Chemical profile, isolated compounds and biological activities from *Swartzia* spp.: a review

Perfil químico, substâncias isoladas e atividades biológicas de *Swartzia* spp.: uma revisão

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**ABSTRACT**

The neotropical genus *Swartzia* Schreb. (Fabaceae) is an abundant and well distributed taxon. This work aimed to review the chemical and biological data published about *Swartzia* spp. For this purpose, there were screened 199 papers which were found related to keyword “Swartzia” in the scientific database ‘SciFinder’ and also checked up to 9,180 results returned from that same term in ‘Google Scholar’. There were obtained chemical and biological information related to 21 species. Chemical screenings performed with *Swartzia* species allowed to find mostly the chemical classes of: flavonoids, isoflavanones, isoflavones, pterocarpanos, triterpenoids, diterpenoids, steroids and saponins. Isolated compounds and extracts were tested for several biological activities showed to be antifungal, antibacterial, larvicidal and antioxidant.

**Keywords:** *Swartzia*; secondary metabolites; biological activities.

**RESUMO**

O gênero neotropical *Swartzia* Schreb. (Fabaceae) é um táxon abundante e bem distribuído. Este trabalho teve como objetivo revisar os dados químicos e biológicos publicados sobre *Swartzia* spp. Para tanto, foram rastreados 199 artigos encontrados relacionados à palavra-chave “Swartzia” na base de dados científica ‘SciFinder’ e também verificados até 9.180 resultados retornados desse mesmo termo no ‘Google Acadêmico’. Foram obtidas informações químicas e biológicas relacionadas a 21 espécies. As triagens químicas realizadas com espécies de *Swartzia* permitiram encontrar principalmente as classes químicas de: flavonoides, isoflavonanas, isoflavonas, pterocarpanos, triterpenoides, diterpenoides, esteroides e saponinas. Extratos e substâncias isoladas foram testados quanto a diversas atividades biológicas, mostrando-se antifúngica, antibacteriana, larvicida e antioxidante.

**Palavras-chave:** *Swartzia*; metabólitos secundários; atividades biológicas.

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INTRODUCTION

Swartzia Schreb. is a neotropical genus comprehending about 180 species distributed throughout Central and South-America (from southern Mexico and Caribbean islands to southern Brazil and Bolivia), with conspicuous diversity in Amazon (MARQUI et al., 2008; TORKE; SCHAAL, 2008; MAGALHÃES et al., 2010). It belongs to Fabaceae, one of the most abundant in Amazon Basin and the third largest Angiosperm’s family, with approximately 770 genera and 19,500 species, subdivided into six subfamilies: Caesalpinioideae DC., Cercidoideae Legume Phylogeny Working Group (stat. nov.), Detarioideae Burmeist., Dialioideae Legume Phylogeny Working Group (stat. nov.), Duparquetioideae Legume Phylogeny Working Group (stat. nov.), and Papilionoideae DC., the former being the one Swartzia belongs to (MAGALHÃES et al., 2010; THE LEGUME PHYLOGENY WORKING GROUP, 2017; GARCIA et al., 2018). The family Fabaceae is rich in flavonoids, a broadly distributed group of secondary metabolites among Angiosperms. On the other hand, isoflavonoids, a group of phytoalexins (substances that act as defenses against abiotic and biotic elicitors), are mostly found only in Fabaceae (GARCIA et al., 2018).

Swartzia is a well-represented genus in Brazil, with 112 species and most of them with occurrence in the north region (81 species) (Flora e Funga do Brasil, 2023). In the genus Swartzia, in turn, it has been frequently found isoflavonoids, diterpenoids and saponins, with antimicrobial and antifungal activity associated (MARQUI et al., 2008; MAGALHÃES et al., 2010). This study aims to present the most recent review for all the substances isolated from genus Swartzia so far, and their biological activities as well.

METHODS

The information regarding to isolated compounds and biological activity gathered in this study was mostly obtained from the scientific database ‘SciFinder’ by typing the term “Swartzia”, which returned 199 references related to the genus. We also checked up to 9,180 results obtained by typing the same term in ‘Google Scholar’ database. The images of the structures of isolated compounds were collected from SciFinder.

RESULTS

Swartzia apetala Raddi
Araujo and others (2009) isolated and characterized the following compounds from hexane and methanol extracts of stems of *Swartzia apetala* Raddi var. *glabra*: (E)-3-hydroxy-5-methoxystilbene (3-methoxy-5-styrylphenol), 5,7-dihydroxyflavanone (pinocembrin), (-)-3-hydroxy-8,9-methylenedioxypterocarpan (maackiain), 5α-lup-20(29)-en-3β-ol (lupeol) and a mixture of 24-methylcholesta-5,22(E)-dien-3β-ol, (campesterol), stigmast-5-en-3β-ol (24-ethylcholest-5-en-3β-ol, β-sitosterol) and 24-ethylcholesta-5,22(E)-dien-3β-ol (stigmasta-5,22(E)-dien-3β-ol, stigmasterol). In turn, from the methanol extract of leaves it was isolated 3β-O-[β-D-glucopyranosyl-(1→4)-β-D-xylpyranosyl] oleanolic acid-(28→1)-β-D-glucopyranosyl ester, mauritianin, kaempferol and triterpene saponin β-D-glucopyranosyl 3β-hydroxy-olean-12-en-28-oate (Fig. 1) (ARAÚJO et al., 2013).

