Antimicrobial activities of extracts from leaves and stem-bark of Buddleja salviifolia

1,2Pillai, M.K., 1Matamane, R.P. and 2Mekbib, S.B.

1Department of Chemistry and Chemical Technology, Faculty of Science and Technology, National University of Lesotho, Roma Campus, P. O. Roma 180, Kingdom of Lesotho, Southern Africa
2Department of Biology, Faculty of Science and Technology, National University of Lesotho, Roma Campus, P. O. Roma 180, Kingdom of Lesotho, Southern Africa

Abstract

Buddleja salviifolia has been used as a food ingredient for improving digestion, anti-emetic, to relieve coughs, colic and constipation. B. salviifolia has also been used in traditional medicine to treat varieties of diseases, which include eye infections, tuberculosis (TB), cervical cancer, syphilis, neurodegenerative conditions. A few articles on the antimicrobial activities of extracts from leaves of B. salviifolia have previously been reported. However, the antimicrobial activities of hexane, chloroform, ethyl acetate and methanolic extracts from the leaves and stem-bark of B. salviifolia have not been reported previously. Therefore, in the present study, we evaluated the antimicrobial activities of these extracts against six bacterial isolates viz. Escherichia coli (wild strain), Escherichia coli (O157:H7), Listeria monocytogenes, Staphylococcus aureus, Serratia marcescens and Pseudomonas aeruginosa and two fungal isolates viz. Penicillium digitatum and Candida albicans. Their inhibition zones were found to be in the range of 7.0±1.4 to 36.5±7.8 mm against bacterial isolates and 7.0±0.0 to 22.0±1.4 mm against fungal isolates. Additionally, the MIC values of these extracts were found to be in the range of <31.25 to >1000 µg/mL against both bacterial and fungal isolates. To conclude, extracts from B. salviifolia exhibited promising antimicrobial activities. Since B. salviifolia has wide verities of applications as a food ingredient and in the traditional medicine, further studies on various parts of this plant will be useful to commercialize products.

1. Introduction

Buddleja salviifolia belongs to the Scrophulariaceae family of the Buddleja genus (Van Wyk and Van Wyk, 1997; Tank et al., 2006; Van Laere et al., 2011). B. salviifolia is also known by other names such as sagewood, wildsail, saliehout, etc. (Van Wyk and Van Wyk, 1997). Approximately, 150 species are found in the genus Buddleja (Ream, 2006). B. salviifolia is widely distributed in Southern parts of Africa such as South Africa, Lesotho, Zimbabwe, Swaziland, etc. and grows mostly in rocky mountain slopes, dry hillsides, forest margins, coastal and along with the water courses (Palmer, 1977; Ream, 2006). B. salviifolia is a semi-evergreen plant with greyish appearance (Van Wyk and Van Wyk, 1997) and reaches up to 3 to 8-meter height with many stems at the base (Drummond, 1981). B. salviifolia can be characterized by its small, tubular flowers with enclosing stamens. It has a strong and sweet perfumed smell, especially in the early spring (Palmer, 1977). The leaves of B. salviifolia have been used as a food ingredient for improving digestion, anti-emetic, relieve nausea, coughs, colic and constipation (Kose et al., 2015). Additionally, the leaves of B. salviifolia have been used in the traditional medicine to treat TB, syphilis, herpes, cervical cancer, complications associated with pregnancy, etc. (Kose et al., 2015). The leaves of B. salviifolia have also been used to treat neurodegenerative conditions and eye infections (Pendota et al., 2014). Our literature search showed that a 20% methanolic crude extract obtained from the leaves of B. salviifolia and its hexane, dichloromethane, ethyl acetate, and butanol fractions have previously been studied for their antimicrobial activities against Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Klebsiella pneumoniae and Candida albicans (Pendota et al., 2013). Additionally, three pure compounds viz. 4-hydroxyphenyl ethyl vanillate, acteoside, and quercetin have been isolated from the...
ethyl acetate fraction of the leaves extract (Pendeta et al., 2013) and these three pure compounds have also been evaluated for their antimicrobial activities (Pendeta et al., 2013). However, to the best of our knowledge, hexane, chloroform, ethyl acetate, and 100% methanolic crude extracts from the leaves and stem-bark of this plant have not been explored well for their antimicrobial studies. Therefore, the aim of the present study was to evaluate the antibacterial and antifungal activities of hexane, chloroform, ethyl acetate and methanol extracts from leaves and stem-bark of _B. salviifolia_ against six bacterial isolates viz. _E. coli_ (wild strain), _E. coli_ O157: H7, _L. monocytogenes_, _S. aureus_, _Serratia marcescens_ and _Pseudomonas aeruginosa_ and two fungal isolates viz. _Penicillium digitatum_ and _C. albicans_.

