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Review Article

Sansevieria trifasciata Prain.: A Review on Its Phytochemicals and Pharmacological Potential

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Abstract

Sansevieria trifasciata Prain is known to contain phytochemical compounds and has the potential to treat various diseases. A systematic review was conducted by searching articles on Google Scholar, PubMed, NCBI, and Science Direct to gather information on identified chemical compounds and the pharmacological test results of *S. trifasciata* Prain leaves, both in vitro, in vivo, and in silico. The results showed that phytochemicals were derivatives of the flavonoids, alkaloids, steroids, saponins, glycosides, polyphenols, and fatty acids groups. These phytochemicals exhibited pharmacological properties, including antidiabetic, antibacterial, anticancer, antihelminthic, antimalarial, antifungal, antioxidant, antiwound healing, antianalgesic, and antiallergic properties. Acute toxicity tests indicated that S. trifasciata Prain. was safe for use, with an LC_{50} value exceeding 2000 mg/kgBW. We can conclude that *Sansevieria trifasciata* Prain. is a potential herb as medicine to treat various diseases based on its chemical compounds.

Keywords: Chemical compounds, Review, Snake plant

Sansevieria trifasciata Prain.: Review Kandungan Senyawa Kimia dan Aktivitas Farmakologi

Abstrak

Sansevieria trifasciata Prain. diketahui mengandung senyawa fitokimia dan memiliki potensi untuk mengobati berbagai penyakit. Sebuah tinjauan sistematis dilakukan dengan mencari artikel di *Google Scholar, PubMed, NCBI,* dan *Science Direct* untuk mengumpulkan informasi tentang senyawa kimia yang teridentifikasi dan hasil uji farmakologis daun *S. trifasciata* Prain., baik secara in vitro, in vivo, maupun in silico. Hasil menunjukkan bahwa fitokimia tersebut adalah turunan dari golongan flavonoid, alkaloid, steroid, saponin, glikosida, polifenol, dan asam lemak. Senyawa-senyawa ini menunjukkan sifat farmakologis, termasuk sebagai antidiabetes, antibakteri, antikanker, antihelminthik, antimalarial, antijamur, antioksidan, penyembuhan luka, anti-nociceptive, dan antialergi. Uji toksisitas akut menunjukkan bahwa S. trifasciata Prain. aman digunakan, dengan nilai LC_{50} >2000 mg/kgBB. *S. trifasciata* Prain. adalah tanaman herbal potensial sebagai obat untuk mengobati berbagai penyakit berdasarkan senyawa kimianya.

Kata Kunci: Kandungan kimia, Lidah mertua, Review,

1. Introduction

Indonesia is one of the megabiodiverse countries in the world.[1] The abundance of flora species that grow is utilized by the local community for medicinal purposes. This is associated with fewer side effects compared to the use of conventional medicine.[2] Furthermore, the multitude of flora species serves as a refuge for exploration and development of new drugs, along with molecular studies. One of the plants utilized by the community for medicinal purposes is the snake plant, scientifically known as *Sansevieria trifasciata* Prain.

The *Sansevieria trifasciata* Prain., commonly used as an ornamental plant originating from the tropical African continent, is now widely found in Indonesia. *S. trifasciata* Prain. is rich in phytochemical compounds.[3,4,5,6,7,8] The compounds found in *S. trifasciata* Prain are known to influence its pharmacological effects on various diseases.[6,9,10,11,12,13,14,15] The empirical evidence of these pharmacological effects has been extensively demonstrated through in vitro and in vivo studies.

Although some studies examining the compound content and pharmacological effects have been conducted, published reviews on this matter are still limited and the presented data do not yet include recent research on either the compound content or its pharmacological effects. Additionally, to our knowledge, *S. trifasciata* Prain. does not have a monograph in Indonesian herbal pharmacopoeias, leading to a lack of relevant information regarding the compound content and pharmacological effects of this plant. Therefore, this article conducts a review on the phytochemical and pharmacological activity of *Sansevieria trifasciata* Prain.

2. Method

The systematic review was conducted to identify full the phytochemicals and therapeutic potential from *Sansevieria trifasciata* Prain. The following databases were searched, from earliest available date: Google Scholar, PubMed, NCBI, Science Direct. The articles used from international and national journals with keywords "sansevieria trifasciata Prain., "mother-in-law's tongue leaves", "Dracaena trifasciata (Prain) Mabb." The article search yielded 292 articles, including research articles, proceedings papers, and reviews. All identified articles were read, and a sorting process was conducted based on the topics of phytochemical and pharmacological activity, and these were articles from the last 10 years. The separation process resulted in 44 articles which were subsequently used in this review." All articles were then input into reference management software (Mendeley) to eliminate duplicate entries.

