Syzygium samarangense (Jamb) - Its Ethnobotanical Knowledge, Phytochemical Studies, Pharmacological Aspects and Future Prospects

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ABSTRACT:

Syzygium samarangense (Jamb) is an genus of woody flowering plants. Numerous fruits in this family have a long history of usage as both edibles and traditional medicines, and plants in this family are known to be abundant in volatile oils that are recorded for their usefulness in medicine. As Indians and other Asians know these uses it is widely used in Indian and Asian cuisine, so has economic importance. Except fruits and buds other parts weren't much used except for medicinal purposes. This plant shows the presence of flavonoids, terpenoids, saponins, steroids, carbohydrates, sugar, tanins and phenolic compounds. The leaves, stem, bark, fruits and pulp shows so many pharmacological activities such as antidiarrhoeal activity, hepatoprotective activity, anticholinesterase activity, immunopharmacological activity, Central Nervous System (CNS) activity, thrombolytic activity, spasmolytic activity, antibacterial activity, antiviral activity, anti-inflammatory activity, antihyperglycaemic activity, cytotoxic activity, antimicrobial activity, analgesic activity, anthelmintic activity, antidiabetic activity, anticancer activity, antioxidant activity, anxiolytic activity and anti-inflammatory activity.

KEYWORDS:

Syzygium samarangense (Jamb), traditional uses, medicinal uses, phytochemical constituent, isolated compounds, pharmacological activity, economic importants and future prospects.

INTODUCTION:

Syzygium is the genus of woody flowering plants, which belongs to the family *Myrtaceae*. The genus comprises about 1200 species (Ahmad *et al*., 2016). The genus *Syzygium* is named after a Greek word meaning "coupled," an illusion to the paired branches and leaves (Nigam *et al*., 2012). This genus is believed to have originated in South-East Asia although current distribution of the tree have been documented in India and throughout South-East Asia to the Pacific Islands (Tarigan *et al*., 2021). Most species are evergreen trees and shrubs, which are grown as ornamental plants for their attractive glossy foliage, and a few produce edible fruits that are eaten fresh or used in jams and jellies. At times *Syzygium* was confused taxonomically with the genus Eugenia (ca. 1000 species), but the latter genus has its highest specific diversity in the neotropics. Its biophysical limits range from sea level to 800 m altitude. This plant has wide temperature limit ranging from mean annual temperature of -20°C to 480°C and grows where mean annual rainfall ranges between 900 and 1000 mm or more. *Syzygium* species grows in a great variety of soils and geological formations such as alluvial, lateritic, sandy alluvia, marl and olitic limestone. Some of them tolerate saline soil and are found on deep, rich, well-drained soils (Nigam *et al*., 2012). Many species formerly classed as Eugenia are now included in the genus *Syzygium*, although the former name may persist in horticulture (Wrigley and Fagg, 2013). Jambu is considered a "fruit of the gods" by many Hindus. The numerous fruits in this family have a long history of usage as both edibles and traditional medicines, and volatile oils, which have been used in medicine, are known to be abundant in plants of this family. The fruits, juice, and seed all contain a biochemical known as 'jamboline,' which is thought to prevent the pathological conversion of starch to sugar in the event of excessive glucose production (Shukla, 2013). The cutting, grafting, sowing and air-layering can all be used to propagate this plant. Plants of the genus *Syzygium* are used to treat a wide range of illnesses mainly diabetes. In some species the medicinally useful part is leaves while in some it may be root or fruit or seed or bark. In the genus *Syzygium* plant products of some species are consumed as food like fruits of *Syzygium cumini*, *Syzygium jambolanum*, *Syzygium australe* and *Syzygium*

leuhmani. As Indians and other Asians know these uses it is widely used in Indian and Asian cuisine, so has economic importance. Except fruits and buds other parts weren't much used except for medicinal purposes (Lakshmi *et al*., 2021).

Vernacular names (Name in various Indian language):
English: Jaman, Jambolan, Black plum, Wax jambu, Wax apple (Khandekar *et al*., 2012), Hindi: Jamun, Jambhal, Jaman, Bada jamun, Jam, Jamb, Bengali: Jam, Kalajam, Gujarati: Jambu, Jamli, Kannada: Nerale, Jambuva, Malayalam: Naval, Perinnaral, Marathi: Jaman, Jambul, Tamil: Naval, Kottainaval, Neredam, Sambal, Telgu: Neredu, Assam: Jamu, Burma: Thabyebyu, Oriya: Jamo, Jamkuli, Bhotojam, Chuajamo, Jamo, Urudu: Jaman, Phalenda (Sharma and Mehta, 1969).