2. Materials and methods

2.1 Plant materials

Fresh leaves of _B. salviifolia_ were collected in August 2018 inside the Roma Campus of National University of Lesotho, Lesotho, Southern Africa. Additionally, a piece of stem-bark was cut from the same plant. Mr. Moretloa Polaki, Lecturer, Department of Biology, Faculty of Science and Technology, National University of Lesotho, Roma Campus, Roma P.O. 180, Lesotho, Southern Africa identified the plant material. A voucher specimen viz. Matamane/BSLS/2018 and Matamane/BSSB/2018 leaves and stem-bark, respectively, were kept separately in the Organic Research Laboratory, Department of Chemistry and Chemical Technology, Faculty of Science and Technology, National University of Lesotho, Roma Campus, Maseru, the Kingdom of Lesotho, Southern Africa.

2.2 Material processing

The leaves were allowed to air-dry at room temperature (about 18-24°C) for two weeks. The crushed leaves were ground into powder (523.86 g) using a dry laboratory blender (Waring Blender, Blender 80119, Model HGB2WT93, 240V AC, 3.5 AMPS, Laboratory and Analytical Supplies). The chopped stem-bark was allowed to air-dry at room temperature (about 18-24°C) for two weeks and then ground into powder (760.46 g) using the same blender.

2.3 Preparation of plant extracts

A 100.11 g of powdered leaves was extracted with hexane for three days at room temperature. The solution was filtered off using a vacuum filter (ATB, Model: 284065–H, Power: 230V 3.0A, 1320/min 50Hz). The solvent was removed in vacuo. The extract was transferred to pre-weighed clean and dry beaker. The same procedure was repeated twice. Finally, the leaves were extracted with hexane at reflux condition for 10 hours. About 1.85 g of combined hexane extract was obtained after removal of solvent. The same procedure was repeated with chloroform, ethyl acetate and methanol separately. Approximately, 7.48, 8.13 and 14.61 g of chloroform, ethyl acetate and methanol leave extracts respectively, were obtained from 98.88 g, 100.23 g and 175.45 g of powdered leaves. Similarly, using the same procedure, 0.43, 1.07, 2.18 and 8.86 g of hexane, chloroform, ethyl acetate and methanol stem-bark extracts, respectively, were obtained from 200.09 g, 200.01 g, 202.52 g and 157.82 g powdered stem-bark.

