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Jasmine (*Jasminum sambac* (L.) Aiton): Potential Utilization and Bioactivity

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Jasminum sambac (Oleaceae) is a multi-functional plant that is used as decoration, traditional medicine, and a source of essential oil. This study aims to explain the botany, bioactivity and essential oil of *J. sambac*. The research method with online library research is mainly sourced from Google Scholar using the keywords *J. sambac*, uses of *J. sambac* and *J. sambac* essential oil. The essential oil of *J. sambac* is one of the most expensive oils used in the cosmetic, pharmaceutical, perfumery and aromatherapy industries. In traditional medicine *J. sambac* is used to treat dysmenorrhea, menorrhea, ringworm, leprosy, skin diseases, analgesic, antidepressant, anti-inflammatory, antiseptic, aphrodisiac, sedative, expectorant, fever, pain and inflammation and cancer. The bioactivity of *J. sambac* is to suppress lactation, analgesic, anti-microbial, antioxidant, anti-cancer, anti-hypertensive, treat wounds, treat ulcers. The distinctive aroma of *J. sambac* flowers is related to the content of essential oils, namely linalool, α- farnesene, d-nerolidol, geraniol, α-cadinol, benzyl alcohol, benzaldehyde, benzyl acetate, benzyl benzoate, 3-hexen-1-ol benzoate, and (Z) -3-hexen-1-ol acetate. The bioactivity of *J. sambac* as an anti-microbial can be developed as a natural food preservative and also to keep the body fresh.

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1. INTRODUCTION

Jasmine or *J. sambac* is a multi-functional plant that is easy to find in Indonesia and is often used as an ornamental plant in the yard. Even though *J. sambac* is not indigenous to Indonesia, this plant has cultural values attached to the various ethnicities used for ritual materials, "tea", and wedding decorations. The *J. sambac* is used as the main component in ritual ceremonies such as the Babad Dalan ritual (Fig. 1) by ethnic Javanese in Gunung Kidul, Indonesia [1]. Empirically it can be seen that *J. sambac* has long been traded in various traditional and modern markets so that it plays a role in improving the economy. Jasmine has an optimistic and potential market potential by Indonesia by seeking the quality of white jasmine flowers in accordance with the requirements desired by export destination countries [2].

The *J. sambac* has the most significant economic value because it has a refreshing fragrance that is widely used in various industries [3], food, cosmetics or other chemicals [4,5]. These compounds (methyl anthranilate and (R)-(−)-linalool) were determined as the main aroma of jasmine tea flavor [5]. Younis et al. [6] stated that J. sambac essential oil is one of the most expensive oils used in the cosmetic, pharmaceutical, perfumery and aromatherapy industries.

Besides being used in various industries, *J. sambac* flowers have been used as traditional medicine in Asia to treat various diseases, including dermatitis, diarrhea, and fever [7]. The ethanol extract of *J. sambac* is becoming a source for obtaining new and effective herbal medicines to treat infections against various infectious diseases [8]. The use of *J. sambac* as a traditional medicine is related to its bioactivity. The extract of *J. sambac* has anti-inflammatory, analgesic, and antipyretic activities related to its secondary metabolites, especially hesperidin [9]. Essential oil compounds have therapeutic properties and can be used as analgesics, antidepressants, anti-inflammatories, antiseptics, antispasmodics and stimulants [6]. Empirically it appears that local Indonesian people have long used *J. sambac* as both traditional and cultural medicine, but in-depth studies of *J. sambac* have not been found much. This study aims to explain the botany, utilization and *J. sambac* essential oil in a comprehensive manner so that the potential for its utilization can be increased.

Fig. 1. A. Offerings in the Babad Dalan ceremony in Giring Village, Gunung Kidul (*J. sambac* as one of its components

2. METHODS

The method used in this research is a literature study. Literature is obtained online, mainly sourced from Google Scholar using several keywords such as *J. sambac*, uses of *J. sambac* and *J. sambac* essential oil. The information obtained is synthesized so that it can explain the botany, utilization and essential oils from *J. sambac*.

