BIODIVERSITAS
Volume 22, Number 1, January 2021
Pages: 408-415

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d220150

The potency of *Sansevieria trifasciata* and *S. cylindrica* leaves extracts as an antibacterial against *Pseudomonas aeruginosa*

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Manuscript received: 4 December 2020. Revision accepted: 27 December 2020.

Abstract. *Nugroho LH, Dewatisari WF, Retnaningrum E, Purwestri YA. 2021. The potency of S*ansevieria trifasciata *and* S. cylindrica *leaves extracts as an antibacterial against* Pseudomonas aeruginosa. *Biodiversitas 22: 408-415. Sansevieria trifasciata* and *Sansevieria cylindrica* are the major herbs in Indonesia, which contain several bioactive compounds as potential sources of antibacterial agents. This study aims to evaluate the antibacterial activity of *S. trifasciata* and *S. cylindrica* leaves extract and fraction against *Pseudomonas aeruginosa* and to identify its bioactive compounds. Crude ethanolic extract of *S. trifasciata* and *S. cylindrica* leaves were tested for their antimicrobial activity by disk diffusion method against *P. aeruginosa*. *S. trifasciata* showed strong antibacterial activity with an inhibition zone of 18.3 mm compared to *S. cylindrica*. Different concentrations of extract i.e. 4 mg/mL, 8 mg/mL, 16 mg/mL, 32 mg/mL, 64 mg/mL, 128 mg/mL and 256 mg/mL were tested for their minimum inhibitory concentrations (MIC). The MIC results showed that the *S. trifasciata* extract was able to inhibit bacterial growth at a concentration of 32 mg/mL. Results of vacuum liquid chromatography (VLC) and thin-layer chromatography (TLC) revealed that only fraction 3 showed the highest antibacterial activity at 16 mg/mL. In TLC bioautography analysis, fraction 3 showed a clear zone at Rf 0.93. The phytochemical analysis showed that terpenoid, phenolic, triterpenoid, and flavonoid compounds were found in *S. trifasciata* extract that were associated with antibacterial activity.

Keywords: Antibacterial, ethanolic extract, *Pseudomonas aeruginosa, Sansevieria cylindrica, Sansevieria trifasciata*

INTRODUCTION

Sansevieria trifasciata and *S. cylindrica* are plants that have therapeutic potential and easy to grow in Indonesia. *Sansevieria trifasciata* has round, leathery and stiff leaves while *S. cylindrica* has flat, sword-shaped leaves. These plants are distributed in tropical and subtropical areas, with a distribution ranging from Africa to Southeast Asia and the islands of the Indian Ocean (Lu et al. 2014; Umoh et al. 2020). Both plants have ethnobotanical uses that vary in their geographic range. These plants have occupied an important position among plant genera applied to the wide-spectrum treatment of diseases with immune disorders (Khalumba and Mbugua 2005; Staples and Herbst 2005; Takawira-Nyenya et al. 2014). These species are traditionally used for the treatment of various diseases such as colds, diarrhea, coughs, inflammation of the respiratory tract, swelling, bumps, bruises, ulcers, poisonous snake bites, and hair fertilizers (Berame 2017; Andhare et al. 2012). *Sansevieria trifasciata* and *S. cylindrica* have been studied for their pharmacological activities, such as antioxidant, anti-tumor, antidiabetic anaphylaxis, and activity inhibition of capillary permeability (Andhare et al. 2012; Sheela et al. 2012; Tkachenko 2017; Berame et al. 2017; Buyun et al. 2017).

Pseudomonas aeruginosa is a normal bacteria and is pathogenic in low immune conditions due to environmental factors and high stress (Dzen 2003). These bacteria have been known for years as the cause of serious infectious diseases such as eye, ear, chronic respiratory disease, pneumonia, urinary tract, blood vessels, and skin infections (Wu et al. 2015). Compared to other bacteria *P. aeruginosa* has stronger resistance to the physical environment and chemicals (Umoh 2009; Retnaningrum and Wilopo 2018; Purwestri et al. 2016).

