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Full Length Research Paper

Antimicrobial activity of *Berkheya bergiana* leaves extracts

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The leaves of *Berkheya bergiana* Soderberg (Asteraceae) were screened for phytochemical composition and antimicrobial potential. Phytochemical screening of the crude methanol extract showed the presence of various secondary metabolites. *In vitro* antimicrobial activities of the extracts obtained from six solvents were carried out against 28 bacterial strains using traditional methods. Chloroform extract exhibited the highest broad spectrum antibacterial activity against the tested bacteria and decreased in the order chloroform > ethyl acetate > butanol > hexane > aqueous extract at a concentration of 5.0 mg mL^{-1} for bacteria. The minimum inhibitory concentration (MIC) exhibited by EtOAc, $CHCl_3$ and HEX extracts against the bacterial strains range between 0.07 and 2.5 mg mL^{-1}, while that of BuOH and aqueous extracts ranged between 0.07 and 5.0 mg mL^{-1}. The antibacterial activities of the plant were compared with standard (neomycin, ampicilin and tetracycline) antibiotics at the same concentration. The leaves extracts showed antibacterial potential, inhibiting the growth of some of the tested bacterial more than the standard drugs. The results obtained appeared to confirm the antibacterial potential of the plant investigated.

Key words: *Berkheya bergiana*, Asteraceae, antimicrobial activity, screening.

INTRODUCTION

South Africa has an abundance of medicinal plants, used in the traditional treatment of various diseases on an empirical basis (Hutchings and van Stedan, 1994; Neumann et al., 2004). The majority of the population of many developing countries uses herbal medicines either because people cannot afford western pharmaceuticals or because herbs are more acceptable (Cunningham, 1991). Today, an estimated 80% of the black population of South Africa makes use of indigenous medicinal plants for the treatment of various ailments in man and animals (Kelmanson et al., 2000). This practice may be due to easy access to traditional medication, especially in rural areas, where the majority of people cannot afford prescribed medicines.

The problem of bacterial resistance to commonly used antibiotics and the high cost of conventional drugs have necessitated the search for newer and alternative sources of drugs for the treatment of drug resistant infections. Medicinal plants have from generations been used for the treatment of ailments including infectious diseases. Several findings on the chemotherapeutics potential of some plants have shown that they can be good sources of antimicrobial compounds of value (Rios and Recio, 2005).

The genus *Berkheya* belongs to the Astereceae family. There are about 75 species of *Berkheya* with 71 species widespread in Southern Africa with about 30 species in the Natal region. *B. bergiana* Soderberg is an asteraceous perennial herb having leaves rough above with white cobwebby beneath, flower with yellow tips and spiny margins. The plant is extensively utilized in traditional medicinal practices in West, Central and South Africa. Decoction of leaves and roots are used for the treatment of coughs, gonorrhea, rheumatism and abdominal disorders especially for pains after eating. It is also used as anti-emetics. Unusual sesquiterpenoids and

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thiophene derivatives (isocomene, β-isocomene and modhepene) have been isolated from *Berkheya* species (Hutchings et al., 1996).

This study is aimed at determining antibacterial properties of various extracts of *B. bergiana* leaves against some disease causing pathogens. The evaluation of antibacterial activities of crude extracts is considered as an important step prior to isolation of bioactive compounds. The bacterial organisms used in this study are known to cause wound infection, diarrhea, pneumonia and chest pain.

MATERIALS AND METHODS

Plant material

Fresh leaves of *B. bergiana* Soderberg were collected from their natural habitat within and around University of Zululand in March 2007. Its identification was confirmed by Mrs. Anne Hutchings of the herbarium unit of the Botany Department, University of Zululand, KwaZulu-Natal, South Africa and voucher specimen deposited therein for reference purposes (Odeleye O.M. 2 (ZULU)).

