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(RESEARCH ARTICLE)

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Utilization *Sesbania grandiflora* (L.) Pers. as traditional medicine and its bioactivity

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Abstract

Sesbania grandiflora (Fabaceae) has been long used as food and traditional medicine. This study aims to explain the botany, benefits and bioactivity of *S. glandiflora*. The method is library research of various articles published online on Google Scholar using the keywords *S. glandiflora*, uses of *S. glandiflora* and bioactivities of *S. glandiflora*. In traditional medicine, *S. glandiflora* is used to treat diarrhea, snake bites, malaria, smallpox, fever, scabies, ulcers, and gastric disorders. *S. glandiflora* bioactivity includes anti-diabetes mellitus, anti-bacterial, antioxidant, anti-helminthic, anti-hyperlipidemic, anti-diarrheal and anti-cancer. The bioactivity of *S. glandiflora* is related to the content of its secondary metabolites. The tocopherols contained in *S. glandiflora* seeds showed potential as antioxidants while the phytosterols showed anti-inflammatory, analgesic and antipyretic potential. *S. glandiflora* has the potential to be developed as a natural food preservative because it has antimicrobial activity.

Keywords: *Sesbania glandiflora*; Anti-microbial; Tocopherol; Traditional medicine

1. Introduction

Sesbania grandiflora L. Poir has been long used as food and traditional medicine. This plant is widespread in Asian countries including Indonesia and has begun to be cultivated in the yard, but mostly grows well in neglected vacant lands (Figure 1A). Empirically, *S. glandiflora* has beautiful flower characteristics so it is often used as an ornamental plant. Silalahi [1] reported that *S. glandiflora* flowers, especially the white ones, have long been traded in the market for use as vegetable ingredients. Traditional Indonesian food such as *pecel* (traditional salad by Javanese) uses *S. glandiflora* flowers as a of its components.

Although it has been long used as a food ingredient, the supply of *S. glandiflora* flowers in traditional markets is small and seasonal with a selling price of around Rp. 8,000-12,000 per 250 grams (Figure 1B) depending on the supply [1]. This is thought to be related to the flowering season of *S. grandiflora*. Besides being used as food, *S. glandiflora* is also used as traditional medicine. In traditional medicine, *S. glandiflora* is also used as a traditional medicine. It used to treat diarrhea, snakebite, malaria, smallpox, fever, scabies, ulcers, and gastric disorders [2]. The leaves *S. glandiflora* as traditional medicine are used for antioxidant, antidiarrheal and antimicrobial activity [3]. The utilization is related to its bioactivity, including hypolipidemic, wound healing, anti-ulcer, antioxidant, hepatoprotective, antidiabetic, antioxidant, antipyretic, and expectorant [4].

The bioactivity of *S. glandiflora* as related to its secondary metabolite content of flavonoids [5,6], rutin [5], alkaloids, glycosides, saponins, tannins, sterols [6], tocopherols and phytosterols [7]. The tocopherols present in the seeds of *S. glandiflora* show potential as antioxidants, while the phytosterols exhibit anti-inflammatory, analgesic and antipyretic potential [7]. Phytosterols of *S. glandiflora* can also be used as raw materials for the production of steroid hormones and the manufacture of cosmetic products [7]. Saifudin et al [8] stated that *S. glandiflora* flower is a promising material

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to be developed as an active ingredient in anti-plaque toothpaste and mouthwash solution. The flower of *S. glandiflora* can be used as a dietary supplement that is useful for controlling postprandial blood glucose [9].

Although *S. glandiflora* has long been used and traded as food and traditional medicine, its use is only known by certain circles. This is thought to be related to limited information on the use and efficacy of *S. grandiflora*, therefore this study aims to explain the benefits and bioactivity of *S. grandiflora*.

2. Methods

The method used in writing this article is library research obtained from Google scholar using the keywords *S. grandiflora*, uses *S. glandiflora* and *S. grandiflora* bioactivities. The results obtained were synthesized so that the botany, utilization and bioactivity of *S. glandiflora* were explained in a comprehensive manner.

3. Results and discussion

3.1. Botany of *Sesbania glandiflora* (L)

Sesbania glandiflora is a species in the Fabaceae. Fabaceae is a cosmopolitan distributed family, with about 730 genera and 19,400 species, ranking third in terms of number of species after Asteraceae and Orchidaceae [10]. It has about 50 species and is one of the most common genera found in the tropics [11], including Indonesia.

