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PHARMACOLOGICAL AND THERAPEUTIC EFFECTS OF *JASMINUM SAMBAC*- A REVIEW

Ali Esmail Al-Snafi
Department of Pharmacology, College of Medicine, University of Thi qar, Iraq.
Cell: +9647801397994. E mail: aboahmad61@yahoo.com

Abstract:
The phytochemical analysis of Jasminum sambac *revealed the presence of carbohydrates, proteins, amino acids, coumarins, glycosides, tannins, phenolic compounds, flavonoids, phenolics, saponins, steroids, fats, essential oils, fixed oils, terpines, resin, and salicylic acid. The pharmacological studies revealed that the plant extracts possessed antimicrobial, insecticidal, analgesic, antipyretic, antiinflammatory, antioxidant, antidiabetic, dermatological, anticancer, CNS and peripheral NS, cardiovascular, lipid peroxidation inhibition and anti-obesity and gastroprotective effects. This review will highlight the chemical constituents, pharmacological and therapeutic effects of* Jasminum sambac.

Keywords: *chemical constituents, pharmacology,* Jasminum sambac

Corresponding author:
Ali Esmail Al-Snafi
Department of Pharmacology,
College of Medicine,
University of Thi qar, Iraq
Cell: +9647801397994.
E mail: aboahmad61@yahoo.com

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INTRODUCTION:

Plants have been used as drugs by humans since thousands of years ago. As a result of accumulated experience from the past generations, today, all the world's cultures have an extensive knowledge of herbal medicine. . However, plants are still provide some of our most valuable medicines [1-32]. The phytochemical analysis of *Jasminum sambac* revealed the presence of carbohydrates, proteins, amino acids, coumarins, glycosides, tannins, phenolic compounds, flavonoids, phenolics, saponins, steroids, fats, essential oils, fixed oils, terpines, resin, and salicylic acid. The pharmacological studies revealed that the plant extracts possessed antimicrobial, insecticidal, analgesic, antipyretic, antiinflammatory, antioxidant, antidiabetic, dermatological, anticancer, CNS and peripheral NS, cardiovascular, lipid peroxidation inhibition and anti-obesity and gastroprotective effects. This review was designed to highlight the chemical constituents, pharmacological and therapeutic effects of *Jasminum sambac*.

Synonyms:

Jasminum bicorollatum Noronha, *Jasminum blancoi* Hassk., *Jasminum heyneanum* Wall. ex G.Don , *Jasminum odoratum* Noronha, *Jasminum quinqueflorum* B.Heyne ex G.Don, *Jasminum quinqueflorum* var. *pubescens* G.Don, *Jasminum sambac* var. *duplex* Voigt, *Jasminum sambac* var. *gimea* [Zuccagni] DC., *Jasminum sambac* var. *goaense* [Zuccagni] DC., *Jasminum sambac* var. *heyneanum* [Wall. ex G.Don] C.B.Clarke, *Jasminum sambac* var. *kerianum* Kuntze, *Jasminum sambac* var. *nemocalyx* Kuntze, *Jasminum sambac* var. *nemocalyx* Kuntze, *Jasminum sambac* var. *plenum* Stokes, *Jasminum sambac* var. *syringifolium* Wall. ex Kuntze, *Jasminum sambac* var. *trifoliatum* Vahl, *Jasminum sambac* var. *trifoliatum* [L.] Sims, *Jasminum sambac* var. *undulatum* [L.] Kuntze, *Jasminum sambac* var. *verum* DC., *Jasminum undulatum* [L.] Willd., *Mogorium gimea* Zuccagni, *Mogorium goaense* Zuccagni, *Mogorium sambac* [L.] Lam., *Mogorium undulatum* [L.] Lam., *Nyctanthes goa* Steud., *Nyctanthes sambac* L., *Nyctanthes undulata* L[33].

Taxonomic classification:

Kingdom: Plantae, Subkingdom: Viridiplantae, **Infrakingdom**: Streptophyta, **Superdivision**: Embryophyta, **Division**: Tracheophyta, **Subdivision**: Spermatophytina, **Class**: Magnoliopsida, **Superorder**: Asteranae, **Order**: Lamiales, **Family**: Oleaceae, **Genus**: Jasminum, **Species***: Jasminum sambac*[34] .

Common names:

Medieval Arabic [zanbaq] meant jasmine flower-oil from the flowers of any species of jasmine. This word entered late medieval Latin as [*sambacus*] and [*zambacca*] with the same meaning as the Arabic, and then in post-medieval Latin plant taxonomy the word was adopted as a label for the *J. sambac* species[35].

Arabic, Ful, Razki, Zunbiq, Yasamin Arabi; **Chinese**: mo li hua; **English**: Arabian jasmine, Sambac jasmine; **French**: jasmin d'Arabie; **German**: arabischer Jasmin; **Italian**: gesimino d'Arabia, mugherine; **Portuguese**: bogarim, jasmim; **Spanish**: jazmín de Arabia [36].