Regarding to its biological activity, Araujo and others (2009) tested three of the compounds they isolated – stilbene, flavanone and pterocarpan – against nine yeast strains of the pathogenic fungi *Candida* spp. The inhibition zone values showed by positive control Myconazole nitrate varied from 25 ± 0.03 (*C. tropicalis*) to 40 ± 1.6 (*C. guillermondii*), including *C. albicans* with inhibition zone of 30 ± 0.06. Meanwhile, the compound stilbene showed inhibition zones variation of 11 ± 0.08 (*C. krusei*) to 16 ± 0.09 (*C. guillermondii*), with activity against *C. albicans* showing 15 ± 0.05 of inhibition. Flavanone varied from 5 ± 0.05 (*C. glabrata*) to 14 ± 0.05 (*C. albicans*) and the pterocarpan varied from 0 (*C. glabrata*) to 11 ± 0.04 (*C. lusitaneae*) and showed inhibition value against *C. albicans* of 10 ± 0.07.

For its turn, crude methanolic extract and isolated compounds from leaves, also tested for antifungal activity, obtained better results against *Candida krusei*, with inhibition zone of 18.0 ±0.4 (positive control: 24.0 ±0.1) and the compounds 3β-O-[β-D-glucopyranosyl-(1→4)-β-D-xylpyranosyl] oleanolic acid-(28→1)-D glucopyranosyl ester and mauritianin against *Candida albicans* with inhibition zone of 21.0 ± 0.1 and 20.0 ± 0.1 respectively (positive control: 40.0 ± 0.0) (Fig. 1) (ARAÚJO et al., 2013).

**Figure 1** - Isolated substances from *Swartzia apetala*
Isolation and structure elucidation from *Swartzia arborescens* extracts yielded five diterpenoids called swartziarboreols A-E (Fig. 2) (ORPHELIN et al. 1996).
Swartzia argentea Spruce ex. Benth.

According to Barbosa and others (2006), tests realized regards to flavonoids and tannins occurrence in ethanolic extract of barks of *Swartzia argentea* detected catechin, flavanone, flavononol and condensed tannin; Regarding to other classes of chemical compounds, it was detected organic acid, alkaloid, steroid, resin, saponin and triterpenoid. The bark has also being used in traditional medicine by indigenous people of the Upper Rio Negro in Amazonas, Brazil, to treat malaria. The treatment consists in having half a cup of the tea produced from its decoction three times a day (KFFURI et al., 2016).

Swartzia brachyrachis Harms

Sanchez and others (1999) prepared benzenic and chloroformic extracts from the barks of *Swartzia brachyrachis* Harms var. *brachyrachis*. From the benzenic extract it was isolated the isoflavone 7,4′-dihydroxy-5,3′,5′-trimethoxy-6-methylisoflavone, which is called brachyrachisina, and from the chloroformic extract it was isolated the glycoside 3-O-β-D-glucopyranosylsitosterol (Fig. 3).
Swartzia flaemingii Raddi

The red latex obtained from *S. flaemingii* dissolved in deuterated methanol was investigated for total phenolic and flavonoid contents and antioxidant activity. For phenolic compounds it afforded the value of 433.88 mg GAE/g and for flavonoid contents, 398.17 mg QE/g. Its antioxidant capacity, measured by iron-reducing activity, was 1513.55 ± 146.21 mM Fe$^{+2}$/g, value that was comparable to that of vitamin C, 1184.77 ± 21.41 mM Fe$^{+2}$/g, and half of that of quercetin, 3040.21 ± 250 mM Fe$^{+2}$/g, both used as reference antioxidant agents (OLIVEIRA et al., 2021).

Swartzia laevicarpa Amshoff

The few studies made for *Swartzia laevicarpa*, popularly known as “saborana”, so far have afforded specially isoflavonoids. Barbosa and others (2006) made a general screening on ethanolic extract obtained from the bark of *S. laevicarpa* for flavonoids and tannins occurrence, and other classes of chemical compounds. They detected the presence of catechin, flavanone, flavone, flavonol, xanthone, condensed tannins, organic acid, alkaloid, anthranol, quartenary basis, steroid, cyanogenic heteroside, resin and triterpenoid. It could also be detected through histochemical tests performed by Barbosa and others (2021) on the cross-sections of fresh samples of the aril, seed coat and cotyledons of *S. laevicarpa*, the presence of phenolic compounds on the seed coat, and alkaloids on the aril and seed coat. From an ethanol extract of the trunk wood of *S. laevicarpa* it was isolated six isoflavonoids: (6aR,11aR)-2,8-dihydroxy-3,9-dimethoxypterocarpan; (6aR,11aR)-2,8-dihydroxy-3,9,10-trimethoxypterocarpan; (6aR,11aR)-8-hydroxy-3,4,9,10-tetramethoxypterocarpan; 5-chloro-8-hydroxy-6-methoxy-3-methylisoucoumarin; 7-chloro-8-hydroxy-6-methoxy-3-methylisoucoumarin; and 5-hydroxy-7,8-dimethoxy-2-methylchromone (BRAZ-FILHO;
MORAES; GOTTLIEB, 1979). Garcia and others (2018) investigated a methanol extract of *S. laevicarpa* wood residues and isolated the isoflavonoid 3'-hydroxy-7,8,4',5'-tetramethoxypterocarpan (Fig. 4).