3. Result and Discussion

3.1. Taxonomic classification

Kingdom : Plantae, Division : Spermatophyta, Subdivision : Angiospermae (Monocotyledonae), Ordo : Lyliales, Family : Agavaceae, Genus : Sanseivieria, Spesies : *Sanseivieria trifasciata* Prain.[16]

3.2. Common names

Snack plant, mother in-law tongue, devil's tongue, bow string hemp, snake's tongue,[17] Dracaena trifasciata (Prain.) Mabb18, Lidah mertua (Indonesia), Letah menyawak (Sumatera), Pacing towo (Jawa), Mandafika (Madura).[19]

3.3. Traditional Uses

The leaves of Sansevieria trifasciata Prain. was used traditionally as medicine for various types of dis¬eases, such as colds, diarrhea, coughs, respiratory tract inflammation, venomous snake bites, and hair growth.[20] The indigenous people of Perak, Malaysia, use this plant for the treatment of earaches, swelling, boils, fever, and wound dressings.[21] The leaves and rhizomes of *Sansevieria trifasciata* Prain are traditionally used for bronchitis, asthma, food poisoning, toxaemia, cough, snake bites, and insect bites.[22] In addition, this plant can be used for earaches, stomach ulcers, jaundice, pharyngitis, itching on the skin, urinary tract diseases, analgesic, and antipyretic purposes. In Bangladesh, the whole plant is used for the treatment of alopecia, malaria, as a tonic, and

for snake bites, sprains, bruises, boils, and abscesses.[23]

3.4. Phytochemical compounds

The exploration of the chemical content of Sansevieria trifasciata Prain. has been extensively conducted. The identified compounds include (Tabel 1.). The alkaloid derivative compounds are 1-Acetyl-β-carboline, methyl pyrophaeophorbide A and oliveramine. Derivate of flavonoids is (2S)-3′, 4′-Methylenedioxy-5, 7-dimethoxyflavane. Other compound are 1-Acetyl-β-carboline, digiprolactone, and trichosanic acid 7. The derivative pyridone alkaloid is 5-methyl-11-(2-oxopyridin-1(2H)-yl) undecaneperoxoicacid.[13] The identified compounds in the extract and fractions of *Sansevieria trifasciata* Prain. include flavonone, isoflavone, imidazole alkaloids, pheophorbide A, polyphenol coumarin, polyphenol hydrocoumarin, and saponin.[8] Citronellol, 7,8-Epoxylanostan-11-ol, and 3-acetoxy, as well as derivatives of fatty acids 24. Gallic acid, protocatechuic acid, p-hydroxybenzoic acid, catechin, chlorogenic acid, caffeic acid, syringic acid, vanillic acid, ferulic acid, rutin, apigenin-7-glucoside, rosmarinic acid, cinnamic acid, quercetin and kaempferol.[6]

3.5. Pharmacological Properties

Research related to the pharmacological activities of the *Sansevieria trifasciata* Prain. plant has been widely reported, including for the treatment of degenerative diseases, infectious diseases, diseases related to inflammation, allergies, and alopecia. Here, we present a review of these pharmacological activities.

a. Antidiabetes mellitus

The antidiabetic activity of *S. trifasciata* Prain leaves has been reported in several studies. In vitro assay on the α-amylase enzyme using ethanol extract showed that the crude extract could inhibited the α-amylase with an IC_{50} of 158.31 ppm. The IC_{50} value of the standard positive control, acarbose, was 42.7 ppm. The α -amylase enzyme plays a role in the digestion of carbohydrates into monosaccharides that are absorbed by the wall of the small intestines. Inhibiting this enzyme is one of the expected mechanisms in the treatment of diabetes from the sample drug. The ability to reduce blood glucose levels from *S. trifasciata* Prain. is thought to be due to its antioxidant properties.[9] In a different in vitro study, an assay was conducted on the α-glucosidase enzyme. The treatment groups were divided into 4, namely groups given water extract, 70% ethyl acetate, 70% ethanol, and acarbose. The results showed IC_{50} values for each group in the order of >50000; 4708.71; 15161.72; 0.25 ppm, respectively. These results indicate that the smallest IC_{50} value was for acarbose, followed by the ethyl acetate fraction. Therefore, the ethyl acetate fraction shows promise for further development as a potential medication.[10]

In vivo assay of the extract on *Rattus norvegicus* L. has also been reported in several studies. Diabetic animals using the oral glucose tolerance assay method showed that the administration of a mixture of leaf and rhizome extract at a dose of 100 mg/kgBW and glibenclamide could significantly decrease ($P<0.001$) blood glucose levels after 15 days of treatment, with blood glucose values of 80.22 mg/dL for the extract group and 72.29 mg/dL for the glibenclamide group. Furthermore, the results of the glucose tolerance test after 2 hours of administering extract doses of 50 mg/kgBW and 100 mg/kgBW were 96 mg/dL and 78.5 mg/dL, respectively.[25] In a different study, in vivo assay using sucrose modeling given to Rattus norvegicus showed that ethanol extract of *S. trifasciata* Prain. has the potential to lower blood glucose levels. The dose of ethanol extract at 0.083 g/kgBW exhibited the lowest blood glucose level, which was 86 mg/dL, followed by the glibenclamide group, extract dose of 0.0083 g/kgBW, and doses of 0.041 g/kgBW, with blood glucose values of 60.67, 53.34, and 45.67 mg/dL, respectively.[11] In a different study conducted on alloxan-induced diabetic animals, the administration of *S. trifasciata* Prain. extract obtained through decoction processes showed that groups given

doses of 100, 150, and 200 mg/kgBW could lower blood glucose levels and increase the density of Langerhans beta-cell granules.[12]