Several studies have reported the antibacterial activity of *S. trifasciata* and *S. cylindrica* against *P. aeruginosa* (Kingsley et al. 2013; Buyun et al. 2018). *S. trifasciata* and *S. cylindrica* leaves contain phytochemicals such as dicarboxylic acids, phenols, steroid saponins, flavonoids, saponins, coumarins, homoisoflavanone, and fatty acid (Said et al. 2015; Berame et al. 2017; Tkachenko 2017; Ahamad et al. 2017; Umoh et al. 2020). Several bioactive compounds have been reported in *Sansevieria* that are responsible for the antibacterial activity such as quinolone, 3,4-dimethoxybenzoic acid, palmitaldehyde, 1,2-benzene-dicarboxylic acid, and delta-undecalactone (Philip 2011; Yumna et al. 2018).

The presence of various chemical compounds attracted researchers to conduct antibacterial testing of ethanolic extract and its fractions. Ethanol is a non-toxic organic solvent used in the extraction of bioactive plant materials. In the present study, extracts were made by multilevel maceration method which is the novelty of this research.

The objectives of this study were: (i) To compare the antibacterial activity of *S. trifasciata* and *S. cylindrica* leaves extracts and fractions from potential extract against *P. aeruginos*a; (ii) To identify bioactive compounds using TLC reagents.

MATERIALS AND METHODS

The materials used in the present study were leaves of *S. trifasciata*, *S. cylindrica*, and bacteria *P. aeruginosa* FBGMU 01. The leaves were collected from Bandar Lampung, Lampung, Indonesia (5° 21' 30.16" S | 105° 13' 58.62" E). The investigation was carried out at the Faculty of Biology Universitas Gadjah Mada (UGM) Yogyakarta, Indonesia. *Sansevieria trifasciata* and *S. cylindrica* have been identified in the Plant Systematics Laboratory, Faculty of Biology, Universitas Gadjah Mada with a certificate number 014527/S.Tb.//II/2019. The herbarium *S. trifasciata* and *S. cylindrica* stored in the Plant Systematics Laboratory, Department of Tropical Biology, Faculty of Biology.

Leaves extraction of *S. trifasciat*a and *S. cylindrica*

The leaves of *S. trifasciata* and *S. cylindrica* were first washed with sterile distilled water and dried in oven at 50°C for 24 hours. The dried samples were ground using a grinder and then sieved with 40 mesh to obtain fine powder. Then powder sample was extracted by graded maceration method with chloroform solvent, and then the maceration was continued with ethanol. The ratio of plant materials and solvent was 1: 3 (w/v)

Determination of antibacterial activity using disk diffusion

*Pseudomonas aeruginos*a FBGMU 01 with a cell number of $1.5x10^8$ cfu/mL which equivalent to turbidity of 0.5 McFarland was inoculated into NA media by pour plate method. Paper discs containing extract with 16 mg/mL, positive control of ciprofloxacin, and negative control of 10% DMSO were further placed on bacterial culture agar plate. After 24 hours of inoculation, antibacterial activity was analyzed by measuring diameter of inhibition zone.

Minimum Inhibitory Concentration(MIC) determination

MIC determination was estimated by following the method of Balouiri et al. (2016) and Arung et al. (2017) with slight modification. The different concentrations of *S. trifasciata* leaves extract were used i.e. 4 mg/mL, 8 mg/mL, 16 mg/mL, 32 mg/mL, 64 mg/mL, 128 mg/mL, and 256 mg/mL. 200 µL bacterial culture with a cell number of $1.5x10^8$ cfu/mL were inoculated with 8.8 mL of NB medium into a test tube. After incubation at 37°C for 24 hours, the growth of *P. aeruginosa* was observed and measured using optical density using the Elisa Reader at wavelength at 595 nm.

Fractionation using Vaccum Liquid Chromatography (VLC)

For VLC fractionations, twelve grams of silica gel 60 GF254 (Merck) was used as the stationary phase. The leaves extract of *S. trifasciata* (2.5 grams) was mixed with 5 g of GF254 silica gel powder. The mobile phase used was a mixture of n-hexane: chloroform 3: 1 (v/v), 2: 2 (v/v), 1: 3 (v/v), 100 % chloroform, chloroform: ethanol 3: 1 (v/v), 2: 2 (v/v), 1: 3 (v/v), 100 % ethanol. Eluent was then collected in a 10 mL vial tube followed by Thin Layer Chromatography (TLC) analysis (Pinteus et al. 2013).

