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Research Article

Chemical Constituents of *Spathodea Campanulata* (Bignoniaceae), their Antimicrobial and Antioxidant Activities

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ABSTRACT

A new cerebroside namely *Campanulatoside* (1) was isolated from the stem bark of S. *campanulata* along with seven known compounds including ursolic acid (2), oleanolic acid (3), 3-(3',4'-methylenedioxyphenyl)-2,3-epoxypropanol (4), spinasterol (5); stigmasterol (6); campesterol (7) and β-D-Glucopyranosyl-O-(1→2)-β-D-fructofuranoside (8). The structures of these compounds were established by 1D (1H and 13C) and 2D (COSY, HSQC and HMBC) NMR spectroscopy and by comparison with published data. Compounds 1-8 and crude extracts (leaves and stem) were evaluated for their antimicrobial and antioxidant activities. Compounds 4, 7, 8 and both crude extracts showed good activities against Staphylococcus epidermidis and *Candida albicans* with MIC value of 0.78 and 7.81 µg/mL respectively. Compound 1 showed significant activity against S. epidermidis and C. *albicans* with the MIC values of 1.56 and 3.12 µg/mL respectively and good antioxidant activity with IC50 varying from 49.21 to 52.21 µg/mL against DPPH.

Keywords: *Spathodea campanulata*; *Cerebroside*; *Campanulatoside*; Antimicrobial; Antioxidant.

INTRODUCTION

Infectious diseases are all diseases caused by the transmission of pathogen such as bacteria, viruses, parasites and fungi. The consequence of all of this is the disruption of the pro and antioxidant balance not to mention the inflammation caused by infection and radicals, the treatment of fungal infections causes the generation of free radicals through oxidative stress. To this, can be added the appearance of certain metabolic diseases that we know to be responsible for millions of deaths in developing countries [1]. Antimicrobial drugs have reduced the morbidity rate and significantly improved the survival of patients with fungal infections. Despite the development of vaccines and antibiotics, prevention and eradication of fungal infections has not yet been achieved, due to the high cost of the vaccine and antibiotics on the market [2]. In addition to the length of treatment, drug misuse is leading to the increasing emergence of strains resistant to available antibiotics [3]. It is therefore urgent to find new therapeutic targets, non-toxic, with no side effects and having new mechanisms of action able to fight microbial infections.

Spathodea campanulata, is a tree widely spread in tropical Africa and belonging to the Bignoniaceae family. Decoction of its leaves and barks is used to treat skin wounds and hemorrhoids [4]. In addition, the flowers and barks are used to treat fever, bacterial infections, HIV, respiratory ailments, genital-urinary system disorders, heartworms and gonorrhea [5]. Previous phytochemical

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investigations of S. *campanulata* have led to the isolation of diverse classes of compounds, including polyphenols, flavonoids, reducing sugars, anthocyanins, alkaloids, terpenes and saponins [6]. In this study, locking forward of bioactive natural products, the extract of the stem bark of S. *campanulata* was subjected to phytochemical investigation, leading to the isolation and characterization of an unreported cerebroside along with seven known compounds. In addition, we are tested all compounds and crude extracts for their antimicrobial and antioxidant activities.

MATERIAL AND METHODS

General experimental procedures

Column chromatography (CC) was carried out on silica gel 230-400 mesh (Merck). Thin Layer Chromatography (TLC) was performed on Merck percolated silica gel 60 F254 aluminum and compound spots were visualized under UV light (254 and 365 nm) and by spraying with diluted sulfuric acid followed by heating at about 100°C for 5 to 10 minutes. Low resolution mass spectra were obtained with a QTOF Compact Spectrometer (Bruker). The spectrometer was operated in positive (mass range: 50-1500, with a scan rate of 1.00 Hz) with automatic gain control to provide high-accuracy mass measurements within 0.4 ppm deviation using Na formate as calibrant. The 1H and 13C NMR spectra were recorded on AVANCE 500 MHz and 125 MHz NMR spectrometers in deuterated solvents. Chemical shifts were reported in δ (ppm) using TetraMethylSilane (TMS) as an internal standard, while coupling constants (J) were measured in Hz.

