranging from 51.2 ml/g to 287.9 ml/g [42]. Vambe *et al.* [30] evaluated the antibacterial activities of methanol extract of *B. speciosus* bark against multidrug-resistant Escherichia coli and *Klebsiella pneumoniae* using microdilution assay. The authors also evaluated the antibacterial synergistic interactions of the extracts combined with antibiotics, ampicillin, cefotaxime, chloramphenicol and penicillin against *Escherichia coli* and *Klebsiella pneumoniae* using the checkerboard titration method and the time-kill assay. The extract exhibited activities against *Escherichia coli* and *Klebsiella pneumoniae* with MIC values of 0.6 mg/ml and 1.3 mg/ml, respectively. The checkerboard assay detected antibacterial synergistic interactions in combinations with chloramphenicol against *Escherichia coli* [30].

Antigonococcal Activities

Mulaudzi *et al.* [29] evaluated the antigonococcal activities of acetone, petroleum ether and dichloromethane extracts of *B. speciosus* bark, leaves and stems against *Neisseria gonorrhoeae* through determination of clear zones of inhibition with ciprofloxacin as a positive controls. The extracts exhibited moderate to high activities with percentage inhibition ranging from 44.0% to 75.0% [29]. Vambe *et al.* [30] evaluated the antigonococcal activities of water, dichloromethane, methanol and petroleum ether extracts of *B. speciosus* bark against *Neisseria gonorrhoeae* using microdilution and agar disk diffusion techniques. The extracts exhibited activities against the tested pathogen with MIC values ranging from 0.6 mg/ml to >2.5 mg/ml [30].

Antimycobacterial Activities

Elisha *et al.* [43] evaluated the antimycobacterial activities of acetone extract of *B. speciosus* leaves

against *Mycobacterium smegmatis, Mycobacterium aurum* and *Mycobacterium fortuitum* using the microdilution method with rifampicin and streptomycin as positive controls. The extracts exhibited activities against the tested pathogens with MIC values ranging from 1.3 mg/ml to 2.5 mg/ml and the total antimycobacterial activity values ranging from 9.2 ml/g to 18.4 ml/g. The positive controls exhibited the MIC values ranging from 0.01 mg/ml to 0.06 mg/ml [43].

Antifungal Activities

Bojase *et al.* [36] evaluated the antifungal activities of the compounds bolusanthin II, bolucarpan A, bolucarpan B, bolucarpan C, bolucarpan D, 5,7,3'-trihydroxy-4'-methoxy-5'-prenylisoflavanone, 5,7,2'-trihydroxy-4'-methoxy-6,5'-diprenylisoflavanone, 5,7,2',4'-tetrahydroxy-8,3'-diprenylisoflavanone, 4,2',3',4'-tetrahydroxy-6,7-methylenedioxyisoflavonol, 4,7,2'-trihydroxy-4'-methoxyisoflavanol, 5,7,3',4'-tetrahydroxy-5'-γ,γ-dimethylallyl-isoflavanone, 5,7,4'-trihydroxy-6,3'-di(γ,γ-dimethylallyl)isoflavanone and 5,7,3',4'-tetrahydroxy-5'-(2,3-epoxy-3-methylbutyl)isoflavanone isolated from the root bark of *B. speciosus* against *Candida cerevisiae* and *Candida mycoderma* using the TLC bioautography technique with miconazole as a positive control. All the compounds exhibited activities against the tested pathogens with MIC values ranging from 0.01 µg to 10.0 µg [36]. Erasto *et al.* [37] evaluated the antifungal activities of the flavonoids, 7-hydroxy-4'-methoxyisoflavone, 7,3'-dihydroxy-4'-methoxyisoflavone, bolusanthin III, bolusanthin IV, derrone, gancaonin C, genistein, isogancaonin C, lupiwighteone, medicarpan and wighteone isolated from the root wood of *B. speciosus* against *Candida mycoderma* using the TLC bioautography technique with miconazole as a positive control. The compounds exhibited activities against tested pathogen with the MIC values ranging from 0.05 µg to 10.0 µg [37]. Mulaudzi *et al.* [29] investigated the antifungal activities of acetone, aqueous, petroleum ether and dichloromethane extracts of *B. speciosus* bark, leaves and stems against *Candida albicans* using the microdilution method with amphotericin B as a positive control. The extracts exhibited activities against the tested pathogen with MIC and minimum fungicidal concentration (MFC) values ranging from 0.01 mg/ml to 6.3 mg/ml and 0.01 mg/ml to 12.5 mg/ml, respectively [29].