**Figure 4** - Isolated substances from *Swartzia laevicarpa*  

5-hydroxy-7,8-dimethoxy-2-methylchromone  
5-chloro-8-hydroxy-6-methoxy-3-methylisocoumarin  
(6aR,11aR)-2,8-dihydroxy-3,9-dimethoxypterocarpan  
(6aR,11aR)-2,8-dihydroxy-3,9,10-trimethoxypterocarpan  
(6aR,11aR)-8-hydroxy 3,4,9,10-tetramethoxypterocarpan  
7-chloro-8-hydroxy-6-methoxy-3-methylisocoumarin

**Swartzia langsdorfii** Raddi

Chromatographic fractionation of ethanolic extracts of *S. langsdorfii* leaves led Marqui and others (2008) to the pentacyclic triterpenes oleanolic acid and lupeol, and two saponins: oleanolic acid 3-sophoroside and the ester 3-O-β-D-(6'-methyl)-glucopyranosyl-28-O-β-D-glucopyranosyl-oleanate. Petroleum ether extract of its roots afforded the swartiarboreols diterpenes 11-O-Methylswartziarboreol C and 15,16-Dihydroswartziarboreol C (Fig. 5), the latter testing positive for bacterial activity against *Staphylococcus aureus* (MAGALHÃES et al., 2005).

Roesler and others (2007) performed a screening on some fruits from Brazilian Cerrado seeking for total phenols and antioxidant activity, in which *S. langsdorfii* had its
pulp, seed and peel of the fruits investigated through their ethanolic and aqueous extracts. The ethanolic extract of the peel of the *S. langsdorfii* fruits showed 99.18 ± 3.935 content of total phenols expressed in gallic acid equivalent (g GAE.kg\(^{-1}\) ms), whilst the aqueous extract of this same part of the fruit, and the ethanolic and aqueous extracts of seed and pulp showed no relevant results in total phenols (> 20 g GAE.kg-1 ms). The ability to sequester free radicals was measured from the ethanolic extract of the peel of the fruit, resulting in a IC\(_{50}\) of 37.42 ± 1.54 mg.mL\(^{-1}\).m.v\(^{-1}\) (Reference value: gallic acid 1.38 ± 0.01 mg.mL\(^{-1}\).m.v\(^{-1}\)).

The red latex obtained from *S. langsdorffii* dissolved in deuterated methanol were investigated for total phenolic and flavonoid contents and antioxidant activity and was also screened for its chemical profile. *S. langsdorffii* afforded for phenolic compounds the value of 392.28 mg GAE/g, and for flavonoid contents 366.96 mg QE/g. The chemical profile identified the presence of sucrose, phenolic compounds, glucoside catechins, chlorophyll derivatives and saponins. The iron-reducing activity was 1567.94 ± 202.43 mM Fe\(^{2+}\)/g, values that was comparable to that of vitamin C, 1184.77 ± 21.41 mM Fe\(^{2+}\)/g, and half of that of quercetin, 3040.21 ± 250 mM Fe\(^{2+}\)/g (OLIVEIRA et al., 2021). Antioxidant tests were also performed by Santos and others (2009) using ethanol extracts of *S. langsdorffii* leaves. The extracts showed moderate antioxidant activity against the free radical in DPPH: IC\(_{50}\) 1.532 mg.mL\(^{-1}\) (Reference value: Quercetin 0.017 mg.mL\(^{-1}\)). Magalhães and others (2003) investigated *S. langsdorffii* for saponins, molluscicidal activity against eggs and adults of *Biomphalaria glabrata*, and lethality against the brine shrimp *Artemia salina* (only extracts of fruits, seeds and arils were tested against *A. salina*). The plant parts used for the bioassays were roots, leaves, seeds and fruits, all extracted with 95% ethanol. Saponin mixtures were obtained from fruit and seed and tested against *A. salina*, which showed lethal concentration 50% ranging from 3.59 µg.mL\(^{-1}\) to 120.5 µg.mL\(^{-1}\), thus being considered active. Aril saponin mixture nevertheless showed to be inactive with lethal concentration of > 1000 µg.mL\(^{-1}\). All the samples tested showed a significant molluscicidal activity against adults of *B. glabrata*, but not against the eggs.

The evaluation of antifungal activity with four purified saponins from *S. langsdorffii* resulted in moderate activity for 3-O-β-D-(6′-methyl)-glucopyranosyl-28-O-β-D-glucopyranosyl-oleanate and 3-sophoroside (Minimal Inhibitory Concentration – MIC: 100.0 mg.mL\(^{-1}\) / MIC considered highly active in the study: < 75.0 mg.mL\(^{-1}\)), low
activity for oleanolic acid (MIC: 200.0 mg.mL\(^{-1}\)) and no activity for lupeol (MIC > 200.0 mg.mL\(^{-1}\)) against *Candida albicans*, *Candida krusei*, *Candida parapsilosis* e *Cryptococcus neoformans* (MARQUI et al., 2008).

**Figure 5** - Isolated substances from *Swartzia langsdorffii*

![Chemical structures](image)

Oleanolic acid  
Lupeol  
Oleanolic acid 3-sophoroside  
11-O-Methylswartziarboreol C  
15,16-Dihydroswartziarboreol C  

*Swartzia leiocalycyna* Benth.

Donnelly and Fitzgerald (1971) isolated from a heartwood ketone extract two coumestones named by 6-hydroxy-5,7-dimethoxy-11,12-methylenedioxycoumestone and 6-hydroxy-7-methoxy-11,12-methylenedioxycoumestone and a pterocarpan compound named as 6aR,11aR-2-hydroxy-3-methoxy-8,9-methylenedioxypterocarpan (Fig. 6).

**Figure 6** - Isolated substances from *Swartzia leiocalycyna*

![Chemical structures](image)

6-hydroxy-7-methoxy-11,12-methylenedioxycoumestone  
6-hydroxy-5,7-dimethoxy-11,12-methylenedioxycoumestone
Swartzia leptopetala Benth

Swartzia leptopetala ethanol extracts were subjected to biological screening including cardiovascular activity, brine shrimp lethality and effects on the enzymatic activity of glucose-6-phosphatase. The aim of the cardiovascular bioassay was to diminish rat arterial blood pressure, but S. leptopetala fruit extracts killed all experimental animals during the bioassay and its leaves and twigs gave no activity. For brine shrimp lethality, a bioassay frequently used to preliminarily detect potential antitumor and pesticidal compounds in extracts, the extracts of S. leptopetala showed no significant lethality (JIMÉNEZ et al., 2001).