3. RESULTS AND DISCUSSION

3.1 Botany of *Jasminum sambac* (L.) Aiton

The Oleaceae has about 28 genera and 900 species [10]. *Jasminum* L. is the largest genus containing 200 species [10-12]. Jasminum is native to tropical and warm climates in Eurasia, Australasia, and Oceania [11]. *Jasminum sambac* is a species that has been commercialized and is widely used in the pharmaceutical and beauty industries. *Jasminum sambac* originates from tropical and sub-tropical regions [13]. The distribution of the genus is wide but most of the species are centered in India, China and Malaysia. The *J. sambac* is native to the East Himalayas and India, while in Indonesia it is an introduced plant, but has long been cultivated [14].

The *J. sambac* has a perennial shrub habitus that propagates with a height of about 0.3 – 2 m. The stem is brown, woody, round to rectangular in shape, knuckles and branches as if clumping. Single leaf and located opposite (Fig. 2A). The petioles is short, the lamina is ovoid with 2.5–10 cm x 1.5–6 cm. The apex acuminates, rounded base. Leaf veins pinnate, prominent on the under surface and glossy green leaf surface. The inflorescence located axillary (in the armpits of the leaves). In one flower base will grow 3 flowers at once, so it will look solid (Figs. 2B and C). The arrangement of the crown is single or double (stacked), fragrant, but some types of jasmine flowers have no fragrance. Petals numbered 4-9 pieces. Stamens are 2 in number with very short filaments. This flower also has 4 ovules and 2 stamens or loculus [15].

Fig. 2. *Jasminum sambac*. A. Habitus and opposite leaves, B. Twigs with flowering, C. Flowers with white corolla [Photo by Silalahi M].

3.2 Uses and Bioactivities

Natural products are increasingly in demand because this system is pollution free, less toxic and without side effects [13]. Extract from *J. sambac* flowers can be a strong antioxidant, bleach, and non-toxic material that can be used in the pharmaceutical, cosmetic, and food industries [16]. Traditionally *J. sambac* is used to treat dysmenorrhea, amenorrhea, ringworm, leprosy, skin diseases, analgesic, antidepressant, anti-inflammatory, antiseptic, aphrodisiac, sedative, expectorant [13], fever, pain and inflammation [9,17], and cancer [18]. The following will explain in more detail the bioactivity of *J. sambac* to suppress lactation, analgesic, anti-microbial, antioxidant, anti-cancer, anti-hypertensive, treat wounds, and treat ulcers.

3.3 Suppresses Lactation

The essential oil of *J. sambac* flowers is used as perfume and anti-lactation [19,20]. Bromocriptine (a standard drug to treat prolactin too high) and *J. sambac* flowers resulted in a significant reduction in serum prolactin, a significantly greater reduction with bromocriptine. The reduction of breast swelling, milk production and intake of *J. sambac* flower analgesics and Bromocriptine are equally effective. Jasmine flower seems to be an effective and inexpensive method to suppress puerperal lactation [18]. The ethanol extract of *J. sambac* root has anti-inflammatory, analgesic, and anti- pyretic activity [9].

3.4 Analgesic

The ethanol extract of dry leaf *J. sambac* has analgesic activity [9,17,21,22]. The *J. sambac* floral alcohol extract (400 mg/kg body weight) significantly reduced carrageenan-induced edema formation. Acetic acid-induced writhing rats, extracts and fractions had a good analgesic effect which was marked by a decrease in the number of writhes comparable to Diclofenac sodium (standard drug) [17]. The extract of dry leaf *J. sambac* produced significant inhibition of acetic acid-induced writhing in rats at oral doses of 250 and 500 mg/kg body weight comparable to the standard drug diclofenac sodium (25 mg/kg body weight) [21]. Its bioactivity as an analgesic is related to its secondary metabolites, especially its hesperidin [9]. The ethanol extract of *J. sambac* leaves contains flavonoids, phenols, saponins, tannins and hesperidin [9]. The *J. sambac* leaf ethanol extract significantly inhibited adjuvant-induced arthritis and also showed significant antipyretic effect [9]. Jasmine root methanol extract (200 and 400 mg/kg) is similar to standard drugs such as Buprenorphine (0.05 mg/kg subcutaneously) and Aspirin (100 mg/kg intraperitoneally) [22].