Common names:

Table no.1: Common names of *Syzygium samarangense*

Language	Names
Thai	Wax apple, love apple, java apple, chomphu
Vietnam	Man
Taiwan	Bellfruit
Jamaica	Jamaican Apple, Otaheti Apple
Indonesian	Jambu air
Sri Lanka	Jumbu
Malay	Water apple, mountain apple, cloud apple, jambu air, water guava
Philippines	Wax jambu, rose apple, bell offruit, makopa, tambis (Mollika *et al*., 2013)

Figure 1: *Syzygium samarangense* (Jamb) plant

Figure 2: *Syzygium samarangense* flowers

Figure 3: *Syzygium samarangense* fruits

Table no.2: Taxanomic rank of *Syzygium samarangense* (Jamb).

Kingdom	Plantae
Sub kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta

Class	Magnoliopsida
Order	Myrtales
Family	Myrtaceae
Genus	*Syzygium*
Species	*Syzygium samarangense* (Blume) Merr. & Perry

OCCURANCE:

The genus is native to India, Malaysia, Myanmar, Philippines, Sri Lanka, Bangladesh, Pakistan, Guangdong, Guangxi and Thailand. It is considered as exotic in Algeria, Antigua, Barbuda, Australia, Bahamas, Barbados, Colombia, Cuba, Dominica, Ghana, Grenada, Guadeloupe, Guatemala, Guyana, Jamaica, Kenya, Martinique, Mexico, Montserrat, Nepal, Netherlands Antilles, Nicaragua, Panama, South Africa, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Sudan, Tanzania, Trinidad and United States of America (Nigam *et al*., 2012).

BOTANICAL DISCRIPTION:

Syzygium samarangense (Blume) Merr. & Perry belongs to genus *Syzygium* and myrtle family *Myrtaceae*. This 15-meter-tall tree has a short, crooked trunk that is 25–50 cm in diameter, frequently branched around the base, and an asymmetrical canopy (Antora, 2016). The lower portion of the tree trunk of all Syzygium species has rough, cracked, flaking and discolored, smooth and light-grey bark (Nigam *et al*., 2012). The evergreen leaves are opposite, soft leathery and dark green (Lawal *et al*., 2014). They are opposite, elliptic to elliptic-oblong, 10 to 25 centimetres by 5 to 12 centimetres, coriaceous with thin edge, pellucid spotted, and rather strongly scented when damaged; petiole stout, 3-5 millimetres long (Antora, 2016). The flowers are invariably 3-4cm in diameter with a calyx-tube about 1.5cm long. They are ventricose at the apex with lobes 3-5mm long with 4 petals. Their shape are orbicular to spathulate, 10-15mm long and yellow to white in color with numerous stamens and a style numerous, up to 3cm long (Tehrani, 2012). Fruit's skin is very thin, and its white, spongy, dry to juicy, subacid and flavorfully bland flesh (Alam, 2017). The stalk's length and width are estimated to be 3-5mm and 8-10mm respectively (Taringan *et al*., 2021). The blossoms and consequent fruit are not just found in the leaf axils; they can be found almost anywhere on the branches' and trunk's exterior. When fully mature, the tree is thought to be a heavy bearer because it may produce up to 700 fruits (Mollika *et al*., 2013). Each fruit contains a single large, subglobose seed or a pair of subglobose to emispherical seeds 1.6–2cm (0.6–0.8in) in diameter, light brown externally, green internally, and somewhat meaty in texture. The fruits of some trees are entirely seedless (Tabassum, 2016). Seeds are compacted into a mass that resembles a single seed with the entire seed enclosed in a cream coloured, coriaceous coating that is smooth, oval or roundish and 1cm long, 1cm wide and brownish-black in colour (Shukla, 2013). The date varies from year to year, but the trees have distinct flowering seasons, frequently twice and occasionally three times per year (Tehrani, 2012).