Preparation of extracts

The leaves were air-dried at room temperature for 18 to 24 h and mechanically milled. Exactly 100 g of the powdered plant material was cold-extracted using 90% methanol for 2 days with occasional shaking. The extracts obtained from 3 cycles of extraction were combined after TLC analysis to ensure complete extraction. The mixture was then, filtered through Whatman filter paper no. 1 and the filtrate was concentrated to dryness using a rotary evaporator. This gave a yield of 19.39 g. (19.39%)

In a subsequent method, the air-dried and powdered leaves of *B. bergiana* (370 g) were extracted sequentially with hexane, chloroform, ethyl acetate, butanol and water at room temperature for 2 days with occasional shaking. The extraction was repeated 3 times. The extracts were filtered through Whatman filter paper no. 1 and the filtrates were concentrated to dryness using a rotary evaporator. The various extracts were combined to obtain 4.99, 5.53, 1.66, 4.71 and 2.78 g, respectively.

Phytochemical screening of the plant extract

A small portion of the dry methanolic extract was used for phytochemical screening using standard procedures described by Sofowora (1982), Trease and Evans (1996) and Harborne (1998) for the determination of some of the secondary metabolites.

Bacteria strains used in the study

Bacteria strains used in this study consisted of reference strains identified and obtained from University of Fort Hare namely *Escherichia coli* (ATCC 8739), *E. coil* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 19582), *Staphylococcus aureus* (ATCC 6538), *Staphylococcus faecalis* (ATCC 29212), *Bacillus cereus* (ATCC 10702), *Bacillus pumilus* (ATCC 14884), *P. aeruginosa* (ATCC 7700), *Enterobacter cloacae* (ATCC 13047), *Klebsiella pneumonia* (ATCC 10031), *K. pneumonia* (ATCC 4352), *Proteus vulgaris* (ATCC 6830), *P. vulgaris* (CSIR 0030), *Serratia marscens* (ATCC 9986), *Acinetobacter calcaoceuticus* (Aci1), *A. calcaoceuticus* (Aci2). Also included in this study were environmental strains of *K. pneumonia*, *Bacillus subtilis*, *Shigella flexineri*, *Salmonella* spp, *Staphylococcus epidermidis*, *P. aeruginosa*, *P. vulgaris*, *Enterococcus faecalis*, *E. coil*, *S. aureus*, *Micrococcus kristinae* and *Micrococcus luteus*.

Assay for antibacterial activity

Antibacterial activity of the extracts was carried out using the agar disc diffusion method described by Bauer et al. (1966). Bacteria were maintained on Mueller-Hinton nutrient agar at 4°C. Molten Mueller-Hinton agar was inoculated with a broth culture of the respective bacterial strains and poured over sterile 90 mm Petri dishes. The extract and fractions were dissolved in methanol to final concentration of 5.0 mg mL^{-1} and sterile Whatman no. 1 (6 mm) discs were impregnated with each sample to be tested at concentration of 5.0 mg mL^{-1}. Each Petri dish with agar and bacteria contained one Whatman filter paper (no. 1) discs of 6.0 mm diameter with plant extracts. The plates were incubated at 37°C for 24 h and the zones of inhibition were measured at the end of the incubation period. The standard antibiotics for reference drugs used were neomycin, ampicilin and tetracycline.

Minimum inhibitory concentration

The minimum inhibition concentration (MIC) of the plant extracts were determined using the 96 well microplate dilution method described by Eloff (1998). The final plate concentrations were 5.0, 2.5, 1.25, 0.625, 0.313, 0.157, 0.078 and 0.039 mg mL-1 for the extract/fractions. Standard antibiotics (neomycin, ampicilin and tetracycline) were used as positive control. Bacteria were grown for 18 h in nutrient broth and cultures of 108 colony forming unit (cfu) mL^{-1} were used and incubated for 24 h at 37°C. As an indicator of bacterial growth, 40 µl of 0.2 mg/ml p-iodonitrotetrazolium (INT) solution was added to each well and incubated at 37°C for 30 to 120 min. The colorless tetrazolium salt was reduced to a red colored product by biological activity of the organisms, thereby making the inhibition of bacterial growth visible as clear well. MIC values were recorded as the lowest concentration in which there was no bacterial growth. Each treatment was replicated thrice.