The mechanism of *S. trifasciata* Prain. in lowering blood glucose levels also can be explained through the approach of its compound content. One of the flavonoid compounds in this plant is a derivative of 5, 7-dimethoxyflavane. This compound has been reported to reduce the effects induced by streptozotocin, allowing insulin to be produced again by pancreatic beta cells through antioxidant mechanisms and protection of pancreatic beta cells from damage due to induction.[26]

b. Antibacterial

Antibacterial activity of *S. trifasciata* Prain. has been conducted, using gram-positive and gram-negative bacteria. The result indicated that *S. trifasciata* Prain had the potential and effectiveness to inhibit bacterial growth. A study that examined extracts, fractions, subfractions, and isolates against *Streptococcus aureus* and *Escherichia coli* bacteria showed that the isolate 5-methyl-11-(2-oxopyridin-1(2H)-yl) undecaneperoxoicacid could significantly inhibit the growth of *E.coli* bacteria ($p<0.05$), and followed with subfractions, extracts, and fractions, respectively. Meanwhile, determination on *S.aureus* bacteria showed the smallest bacterial growth in the group given subfractions, isolates, fractions, and extracts, respectively. The molecular mechanism of the isolate indicates the ability to inhibit β-ketoacyl-ACP synthase enzyme from *E.coli* and TyrRS from *S.aureus.*[13] In a different study, ethyl acetate extract also demonstrated better effectiveness in inhibiting the growth of *E.coli* and *S.aureus* bacteria with inhibition zone diameters of 8.50 mm and 8.20 mm, respectively.[27]

Antibacterial assay on *Pseudomonas aeruginosa* bacteria using fractions from *S. trifasciata* Prain. showed that the fraction could inhibit the growth of *P.aeruginosa* with an MIC value of 4 mg/mL. Additionally, methanol extract could inhibit biofilm formation by the bacteria by 60% 28. In a different study, ethanol extract showed strong antibacterial activity with an inhibition zone of 18.3 mm, with Minimum Inhibitory Concentration (MIC) of 32 mg/mL.[29] The n-hexane and butanol fractions can inhibit the growth of *Salmonella* sp. and *Staphylococcus aureus* bacteria.[30] Additionally, the extract of *S. trifasciata* Prain. also inhibits the growth of *Bacillus subtilis* and *Pseudomonas aeruginosa* bacteria.[24] Petroleum ether and ethanol extracts were used to antibacterial assay against the *Staphylococcus aureus, Proteus vulgaris, Bacillus subtilis, Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Escherichia coli* using the well plate method, where the *Proteus vulgaris, Staphylococcus aureus* bacteria were most susceptible to ethanol and petroleum ether extracts.[15]

c. Anticancer

The leaves of *S. trifasciata* Prain. have been used in anticancer studies. A study was conducted to determine the cytotoxic activity of petroleum ether and ethanol extracts against human colorectal cancer cells (HCT-116) and primary colon epithelial (PCE) cell lines using the MTT assay method. The results showed that the ethanolic extract exhibited a lower IC_{50} value in HCT-116 compared to the petroleum ether extract. The IC_{50} values for HCT-116 and PCE after 72 hours of incubation were 10.00 µg/mL and 92.9 µg/mL, respectively. The standard control, fluorouracil, yielded an IC_{50} value of 10 µg/mL.[15] In a different study, ethanol extract was used in cytotoxicity tests against colon carcinoma cells ($CaCO_2$), human lung cancer cell line (A-549 cells), and human hepatocellular carcinoma (HepG-2 cells). The results showed that the extract was potent in inhibiting the growth of HepG-2 cells with an IC_{50} of 81 µg/mL, but it was not potent against $CaCO_2$ and A-549 cells as the IC_{50} values were > 100 µg/mL.[6] In a different study, the extract did not show cytotoxic activity against hepatic cancer cells (HepG-2), breast cancer cells (MCF-7), and intestinal epithelium cells (Caco-2).[31] So far, a specific molecular mechanism explaining this plant's potential to inhibit cancer cell growth has not been identified. However, its

chemical components are noteworthy. One of the compounds found in *S. trifasciata* Prain. is a derivative of 5,7-Dimethoxyflavone. Studies indicate that this compound can suppress the growth of HEPG2 liver cancer cells by causing cell cycle arrest through the generation of reactive oxygen species (ROS), impacting the Sub-G1 phase of the cell cycle. ROS are normal byproducts of many cellular processes. Cancer cells usually exhibit higher baseline levels of ROS than normal cells, due to an imbalance between oxidants and antioxidants. ROS have a dual role in cell metabolism: at low to moderate levels, they function as signaling molecules to stimulate cell proliferation, migration, invasion, and angiogenesis, while at high levels, they cause damage to proteins, nucleic acids, lipids, membranes, and organelles, leading to cell death.[32] The study showed that 5,7-DMF has been reported to generate reactive oxygen intermediates in cancer cells, with their percentage increasing over time. The accumulation of intracellular ROS leads to the disruption of the mitochondrial membrane potential, the release of cytochrome c into the cytosol, subsequent activation of the caspase cascade, and ultimately, apoptosis.[33] The β-carboline derivative compounds found in *S. trifasciata* Prain. are also suspected to play a role in its anticancer activity. A study showed that β-carboline can stimulate DNA intercalation and interact with the enzyme GPX4, topoisomerases, and kinases needed for cancer cell replication.[34] Further research is needed to assess the anticancer activity of this plant.

