International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Panoramic Review of Traditional Use, Phytochemical Composition and Pharmacology of *Justicia Gendarussa* Burm f

Pallavi Dnyaneshwar Bhagwat[1], Pratiksha Ramesh Pawar[2]

[1]Student, S.M.B.T College of Pharmacy
[2]Assistant Professor, S.M.B.T College of Pharmacy

Abstract

Justicia gendarussa Burm f. also known as Willow-leaved justicia (family Acanthaceae) is a plant species native to china. This shrub has been used in Indian and Chinese traditional medicine. This plant can be located in different Asian countries. Various phytoconstituents are identified from this plant like Flavonoids, alkaloids, steroids, triterpenoids, phenolic compounds, saponin and glycosides. The main biologically active constituents found are Lupeol, stigmasterol, Aromadendrin, naringenin, Vitexin, apigenin, Justiprocumin A and B, Patentiflorin A and Justidrusamide A-D. These constituents help to contributes various pharmacological activities like anti-inflammatory, anti-oxidant, anti-viral, anti-helmintic, anti-bacterial, anti-fungal, anti-angiogenic, hepatoprotective action and antifertility activity.

The current review focus on the botanical description, traditional uses, phytochemical constituents and pharmacological activities of the plant *Justicia gendarussa*Burm f.

Keywords: *Justicia gendarussa*Burm f., Acanthaceae, Traditional uses, Anti-inflammatory activity, Patentiflorin A.

1 Introduction

*Justicia gendarussa*Burm. f is herb or shrubs in family Acanthaceae, which are spread in Asian countries such as, India, China, Philippines,Indonesia, Malaysia, Sri Lanka, Pakistan, Thailand and the Andaman Islands. The genus Justicia is distributed in tropical regions of the world. A species native to China. There are around 300 species all over the world among which about 50 are reported in India (1).Some of the species which belongs to genus Justicia are *Justicia bentonia* L, *Justicia glabra* J. Koenig ex Roxb, *Justicia diffusa*Willd, *Justicia glauca*Rottler, *Justicia prostrate* (C.B. Clarke) Gamble, *Justicia procumbens* L, *Justicia simplex* D. Don, *Justicia bentonica*, *Justicia traquebariensis*L.f, *Justicia spicigera*, *Justicia beddomei* (Clarke) Bennett(2).This plant is generally use for treatment of rheumatism, fever, headache, hemiplegia, ear discomfort, muscle pain, gastrointestinal problems, eczema, bronchitis, dyspepsia, symptoms of vaginal discharges and eye diseases in Indian and Chinese traditional medicine(3). This plant shows various bioactivities including anti-inflammatory, antimicrobial (antifungal, antiviral, antibacterial),antitumor, anti-sickling, anthelmintic, andanalgesic property.A wide variety of biologically active bioactive compounds have been found such as alkaloids,

flavonoids, steroids, saponins, phenolic compounds, terpenoids and carbohydrates are found in this plant(4).

2 Data collection

The data presented in review concerning about Botanical description, taxonomy, geographical distribution, traditional uses, phytochemical composition and pharmacological activities of Justicia gendarussa Burm.f was obtained using diferent scientific search engines such as Pubmed, Science direct, Goggle scholar, Scihub, Springer link and Scifinder. The data was also collected from various books (The wealth of India, Indian Medicinal Plants with illustrations). Different review and research papers related to justicia gendarussa were collected, organized, classified, analysed and summarised in this review accoding to each field. For this survey various keywords realated to justicia gendarussa Burm.f were used including chemical constituents of justicia gendarussa, biological effects of justicia gendarussa, traditional uses of justicia gendarussa. The related phytochemistry data, the IUPAC names of the recognized chemical compounds were checked using Pubchem database. The chemical structure of Phytoconstituents were drawn using Chem Draw 7.0 software.

3 Botanical description

3.1.1 Morphology

It is an evergreen perfumed shrub (0.6 – 1.2m) high,branches are subterete with raised lines or a line of pubescence, obtainall over the greater part of Andaman Islands and India(1). Stem is erect, woody at base, herbaceous, highly branched and violet-brown in colour.Leaves (7.5 – 12.5 cm) long, 1.5-3.5cm width, are lanceolate, linear-lanceolate or glabrate except when young with dark green colour along with dark violet nerves, margins are irregularly toothed. Small white flowers (1.6- 2cm)long, with pink or purple spots within, from the uppermost leaf- axils in interrupted spikes (5-12.5cm) long and forms a terminale panicle(5). The flowers of this plant are bisexual, hypogynous and zygomorphic. Bracts are linear and small about 3mm only. Calyx with 5 sepals, (3.8 – 5mm) with nearly blad straight segment; lobes lanceolate. Corolla (5 petals), 1.3 cm it is gamopetalous,white with purple blotch and veins. Capsule 1.3cm clavate, glabrous and ellipsoid which contains 4 seeds, suborbicular. The flowering period for this plant is from November-April(6).

3.1.2 Taxonomy andGeographicaldistribution

*Justiciagendarussa*Burm. f (synonym: *Gendarussa vulgaris*Nees, *Adhotodasubserrata*) is a member of family Acanthaceae and is commonly called as willow-leaved justicia, Nilinurgundi, Warer willow orDaunRusa.

Scientific classification:

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Scrophulariales

Family: Acanthaceae

Genus: *Justicia*

Species*: gendarussa*

The plant is known by various regional names like Arabic: Aslakavad; Assam: Bishalya-karani, Tita-bahak; Bengal: Jagatmadan, Jogmodan; Bombay: Tao, Kalaadulsa;Burma:Bawanet, Bavanet; Canarese: Karalakkigidde, karinekki, Aduthodagidda, Nachukaddi; Chinese: Ch'in Ch'iu; Deccan: Kalishanbali; Hindi: Nilinurgundi, Udisanbhalu; Java: Gandaroesa; La Reunion: Guerit petite colique, Nitchouli, Natchouli; Madagascar: Dingadingambazaha; Malayalam: Vatankolli, Karinochil, Vatankutti, Vatankurunnu; Marathi: Tao, Bakas, Kalaadulsa; Mauritius: Nitechouli, Natchouli; Mizir: Titiria-sosoarong; Persian: Banjangashtesiyah; Sanskrit: Bhutakeshi,Gandharasa,Indrani,Kapika, Krishnasurasu, Krishnanirgundi,Marupatn, Nilanirgundi, Nilamanjari, Nilasinduvar, Nilasinduka,Nilika, Nirgundi, Pitasaha, Sinduka, Shophalika, Shitabhiru, Vanendrani, Vanaja; Sinhalese: Kaluvarania,Tagalog: Capanitulot, Paritulot; Tamil: Vadaikkutti, Karunochi;Telgu: Gandharasamu, Addasaramu, Nallanochili, Nallavavili, Nelavavili; Oriya: Kukurodonti; Visayan: Bunlao(7).

