REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE

Chemical profiling by HPLC-ESI-MS and anti-Candida activity of the flowers and leaves of Strelitzia reginae (Strelitziaceae)

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Palavras-chave

Strelitzia reginae, atividade anti-Candida, polifenóis, CLAE-IES-EM.

RESUMO

Strelitzia reginae é uma planta ornamental de grande relevância para o setor da floricultura e para a economia de diversos países. Na medicinal popular, a espécie é utilizada no tratamento de edemas e inchaços de glândulas associados a infecções sexualmente transmissíveis. Mesmo sendo uma espécie bem conhecida, ainda há um amplo campo para novas investigações quanto às suas propriedades químicas e biológicas. Extratos etanólicos e partições das folhas e flores foram preparados e avaliados pelo método da microdiluição em caldo contra Candida spp.. A partição acetato de etila (PAE) das flores apresentou relevante atividade antifúngica contra Candida albicans, Candida tropicalis e Candida glabrata, com valores de CIM de 23,43, 46,87 e 11,72 µg/mL, respectivamente. Essa partição biaotiva foi analisada por cromatografia líquida acoplada à espectrometria de massas com fonte de ionização por eletrospray (CLAE-IES-EM) e revelou a presença de ácidos orgânicos, ácidos fenólicos, flavonoides, proantocianidinas e benzofenonas. Entre os compostos anotados estão ácido gálico, ácido protocatecuico, catequina, rutina e derivados de quercetina, isoramnetina e kaempferol. Alguns desses metabólitos já foram descritos em S. reginae ou em espécies do mesmo gênero, mas a ocorrência em flores e folhas ainda é pouco relatada. A atividade antifúngica observada para a PAE das flores pode estar associada à presença de compostos fenólicos em sua composição química. Os resultados evidenciam o potencial das flores de S. reginae como fonte de protótipos moleculares para o desenvolvimento de novos agentes anti-Candida, especialmente diante da crescente resistência das leveduras aos antifúngicos convencionais.

ABSTRACT

Strelitzia reginae is an ornamental plant of great importance to the floriculture sector and the economy of several countries. In folk medicine, it has been traditionally used to treat edema and swollen glands associated with sexually transmitted infections. Despite being a well-known species, there is still a wide field for further investigations into its chemical and biological properties. Ethanolic extracts and partitions of the leaves and flowers were prepared and evaluated by the broth microdilution method against Candida spp.. The ethyl acetate partition (EAP) from the flowers showed relevant antifungal activity against Candida albicans, Candida tropicalis and Candida glabrata, with MIC values of 23.43, 46.87 and 11.72 µg/mL, respectively. This bioactive partition was analyzed by liquid chromatography coupled to mass spectrometry with electrospray ionization source (HPLC-ESI-MS) and revealed the presence of organic acids,

phenolic acids, flavonoids, proanthocyanidins, and benzophenones. Among the compounds annotated are gallic acid, protocatechuic acid, catechin, rutin, and derivatives of quercetin, isorhamnetin, and kaempferol. Some of these metabolites have previously been reported in S. reginae or in species of the same genus; however, their occurrence in flowers and leaves remains scarcely documented. The antifungal activity observed for EAP from flowers may be associated with the presence of phenolic compounds in its chemical composition. The findings highlight the potential of S. reginae flowers as promising source of molecular prototypes for the development of new anti-Candida agents, especially in light of the increasing resistance of yeasts to conventional antifungals therapies.

Keywords: Strelitzia reginae, anti-Candida activity, polyphenols, HPLC-ESI-MS.

INTRODUCTION

Strelitzia reginae (Strelitziaceae), popularly known as the bird of paradise or strelitzia, is an ornamental plant native to South Africa that is widely cultivated in tropical and subtropical regions (Lorenzi; Souza, 1999; Kantharaju et al., 2008). This species stands out in the genus for its robustness, resistance, intense color of the inflorescences, and long durability of the flowers post-harvest (Wood, 1995). In addition to its relevance within global floriculture (Vieira et al., 2012), some studies indicate that different parts of S. reginae present metabolites with bioactive potential and promising biological properties.

Regarding the classes of metabolites present in *S. reginae*, a qualitative phytochemical study carried out with the leaves of this species showed the occurrence of primary metabolites, such as carbohydrates, proteins, oils, and fats, as well as specialized metabolites, including phenols, flavonoids, steroids, saponins, alkaloids, tannins, and glycosides (Londonkar; Rajani, 2021; Hinol *et al.*, 2025). From the leaves of *S. reginae*, the flavonoids kaempferol, quercetin, vitexin, and rutin, as well as the phytosterol glycoside daucosterol, have been isolated (Mahmoud *et al.*, 2024). From the rhizomes of the species, different phenalenones, such as 4-hydroxy-2-methoxyphenalen-1-one; 2,4-dimethoxyphenalen-1-one and 7,8-dimethoxyphenalen-1-one were identified (Holscher; Schneider, 2000).

Some studies have investigated the biological properties of *S. reginae*. Ethyl acetate and *n*-butanol fractions from the leaves showed activity against Gram-positive and Gram-negative bacteria, including *Klebsiella pneumoniae* and *Staphylococcus aureus* (Mahmoud *et al.*, 2024). In another study, non-polar and polar extracts from the leaves also showed an effect against these bacteria (Sujitha; Vijayan, 2025). The aqueous and dichloromethane/methanol extracts of the leaves showed activity against different microorganisms of the urogenital tract (Vuuren; Naidoo, 2010). The methanolic extract of the leaves revealed the presence of several classes of phytochemicals and low toxicity; however, it did not show anti-inflammatory activity (Hinol *et al.*, 2025). The methanolic and chloroform extracts of *S. reginae* leaves showed moderate antioxidant activity (Moussa *et al.*, 2011). Furthermore, the methanolic extract of the aerial parts showed a significant antiarthritic effect (Ali *et al.*, 2024). In folk medicine, a decoction of the flowers and leaves is used to treat swollen glands associated with sexually transmitted diseases (Vuuren; Naidoo, 2010).