d. Anthelmintic

Research on Fasciola hepatica indicates that *S. trifasciata* Prain. has anthelmintic potential. The study results show that all the studied dosages of 200mg/mL, 400mg/mL, and 800mg/mL exhibit anthelmintic activity, with mean death times of 97.83, 55.00, and 18.33 minutes, respectively, compared with albendazole as the standard with a mean death time of 15.00 minutes. The anthelmintic activity of the plant extract was comparable to that of albendazole at a dose of 800mg/mL.[35]

e. Antimalarial

Sansevieria trifasciata Prain has antimalarial activity. A study conducting an antiplasmodial assay of the extracts revealed that the ethyl acetate extract exhibited stronger suppression against Plasmodium falciparum with an IC_{50} value of 21.29 µg/mL compared to the ethanol extract with an IC_{50} value of 21.29 µg/mL. It is suspected that the compound phytol plays a role in this antimalarial activity.[36] Furthermore, β-carboline alkaloid derivatives found in *S. trifasciata* Prain. can inhibit DNA synthesis by intercalating DNA base pairs. Therefore, this compounds have the potential to inhibit parasite growth by disrupting parasite DNA synthesis.[37]

f. Antifungal

Research reporting on the antifungal activity of *Sansevieria trifasciata* Prain. is still very limited. One study indicates that *Sansevieria trifasciata* Prain. shows potential in inhibiting the growth of *Candida albicans.* Administration of the ethanol extract of *S. trifasciata* Prain. at a concentration of 90% can suppress fungal growth with an inhibition zone of approximately 21 mm, approaching the effectiveness of the positive control.[38] The ability to inhibit the growth of the fungus *Candida albicans* has also been reported in an emulgel preparation containing a mixture of *S. trifasciata* Prain and *C. longa* Linn. In this emulgel preparation, three formulations were made with varying amounts of *S. trifasciata* Prain: 0%, 5%, and 10% 39. In a different study using root and leaf extracts, it was shown that a leaf extract at a dose of 1000 µg/mL could inhibit the growth of Penicillium italicum by 21.7%.[40]

g. Antiallergic

The ethanol extract of *S. trifasciata* Prain. can be used as an antiallergic. Groups of rats given ethanol extract at doses of 100 and 200 mg/kg body weight, orally, showed a significant decrease ($p<0.05$) in eosinophils, neutrophils, and monocytes induced by milk, with respective counts of 8.60, 6.60, and

42.40 (x10c/µl) after treatment with ethanol extract at 100 mg/kg body weight, and 7.80, 7.00, and 39.80 (x10c/µl) after treatment with ethanol extract at 200 mg/kg body weight. In addition, ethanol extract can also prevent passive and active skin anaphylactoid reactions. It prevents compound 48/80 from inducing degranulation of sensitized mesenteric mast cells, and significantly inhibits the formation of pedal edema due to histamine. Initial treatment with ethanol extract inhibits the Schultz-Dale reaction in the experimental rabbit ileum and also exhibits strong antioxidant activity.[22]

h. Wound Healing

Wound healing is a complex process that occurs in the body to repair tissue damage after an injury. This process involves several distinct stages, all of which work together to ensure that the wound is closed and the tissue returns to its normal function.[41] Several studies have investigated the wound healing properties of *S. trifasciata* Prain. Extract formulations of *S. trifasciata* Prain. in gel form were applied to mice, and the results demonstrated that formulas containing 15%, 20%, and 25% extract concentrations promoted faster wound closure. The group of animals treated with the 25% formula experienced faster wound closure compared to the group treated with octenidine gel as the positive control.[42]

i. Antioxidant

The *S. trifasciata* Prain. shows antioxidant activity. A study was conducted to assess lipid peroxidation activity using the 2-thiobarbituric acid reactive substances (TBARS) method. The results indicate that the extract can increase TBARS levels by 51.6%.[43] In another study, the ethanol extract was tested using the DPPH method, showing very strong antioxidant activity with an IC50 value of 49.72 ppm.[44] In a different study, the ethanol extract also exhibited very strong antioxidant activity with an IC_{50} value of 9.44 ppm.[45] However, in a different study, the ethanol extract showed weak antioxidant activity with an IC_{50} value of 503.4 ppm, which is believed to be due to differences in the drying process of the snake plant leaves. Drying in an oven at a temperature of 60°C for 26 hours allows prolonged contact between the sample and heat, leading to the degradation of active compounds that function as antioxidants (Hutabarat et al., 2023). The difference in extraction methods also affects the antioxidant capacity of *S. trifasciata* Prain. The extract obtained from the decoction process shows a lower total antioxidant activity (15.97 mg C/g) compared to the extract obtained from the microwave-assisted method (16.88 mg C/g).[47]