Thin Layer Chromatography (TLC)

TLC of *S. trifasciata* extract was carried out with silica gel F254 (E. Merck) as a stationary phase and ethyl acetate-methanol (3: 2) as mobile phase. Chromatogram detection was measured at 254 and 366 nm ultraviolet light. The same pattern in the results of the TLC analysis was combined into one fraction.

Bioautography

Bioautography of the tested bacteria was carried out by placing the TLC plate containing the chromatogram of the potential fraction on the NB medium which already contained the tested bacteria. The TLC plates were left to stand for 30 minutes then incubated at 37 ° C for 18-24 hours. The presence of a clear zone (no growth of bacterial colonies) after incubation indicates that the chromatogram spots contain antibacterial compounds (Dewanjee et al 2015). The spots showed the clear zone was calculated by retardation factor (Rf) value by: Rf = Distance traveled by spot/Distance traveled by solvent

Identification of bioactive compounds using TLC Reagents

The potential fraction was assessed for the existence of the phytochemical analysis by using the standard methods according to Jork (1994). Chromatogram sprayed with various reagents: (i) Vanillin/Sulfuric acid indicated the presence of terpenoid, steroid, phenols, and essential oil, (ii) Iron(III) chloride for phenols; (iii) Lieberman-Burchard for triterpenoids; (iv) Aluminum chloride for flavonoid, and (5) Dragendorff's Reagent for alkaloid.

The chromatogram observed under UV 254 nm and 366 nm was then sprayed with the coloring reagent Dragendorff reagent that produced orange color for alkaloid, Aluminum chloride that produced yellow color for flavanoid, and sulfate vanillin that produced purple color for terpenoid. Analysis of secondary metabolites compounds was done by the measurement of Rf value.

Data analysis

All the experiments were repeated three times. The results obtained were analyzed qualitatively and quantitatively. The data were processed using SPSS 26 and analyzed using one-way ANOVA at a confidence level of 95 % and the significance value is $P < 0.05$.

RESULTS AND DISCUSSION

The antibacterial activity of crude extract of *Sansevieria trifasciata* and *S. cylindrica leaves*

The ethanolic extract of *S. trifasciata* leaves showed strong antibacterial activity against *P. aeruginosa* with 18.33±0.53 mm zone of inhibition while moderate antibacterial activity 10.33±0.58 mm was recorded in *S. cylindrica* (Table 1). Ciprofloxacin exhibited strong inhibition zone with 31.17 mm. For the negative control, DMSO 10 % showed no (0.00 mm) inhibition zone (Figure 1). The crude extract of *S. trifasciata* leaves had higher antibacterial activity than the *S. cylindrica* and was significantly ($p<0.05$) different. Out of two extracts, only *S. trifasciata* extract showed high area of inhibition, so it was used for further tests.

Minimum inhibitory concentration of *Sansevieria trifasciata* leaves extract

Results revealed that lowest 4mg/mL MIC value recorded from leaves extract of *S. trifasciata* which inhibited bacterial growth. At this concentration, the tube looks clearer than the positive control. In optical density measurement using ELISA Reader, the reduced bacterial population ≥50% was obtained at a concentration of 32 mg/mL (Figure 2, Table 2).

Fraction of *Sansevieria trifasciata* leaves

The results showed that total of eight fractions of *S. trifasciata* was obtained using VLC. Out of eight, four fractions were then tested for their antibacterial activity by disk diffusion method. The largest inhibition zone of *S. trifasciata* leaves extract fraction was noted in fraction 3 (13.00 mm) followed by fraction 4 (9.69 mm), fraction 2 (6.00 mm), and fraction 1 (5.50 mm) The fraction 3 of *S. trifasciata* leaves showed the best antibacterial activity (Table 3, Figure 3).