Justicia gendarussa is native to china and is scattered around many Asian countries like India, Malaysia, Thailand, Indonesia, Philippines, Sri Lanka and Pakistan. The plant is found in tropical and subtropical regions of Asia and in India it is located at seashore area like Surat, Valsad and hills like Khasi hills, Pavagarh. In India gardens it is frequently grown as a border plant or fence. Very often it is known as an escape. It grows very fast and is propagated by cutting. This plant can survive in adverse conditions and can resist heavy rainfall and thrives in shade(8).

Figure 1: whole plant of *justicia gendarussa*

4 Traditional uses

In traditional medicinal system, various parts of plant are used for treatment of different diseases.The plant has been used by the native medical practitioners and tribes to treat different ailments including inflammation, liver disorders, tumours and skin diseases.In Ayurveda, the plant is beneficial for the treatment of inflammation,myringitis, bronchitis, vaginal discharges, eye diseases, dyspepsia and fever(9). The plant has strong pungent odour, bitter, hot and dry; is considered as emetic, febrifuge, emmengogue and diaphoretic. Theleaves and tender shoots are assumed to be diaphoretic and they are given in the treatment of chronic rheumatism. The leaves are utilized as antiperiodic, insecticidal and

alterative(10). The fresh leaves are applied topically in rheumatism and oedema of beriberi.An infusion of the leaves is given internally for hemiplegia, cephalalgia and facial paralysis(7). The juice prepared from the fresh leaves is identified to possess the property of stopping internal bleeding; it is dropped into the ear for earache and into the corresponding nostril on the side of the head affected with hemicrania; it is also used for colic problems in children.Oil prepared from the leaves of *Justicia gendarussa* is useful in dermatitis(11).The Malays employ the plant as an antipyretic; use in the treatment of lunacy, frailty, and snake bite; it is also given for stomach troubles and amenorrhoea. In La Reunion the decoction of leaves is use as an stimulant and emetic. The roots alsoposses many medicinal properties(12). The extract obtain from the roots of willow leaved Justicia is prescribed for constipation, laxative action helps in easy bowel movement. In Madagascar, the plant is mainly use for arthritis, the decoction of the root boiled with milk is used in dysentery, rheumatism and jaundice(13). The decoction of the flower tops is generally used for the purpose of fumigation or as a drink. The bark is also use as emetic.Leaves are utilized as contraceptive agents in both male and female. Chewing of leaves in male cause decrease in sperm count and in female it helps to postpone pregnancy.

Table 1: Traditional uses of plant parts

Sr no	Parts	Traditional use
1.	Leaf, stem	Bronchitis, vaginal discharges, dyspepsia, eye diseases, inflammation, fever and tympanitis
2.	Leaf infusion	Hemiplegia, facial paralysis and cephalagia
3.	Leaf decoction	Emetic and stimulant
4.	Fresh leaf juice	Earache and hemicrania
5.	Oil (leaves)	Dermatitis
6.	Leaf and flower top decoction	Drink or as fumigation
7.	Leaf juice	Chest cold and Colic in children
8.	Leaf mixed with oil	Cures glandular swelling of the throat and neck
.	Leaves and tender stalks	Chronic rheumatism and joint pain
10.	Bark	Emetic
11.	Flowers	Eye diseases
12.	Roots	Antiseptic, antipyretic, ulcerosis, leucorrhoea
13.	Roots decoction boiled in milk	Stomach troubles, jaundice, fever, dysentery and rheumatism
14.	Whole plant	Emetic, diaphoretic and

		emmenagogue

5 Phytochemical constituents

The phytoconstituents present in gendarussa vulgaris Nees were identified by performing preliminary phytochemical tests on the extractobtain by the leaves of plant, which showed the presence of saponin, tannin, flavonoids, terpenoids, steroids, triterpenoid, polyphenol, carbohydrate, anthroquinone, glycoside(14). Bioactive compounds are islotated using column chromatography. The compounds are shown. The quantitative evaluation of phytochemical constituents of leaves of willow leaved *Justicia* shows the presence of alkaloids (1.62 ±0.08%w/w), triterpenoids (0.199±0.009%w/w), flavonoids {2.03±0.105%w/w), phenolic compounds (2.21±0.11%w/w),carotenoids (7.88±0.394%w/w), starch (5.85±0.292%w/w) and sugar (8.74±0.43%w/w)(15).

Table 2:Phytochemicals identified in plants

Sr no	Phytochemicals	Aqueous extract	Methanol extract
1	Saponin	+	+
2	Flavonoids	+	+
3	Tannin	-	+
4	Steroids	+	+
5	Protein	-	-
6	Alkaloids	+	+
7	Carbohydrate	+	+
8	Anthroquinone	+	+
9	Glycoside	+	+
10	Polyphenol	+	++
11	Terpenoids	+	+
12	Triterpenoids	+	+
13	Phlobatannin	-	-

5.1 Steroids and triterpenoids

Identification of stigmasterol, lupeol and 16-hydroxylupeol.the study of identification and isolation of different phytochemicals were carried out by researchers on the samples of plant justicia gendarussa from Kishoregonj, Bangladesh in November, 2009, which was identified by an expert taxonomist. The air-dried powder of whole plant (0.5 kg) of gendarussa vulgarisNees was soaked for 10 days in 2.5 L of methanol at room temperature and was then filtered through cotton plug, followed by whatman filter paper number 1(16). Rotary evaporator was used to concentrare the extract.the concentrated methanolic extract aliquot (5.0 g) was fractioned into petroleum ether (PEF, 1.8g), chloroform (CLF, 0.7g), carbon tetrachloride (CTF, 0.9g) and aqueous (AQF, 1.1g) soluble fractions by using modified Kupchan partitioning method.Series of different processes were carried out which includes solvent-solvent partitioning, purification of methanol extract of the whole plant by using petrol-ether fraction and repeated chromatographic separation which helped to identify some compounds that is Stigmasterol,

lupeol and 16-hydroxylupeol.Sephadex (LH-20) was used for the chromatography of the fraction and was eluted using solvents like dichloromethane: methanol: n-hexane mixture (5:1:2) followed by dichloromethane and methanol mixture (9:1; 1:1) and then methanol (100%)(17). The elucidation of structures was done by NMR data examination, similarity with noted values and co-TLC with standards. Needle like crystalline mass of stigmasterol was obtained from n-hexane: dichloromethane: methanol (2:5:1) fraction. Lupeol observed as whitish solid. Preparative TLC eluted with dichloromethane: methanol (9:1) fraction and then lastly with 20% ethylacetate in toluene gave 16-hydroxylupeol(18).