Plant material

The stem bark of S. *campanulata* were collected on June 2018 in Monatélé, Center Region of Cameroon. The plant species was identified by Mr. Nana Victor, a botanist at the National Herbarium of Cameroon in Yaoundé, where a specimen was deposited under the voucher HNC 45706/RSF-Cam.

Extraction and isolation

The dried and powdered stem bark of S. *campanulata* (2.0 kg) was macerated in MeOH for 72 h, three times at room temperature. After filtration and evaporation under reduced pressure, 70.2 g of a crude extract were obtained. 50.2 g of the crude extract was fractionated using column chromatography and eluted with n-hexane and EtOAc to yield the n-hexane (F1, 17.1 g), EtOAc (F2, 10.6 g) fractions and the residual MeOH fraction (F3, 25.3 g). The EtOAc fraction was subjected to column chromatography (CC) on silica gel (hexane/EtOAc/MeOH, gradient) to afford, compound 2 and 3 (10 mg) at AcOEt 100%, 1 (6 mg) at AcOEt/MeOH 98:2 and 4 (10 mg) at Hex/AcOEt 95:5 together with four fractions V1-V4 grouped on the basis of the TLC profile. Fraction V1 (13.6 g) was subjected to CC on silica gel and eluted with a gradient of Hexane/EtOAc to yield 5 (8 mg) and 6 (10 mg) at hexane/EtOAc 90:10. Fraction V2 (9.5 g) was submitted to an isocratic CC over silica gel with EtOAc as solvent which yields 7 (10 mg). Fraction V3 (12.1 g) was also subjected to a CC over silica gel and eluted gradiently with hexane/EtOAc (7:3-0:1) to give 8 (11 mg) at MeOH 100%.

Antimicrobial activities assessment

Microorganisms: Extracts and isolated compounds were tested for their antimicrobial activity against bacteria and yeast strains. The strains of microorganisms used in this study were obtained from Resources and clinical isolates obtained from 'Centre Pasteur' of Yaoundé-Cameroon. These microorganisms included two yeast viz *Candida parapsilosis* and *Candida albicans* together with five bacterial species viz Staphylococcus epidermidis (Cocci Gram+), *Pseudomonas aeruginosa* (ATCC 27853), *Eschelichia coli* (ATCC 25922), *Samonella thyphi* (ATCC 19430) and *Samonella enterica* (NR4294) (Bacille Gram-).

Preparation of stock solutions of fungal extracts and reference drugs

The stock solutions were prepared at 0.5 µg/mL of crude extracts and 1 µg/mL for the compounds using 10% DMSO. *Fluconazol* and *Ciprofloxacin* (Sigma Aldrich) were used as reference drugs respectively for fungal and bacteria.

Antimicrobial assay

For the estimation of the antimicrobial activities of extracts and isolated compounds, a broth dilution method was employed for Minimum Inhibitory Concentration (MIC) determination following the Clinical and Laboratory Standards Institute (CLSI) guidelines M27-A3 for yeast and M7-A10 for bacteria [7]. Each extract/compound was firstly tested in triplicate at 500 µg/mL and only samples showing inhibition were subsequently considered for MIC determination. More specifically, 50 mL of Sabouraud Dextrose Broth (SDB) or Mueller Hinton Broth (MHB) were introduced in a 96-well microplate respectively for fungal and bacteria. 50 mL of extract/compound concentrated at 1000 µg/mL were added to wells of the first line. A serial two-fold dilution was made by transferring 50 mL of the mixture of the first wells to the next one up to the last, final concentrations varying from 500 to 31.25 µg/mL. Then, 50 mL of an inoculum of 1 × 105 cells/mL for yeast and 1 × 106 cells/mL for bacteria were introduced in all the wells except those of the sterility control. Each plate also contained a positive control, a negative control and a blank. Plates were incubated during 24 and 48 hours for bacterial and fungi respectively. The lowest concentration of extract/compound that inhibited the visible growth of a microorganism was defined as MIC. The classification of criteria of the antibacterial activity of extract, fraction and compounds were based on the MIC threshold reported by Kuete and Efferth [8]. The ratio MBC/MIC was calculated to determine the bactericidal (MBC/MIC≤4) and bacteriostatic (MBC/MIC>4).