j. Antialopesia

Sansevieria trifasciata Prain. has been traditionally used for promoting hair growth. Supporting research has also been conducted, indicating that the extract can stimulate hair growth.[48,49] In another study, the extract and hair tonic of *S. trifasciata* Prain. were found to be effective in promoting hair growth in the test animals.[50] The separation of compounds from the extract of *S. trifasciata* Prain. resulted in six subfractions, which were then used in antialopecia testing on rabbit test subjects. The results indicated that the administration of subfractions could enhance hair growth in rabbits. This is associated with their ability to increase the anagen:telogen ratio. Based on histological examination, subfraction C increased the anagen:telogen ratio to 8.26:21.79%, showing statistically comparable effectiveness ($p>0.05$) to minoxidil.[51] The results of compound identification in *S.trifasciata* Prain. using LC-MS/MS show the presence of compounds such as Methyl pyrophaeophorbide A, (2S)-3′, 4′-Methylenedioxy-5, 7-dimethoxyflavane, oliveramine, and 1-Acetyl-β-carboline, indicating a good binding affinity with the androgen receptor,[7] In a different study, it was found that Oliveramine and Methyl pyropheophorbide A can inhibit the enzyme 5α-reductase.[52]

k. Toxicity

Research related to the toxicity of *Sansevieria trifasciata* Prain. has been

conducted previously. Ethanol extract doses of 500, 750, 1000, 1500, and 2000 mg/kg were orally administered to rats for acute toxicity assay. The results indicate that the administration of ethanol extract did not cause death or changes in behavior and toxic symptoms either immediately or during the 96-hour observation period. Therefore, the LD_{50} is considered to be greater than 2000 mg/kg.[22] The same findings were also reported in a different study, where chloroform extract was used in testing to assess acute toxicity in rats. The results indicated that a dose of 2000 mg/kg body weight given for 14 days did not show any signs of toxicity in terms of body weight, core temperature, individual and social behavior, food and water intake, as well as hematological profile, clinical biochemical parameters, and relative organ weights (visceral organ index).[54]

4. Conclusion

This review provides an overview of the phytochemical content and pharmacological activities of *Sansevieria trifasciata* Prain. The plant part commonly used in pharmacological studies is the leaf. The identified chemical constituents include compounds from the groups of flavonoids, alkaloids, steroids, saponins, glycosides, polyphenols, and fatty acids. These compounds contribute to its pharmacological activities, such as antidiabetic, antibacterial, anticancer, antihelminthic, antimalarial, antifungal, antioxidant, antiwound healing, antianalgesic, and antiallergic properties. However, it is emphasized that more clinical studies are necessary to assess the safety and efficacy of this plant in treating various conditions. Further research is also needed to determine if there are any toxicological implications associated with the prolonged consumption of high doses of *Sansevieria trifasciata* Prain. extract.

References

1. Sanka I, Kusuma AB, Martha F, Hendrawan A, Pramanda IT, Wicaksono A, et al. Synthetic biology in Indonesia: Potential and projection in a country with mega biodiversity. Biotechnol Notes [Internet]. 2023;4:41–8. Available from: https://www.sciencedirect.com/science/article/pii/S2665906923000028
2. Bhardwaj M, Yadav P, Vashishth D, Sharma K, Kumar A, Chahal J, et al. A review on obesity management through natural compounds and a green nanomedicine-based approach. Molecules. 2021;26(11):3278.
3. Tchegnitegni BT, Teponno RB, Jenett-Siems K, Melzig MF, Miyamoto T, Tapondjou LA. A dihydrochalcone derivative and further steroidal saponins from Sansevieria trifasciata Prain. Zeitschrift fur Naturforsch - Sect C J Biosci [Internet]. 2017 Oct 26 [cited 2022 Jun 17];72(11–12):477–82. Available from: https://www.degruyter.com/document/doi/10.1515/znc-2017-0027/html
4. Tchegnitegni BT, Teponno RB, Tanaka C, Gabriel AF, Tapondjou LA, Miyamoto T. Sappanin-type homoisoflavonoids from Sansevieria trifasciata Prain. Phytochem Lett. 2015.
5. González AG, Freire R, García-Estrada MG, Salazar JA, Suárez E. New sources of steroid sapogenins-XIV. 25S-ruscogenin and sansevierigenin, two new spirostan sapogenins from Sansevieria trifasciata. Tetrahedron. 1972;28(5):1289–97.
6. El-Din El-Hawary SS, El-Mahdy El-Tantawy M, Rabeh MA, Ali ZY, Albohy A, Fawaz NE. Sansevieria: An Evaluation Of Potential Cytotoxic Activity In Reference To Metabolomic And Molecular Docking Studies. Egypt J Chem [Internet]. 2021 Feb 1 [cited 2023 Jan 13];64(2):835–49. Available from: https://ejchem.journals.ekb.eg/article_117241.html
7. Kasmawati H, Mustarichie R, Halimah E, Ruslin R, Arfan A, Sida NA. Unrevealing the Potential of Sansevieria trifasciata Prain Fraction for the Treatment of Androgenetic Alope cia by Inhibiting Androgen Receptors Based on LC-MS/MS Analysis, and In-Silico Studies. Molecules. 2022 Jul 1;27(14):1–12.
8. Abdullah, Angelina, Yumna M, Arbianti