2.4 Evaluation of antimicrobial activity

The antimicrobial activities of various extracts of _B. salviifolia_ were evaluated by in vitro hole-plate diffusion method as described in the literature (Manilal et al., 2009; Alghazeer et al., 2012). Solutions of various extracts were prepared separately at a concentration of 100 mg of extract in 1 mL of DMSO. The solutions were then filtered separately using a 0.20 µm filter and then used for both antibacterial and antifungal activities. A volume of 0.1 mL of the broth culture of each bacterial isolate was spread on the NA (Nutrient Agar) plates separately. Agar wells of size 4.00 mm height and 6.00 mm diameter were punched on the agar plate using a sterile cork-borer and filled with 35µL aliquots of the extract. The plates were then incubated at 37°C for 24 hours. Tetracycline served as a positive control for _E. coli_ (wild strain), _E. coli_ (O157: H7), _S. aureus_ and _L. monocytogenes_. Amoxicillin served as a positive control for _P. aeruginosa_ and _S. marcescens_. DMSO served as a negative control. The Petri dishes containing 25 mL of Potato Dextrose Agar (PDA) were used for the antifungal assay. The agar plate was first spread with 0.1 mL of the fungi. Cylindrical cavities of size 4.00 mm height and 6.00 mm diameter were punched using a sterile cork-borer and filled with the 35 µL aliquots of the extract. The plates were incubated at 24°C for 48 hrs. Miconazole nitrate served as a positive control for _C. albicans_. However, we did not maintain positive control for _P. digitatum_. DMSO served as a negative control. The sensitivity of microorganisms to the various extracts of _B. salviifolia_ was determined by measuring the diameter of inhibition zones around the holes of the agar surface. All experiments were performed in duplicate and the results were reported as the average of two experiments. A clear zone > 10 mm are considered as a weak, moderate and strong activities respectively (Emmanuel et al., 2012; Matela et al., 2018).
2.5 Determination of minimum inhibitory concentrations (MICs)

The minimum concentration of the sample that is needed to inhibit the growth of the microorganisms is called MIC value (Alghazeer et al., 2012; Alghazeer et al., 2017). The MIC of < 100 µg/mL, 100 to ≤ 625 µg/mL and > 625 µg/mL were considered as significantly active, moderately active and weakly active, respectively (Emmanuel et al., 2012; Njimoh et al., 2015; Alghazeer et al., 2017). The MICs of various extracts of B. salviifolia were determined as described in the literature (Daud et al., 2005; Alghazeer et al., 2017). Briefly, a stock solution at a concentration of 1000 µg/mL of various extracts of B. salviifolia was prepared separately. Two-fold serial dilutions such as 1000, 500, 250, 125, 62.5 and 31.25 µg/mL were made from these stock solutions. A suspension of the microorganism is prepared at a concentration of one million to two million colony forming units (CFU)/mL by means growing the bacterial strain in nutrient broth in an incubator with continuous shaking (Matela et al., 2018). Cylindrical cavities of size 4.00 mm height and 6.00 mm diameter were punched on the agar plate using a sterile cork-borer and then filled with the 35 µL aliquots of the extract. The plates were then incubated at 37°C for 24 hrs.

2.6 Microorganisms

A total of six bacterial isolates (four Gram-negative bacteria viz. E. coli (wild strain), E. coli O157: H7, S. marcescens and P. aeruginosa), (two Gram-positive bacterial isolates viz. L monocytogenes and S. aureus) and two fungal isolates viz. P. digitatum and C. albicans were used in this study to evaluate the antimicrobial activities of the various extracts from the leaves and stem bark of B. salviifolia. All these microorganisms are available at the Department of Biology, National University of Lesotho, Roma, Kingdom of Lesotho, Southern Africa.

2.7 Statistical analysis

Data analysis was performed using the SPSS 17.0 statistics program by means of two-way analysis of variance. The differences were considered statistically significant when p ≤ 0.05.