Analysis of data

All values are expressed as means ± standard error. The data collected was analyzed using one-way analysis of variance (ANOVA) and the effect of the differences among group means were considered significant when P value was < 0.05

RESULTS AND DISCUSSION

The result of the phytochemical screening of methanolic extract is listed in Table 1. The analysis showed the presence of secondary metabolites including flavonoids, saponins, tannins, trace of alkaloids, phenolic compounds and glycosides but no traces of anthraquinones in the methanolic extract. These secondary metabolites have earlier been reported to exhibit antimicrobial activity (Hostettman and Nakanishi, 1979). Therefore, these compounds may be responsible for the antibacterial activity of the leave extracts of *B. bergiana*. Tannins for example have been found to form irreversible complexes with proline-rich proteins (Hagerman and Butler, 1981).

Table 1. Phytochemical screening of *B. bergiana* methanol extract.

Plant metabolites	***B. bergiana***
Alkaloids	
(a) Preliminary screen	-
Draggendorff's reagent	-
Mayer's reagent	-
(b) Confirmatory test (TLC)	
Anthraquinones	-
(a) Free	-
(b) Combined	-
O-glycosides	
C-glycosides	
Carbohydrates	++
(a) Starch	+
(b) Cellulose	
Cardiac glycosides (Keller-Kiliani test for deoxy sugars)	+++
Flavonoids	++
Lead acetate test	++
Sodium hydroxide test	++
Ferric chloride test	++
HCl + Mg turning	+++
EtoAc + Heat +dil NH_3	
Flavonol (Shinoda reduction test)	++
Terpenoids (Liebermann-Buchard test)	+++
Steroids and sterols (Salkowski test)	+
Saponins	++
Frothing test	++
Blood haemolysis test	
Tannins	
(a) True	-
Phenazone test	+++
Ferric chloride test	
(b) Phlobatannins (Formaldehyde test)	

Keys: +++, Very strongly positive; ++, strongly positive; +, positive; -, negative.

Herbs that contain tannins as their main constituents are astringent in nature and are used for treating intestinal disorders such as diarrhea and dysentery (Dharmananda, 2003) which is one of the traditional uses of *B. bergiana* plant. Quinlan et al. (2000) and Neumann et al. (2004) showed that, steroids and steroidal extracts exhibiting antibacterial and antiviral activities, respectively. Thus, the presence of these compounds in *B. bergiana* corroborates the antibacterial activities observed.

In South Africa, *B. bergiana* plant has been used to treat cough and abdominal disorder infections (Hutchings et al., 1996). The antibacterial activities against some of the tested bacterial strains at a concentration of 5.0 mg mL^{-1} of the extracts of *B. bergiana* are presented in Table 2. The hexane, chloroform, ethyl acetate, butanol and aqueous extracts of the leaf extracts displayed broad

Table 2. The antibacterial activities of crude extract and fractions of *B. bergiana*.