All these reports highlight *S. reginae* as an important source of specialized metabolites with medicinal potential. Nevertheless, it is important to emphasize that there are still several gaps in the literature concerning this species, particularly with respect to its chemical aspects and the assessment of its biological properties.

In this context, the objective of the present study was to enhance the understanding of *S. reginae* by evaluating its antifungal potential against *Candida* spp. and analyzing the chemical profile of its most active sample using high-performance liquid chromatography coupled to electrospray ionization mass spectrometry (HPLC-ESI-MS).

REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE

MATERIALS AND METHODS

Plant material

The leaves and flowers of *S. reginae* were collected in a rural area located in the region of Uberaba/Minas Gerais, Brazil (Coordinates: 19°24'04.3"S-48°05'02.0"W) in August 2016. The species was identified by a specialist, after which the plant material was prepared for subsequent extraction procedures.

Preparation of plant material and ethanolic extraction

Fresh leaves and flowers of *S. reginae* were subjected a drying process in a circulating air oven at 45°C for a period of 10 days. The dried material was then ground using a knife mill (TEC MILL-TE633), and portions of 35.0 g of leaves and 43.0 g of flowers were extracted with 150 mL of ethanol (P.A) by maceration at room temperature for three days in the dark. Subsequently, the mixture was then filtered, and the solvent was evaporated in a rotary evaporator (IKA-RV10) at 45 °C under reduced pressure. This procedure was repeated four times, and the resulting extract was frozen and lyophilized (LIOTOP - L101). The resulting masses of the ethanolic extracts of the leaves and flowers were 5.42 g and 8.76 g, respectively.

Liquid-liquid partition of ethanolic extracts from leaves and flowers of *S. reginae*

The ethanolic extracts of leaves (3.0 g) and flowers (4.0 g) were solubilized in 100 mL of methanol/water solution (9:1 v/v). The liquid-liquid partition was carried out in a separatory funnel using the following sequence of solvents: hexane, dichloromethane, and ethyl acetate. For the successive partition, a total of 800 mL of each of the s olvents (4 x 150 mL) were used. The hexane, dichloromethane, and ethyl acetate solutions, along with the hydromethanolic residue containing their respective extractives, were concentrated under reduced pressure using a rotary evaporator. This process yielded four partitions that were subsequently assessed for their antifungal activity. The resulting masses of the leaf partitions were as follows: hexane partition, 0.87 g; dichloromethane partition, 0.54 g; ethyl acetate partition, 0.07 g; and hydromethanolic residue, 1.09 g. For the flowers, the resulting masses were as follows: hexane partition, 1.57 g; dichloromethane partition, 1.79 g; ethyl acetate partition, 0.02 g; and hydromethanolic residue, 0.48 g.

Antifungal activity

The antifungal activity of *S. reginae* extracts and partitions was conducted using the broth microdilution method, following the guidelines of the Clinical and Laboratory Standards Institute (CLSI) (CLSI, 2008). The yeasts utilized in the experimental trials were obtained from the American Type Culture Collection (ATCC, Rockville, MD, USA). The yeasts included in the study were *Candida albicans* (ATCC 28366), *Candida tropicalis* (ATCC 13803) and *Candida glabrata* (ATCC 15126).

The determination of the minimum inhibitory concentration (MIC) was performed in 96-well microdilution plates, where serial dilutions were made with sample concentrations ranging from 3000 to 0.48 µg/mL.

Amphotericin B was used as positive control, being diluted in broth for concentrations between 0.031 to 16.0 µg/mL. The negative control (DMSO) was tested with concentrations ranging from 1% to 10% v/v and not influenced in yeast growth. The added inoculum medium was used as culture growth control. Sterility controls of the culture medium and the samples were also performed.

For assay validation, the positive control amphotericin B was tested against the reference strains *Candida krusei* (ATCC 6258) and *Candida parapsilosis* (ATCC 22019) within a MIC range between 0.5 and 2.0 µg/mL, according to the CLSI reference protocol M27-A3 (2008). At the end of the procedure, the minimum inhibitory concentration (MIC) was

determined, which corresponds to the minimum concentration of the sample capable of inhibiting yeast growth. The details of the assay, as well as the controls used, are described in Rocha *et al.* (2018).

High-performance liquid chromatography coupled to electrospray ionization mass spectrometry (HPLC-ESI-MS)

The analysis of the most active partition was performed on an Agilent Infinity 1260 chromatograph coupled to a high resolution mass spectrometer (Agilent® 6520 B), quadrupole time of flight (QTOF) with an electrospray ionization source (ESI). The sample was analyzed at a concentration of 2.0 mg/mL. A sample volume of 1.0 µL was injected into a C18 column (50 mm × 2.1 mm, 1.8 µm particle size). The chromatographic conditions used were ultrapure water containing 0.1% formic acid (v/v) (mobile phase A), and methanol (mobile phase B). The solvent gradient system started with 2 % B (0-2 min), 98% B (2-15 min), reaching 100% B in 17 min, and returning to 2% B in 1 min, at a flow rate of 0.4 mL/min.