Anti-HIV Activities

Mulaudzi *et al.* [29] evaluated the anti-HIV activities of aqueous and methanol extracts of *B. speciosus* bark, leaves and stems against a non-radioactive HIV-1 reverse transcriptase colorimetric ELISA kit with combivir and kaletra as positive controls. The extracts exhibited activities with inhibition percentage of 70.0% at 1.0 mg/ml and IC_{50} values ranging from 0.03 mg/ml to 0.4 mg/ml, which were comparable to IC_{50} values of 0.06 mg/ml to 0.3 mg/ml exhibited by the positive control [29].

Anti-Inflammatory Activities

Mulaudzi *et al.* [44] evaluated the anti-inflammatory activities of 80% ethanol, water, dichloromethane and petroleum ether extracts of *B. speciosus* bark, leaves and stems against the cyclooxygenase (COX-1 and COX-2) enzymes. The 80% ethanol, dichloromethane and petroleum ether extracts exhibited activities towards both COX-1 and COX-2 with percentage inhibition of at least 50.0% [44]. Elisha *et al.* [39] evaluated the anti-inflammatory activities of acetone extract of *B. speciosus* leaves by determining the inhibition of nitric oxide production in lipopolysaccharide activated RAW 264.7 macrophages as well as 15-lipoxygenase enzyme inhibition. The extract exhibited activities by inhibiting nitric oxide production in a dose-dependent manner in the LPS-stimulated RAW 264.7 macrophages with NO production of 61.4% at a concentration of 30.0 µg/ml. The extract exhibited activities against 15-lipoxygenase enzyme with an IC_{50} value of 40.0 µg/ml, which was lower than an IC_{50} value of 53.7 µg/ml exhibited by the positive control quercetin [39].

Antioxidant Activities

Erasto *et al.* [37] evaluated the antioxidant activities of the flavonoids, 7-hydroxy-4'-methoxyisoflavone, 7,3'-dihydroxy-4'-methoxyisoflavone, bolusanthin III, bolusanthin IV, derrone, gancaonin C, genistein, isogancaonin C, lupiwighteone, medicarpan and wighteone isolated from the root wood of *B. speciosus* using the 2,2-diphenyl-1-picrylhydrazyl or 2,2-diphenyl-1-(2,4,6-trinitrophenyl)-hydrazyl (DPPH) free radical scavenging and TLC autographic assays with quercetin, gallic acid and ascorbic acid as positive controls. The compounds 7,3'-dihydroxy-4'-methoxyisoflavone, blusanthin III and bolusanthin IV exhibited the best activities with an IC_{50} values in DPPH ranging from 11.0 µg/ml to 150.0 µg/ml and TLC values ranging from 0.1 µg to 0.5 µg [37]. Elisha *et al.* [39] evaluated the antioxidant activities of acetone extract of *B. speciosus* leaves using the 2,2'-azinobis-3-ethylbenzothiazoline-6-sulphonate (ABTS), DPPH free radical scavenging, ferric reducing power (FRAP)

and the trolox equivalent antioxidant capacity (TEAC) assays with ascorbic acid and trolox as positive controls. The extract exhibited activities with an IC_{50} values of 60.0 µg/mL and 115.1 µg/mL in ABTS and DPPH, respectively, which were higher than an IC_{50} values ranging from 2.9 µg/mL to 5.6 µg/mL exhibited by the two positive controls. The FRAP and TEAC values were 0.07 and 0.1, respectively, while the positive controls showed values ranging from 1.0 to 3.7 [39].

CONCLUSION

While several ethnopharmacological studies aimed at evaluating the phytochemical composition and pharmacological properties of crude extracts and compounds isolated from *B. speciosus* have been conducted, few studies focused on toxicological properties of the species. Toxicological screening, *in vivo* studies and clinical trials should ideally be performed in parallel with therapeutic screening studies to allow the safety index to also be reported. In addition to this, it is important to conduct toxicological studies involving more than one toxicity model.

AUTHOR'S CONTRIBUTIONS

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

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this paper.

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