Distribution:

Jasminum sambac was distributed in Asia-tropical and Asia-temperate. It was one of the most cultivated species in many countries in Asia[36].

Description:

Scandent or suberect shrub; 1-3 m tall, branchlets pubescent. Leaves opposite or in whorls of three, entire, elliptic or broad elliptic to sub-orbicular, obtuse or acute, very variable in size, up to 9 cm long and 6 cm broad, glabrous, shining above; nerves prominent beneath; petiole short, pubescent. Flowers fragrant, in few-flowered terminal cymes, pedicels up to 6 mm; bracts linear, up to 6 mm long. Calyx teeth 5-9, c. 1 cm long, V-shaped, pubescent. Corolla white, simple or double, tube 1 cm long, lobes 5-9, oblong, acute or obtuse, or orbicular under cultivation, 1.5 cm long. Berry simple or didymous, globose, 6 mm in diameter, black when ripe, surrounded by the suberect subulate calyx teeth. Pubescent climbers with angular branchlets, simple elliptic to ovate leaves up to 10 cm long, acute or obtuse, base rounded or cuneate, nearly glabrous, with evident veins; petiole pubescent, short, arched; flowers fragrant; calyx-lobes linear, c. 6-7 mm long, ciliate or glabrous; corolla white, often doubled, the lobes oblong to nearly orbicular, obtuse, as long as the tube[37-38].

Traditional uses:

The flowers of *Jasminum sambac* were used in the preparation of an essential oil and for making jasmine tea. The flowers are bitter, pungent, cooling, braintonic, purgative, cure tridosha, biliousness, itching sensation, fever, stop vomiting, useful in the diseases of eye, ear, mouth, used in skin diseases, leprosy and ulcers. The flowers were also used for the treatment of diarrhea, abdominal pain, conjunctivitis, asthma, cancer, wound healing, toothache and dermatitis. The leaves were used to heal the wounds.

The flowers and leaf were also used in folk medicine to prevent and treat breast cancer. The flowers were used by the women when brewed as a tonic as it aids in preventing breast cancer and stopping uterine bleeding. The plant was included in herbal preparations for the treatment of insanity and epilepsy [39-48].

The whole plant is considered to be anthelmintic, diuretic and emmenagogue [49].

In Malaya, women used the soaked flowers to wash the face. The flowers were applied as a poultice to the breasts of women as a lactifuge [50].

The leaves and roots of the plant were used traditionally in the treatment of inflammation, fever and pain [51].

Jasmine oil has a wide range of medicinal applications and was used in perfumery, soaps, flavorings and the cosmetic industry. Medicinally, it was used for the treatment of dry, greasy, irritated and sensitive skin, irritating coughs, alleviating muscular pain and treating sprains, antidepressant, antiseptic, antispasmodic, sedative and uterine tonic[52-55].

Parts used:
Flowers, roots and leaves [40-48].

Physicochemical properties:
Physicochemical properties of essential oil of *Jasminum sambac* [closed buds open flowers]: color was clear yellow and off-whitish yellow, refractive index was 1.47 at 20°C and 1.49 at 20°C, congealing point was 17°C and 17.25°C, optical rotation was +3.30 at 20°C and +3.50 at 20°C, specific gravity was 0.956 at 20°C and 0.9850 at 20°C,acid number was 6.85 and 6.89 and ester number was 242.58 and 240.02 respectively[52].

The physiochemical parameters of leaves *Jasminum sambac* were: total ash 14%, water soluble ash 7%, acid insoluble ash 8.5%, alcohol soluble extractive 32%, water soluble extractive 12.8%, moisture content 6.11%, crude fiber content 15%, swelling index 1 and foaming index: less than 100[56].

Chemical constituents:
The preliminary phytochemical analysis of *Jasminum sambac* revealed the presence of carbohydrates, proteins, amino acids, coumarins, glycosides, tannins, phenolic compounds, flavonoids, phenolics, saponins, steroids, fats, essential oils, fixed oils, terpines, resin, and salicylic acid[48, 56-58].

Dotriacontanoic acid, dotriacontanol, oleanolic acid, daucosterol, hesperidin, [+]-jasminoids A, B, C, and D were isolated from the roots of Jasminum sambac [59-60].

Rutin, quercitrin, isoquercitrin, quercitrin-3-dirhamnoglycoside, kaempherol-3-rhamnoglycosides, α-amyrin, β-sitisterol were identified in the leaves3 [45]
The amounts of rutin and isoquercitrin in the dried leaf powder of *Jasminum sambac* Ait. were found to be 0.4959mg/g and 0.6481mg/g respectively, while, hesperidin in the ethanolic extract of the roots was found to be 4.25%w/w[42, 57].