The high resolution mass spectrometer operated with a nebulizer pressure of 58 PSI, with a drying gas flow of 8.0 L/min at a temperature of 220 °C. An energy of 4.5 kV was applied to the capillary. The data were acquired in negative mode, obtaining $[M-H]^-$ ions. The masses were obtained in high resolution (MS) and compared with the proposed molecular formula through the error (in ppm), according to the equation: Error (ppm) = experimental mass - exact mass / exact mass x 10^6. Sequential mass spectrometry (MS/MS) was performed at different collision energies (5-30 eV) for the negative mode. Based on the fragment spectra and high-resolution mass, the constituents present in the sample were annotated. The compounds were annotated according to other studies in the literature and the Metlin database.

RESULTS AND DISCUSSION

Antifungal activity

The results of the antifungal activity of extracts and fractions from the leaves and flowers of *S. reginae* against the yeasts *C. albicans*, *C. tropicalis*, and *C. glabrata* are presented in Table 1. The values are expressed in minimum inhibitory concentration (µg/mL), which represents the lowest concentration capable of inhibiting the growth of the yeasts tested.

Table 1 – Minimum inhibitory concentration for extracts and partitions of *S. reginae*

	Samples	Minimum inhibitory concentration - MIC (µg/mL)		
		C. albicans (ATCC 28366)	*C. tropicalis* (ATCC 13803)	*C. glabrata* (ATCC 15126)
Leaves	EE	> 3000	> 3000	375
	HP	> 3000	> 3000	750
	DP	> 3000	> 3000	750
	EAP	> 3000	> 3000	750
	HMP	> 3000	> 3000	750
Flowers	EE	> 3000	> 3000	187.5
	HP	> 3000	> 3000	1500

REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE

	Samples	Minimum inhibitory concentration - MIC (µg/mL)		
		C. albicans (ATCC 28366)	*C. tropicalis* (ATCC 13803)	*C. glabrata* (ATCC 15126)
	DP	> 3000	> 3000	93.75
	EAP	23.43	46.87	11.72
	HMP	> 3000	> 3000	375
C+	Amphotericin B	0.25	0.25	0.12

Note: EE: Ethanolic extract. HP: Hexane partition. DP: Dichloromethane partition. EAP: Ethyl acetate partition. HMP: Hydromethanolic partition. Control yeasts for validation of the method by the protocol M27-A3 CLSI (2008): *Candida krusei* – MIC 1 µg/mL, *Candida parapsilosis* – MIC 0.25 µg/mL.

Source: Authors (2025).

The ethyl acetate partition (EAP) of the flowers demonstrated anti-*Candida* activity against *C. albicans*, *C. tropicalis* and *C. glabrata*, with minimum inhibitory concentrations of 23.43, 46.87 and 11.72 µg/mL, respectively. These results can be considered noteworthy. Some studies indicate that MIC values below 100 µg/mL for natural product extracts, the results can be considered promising (Rios e Recio, 2005; Holetz *et al.*, 2002).

The ethanolic extracts of the flowers and leaves, as well as the leaves partitions and the HP, DP, and HMP partitions of the flowers, showed no activity against *C. albicans* and *C. tropicalis* within the tested concentration range (1.46–3000 µg/mL). In contrast, *C. glabrata* was sensitive to all extracts and fractions evaluated, with MIC values ranging from 11.72 to 1500 µg/mL.

Some studies have already shown that *S. reginae* has antimicrobial activity. In the study by Mahmoud *et al.* (2024), the ethyl acetate and n-butanol fractions of the leaves showed an effect against methicillin-resistant *Klebsiella pneumonia* and *Staphylococcus aureus* with MICs between 1250 and 2500 µg/mL. However, these fractions did not show satisfactory activity against the clinical isolates *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Candida albicans* compared to the standards used. In another study, leaf extracts prepared using a Soxhlet apparatus with petroleum ether, chloroform, methanol, and water also showed activity against *K. pneumonia* and *S. aureus* in the diffusion method (Sujitha; Vijayan, 2025). The chloroform:methanol and aqueous leaf extracts exhibited MIC values ranging from 600 to 8000 µg/mL against microorganisms associated with urogenital infections, including *Trichomonas vaginalis*, *C. albicans*, *Oligella ureolytica*, *Ureaplasma urealyticum*, *Neisseria gonorrhoeae*, and *Gardnerella vaginalis* (Vuuren; Naidoo, 2010). Interestingly, studies on the antimicrobial activity of this species reported in the literature have focused on the leaves, while several gaps remain regarding the flowers.

The results obtained with the ethyl acetate partition of the flowers (EAP) can be considered relevant, since the MIC values for the yeasts tested are below 100 µg/mL and markedly lower than those reported in other studies. These results suggest that the ethyl acetate partition (EAP) of the flowers contains bioactive compounds capable of inhibiting the growth of *C. albicans* and non-*albicans Candida*.