3. Results and discussion

The antibacterial activity of various extracts of B. salviifolia is summarized in Table 1. BSHXLS, BSCHLS, BSEALS, BSMELS are B. salviifolia hexane leaves extract, chloroform leaves extract, ethyl acetate leaves extract and methanol leaves extract, respectively. BSHXSB, BSCHSB, BSEASB and BSMESB are B. salviifolia hexane stem-bark extract, chloroform stem-bark extract, ethyl acetate stem-bark extract and methanol stem-bark extract, respectively. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXLS, BSCHSB, BSEALS and BSMESB exhibited inhibition zones of 10.0±2.8, 14.0±1.4, 15.0±4.2, 13.0±1.4, 13.5±3.5, 16.0±0.7, 10.5±0.7 and 12.0±3.5 mm respectively against E. coli (wild strain). This result showed that BSHXLS, BSEALS, BSMELS, BSHXSB, BSCHSB and BSMESB showed a moderate activity and the remaining extracts, BSHXLS and BSEASB, showed a weak activity against E. coli (wild strain). The positive control, tetracycline, showed an inhibition zone of 19.5±3.5 mm. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSCHSB, BSEASB and BSMESB exhibited inhibition zones of 14.0±0.0, 11.0±1.4, 13.0±1.4, 7.0±1.4, 8.0±2.0, 13.0±4.2 and 11.0±2.8 mm respectively, against E. coli (O157: H7). This result showed that BSHXSB, BSCHLS, BSEASB and BSMELS were weakly active. The BSHXLS, BSEALS and BSCHSB are moderately active. However, BSMESB did not exhibit any visible inhibition zone. The positive control, tetracycline, showed an inhibition zone of 22.5±2.1 mm. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSCHSB, BSEASB and BSMESB exhibited inhibition zones of 16.5±0.7, 18.5±3.5, 36.5±7.8, 13.0±1.4, 13.0±3.5, 13.5±2.1, 13.0±0.0 and 15.5±0.7 mm, respectively, against L. monocytogenes. This result showed that BSEALS is strongly active while the other extracts, BSHXLS, BSCHLS, BSMELS, BSHXSB, BSCHSB, BSEASB and BSMESB are moderately active. The positive control, tetracycline showed an inhibition zone of 22.5±0.7 mm. BSHXLS, BSCHLS, BSEALS, BSHXSB, BSCHSB, BSEASB and BSMESB exhibited inhibition zones of 16.0±2.8, 14.0±0.0, 13.0±1.4, 16.0±2.8, 14.0±1.4 and 15.5±2.1 mm respectively, against S. aureus. Therefore, BSHXLS, BSCHLS, BSEALS, BSHXSB, BSCHSB, BSEASB and BSMESB are moderately active. BSMELS showed no visible zone of inhibition and therefore, it is inactive against S. aureus. The positive control, tetracycline, showed an inhibition zone of 31.5±0.7mm. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSCHSB, BSEASB and BSMESB showed inhibition zones of 19.0±1.4, 11.0±4.2, 13.5±0.7, 14.0±2.8, 10.5±2.1, 11.0±1.4, 9.0±1.4 and 7.5±0.7 mm, respectively, against S. marcescens. This result showed that BSCHLS, BSMESB, BSCHSB, BSEASB and BSHXSB showed inhibition zones of 17.5±4.9, 20.0±0.0, 16.5±0.7, 12.5±2.1, 16.0±2.8, 14.5±2.1, 11.0±4.2 and 16.0±0.0 mm, respectively,
against *P. aeruginosa*. This result showed that BSEASB is weakly active and the other extracts, BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSHXLS, and BSMESB are moderately active. The positive control, amoxicillin, showed an inhibition zone of 22.5±2.1 mm. The anti-fungal activity of various extracts of *B. salviifolia* is also summarized in Table 1. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSHXLS, BSEASB, and BSMESB exhibited inhibition zones of 14.0±0.0, 12.5±0.7, 11.5±0.0, 9.0±1.4, 15.5±3.5, 12.5±4.5, 14.0±2.8 and 7.0±0.0 mm, respectively, against *P. digitatum*. These results showed that BSEASB, BSEALS, and BSMESB are weakly active while the rest, BSHXLS, BSCHLS, BSHXSB, BSHXSB, BSEASB, and BSMESB, are moderately active against *P. digitatum*. BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB, BSHXSB, BSEASB and BSMESB exhibited inhibition zones of 12.0±2.8, 12.5±2.1, 13.5±2.1, 18.0±5.7, 14.0±0.0, 9.5±3.5, 12.0±4.2 and 12.0±5.6 mm respectively, against *C. albicans*. This result indicated that BSHXSB exhibited weak activity while the other extracts, BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXLS, BSEASB and BSMESB exhibited moderate activity. The positive control, miconazole nitrate showed an inhibition zone of 25.8±1.8 mm. The minimum inhibition concentrations (MICs) of various extracts of *B. salviifolia* are summarized in Table 2. The MIC value of BSMELS, BSHXSB and BSMESB was found to be with of 62.5µg/mL for each extract against *E. coli* (wild strain) while BSHXLS, BSCHLS, BSEALS, and BSMESB exhibited a moderate activity with MIC values of 500, 125, 125, 250 and 125 µg/mL, respectively, against the same bacterial isolates. The MIC value of BSMELS, BSHXSB and BSEASB was found to be 62.5 µg/mL for each extract against *E. coli* (O157: H7). However, the MIC values of BSHXLS, BSCHLS, BSEALS, BSMELS, BSHXSB and BSMESB were found to be 125, 500, 500 125 and >1000 µg/mL, respectively, against *E. coli* H0157. The MIC value of BSHXLS and BSHXSB was determined to be >1000 µg/mL for each extract against *L. monocytogenes* while the MIC value of BSEASB, BSMELS, BSEASB and BSMESB was determined to be <31.25, 62.5 and 62.5 µg/mL, respectively, and the MIC value of BSHXSB and BSHXSB were found to be 125 and 250µg/mL respectively against the same bacterial isolates. The MIC value of BSHXLS and BSEALS was found to be 250 µg/mL for each, against *S. aureus*. The MIC value of BSMELS, BSHXSB, BSHXSB, BSEASB and BSMESB was found to be 500 µg/mL for each and the MIC value of BSHXLS was determined to be >1000 µg/mL against the same bacterial isolates. The MIC value of BSHXLS, BSCHLS, BSEALS, and BSMESB was found to be 250 µg/mL for each and the MIC value of BSHXSB showed a MIC value of 125µg/mL for each and BSHXSB showed a MIC value of >1000 µg/mL against *S. marcescens*. The MIC value of BSHXLS, BSCHLS, BSEALS, and BSMESB was found to be 62.5 µg/mL for each against *P. aeruginosa* while BSHXLS, BSCHLS, BSHXSB and BSMESB exhibited MIC values of 250, 125, 125 and 250 µg/mL, respectively, against the same bacterial isolates. The MIC value of BSHXLS, BSCHLS, BSHXSB and BSEASB was found to be 62.5, <31.25, <31.25 and 62.5 µg/mL, respectively against *P. digitatum* while the MIC value for BSHXLS, BSMELS and BSEASB were found to be 500, 500 and 250 µg/mL, respectively, and BSHXLS exhibited an MIC of >1000 µg/mL against this
The minimum inhibitory concentrations (MICs) of hexane, chloroform, ethyl acetate and methanolic extracts of leaves and stem-barks of *B. salviifolia* extracts against bacterial and fungal isolates.