Chlorocoumarin, coumarin derivative and kaempferol a flavanoidal derivative were identified in the leaves of *Jasminum sambac* [61].

Trimeric iridoidal glycoside, sambacoside A, molihuasides A-E were isolated from the flowers of *Jasminum sambac* [62].

A novel plant cysteine-rich peptides family, jasmintides were isolated from Jasminum sambac. Two 27-amino acid jasmintides [jS1 and jS2] were identified at the gene and protein levels[63] .

2, 3 -Dihydro- Benzofuran**,** 1-Nonadecene**,** 2, 6, 10-Trimethyl,14-Ethylene-14-Pentadecne**,**1-Nonadecene**,** 1-Heptacosanol, alpha.-Tocopherol-.beta.-D-mannoside **,** Nonacosane were isolated from the leaves, and 1-Nonadecene, Nonadecyl trifluoroacetate, 1-Heptacosanol**,** 1-Heptacosanol**,** 1-Heptacosanol, E-14-Hexadecenal were isolated from the stems of *Jasminum sambac*[64].

Benzyl 6-O-beta-D-xylopyranosyl-beta-D-gluco-pyranoside [beta-primeveroside], 2-phenylethyl beta-primeveroside, and 2-phenylethyl 6-O-alpha-L-rhamnopyranosyl-beta-D-glucopyranoside [beta-rutinoside] were isolated as aroma precursors of benzyl alcohol and 2-phenylethanol from flower buds of Jasminum sambac [65].

The compounds present in *Jasminum sambac* flower responsible for aroma were: Benzyl alcohol, Cycloheptasiloxane tetradecamethyl- Methyl benzoate, Linalool, Benzyl acetate, Indole, Cyclohexasiloxanedodecamethyl- Hexadeca methyl cyclooctasiloxane, [-]-[R]-Jasmine Lactone, [E,E] -Farnsene, [Z]-3-Hexenyl benzoate, N-Acetyl Methyl anthranilate, Cyclohexasiloxane, [E]-Methyl jasmonete Benzyl benzoate and Isophytol[66-67].

Ethanol extract of the leaves of *Jasminum sambac*, contained Bicyclo[2.2.1]heptane-2,5-diol,1,7,7-trimethyl-,[2-endo,5-ex; Phenol,3,5-bis[1,1-dimethylethyl]-; 1-Octadecyne; 1-Octadecyne; Hexadecanoic acid; 2[4H]-Benzofuranone,5,6,7,7A-Tetrahydro-6-Hy; R-Limonene; 1-Octadecyne; Eicosanoic acid,methyl ester; 9- Octadecenoic acid [Z]-; n-Hexadecenoic acid, Hexadecenoic acid; Ethyl ester; Octadecenoic acid; 9- Octadecenoic acid, Methyl ester,[E]-; Phytol; Tetradecenal,[Z]-; 9-Octadecenoic acid [Z]-; Di-n-octyl phthalate; Squalene and 2,5,7,8-Tetramethyl-2-[4,8,12=Trimethylridecy[40].

The essential oil of *Jasminum sambac* from Pakistan, obtained at two stages of growth [closed bud stage and at the open flower stage] was determinedusing gas chromatography. The major identified compounds were citronellol, phenyl ethyl alcohol, geranial, eugenol, farnesol, geranyl acetate, citrinyl acetate, 2-phenyl ethyl acetate, citral [mixture of cis and trans], and benzyldehyde. However, the relative percentages of the main identified constituents in the essential oil of *Jasminum sambac* flowers [closed bud stage and at the open flower stage] respectively were: Benzyl alcohol 4.51 and 5.26, Benzyldehyde 1.34 and 3.29, Citral [mixture of cis and trans] 0.58 and 0.73, Linalool 1.45 and 2.31, 2-Phenyl ethyl acetate 2.73 and 3.01, Geraniol 3.89 and 6.26, Eugenol 5.98 and 9.8, Farnesol 8.91 and 8.31, Citrinyl acetate 3.56 and 3.57, Nerol - and 0.39, Geranyl acetate 2.79 and 4.98, Nerayl acetate - and 1.00, Phenyl ethyl alcohol 12.98and 14.11 and Citronellol 17.98 and 19.37[52].

The composition of the volatile fraction of Egyptian *Jasminum sambac* flowers was studied using GC/MS. The main volatile constituents of the concrete headspace and the absolute, respectively, were: benzyl acetate [23.7 and 14.2%], indole [13.1 and 13.4%], E-E-α-farnesene [15.9 and 13.1%], Z-3-hexenyl benzoate [4.9 and 9.4%], benzyl alcohol [7.7 and 8.4%], linalool [10.6 and 6.3%], and methyl anthranilate [5.0 and 4.7%][68].