Chromatography on silica gel plates followed by revealing with the reagents Dragendorff and ceric sulfate revealed no orange spots for the former one, which indicates absence of alkaloids, violet and yellow-orange spots for the latter one, which indicates the presence of triterpenoids and flavonoids, respectively. In regards to enzymatic activity of glucose-6-phosphatase, which may be useful in controlling hyperglycemia caused by diabetes, leaves and twigs extract showed 55% of inhibition, being 25–30% inhibition considered significant for a crude extract (JIMÉNEZ et al., 2001).

Swartzia longistipitata Ducke

Seed proteins extracted from Swartzia spp. were tested to show their potential to inhibit the growth of 7 fungi hyphae. Swartzia longistipitata showed growth inhibition (%) of 64.7 ± 4.9 against Aspergillus favus hyphae, 60.0 ± 2.1 against Aspergillus niger and 51.1 ± 2.8 against Fusarium sp. (RAMOS et al. 2018).

Swartzia macrocarpa Spruce ex. Benth.

According to Barbosa and others (2006), tests performed on ethanolic extract of barks regards to flavonoids and tannins occurrence, detected the presence of anthocyanin/anthocyanidin, catechin, chalcone, aurone, flavononol and condensed tannin. Regarding to other classes of chemical compounds, it was detected organic acid,
quaternary basis, steroid, cyanogenic heteroside, resin, saponin and triterpenoid. Also, histochemical tests performed by Barbosa and others (2021) have detected the presence of phenolic compounds on its seed coat.

**Swartzi oblata R.S.Cowan**

Silva and others (2019) obtained ethanolic extracts of leaves and bark of *S. oblata*, which were partitioned and fractioned until isolation of compounds. From the fractionation of bark extracts, it was obtained a crystalline white solid, soluble in CH$_2$Cl$_2$, identified as a mixture of two macrolides: lasiodiplodina (1) and O-metil-lasiodiplodina (2), both unprecedented for the genus *Swartzia* (Fig. 7). Also from the bark extract it was obtained a mixture of two phytosterols: campesterol and sitosterol, both presented as colorless crystals, soluble in CH$_2$Cl$_2$. Tests performed for the presence of several classes of compounds confirmed the absence of alkaloids and coumarins in the extracts. Regarding to its antitumoral activity, all isolated fractions showed discrete reduction on the viability of the lineage of the tested cells.

![Isolated substances from *Swartzia leiocalycyn*a](image)

**Figure 7 - Isolated substances from *Swartzia leiocalycyn*a**

Lasiodiplodina  
O-metil-lasiodiplodina

Mixture of the phytosterols Campesterol and β-sitosterol

In an investigation carried out by Yazbek and others (2019) for traditional uses of tree species, it has been found that *Swartzia oblata* has been used by residents of a quilombo community from the state of São Paulo for therapeutic uses. Both bark and leaves decoctions have been registered to be applied via oral, vaginal and transdermic routes as an anti-inflammatory treatment and for vaginal discharges. The decoction of
leaves was mentioned to relief back pain when ingested and decoction of the barks has been used via oral and transdermic routes to treat scabies and as a coagulant.

**Swartzia panacoco (Aubl.) R.S.Cowan**

Tests performed by Barbosa and others (2006) on ethanolic extract of barks seeking for flavonoids and tannins occurrence, detected the presence of catechin, flavanone, flavononol chalcona, aurone and condensed tannin from *S. panacoco*. Regarding to other classes of chemical compounds, it was found the presence of organic acid, alkaloid, steroid, cyanogenic heteroside, resin, saponin and triterpenoid.

**Swartzia pendula Spruce ex Benth**

*Swartzia pendula* showed a percentage of growth inhibition of 61.3 ± 4.9 against the fungi *Aspergillus favus* and 52.9 ± 9.4 against the fungi *Phomopsis* sp. (RAMOS et al. 2018).

**Swartzia polyphylla DC.**

The species, popularly known as “cumaceba”, has been the most well chemically studied species in the genus *Swartzia*, affording mostly flavonoids, saponins and presenting moderate antimicrobial activity.

In regards to the occurrence of flavonoids and tannins, it was detected on the ethanolic extract of barks the presence of catechin, flavone, flavonol, xanthone and condensed tannin. Regarding to other classes of chemical compounds it was detected the presence of organic acid, alkaloid, quaternary basis, steroid, cyanogenic heteroside and saponin. Also, from ethanolic extracts, it was isolated the isoflavonone 3-hydroxyisoflavonone, also known as ferreirinol, from the bark (DUBOIS; SNEDEN, 1996) and the isoflavone biochanin A, the isoflavanones ferreirin, dalbergioidin and dihydrobiochanin A and the prenylated isoflavonone dihydrolicoisoflavone from the heartwood (DUBOIS; SNEDEN, 1995).