Antioxidant assays

DPPH assay: Anti-radical scavenging is based on the decrease in the absorbance when the 2,2-diphenyl-1-picrylhy-drazyl (DPPH) radical is reduced at 517 nm. This was done according the method described by Brand-William and co-workers and modified by Talla et al. [9,10].

RESULTS AND DISCUSSION

Compound 1 was obtained as a white amorphous solid. Its ESI-MS spectrum revealed a pseudo-molecular ion peak (M+Na)+ at m/z 880.6 corresponding to the molecular formula C49H95O10N having three double bond equivalent. The 1D NMR spectrum pattern of compound 1 coincided with glycosphingolipid skeleton, which shows the presence of an amide linkage, a sugar, and long aliphatic chain moieties. Indeed, the existence of the two signals at δC 50.2 (C–N) and 174.3 (C=O) on the 13C NMR spectrum suggested the presence of an amide group (Figure 1). The 1D-NMR spectra of 1 showed an anomeric centre at δH 4.13 (1H, d, J = 7.8, β, H-1")/δC 103.7 (C-1"), and a set of carbon-atom signals (δC 73.9 (C-3"), 77.3 (C-2"), 70.4 (C-4"), 76.9 (C-5"), and 61.4 (C-6")), consistent to a β-D-glucopyranoside moiety (Table 1). [11-13]. Further extensive analysis of 1H-NMR spectrum of compound 1 reveals aliphatic chains by an intense signal between δH 1.25-1.94 (brs), and two terminal methyls at δH 0.85 (6H, t, J = 6.9, H-21/22') (δC 14.4). In addition, the signals of two olefinic protons are observed at δH 5.31 (1H, m, H-7) and 5.36 (1H, m, H-8). Furthermore, the three unsaturations of 1 are assigned to an olefinic double bond, a carboxylic group [14] and a glucopyranosyl ring. The double bond was found to be trans, as evidenced by the chemical shift of C-6 at δC 32.3 and C-9 at δC 32.5 [11,14-16]. Generally, the stereochemistry of the olefinic functional group is assigned from 13C chemical shift values of allylic carbons, δC 32-33 for trans-configuration and δC 27-28 for cis-configuration [12,15-17]. On 1H NMR spectrum the signals of three oxygenated methines are noticed at δH 3.37 (m, H-3), 3.85 (brs, H-4) and 3.32 (dd; J = 11.4; 5.4, H-2'), and supported by the signals at δC 71.3 (C-4), 71.0 (C-2') and 74.5 (C-3) in the 13C-NMR spectrum which means that the sphingoid base is *phyto*sphingosine [11,17]. The position of the sugar moiety at C-1 was evidenced by the downfield chemical shift of the oxygenated methylene carbon at δC 69.3 [13] and further confirmed by HMBC spectrum in which the anomeric proton at δH 4.13 (H-1") correlated with the carbon at δC 69.3 (C-1). Moreover, the 1H-1H COSY correlations observed between protons at δH 4.10 (H-2), 3.80/3.64 (H-1) with 3.37 (H-3) allowed to locate the hydroxy groups at C-1 and C-3. In addition, the correlations observed between protons at δH 3.85 (H-4) with the one at δH 1.48 (H-5); 1.48 (H-5) and δH1.97 (H-6); 1.97 (H-6) and 5.31 (H-7) which in turn correlate with the proton at δH 5.36 (H-8); 5.36 (H-8) and 1.93 (H-9) led to unambiguously locate the double bond on the *sphingosine moiety* at δ7 (Figure 2). Furthermore, the lengths of the fatty acid and *sphingosine moieties* as well as the position of double bond are determined by analysis of important ion-fragment peaks observed on the ESI-MS (Figure 3). Ion-fragments observed at m/z 519 ((M-C22H43O2)+H)+, 505 ((M-C22H44NO2)+2H)+, 561 ((M-C19H37O2)+H)+, 268 ((M-C31H60NO9)+H)+, 591 ((M-C18H35O)+H)+, and 238 (M-C32H62NO10)+H)+ allow to assign the fatty acid and the long-chain base length to be C22 for the fatty acid moiety and C21 for *sphingosine* [15,18,19]. Based on the biosynthetic evidence and as observed in all the naturally occurring cerebroside with 2,3,4-phyto*sphingosine* and 2'-hydroxy fatty acid moieties, the absolute configurations of C-2, C-3 and C-4 were assigned as 2S, 3R, and 4R respectively [14,17-20] while the configurations S was assigned to C-2' [14-16,21,22]. From the spectroscopic analysis above, 1 was established as *1-O-β-D-glucopyranosyl-2-((2'S)-2'-hydroxydocosanoylamino)-(2S,3R,4R,7E)-henicos-7-en-3,4-diol* and trivially named *Campanulatoside*. To the best of our knowledge, this is the first time that a cerebroside is reported from *Spathodea campanulata*. The known compounds (2-8) (Figure 1) were identified by comparing their NMR spectroscopic data to those reported in the literature, as Ursolic (2) [16], Oleanolic acid (3) [16], 3-(3',4'-méthylènedioxyphényl)-2,3-époxypropanole (4) [23], Spinasterol (5) [24], Stigmasterol (6) [24], Campesterol (7) [25] and α-D-Glucopyranosyl-O-(1→2)-β-D-fructofuranoside (8) [26].