Pharmacological effects:

Antimicrobial effects:

Antimicrobial efficiency of petroleum ether, chloroform, ethyl acetate and ethanol *Jasminum sambac* leaf extracts were examined against *Bacillus subtilis*, *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* as well as against *Aspergillus niger*, *Aspergillus flavus*, *Candida albicans* using agar disc diffusion method. The mean zone of inhibition produced by the extracts in disc diffusion assays were ranged from 5 mm to 27 mm. The ethanol extracts of *Jasminum sambac* showed highest antimicrobial activity, while, the ethyl acetate, petroleum ether and chloroform showed moderate antimicrobial activity against the tested microbial strains [69-70].

The antimicrobial activity of butanol extract of *Jasminum sambac* flowers was evaluated against human pathogenic bacteria, *Salmonella*, *Staphylococcus*, *Pseudomonas*, *Vibrio cholera*, *Streptococcus*, *Corynebacterium*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Proteus vulgaris* and *Escherichia coli*. It showed antibacterial activity against *Salmonella* [14mm], *Vibrio cholera* [15mm], *Streptococcus* [14mm], *Corynebacterium* [12mm], *Proteus vulgaris* [14mm] and *coli*. [13mm][71].

The antimicrobial efficacy of *Jasminum sambac* leaf extracts was evaluated against six bacteria [*Staphylococcus aureus*, *Streptococcus mutans*, *S. pyogenes*, *S. sobrinus*, *S. sanguinis* and *Lactobacillus acidophilus*] and one fungi [*Candida albicans*] causing dental infections. The methanol extract was more efficient in comparison to other extracts. The zone of inhibition ranged between 12.3±0.57-17.3±0.57 mm at 200 mg/ml, respectively. Minimum inhibitory concentration for methanol extract was 3.12-25 mg/ ml[72].

The antibacterial potentials of the methanolic extracts of leaves of *Jasminum sambac* [25, 50, 100,250,500µg/ml] was evaluated against four Gram-positive bacteria [*Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Sarcina luteae*] and four Gram-negative bacteria [*Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Shigella dysenteriae*]. Significant antibacterial activity was recorded at a concentration of 500µg/ml of methanolic extract. It possessed zone of inhibition of 17 mm, 14 mm, 15 mm and 13 mm against *Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Sarcina luteae* respectively and 14 mm, 15 mm, 15 mm and 16mm zone of inhibition against *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Shigella dysenteriae* respectively [73].

The ethanolic callus extracts of J. *sambac* were screened for antimicrobial activity against *Staphylococcus albus*, *Proteus mirabilis* and *Salmonella typhii* at concentrations of 500 and 250mg/ml. The results revealed that the extracts possessed antibacterial activity with zone of inhibition of 10, 11.5, 14.5mm respectively [58].

The antibacterial potential of the hexane, chloroform, ethanol and distilled water extracts of *Jasminum sambac* leaf was studied against Gram positive bacteria [*Staphylococus aureus* and *Bacillus subtilis*] and Gram negative bacteria [*Escherichia coli* and *Pseudomonas aeruginosa*] by agar well diffusion method. The n-hexane extracts of *Jasminum sambac* showed the highest activity against *E. coli*. Aqueous and ethanol extracts exhibited comparatively higher antibacterial potential against Gram negative bacteria than the Gram positive bacteria [74].

Ethyl acetate extracts of *Jasminum sambac* [Leaf and stem] showed antibacterial activity against eight bacterial isolates. The zone of growth inhibition was: *Staphylococcus aureus* ATCC12-13mm and 9-10mm, *Escherichia coli* ATCC 13-14mm and 14-15mm, *Pseudomonas aeruginosa* ATCC 16-17mm and 13-14mm, *Acinetobacter* 11mm and 10-11mm, *Klebsiella* 8-10mm and 8-18mm, *Citrobacter* 9-10mm and 10mm, *Enterobacter* 10-11mm and 9-10mm, *Proteus* 10-11mm and 9-10mm respectively[64].

The essential oil and methanol extract were evaluated for its antimicrobial activity against *Bacillus cereus* LMG 13569, *Enterococcus faecalis* CIP 103907, *Escherichia coli* CIP 11609, *Listeria innocua* LMG 1135668, *Salmonella enterica* CIP 105150, *Shigella dysenteria* CIP 5451, *Staphylococcus aureus* ATCC 9244, *Staphylococcus camorum* LMG 13567 BHI and *Candida albicans* ATCC 10231. The methanol extracts and essential oils were active against gram +ve and -ve bacteria. The antimicrobial activity of essential oil was stronger than that of the methanol extracts. The bacteria most sensitive to the essential oil of *J. sambac* were *S. pyogenes* [41 mm], *S. enterica* CIP 105150, *E. coli* CIP 105182 [31 mm], *S. dysenteria* CIP 5451 [29 mm], *L. innocua* LMG 1135668 [28 mm]. The other bacterial strains were sensitive with diameters of inhibition of 17-25 mm. The bacterial strain *S. camorum* LMG 13567 was resistant to the essential oil of *J. sambac*. The methanol extract of *J. sambac* was more active on *E. faecalis* CIP 103907 [17 mm], *Salmonella enterica* CIP 105150, *S. pyogenes* [16 mm]. The other bacterial strains were sensitive with diameters of inhibittion of 11- 15 mm. *S. camorum* LMG 13567, *E. faecalis*, *P. aeruginosa*, *S. aureus* were resistant to the methanol extract of *J. sambac*[75].