R, Utami TS, Hermansyah H, et al. Flavonoid isolation and identification of mother-in-law ' s tongue leaves (sansevieria trifasciata) and the inhibitory activities to xanthine oxidase enzyme. E3S Web Conf. 2018;03011.
9. Anggia V, Dwita LP, Istikomah. Antioxidant and alpha-amylase inhibitory study of Sansevieria trifasciata Prain. leaves extract. Pharmaciana. 2019;9(1):41 – 46.
10. Yumna M, Angelina, Abdullah, Arbianti R, Utami TS, Hermansyah H. Effect of mother-in-law's tongue leaves (Sansevieria trifasciata) extract's solvent polarity on anti-diabetic activity through in vitro α-glucosidase enzyme inhibition test. E3S Web Conf. 2018;67:1–5.
11. Laimeheriwa C, Wullur AC. UJI EFEK EKSTRAK ETANOL DAUN LIDAH MERTUA (Sansevieria trifasciata Prain) TERHADAP PENURUNAN KADAR GULA DARAH TIKUS PUTIH JANTAN GALUR WISTAR (Rattus norvegicus L .) YANG. PHARMACON J Ilm Farm. 2014;3(3):255–62.
12. Qomariyah N, Sarto M, Pratiwi R. Antidiabetic effects of a decoction of leaves of Sansevieria trifasciata in alloxan-induced diabetic white rats (Rattus norvegicus L.). ITB J Sci. 2012;44 A(4):308–16.
13. Kasmawati H, Ruslin R, Arfan A, Sida NA, Saputra DI, Halimah E, et al. Antibacterial Potency of an Active Compound from Sansevieria trifasciata Prain: An Integrated In Vitro and In Silico Study. Molecules. 2023;28(16):1–17.
14. Febriani Y, Mierza V, Handayani NP, Surismayanti S, Ginting I. Antibacterial Activity of Lidah Mertua (Sansevieria Trifasciata Prain.) Leaves Extract on Escherichia coli and Staphylococcus aureus. Open access Maced J Med Sci. 2019 Nov;7(22):3882–6.
15. Velaga A, Afzal S, Singh AK, Seng WY, Suryadevara N. Antimicrobial And Cytotoxic Activities Of Sansevieria trifasciata Leaf Extracts In Vitro. Malaysian J Med Heal Sci. 2022;18.
16. Purwadaksi, R A, S. A, N. B, M. T. Agar Tanaman Hias Tampil Cantik. 1st ed. Jakarta: AgroMedia; 2007:171.
17. Zakaria NE, Ahmad I, Mohammad WZW, Baharum A. Effects of fibre size on Sansevieria trifasciata/natural rubber/ high density polyethylene biocomposites. Malaysian J Anal Sci. 2018;22(6):1057–64.
18. GE VD, Emanuel IB, Konkel ZM, Martin D, Scott K, Slot J. First Report of Colletotrichum sansevieriae Causing Anthracnose of Snake Plant (Dracaena trifasciata) in Ohio and its Draft Genome. Plant Dis. 2022.
19. Hidayat IRS, Si M, Napitupulu RM, SP M. Kitab Tumbuhan Obat: Agriflo. 2015 [cited 2023 Jun 3];241. Available from: https://books.google.com/books/about/Kitab_Tumbuhan_Obat.html?hl=id&id=vQLLCgAAQBAJ
20. Dewatisari WF, Nugroho LH, Retnaningrum E, Purwestri YA. Inhibition of protease activity and anti-quorum sensing of the potential fraction of ethanolic extract from Sansevieria trifasciata Prain leaves against Pseudomonas aeruginosa. Indones J Biotechnol [Internet]. 2023 Mar 31 [cited 2023 Jun 5];28(1):23–30. Available from: https://journal.ugm.ac.id/ijbiotech/article/view/73649
21. Afrasiabian H, Hododi R, Imanieh MH, Salehi A. Therapeutic Effects of Sansevieria Trifasciata Ointment in Callosities of Toes. Glob J Health Sci. 2016;9(2):264.
22. Andhare RN, Raut MK, Naik SR. Evaluation of antiallergic and anti-anaphylactic activity of ethanolic extract of Sanseveiria trifasciata leaves (EEST) in rodents. J Ethnopharmacol. 2012 Aug;142(3):627–33.
23. Babu K, Prabhu DKS. Studies on anatomy, physico-chemical and thin-layer chromatography of rhizome, root and leaf of Dracaena trifasciata (Prain) Mabb. J Pharmacogn Phytochem. 2023;12(1):668–71.
24. Kaur J, Dhar SK, Chauhan A, Yadav S, Mudgal G, Lyudmila A, et al. GC-MS