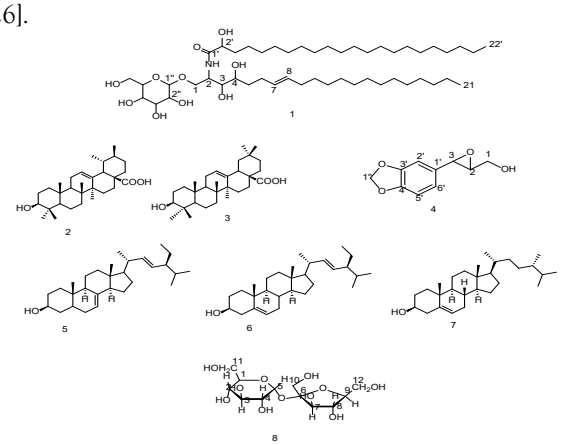

Figure 1: Chemical structures of compounds (1-8) isolated from S. campanulata

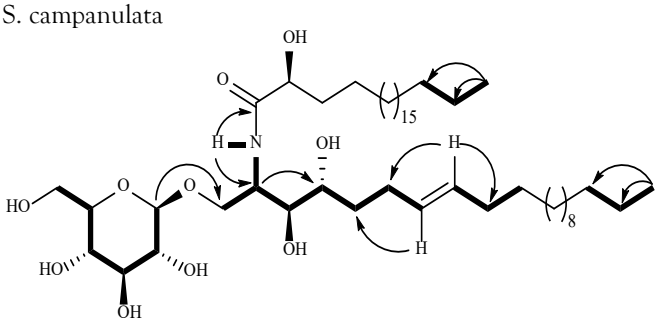

Figure 2: Chemical structures of compounds (1-8) isolated from S. campanulata Keys 1H 1H COSY ( ) and HMBC ( ) correlations of 1.

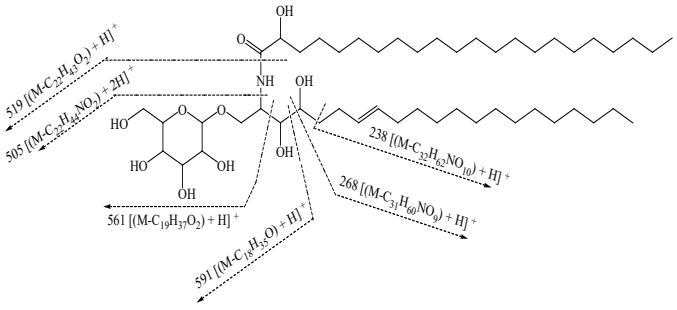

Figure 3: Important fragmentation masses of compound 1

1-O-β-D-glucopyranosyl-2-((2'S)-2'-hydroxydocosanoylamino)-(2S,3R,4R,7E)-henicos-7-en-3,4-diol (1): white amorphous solid.