MEDICINAL & TRADITIONAL USES:

The plant of *S. samarangense* have a several medicinal properties. People in Taiwan create wax apple soup with crystal sugar to alleviate dry coughs (Khandekar *et al*., 2012). The flowers, which contain tannins, desmethoxymatteucinol, 5-O-methyl-40- desmethoxymatteucinol, oleanic acid and b-sitosterol, are used in Taiwan to treat fever and halt diarrhea (Morton, 1987). Fruits have been utilised for a range of ailments and conditions in various traditional medical methods. The fruit of this tree in India as a tonic for the brain and for liver problems, as an astringent, digestive (Kirtikar and Basu, 1988) and moreover, fruit decoction is utilised to treat fever (Alam, 2017). The decoction of root bark of *Syzygium samarangense* has traditionally been used to treat dysentery and amenorrhea, as well as as an abortifacient. Root is a diuretic that is used to treat edoema. Malayans treat itching using powdered dry root concoctions (Madhavi and Ram, 2015). In order to treat fever and stop diarrhoea, leaves are used as an astringent. Cracked tongues are treated with powdered leaves. In lotions and baths, leaf juice is employed. It is additionally used for headaches, diabetes and cough (Alam, 2017) cold, itches, and waist pain treatment (Tarigan *et al*., 2021). The bark is used as an astringent in mouthwash solutions for the treatment of thrush and its juice is used to cure wounds. For diarrhoea, a decoction of the stem is utilised (Peter *et al*., 2011).

PHYTOCHEMICAL CONSTITUENTS:

The phytochemicals could be classified as primary and secondary metabolites. Primary metabolites involved natural sugars, amino acids, proteins, purines and pyrimidines of nucleic acids and chlorophyll. Secondary metabolites are the remaining plant chemicals such as glycosides, alkaloids, terpenoids, flavonoids, lignans, steroids, curcumines, saponins and phenolics (Aung, 2020).

Table no.8: Phytochemicals present in the *Syzygium samarangense* (Jamb).

Plants part	Chemicals
Flower	Tannins, desmethoxymatteucinol, 5-O-methyl-4′- desmethoxymatteucinol, oleanic acid, and β-sitosterol (Lawal *et al*., 2014).
Leaves	Flavonoids, triterpenoid (Tabassum, 2016), tannins, alkaloids (Tarigan *et al*., 2021)
Stem/Bark	Hepatocosane, nonacosane, triacontane, hentriacontane, octacosanol, triacosanol, dotriacosanol, betulinic acid and crotegolic acid (Shukla, 2013).
Fruits	Quercitrin- 3-rhamnosylquercetin (Comalada *et al*., 2005).
Pulp	Hyperin (Lakshmi *et al*., 2021).
Seed	Myricitrin (Simirgiotis ., 2008), -Myricetin-3-O-α-rhamnoside (Domitrović *et al*., 2015). Terpenoids, alkaloids, carbohydrates, saponins, tannins, flavanoids, phenolic compounds. Proteins and aminoacids (Madhavi and Ram, 2015).
Roots	Butanol (Jgapat and Bapat, 2010).

ISOLATED COMPOUNDS:

- **Flower:** Flowers of *S. samarangense contains* two anthocyanins- delphinidin-3- gentiobioside and malvidin-3-laminaribioside; petunidin-3-gentiobioside, malic acid, oxalic acid, tannins, cyanidindiglycosides, waxy component, triterpenhydroxy acid and oleanolic acid (Shukla, 2013).

- **Leaves:** It consists myricetin-3-L-arabinoside, dihydromyricetin, quercetin- 3-Dgalactoside, oleanolic acid, three triterpenoids, acetyl oleanolic acid, eugenia- triterpenoid A and B, ellagic acid, isoquercertin, kaempferol (Shukla, 2013). 5'-dimethyl-6'-methoxychalcone 1, 2',4'- Dihydroxy-3', flavanone 5-O-methyl-4'- desmethoxymatteucinol 2 and 2'4'- dihydroxy-6'-methoxy-3'- methylchalcone 3 (Villaseñor *et al.*, 2005). Triterpenoid - lupeol, betulin, epibetulinicacid (Tabassum, 2016).

- **Stem/Bark:** Hepatocosane, nonacosane, triacontane, hentriacontane, octacosanol, triacosanol, dotriacosanol, betulinic acid and crotegolic acid (Shukla, 2013).