5.2 Glycosides

Bioassay-directed separation of methanolic extracts of stalk and bark of willow leaved justicia helped in identification of two anti-HIV compound . compound 1 and 2 are glycoside moieties which belongs to the class of arylnaphthalide lignan (ANL). HPLC analysis of active fractions of plant extract disclosed that ANL glycosides were present. Active fraction named as F26 obtained from the chromatographic fractionlization of the methanol extract using silica gel column was exposed to preparative HPLC separation to make 8 different fractions (F4 to F48). These two ANL glycoside were elucidated from fractions F45 and F48(19). When the 1H and 13C NMR data was compared with known aryl naphthalide lignan compound both the compounds showed the presence of methylene-dioxy and two methoxy groups. The compounds 1 and 2 with molecular formula C35H38O17 were segregated as a white powder and can be diff erentiated only by the acetyloxy group position. 9-(1,3-benzodioxol-5-yl)-4-[(3-O-acetyl-6-deoxy-4-O-b-Dglucopyranosyl-b-Dglucopyranosyl) oxy] -6,7-dimethoxynaphtho[2,3-c]furan-1(3H)-one and 9-(1,3-benzodioxol-5yl)-4-[(2-O-acetyl-6-deoxy-4-O-b-D-glucopyranosyl-b-Dglucopyranosyl)oxy]-6,7-dimethoxy-naphtho [2,3-c]furan1(3H)-one as compound 1 and 2 respectively. Compounds are named as Justiprocumins A and B(19).

5.3 Flavonoids

5.3.1 Apigenin and vitexin

The flavonoid components were separated and characterized by using Reverse phase high performance liquid chromatography (RP-HPLC) and Thin layer chromatography (TLC). The configurations and chemical bonds were recognized using UltravioletVisible spectrophotometry, Nuclear magnetic resonance NMR (13C and 1H), Fourier Transform-Infra Red spectroscopy (FTIR), Diff erential Scanning Calorimetry (DSC),Chromatography-Mass Spectrometry (LCMS) and Scanning Electron Microscopy (SEM)(20).In the procedure, ethyl ether, petrol ether, and ethyl acetate were used to partition the methanol extract of the leaves. In order to execute column chromatography, the latter was concentrated. The chemicals recovered from column chromatography were used in TLC. The HPLC investigation showed that the TLC-identified compounds 1 and 2 had the same retention times as the reference flavonoids Apigenin and Vitexin. Finally, the identification of two bioactive flavonoids Apigenin and Vitexin was made possible by spectrum data(21).

5.3.2 Naringenin and kaempferol

Naringenin and kaempferol were discovered in methanol extracts of Justicia gendarussa mature and young leaves from 4 areas in Malaysia. Gas chromatography-flame ionisation detector (GC-FID) analysis was used to determine their identities. Mature leaves from the Skudai and Muar districts had the highest quantities of chemicals, measuring 507.692 and 1226.964 mg/kg, respectively(22). Data analysis revealed that the ratio of naringenin to kaempferol in the leaf extracts was proportional. According to the research, geographical differences among plant samples and the physiological stage of organ parts may

be responsible for variability in flavonoid content within a plant species(23).Early in the flavonoid biosynthetic pathway, naringenin was produced and activated by chalcone isomerase (CHI). Then, it was hydroxylated by flavanol synthases to provide dihydrokaempferol, which was then changed into kaempferol (FLS). Mature leaves are when naringenin is entirely transformed into kaempferol. This might be the cause for higher levels of these flavonoids in mature foliage(24).

5.3.3 Gendarusin A and B

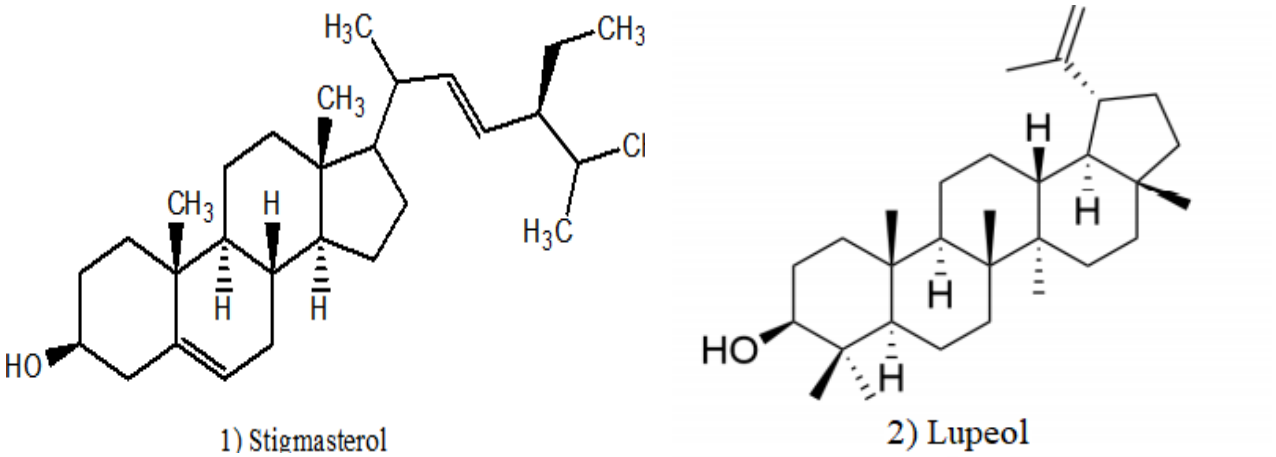
Preparative HPLC used for the isolated n-butanol fraction of justicia gendarussa yielded 6,8-di-C-α-L-arabinocyl-4′,5,7 trihidroxy-flavon or 6,8-di-C-α-L-arabinocylapigenin (gendarusin A) as major compound, and methanol fractionusing MPLC yielded 6,8-di-C-α-L-arabinopyranocyl-4′,5,7trihidroxy-8-C-β-D-cylopyranocylflavone or 6-C-α-Larabinocyl-8-C-β-D-ylocilapigenin (gendarusin B) as minor compound.The comparison revealed that gendarusin A makes up the majority of the standardised extract utilised in clinical studies, whereas 2-aminobenzyl derivatives were specifically exempted during the standardisation procedure. Comparing numerous J. gendarussa specimens obtained from various Indonesian locations helped to identify the best plant material, which contained a higher concentration of Gendarusin A. HIV type-1 reverse transcriptase is inhibited by Gendarusin a and 1.4% is present 70% ethanol fraction of plant.