3.5 Anti-microbial

Antimicrobial compounds are compounds that inhibit the growth of microorganisms. *J. sambac* is widely used as a traditional medicine in India for skin disorders so it is very potential to be developed as an antibiotic [23]. The *Malassezia* sp. cause skin diseases such as pityriasis versicolor, folliculitis, and tropical dermatitis [24]. The microbial pathogenic in human such as: bacteria (*Bacillus subtilis, Bacillus cereus, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa*) and fungi (*Aspergillus niger, Aspergillus flavus, Candida albicans*) [8]. The bioactivity *J. sambac* as an antimicrobial is more prominent than other activities. *J. sambac* can be used as an alternative treatment against skin infections such as Malassezia [24]. The essential oil of *J. sambac* and methanol extract showed better activity against bacterial species than against yeast [25].

The extract *J. sambac* inhibits the growth of bacteria such as *Escherichia coli* [8,11,23,26], *Staphylococcus aureus* [8,11,26], *Pseudomonas aeruginosa* [8,11,26], *Staphylococcus albus, Proteus mirabilis, Salmonella typhi* [23], *Bacillus subtilis* [8,26], *Bacillus* sp., *Streptococcus* sp., *Salmonella* sp., *Pseudomonas* sp., *Serratia marcescens*, *Klebsiella pneumonia* [11], and *Bacillus cereus* [8]. In addition to inhibiting bacteria, *J. sambac* also inhibits the growth of fungi such as *Aspergillus niger, Candida albicans* [8,26], *Aspergillus flavus* [8], and *Trichophyton mentagrophytes* [26]. The bioactivity of *J. sambac* as an anti-microbial varies depending on various factors, namely the organs used [24] and the type of essential oil [26].

Methanol extract of flowers, leaves and essential oil of *J. sambac* flowers had antifungal activity with inhibition zones of 11.10 ± 1.92, 12.90 ± 1.68, and 13.06 ± 0.26 mm respectively [24]. The compounds caryophyllene oxide, benzyl benzoate, farnesyl acetate, and methyl isoeugenol showed moderate activity against *P. aeruginosa* and *A. niger*, and mildle activity against *E. coli, B. subtilis, C. albicans,* and *T.*

mentagrophytes. The compound methyl isoeugenol has little activity against *S. aureus* [26]. The extract of *J. sambac* contains alkaloids, glycosides, flavonoids, terpenoids, tannins, resins, and salicylic acid [23]. The ethanol extract of *J. sambac* leaves was higher than the highest for moderate ethyl acetate, petroleum ether and chloroform against bacterial strains [8]. The phytochemical content of the extract is influenced by the solvent used which results in differences in alkaloids, flavonoids, tannins, saponins, glycosides, steroids and terpenoids [8].

3.6 Antioxidant

Antioxidant compounds are compounds that are able to inhibit free radicals. Antioxidant test was measured with 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenger, ferric reducing antioxidant power (FRAP) and 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) (ABTS)-reducing [27]. The antioxidant properties of Jasminum can be developed as a natural preservative for food and pharmaceutical products [28] and as an anti-depressant [19]. *J. sambac* extract fermented with *Lactobacillus rhamnosus* can effectively repair UVB/H2O2-induced aging skin cells and can be considered as a promising ingredient in skin aging therapy [7]. *Jasminum sambac* flowers will function as strong antioxidant properties against free radicals [28,29].

Free radicals can stimulate skin aging through antioxidant system destruction, wrinkle formation, and melanogenesis [27]. The *J. sambac* has anti-aging activity related to its activity as an antioxidant so that it can be developed as herbal anti-aging agent [27]. Concentrations of antioxidants and several pro-oxidative enzymes in the human brain are thought to be involved in depression [19]. Reducing oxidative stress correlated with antidepressant treatment and led to clinical recovery of moderate depression [19].