| Extracts         | Microorganisms/Minimum inhibitory concentrations (µg/mL) |
|------------------|----------------------------------------------------------|
|                  | *E. coli* (wild strain) | *E. coli* (O157:H7) | *L. monocytogenes* | *S. aureus* | *S. marcescens* | *P. aeruginosa* | *P. digitatum* | *C. albicans* |
| BSXLS            | 500            | 125            | >1000              | >1000         | 250           | 250           | 250           | 500           | 125           |
| BSCHLS           | 125            | 500            | >1000              | 250           | 250           | 125           | 62.5          | >1000         | 62.5          |
| BSEALS           | 125            | 500            | <31.25             | 250           | 250           | 125           | 62.5          | 500           | 62.5          |
| BSMELS           | 62.5           | 62.5           | 62.5               | 500           | 125           | 62.5          | 500           | 500           | 62.5          |
| BSXHSB           | 62.5           | 125            | 125                | 500           | 125           | 62.5          | <31.25        | <31.25        | 62.5          |
| BSCHSB           | 250            | <31.25         | 250                | 500           | >1000         | 125           | <31.25        | <31.25        | 62.5          |
| BSEASB           | 125            | 62.5           | 62.5               | 500           | 125           | 62.5          | 250           | 125           | 62.5          |
| BSMESB           | 62.5           | >1000          | <31.25             | 500           | 250           | 62.5          | 62.5          | 62.5          | 62.5          |