Bacterial and extracts	Zone of inhibition (mm)								
	Crude	Hexane	$CHCl_3$	EtOAc	BuOH	Aqueous	Neomycin	Ampicilin	Tetracycline
E. coil (ATCC 8739)	9.0 ± 1.41	12.5 ± 2.0	10.5 ± 0.5	9.0 ± 0.75	11.0 ± 2.5	9.5 ± 0.75	17.5 ± 1.5	17.5 ± 2.0	22.0 ± 2.5
E. coil (ATCC 25922)	9.5 ± 0.00	7.5 ± 1.0	11.5 ± 2.0	10.0 ± 0.0	12.5 ± 0.0	10.5 ± 0.50	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
P. aeruginosa(ATCC 19582)	12.0 ± 0.00	13.0 ± 2.0	12.0 ± 0.7	15.0 ± 2.0	12.5 ± 0.50	11.5 ± 0.75	18.0 ± 0.75	10.0 ± 0.25	17.0 ± 0.25
S. aureus (ATCC 6538)	13.0 ± 0.00	13.5 ± 2.5	10.5 ± 1.0	15.5 ± 2.5	9.0 ± 0.25	12.0 ± 0.50	25.5 ± 0.0.5	39.0 ± 0.25	28.5 ± 0.75
S. faecalis (ATCC 29212)	9.0 ± 1.10	16.0 ± 2.0	0.0 ± 0.0	10.5 ± 1.0	0.0 ± 0.0	8.0 ± 0.75	0.0 ± 0.0	0.0 ± 0.0	15.0 ± 1.0
B. cereus (ATCC 10702)	10.5 ± 0.75	8.0 ± 0.75	13.5 ± 0.5	8.0 ± 0.75	13.0 ± 1.0	12.0 ± 0.75	21.0 ± 1.0	17.0 ± 0.25	29.0 ± 1.25
B. pumilus (ATCC 14884)	10.0 ± 0.00	7.0 ± 0.75	11.0 ± 1.0	0.0 ± 0.0	0.0 ± 0.0	12.0 ± 1.0	24.5 ± 0.25	36.0 ± 0.75	20.5 ± 0.50
P. aeruginosa (ATCC 7700)	9.0 ± 1.41	15.6 ± 1.0	18.5 ± 2.5	14.0 ± 0.5	15.0 ± 0.75	13.5 ± 0.25	18.5 ± 0.25	32.5 ± 0.75	19.0 ± 0.75
E. cloacae (ATCC 13047)	10.0 ± 0.25	10.0 ± 1.0	15.5 ± 2.0	13.0 ± 0.25	10.0 ± 2.0	8.5 ± 0.00	18.5 ± 0.25	0.0 ± 0.0	23.5 ± 1.0
K. pneumonia(ATCC 10031)	11.0 ± 0.75	16.0 ± 2.0	16.0 ± 0.5	13.0 ± 0.50	14.5 ± 0.0	13.0 ± 2.5	23.5 ± 0.5	15.0 ± 0.25	29.5 ± 2.0
K. pneumonia (ATCC 4352)	11.5 ± 0.75	11.0 ± 1.0	13.0 ± 2.0	10.0 ± 1.0	11.0 ± 0.0	10.5 ± 0.75	19.0 ± 1.0	11.0 ± 0.75	25.0 ± 2.0
P. vulgaris (ATCC 6830)	10.0 ± 3.53	10.0 ± 0.5	10.0 ± 1.0	11.0 ± 0.75	10.0 ± 0.5	9.0 ± 0.0	21.5 ± 1.55	24.0 ± 0.5	20.0 ± 0.25
P. vulgaris (CSIR 0030)	0.0 ± 0.0	12.5 ± 2.0	0.0 ± 0.0	8.0 ± 1.25	8.0 ± 0.75	12.0 ± 0.0	16.5 ± 0.5	11.5 ± 0.50	14.0 ± 0.75
S. marscens (ATCC 9986)	0.0 ± 0.0	9.5 ± 1.0	0.0 ± 0.0	9.0 ± 0.5	9.0 ± 0.25	11.0 ± 1.0	16.5 ± 0.0	0.0 ± 0.0	19.5 ± 0.25
A. calcaoceuticus Aci1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
A. calcaoceuticus Aci2	0.0 ± 0.0	9.5 ± 2.0	0.0 ± 0.0	0.0 ± 0.0	8.0 ± 0.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
K. pneumonia	8.0 ± 1.00	11.0 ± 0.5	0.0 ± 0.0	0.0 ± 0.0	7.5 ± 0.5	11.5 ± 2.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
B. subtilis	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	25.5 ± 1.0	43.0 ± 2.0	40.0 ± 2.5
S. flexineri	11.5 ± 0.25	0.0 ± 0.0	8.0 ± 0.75	15.5 ± 2.5	12.0 ± 2.0	0.0 ± 0.0	12.5 ± 0.5	25.5 ± 0.75	30.0 ± 0.25
Salmonella spp	9.0 ± 0.75	10.5 ± 1.0	10.0 ± 0.5	10.0 ± 1.0	9.5 ± 0.75	0.0 ± 0.0	15.0 ± 0.0	26.5 ± 0.25	30.5 ± 0.25
S. epididirmis	9.0 ± 0.75	9.0 ± 0.75	8.5 ± 1.5	9.0 ± 0.50	10.0 ± 1.0	8.5 ± 0.25	30.0 ± 1.5	29.5 ± 0.75	17.5 ± 0.5
P. aeruginosa	12.0 ± 0.25	8.0 ± 0.25	9.0 ± 2.5	9.5 ± 0.75	0.0 ± 0.0	0.0 ± 0.0	26.5 ± 1.0	30.0 ± 1.5	32.5 ± 2.0
P. vulgaris	10.5 ± 0.50	8.5 ± 0.75	11.0 ± 0.0	9.5 ± 0.75	11.0 ± 0.75	0.0 ± 0.0	17.5 ± 0.25	12.5 ± 0.5	15.0 ± 0.5
E. faecalis	0.0 ± 0.0	0.0 ± 0.0	13.0 ± 1.0	10.0 ± 0.75	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	35.5 ± 1.5	13.5 ± 0.25
E. coil	8.0 ± 0.25	15.5 ± 0.5	11.0 ± 2.5	9.0 ± 0.5	17.0 ± 2.5	0.0 ± 0.0	19.5 ± 0.75	22.5 ± 0.5	27.5 ± 0.5
S. aureus	9.0 ± 0.50	10.0 ± 0.5	11.5 ± 0.5	8.5 ± 0.5	8.0 ± 0.50	0.0 ± 0.0	21.0 ± 1.75	41.5 ± 3.0	34.5 ± 2.5
M. kristinae	8.5 ± 1.00	7.0 ± 0.25	8.5 ± 0.75	11.5 ± 2.0	9.5 ± 0.25	7.0 ± 0.25	16.5 ± 0.0	15.0 ± 0.25	32.5 ±1.0
M. luteus	9.5 ± 1.50	9.5 ± 2.0	11.0 ± 0.0	12.5 ± 0.25	12.5 ± 1.0	10.0 ± 1.0	26.0 ± 0.0	16.0 ± 0.0	24.5 ± 0.5