Table 1. Antibacterial activity of *Sansevieria trifasciata* and *S. cylindrica* leaves extract based on disk diffusion methods

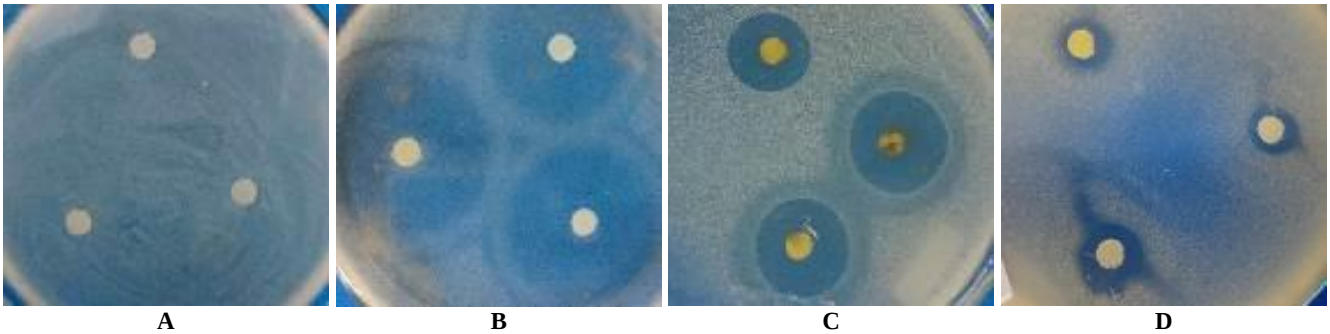
Extract	Diameter of zone inhibition (mm)	Antibacterial activity
DMSO(10%) (-)	$0±0.00^{a}$	Weak
Ciprofloxacin (+)	$31.83±0.87^{d}$	Very strong
S. trifasciata	$18.33±0.53^{c}$	Strong
S. cylindrica	$10.33±0.58^{b}$	Moderate

Note: *The values of antibacterial activity represented by mean ± standard error from 3 replications; Different superscript alphabetic letters were significantly different at ($p< 0.05$) by Tukey test

Table 2. Minimum inhibitory concentration activity at various concentrations of *Sansevieria trifasciat*a leaves extract

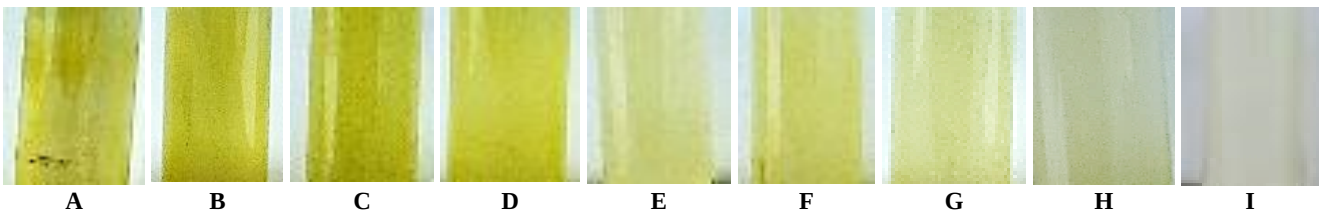
Extract (mg/mL)	Optical Density ± SD
NB & bacteria (+)	$0.632±0.002^{e}$
4	$0.573±0.068^{e}$
8	$0.316±0.011^{d}$
16	$0.274±0.051^{cd}$
32	$0.203±0.014^{bc}$
64	$0.194±0.04^{bc}$
128	$0.192±0.010^{bc}$
256	$0.154±0.026^{b}$
NB (-)	$0.054±0.002^{a}$

Note: *The values of antibacterial activity represented by mean ± standard error from 3 replications; Different superscript alphabetic letters were significantly different at ($p< 0.05$) by Tukey test



A B C D

Figure 1. The inhibition zones of ethanolic extracts showed antibacterial activity against *Pseudomonas aeruginosa*. A. DMSO 10% (-), B. ciprofloxacin (+), C. *Sansevieria trifasciata* leaves extract, D. *S. cylindrica* leaves extract



A B C D E F G H I

Figure 2. The turbidity of *Sansevieria trifasciata* leaves extract in various concentrations: A. Control positive, B. 4 mg/mL, C. 8 mg/mL, D. 16 mg/mL, E. 32 mg/mL, F. 64 mg/mL, G. 128 mg/mL, H. 256 mg/mL, I. Control negative

Based on the Rf value on the TLC spot (Table 4), it can be observed the diversity of the tested isolates. Results exhibited that 3 spots were found in fraction 1, 2 spots in fraction 2, 4 spots in fraction 3, and 2 spots in fraction 4. This showed that the spots that appear in all isolates varied in their number and Rf value. Therefore, it facilitates the purification of the desired components. The results of bioautographic of *S. trifasciata* leaves extract to test for fraction 3 are presented in Figure 4. The resulting fraction was then performed TLC-bioautography. The results of TLC are presented in Figure 4.