The antibacterial activity of Jasminum sambac flower hydro steam distilled essential oil, and six major individual components was assessed against Escherichia coli [MTCC-443] strain. The activity was bactericidal, and the Minimum inhibitory concentration ranged between 1.9-31.25 mul/ml[76].

The methanol extract and essential oil from the flowers and leaves of J. sambac were evaluated for antifungal activity against *Malassezia* sp. and non-*Malassezia* sp. isolated from human skin samples. The methanol extract of flowers and leaves of J. sambac and essential oil of flowers showed potential antifungal activity with inhibition zones of 11.10 ± 1.92, 12.90 ± 1.68, and 13.06 ± 0.26 mm, respectively, and minimum inhibitory concentration [MIC] values of 80mg/ml to 160mg/ml and 50%, respectively [77].

The methanolic leaves extract of Jasminum sambac showed antifungal activity against Alternaria sp isolated from foot infections in cancer patients, with a zone of inhibition of 40mm[78].
Anti-herpes simplex viruses [HSV-1 and HSV-2] and antiadenoviruses [ADV-3, ADV-8 and ADV-11] activities of hot water extract of *Jasminum sambac* flowers was evaluated using XTT-based colorimetric assay. The results revealed that hot water extracts exhibited anti-HSV and anti-ADV activities [79].

Insecticidal effect:
The larvicidal activities of ethanolic extracts [100, 200, 500ppm] of four Philippine plant species [*Citrus microcarpa*, *Chromolaena odorata*, *Nephelium lappaceum*, and *Jasminum sambac*] were evaluated against third instar larvae of dengue mosquito, *Aedes aegypti*. The ethanolic extract of *Jasminum sambac* induced 11.3, 13.3 and 26.7 % mortality at the concentration of 100, 200, 500ppm after 72 hours respectively [80].

Analgesic, antipyretic and antiinflammatory effects:
The anti-inflammatory, analgesic and anti-pyretic activities of the ethanolic extract of the roots from Jasminum sambac [EJS] were investigated experimentally. Analgesic activity of EJS at 100, 200 and 400mg/kg orally was evaluated using writhing test on Swiss albino mice and tail-flick test on Charles Foster albino rats. Anti-inflammatory activity of EJS was assessed by carrageenan-induced rat paw edema, cotton pellet-induced granuloma and Freund′s adjuvant-induced arthritis models, while antipyretic activity was evaluated using Brewer′s yeast induced pyrexia. EJS at 400mg/kg orally, reduced writhing count up to 49.21%, whereas in tail-flick test, EJS in a dose dependent manner increased latency in flicking tail. EJS at 400mg/kg orally, showed significant anti-inflammatory activity after 2nd, 3rd, 4th and 6th h of treatment in carrageenan-induced

edema, while a 33.58% inhibition in cotton pellet induced granuloma formation was observed at same dose level. EJS significantly [p<0.001] inhibited adjuvant-induced arthritis and also showed significant antipyretic activity [57].

The methanol extract [400 mg/kg bw] of *Jasminum sambac* flowers was investigated for anti-inflammatory and analgesic activities using hot plate method, acetic acid induced writhing and carragenan induced paw odema in animal models. In the acetic acid-induced writhing model, the extract possessed significant analgesic and antiinflammatory effects compared to the control, these effects were comparable to that induced by Diclofenac sodium [81].

The analgesic activity of methanolic extract of root of Jasminum sambac [200 and 400 mg/kg] was evaluated in Wister albino rats and mice of using tail flick and acetic acid induced writhing method respectively. The results showed that the methanolic extract of Jasmine root possessed significant analgesic activity by both models, with a maximum effect for 400 mg/kg bw. The authors suggested central as well as peripheral mechanism of analgesic action [82].

The ethanol extract of the dried leaves of *Jasminum sambac* produced significant [*P*<0.001] writhing inhibition in acetic acid-induced writhing in mice at an oral dose of 250 and 500 mg/kg of body weight comparable to the standard drug diclofenac sodium at the dose of 25 mg/kg of body weight[47].