5.4 Alkaloids

Four new alkaloids named as justidrusamides A-D were isolated from the leaves of this plant specimen which contain succinic acid, 2-aminobenzyl alcohol and 2,3-dihydroxy-2-(1-hydroxyethyl) butanoic acid frames. 2-aminobenzyl derivatives and flavonoids present in the water decoction of this plant were compared to the standardized extracts which are used in clinical trials. *Justicia gendarussa* dried powdered leaves (500 g) were progressively extracted with methanol to provide 32 g of extract. 6 g of the whole extract were progressively partitioned with n-butanol, water, hexane, and ethyl acetate. A silica gel column was used to further partition the n-butanol-soluble materials (CHCl3/MeOH, 1:0 → 0:1). To further purify the fraction eluted with CHCl3/MeOH (7:3), justidrusamides A (16.1 mg, 0.0027% yield), B (4.0 mg, 0.00067% yield), C (0.3 mg, 0.00005% yield), and D (0.3 mg, 0.00005% yield) were produced using HPLC with Cadenza 5CD C18, 10 9 250 mm, gradient elution (40% MeOH/0.1% HCOOH aq.)(25)

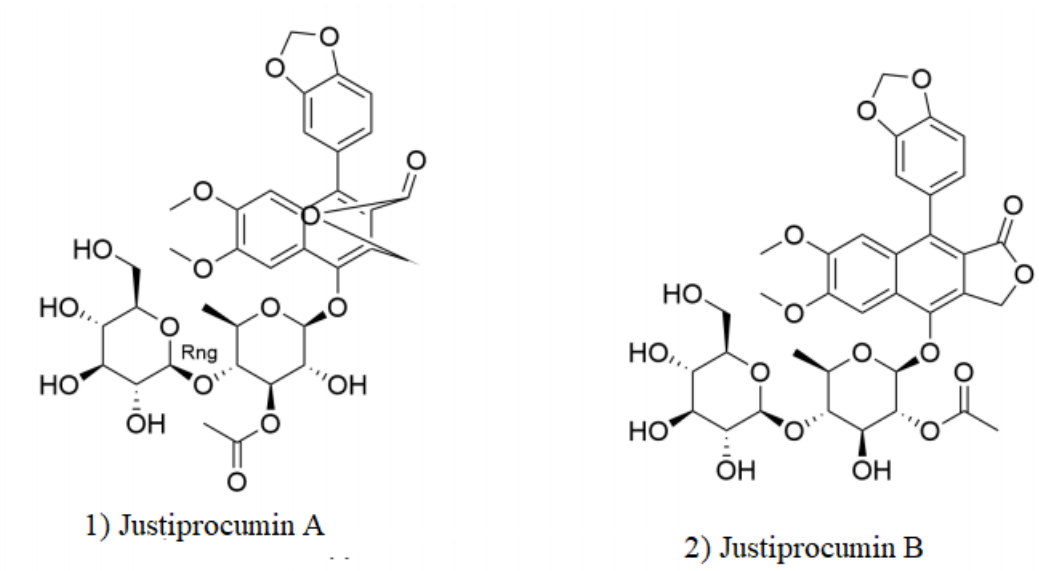
5.4.2 Patentiflorin A

DGP, also known as patentiflorin A, was first discovered in a Justicia gendarussa plant (Acanthaceae). It demonstrated anti-ZIKV activity against other flaviviruses and broad-spectrum antiviral action in vitro and in vivo as the glycosylated diphyllin(26). By limiting the acidification of endosomal/lysosomal compartments in the target cells, MOA demonstrated how DGP prevents ZIKV from fusing with cellular membranes and infecting host cells. Additionally, it exhibits strong action against a variety of HIV strains with IC50 values between 15 and 21 nM;MOA shown that it functions as a possible HIV-1 reverse transcription inhibitor. With IC50 values between 24-37 nM, patentiflorin A from J. gendarussa shown anti-HIV activity against a variety of HIV strains, outperforming the first anti-HIV medication that was clinically utilised, zidovudine AZT (IC50 77–95 nM)(26).