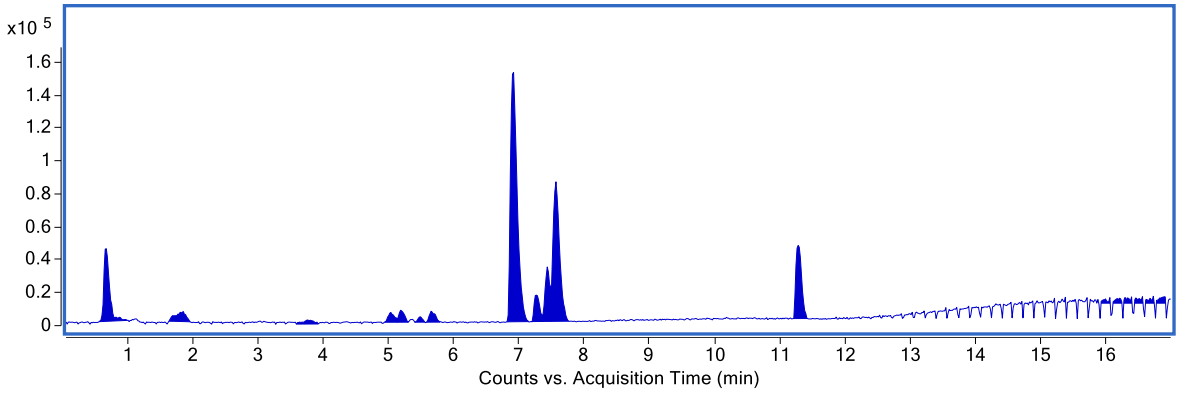
It is worth noting that the yeasts tested in this study play an important role in the development of fungal infections, such as candidiasis, and are among the fungi with the highest infection rates in hospital cases. Contamination by *Candida* spp. has become a global concern, primarily due to the high mortality rates associated with these microorganisms. Another relevant point is that there is not a wide variety of drugs available for treating fungal infections, and these yeasts have developed mechanisms of resistance to the drugs that are available (Parente; de Barros; de Araújo, 2024).

In this context, the data presented here may contribute to the development of new antifungal agents capable of controlling infections caused by *Candida* species. In order to identify possible compounds related to the activity found, the partition of the flowers (EAP) was analyzed by liquid chromatography coupled with mass spectrometry.

Annotation of compounds by liquid chromatography coupled to electrospray ionization mass spectrometry (HPLC-ESI-MS)

The annotation of the compounds by HPLC-ESI-MS was performed from the ethyl acetate (EAP) partition of the flowers, since presented relevant results in the antifungal assays. The base peak chromatogram (BPC) obtained in negative mode is shown in Figure 1. Negative ion mode was selected for the analysis, since ethyl acetate solvent allow to extract phenolic compounds, which are detected as $[M–H]^-$ ions. Table 2 presents eighteen compounds annotated in the EAP of *S. reginae* flowers and Figure 2 shows the chemical structures of these compounds.

Figure 1 – Chromatogram of the EAP from *S. reginae* flowers by HPLC-ESI-MS



Source: Authors (2025).

Table 2 – Metabolites annotated in the ethyl acetate partition of *S. reginae* flowers by HPLC-ESI-MS

N.	Rt (min)	[M – H]–	Error (ppm)	Fragments MS/MS (-)	Molecular formula	Annotation	Metabolite class	Reference
1	0.68	173.0454	2.31	10 eV: 155, 137, 111	C7H10O5	Shikimic acid	Organic acid	Metlin
2	1.11	169.0143	0.59	10 eV: 125	C7H6O5	Gallic acid	Phenolic acid	Metlin
3	1.73	153.0196	1.9	10 eV: 108, 109	C7H6O4	Protocatechuic acid	Phenolic acid	Metlin
4	1.83	299.0773	0.33	5 eV: 299, 239, 179, 157, 137, 119	C13H16O8	Hydroxybenzoic acid-O-hexoside	Phenolic acid	Serag *et al.*, 2019
5	3.79	121.0293	-1.6	25 eV: 121, 106	C7H6O2	4-Hydroxybenzaldeide	Phenolic aldehyde	Metlin
6	5.04	449.1087	-0.44	10 eV: 287, 269, 259, 179, 149, 125, 107	C21H22O11	Eriodictyol hexoside or dihydrokaempferol hexoside	Flavanone	Kang *et al.*, 2016; Abu-Reidah *et al.*, 2015
7	5.04	289.0720	0.69	20 eV: 245, 203, 175, 165, 151, 137, 125, 109	C15H14O6	Catechin	Flavan-3-ol	Lasano *et al.*, 2019
8	5.20	335.0772	0.0	10 eV: 291, 179, 173, 161, 155, 137, 135, 111	C16H16O8	Caffeoylshikimic acid I	Hydroxycinnamic acid derivative	Said et al, 2017; Abu-Reidah *et al.*, 2015
9	5.35	545.1452	-0.18	10 eV: 419, 409, 391, 313, 312, 273, 271, 164	C30H26O10	(Epi)afzelechin-(epi)afzelechin (I)	Proanthocyanidin	Prado *et al.*, 2024