Figure 1 *Sesbania glandiflora*. A. Habitus and habitat, B. Packaging of flowers that are traded, C. Flowers appear from the leaf axils, D. Flowers bloom with white crowns (Personal documentation)

S. glandiflora has a tree habitus (Fig. 1A) with a height of 4-10 m but up to 15 m, with a trunk diameter of 25-30 cm. The bark is deeply wrinkled, forming a thick plate, soft, cork-like, gray, pink or whitish in color. Terete branches, leaf scars and stipule scars are conspicuous. Stipule oblique lanceolate, to 8 mm, caducous. The leaves are alternate and compound, pinnate (Fig. 1c), 15-(20-30)-40 cm long by 20-50(-60), glabrous but densely pubescent when young, and petiole 1-2 mm long. Each leaf has a rachis terete and an acerose style, and a pair of oval leaflets 1.2-5.0 cm long and 0.5-1.6 mm wide, smaller at either end of the rachis than in the middle, both surfaces with or without glands. dense and tortuous purplish-brown. but glabrous, secondary veins 7 or 8 on each side of the midvein but not conspicuous, base rounded to broadly pointed, apex blunt for reuse and with mucro. Leaves are accommodated at the tips of branches, and turn bright yellow before shedding (Fig. 1A).

Inflorescences and bunches 4-7 cm, pendulous (Fig. 1C), flowering 2-5, bracts and bracteoles ovate to ovate-lanceolate, 7-10 mm long, caducous, pubescent on both surfaces, hanging at leaf base and may be red light, red, yellowish or white. Individual flowers are 5-10 cm long, curved and about 30 mm wide before opening. Flowers are produced in short axillary races. Petals bell-shaped, 2 cm long, slightly 2 lobed with 5 shallow teeth; crown of 5 petals fleshy white (Fig. 1D) or red, stemmed at base, oblong spreading standard shorter than others and back arched, 2 wings arched, 2 petals arched together inside; 10 curved stamens, 9 united and one separate, pistil with very narrow stemmed ovary and slender style. The fruit is long (20-60 cm) and narrow (6-9 mm), hanging, flat, insulated, with swollen edges containing about 15 to 50 red-brown seeds [12].

3.2. Uses and Bioactivities

S. glandiflora has been long used as food and traditional medicine. This study is more focused on its use as traditional medicine and its bioactivity. *S. glandiflora* in traditional medicine is used to treat diarrhea, snakebites, malaria, smallpox, fever, scabies; ulcers, and gastric disorders [2]. The following will explain the bioactivity of *S. glandiflora* as anti-diabetes mellitus, anti-bacterial, antioxidant, anti-helminthic, anti-hyperlipidemic, anti-diarrheal and anti-cancer.

3.2.1. Anti-diabetes Mellitus

Diabetes mellitus (DM) is characterized by high blood glucose levels caused by the ineffectiveness of insulin produced in peripheral tissues [13]. In general, DM is divided into 2, namely DM type 1 (the body cannot produce the hormone insulin) and DM type 2 (the body's cells become less sensitive to the hormone insulin). The hormone insulin is a hormone produced by the pancreas that functions to facilitate the entry of glucose into liver cells and muscle cells. If the level of the hormone insulin is low, it causes liver cells to convert glycogen into glucose and release it into the blood so that blood glucose levels become high. Plants used to treat DM are plants that produce compounds that can inhibit the activity of a-amylase and a-glucosidase [9].

Various types of plants have long been used to treat type 2 DM, including *S. glandiflora* [14]. The bioactivity of *S. glandiflora* as an anti-DM has been reported by Thissera et al [9], Panigrahi et al [4], Kothari et al [13] and Kumar et al [14]. Methanol extract of *S. glandiflora* (MESG) has anti-diabetic activity type 2 induced by low-dose streptozotocin and high-fat diet in rats [4]. The MESG (200 and 400 mg/kg, p.o.) significantly reduced rat blood glucose levels [4]. Maximum 81% inhibition of -amylase enzyme was observed at 1000 g/ml compared to standard Acarbose which showed 93% inhibition. The IC50 of the *S. glandiflora* extract was found to be 50.95µg/ml and for Acarbose 34.83 M [13]. Alcohol extracts of 250 and 500 mg/kg of *S. glandiflora* flowers showed significant antidiabetic activity compared to alloxan-induced diabetes control [14].