The results of bioautography on TLC showed three clear zones, with only fraction 3 found to be against *P. aeruginosa*. The clear zone appeared at Rf 0.93. Thus, it showed that the spot contains bioactive compounds that can inhibit the growth of *P. aeruginosa*. The greatest inhibition zone appeared at Rf 0.93. The inhibition zone appeared because bioactive compounds diffuse into the media and inhibit the growth of *P. aeruginosa*. Other fractions also showed a clear zone, but the inhibition zone was small. This shows that the antibacterial strength was different in these fractions, even though the Rf value was found to be the same. Based on the Rf value and the type of solvent used in this study, it can be concluded that the active compound is polar. The results of bioautography and disk diffusion test exhibited that fraction 3 had the highest inhibition zone (Figure 5). Fraction 3 was then used for MIC determination. As shown in Table 5, the MIC of fraction 3 obtained was 16 mg/mL.

Identification of bioactive compounds

Spots of secondary metabolites in TLC plate can be seen in Figure 7. Result indicated that terpenoid was detected in Rf 0.625, Rf 0.69, and Rf 0.93. Phenolic was detected in Rf 0.93. Triterpenoid was found in Rf 0.69 and Rf 0.93, Flavonoid with Rf 0.69 and Rf 0.93 while the alkaloid was not detected in any plate (Figure 6 and Table 6). This showed that the leaves of *S. trifasciata* were containing polar and semipolar compounds.

Discussion

Plants have been known to produce various chemical components that have different biological activities against various microorganisms (Matic et al. 2016). The inhibition zone of *S. trifasciata* extract against *P. aeruginosa* showed stronger antibacterial activity than *S. cylindrica*. These results differ from research conducted by Buyun et al (2018), the antibacterial activity of *S. cylindrica* showed 17.8 mm zone of inhibition against *P. aeruginosa*.

Table 3. Antibacterial activity of 4 fractions obtained from Vacuum Liquid Chromatography

Fractions	Zone inhibition (mm)
DMSO(10%) (-)	0 ± 0.00^{a}
Ciprofloxacin (+)	31.17 ± 1.94^{e}
1	5.50 ± 0.87^{b}
2	6.00 ± 1.00^{b}
3	13.00 ± 1.00^{d}
4	9.69 ± 0.58^{c}

Note: *The values of antibacterial activity represented by mean ± standard error from 3 replications; Different superscript alphabetic letters were significantly different at ($p< 0.05$) by Tukey test.

Table 4. The Rf value of the TLC chromatogram

Fraction	Rf
F1	0
	0.81
	0.93
F2	0
	0.93
F3	0
	0.44
	0.625
	0.69
	0.93
F4	0
	0.93

Table 5. Minimum inhibitory concentration activity at various concentration fractions of *Sansevieria trifasciata* leaves

Concentration of fraction (mg/mL)	Optical Density ± SD
NB + bacteria (+)	0.326 ± 0.0037^{d}
4	0.281 ± 0.006^{d}
8	$0.250\pm0.041c^{d}$
16	0.187 ± 0.052^{bc}
32	0.166 ± 0.07^{ab}
64	0.130 ± 0.02^{ab}
128	0.122 ± 0.013^{ab}
256	0.139 ± 0.035^{ab}
NB (-)	0.097 ± 0.006^{a}

Note: *The values of antibacterial activity represented by mean ± standard error from 3 replications; Different superscript alphabetic letters were significantly different at ($p< 0.05$) by Tukey test

Table 6. Results bioactive compounds present in fraction 3 of *Sansevieria trifasciata* leaves