N.	Rt (min)	[M – H]–	Error (ppm)	Fragments MS/MS (-)	Molecular formula	Annotation	Metabolite class	Reference
10	5.49	335.0777	1.40	20 eV: 291, 179, 173, 161, 155, 137, 135, 111	C16H16O8	Caffeoylshikimic acid II	Hydroxycinnamic acid derivative	Said *et al.*, 2017; Abu-Reidah *et al.*, 2015
11	5.65	545.1450	-0.55	10 eV: 419, 409, 391, 313, 312, 273, 271, 164	C30H26O10	(Epi)afzelechin-(epi)afzelechin (II)	Proanthocyanidin	Prado *et al.*, 2024
12	5.79	273.0773	1.83	20 eV: 237, 231, 220, 213, 185, 146, 123, 107	C15H14O5	Trihydroxy-ethoxybenzophenone	Phenolic benzophenone	Metlin
13	6.92	609.1466	0.82	20 eV: 609, 301, 300	C27H30O16	Quercetin-3-O-rutinoside (Rutin)	Flavone	Metlin
14	7.07	463.0880	-0.43	20 eV: 343, 301, 300, 271, 243, 209, 191, 179, 151	C21H20O12	Quercetin-3-O-hexoside	Flavone	Metlin; Ghareeb *et al.*, 2021; Serag *et al.*, 2019
15	7.27	593.1515	0.50	30 eV: 357, 327, 299, 285, 284, 255, 227, 175, 159, 151, 125	C27H30O15	Kaempferol-O-rutinoside I	Flavonol	Abu-Reidah *et al.*, 2015; Ghareeb *et al.*, 2021
16	7.43	593.1510	-0.33	30 eV: 357, 327, 285, 284, 269, 255, 227, 179, 133, 107	C27H30O15	Kaempferol-O-rutinoside II	Flavonol	Falcão *et al.*, 2012
17	7.43	477.1035	-0.62	20 eV: 315, 314, 299, 285, 271, 257, 243, 201, 151, 121	C22H22O12	Isorhamnetin-O- hexoside	Flavonol	Zhang et al., 2018; Said et al., 2017; Serag et al., 2019
18	7.57	623.1622	0.64	20 eV: 315, 300, 299, 271, 255, 179, 151	C22H22O12	Isorhamnetin-O-rutinoside	Flavonol	Ghareeb *et al.*, 2021; Zhang *et al.*, 2018

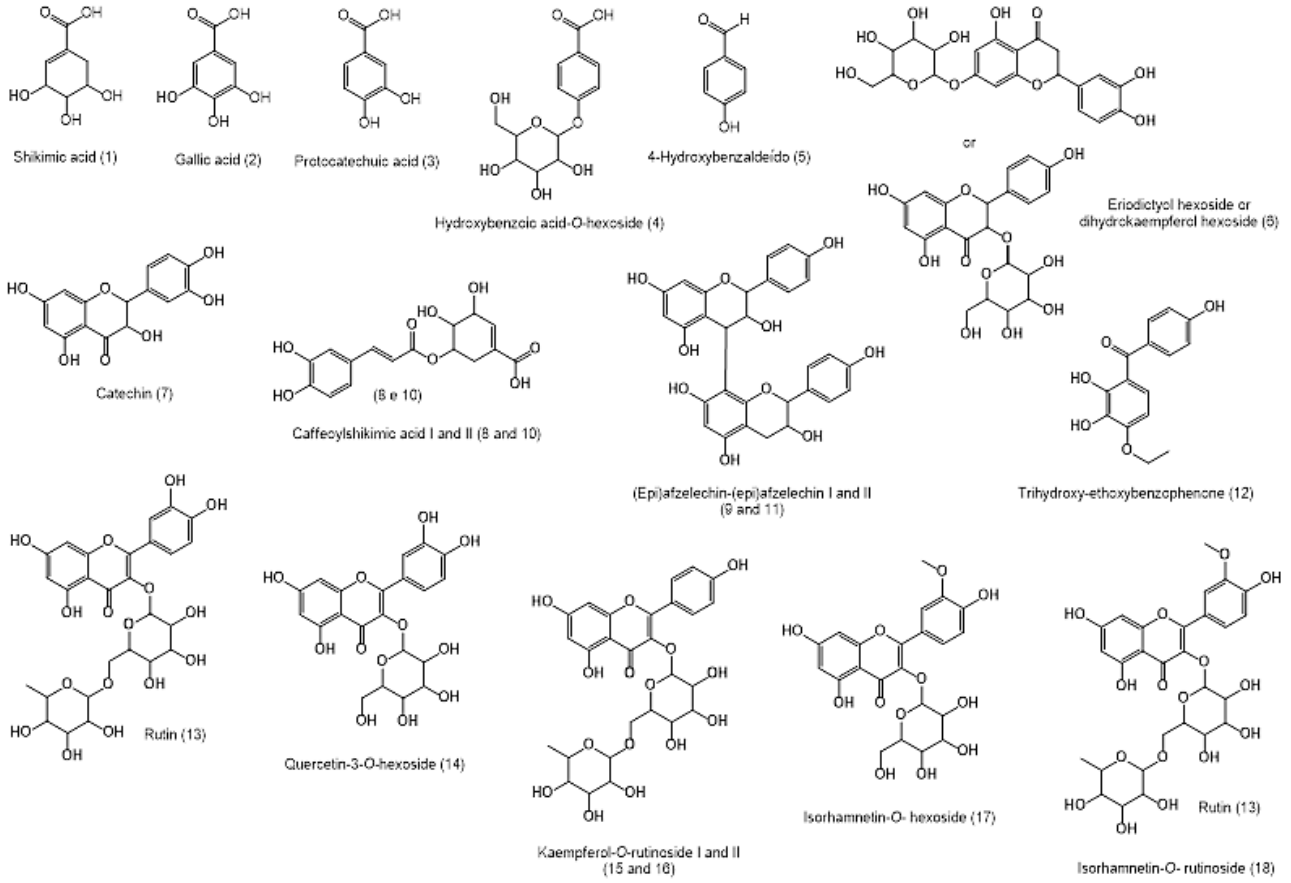
Source: Authors (2025).

According to the compounds annotated by HPLC-ESI-MS, the bioactive ethyl acetate partition (EAP) of the flowers was found to contain metabolites from the classes of organic acids, phenolic acids, flavonoids (both aglycones and glycosides), proanthocyanidins, and benzophenones. Phenolic compounds, including phenolic acids and flavonoids, have been reported in methanolic and ethyl acetate extracts of *S. reginae* leaves (Sujitha; Vijayan, 2025; Londonkar; Rajani, 2021; Hinol *et al.*, 2025; Mahmoud *et al.*, 2024).