- **Fruits:** The fruits has a gallic and ellagic acids, corilagin and related ellagitannis, 3, 6-hexahydroxydiphenoyl glucose and its isomer 4,6-hexahydroxydiphenoyl glucose, 1- galloylglucose, 3-galloylglucose, -di-0-′-tri-0-methylellagic, 3,4′,4′quercetin, 3,3 methylellagic, caffeic, ferulic, guaiacol, resorcinol dimethyl ether, veratrole, lignanglucoside, medioresinol 4"-0-beta-glucoside, (+)- pinoresinol-0-beta- glucoside, (+)- syringaresinol 0-beta-glucoside, dihydrodehydrodiconiferyl -0- beta- glucoside and 5-′alcohol 4 (hydroxymethyl) furfural (Shukla, 2013).

- **Seed:** *S. samarangense* seeds contains methylxanthoxyline and 2, 6 dihydroxy 4- methoxyacetophenone (unsaponifiable fraction); - pineneβ- pinene and αbornyl acetate (Shukla, 2013).

- **Essential oil:** Leaf oil is largely composed of monoterpenes (30% sesquiterpenes, 9 % caryophyllene) (Tabassum, 2016). It has been identified a total of 74 compounds of the essential oils from the leaves of five varieties of wax apple trees: 'An Phuoc', 'Hoa An', 'Hong Dao', 'Sua', and 'Xanh Duong' collected in Dong Thap Province, Vietnam. The results suggested that the concentrations of the main constituents of the

essential oils of the five studied varieties were a variety and significantly different from what was reported in previous studies. The main constitutes of essential oils were: o-cymene (13.47% - 'An Phuoc'), α-cubebene (21.49% - 'Hoa An'), epizonarene (13.10% - 'Hong Dao'), β-gurjunene (10.73% - 'Sua'), and α-selinene (20.11% - 'Xanh Duong'). The essential oils from the leaves of five varieties of wax apple trees in this study showed the antibacterial effect against four tested microorganisms: *B. cereus, E. coli, S. enteritidis* and *S. aureus* (Van *et al*., 2020).

PHARMACOLOGICAL ACTIVITY:

Table no.9: Pharmacological activities of *Syzygium samarangense* (Jamb).

Plants part	Activity
Leaves	Antidiarrhoeal activity, Hepatoprotective activity, Anticholinesterase activity, Immunopharmacological activity, Central nervous system (CNS) activity, Thrombolytic and spasmolytic activity, Antibactirial activity, Antiviral activity, Analgesic and Anti-Inflammatory activity, Antihyperglycaemic activity, Cytotoxic activity, Antimicrobial activity.
Stem/Bark	Analgesic activity, Anthelmintic activity.
Fruits	Antidiabetic activity, Anticancer activity, Hepatoprotective activity, Antioxidant activity.
Pulp	Anticancer activity.
Whole plant	Anxiolytic activity, Anti-inflammatory activity.

LEAVES:

Antidiarrhoeal activity:
The isolated rabbit jejunum was observed to relax spontaneously contracting in a dose-dependent (10–3000 microg/mL) manner when exposed to S. samarangense hexane extract. The extract (10–1000 microg/mL) reduced the Ca++ dose-response curves in a dose-dependent manner (30–100 microg/mL) and attenuated the high K+–induced contractions, demonstrating the CCB activity. The spasmolytic potential of the flavonoids isolated from the hexane extract was assessed. Each flavonoid demonstrated a dose-dependent spasmolytic effect (10–1000 microg/mL). These findings suggest that the plant's therapeutic effectiveness in diarrhoea may be due to the presence of chemicals with spasmolytic and calcium antagonist effects (Tabassum, 2016).

Hepatoprotective activity:
In carbon tetrachloride (CCl_4) the rats was treated and the methanolic extract of leaves demonstrated hepatoprotective action. Because carbon tetrachloride is converted into halogenated free radicals by cytochrome P450s in the liver, it causes severe hepatic damage. These metabolites cause significant lipid peroxidation and hepatic tissue destruction. It also has to do with the creation of covalent bonds in membrane lipids. Superoxide dismutase activities increased by 26–27%, decreased glutathione by 84.75 percent and total bilirubin by less than 1 percent when this extract was tested by 37 percent, total cholesterol by 13.26 percent, and total cholesterol glycerides by 15.15 percent as well as decrease total bilirubin, total cholesterol, and total cholesterol glycerides by 15.15 percent. Histopathological examinations backed up this claim (Sobeh *et al*., 2018).