Methanolic extract of heartwood of *Swartzia polyphylla* afforded seven flavonoids, identified as: (S)-naringenin, formononetin, biochanin a, ferreirin, darbergioidin, 5,7-dihydroxy-4’-methoxyisoflavonone (dihydrobiochanin A) and 5,2’4’-trihydroxy-7-methoxyisoflavonone (cajanin). The isoflavanones showed strong inhibitory activity, with an inhibitory zone at 125 μg/disk of less against the cariogenic
bacteria *Streptococcus mutans* and *S. sobrinus*, whilst the flavones, flavanones and isoflavones showed none or not relevant inhibitory effect (inactivity ≥ 500 μg/disk; high activity ≤ 62 μg/disk) (OSAWA et al., 1992). Chromatographic profile of powdered barks showed mainly tannins based on (epi)-afzelechin-(epi)-catechin, ellagitannins and flavonoids (Fig. 8) (SCHMEDA-HIRSCHMANN et al., 2018).

Schmeda-Hirschmann and others (2018) investigated some plants used as male sexual enhancers from Peruvian Amazon, including *S. polyphylla*. The traditional preparation is a mixture of the macerated tree barks, 18-20% ethanol and bee honey, which were filtered and dried to be analyzed by the authors. They also powdered the barks used in the traditional preparation and extracted them in methanol and methanol:water (1:1) as a reference basis. The analysis of the extract of *S. polyphylla* showed low effect to inhibit the enzyme PDHE-5, the one that is inhibited by commercial drug used as male sexual enhancer sildenafil citrate (Viagra®), there being higher activity of inhibition for the other species used on the traditional preparations.

_Swartzia polyphylla_ barks mixed with barks from other species have been used in a traditional preparation in Peru called “7 or 21 raices” which consists in an alcoholic maceration used as “tonic” to fortify the body, reinforce libido and treat rheumatism (SCHMEDA-HIRSCHMANN et al. 2018). Based on the traditional knowledge, Roumy and others (2019) investigated the species for antibacterial activity, which showed Minimal Inhibitory Concentration (MIC) of 0.15 mg.mL⁻¹ for the Gram-positive cocci *Streptococcus agalactiae* (Reference value: gentamicin 0.25 mg.mL⁻¹) and *Streptococcus dysgalactiae* (Reference value: gentamicin 0.5 mg.mL⁻¹).

Less relevant antibacterial activity was found for other strains, like the Gram-negative bacilli *Yersinia pseudotuberculosis* (enterobacteria), *Acinetobacter baumanii* and *Stenotrophomas maltophilia* (non enterobacterias) (MIC: 1.2 mg.mL⁻¹, 1.2 mg.mL⁻¹ and 0.6 mg.mL⁻¹ respectively - Reference value: gentamicin 0.5 mg.mL⁻¹, 0.5 mg.mL⁻¹, and 4.0 mg.mL⁻¹ respectively). Also, against Gram-positive cocci *Enterococcus faecalis*, and *Enterococcus* sp. (MIC: 0.6 mg.mL⁻¹ for both of them - Reference value: vancomycin 0.5 mg.mL⁻¹; gentamicin 2.0 mg.mL⁻¹ respectively), *Staphylococcus aureus*, *S. epidermidis*, *S. lugdunensis*, *S. warneri* (MIC: 0.3 mg.mL⁻¹ – Reference values of antibiotics varied from 0.25 to 32 mg.mL⁻¹); and lastly against miscellaneous strains *Corynebacterium striatum* and *Mycobacterium smegmatis* (MIC: 0.3 mg.mL⁻¹ for both of them – Reference value: gentamicin 0.06, and 0.03 mg.mL⁻¹ respectively), and *Candida*
albicans (MIC: 0.6 mg.mL\(^{-1}\) – Reference value: amphotericin B 0.06 mg.mL\(^{-1}\)) (ROUMY et al., 2019).

In regard to its biological activity against fungi, Ramos and others (2018) tested proteins extracted from seeds of \(S.\ polyphylla\) to show their potential to inhibit the growth of 7 fungi hyphae. It showed growth inhibition percentage of 59.5 ± 8.8, 90.5 ± 0.7, 60.9 ± 13.8 and 60.4 ± 2.2 against \(Aspergillus\ flavus\), \(Aspergillus\ niger\), \(Aspergillus\ sp.\) and \(Phomopsis\ sp.\) respectively. Another study realized by Rojas and others (2006) investigated the 95% ethanol extract of bark of \(S.\ polyphylla\) partitioned in hexane and 90% methanol fractions, obtaining larvicidal and antimycobacterial activities in the former one, whilst the latter afforded antifungal activity.

T-cadinol was obtained from a hexane partition, which showed a moderate anti-\(Mycobacterium\ tuberculos\)is activity (MIC = 50 μg.mL\(^{-1}\) for the sensitive and multidrug-resistant strains) and yielding a 100% mortality for larvae of \(Culex\ quinquefasciatus\) at concentration of 300 μg.mL\(^{-1}\) after 1 h of exposure. Regarding to antifungal activity, the compounds biochanin A and dihydrobiochanin A were the most active, showing a growth inhibition zone diameter of 31 and 41 mm respectively against \(Tichophyton\ mentagrophytes\) (Positive controls: 37 and 19 mm) and 33 and 47 mm against \(Microsporum\ gypseum\) (Positive controls: 35 and 27 mm) (ROJAS et al. 2006).

**Figure 8** - Isolated substances from \(Swartzia\ polyphylla\)

- Ferreirinol
- Biochanin A
- Ferreirin
- Dalbergioidin
- Dihydrobiochanin A
- Dihydricoiso-flavone
- Cajanin
- Formononetin
- (S)-Naringenin
**Swartzia psilonema** Harms

Silveira and others (2018) tested *Swartzia psilonema* for resistance to decay by exposing its bark to four decay fungi (*Trametes versicolor*, *Pycnoporus sanguineus*, *Gloeophyllum trabeum* and *Gloeophyllum striatum*), to what it showed to be moderately resistant.