The bioactivity of *S. glandiflora* as anti-diabetes mellitus is related to the bioactivity of its secondary metabolites which are able to inhibit the activity of α-amylase and α-glucosidase [9]. The terpenoids of *S. glandiflora*, namely vomifoliol and loliolide, inhibited a-glucosidase activity with IC50 values of 64.5 and 388.48 mM, respectively, while quercetin inhibited a-glucosidase the highest with IC50 values of 17.45 mM [9].

3.2.2. Anti-microbial

Antimicrobial resistance is one of the impacts of the use of antibiotics, therefore the search for natural ingredients to fight bacteria continues [15,16]. Various types of pathogenic bacteria can cause various infections in humans such as gastrointestinal, respiratory and urinary tract infections. Streptococcus mutans causes plaque on the teeth [8]. Plants used as antimicrobials are plants that produce compounds that can inhibit or cause bacterial death.

The bioactivity of *S. glandiflora* as an antimicrobial has been reported by China et al [15], Saifudin et al [8], Cayme and Ragasa [17], Guzman et al [15], Padmalochana and Rajan [18], Anantaworasakul et al [16], Powthong et al [19], Noviany

et al [20], and Hasan et al [21]. Crude ethanol extract and extract fraction of *S. glandiflora* significantly inhibited the growth of bacteria known to cause urinary tract infections [3].

Flower polyphenol extracts of *S. glandiflora* inhibited the growth of *Staphylococcus aureus, Shigella flexneri, Salmonella Typhi, Escherichia coli* and *Vibrio cholerae* [5]. Bacterial sensitivity to polyphenol extracts of *S. glandiflora* varied. Gram-positive bacteria (*S. aureus*) were more sensitive to polyphenols with a minimum inhibitory concentration (MIC) of 0.013 mg/mL) compared to *V. cholera* with an MIC of 0.25 mg/mL. The bioactivity of *S. glandiflora* as an anti-bacterial is related to the content of rutin, flavonoids [5]. The ethanolic extract of *S. glandiflora* flower showed the strongest activity with an inhibition zone diameter of 18.5 mm compared to erythromycin (standard drug) with an inhibitory diameter of 18.0 mm [8]. The compound 3-stigmasterol, 3-sitosterol, and oleanolic acid from *S. glandiflora* flowers showed high activity against Pseudomonas aeruginosa and *Aspergillus niger*, mild activity against *S. aureus*, *E. coli*, *Candida albicans*, and *Trichophyton mentagrophytes* [18]. The *S. glandiflora* inhibited the growth of *V. cholerae* at 7.81 mg/mL and was bactericidal at 15.63 mg/mL [15].

The aqueous extract, methanol and acetone of the leaves of *S. glandiflora* had antimicrobial activity against *S. aureus* and *Candida* sp. methicillin-resistant [18]. The ethanol extract showed good antibacterial activity compared to the aqueous and acetone extracts. Antibacterial bioactivity is related to the content of alkaloids, flavonoids, tannins and steroids of *S. glandiflora* and is highest in ethanol extracts [18]. The ethyl acetate extract of *S. glandiflora* showed the highest activity with MICs against methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant *Enterococci* of 1.6 and 0.4 mg/mL, respectively, and against Gram negative [16].

The bioactivity of *S. glandiflora* as an anti-bacterial is thought to be related to its endophytic fungi. Endophytic fungi isolated from the branches and leaves of *S. glandiflora* had antibacterial activity (*S. aureus, Bacillus subtilis, E. coli* and *P. aeruginosa*) and yeast (*C. albicans* and *Cryptococcus neoformans*), and 6 fungi (*Rhizopus* spp., *Mucor* spp., *Penicillium* spp., *Aspergillus* spp., *Curvularia* spp., and *Alternaria* spp) [19]. Sesbagrandiflora compounds A and B which have been isolated from the bark of *S. glandiflora* showed moderate activity against *Mycobacterium tuberculosis* [20]. Isoflavanoids isolated from the roots of *S. glandiflora*, namely isovestitol, medicarpin, and sativan, betulinic acid showed antituberculosis activity against *M. tuberculosis* with MIC values of 50 g/mL for isovestitol, medicarpin, and sativan compounds, and 100 g/mL for betulinic acid compounds, while the methanol extract showed antituberculosis activity of 625 g/mL. isoflavonoids in this case plants and their antituberculosis activity [21].