Reagents	Bioactive compound	Interpretation	Color observation
Vanillin/sulfuric acid	Terpenoid	Purplish blue, brown	Purplish blue, brown (+)
Iron(III) chloride	Phenolic	Purplish gray	Purplish gray (+)
Lieberman-Burchard	Triterpenoid	Brownish purple, brown	Brownish purple(+)
Aluminum chloride	Flavonoid	Yellow	Light yellow (+)
Deggendorf	Alkaloid	Orange	Light green (-)

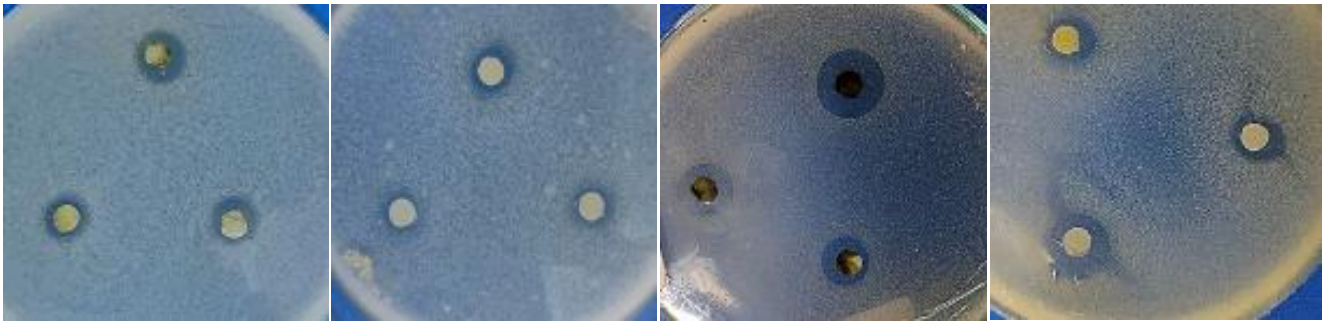


Figure 3. The inhibition zones of *Sansevieria trifasciata* leaves fraction showed antibacterial activity against *Pseudomonas aeruginosa*: A. Fraction 1, B. Fraction 2, C. Fraction 3, D. Fraction 4

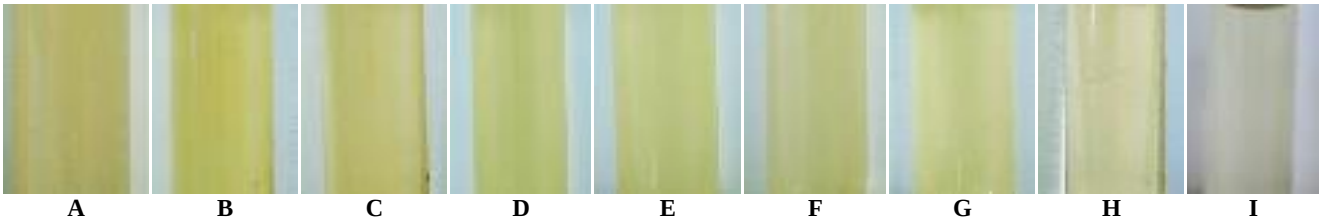


Figure 5. The turbidity fraction 3 of *Sansevieria trifasciata* leaves in various concentrations: A. Control positive, B. 4 mg/mL, C. 8 mg/mL, D. 16 mg/mL, E. 32 mg/mL, F. 64 mg/mL, G. 128 mg/mL, H. 256 mg/mL, I. Control negative

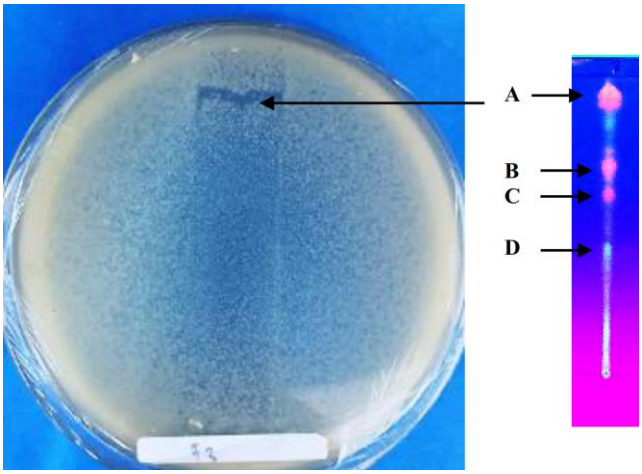


Figure 4. Bioautography fraction 3 of *Sansevieria trifasciata* leaves: A. Spot 4(Rf 0.93), B. Spot 3(Rf 0.69, C. Spot 2(Rf 0.625), D. Spot 1(Rf 0.44)