The bioactivity of *J. sambac* as an antioxidant is influenced by dose [29]. The young leaves showed a moderate reducing effect in sequence against DPPH radicals (122 g/mL), nitric oxide (173.94 g/mL) and hydrogen peroxide (125µg/mL) when compared to ascorbic acid [19]. The essential oil of *J. sambac* has antioxidant activity which was tested by DPPH and β-carotene-linoleic acid free radical scavenging tests compared to Butylated hydroxytoluene (BHT) (positive control) [25]. Increasing the activity of hyaluronidase, elastase and collagenase causes skin aging [27]. Anti-aging properties are measured through the inhibitory activity of collagenase, elastase, and hyaluronidase [27].

The bioactivity of *J. sambac* as an antioxidant is related to its bioactive compounds. *J. sambac* showed the presence of low levels of phenols, triterpenoids, and flavonoids, and high levels of terpenoids [27]. The main compounds identified from the methanol extract of *J. sambac* flowers were α-farnesene, nerolidol, benzyl alcohol, linalool, benzaldehyde, and α-cadinol [28]. The antioxidant bioactivity of young leaves is thought to be related to the content of alkaloids, glycosides, tannins and flavonoids [19].

3.7 Anti-cancer

Anti-cancer compounds are compounds that inhibit excessive cell division. The *J. sambac* has an anticancer effect which was tested in albino rats [29]. The activity of inhibiting tumor cell proliferation of methanol extract of *J. sambac* flowers was dose- dependent on HeLa fibroblast cells at concentrations of 25-400µg/ml [29].

3.8 Anti-hypertension

Jasminum sambac is a South Asian folkloric medicinal plant that has traditionally been used to treat cardiovascular problems [30] such as hypertension. The extract of raw *J. sambac* leaf produced ex-vivo vasorelaxant effects in endothelial intact aortic ring preparations and hypotensive effects [30]. Oral administration of ethanol extract of *J. sambac* flowers to rats causes a vasodilatory effect on the rat aorta [31]. Jasmine flower extract in 0.05% dimethyl sulfoxide (DMSO) markedly reduced the tone of isolated thoracic aortic endothelium ring pre-constricted with phenylephrine (10^{-6} M), as a dose-dependent manner [31]. The vasorelaxant and cardioprotective effects are thought to be via activation of muscarinic receptors, release of nitric oxide, and reduced adrenaline [30].

3.9 Anti-ulcers

The ethanol extract of *J. sambac* has a gastroprotective effect against acidified ethanol-induced gastric ulcers in rats. In the laboratory, ulcers in rats can be induced with carboxymethylcellulose. The ethanol extract of *J. sambac* showed significant protection against gastric mucosal injury showing a significant

reduction in ulcer area (compared to the standard compound omeprazole). Histology showed reduced edema and leukocytes, significant submucosal infiltration [32].

3.10 Cure of Wounds

Wounds are one way for pathogenic microbes to enter the body, and to heal wounds, new tissue formation is needed. Water and ethanol extracts of *J. sambac* leaves in the form of an ointment (200 mg/kg BW and 400 mg/kg BW) have wound healing activity in rats. The aqueous extract has shown a significant increase in wound contraction, hydroxyproline content and decreased period of epithelialization in the excision wound model compared to the ethanol extract [33]. The increased wound healing activity of aqueous extracts may be due to the action of free radicals and the antibacterial properties of the phytoconstituents (tannins and flavonoids) present in them [33].

3.11 Essential Oil

Plants produce a variety of secondary metabolites that can be used directly or indirectly by humans. Essential oil is one of the secondary metabolites of plants that have economic value because it can be used as a raw material for making various aromatherapy, cosmetics, perfumes and other industries [34]. The essential oil *J. sambac* is one of the most expensive oils used in cosmetics, pharmaceutical, perfumery and aromatherapy industries [6,35]. Volatile compounds namely linalool, α-farnesene, d-nerolidol, geraniol, α-cadinol, benyzl alcohol, benzaldehyde, benzyl acetate, benzyl benzoate, 3-hexen-1-ol benzoate, and (Z)-3-hexen-1- ol acetate plays an important role in the distinctive aroma of jasmine [36,37], while benzene acetaldehyde, benzoic acid, methyl anthranilate, methyl 2-(methylamino) benzoate, and (E)-2-hexenal modify the aroma of jasmine [36].