The ethanol [50%] extract of the leaves of *Jasminum sambac* was investigated for anti-inflammatory activity using carrageenan induced hind paw oedema and cotton pellet induced granuloma models in rats. The extract [100, 200 and 400mg/kg bw] caused dose dependent significant decrease in paw oedema and weight of granuloma. The extract at 400mg/kg bw, exhibited potential anti-inflammatory activity, comparable to dichlofenac [83].

The antiinflammatory property of the formulated topical gel from the extract of *Jasminum sambac* was evaluated against 1% diclofenac emugel as positive control in rats. The leaves of *Jasminum sambac* was extracted with 80% methanol. The extract was used for the formulation of the different concentration of topical gel. The extract possessed significant antiinflammatory activity [84].

Antioxidant effect:

The antioxidant status of Jasminum sambac was evaluated using mammalian liver slice technique in in vivo simulated in vitro model. Antioxidant activity was studied against H2O2 induced free radicals in goat liver. The results showed that, the levels of enzymic and non enzymic antioxidants were significantly decreased in H2O2 induced group. Treatment with J. sambac at 20 mg/ml of HBSS caused significant increase in those values when compared with toxic group. H2O2 intoxicated group showed significant elevation in the level of LPO. Effect of J sambac showed very potent lipid peroxidation inhibition [85].

The antioxidant property of methanol and ethanol extracts of *Jasminum grandiflorum*, *Jasminum sambac* cultivar variety, *Jasminum aungustifolium*, *Jasminum sambac* wild variety was determined by hydrogen peroxide method. All methanol and ethanol extractsof the eight samples had antioxidant capacity and *Jasminum sambac* cultivar variety showed the maximum antioxidant property [86]

The antioxidant activity of the essential oil and methanol extract were tested using DPPH free radical scavenging and β-carotene-linoleic acid assays. In the DPPH test, the IC50 value of essential oil and methanol extract were 7.43 and 2.30 µg/ml respectively. In the β-carotene-linoleic acid system, oxidation was effectively inhibited by *Jasminum sambac*, the RAA value of essential oil and methanol extract were 96.6 and 93.9% respectively [75].

The antioxidant potential of hydroalcoholic extract of leaves of *Jasminum sambac* was tested using DPPH assay, scavenging of nitric oxide and hydrogen peroxide were determined. Total reducing power and antioxidant capacity of the hydroalcoholic extract were also evaluated. *Jasminum sambac* showed moderate scavenging effect, DPPH radicals [122 µg/ml], nitric oxide [173.94 µg/ml] and hydrogen peroxide [125µg/ml] when compared to ascorbic acid. The results indicate that the total antioxidant capacity was 155.40 µg/ml and reducing power was 44.28 µg/ml[87].

Dermatological effects:

The ethanol stems extract of Jasminum sambac was evaluated for wound healing activity in the ointment dosage form in excision wound model in mice. The extract was tested for wound healing activity at two dose level [200 and 400 mg/kg bw] using dermal route. Total ethanol extract at dose level of 400mg/kg body weight had shown significant increase in wound contraction, hydroxyproline content and decreased

epithelization period in excision wound model as compared to control group[88].

The aqueous and ethanol extracts of *Jasminum sambac* leaves were evaluated for its wound healing [200 and 400mg/kg bw, by dermal route], in excision wound model using albino mice. Aqueous extract had shown significant increase in wound contraction, hydroxyproline content and decreased epithelization period in excision wound model as compared to ethanol extract. The authors postulated that the enhanced wound healing activity of aqueous extract may be due to free radical scavenging action and antibacterial property of the phytoconstituents [tannins and flavonoids] identified in the extract[89].The aqueous and ethanolic extracts of the leaves of *of Jasminum sambac*were incorporated in simple ointment base and screened for wound healing activity using [excision, incision and dead space wound models] in rats . The extracts possessed significant wound healing in all models [90]

Anticancer activity:

The anticancer activity of the ethanolic extract of Jasminum sambac [100 mg/kg bw] was investigated against Dalton's lymphoma ascites-induced lymphatic cancer in Swiss albino mice. The anticancer activity of J. sambac was studied against lymphoma using lipid profiles, biochemical parameters, and membrane-bound marker enzymes. The levels of cholesterol, triglyceride, VLDL cholesterol, and LDL cholesterol were significantly decreased in tumor-induced mice, while HDL cholesterol was increased. On treatment with J. sambac, the levels were brought back to near normal. The albumin, creatinine, total protein, urea, and uric acid contents were also approaching normal values. There was a significant increase in the levels of ATPase in Dalton's lymphoma ascites-induced mice. These levels were brought back to normal upon plant extract treatment of mice. DNA fragmentation occurred in the tumor-induced group of tissue, and treatment with ethanolic extract reduced the DNA damage caused by lymphoma. Expression of lactate dehydrogenase [LDH] isoenzymes showed an increase in the levels of LDH-4 and LDH-5 in cancer-bearing animals which is brought back to near normal with the plant extract treatment [91].