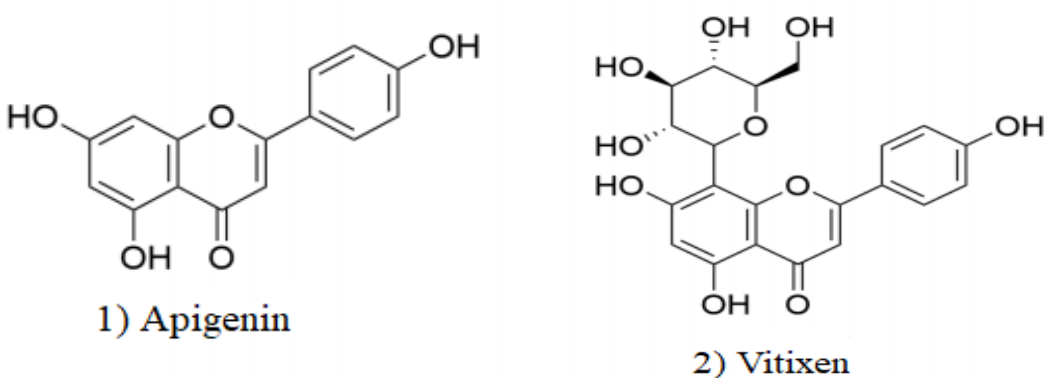
1) Stigmasterol 2) Lupeol

Figure 2: Structure of steroid and triterpenoid

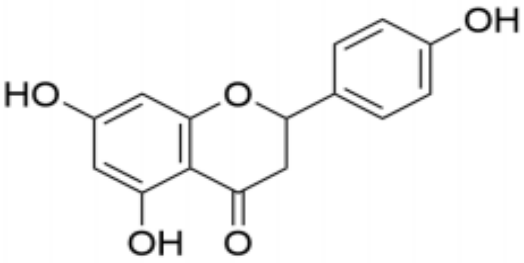


1) Justiprocumin A 2) Justiprocumin B

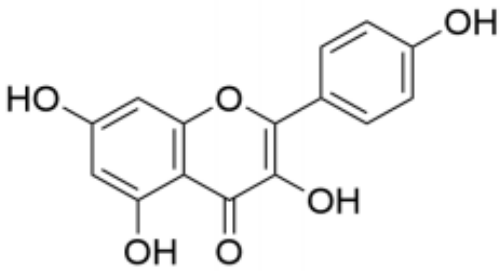
Figure 3: Structure of Glycoside



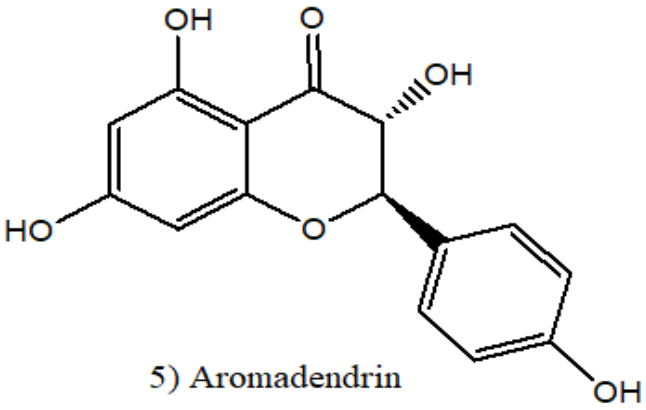
1) Apigenin 2) Vitixen



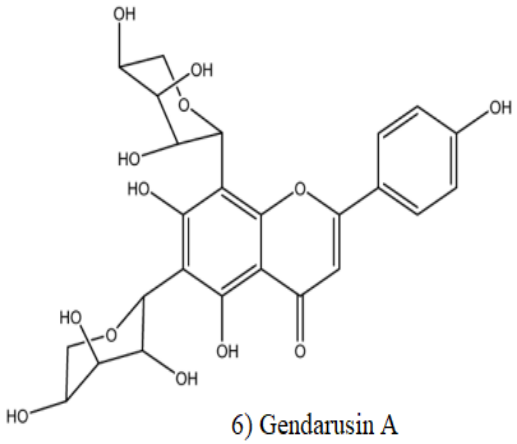
3) Naringenin



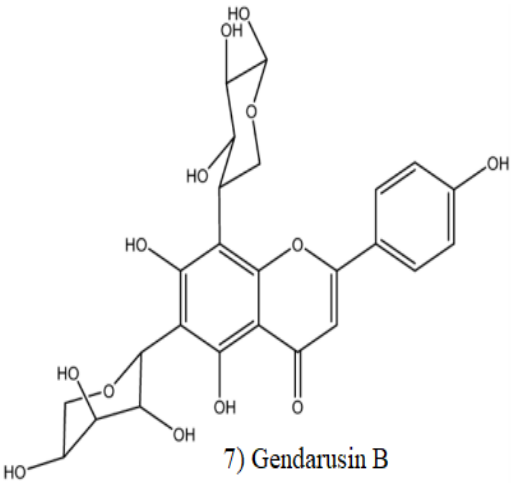
4) Kaempferol



5) Aromadendrin

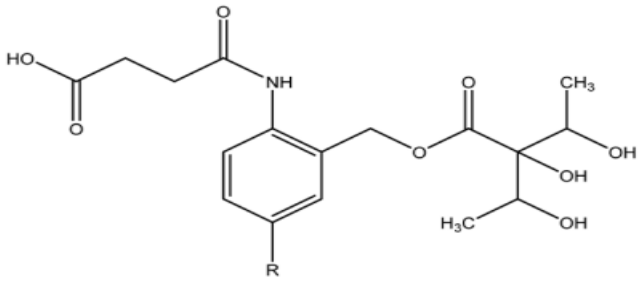


6) Gendarusin A



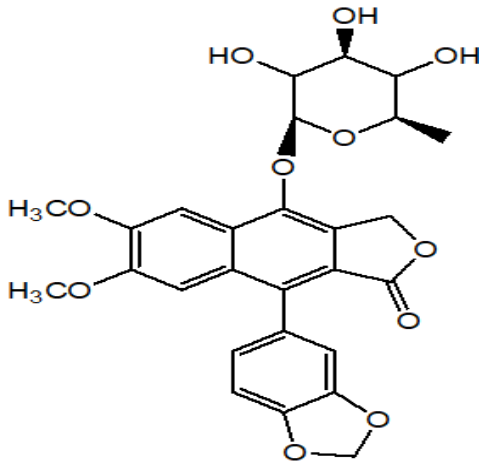
7) Gendarusin B

Figure 4: Structure of Flavonoids



1) Justidrusamide A: R=H, 9s, 10S,12R
2) Justidrusamide B: R=H, rac-(10R, 12R)
3) Justidrusamide C: R=OH, 9s, 10s, 12R
4) Justidrusamide D : R=OH, rac-(10R, 12R)

Figure 5: Structure of Alkaloids



Patentiforin A

Figure 6: Structure of Patentiflorin

6 Pharmacological activities

6.1 Anti-Oxidant Activity

The Justicia gendarussa plant's aerial component (leaf) extract was tested for its anti-oxidant action using DPPH for free radical scavenging activity at a concentration of 10 µg/mL. Utilizing in-vitro models, the plant's methanolic extract was investigated for its anti-oxidant properties(14). At concentrations of 145± 5.00 g/ml and 185± 8.66 g/ml, respectively, the plant extract of stem (methanol) Justicia gendarussa generated callus on the solid and liquid surface demonstrated the significant anti-oxidant activity(27).The Justicia gendarussa plant's leaf extract in methanol demonstrated exceptional anti-oxidant activity utilising the DPPH radicalscavenging assay against the standard flavonoids (Ascorbic acid, Gallic acid and Butylatedhydroxyl toluene). By using a hydrogen peroxide scavenging

activity method, an extract (methanol) of the plant leaf Justicia gendarussa demonstrated anti-oxidant activity at a concentration of 50-200µg/mL−1(27).Ethyl acetate leaf extract of Justicia gendarussa uses the Ferric Reducing Antioxidant Power (FRAP) assay to demonstrate the impressive anti-oxidant activity. Leaf extract from the plant Justicia gendarussa demonstrated anti-oxidant action through Nitric Oxide Scavenging activity. By DPPH free radical scavenging activity, the plant leaf from Justicia gendarussa has demonstrated significant anti-oxidant activity(16)(28).

6.2 Anti-viral activity

The diphyllin glycosides found in the Justicia gendarussa plant's leaves and stems exhibit anti-HIV activity against a variety of HIV strains. The plant extract (ethanolic) from Justicia gendarussa leaves has an anti-HIV impact on HIV-infected MT-4 cells (Human T-cell leukaemia lines). Using a standardised human PBMC (Human Peripheral Blood Mononuclear Cell) assay, the arylnaphthalene lignin (ANL) glycoside, pententiflorin isolated from the MeOH extract of plant leaf and stem Justicia gendarussa, exhibits remarkable anti-HIV activity against the HIV-1 clinical isolates BAL and SF162 (Both M-tropic), LAV0.04 (T-tropic), and 89.6 (dual tropic)(19).Additionally, justiprocumin B demonstrated potent activity against a variety of HIV strains, with IC50 values between 15 -21 nM (AZT, IC50 77 to 95 nM), the AZT-resistant isolate HIV-11617-1 (IC50 185 nM) and an IC50 value of 495 nM for the nevirapine-resistant isolate HIV-1N119 . Both the NNRTI-resistant isolate (HIV-1N) of the analogue nevaripine and the NRTI-resistant isolate HIV-1 of the analogue AZT were highly inhibited by the substance(19).