BSXLS = *B. salviifolia* hexane leaves extract, BSCHLS = *B. salviifolia* chloroform leaves extract, BSEALS = *B. salviifolia* ethyl acetate leaves extracts, BSMELS = *B. salviifolia* methanol leaves extract, BSXHSB = *B. salviifolia* hexane stem-bark extract, BSCHSB = *B. salviifolia* chloroform stem-bark extract, BSEASB = *B. salviifolia* ethyl acetate stem-bark extract, BSMESB = *B. salviifolia* methanol stem-bark extract.

The MIC value for BSXLS, BSEALS, BSMELS, BSXHSB and BSMESB were found to be 62.5µg/mL for each against *C. albicans* while BSCHSB showed a MIC of 31.25 µg/mL. However, the MIC values for BSXLS and BSEASB were found to be 125 µg/mL for each against this fungal isolate.

Pendota et al. (2013) obtained a 20% methanolic crude extract from the leaves of *B. salviifolia*. Additionally, hexane, dichloromethane, ethyl acetate and butanol fractions were also obtained from this crude extract. The crude extract and these four fractions were screened for their MIC values against four bacterial isolates viz. *E. coli*, *S. aureus*, *B. subtilis* and *K. pneumoniae* and one fungal isolate, *C. albicans* (Pendota et al., 2013). They showed MIC values ranging from 390 -1560 µg/mL against these microorganisms. The MIC values of crude extract and hexane, dichloromethane, ethyl acetate and butanol fractions were found to be 6250.0, 780.0, 1560.0, 1560.0 and 1560.0 µg/mL, respectively, against *E. coli*. The microorganisms *E. coli* is common to our study also. However, we found that the MIC value of methanolic leave extract as 62.5 µg/mL. The low MIC value in our study may be due to more extractive power of 100% methanol relative to 20% methanol. The MIC values of crude extract, hexane, dichloromethane, ethyl acetate and butanol fractions were found to be 3125.0, 1560.0, 780.0, 390.0 and 3125.0 µg/mL, respectively, against *S. aureus*. The microorganisms *S. aureus* also is common to our study. However, we found that the MIC value of methanolic leave extract as 500 µg/mL. This is again due to more extractive power of methanol relative to 20% methanol. The MIC value for crude extract, hexane and dichloromethane fractions were determined to be 3125.0 µg/mL for each against *B. subtilis*. The ethyl acetate and butanol fractions showed MIC values of 780.0 and 1560.0 µg/mL, respectively, against *B. subtilis*. The MIC values of crude extract and hexane, dichloromethane, ethyl acetate and butanol fractions were found to be 6250.0, 1560.0, 1560.0, 3125.0 and 3125.0 µg/mL respectively, against *K. pneumoniae*.

Additionally, three pure compounds viz. 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin have been isolated from the ethyl acetate fraction and were evaluated for their antibacterial and antifungal activities against the above microbes (Pendota et al., 2013). The MIC value of 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin were found to be 125.0 µg/mL for each, against *viz. E. coli*. The MIC values for 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin were determined to be 250.0, 62.5 and 250.0 µg/mL, respectively, against *S. aureus* (Pendota et al., 2013). The MIC values of 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin were found to be 125.0, 250.0 and 250.0 µg/mL, respectively, against *B. subtilis*. On the other hand, 4-hydroxyphenyl ethyl vanillate and acteoside exhibited a MIC value of 62.5 µg/mL for each and quercetin showed a MIC value of 125.0 µg/mL against *K. pneumonia* (Pendota et al., 2013).