In the chemical composition of the EAP of flowers, the class of organic acids was represented only by shikimic acid (1). Among the phenolic acids, gallic acid (2), protocatechuic acid (3) and hydroxybenzoic acid-O-hexoside (4) were annotated. Two phenolic isomers derived from hydroxycinnamic acid (Caffeic acid) were annotated as caffeoylshikimic acid I (8) and caffeoylshikimic acid II (10). A phenolic benzophenone was annotated as 2,3,4-trihydroxy-4´-ethoxybenzophenone (12). Within the flavonoid class, catechin (7) was the only annotated aglycone, while the remaining flavonoids corresponded to heterosides, including eriodictyol-*O*-hexoside or dihydrokaempferol-*O*-hexoside (6), quercetin-3-*O*-rutinoside (rutin) (13), quercetin-*O*-hexoside (14), kaempferol-*O*-rutinoside (15 and 16), isorhamnetin-*O*-hexoside (17) and isorhamnetin-3-*O*-rutinoside (18). Additionally, two isomeric proanthocyanidins were annotated as (epi)afzelechin-(epi)afzelechin I and II (9 and 11).

Figure 2 – Structures of the compounds annotate in the ethyl acetate partition of the *S. reginae* flowers

REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE



Source: Authors (2025).

The constituents in the acetate partition of *S. reginae* flowers are predominantly phenolic, demonstrating the efficiency of the liquid-liquid partition process, which enabled the enrichment of these compounds in the same fraction.

With the exception of the flavonoid rutin (13), which has previously been isolated from the leaves of *S. reginae* (Mahmoud *et al.,* 2024), no reports were found in the literature regarding the occurrence of the other compounds in the flowers and leaves of this species.

Although the chemical composition of *S. reginae* has not yet been extensively characterized, some metabolites identified in this study have previously been reported in another species of the same genus. Specifically, rutin, quercetin-3-*O*-glucoside, isorhamnetin-3-*O*-rutinoside, and kaempferol-3-*O*-rutinoside, detected in the flowers of *S. reginae*, were also reported in the ethyl acetate extract of *Strelitzia nicolai* leaves (Ghareeb *et al.*, 2018).

The promising anti-*Candida* activity found for the EAP partition from flowers may be related to its chemical composition. In the work of Esmaelli *et al.* (2025), several studies were cited showing that extracts or fractions enriched with phenolic compounds have antifungal properties against *Candida* species, including *C. albicans*, *C. glabrata* and *C. tropicalis*. This study also highlights that extensive research, both *in vivo* and *in vitro*, of plant extracts against *Candida* species has led to the identification of anti-*Candida* agents with significant efficacy.

In particular, phenolic acids and flavonoids have been linked to antifungal capacity. In the work of Teodoro *et al.* (2015), phenolic acids present in plant extracts and isolates were identified as promising agents against *Candida* species, including some of them detected in this study, such as gallic acid and protocatechuic acid. Flavonoids (flavones, flavonols, flavanones, flavan-3-ols, chalcones, isoflavones, and anthocyanidins) have also demonstrated potent anti-*Candida* activity. Their mechanisms of action include inhibition of cell wall synthesis, inhibition of mitochondrial function and cell division, and disruption of the cell membrane (Susilawati *et al.*, 2023).

Thus, correlating the biological results with the chemical composition of the ethyl acetate partition (EAP) of *S. reginae* flowers suggests that this plant matrix represents a promising source of molecular prototypes for the development of agents against *Candida* species. Given that the classes of compounds present in the EAP partition are well known for their anti-*Candida* properties, and that some individual metabolites have already demonstrated activity in isolation, it can be inferred that the observed effect is likely due to a synergistic interaction between phenolic acids and flavonoids.

CONCLUSION

The results obtained in this study show that ethyl acetate partitioning (EAP) of *Strelitzia reginae* flowers exhibits antifungal activity against *Candida* species. The chemical characterization of EAP revealed a profile rich in phenolic acids and flavonoids, classes already recognized for their relevance in antimicrobial activity. The association between these metabolites may explain the observed effect, reinforcing the hypothesis of a possible synergism between them. Thus, this study contributes to the understanding of the bioactive potential of *S. reginae* flowers, which have been little explored, and suggests that this plant matrix may serve as a valuable source of molecular prototypes for the development of new antifungal agents targeting *Candida* spp., whose clinical and hospital significance is increasing.

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REFERENCES

ABU-REIDAH, I. M. *et al.* Comprehensive metabolite profiling of *Arum palaestinum* (Araceae) leaves by using liquid chromatography–tandem mass spectrometry. **Food Research International**, v. 70, p. 74–86, 2015. DOI: https://doi.org/10.1016/j.foodres.2015.01.023. Available at: https://www.sciencedirect.com/science/article/pii/S0963996915000381. Accessed on: sept. 25, 2025.

ALI, A. *et al.* Appraisal of the anti-arthritic potential of Strelitzia reginae in Wistar rats via modulating molecular inflammatory cascades IL-6, IL-17A, IL-1β, TNF-α, IFN-γ, RANKL, OPG, and IL-4 and attenuating oxidative stress biomarkers. **Journal of King Saud University Science**, v. 36, n. 8, p. 103315, 2024. DOI: https://doi.org/10.1016/j.jksus.2024.103315. Available at: https://jksus.org/appraisal-of-the-anti-arthritic-potential-of-strelitzia-reginae-inwistar-rats-via-modulating-molecular-inflammatory-cascadesil-6il-17a-il-1tnf-ifn-rankl-opg-and-il-4-a/. Acessed on sep. 25, 2025.