Anticholinesterase activity:
The real inhibitory experiment is mixing 2.8 µL of phosphate buffer with 30 µL of test sample solution and 30 µL of enzyme stock solution. The mixture was incubated at 25°C for 5 to 10 minutes. The absorbance at 412 nm was then measured after the addition of 100 µL of DTNB stock solution and 30 µL of substrate stock solution. Physostigmine served as the control. The inhibition percentage was determined. At a concentration of 0.20mM, it displayed 68.0% inhibitory activity when tested against butyrylcholinesterase, and its IC_{50} value was reported to be 127 µM. The positive control, physostigmine, has an inhibitory concentration (IC_{50}) against acetylcholinesterase and butyrylcholinesterase of 0.041µM and 0.857 µM, respectively (Tabassum, 2016).

Immunopharmacological activity:
The immunopharmacological action of the *S. samarangense* flavonoids was examined. Human peripheral blood mononuclear cells (PBMCs) were used as the target cells, and 3H-thymidine uptake was used to evaluate cell growth. Strobopinin, myricetin, alpha-rhamnopyranoside, epigallocatechin, and myricetin alpha-rhamnopyranoside among the flavanoids demonstrated inhibitory effectiveness on PBMC proliferation induced

by phytohemagglutinin (PHA). Compounds 1, 2, 3 and 4 had IC_{50} values of 36.3, 11.9, 28.9, and 75.6 µM on the proliferation of activated PBMCs, respectively. Since compounds 1, 2, 3, and 4 lowered the production of interleukin-2 (IL-2) and interferon-gamma (IFN-gamma), the inhibitory mechanisms may entail inhibiting these cytokines and IFN gamma production in PBMC in a dose-dependent manner (Tabassum, 2016).

Central nervous system (CNS) activity:

The plant *Syzygium Samarangense* has potential as a medication. The purpose was to assess the methanolic extract of leaves' analgesic, anti-inflammatory, and CNS effects in mice. Induced writhing in acetic acid and formalin tests were used to evaluate the analgesic efficacy. Utilizing a model of hind paw edoema brought on by carrageenan, the anti-inflammatory action was investigated. The acetic acid-induced writhing and formalin tests, which were administered at dosages of 200 mg/kg body weight and 100 mg/kg body weight, respectively, and were used to evaluate the analgesic potency of the methanolic extract of leaves. The results of the study revealed that *S. Samarangense* leaf methanolic extract had exceptional analgesic, moderate anti-inflammatory, and considerable CNS effects, conforming to the traditional use of this plant for inflammatory pain relief (Antora, 2016).

Thrombolytic and spasmolytic activity:
In comparison to distilled water served as the negative control (5.55 ± 1.20 percent), while the positive control was the streptokinase drug (75.00 ± 2.60 percent) methanolic extract of *S. samarangense* leaves efficiently showed thrombolytic activity by its considerable clot lysis activity (32.73 ± 2.57 percent) (Hossain *et al*., 2020). The contracting isolated rabbit jejunum was shown to be eased by n-hexane extract of jambu semarang in an in vivo spasmolytic activity investigation (Lim, 2012).

Antibactirial activity:
The methanolic and petroleum ether extracts of *S. samarangense* displayed notable antibacterial action on several pathogens, according to Asian Journal of Biochemical and Pharmaceutical Research. By employing the 96-well microtitre plate method and the microdilution method, the minimal concentrations of bacterial and fungal growth and inhibition were determined. The inhibitory impact likewise grows as the disc dosage level does. The extracts were demonstrated to be stronger gram negative bacteria inhibitors than gram positive bacteria (Tabassum, 2016).

Antiviral activity:
Oleanic acid has a reputation for being a powerful anti-HIV agent. In the leaves *of S. samarangense* several chemicals are also found (Tarigan *et al*., 2021). Oleanolic acid, an anti-HIV compound and ursolic acid have also been isolated from leaves. Both oleanolic acid and ursolic acid were found effective in protecting against chemically induced liver injury in laboratory animals. The Oleanolic acid has been marketed in China as an oral drug for human liver disorders. The oleanolic acid and ursolic acid have also been long recognized to have anti-inflammatory and antihyperlipidemic properties in laboratory animals. Oleanolic acid and ursolic acid are relatively nontoxic, and have been used in cosmetics and health products (Liu, 1995). Oleanolic acid also possessed anti-HIV activity. Studies showed that oleanolic acid inhibited the human immunodeficiency virus-1 (HIV-1) replication in all the cellular systems (cultures of human peripheral mononuclear cells (PBMC) and of monocyte/ macrophages) (Mengoni *et al*., 2002).