The methanol extracts of 56 plant parts from 47 medical and edible plants cultivated in Okinawa were tested for their proliferative effects on NB1RGB skin fibroblast cells. Methanol extracts of Jasminum sambac showed higher NB1RGB cell proliferation activity [>10%] than the control [92].

The anticancer effect of Jasminum sambac was evaluated against Daltons ascites lymphoma induced Swiss albino mice in in vitro and in vivo model. The tumor cell proliferation inhibitory activity of methanolic extract showed dose dependent in both HeLa and mouse fibroblast cells. At concentrations 25-400µg/ml, the percentage of cell inhibition concentration of normal and cancer cells was 123.3 and 93.8 µg/ml respectively. The methanolic extract at oral dose of 100mg/kg body weight exhibited a significant [$p< 0.05$] changes in the levels of hematological profiles, AST, ALT, ACP, ALT and LDH and cancer marker enzymes such as 5-Nucleotidase, β-D- Glucuronidase, γ-Glutamyl transferase as compared to DLA induced group[46].

The ethanol extract of *Jasminum sambac* was evaluated *in vitro* for antiproliferative activity against Hep-2, MCF-7, and Vero cell lines. The extract showed significant antiproliferative activity against one or more of the cell lines[93].

The crude ethanolic extract produced the most prominent cytotoxic activity against brine shrimp *Artemia salina* [LC50 = 50 µg/ml and LC90 = 100 µg/ml][47].

CNS and Peripheral NS effects:

The anxiolytic and antidepressant activities of ethanolic extract of *Jasminum sambac* flowers were evaluated using elevated plus maze, actophotometer, froced swim test and tail suspension test in mice. The ethanolic extracts of flowers of *J.Sambac* at a dose of 200 and 400mg/kg ip, significantly possessed antidepressant and anxiolytic activity [94].

The effect of the odor of jasmine tea on autonomic nerve activity and mood states was investigated in a total of 24 healthy volunteers. The odor of jasmine tea was used at the lowest concentration that could be detected by each subject but that did not elicit any psychological effects. R-R intervals and the POMS test were measured before and after inhalation of the odors for 5 min. Jasmine tea odor caused significant decreases in heart rate and significant increases in spectral integrated values at high-frequency component in comparison with the control [$P < 0.05$]. In the POMS tests, odor produced calm and vigorous mood states [95].

The antistress activity of the methanolic extract of Jasminum sambac [MEJS] leaves was studied against swimming stress induced gastric ulceration in rats and swimming endurance test in mice. Swimming stress induced changes in Ulcer index and histopathology in rats were compared with the

standard. The biochemical parameters such as Urea, Triglycerides, Cholesterol, Alkaline phosphatase, SGPT, SGOT etc were examined in stressed and treated groups of rats. MEJS at a dose of 100 mg/kg and 200 mg/kg po, exhibited good antistress effect in both tested models. MEJS reduced the incidence of gastric ulceration in stressed rats. It also prevented the biochemical changes induced by forced swimming stress such as increase in plasma alkaline phosphatase, SGPT,SGOT, Urea, Triglycerides and Cholesterol. The stress induced rise in cholesterol and urea levels were significantly lowered by the extract. Also, the stress induced rise in plasma enzyme levels of SGPT and SGOT were significantly reduced when treated with the methanolic extract of Jasminum sambac at 100mg/kg and 200mg/kg bw and was comparable with the standard drug Geriforte at 43mg/kg bw. The MEJS treated animals also showed an increase in swimming endurance time, which was almost comparable with that of standard drug[96].
Jasmine showed spasmolytic activity in guinea-pig ileum and rat uterus in vitro. The mechanism of action of the spasmolytic activity, was studied in vitro using a guinea-pig ileum smooth muscle preparation, it appeared that it was postsynaptic and not atropine-like. It was most likely mediated through cAMP, and not through cGMP. The mode of action in vitro resembled that of geranium, lavender and peppermint oils [97].

The effect of aromatherapy massage with jasmine oil [Jasminum sambac] was investigated on human. Healthy volunteer's autonomic parameters, [blood pressure, pulse rate, blood oxygen saturation, breathing rate, and skin temperature] were recorded as indicators of the arousal level of the autonomic nervous system. Furthermore, participants mentioned their emotional condition in terms of relaxation, vigor, calmness, attentiveness, mood, and alertness in order to assess subjective behavioral arousal. Jasmine oil caused significant increases of breathing rate, blood oxygen saturation, and systolic and diastolic blood pressure, which indicated an increase of autonomic arousal. At the emotional level, subjects in the jasmine oil group rated themselves as more alert, more vigorous and less relaxed than subjects in the control group[98].