CLINICAL AND LABORATORY STANDARDS INSTITUTE. **Reference method for broth dilution antifungal susceptibility testing of yeasts**. 3rd ed. Wayne, PA: Clinical and Laboratory Standards Institute, 2008. (CLSI document M27-A3).

ESMAEILI, A.; SALEH, I.; ABU-DIEYEH, M. H. Antifungal potential of plant-based extracts against *Candida* species: values, safety concerns, and possible applications. **Phytochemistry Reviews**, v. 24, p. 5801-5844, 2025. DOI: https://doi.org/10.1007/s11101-025-10093-x. Available at: https://link.springer.com/article/10.1007/s11101-025-10093-x. Accessed on: sept. 25, 2025.

FALCÃO, S. I. *et al.* Phenolic profiling of portuguese propolis by LC-MS spectrometry: uncommon propolis rich in flavonoid glycosides. **Phytochemical Analysis**, v. 24, n. 4, p. 309-318, 2013. DOI: https://doi.org/10.1002/pca.2412. Available at: http://pubmed.ncbi.nlm.nih.gov/23172843/. Acessed on sep. 25, 2025.

GHAREEB, M. HPLC-DAD-ESI-MS/MS Characterization of bioactive secondary metabolites from *Strelitzia nicolai* leaf extracts and their antioxidant and anticancer activities in vitro. **Pharmacognosy Research**, v. 10, n. 4, p.368-378. DOI: https://doi.org/10.4103/pr.pr_89_18. Available at: https://www.phcogres.com/article/2018/10/4/104103prpr8918. Acessed on sep. 29, 2025.

GHAREEB, M. HPLC-DAD-ESI-MS/MS characterization of bioactive secondary metabolites from *Strelitzia nicolai* leaf extracts and their antioxidant and anticancer activities in vitro. **Pharmacognosy Research**, v. 10, n. 4, p. 368-378, 2018. DOI: https://doi.org/10.4103/pr.pr_89_18. Available at: https://www.phcogres.com/article/2018/10/4/104103prpr8918. Accessed on: sept. 29, 2025.

HINOL, L. D. H. D. *et al.* Determination of the anti-inflammatory activity of the methanolic leaf extract of *Strelitzia reginae* (Strelitziaceae). **Pacific journal of health**, v. 8, n. 1, 2025. DOI: https://doi.org/10.56031/2576-215X.1101. Available at: https://scholarlycommons.pacific.edu/pjh/vol8/iss1/13/. Acessed on sep. 22, 2025.

HOLETZ, F. B. *et al.* Screening of some plants used in the Brazilian folk medicine for the treatment of infectious diseases. **Memórias do Instituto Oswaldo Cruz**, v. 97, n. 7, p. 1027-1031, 2002. DOI: https://doi.org/10.1590/S0074-02762002000700017. Available at: https://www.scielo.br/j/mioc/a/SMRK4jhMw84QBZLX6knbbSx/?lang=en. Acessed on sep. 24, 2025.

HÖLSCHER, D.; SCHNEIDER, B. Phenalenones from *Strelitzia reginae*. **Journal of Natural Products**, v. 63, n. 7, p. 1027-1028, 2000. DOI: https://doi.org/10.1021/np000035c. Available at: https://pubs.acs.org/doi/pdf/10.1021/np000035c. Acessed on sep. 24, 2025.

KANG, J. *et al.* Identification and characterization of phenolic compounds in hydromethanolic extracts of sorghum wholegrains by LC-ESI-MS(n). **Food Chemistry**, v. 211, p. 215-226, 2016. DOI: https://doi.org/10.1016/j.foodchem.2016.05.052. Available at: https://www.sciencedirect.com/science/article/pii/S0308814616307336. Accessed on: sept. 25, 2025.

KANTHARAJU, M. *et al.* Effect of antioxidant on in vitro establishment of *Strelitzia reginae* through shoot tip explants. **Karnataka Journal of Agricultural Sciences**, v. 21, n. 2, p. 324-325, 2008.

LASANO, N. F. *et al.* Nutritional composition, anti-diabetic properties and identification of active compounds using UHPLC-ESI-Orbitrap-MS/MS in *Mangifera odorata* L. peel and seed kernel. **Molecules**, v. 24, n. 2, 320, 2019. DOI: https://doi.org/10.3390/molecules24020320. Available at: https://www.mdpi.com/1420-3049/24/2/320. Accessed on: sept. 22, 2025.

LONDONKAR, R.; RAJANI, K. S. Phytochemical studies on the leaf extracts of *Strelitzia reginae*. **Plant Archives**, v. 21, n. 1, p. 1014-1023, 2021. DOI: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.140. Available at: https://www.plantarchives.org/article/phytochemical-studies-on-the-leaf-extracts-of-streliezia-reginae.pdf. Accessed on: sept. 25, 2025.

LORENZI, H.; SOUZA, H. M. **Plantas ornamentais do Brasil: arbustivas, herbáceas e trepadeiras**. Nova Odessa: Instituto Plantarum, 1999. 1098 p.

MAHMOUD, A. *et al. Strelitzia reginae* leaves: phytochemical elucidation and antimicrobial assessment on clinical isolates and standard strains. **Azhar International Journal of Pharmaceutical and Medical Sciences**, v. 4, n. 1, p. 52-61, 2024. DOI: https://doi.org/10.21608/aijpms.2023.178758.1181. Available at: https://aijpms.journals.ekb.eg/article_330537.html. Accessed on: sept. 22, 2025.