Analgesic and Anti-Inflammatory activity:
To evaluate the analgesic and anti-Inflammatory activity the 6.25 mg/kg body weight and 12.5 mg/kg body weight were the appropriate amountsof doses which were used, 24-methylenecycloartanyl stearate, cycloartenyl stearate, lupenyl stearate sand sitosteryl stearate from the air-dried leaves of *Syzygium samarangense* displayed significant analgesic and anti-inflammatory effects, respectively. Additionally, it has a very low harmful effect on the embryonic tissues of zebra fish. There were deaths after sample 1 was exposed directly to dechorionated embryos, but the treatment with intact chorion resulted in more deaths and aberrations (Tabassum, 2016).

Antihyperglycaemic activity:
In one of the study it was found that, together with their isomeric flavanone 5-O-methyl- 4' -desmethoxymatte When 3 was isolated from leaves and given 15 minutes after a glucose load, it considerably reduced blood glucose levels (BGLs) in glucose-hyperglycaemic mice, demonstrating that it has antihyperglycemic properties (Tabassum, 2016).

Cytotoxic activity:

Human breast cancer (HeLa) cells were shown to be cytotoxic by an ethanolic preparation of jambu leaves. A dose-dependent pattern effect was seen after viable cancer cells were incubated with various extract doses; the IC50 value was 40.5 mg/ml. Preliminary screening indicates that the cytotoxicity activity of *S. samarangense* extract is caused by fatty acids, alkaloids, flavonoids, terpenoids, saponins, tannins, and steroids (Mini *et al*., 2019). This extract for cytotoxic properties were also used for testing against two additional tumour cell lines, HepG2 and MDA-MB-231, which shows strong cytotoxic properties with respective potencies ranging from 1.73-32.90 µM and 4.02-37.83 µM (Yang *et al*., 2018).

Antimicrobial activity:
The several phenolics that kill bacteria or decrease virulence factors are often linked to antimicrobial activity. Infectious bacteria that cause diarrhoea are both enteric and nosocomial, including *E. coli, Klebsiella oxytoca* (KO), *K. pneumoniae, P. vulgaris, P. aeruginosa, S. enteritidis, S. paratyphi, S. typhimurium, S. dysenteriae* and *S. sonnei* showed antimicrobial activity in volatile oils (Veeresham *et al*., 2012). By using the microdilution method the antibacterial activity of *S. semarangense* volatile oil was determined to be particularly active against *S. typhimurium*, with an IC50 of 0.17±0.005%v/v (Adesegun *et al*., 2013). Recent research into the antibacterial impact of volatile oil from leaves revealed that *E. coli* 25922 growth was inhibited with an IC50 of 0.42 % (v/v). Another investigation on the volatile oil of *S. samarangese* found that the oil had better action against Gram-positive bacteria with *B. spizizenii* being the most vulnerable than Gram-negative bacteria (Choirani and Fareza, 2018).

STEM/BARK:

Analgesic activity:
The acetic acid-induced writhing and formalin test were used to assess the analgesic efficacy of an ethanolic extract of jamb bark. The outcomes showed that the extract, at doses of 100 mg/kg and 200 mg/kg, decreased the number of writhing and licking repeats caused by formalin and acetic acid, respectively. An ethanolic extract of the barks was used in a preclinical research on Swiss-Alpino mice at dosages of 100 mg and 200 mg per kilogramme of body weight revealed a strong depressive effect manifested by a decrease in activity involving movement, open-field exploration and a hole cross testing (Tarigan *et al*., 2021).

Anthelmintic activity:
The paralysis and mortality rate effect of living parasites was traditionally tested in an anthelmintic investigation. When compared to the common anthelmintic medicine albendazole, ethanolic extract of barks likewise showed antihelmintic action. The extract was tested at 25, 50, 100, and 200 mg/ml in both investigations. These two investigations' time estimations revealed that larger extract concentrations resulted in faster paralysis and death. The effect of methanolic leaves extract on paralysis and mortality of anthelmintics parasites at 200 mg/dl was used to determine the vermicidal activity of the extract (Hossain et *al*., 2020). In vitro testing revealed that the impact was dosage dependant and statistically significant (Gayen *et al*., 2016).