**Swartzia recurva** Poepp

Regarding to its general chemical profile, histochemical tests performed by Barbosa and others (2021) have detected the presence of phenolic compounds on the seed coat and alkaloids in the cotyledons of *S. recurva*. Also, *S. recurva* showed a percentage of growth inhibition of 50.7 ± 5.1 against the fungi *Fusarium* sp. and 56.4 ± 4.9 against the fungi *Phomopsis* sp. (RAMOS et al. 2018).

**Swartzia schomburgkii** Benth.

Methanolic extracts of leaves and bark of *Swartzia schomburgkii* var. *schomburgkii* yielded the isolation of 8 saponins by Abdel-Kader and others (2000). Their identification is as follows: oleanolic acid 3-O-β-D-glucopyranoside (androseptoside A), hederagenin-3-O-β-D-glucopyranoside (HNsaponin D₁₁), oleanolic acid-3-O-β-D-glucopyranosyl-(1→3)-β-D-glucopyranoside (randianin), oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-β-D-glucopyranoside (oleanolic acid-3-sophoroside, acutoside A), oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-[β-D-glucopyranosyl]-(1→3)-β-D-glucopyranoside (anchusosid 2), and oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-[β-D-xylopyranosyl]-(1→3)-β-D-glucopyranoside-28-O-β-D-glucopyranoside ester (araliasaponin IV) (Fig. 9) (ABDEL-KADER et al., 2000).

**Figure 9** - Isolated substances from *Swartzia schomburgkii*
Swartzia sericea Vogel

Swartzia sericea showed a percentage of inhibition growth of 78.8 ± 2.5, 87.0 ± 3.3, 85.0 ± 9.1, 52.5 ± 1.4 and 67.9 ± 1.6 against the fungi Aspergillus flavus, Aspergillus niger, Aspergillus sp., Fusarium sp. and Phomopsis sp. respectively (RAMOS et al. 2018).

Barbosa and others (2021) performed histochemical tests by applying some reagents on the cross-sections of fresh samples of the aril, seed coat and cotyledons of S. sericea. It has been detected the presence of phenolic compounds on the seed coat, and the presence of alkaloids on the aril and seed coat.

Swartzia simplex (Sw.) Spreng.

Dorsaz and others (2017) performed a screening seeking for new natural products against pathogenic fungi Candida albicans. Among the species screened, Swartzia simplex showed activity against C. albicans at 32 µg.mL\(^{-1}\) at pH 7 and 16 µg.mL\(^{-1}\) at pH 4.6. It also showed activity against C. albicans biofilm (cell populations with intrinsic resistance to antifungal drugs) at 25 µg.mL\(^{-1}\). The natural product responsible for this antifungal activity was identified as simplexene D. Compounds isolated from
dichloromethane extracts of roots of *S. simplex* were evaluated against both a highly susceptible and a wild-type strain of *Candida albicans* and for their antibiofilm activities. The crude extract showed significant activity against the highly susceptible strain but not against the wild-type one. Isolation yielded 14 diterpenes which were also tested regards to their antifungal activity. On the bioautography assay, five compounds (swartiarboreol B, (5S,10S)-11,15(R)-dihydroxy,12-methoxyswartziarboreol G, simplexene C, simplexene D, and 11,12-dihydroxy-15,16-dihydroswartziarboreol C) (Fig. 10) gave Minimal Inhibitory Quantity (MIQ) value between 5 and 20 μg against the susceptible strain, and one ((5S,10S)-11,15(R)-dihydroxy,12-methoxyswartziarboreol G) gave MIQ value of 2 μg against the wild-type strain (Inactive: MIQ > 50 μg) (FAVRE-GODAL et al., 2015). On dilution methods, two compounds ((5S,10S)-11,15(R)-Dihydroxy,12-methoxyswartziarboreol G and simplexene D) showed notable activity, both with minimal inhibitory concentration (MIC) value of 32 μg.mL⁻¹ against the *C. albicans* wild-type strain (Inactive: MIC > 32 μg.mL⁻¹). On the assay against mature biofilms of the wild-type strain, five compounds (simplexene A, (5S,10S)-11,15(R)-dihydroxy,12-methoxyswartziarboreol G, simplexene B, 11,12-dihydroxy-15,16-dihydroswartziarboreol C and 11,12-dihydroxy-8,11-13,15-cassatetraen-17,16-olide) showed MIC of 50 μg.mL⁻¹ and simplexene D showed a MIC value of 25 μg.mL⁻¹ (Inactive: biofilm > 50 μg) (FAVRE-GODAL et al., 2015).

**Figure 10** - Isolated substances from *Swartzia simplex*
Swartzia ulei Harms

Benzene extracts of trunk wood from Swartzia ulei gave a mixture of sitosterol and stigmasterol and O-acetyloleanolic acid (Fig. 11) (FORMIGA et al., 1975).