Table 1: MIC and MBC of extracts and isolated compounds from S. campanulata.

Pathogen		Yeast		Gram (+)	Gram (-)			
Sample	**Strains**	*C. albicans*	*C. parasilosis*	*S. épidermidis*	*P. aeruginosa*	*E. coli*	*S. typhii*	*S. enterica*
Scf	MIC	62.5	31.25	62.5	15.6	62.5	62.5	15.62
	MBC	125	62;5	125	62.5	ND	125	62.5
	Ratio	2	2	2	4	-	2	4
Sce	MIC	15.62	31.25	7.81	15.62	15.62	31.25	ND
	MBC	31.25	62.5	15.6	ND	ND	ND	ND
	Ratio	2	2	2	-	-	-	-
1	MIC	3.12	12.5	1.56	3.12	3.12	6.25	3.12
	MBC	6.25	25	3.12	6.25	6.25	12.5	6.25
	Ratio	2	2	2	2	2	2	2
4	MIC	6.25	3.12	0.78	6.25	12.5	12.5	12.5
	MBC	12.5	6.25	1.56	12.5	25	25	ND
	Ratio	2	2	2	2	2	2	-
5	MIC	/	/	1.56	/	/	/	/
	MBC	/	/	6.25	/	/	/	/
	Ratio	-	-	4	-	-	-	-
7	MIC	6.25	3.12	1.56	3.12	12.5	6.25	6.25
	MBC	12.5	12.5	6.25	6.25	ND	12.5	12.5
	Ratio	2	4	4	2	-	2	2
Ciproflaxacin	MIC	–	–	1.56	1.56	1.56	1.56	1.56
	MBC	–	–	1.56	1.56	1.56	1.56	1.56
	Ratio	-	-	1	1	1	1	1
Fluconazole	MIC	0.78	0.78	–	–	–	–	–
	MBC	0.78	1.56	–	–	–	–	–
	Ratio	1	2	-	-	-	-	-

MIC and MBC were expressed as µg/mL; Sce: S. campanulata, stem bark extract; Scf: S. campanulata, leave bark extract

ND: Not determined; / : MIC or MBC > 125 µg/mL; – : Not tested; MIC < 10 µg/mL: Strong inhibition; 10 ≤ MIC < 100 µg/mL: Moderate inhibition; MIC ≥ 100 µg/mL: Weak inhibition (Kuete et al., 2010)

ESI-MS: m/z = 880.6 (M+Na)+calc. 857.6 for C49H95NO10. 1H NMR (500 MHz, DMSO-d6): δH: 3.66 (m, 1H, H-1a), 3.81 (tt, J=3.8, 10.7 Hz, 1H, H-1b), 4.10 (dd, J = 5.1, 9.6 Hz, 1H, H-2), 3.37 (m, 1H, H-3), 3.85 (m, 1H, H-4), 1.48 (dt, J = 1.4, 4.8 Hz, 2H, H-5), 1.96 (t, J = 6.5Hz, 1H, H-6), 1.51 (tt, J = 4.7, 9.9 Hz, 1H, H-6), 5.35 (m, 1H, H-7), 5.31 (m,1H, H-8), 1.93-1.51 (m, 1H, H9-20), 1.30 (m, 2H, H-21), 0.85 (t, J=6.5Hz, 3H, H-22), 7.53 (d, J=9.5 Hz, 1H, NH). 3.32 (dd, J=11.4, 5.4 Hz, 1H, H-2'), 1.59 (tt, J=9.9, 4.7 Hz, 1H, H-3'), 1.46 (dt, J=14.7, 4.8 Hz, 1H, H-3'), 1.25-1.94 (m, 1H, H4'-19'), 0.84 (t, J=6.5 Hz, 2H, H-20'), 0.84 (t, J=6.9 Hz, 2H, H-21'), 4.13 (d, J=7.8 Hz,1H, H-1"), 3.08 (dd, J=3.9, 2.1 Hz, 1H, H-2"), 2.94 (t, J=8.4 Hz, 1H, H-3"), 3.03 (d, J=9.1 Hz, 1H, H-4"), 3.14 (t, J=8.8 Hz, 1H, H-5"), 3.66 (m, 1H, H-6"), 3.34 (m, 1H, H-6"). 13C NMR (125 MHz, DMSO-d6): δC: 174.3 (C-1'), 71.0 (C-2'), 73.9 (C-3'), 27.4-31.8 (C-4'-C-19'), 22.6 (C-20'), 14.4 (C-21'), 103.7 (C-1"), 77.3 (C-2 "), 73.9 (C-3 "), 70.4 (C-4 "), 76.9 (C-5 "), 61.4 (C-6 "), 69.3 (C-1), 50.2 (C-2), 74.5 (C-3), 71.3 (C-4), 26.0 (C-5), 32.3 (C-6), 130.5 (C-7), 129.5 (C-8), 32.3-32.7 (C9-20), 25.90 (C-21), 14.4 (C-22).