Dose, 5 mg mL^{-1}; disc diameter, 6 mm; *, significantly different from the control ($P < 0.05$) by using analysis of variance (ANOVA). The data given are mean (n = 3) ± standard error.

Table 3. Minimum inhibitory concentration (MICs) of the crude extract and fractions of *B. bergiana* leaves.

Bacterial and extracts	MIC (mg/ml)								
	Crude	Hexane	$CHCl_3$	EtOAc	BuOH	Aqueous	Neomycin	Ampicilin	Tetracycline
E. coil (ATCC 8739)	0.312	5.000	2.500	1.250	0.039	0.039	0.039	0.039	0.039
E. coil (ATCC 25922)	1.250	5.000	1.250	-	1.250	0.625	-	-	-
P. aeruginosa(ATCC 19582)	1.250	5.000	0.156	0.156	0.312	0.156	0.039	0.039	0.156
S. aureus (ATCC 6538)	0.625	5.000	0.625	0.312	0.312	-	0.039	2.500	0.039
S. faecalis (ATCC 29212)	2.500	5.000	-	0.625	-	1.250	-	-	0.078
B. cereus (ATCC 10702)	2.500	-	1.250	0.625	1.250	5.000	0.039	5.000	0.039
B. pumilus (ATCC 14884)	2.500	-	2.500	-	-	-	0.039	5.000	0.156
P. aeruginosa (ATCC 7700)	0.625	2.500	0.312	1.250	0.625	2.500	0.039	0.039	0.156
E. cloacae (ATCC 13047)	0.312	5.000	0.0780	0.078	0.078	0.312	0.039	-	0.078
K. pneumonia(ATCC 10031)	0.625	2.500	0.625	1.250	0.312	-	0.039	-	0.156
K. pneumonia (ATCC 4352)	2.500	5.000	1.250	0.625	0.625	-	0.039	1.250	0.039
P. vulgaris (ATCC 6830)	1.250	1.250	1.250	0.312	0.625	-	0.039	-	0.039
P. vulgaris (CSIR 0030)	ND	ND	ND	ND	ND	ND	ND	ND	ND
S. marscens (ATCC 9986)	ND	ND	ND	ND	ND	ND	ND	ND	ND
A. calcaoceuticus Aci1 (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND
A. calcaoceuticus Aci2 (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND
K. pneumonia (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND
B. subtilis (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND
S. flexineri (LIO)	0.625	-	0.625	0.625	0.625	-	0.039	1.25	0.039
Salmonella spp (LIO)	0.625	5.000	0.625	0.625	0.156	-	0.039	0.156	0.039
S. epididirmis (LIO)	0.312	5.000	0.156	0.156	1.250	0.312	0.039	0.625	0.039
P. aeruginosa (LIO)	0.312	5.000	0.312	0.312	-	-	0.039	2.500	0.039
P. vulgaris (LIO)	0.078	2.500	0.078	0.039	0.039	-	0.039	0.312	0.039
E. faecalis (LIO)	-	2.500	0.625	0.625	-	-	-	0.039	0.039
E. coil (LIO)	0.078	2.500	0.625	0.625	0.039	-	0.039	0.625	0.039
S. aureus (LIO)	0.078	-	2.500	2.500	2.500	-	0.039	0.039	0.039
M. kristinae (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND
M. luteus (LIO)	ND	ND	ND	ND	ND	ND	ND	ND	ND