Flowers are the main part of *J. sambac* which is used as a source of essential oil. Aroma, grade, type of essential oils are influenced by geography [38], time of harvest [36-38], temperature, length of storage [40], and stage of flower development Younis *et al* [6]. The main content of *J. sambac* essential oil from Egypt is almost qualitatively similar but quantitatively different from that grown in other geographical areas [38]. Flowers harvested at the open stage produced more essential oil than those harvested at the closed bud stage [6].

The proportion of benzyl acetate decreased when the flowers were picked from morning to evening and then increased at night collection [39], which is thought to be related to the blooming process [36]. The floral aroma of *J. sambac* is related to volatile condensate (FVC) compounds such as linalool, indole, and methyl anthranilate [40]. Storage at room temperature for 30 months reduced the abundance of strong odors and aroma intensity, but cold temperature storage (4°C) was able to maintain the intensity of the FVC aroma [40]).

The main ingredients in *J. sambac* flower aroma are linalool, benzyl acetate [16,38,39], cis-3-hexenyl acetate, (E)-β-ocimene, and (E,E)-α-farnesene [38,39], pinene, pentadecyl-2-propyl ester, citronellol, jasminolactone, farnesol, and jasmon [16]. The essential oils produced by *J. sambac* have distinctive sensory aromas such as linalool (flowers), methyl anthranilate (like grapes), 4-hexanolide (sweet), 4-nonanolide (sweet), (E)-2-hexenyl hexanoate (green), and 4-hydroxy-2,5-dimethyl-3(2H)-furanone (sweet) [5]. The removal of methyl anthranilate and the replacement of (R)-(−)-linalool by (S)-(+)-linalool causes a major change in the odor model [5]. The aroma of jasmine flowers is associated with a mixture of linalool, benzyl benzoate, farnesyl acetate, and methyl isoeugenol [4,16], cis-3-hexenyl acetate, linalyl acetate, eugenol and methyl salicylate [4]. Methyl anthranilate and (R)-(−)-linalool) are the main aroma of jasmine tea flavor [5].

The *J. sambac* flowers produce caryophyllene oxide, a mixture of benzyl benzoate and farnesyl acetate, methyl isoeugenol, squalene, and sitosterol [26]. Other ingredients of *J. sambac* flowers are benzyl-O-β-D-glucopyranoside (1), benzyl-O-β-D- xylopyranoxyl (1→6-β-D-glucopyranoside, tertraol, molihuaosideD, sambacoside A, sambacoside E, rutin , kaempferol-3-O-(2, 6-di-O-α-L-rhamnopyranosyl)- β-D- galactopyranoside, and quercetin-3-O-(2, 6-di-O-α-L-rhamnopyranosyl)-β-D- galactopyranoside [41], citronellol, phenyl ethyl alcohol, geranial, eugenol, farnesol, geranyl acetate, citrinyl acetate, 2-phenyl ethyl acetate, citral (cis and trans mixture), and benzylaldehyde [6] .

4. CONCLUSIONS

In traditional medicine *Jasminum sambac* is used to treat dysmenorrhea, menorrhea, ringworm, leprosy, skin diseases, analgesic,

antidepressant, anti- inflammatory, antiseptic, aphrodisiac, sedative, expectorant, fever, pain and inflammation and cancer.

The bioactivity of *J. sambac* is to suppress lactation, analgesic, anti-microbial, antioxidant, anti-cancer, anti-hypertensive, treat wounds, and treat ulcers. The distinctive aroma of *J. sambac* flowers is related to the content of essential oils, namely linalool, α-farnesene, d-nerolidol, geraniol, α-cadinol, benzyl alcohol, benzaldehyde, benzyl acetate, benzyl benzoate, 3-hexen-1-ol benzoate, and (Z) - 3-hexen-1-ol acetate.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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