**Figure 11 - Isolated substances from Swartzia ulei**

![O-Acetyloleanolic acid]

**Table 1 - Isolated substances from Swartzia spp. and their biological activities**

<table>
<thead>
<tr>
<th>Isolated substance</th>
<th>Chemical class</th>
<th>Plant part</th>
<th>Type of extract</th>
<th>Biological activity</th>
<th>Species</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E)-3-hydroxy-5-methoxystilbene (3-methoxy-5-styrylphenol)</td>
<td>stilbenoid</td>
<td>S</td>
<td>H</td>
<td>Antifungal</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>5,7-dihydroxyflavanone (pinocembrin)</td>
<td>flavanone</td>
<td>S</td>
<td>H</td>
<td>Antifungal</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>(-)-3-hydroxy-8,9-methylenedioxypterocarpan (maackiain)</td>
<td>pterocarpan</td>
<td>S</td>
<td>H</td>
<td>Antifungal</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>5α-lup-20(29)-en-3β-ol (lupeol)</td>
<td>triterpenoid</td>
<td>S</td>
<td>H</td>
<td>-</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>24-methylcholesta-5,22(E)-dien-3β-ol (campesterol)</td>
<td>steroid</td>
<td>S</td>
<td>H</td>
<td>-</td>
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<tr>
<td>Stigmast-5-en-3β-ol (24-ethylcholesta-5-en-3β-ol, β-sitosterol)</td>
<td>steroid</td>
<td>S</td>
<td>H</td>
<td>-</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>24-ethylcholesta-5,22(E)-dien-3β-ol (stigmasta-5,22(E)-dien-3β-ol, stigmasterol)</td>
<td>steroid</td>
<td>S</td>
<td>H</td>
<td>-</td>
<td>S. apetala</td>
<td>Araújo et al., 2009</td>
</tr>
<tr>
<td>3β-O-[β-D-glucopyranosyl-(1→4)-β-D-xylopyranosyl] oleanolic acid- (28→1)-b-D-glucopyranosyl ester</td>
<td>triterpenoid saponin</td>
<td>L</td>
<td>M</td>
<td>Antifungal</td>
<td>S. apetala</td>
<td>Araújo et al., 2013</td>
</tr>
<tr>
<td>Mauritianin</td>
<td>flavonol</td>
<td>L</td>
<td>M</td>
<td>Antifungal</td>
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<td>Araújo et al., 2013</td>
</tr>
<tr>
<td>Kaempferol</td>
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<td>M</td>
<td>Antifungal</td>
<td>S. apetala</td>
<td>Araújo et al., 2013</td>
</tr>
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<td>β-D-glucopyranosyl 3β-hydroxyolean-12-en-28-oate</td>
<td>triterpene</td>
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<td>M</td>
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<td>Araújo et al., 2013</td>
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<td>-</td>
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<tr>
<td>Swartziaboreol B</td>
<td>diterpenoid</td>
<td>R</td>
<td>D</td>
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<td>S. simplex</td>
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<td>Orphelin et al., 1996</td>
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<tr>
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<td>-</td>
<td>-</td>
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<td>Orphelin et al., 1996</td>
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<tr>
<td>7,4'-dihydroxy-5,3',5'-trimethoxy-6-methylisoflavone (brachyrachisina)</td>
<td>isoflavona</td>
<td>B</td>
<td>B</td>
<td>-</td>
<td>S. brachyrachis</td>
<td>Sanchez et al., 1999</td>
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</table>