Antidiabetic effect:
The antidiabetic potential of flower extract of *J. sambac* was evaluated using oral glucose tolerance test, alloxan induced diabetes and streptozotocin induced diabetes models inrats. The blood glucose levels of test extract treated animals were found to be significantly less in all the models compared to diabetic control [99].

The antidiabetic effects of ethyl acetate and water extracts of leaves of *Jasminum sambac* at a dose of 300mg/kg, orally, for 21 days were evaluated in alloxan induced diabetic rats. Aqueous extract showed significant [$p<0.01$] reduction of elevated blood glucose level, while, ethyl acetate extract was less active compared to aqueous extract[100].

Cardiovascular effects:
The vasodilatation effect of the 95% ethanolic extract of of *Jasminum sambac* flowers on isolated aortic rats was investigated. Compared with the control group, the Jasmine flowers extract in 0.05% DMSO reduced the tonus of isolated endothelium thoracic aortic rings preconstricted with phenylephrine [10^{-6} M], dose-dependently. However, this effect was disappeared after the preincubation of the rings with atropine [10^{-6} M] or with Nω-nitro-L-arginine [10^{-4} M][48].

Effect on puerperal lactation:
The efficacy of *Jasminum sambac* flowers applied to the breasts to suppress puerperal lactation was compared to Bromocriptine. Effectiveness of both regimens was monitored by serum prolactin levels, clinical evaluation of the degree of breast engorgement and milk production and the analgesic intake. While both bromocriptine and Jasmine flowers brought about a significant reduction in serum prolactin, the decrease was significantly greater with bromocriptine. However, clinical parameters such as breast engorgement, milk production and analgesic intake showed that both treatments were equally effective. The failure rates of the two treatments to suppress lactation were similar, rebound lactation occurred in a small proportion of women treated with bromocriptine [51].

Gastroprotective effect:
The gastroprotective effects of ethanolic extracts of *J. sambac* leaves [62.5, 125, 250, and 500 mg/kg] was studied against acidified ethanol-induced gastric ulcers in rats. Ulcer group exhibited significantly severe mucosal injury as compared with omeprazole or extract which shows significant protection towards gastric mucosal injury, the plant promoted ulcer protection as it showed significant reduction of ulcer area [grossly], marked reduction of edema and leucocytes infiltration of submucosal layer [histologically] compared with ulcer group. Immunohistochemistry showed overexpression of Hsp70 protein and downexpression of Bax protein in rats pretreated with extract [101].

The antiulcer activity of flower extract of *J. sambac* was studied in gastric ulcers induced by oral

administration of ethanol or by pyloric ligation in rat. The ulcer index in the test extract treated animals was found to be significantly less in all the models compared to vehicle control animals [99].

The methanolic extract of Jasminum sambac [MEJS] leaves was studied against swimming stress induced gastric ulceration in rats. The extract reduced the incidence of gastric ulceration in stressed rats at dose of 100 mg/kg and 200 mg/kg po [96].

Lipid peroxidation inhibition and anti-obesity effects:

The anti-lipid peroxidation effect of *J sambac* was evaluated using the standard antioxidants BHT, Vitamin C, Vitamin E and Rutin. The methanolic extract of the *J sambac* flowers shows anti-lipid peroxidative effect which was similar to that of all standards [102].

The ethanolic extract of *Jasminum sambac* flowers was evaluated as the anti-obesity in an *in vitro* assay using pancreatic lipase enzyme and *in vivo* on high-fat diet-induced mice. The ethanolic extract of *Jasminum sambac* flowers at a dose 100 mg/kg and 300 mg/kg bw caused significant decrease of mice body weight, fat index, and food intake. In *in vitro* assay, the ethanolic extract of *Jasminum sambac* flowers inhibited pancreatic lipase enzyme activity[103].

Side effects and toxicity:

Intravenous injection at a single dose of 0.5 ml/mouse [15 mg] of the flower extract produced no systemic biological toxicity in ICR mice. The LD50 of the extract was higher than 5.000 mg/kg bw in rats by oral administration [48].

The acute and subchronic toxicity of the methanolic extract of *J. sambac* [MEJS] were studied in mice. For acute toxicity study 500-2000 mg/kg MEJS were administered orally and obvious toxic symptoms and mortality was studied upto 14days. In subchronic study, effect of multiple weekly dosing of 400 mg/kg [one-fifth of the maximum tolerated dose] of MEJS was investigated in mice for six weeks using hematological parameters, biochemical estimations of hepatorenal parameters, antioxidant status, and histological observations of the tissue. The extract was found to be well tolerated upto 2g/kg in acute toxicity study. In subchronic toxicity study it showed no significant alteration on any of the parameters, which was confirmed by the histological studies. Accordingly, the methanol extract of J. sambac flower was quite safe [104].

CONCLUSION:

The review highlighted the chemical constituent, pharmacological and therapeutic effects of *Jasminum sambac* as promising source of drugs because of its safety and effectiveness.

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