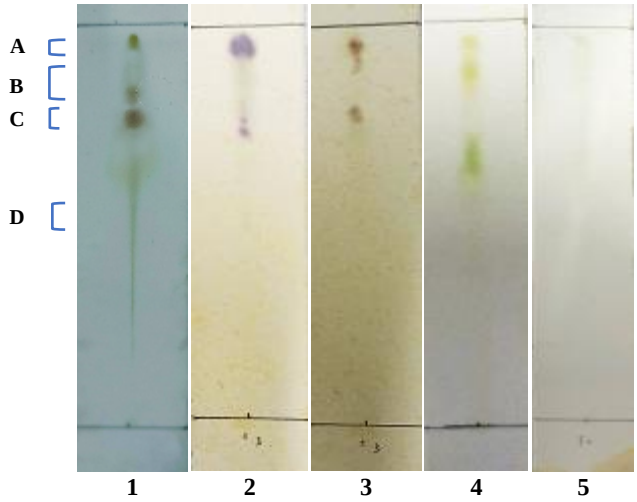


Figure 6. The results of TLC determine the group of bioactive compounds fraction 3 of *Sansevieria trifasciata* leaves: (1)Terpenoid, (2) Phenolic, (3) Triterpenoid, (4) Flavonoid, (5) Alkaloid. A. Rf 0.93, B. Rf 0.69, C. Rf 0.625, D. Rf 0.44

The low antibacterial activity in the present study may be the consequence of different geographical locations in which soil minerals and environmental factors have a great influence on the phytochemical contents of the plant. Secondary metabolites such as phenolics, flavonoids, terpenoids and alkaloids produced from various biochemical processes to crucial environmental stresses, including light irradiation, temperature, soil water, soil fertility and salinity. Extracts from the same plant but taken from different areas will produce different active compounds(Prance 1994; Borokini and Ayodele 2012; Yang et al. 2018).

The antibacterial activity of *S. trifasciata* was found very strong with 18 mm zone of inhibition. Kingsley (2013) reported that the inhibition zone diameter of ethanolic extract of *S. trifasciata* leaves was 13 mm.. The

category of inhibition zone i.e. ≥20 mm has very strong antibacterial activity, 10-20 mm is in a strong category, 5-10 mm is moderate and 5 mm is weak (Hudzicki 2016). The results of the inhibition zone showed that the inhibition was higher because in this study extraction was performed with a multilevel maceration method. Multilevel extraction produces certain compounds that are specifically extracted in each solvent used, while single extraction results in less yield and produces not specific compounds. The compound content obtained was higher in multilevel extraction than those of in unstaged extraction (Sulmartiwi et al. 2012).

During the multilevel maceration process, chloroform and ethanol solvents were used. The advantage of this multilevel extraction method is that it can produce large amount of compounds which have different level of polarity. The multilevel extraction was carried out consecutively starting with a non-polar solvent in the form of chloroform and continued with ethanol from a polar solvent (Lisichkov et al. 2014). Ethanol is an efficient organic solvent for use in the extraction of bioactive plant materials. Ethanol is volatile and allows the dissolution of polar compounds such as flavonoid aglycones. This solvent is non-toxic and non-hygroscopic. The antibacterial activity of *S. trifasciata* extract indicates the presence of bioactive compounds. Antibacterial activity is probably due to the presence of alkaloids, saponins, terpenoids, steroids, glycosides, tannins, acid compounds, fats, and oils in their composition (Andhare et al. 2012; Akindele et al. 2015). In this study, after the antibacterial test MIC testing was performed, which is the inhibition value of an antibacterial compound. One of the factors influencing antibacterial activity is the concentration of antibacterial (Frazier and Westhoff 1983). MIC test is a value in which 50% of the isolates in the test population are inhibited (Schwarz et al 2010). The results showed that 8 mg/mL MIC concentration inhibited the turbidity of bacteria. This means that at this concentration the *S. trifasciata* leaves extract can reduce or kill the bacterial population up to ≥50%. One of the factors influencing antibacterial activity is the concentration of antibacterial substances (Frazier and Westhoff 1983).