validated phytochemical up-leveling with in vitro-raised Sansevieria trifasciata [Prain]: The Mother in Law's tongue gets more antibacterial. Curr Plant Biol [Internet]. 2023;35–36:100308. Available from: https://www.sciencedirect.com/science/article/pii/S2214662823000373
25. Dey B, Bhattacharjee R, Mitra A, Singla RK, Pal A. Mechanistic Explorations of Antidiabetic Potentials of Sansevieria Trifasciata. Indo Glob J Pharm Sci. 2014;4(2):113–22.
26. Xie Y, Zhang Y, Su X. Antidiabetic and Hypolipidemic Effects of 5,7-Dimethoxyflavone in Streptozotocin-Induced Diabetic Rats. Med Sci Monit Int Med J Exp Clin Res. 2019 Dec;25:9893–901.
27. Febriani Y, Mierza V, Handayani NP, Surismayanti S, Ginting I. Antibacterial Activity of Lidah Mertua (Sansevieria Trifasciata Prain.) Leaves Extract on Escherichia coli and Staphylococcus aureus. Herb Med Pharm Clin Sci Rasm No [Internet]. 2019 [cited 2023 Jun 5];7(22):1857–9655. Available from: https://doi.org/10.3889/oamjms.2019.525
28. Dewatisari WF, Nugroho LH, Retnaningrum E, Purwestri YA. Antibacterial and Anti-biofilm-Forming Activity of Secondary Metabolites from Sansevieria trifasciata Leaves Against Pseudomonas aeruginosa. Indones J Pharm. 2022;33(1):100–9.
29. Dewatisari WF, Nugroho LH, Retnaningrum E, Purwestri YA. The potency of sansevieria trifasciata and s. Cylindrica leaves extracts as an antibacterial against pseudomonas aeruginosa. Biodiversitas. 2021;22(1):408–15.
30. Desi S, Siti HA, Mery S. Potensi Lidah Mertua (Sansevierria trifasciata Prain) Dalam Menghambat Pertumbuhan Bakteri Salmonella spp.dan Staphylococcus aureus. Ris Inf Kesehat. 2018;7(2):129–33.
31. Abdul-Hafeez EY, Orabi MAA, Ibrahim OHM, Ilinskaya O, Karamova NS. In vitro cytotoxic activity of certain succulent plants against human colon, breast and liver cancer cell lines. South African J Bot [Internet]. 2020;131:295–301. Available from: https://www.sciencedirect.com/science/article/pii/S0254629919301176
32. Nakamura H, Takada K. Reactive oxygen species in cancer: Current findings and future directions. Cancer Sci. 2021 Oct;112(10):3945–52.
33. Li H, Zhang X, Wang W. ANTICANCER ACTIVITY OF 5, 7-DIMETHOXYFLAVONE AGAINST LIVER CANCER CELL LINE HEPG2 INVOLVES APOPTOSIS, ROS GENERATION AND CELL CYCLE ARREST. African J Tradit Complement Altern Med AJTCAM. 2017;14(4):213–20.
34. Aaghaz S, Sharma K, Jain R, Kamal A. β-Carbolines as potential anticancer agents. Eur J Med Chem [Internet]. 2021;216:113321. Available from: https://www.sciencedirect.com/science/article/pii/S0223523421001707
35. Karomo WF, Rwai WW. In vitro anthelmintic activity of Sansevieria trifasciata leaves extract against Fasciola hepatica. World J Pharm Sci. 2016;4(11):136–9.
36. Lestari E, Setyaningrum E, Wahyuningsih S, Rosa E, Nurcahyani N, Kanedi M. Antimalarial activity test and GC-MS analysis of ethanol and ethyl acetate extract of snake plant (Sansevieria trifasciata Prain). World J Biol Pharm Heal Sci. 2023;15(2):091–097.
37. Gorki V, Walter NS, Singh R, Chauhan M, Dhingra N, Salunke DB, et al. β-Carboline Derivatives Tackling Malaria: Biological Evaluation and Docking Analysis. ACS omega. 2020 Jul;5(29):17993–8006.
38. Komala O, Yulia I, Pebrianti R, Program), Biologi S, Farmasi S. UJI EFEKTIVITAS EKSTRAK ETANOL DAUN LIDAH MERTUA (Sansevieria trifasciata Prain) TERHADAP KHAMIR Candida albicans. FITOFARMAKA J Ilm Farm [Internet]. 2012 Dec 1 [cited 2022 Jun 17];2(2):146–52. Available from: https://journal.unpak.ac.id/index.php/