Against *C. albicans*, the MIC values of crude extract, hexane, dichloromethane, ethyl acetate and butanol fractions were reported to be 1560.0, 390.0, 390.0, 780.0 and 1560.0 µg/mL respectively (Pendota et al., 2013). The MIC values of 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin were found to be 250.0, 250.0 and 125.0 µg/mL, respectively, against the same fungal isolates, *C. albicans*. In our study, the MIC value of methanolic extract was found to be 62.5 µg/mL. The minimum fungicidal concentration (MFC) of crude extract, hexane, dichloromethane, ethyl acetate and butanol fractions have been reported to be 3125.0, 390.0, 390.0, 1560.0 and 1250.0 µg/mL, respectively, against *C. albicans*. The MFC of 4-hydroxyphenyl ethyl
vanillate, acteoside and quercetin were found to be 250.0µg/mL for each, against C. albicans. (Pendota et al., 2013).

As such, the report from Pendota et al. (2013) has been limited only to MIC and MFC values of a 20% methanolic crude extract from the leaves of B. salviifolia and its hexane, dichloromethane, ethyl acetate and butanol fractions. They used four bacterial and one fungal isolate for their study. Additionally, the MIC and MFC values of three pure compounds viz. 4-hydroxyphenyl ethyl vanillate, acteoside and quercetin were also evaluated against these four bacterial and one fungal isolate (Pendota et al., 2013). However, in our study, we discussed not only MIC values but also the exact inhibitory effects of eight extracts (four extracts from leaves and the other four from stem-bark) against six bacterial and two fungal isolates.

It has been reported that B. subtilis, S. aureus, E. coli, K. pneumoniae, C. albicans etc. are responsible for some common ocular infections (Pendota et al., 2013). For example, E. coli is responsible for ocular inflammations such as keratitis, blepharitis and conjunctivitis (Bruiser and Burd, 1996). Some Bacillus spp. are responsible for a severe eye interior inflammation with 70% vision loss after trauma and/or surgery infection (David et al., 1994). In South Africa, leaves extract of B. salviifolia has been used to treat eye infections (Pendota et al., 2014). This may be due to the fact that B. salviifolia might have contained antibacterial metabolites against E. coli, Bacillus spp. etc. El-Ganiny et al. (2017) reported that extracts from B. salviifolia exhibited a significant biofilm inhibition and also eradicated preformed biofilm. Additionally, B. salviifolia have been showing a variety of other bioactivities such as anti-hypersensitive, analgesic, immunosuppressive, antitumor activities etc. (Herbert et al., 1991).

4. Conclusion

We evaluated antibacterial and antifungal activities of hexane, chloroform, ethyl acetate, methanol extracts from leaves and stem-bark of B. salviifolia. Gram-negative bacteria such as E. coli (wild strain), E. coli O157: H7, S. marcescens and P. aeruginosa, Gram-positive bacteria such as L. monocytogenes and S. aureus and two fungal isolates viz. P. digitatum and C. albicans were used in this study. All extracts exhibited antimicrobial activity with inhibition zones ranging from 7.0±1.4 to 36.5±7.8 mm against bacterial and 7.0±0.0 to 22.0±1.4 mm against fungal isolates. Additionally, all these extracts were also evaluated for their minimum inhibitory concentrations (MICs) and were found to be in the range of <31.25 µg/mL to >1000 µg/mL against both bacterial and fungal isolates. To conclude, B. salviifolia exhibited promising antimicrobial activities. B. salviifolia has been used as a food ingredient. In traditional medicine, the leaves of B. salviifolia have been used to treat eye infections and neurodegenerative conditions. Therefore, further studies on various parts of this pant will be useful to commercialize products.

Conflict of Interest
The authors declare no conflict of interest.

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