3.2.3. Antioxidant

A free radical is an atomic molecule or compound that contains one or more unpaired electrons so it is highly reactive which is directly or indirectly associated with various diseases such as cancer, diabetes mellitus and heart disease. The extract of leaves *S. glandiflora* showed satisfactory antioxidant potential in the 1,1-difenil-2-pikrilhidrazil (DPPH) free radical scavenging assay with IC50 values found in the petroleum ether soluble fraction (18.05 ± 1.90) compared to ascorbic acid (17.50 ± 0.20) [3]. The antioxidant activity test was tested by the DPPH method. Antioxidant activity was indicated by the IC50 value of the n-hexane extract of white *S. glandiflora* flower > 1000 g/ml; ethyl acetate extract > 1000 g/ml; flower methanol extract 836.91 g/ml [22]. The tocopherols present in the seeds of *S. glandiflora* show great potential as antioxidant agents [7]. The flower of *S. glandiflora* are a promising source of high value-added compounds with enzyme inhibitory and antioxidant properties [23].

Administration of aqueous suspension of *S. glandiflora* significantly reduced the increase in markers of liver peroxidation (aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase), kidney and lipids (thiobarbituric acid reactive substances and antioxidant enzymes, namely superoxide dismutase, catalase, glutathione peroxidase, glutathione reductase, glutathione-S). The transferase and glucose-6-phosphate dehydrogenase activity) and ameliorated reduced antioxidant levels while restoring liver and kidney structure in cigarette smoke exposed mice [24].

3.2.4. Anti-helminthic

The leaves of *S. glandiflora* have an anthelmintic effect on gastrointestinal parasitic infections of goats. Giving fresh leaf extract to goats involved a reduction of nematode eggs in goat feces by 42% and 40 % in the administration of dry leaves [25]. Acetone, ethanol and water extracts from *S. glandiflora* flower had anthelmintic activity against *Pheretima posthuma*. Extracts with concentrations (100, 150, 200 mg/ml) showed an increase in anthelmintic activity which was observed gradually according to the increase in concentration [26].

3.2.5. Anti-ulcer

The ethanolic extract of the leaves of *S. glandiflora* has an antiulcer effect on rats suffering from gastric ulcers. Acute gastric ulceration in rats is induced by oral administration of various harmful chemicals such as aspirin or ethanol or indomethacin. The ethanol extract of *S. glandiflora* leaves at a dose of 400 mg kg orally resulted in a significant decrease in the ulcer index. The ethanolic extract of *S. glandiflora* leaves significantly inhibited the gastric mucosal damage induced by aspirin, ethanol and indomethacin and significantly reduced basal gastric acid secretion. The protective effect of the extract is thought to be mediated by anti-secretory and cytoprotective mechanisms [2].

Ethanol extract of the bark of *S. glandiflora* prevented acute gastric injury in rats [27]. Ethanol extract of *S. glandiflora* leaf showed improvement of pyloric ligation in rats with ethanol-induced ulcers. Orally administered concentrations of *S. glandiflora* leaf methanol extract (250 and 500 mg/kg) showed a significant reduction in gastric volume and ulcer index compared to controls in both ulcer models [28]. The stem water extract of *S. glandiflora* has activity against ethanol-induced ulcers in Wister rats. Extracts (250 and 500 mg/kg) showed a significant decrease in ulcer index compared to controls in an ethanol-induced ulcer model [29].

3.2.6. Anti-cancer

The leaves of *S. glandiflora* have anticancer properties against these cancer cell lines as MCF-7, HepG2, Hep-2, HCT-15, and A549. The methanol fraction of *S. glandiflora* was found to have a strong antiproliferative effect especially on the human lung cancer cell line, A549. Caspase 3 was activated in the methanol fraction treated with A549 cells thereby causing cell death by apoptosis. Decreased cyclin D1 levels and decreased NFkB activation were observed in A549 cells upon treatment with the methanol fraction, providing clues about a possible mechanism of action [30]. New 2-arylbenzofuran compound, sesbaggrandiflora C; 2- (3,4-dihydroxy-2- methoxyphenyl) -4-hydroxy-6-methoxybenzofuran-3-carbaldehyde; 2- (4-hydroxy-2-methoxyphenyl)-5,6-dimethoxybenzofuran- 3-carboxaldehyde; sesbagrandiflora A; and sesbagrandiflora B isolated from the bark of *S. glandiflora* had moderate cytotoxicity to HeLa, HepG2, and MCF-7 cancer cell line [20].