Antimicrobial assay

The crude extract of stem bark, leaves and compounds 1, 4, 5 and 7 from S. *campanulata* were evaluated for their antimicrobial properties against four bacterial Gram-negative strains: Escherichia coli (ATCC 25922), *Salmonella typhi* (ATCC 19430), *Samonella enterica*, *Pseudomonas aeruginosa* (ATCC 27853), one bacterial Gram-positive Staphylococcus epidermidis, and two yeasts *Candida parapsilosis* and *Candida albicans*. The antimicrobi-

al activities of the extracts (Sce and Scf) and isolated compounds along with the standard drugs were reported in the Table 1. Sce and Scf displayed significant activity against selected pathogens with a MIC a value ranging from 7.81 – 62.5 µg/mL according to classification of antimicrobial plant extracts. In this work, the antimicrobial activities of the Sce were reported for the first time; however, with comparison to the study [27], the Scf exerted better inhibition of certain pathogens including *C. albicans, C. parapsilosis, P. aeruginosa, E. coli* and *S. typhi*. Regarding the MIC values, pathogens were more sensitive in the presence of the Sce than in the presence of the Scf. The gram (+) S. *epidermis* was the most sensitive with a MIC value of 7.81 µg/mL with the Sce followed by *C. albicans* (MIC = 15.62 µg/mL) and the *C. parapsilosis* (MIC = 32.25 µg/mL). The Sce as well as the Scf acted as good bactericide and fungicide against these pathogens suggesting that they could be potent candidates for the treatment of skin and other infectious diseases.

Scf and Sce displayed significant activity against selected pathogens with a MIC a value ranging from 7.81 – 62.5 µg/mL according to [27] classification of antimicrobial plant extracts. This potential of these extracts (Scf and Sce) led to the elucidation of their bioactive compounds. From the Sce, the compound 1, 4, 5 and 7 had been isolated Figure 1. These compounds showed significant inhibition (MIC = 1.56 – 12.5 µg/mL) of the range of tested pathogens Table 1, the presence of hydroxyls groups, amide, alkene, ester functions, phenols and carboxylic acids and their positions could be critical for their activities. Indeed, the gram (+) S. epidermis was the most sensitive with a MIC value of 1.56 µg/mL on these compounds and the *ciproflaxacin* yet their mode of action was different; compound 4 was bacteriostatic however 5, 7 and *ciproflaxacin* were bactericides showing that they may have similar action mechanism on this bacteria strain. Moreover, compound 1 acted as bactericides against selected gram (-) with the lower MIC values compared to other isolated compounds synergistically. The synergistic action of compound 1 and 4 increased the sensitivity (MIC = 0.78 µg/mL) of the S. epidermis with comparison to the *ciproflaxacin* (MIC = 1.56 µg/mL). Besides, the compound 4 and the positive control exerted a bactericidal effect on this gram (+) strain however compound 5 acted as bacteriostatic. The sensitivity of yeast strains was similar regarding the MIC of compound 4 and 1, both compound 4 and the 1 acted as fungicides against the *C. albicans* however only the compound 1 act as fungicide against the *C. parapsilosis*. Although the prevalence of antifungal resistance is not as high as antibacterial resistance levels, the results obtained support the use of S. *campanulata* in alternative medicine to treat skin diseases of fungal origin.