6.3 Anti-arthritic activity

At a dosage of 100 mg/kg, the extract (95% ethanolic extract) from the Justicia gendarussa plant leaf has anti-arthritic activity in male albino wistar rats subjected to FCA (Freund's complete adjuvant) induced arthritis as well as bovine type II collagen-induced arthritis.In Freund's complete adjuvant induced arthritic model and collagen induced arthritis, the treated rats demonstrated significant reductions in paw volume of 43% and 47% respectively, when compared to the standard (aspirin), which showed 26% and 38%. 33. Increased levels of WBC count and C-reactive protein (levels rise dramatically during inflammatory) were significantly suppressed in plant-treated rats, indicating a potent recovery from anaemia(27).

6.4 Cytotoxic activity

The root of Gendarussa vulgaris was tested for cytotoxicity on vero cell lines and MCF7 cell lines. The effect of a defatted methanolic extract of justicia gendarussa root at 100, 500, and 1000 ug/ml concentrations was compared to standard Vinblastine by using viability and Trypan blue assays on MCF7 cell line. MTT cell viability assay of methanolic extract of root shows 7.3% cytotoxity in MCF 7 cell line at 1000ug/ml concentration. MTT cell viability assay of methanolic extract of root shows 24.9% cytotoxicity in vero cell line at 1000g/ml concentration. In VERO and MCF 7 cell lines, the methanolic root extract of Gendarussa vulgaris has no cytotoxic activity(29).

The studies also showed that Justicia gendarussa leaf extract in methanol exhibits excellent cytotoxic activity against breast cancer. In the MTT assay, standard drug used is tamoxifen. Justicia gendarussa plant extract exhibits cytotoxic action against human cancer cell lines (HepG2 and HeLa cell lines is a human liver carcinoma Cell lines). Through the MTT assay testing, it has been demonstrated that the leaf extract of plant justicia gendarussa showed significant cytotoxic effects against the human cancer cell lines (HT-29, HeLa, and BxPC3). Using the brine shrimp lethality bioassay method, the

hydroalcoholic extract of the plant Justicia gendarussa's root and leaves sowed the cytotoxic activity.A brine shrimp lethality bioassay was used to test the test substances at various concentrations (1-1000 g/ml). The methanolic extract was the most cytotoxic. The LD 50 value was determined to be 25.44 g/ml.The IC50 values are determined to be 16 ug/mland 5 ug/ml, respectively. J. gendarussa leaf extract may have cytotoxic activity on human cancer cell lines, particularly BxPC-3 cells(22).

6.5 Analgesic activity

Through the use of a hot plate and an acetic acid-induced writhing test method, an aerial component of the plant Justicia gendarussa with ethanol (95% v/v) demonstrated significant analgesic action. Through the acetic acid-induced writhing experiment and hot plate method, the 95% ethanolic extract of Justicia gendarussa leaves exhibits analgesic effect on Swiss albino mice at concentrations of 125, 250, and 500mg/kg(30).

6.6 Anti-angiogenic activity

The plant's leaves demonstrated strong antiangiogenic activity. Angiogenesis, also known as neovascularisation, is the activation, proliferation, and migration of endothelial cells from preexisting blood vessels. It is essential for wound healing.The ChrioAllontoic Membrane assay (CAM) assay was used to determine the anti-angiogenic activity of the aqueous and ethanolic extract of leaves obtain from plant *gendarussa vulgaris*Nees(16).The acute toxicity of aqueous and ethanol extracts was also investigated using a brine shrimp lethality bio assay, which revealed that the LC50 values for both extracts were greater than 1000 ppm. As a control, ß-1,4 galactan sulphate was used. Both extracts had no effect at low concentrations (less than 10ug/ml). Both extracts inhibited neovascularization in a dose-dependent manner at concentrations ranging from 10-100 ug/ml and is applicable for both the methods.

6.7 Anti-bacterial activity

Justicia gendarussa phytochemical extracts such as alkaloid, flavonoid, terpenoids and glycoside extract demonstrated significant antibacterial activity against gram positive and gram negative strains of microorganism. The alkaloid extract was found to act as a more relevant inhibitor in both gram negative and grame positive bacteria compared to all other extracts in this study(31). At 20 ul/ml, the chloroform extract of Justicia gendarussa demonstrated significant ($p<0.005$) antibacterial activity against both Pseudomonas aeroginosa and Staphylococcus aureus, but not for E. coli, Vibrio chlorea and Proteus mirabilis(32). At 1000 ug/ml concentration ethyl acetate and ethanol extracts of Justicia gendarussa leaves exhibited potent antibacterial activity against gram positive and gram negative strains.Thedics diffusion method was also used to assess the antibacterial activity of plant Justicia gendarussa stem extract (hexane and aqueous extract) against Escherichia coli and Staphylococcus aureus. Using the disc diffusion method, the solvent (petroleum ether, methanolic and chloroform) used for the extraction purpose of the plant Justicia gendarussa displayed anti-bacterial activity at concentrations of 25, 50, 75, and 100µL. Also the Justicia gendarussa leaves were being extracted using solvents like diethyl ether, hexane, ethyl acetate, dichloromethane and methanol, and the antibacterial activity was examined using the disc diffusion method against bacteria (gm +ve and gm -ve) including with zone of inhibition Staphylococcus aureus (26.33mm),Salmonella paratypi A (19.50mm),Bacillus subtilis (20.25mm),Salmonella typhimusium (17.20mm), Escherichia coli (21.40 mm),Shigella flexneri (26.20 mm) and Proleus mirabilis (24.50mm).

6.8 Anti-inflammatory activity

In an ethyl acetate fraction purified from a methanolic extract of roots of Justicia gendarussa (EJG). the anti-inflammatory activity and mechanism(s) of action were investigated . Using partitioned fractions obtained from the methanolic extract of J. partitioned fractions were used in anti-inflammatory tests on rats(33). Comparing ethyl acetate fraction to other extracts and Voveran, it inhibited edoema by 80% and 93% during the third and fifth hours of carrageenan-induced rat paw edoema. Male Wistar rats weighing 120–150 g were utilised for the tests. Carrageenan was employed to cause rat paw edoema(34).By injecting 0.1 ml of 1% carrageenan in 0.9% saline by using an aponeurosis injection, an edoema was generated on the right hind paw. Crude methanolic extract of J. gendarussa root extract was fractionated under the guidance of bioassays to produce the fractions hexane fraction (HJG),butanol fraction (BJG), ethyl acetate fraction (EJG),dichloromethane fraction (DJG), and aqueous fraction (AJG). One hour before to the injection of carrageenan, these fractions were given orally at a dose of 50 mg/kg along with the conventional medication (Voveran) at a dose of 20 mg/kg. A paw edoema metre was used to measure the volume of the right paw prior to injection as well as three and five hours after inflammation was induced(35).