3.2.7. Anti-hyperlipidemia

The *S. glandiflora* at a dose of 200µg/kg (p.o) administered to triton-induced hyperlipidemic rats showed a significant decrease in serum cholesterol, phospholipid, triglyceride, low-density lipoprotein (LDL), very low density lipoprotein (VLDL) levels and a significant increase in blood serum HDL levels. The aqueous extract fraction of *S. glandiflora* reduced total cholesterol levels by 69.72 and increased serum high density lipoprotein (HDL) cholesterol levels by 24.11 and decreased LDL cholesterol with aqueous extracts by 30.31 [31]. Infusion of decoctions of *S. glandiflora* flowers inhibits the activity of enzymes involved in the onset of obesity (lipase) [23]. Adult rats exposed to cigarette smoke for 90 days were then given a suspension of *S. grandiflora* leaf water, 1000 mg/kg for 3 weeks orally, showing hypolipidemia. Total lipids, total cholesterol, triglycerides, low density lipoprotein cholesterol, and very low density lipoprotein cholesterol increased significantly while phospholipids and high density lipoprotein cholesterol decreased significantly in rats exposed to cigarette smoke [24].

3.2.8. Anti-kidney Stone

Kidney stone disease or often also known as nephrolithiasis is caused by a buildup of minerals and salts in the kidneys. Urinary tract stones generally contain elements: calcium oxalate, calcium phosphate, uric acid, magnesium-ammonium-phosphate (MAP), xanthin and cystine [32]. The leaves of *S. glandiflora* showed anti-urolithic activity in rats suffering from kidney stones induced by using gentamicin (subcutaneously) and 5% ammonium oxalate in feed to induce calcium oxalate-type stones. The juice of *S. glandiflora* leaf juice was safe for consumption and exhibited no changes in gross behavior except for increased urination. Leaf juice showed significant anti-urolithic activity against types of calcium oxalate stones and also showed antioxidant properties [33].

3.2.9. Anti-diarrhea

Diarrhea is one of the digestive tract infection disorders caused by microorganisms. In the antidiarrheal test, the ethanolic extract of *S. glandiflora* inhibited the average number of bowel movements by 24.97% and 41.05% at 200 mg/kg and 400 mg/kg body weight, respectively. The leaf fraction of *S. glandiflora* showed relatively more prominent antibacterial activity in gram-negative bacteria than in gram-positive bacteria. The content of flavonoids and tannins showed a significant and positive correlation between the content of total phenolic compounds and the pharmacological activity of *S. glandiflora* [34]. The roots of *S. glandiflora* contain compounds l, l'-binaphthalene-2,2'-diol, isoflavanoids [36]. The leaves of *S. grandiflora* have the potential to be used as a medicine for thrombosis, diarrhea, and inflammatory diseases and against several important pathogenic bacteria [35].

3.2.10. Nerve Protector

The *S. glandiflora* contains alkaloids, flavonoids, tannins, triterpenes, gums, mucus, and anthraquinone glycosides. A central nervous system depressant and analgesic can be produced from *S. grandiflora* leaves through suitable formulations [37]. Smoking has been associated with a high risk of neurological diseases such as stroke, Alzheimer's disease, multiple sclerosis. Exposure to cigarette smoke in rats resulted in significant changes in total brain lipids, total cholesterol, triglyceride and phospholipid content. The extract of *S. glandiflora* recovers the brain from cigarette smoke induced oxidative damage. *S. glandiflora* provides protection to the brain by stabilizing cell membranes and preventing protein oxidation, possibly through its free radical scavenging and anti-peroxidative effects [38]. Also cigarette smoke exposure resulted in a marked increase in copper and decreased levels of zinc, manganese and selenium in the brain. Administration of aqueous extract of *S. glandiflora* attenuated lipid peroxidation, enhanced antioxidant status, restored micronutrient levels and maintained brain histology. Chronic cigarette smoke exposure accelerates oxidative stress, thereby disrupting the brain's defense mechanisms and *S. glandiflora* protects the brain from oxidative damage [39].

4. Conclusion

In traditional medicine, *S. glandiflora* is used to treat diarrhea, snake bites, malaria, smallpox, fever, scabies, ulcers, and gastric disorders. The bioactivity of *S. glandiflora* includes anti-diabetes mellitus, anti-bacterial, and antioxidant, anti-helminthic, anti-hyperlipidemic, anti-diarrheal and anti-cancer. The bioactivity of *S. glandiflora* as related to the content of its secondary metabolites.

Compliance with ethical standards

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