METLIN. **METLIN metabolite database**. La Jolla: Scripps Research, [n. d.]. Available at: https://metlin.scripps.edu. Accessed on: sept. 21, 2025.

REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE

MOUSSA, A. M. *et al.* Evaluation of antioxidant potential of 124 Egyptian plants with emphasis on the action of *Punica granatum* leaf extract on rats. **International Food Research Journal**, v. 18, n. 2, p. 535-542, 2011. Available at: http://www.ifrj.upm.edu.my/18%20(02)%202011/(10)%20IFRJ-2010-197.pdf. Accessed on: sept. 25, 2025.

PARENTE, L. H. N.; BARROS, N. B. de; ARAUJO, R. A. B. de. Incidência de doenças produzidas por fungos *Candida albicans* e *Candida glabrata* e os mecanismos de resistência aos antifúngicos. **Brazilian Journal of Health Review**, v. 7, n. 9, e76023, 2024. DOI: https://doi.org/10.34119/bjhrv7n9-413. Available at: https://ojs.brazilianjournals.com.br/ojs/index.php/BJHR/article/view/76023. Accessed on: sept. 29, 2025.

PRADO, D. G. *et al.* Phytochemical profiling by HPLC-ESI-MS/MS and *in vitro* investigation of the antidiabetic activity of *Cassia bakeriana* bark extract and fractions. **Journal of Mass Spectrometry**, v. 59, n. 12, e5099, 2024. DOI: https://doi.org/10.1002/jms.5099. Available at: https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/10.1002/jms.5099. Accessed on: sept. 22, 2025.

RÍOS, J. L.; RECIO, M. C. Medicinal plants and antimicrobial activity. **Journal of Ethnopharmacology**, v. 100, n. 1-2, p. 80-84, 2005. DOI: https://doi.org/10.1016/j.jep.2005.04.025.

ROCHA, E. O. *et al.* Composição química e atividade antimicrobiana do óleo essencial das flores de *Banisteriopsis campestris* (A. Juss.) Little. **Revista Virtual de Química**, v. 10, n. 5, p. 1562-1577, 2018. DOI: https://doi.org/10.21577/1984-6835.20180106. Available at: https://rvq-sub.sbq.org.br/index.php/rvq/article/view/2774. Accessed on: sept. 23, 2025.

SAID, R. B. *et al.* Tentative characterization of polyphenolic compounds in the male flowers of *Phoenix dactylifera* by liquid chromatography coupled with mass spectrometry and DFT. **International Journal of Molecular Sciences**, v. 18, n. 3, 512, 2017. DOI: https://doi.org/10.3390/ijms18030512. Available at: https://www.mdpi.com/1422-0067/18/3/512. Accessed on: sept. 25, 2025.

SERAG, A. *et al.* UHPLC-MS metabolome-based classification of umbelliferous fruit taxa: a prospect for phyto-equivalency of its different accessions and in response to roasting. **RSC Advances**, v. 10, n. 1, p. 76-85, 2020. DOI: https://doi.org/10.1039/C9RA07841J. Available at: https://pubs.rsc.org/en/content/articlelanding/2020/ra/c9ra07841j. Accessed on: sept. 25, 2025.

SUJITHA, K.; VIJAYAN, R. Phytochemical analysis and medicinal properties of *Strelitzia reginae* leaf extract. **International Journal of Scientific Research and Engineering Development**, v. 8, n. 2, p. 2295-2307, 2025. Available at: https://zenodo.org/records/15334337. Accessed on: sept. 25, 2025.

SUSILAWATI, S. *et al.* Flavonoid as anti-*Candida* agents. **Indonesian Journal of Fundamental and Applied Chemistry**, v. 8, n. 2, p. 88-97, 2023. DOI: https://doi.org/10.24845/ijfac.v8.i2.88. Available at: https://ijfac.unsri.ac.id/index.php/ijfac/article/download/318/162. Accessed on: sept. 25, 2025.

TEODORO, G. R. *et al.* Potential use of phenolic acids as anti-*Candida* agents: a review. **Frontiers in Microbiology**, v. 6, 1420, 2015. DOI: https://doi.org/10.3389/fmicb.2015.01420. Available at: https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2015.01420/full. Accessed on: sept. 25, 2025.

VAN VUUREN, S. F.; NAIDOO, D. An antimicrobial investigation of plants used traditionally in southern Africa to treat sexually transmitted infections. **Journal of Ethnopharmacology**, v. 130, n. 3, p. 552-558, 2010. DOI: https://doi.org/10.1016/j.jep.2010.05.045. Available at: https://www.sciencedirect.com/science/article/pii/S037887411000365X. Accessed on: sept. 25, 2025.

VIEIRA, M. R. da S. *et al.* Genus: *Strelitzia*. **Journal of Horticulture and Forestry**, v. 4, n. 11, p. 178-180, 2012. DOI: https://doi.org/10.5897/JHF12.025. Available at: https://academicjournals.org/journal/JHF/article-full-text-pdf/58282982836. Accessed on: sept. 25, 2025.

REPES
REVISTA DE ENSINO, PESQUISA E EXTENSÃO EM SAÚDE

WOOD, T. Ornamental Zingiberaceae. **Revista Brasileira de Horticultura Ornamental**, v. 1, n. 1, p. 12-13, 1995. DOI: https://doi.org/10.14295/rbho.v1i1.104. Available at: https://ornamentalhorticulture.com.br/rbho/article/view/104. Accessed on: sept. 22, 2025.