The VLC method was used to separate the compounds based on their polarity. Of the four fractions, fraction 3 showed the highest antibacterial activity. Based on the results decrease in antibacterial activity between the crude extract and the fractionation inhibition zone. All crude plant extracts contain several biologically active compounds at very high concentrations. High concentrations of the main compounds can be considered part of the plant's defense system (Hossain et al. 2014). The plant extracts contain many metabolites and compounds, each of which is capable of acting synergistically or antagonistically, these compound components can have the maximum effect if they are in complex conditions along with other compound components (Virganita et al. 2009; Nur and Nugroho 2018). The MIC in this fraction was 32 mg mL. This concentration can reduce the bacterial population by up to ≥50%. Fraction 3 allows demonstrating a bacteriostatic effect against *P. aeruginosa*.

The effect of antibacterial components on bacterial cells can cause cell damage. These antibacterial components may be bacteriostatic or bacteriocidal (Wu and Li 2016). Eve et al. (2020) report that the susceptibility of gram-negative bacteria to antibacterial agents is due to the composition of various cell wall structures such as peptidoglycan, lipids, and cross-linking, which can greatly influence the penetration, binding, and activity of antimicrobial agents. P. aeruginosa is a gram-negative bacterium with a high-fat content in its cell walls (11-22%). Besides, the cell wall consists of three layers: lipoproteins, phospholipids (outer membrane), and lipopolysaccharides. The presence of a phospholipid outer membrane can reduce the penetration of antibacterial compounds into cells (Fitri and Bustam 2010).

The development of bacterial resistance to currently available antibiotics requires the discovery of new antimicrobial agents. Ciprofloxacin is the most important antibiotics in the treatment of *P. aeruginosa* infections. Ciprofloxacin as positive control is a wide-spectrum antibiotic for the fluoroquinolone class used to treat respiratory infections, urinary tract infections, intraabdominal infections, bone and joint infections, skin and soft tissue infections, and many other infections (Kraatz et al. 2014; Setyorini 2018).

Pseudomonas aeruginosa demonstrates a wide variety of available resistance mechanisms, which can act in combination and even render antibiotics such as ciprofloxacin inoperative (Kraatz et al. 2014; Setyorini 2018; Zhao et al. 2020). Soares et al. (2019) reported that ciprofloxacin first induces bacterial killing of most bacterial cells, but simultaneously activates a strict response mechanism that contributes to the transition of the subpopulation towards the persister phenotype. After the persistent phenotype was expressed, and although the biofilm matrix had unexpected changes, ciprofloxacin failed to eradicate the biofilm.

Phytochemical analysis of fraction showed the presence of various bioactive substances such as triterpenoid, phenolic, terpenoids, and flavonoids. The presence of compounds in the fraction of *S. trifasciata* leaves was associated with antibacterial activity. Terpenoid acts as antiseptic, antimicrobial, antibiotics. It can regulate plant growth, cure skin disorders, and diabetes (Febriyani et al. 2018; Joshee et al. 2019). Flavonoids protect plants from UV radiation, temperature stress and tolerance to heavy metals and insects attack. It also has anticancer, antimicrobial and antiviral activities. Numerous researches have reported that flavonoid compounds can disrupt the integrity of bacterial cell membranes (Harborne 1998; Kristanti and Tunjung 2013).

Ethanolic extracts of the leaves of *S. trifasciata* contain a variety of bioactive compounds that inhibit bacterial growth, further, this extract can be used as a natural antibacterial and antiseptic agent. (Buyun et al. 2018; Tkachenko 2017). Further research is needed to determine the active ingredients of plants that are responsible for the inhibition of *P. aeruginosa*. Also, this study suggests the ethnomedical use of *S. trifasciata*.

ACKNOWLEDGEMENTS

We would like to thank the Ministry of Research and Technology/National Research and Innovation Agency of the Republic of Indonesia for supporting the research through PDD grants with contract number 3061/UN1.DITLIT/D IT-LIT/PT/2020. The authors declare that there is no conflict of interest regarding the publication of this paper.

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