All the bacterial strains and antifungal strains used in this study were gram-negative bacteria, gram positif bacteria and yeast possessing complex and multilayered lipopolysaccharides cell walls. Herefore, for many compound including synthetic and natural antibiotics, the access to this membrane is more restricted [28]. He activity of all the compounds against the gram (-) bacteria used in this study suggests that these compounds could be able to cross this tough barrier. All these compounds presented in their structures many organic functions (hydroxyls groups, amide, alkene, ester functions, phenols and carboxylic acids) that can be responsible for the observed activities [29,30]. His study confrms the fact that the number and the position of hydroxyl groups infl-luenced the membrane interaction effects of organic compound. Although the prevalence of antifungal resistance is not as high as antibacterial resistance levels, the results obtained support the use of S. *campanulata* in alternative medicine to treat skin diseases of fungal origin (Table 2).

Table 2: Antioxidant activities of the extracts (Scf and Sce) and isolated compounds

Sample	IC50 (µg/mL)
Sce	47.75 ± 4.13
Scf	51.90 ± 2.82
Compound 1	49.21 ± 2.80
Compound 4	48.05 ± 5.24
Compound 5	52.21 ± 3.23
Compound 7	50.44 ± 2.05
Gallic acid	2.86 ± 0.53

Antioxidant assay

For the antioxidant activity of S. *campanulata*, samples were tested at several concentrations, then from the dose–response activities the SC50 values were obtained and are presented in (Table 2). The SC50 values for the different crude extracts and compounds ranged from 49.21 ± 2, 80 to 52.21 ± 3.23 µg/mL in the DPPH assay. The crude extract of stem barks and leaves S. *campanulata* (Sce and Scf) and compounds 1,4, 5 and 7 were found to possess moderate scavenging capacities toward DPPH free radical but not really significant with comparison to the gallic acid. All these compounds presented in their structures many organic functions (hydroxyls groups, amide, alkene, ester functions, phenols and carboxylic acids) that can be responsible for the observed activities [31,32]. This compound belongs to the phenolic group which is well known for their antioxidant capacities due to the formation of stable radical when they give hydrogens to the radical DPPH [31,32]. The different extracts showed an increase of SC50 the 48.05 ± 5.24 to 50.44 ± 2.05 for the compounds (Table 2). However, the scavenging capacity of each isolated compound was similar except those of the compound 1 which had an SC50 of 47.72 ± 5.24 µg/mL. The DPPH scavenging assay helped to reveal the antioxidant activities of the plant. As the results suggest, the plant exhibits antioxidant properties which can be exploited for further benefits to mankind [33].

CONCLUSION

The chemical investigation of the aerial parts of *Spathodea campanulata*. were fractionated using column chromatography, and afforded eight compounds: *Campanulatoside* (1), a mixture of

Ursolic (2) and Oleanolic acid (3), 3-(3',4'-méthylènedioxyphényl)-2,3-époxypropanole (4), Spinasterol (5), Stigmasterol (6), Campesterol (7) and α-D-Glucopyranosyl-O-(1→2)-β-D-fructofuranoside (8). The crude extract demonstrated significant activity on the tested bacteria strains with MIC values of 7.81 µg/mL. While compounds 4, 7 and 8 showed various degrees of antibacterial activities ranging from 0.78 to 6, 25 µg/mL. In addition, all compounds and extracts showed a good activity against S. epidermidis with MIC ranging from 0.78 to 7.81 µg/mL. The SC50 values for the different crude extracts and compounds ranged from 49.21 ± 2,80 to 52.21 ± 3.23 µg/mL against DPPH. This observed bioactivity may explain the use of extracts of this plant in traditional medicine.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors

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