The invitro anti-inflammatory activity was studied using HRBC method.Healthy subjects blood was drawn and combined with an equal amount of sterilised Alsevers solution. The packed cells in this blood solution were separated after being centrifuged at 3000 rpm(36). Isosaline solution was used to wash the packed cells and to create a 10% v/v suspension. The assessment of the anti-inflammatory properties was done using this HRBC suspension. Separate mixtures of various extract concentrations, reference samples, and controls were added to 1 mL of phosphate buffer, 2 mL of hyposaline and 0.5 mL of HRBC suspension.All of the assay solutions were centrifuged at 3000 rpm after 30 minutes of incubation at 37°C. A spectrophotometer operating at 560 nm was used to determine the haemoglobin concentration after the supernatant liquid was decanted. By assuming that all of the hemolysis produced in the control was created, the percentage hemolysis was estimated(37).

6.9 Anti -anxiety activity

The ethanolic extract of the plant's aerial part was evaluated in Swiss albino mice for anti-anxiety activity using the light dark test as well as the elevated plus maze test. For 21 days, an ethanolic extract of the plant at a concentration of 200 - 500 mg/kg body weight was administered orally. The elevated plus maze test method revealed that the ethanolic extract increased the time spent in the open arms as well as the number of entries into the open arms(38). The extract also increases the time spent in the light area in the light dark test model. The outcome was compared to the standard medication diazepam. This study found that an ethanolic extract of the plant has significant ($p<0.01$) anti-anxiety activity.

6.10 Anti-helmentic activity

Methanolic extracts of the stems and leaves were found to be effective against Pheretimaposthuma. Various concentrations of stem and leaf extract (10, 20, 30, 40, and 50 mg/ml) were applied to earth worms in petri dishes(5). The duration of paralysis and death were measured and compared to the standard drug Albendazole. In comparison to the reference drug, which showed paralysis at 17 minutes and death at 48 minutes at a concentration of 10 mg/ml, the leaf and stem extracts showed paralysis at 35.33 min and 41.33 min, respectively, and death at 70.67 min and 89.33 min(12).

6.11 Anti - fungal activity

The antifungal activity of different extracts of Justicia gendarussa against dermatophytic species was tested in vitro using the agar cup diffusion technique. Trichophyton mentagrophytes, Trichophyton rubrum, Microsporumgypseum, and Microsporumfulvum were tested using chloroform, methanol, and aqueous extracts of the whole plant. The antifungal activity of different solvent extracts of Justicia gendarussa in terms of inhibition zone diameter can be concluded as chloroform> methanol> water in decreasing order(39).The disc diffusion method was used to investigate the antifungal activity of Justicia gendarussa stem aqueous and hexane extracts. The Candida albicans inoculum was made with potato dextrose broth. To make potato dextrose agar media, autoclave 3.9 gm in 100ml. Using sterile cotton swabs, inoculate the test microorganisms on the Potato dextrose agar plates. On sterile discs, aqueous and hexane extracts of Justicia gendarussa Burm stem were placed. To remove the solvent, the discs were dried aseptically under laminar air flow. Dried discs were placed on the surface of culture-inoculated potato dextrose agar plates and incubated for 48 hours at room temperature(40).Himedia zone reader was used to assess antifungal activity. The above results clearly show that aqueous extract of Justicia gendarussa and STD had more potent antifungal activity against Candida albicans than hexane extract. The zone of inhibition of aqueous extract was 11mm, hexane extract was 7mm, and standard was only 2mm(39).

6.12 Hepatoprotective activity

In vitro and in vivo models of carbon tetra chloride-induced liver injury demonstrated a strong hepatoprotective effect activity by the plant Justicia gendarussa's methanolic extract.Using primary rat hepatocytes and carbon tetra chloride as a hepatotoxin, researchers examined the in vitro hepatoprotective effect of Justicia gendarussa Burm(12). In addition to CCl4 (10 mM), different doses of plant extract (10, 50, and 100 ug/ml) and silymarin (100 ug/ml) were treated with the isolated primary rat hepatocytes(18). Cell viability was measured by Trypan blue exclusion assay. The transaminase enzymes in cell suspension were measured. Methanolic extract produced significant moderate hepatoprotective effect.The extract significantly decreased the levels of the liver enzymes AST and ALT while increasing the levels of antioxidant enzymes. At a dose of 300 mg/kg, the effect was seen to be meaningful(41).

Conclusion:

As evidenced by study *Justicia gendarussa* is an alluring specimen with a long history of traditional medicinal use. This review broadly elaborates the traditional use, phytochemical constituents and pharmacological activities of the plant *Justicia gendarussa*Burm f. The study shows that the plant species poses various pharmacological activities like Anti-inflammatory, Anti-oxidant, Anti-viral, Anti-bacterial, Anti-fungal, Anti-angiogenic activity. The different chemical constituents identified in this species are Saponin, Terpenoids, Flavonoids, Glycosides, Alkaloids. From this it can be concluded that the plant specimen could be useful for development of different commercial drugs.

References:-

1. Kavitha K, Sridevi KS, Sujatha K, Umamaheswari S. Phytochemical and Pharmacological Profile of Justicia gendarussa Burm f . – Review. J Pharm Res. 2014;8(July):990–7.
2. Sonal P, Maitreyi Z. Pharmacognostic study of the root of Justicia gendarussa Burm. 2011;6(2).
3. Putri VA, . Z, Asra R, Chandra B. Overview of Phytochemical and Pharmacological of Gandarussa Extract (Justicia Gendarussa Burm). EAS J Pharm Pharmacol. 2020;2(5):180–5.