ATCC, American type culture collection; CSIR, Council for Scientific and Industrial Research; LIO, locally isolated organism; $CHCl_3$, chloroform; EtOAc, ethyl acetate; BuOH, butanol; ND, not determined.

inhibitory effect against the tested bacteria at various degrees. However, these various extracts may contain different chemical constituents in different solvents due to their polarity and so, these components of each extract were responsible for the antibacterial activities of different extracts by diffusion of the components of each extract using water-based agar. This support Freiburghans et al. (1996) that, different solvent system extracts of some plant may exhibit diffe-rent pharmacological properties. The most sensitive bacteria to the six extracts were *P. aeruginosa, S. aureus, B. cereus, K. pneumonia, E. coli, P. vulgaris* and *M. luteus.* The chloroform and ethyl acetate extracts were the most active extracts. However, chloroform was more active with zones of inhibition ranging between 8.0 and 18.5 mm while the hexane and aqueous fractions showed low activity with the aqueous extract showing least activities with zones of inhibition ranging between 7.5 and 13.0 mm. Though water had been reported by traditional healers and herbalists to be the most commonly used solvent to extract biologically active compounds due to its easy availability but semi-organic solvents are more active. In comparison with standard commercial drugs, the antibacterial property of *B. bergiana* leaves (inhibition zones of 9.7 to 16.0 mm diameter) was as effective as the commercial antibiotics tetracycline, neomycin and ampicillin (inhibition zones of 11.0 to 43.0 mm) in some bacteria. The MIC of the extracts of *B. bergiana* leaves range from 5.0 to 0.07812 mg/ml (Table 3). The most active extract was chloroform with MIC ranges from 2.5 to 0.07812 mg/ml. The ability of the extracts from *B. bergiana* to inhibit the growth of some of the tested bacteria strains like *E. coli, S. aureus, S. flexineri, P. vulgaris* and *P. aeruginosa* is an indication of the potential of the plant as a broad spectrum antibacterial agent. *B. bergiana* has been used traditionally for the treatment of various respiratory diseases by the people of Kwazulu-Natal for a long time. *B. cereus* and *K. pneumonia* are respiratory bpathogens

commonly associated with cold and flu (Viljoen et al., 2004). The inhibitory property of the extracts from *B. bergiana* against pathogens might have justified the use of this plant for the treatment of cough and influenza fever by people of Kwazulu-Natal. The results also indicated that, the extracts exhibited antibacterial activity against *E. coli* and *S. aureus,* the causative micro-organisms of abdominal disorder like diarrhea. As these bacteria are implicated in opportunistic infections and the extract showed pronounced activity against some of them, the extract may be useful in management of such opportunistic infections

B. bergiana is a plant that has shown tremendous potential as a source of novel chemotherapeutic agents. It is therefore, one of the prime medicinal plants of Africa that can provide relief to the millions of the poor people of the continent if its potentials are adequately explored. This plant *B. bergiana* displayed a better antibacterial activity against indicator organisms. Hence, extracts have potential of being used as source of biopharmaceutical substances with antibacterial property. Further work aimed at isolation and identification of specific anti-bacterial agents in extracts in the next focus of this research.

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