fitofarmaka/article/view/169
39. Chasanah U, Permatasari AR. In vitro testing of emulgel with a combined extract of Sansevieria trifasciata Prain. and Curcuma longa Linn. against the Candida albicans. Farmasains J Farm dan Ilmu Kesehat [Internet]. 2020 Aug 7;5(1 SE-):31–4. Available from: https://ejournal.umm.ac.id/index.php/farmasains/article/view/13185
40. Ibrahim OHM, Abo-Elyousr KAM. Potential antifungal activity of various botanical extracts against the causal pathogen of the blue mold of citrus fruits. J Plant Pathol. 2023;105(2):527–38.
41. Vasalou V, Kotidis E, Tatsis D, Boulogeorgou K, Grivas I, Koliakos G, et al. The Effects of Tissue Healing Factors in Wound Repair Involving Absorbable Meshes: A Narrative Review. J Clin Med. 2023 Aug;12(17).
42. Yuniarsih N, Hidayah H, Gunarti NS, Kusumawati AH, Farhamzah F, Sadino A, et al. Evaluation of Wound-Healing Activity of Hydrogel Extract of Sansevieria trifasciata Leaves (Asparagaceae). Addi M, editor. Adv Pharmacol Pharm Sci [Internet]. 2023;2023:7680518. Available from: https://doi.org/10.1155/2023/7680518
43. Tkachenko H, Buyun L, Kurhaluk N, Maryniuk M, Osadowski Z. Preliminary In Vitro Assessment of Effects of Leaf Extracts of Various Sansevieria Thunb. Species on the Lipid Peroxidation Level in the Equine Plasma. Agrobiodiversity Improv Nutr Heal Life Qual. 2019;20(3):439–50.
44. Yuningsih LM, Mulyadi D, Inayah S, Marwah SS. Formulation And Physical Stability Test Of Mother-In-Law's Tongue Leaves Extract Lotion As An Antioxidant. J Kim MULAWARMAN; Vol 21 No 1 (2023)DO - 1030872/jkm.v21i11235 [Internet]. 2023 Nov 26;21(1):24–37. Available from: http://jurnal.kimia.fmipa.unmul.ac.id/index.php/JKM/article/view/1235
45. Sarjani T, Mawardi A, Pandia E, Siregar A. Antioxidant Activity and Phytochemical Screening of Some Sansevieria Plants. Adv Soc Sci Educ Humanit Res Vol 576382. 2021 Jan 1;576:381–4.
46. HUTABARAT MP, LUBIS Z, SILALAHI J. The effect of brewing time herbal tea from mother-in-law's tongue leaves (Sansevieria trifasciata Prain) on total phenol, total flavonoid, and antioxidant activity. J Nat. 2023;23(1):41–6.
47. Dohre V, Yadav S. Impact of Two Different Methods of Extraction on Total Antioxidant Activity and Phenolic Content in an Uncommon Plant (Sansevieria trifasciata) and Commonly Consumed Fruits. Flora and Fauna [Internet]. 2021 [cited 2022 Jun 17];27(1):35–41. Available from: https://doi.org/10.33451/florafauna.v27i1pp35-41
48. Septiani A G. Uji Aktivitas Pertumbuhan Rambut Kombinasi Ekstrak Etanol Daun Pandan Wangi (Pandanus amaryllifolius Roxb.) dan Daun Lidah Mertua (Sansevieria trifasciata Prain.). J Pharmacopolium. 2018;1(2):69–73.
49. Nurjanah, Krisnawati M. Pengaruh Hair Tonic Lidah Mertua (Sanseviera Trifasciata Prain) dan Seledri (Apium Graveolens Linn) Untuk Mengurangi Rambut Rontok. J Beauty Beauty Heal Educ. 2014;3(1):1–7.
50. Mutia AC. HAIR TONIC ACTIVITY TEST OF THE LEAVES OF THE LAW OF THE LAW (SANSEVIERIA TRIFASCIATA PRAIN) ON HAIR GROWTH OF MALE RABBITS (LEPUS NIGRICOLLIS). Asian J Heal Sci. 2022;1(1):11–20.
51. Kasmawati H, Mustarichie R, Halimah E, Ruslin R, A Sida N. Antialopecia Activity and IR-Spectrometry Characterization of Bioactive Compounds From Sansevieria trifasciata P. Egypt J Chem [Internet]. 2022 Apr 20 [cited 2022 Jun 20];65(0):19–24. Available from: https://ejchem.journals.ekb.eg/article_232098.html
52. H. Kasmawati, R. Mustarichie, E. Halimah, R. Ruslin, A. Arfan, Sida NA, et al. ANTIALOPECIA ACTIVITY EXPLORATION BY In-silico ANALYSIS OF BIOACTIVE COMPOUNDS

FROM Sansevieria trifasciata PRAIN LEAVES THROUGH 5α-REDUCTASE INHIBITION. RASAYAN J Chem. 2023;16(03):1727–33.
53. Teponno RB, Tanaka C, Jie B, Tapondjou LA, Miyamoto T. Trifasciatosides A–J, Steroidal Saponins from Sansevieria trifasciata. Chem Pharm Bull. 2016 Sep 1;64(9):1347–55.
54. Fitria L, Gunawan ICP, Sanjaya WBT, Meidianing MI. Single-dose acute oral toxicity study of chloroform extract of snake plant (Sansevieria trifasciata Prain.) leaf in Wistar rats (Rattus norvegicus Berkenhout, 1769). J Trop Biodivers Biotechnol. 2022;7(1):69389.