Sanchez et al., 1999
<table>
<thead>
<tr>
<th>Compound/Structure</th>
<th>Type</th>
<th>Activity</th>
<th>Species</th>
<th>References</th>
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<tr>
<td>3-O-β-D-glucopyranosylsitosterol</td>
<td>steroid</td>
<td>B</td>
<td>C</td>
<td>S. brachyrrhachis</td>
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<tr>
<td>(6αR,11αR)-2,8-dihydroxy-3,9-dimethoxypterocarpan</td>
<td>pterocarpan</td>
<td>T</td>
<td>E</td>
<td>S. laevescarpa</td>
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<tr>
<td>(6αR,11αR)-2,8-dihydroxy-3,9,10-trimethoxypterocarpan</td>
<td>pterocarpan</td>
<td>T</td>
<td>E</td>
<td>S. laevescarpa</td>
</tr>
<tr>
<td>(6αR,11αR)-8-hydroxy-3,4,9,10-tetramethoxypterocarpan</td>
<td>pterocarpan</td>
<td>T</td>
<td>E</td>
<td>S. laevescarpa</td>
</tr>
<tr>
<td>5-chloro-8-hydroxy-6-methoxy-3-methylisoucuminarin</td>
<td>isocoumarin</td>
<td>T</td>
<td>E</td>
<td>S. laevescarpa</td>
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<tr>
<td>7-chloro-8-hydroxy-6-methoxy-3-methylisoucuminarin</td>
<td>isocoumarin</td>
<td>T</td>
<td>E</td>
<td>S. laevescarpa</td>
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<tr>
<td>3'-hydroxy-7,8,4',5'-tetramethoxypterocarpan</td>
<td>pterocarpan</td>
<td>WR</td>
<td>M</td>
<td>S. laevescarpa</td>
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<tr>
<td>Oleanolic acid</td>
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<td>L</td>
<td>E</td>
<td>Antifungal (low)</td>
</tr>
<tr>
<td>3-sophoroside</td>
<td>flavonoid</td>
<td>L</td>
<td>E</td>
<td>Antifungal (moderate)</td>
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<tr>
<td>3-0-β-D-(6'-methyl)-glucopyranosyl-28-O-β-D-glucopyranosyl-oleanate</td>
<td>saponin</td>
<td>L</td>
<td>E</td>
<td>Antifungal (moderate)</td>
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<tr>
<td>11-O-Methylswartziarboreol C</td>
<td>diterpene</td>
<td>R</td>
<td>PE</td>
<td>Inactive (against bacteria)</td>
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<tr>
<td>15,16-Dihydroswartziarboreol C</td>
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<td>R</td>
<td>PE</td>
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<td>6-hydroxy-5,7-dimethoxy-11,12-methyleneediosycoumestone</td>
<td>coumestane</td>
<td>H</td>
<td>Ke</td>
<td>-</td>
</tr>
<tr>
<td>6-hydroxy-7-methoxy-11,12-methyleneediosycoumestone</td>
<td>coumestane</td>
<td>H</td>
<td>Ke</td>
<td>-</td>
</tr>
<tr>
<td>6αR,11αR-2-hydroxy-3-methoxy-8,9-methyleneediosyptrolcarpan</td>
<td>coumestane</td>
<td>H</td>
<td>Ke</td>
<td>-</td>
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<tr>
<td>Lasiodiplodina</td>
<td>macrolides</td>
<td>L, B</td>
<td>E</td>
<td>Antitumoral (low)</td>
</tr>
<tr>
<td>O-methyl-lasiodiplodina</td>
<td>macrolides</td>
<td>L, B</td>
<td>E</td>
<td>Antitumoral (low)</td>
</tr>
<tr>
<td>Campesterol and β-sitosterol</td>
<td>macrolides</td>
<td>L, B</td>
<td>E</td>
<td>Antitumoral (low)</td>
</tr>
<tr>
<td>Ferreirin</td>
<td>isoflavone</td>
<td>B</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>Biochanin A</td>
<td>isoflavone</td>
<td>H</td>
<td>E, M</td>
<td>Antifungal</td>
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<tr>
<td>Ferreirin</td>
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<td>H</td>
<td>E, M</td>
<td>Antibacterial</td>
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<td>H</td>
<td>E, M</td>
<td>Antibacterial</td>
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<td>5,7-dihydroxy-4'-methoxyisoflavanone (Dihydrobiochanin A)</td>
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<td>H</td>
<td>E, M</td>
<td>Antifungal</td>
</tr>
<tr>
<td>Dihydricocoiso-flavone</td>
<td>isoflavone</td>
<td>H</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>(S)-Naringenin</td>
<td>flavone</td>
<td>H</td>
<td>M</td>
<td>Inactive (against bacteria)</td>
</tr>
<tr>
<td>Formononetin</td>
<td>isoflavone</td>
<td>H</td>
<td>M</td>
<td>Inactive (against bacteria)</td>
</tr>
<tr>
<td>5,2',4'-trihydroxy-7-methoxyisoflavanone (Cajalin)</td>
<td>isoflavone</td>
<td>H</td>
<td>M</td>
<td>Antibacterial</td>
</tr>
<tr>
<td>7-cadinol</td>
<td>sesquiterpenoid</td>
<td>B</td>
<td>E</td>
<td>Larvicidal</td>
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<table>
<thead>
<tr>
<th>Chemical Compound</th>
<th>Type of Compound</th>
<th>Antifungal Activity</th>
<th>S. schomburgii</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>3-O-β-D-glucopyranoside (Androseptoside A)</td>
<td>saponin</td>
<td>L, B</td>
<td>M</td>
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</tr>
<tr>
<td>Hederagenin-3-O-β-D-glucopyranoside (HNsaponin D1)</td>
<td>saponin</td>
<td>L, B</td>
<td>M</td>
<td>-</td>
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<tr>
<td>Oleanolic acid-3-O-β-D-glucopyranosyl-(1→3)-β-D-glucopyranoside (Randianin)</td>
<td>saponin</td>
<td>L, B</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-β-D-glucopyranoside (Acutoside A)</td>
<td>triterpenoid</td>
<td>L, B</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-[β-D-glucopyranosyl]-(1→3)-β-D-glucopyranoside (Anchusosid 2)</td>
<td>triterpenoid</td>
<td>L, B</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Oleanolic acid-3-O-β-D-glucopyranosyl-(1→2)-[β-D-xylopyranosyl]-(1→3)-β-D-glucopyranoside-28-O-β-D-glucopyranoside ester (Araliasaponin IV)</td>
<td>triterpene saponin</td>
<td>L, B</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Simplexene D</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (high)</td>
</tr>
<tr>
<td>(5S,10S)-11,15(R)-Dihydroxy,12-methoxyswartziarboleol G</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (high)</td>
</tr>
<tr>
<td>Simplexene C</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (moderate)</td>
</tr>
<tr>
<td>11,12-Dihydroxy-15,16-dihydroxyswartziarboleol C</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (low)</td>
</tr>
<tr>
<td>Simplexene A</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (moderate)</td>
</tr>
<tr>
<td>Simplexene B</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (moderate)</td>
</tr>
<tr>
<td>11,12-Dihydroxy-8,11-13,15-cassatetraen-17,16-olide</td>
<td>diterpene</td>
<td>R</td>
<td>D</td>
<td>Antifungal (high)</td>
</tr>
<tr>
<td>Sitosterol</td>
<td>steroid</td>
<td>T</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>Stigmasterol</td>
<td>steroid</td>
<td>T</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>O-acetyloleanolic</td>
<td>triterpenoid</td>
<td>T</td>
<td>B</td>
<td>-</td>
</tr>
</tbody>
</table>

**Legend:** Plant part: B – bark; H – heartwood; L – leaves; R – roots; S – stem; T – trunkwood; WR – wood residues. Type of extract: B – benzene; C – chloroform; Ke – ketone; D – dichloromethane; E – ethanol; H – hexane; M – methanol; PE – petroleum ether.

**CONCLUSION**

Chemical screenings performed with *Swartzia* species allowed to find mostly the chemical classes of: flavonoids, isoflavanones, isoflavones, pterocarpan, triterpenoids, diterpenoids, steroids and saponins. Isolated compounds and extracts were tested for several biological activities showed to be antifungal, antibacterial, larvicidal and antioxidant. Although *Swartzia* spp. is a well-known and distributed genus, only 21 species have been biological and/or chemically studied so far. Considering they have been shown to be a potential source for pharmacological compounds, more species should be screened and tested in the future.

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REFERENCES