4. Nibalvos AVG, Tan-Nibalvos CH, U. Kruse JR. Physical and Phytochemical Analysis of Justicia gendarussa Burm. F. Leaf Extracts. Indian J Sci Technol. 2019;12(42):1–5.
5. Jagannath S. Pharmacognostical and pharmacological activity of J. 2020;11(3):3384–90.
6. Basu .B.D and Kiritikar.K.R. Indian Medicinal Plants with illustration. second edi. 2019. 2610–2613 p.
7. Wealth of India. The council of scientific and Industrial Research; 2001. 312–313 p.
8. Kirtikar.K B. Indian Medicinal Plants with illustrations volume 8. 2nd ed. Oriental enterprises; 2003. 2386–2748 p.
9. Kumar KS, Vijayan V, Bhaskar S, Krishnan K, Shalini V, Helen A. Anti-inflammatory potential of an ethyl acetate fraction isolated from Justicia gendarussa roots through inhibition of iNOS and COX-2 expression via NF-κB pathway. Cell Immunol. 2012;272(2):283–9.
10. Wali A. Traditional Herbal Drugs. Ankur Publications; 2016. 141 p.
11. Nadu T, Nadu T, Nadu T. MOLECULAR IDENTIFICATION OF THE MEDICINAL PLANT JUSTICIA. 2019;5(663):663–74.
12. Roy P, Joseph LJ. Bioactive constituents and pharmacological profile of willow-leaved Justicia: A review. Nat Resour Hum Heal [Internet]. 2022 Aug 9;2(4):450–61. Available from: https://www.nrfhh.com/Bioactive-constituents-and-pharmacological-profile-of-willow-leaved-Justicia-A-review,146769,0,2.html
13. Kaur A, Nain P, Nain J. Herbal plants used in treatment of rheumatoid arthritis: A review. Int J Pharm Pharm Sci. 2012;4(SUPPL. 4):44–57.
14. Pal K, Rahaman CH. Phytochemical and Antioxidant Studies of Justicia gendarussa Burm. F. an Ethnomedicinal Plant. Int J Pharm Sci Res [Internet]. 2015;6(8):3454. Available from: http://dx.doi.org/10.13040/IJPSR.0975-8232.6
15. Shamili G, Santhi G. Identification and Characterization of Bioactive Compounds of Leaves of Justicia Gendarussa Burm . F . 2019;6(1):145–53.
16. Uddin R, Sinha S, Hossain A, Kaisar A, Hossain K, Rashid MA. Chemical and Biological Investigations of Justicia gendarussa (Burm . f). 2011;10(1):53–7.
17. Sonal P, Maitreyi Z. Pharmacognostic study of the root of Justicia gendarussa Burm. Asian J Tradit Med. 2011;6(2):61–72.
18. Uddin MR, Sinha S, Hossain MA, Kaisar MA, Hossain MK, Rashid MA. Chemical and biological investigations of Justicia gendarussa (Burm. F). Dhaka Univ J Pharm Sci. 2011;10(1):53–7.
19. Zhang HJ, Rumschlag-Booms E, Guan YF, Liu KL, Wang DY, Li WF, et al. Anti-HIV diphyllin glycosides from Justicia gendarussa. Phytochemistry [Internet]. 2017;136:94–100. Available from: http://dx.doi.org/10.1016/j.phytochem.2017.01.005
20. Ratih GAM, Imawati MF, Nugroho RR, Purwanti DI, Wongso S, Prajogo B, et al. Phytochemicals of gandarusa (Justicia gendarussa) and its preparations. Nat Prod Commun. 2019;14(6):1–10.
21. Corrêa GM, Alcântara AFDC. Chemical constituents and biological activities of species of Justicia - a review. Brazilian J Pharmacogn. 2012;22(May 2011):220–38.
22. Ayob Z, Abd Samad A, Mohd Bohari SP. Cytotoxicity activities in local Justicia gendarussa crude extracts against human cancer cell lines. J Teknol (Sciences Eng. 2013;64(2):45–52.
23. Widyowati R, Agil M. Natural Products Chemistry of Global Tropical and Subtropical Plants

Chemical Constituents and Bioactivities of Several Indonesian Plants Typically Used in Jamu. Chem Pharm Bull (Tokyo). 2018;66(5):506–18.
24. Indrayoni P, Purwanti DI, Wongso S, Prajogo BEW, Indrayanto G. Metabolite profiles in various plant organs of Justicia gendarussa Burm.F. and its in vitro cultures. Sci Pharm. 2016;84(3):555–66.
25. Kiren Y, Deguchi J, Hirasawa Y, Morita H, Prajogo B. Justidrusamides A-D, new 2-aminobenzyl alcohol derivatives from Justicia gendarussa. J Nat Med. 2014;68(4):754–8.
26. Cui Q, Du R, Liu M, Rong L. Lignans and Their Derivatives from Plants as Antivirals. 1818;1–17.
27. Vijayakumar AS, Jeyaraj M, Abirami E. Pharmacological Activity of Silver Nanoparticles, Ethanolic Extract From Justicia gendarussa (Burm) F Plant Leaves. Res J Life Sci Bioinformatics, Pharm Chem Sci [Internet]. 2019;5(2):463–75. Available from: www.rjlbpcs.com
28. Alam N, Bristi NJ. Review on in vivo and in vitro methods evaluation of antioxidant activity. Saudi Pharm J [Internet]. 2013;21(2):143–52. Available from: http://dx.doi.org/10.1016/j.jsps.2012.05.002
29. Mahmud SMN, Sohrab MH, Begum MN, Rony SR, Sharmin S, Moni F, et al. Cytotoxicity, antioxidant, antimicrobial studies and phytochemical screening of endophytic fungi isolated from Justicia gendarussa. Ann Agric Sci [Internet]. 2020;65(2):225–32. Available from: https://doi.org/10.1016/j.aoas.2020.12.003
30. analgesic anti-inflamatory Jg.pdf.
31. Nirmalraj S, Ravikumar M, Mahendrakumar M, Bharath B, Perinbam K. Antibacterial and Anti-Inflammatory Activity of Justicia gendarussa Burm . F . Leaves. 2015;1–5.
32. Merrill F, Subhashini S, Poonguzhali T V, Madha V. Quantitative phytochemical analysis of Ecbolium. 2013;2:34–7.
33. Dilip C, Sankar C, Duraisami R. Anti-inflammatory activity of the leaf extacts of Gendarussa vulgaris Nees. 2011;1(2):147–9.
34. Bhaskar S. Anti-inflammatory potential of an ethyl acetate fraction isolated from Justicia gendarussa roots through inhibit ... 2015;
35. Satapathy AK, Gunasekaran G, Sahoo SC, Amit K, Rodrigues P V. Corrosion inhibition by Justicia gendarussa plant extract in hydrochloric acid solution. Corros Sci. 2009;51(12):2848–56.
36. Aye MM, Aung HT, Sein MM, Armijos C. A review on the phytochemistry, medicinal properties and pharmacological activities of 15 selected myanmar medicinal plants. Molecules. 2019;24(2).
37. Kas HS. International Journal of Pharmaceutics: Preface. Int J Pharm. 2002;242(1–2):1.
38. Periya S, Garden TB, Suja SR, Nehru J, Botanic T, Sukumaran S, et al. Anti-inflammatory and antinociceptive activity of Justicia gendarussa Burm . f . leaves. 2014;(January 2010).
39. Venkatachalam D, Rahman A, Sunny B, Jacob J, Kuriyan N, Raman R, et al. Screening of Antimicrobial Activity of Various Extracts of the Stem Justicia gendarussa. Asian J Res Med Pharm Sci. 2019;1–7.
40. Nirmalraj S, Ravikumar M, Mahendrakumar M, Bharath B, Perinbam K. Antibacterial and anti-inflammatory activity of Justicia gendarussa Burm. F. Leaves. J Plant Sci. 2015;10(2):70–4.
41. Plant H, Gendarussa J. International Journal of Pharmaceutics & Drug Research. 2020;8(2):15–22.