FRUITS:

Antidiabetic activity:
Flavanoids isolated from *S. samarangense* were found to have antihyperglycemic action in diabetic mice treated with alloxan. The aqueous fruit extract of jambu semarang increased glycogen storage, glycolysis, and gluconeogenesis activity, as well as the expression of the enzymes such as aldolase, glucose-6-phosphate dehydrogenase (G6PD), hexokinase (HXK), glycogen synthase (GS) and phosphofructokinase expression (PFK) which could help to reduce hyperglycemia in diabetes mellitus (DM) type 2. The study looked at the absorption of 2-[N-(7-nitrobenz-2-oxa-1, 3-diazol-4-yl)amino] in FL83B mouse hepatocytes that had been treated with TNF to induce insulin resistance 2-deoxyglucose (2 NBDG), a fluorescent D-glucose derivative, was used in a Western blot experiment. In a diabetic rat model, vescalagin was found to treat hyperglycemia by lowering glucose levels after an oral glucose tolerance test. It also lowered the concentrations of tumour necrosis factor (TNF), advanced glycation end products (AGEs) and cardiovascular risk index. To avoid -cell damage from MG-induced carbohydrate metabolic problem in rats, antiglycation was aided by boosting D-lactate, which inhibits AGE formation, and lowering cytokine release. Vescalagin has been shown to have anti-diabetic properties in this research (Tarigan *et al*., 2021).

Anticancer activity:
The antioxidant properties of ethanolic extracts of fruit powder indicated that the java apple fruit is advantageous to human health. Methanolic extracts of the pulp and seeds of *Syzygium samarangense* fruits

revealed four cytotoxic flavanoid chemicals and eight antioxidant compounds, according to studies (Simirgiotis *et al*., 2008).

Hepatoprotective activity:
The fruits of *S. samarangense* have been shown to protect mice against alcohol-induced liver damage. Chronic alcohol exposure raised Total bilirubin (TB), alanine transaminase (ALT), aspartate transaminase (AST), triglyceride (TG) and malondialdehyde (MDA) levels, while decreasing total protein levels (TP). These biochemical markers were brought back to normal with the fruit extract which proves that it has a hepatoprotective activity (Zhang *et al*., 2016).

Antioxidant activity:
Fruits were examined for *S. samarangense*'s antioxidant properties. For this, their fully developed fruits were first cut into little pieces, dried in the sun, and then ground into a powder using a grinder. Fruit powder ethanolic extracts were made using ethanol that was 99.99% ethanol. Using the extracts' capacity to scavenge the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radical as a gauge, the antioxidative actions of the compounds were identified. Antioxidant activity was examined to be present in the ethanolic extracts of *S. samarangense*. The S. samarangense ethanolic extract had an IC50 of 200 /mL. This suggests that the fruit is healthy for people (Antora, 2016).

PULP:

Anticancer activity:
The MTT (3-(4,5-dimethylthiazol-2-yl)-2-5-diphenyltetrazolium bromide) assay was used to examine the anti-colon cancer effectiveness of *S. samarangense* pulp in methanol extract using the SW-480 human colon cancer cell line as a positive control. The findings revealed a high level of toxicity towards cancer cells, and more toxicity research is needed (Chua *et al*., 2019).

WHOLE PLANT:

Anxiolytic activity:
The light and dark box test (LDB) was used to assess the anxiolytic efficacy of *S. samarangense* methanol extract at doses of 200 and 400 mg/kg body weight. In comparison to diazepam 28.50 ± 2.31 and 254.00 ± 7.34 second as the standard, the extract showed that more animal models crossed paths and spent longer periods of time in either the light or dark boxes respectively, at 29.67 ± 2.71 and 230.80 ± 16.39 seconds by using an elevated plus maze (EPM) and anxiolytic action was also determined. The test revealed that, as compared to the negative control group, this extract increased the proportion of entries and length required in the open arm. This study also shows a substantial dose-dependent effect statistically (Hossain et *al*., 2020).

Anti-inflammatory activity:
The albumin denaturation assay, ethyl acetate, methanol and water root extract were found to have antiinflammatory properties. The most active extract was methanolic extract, which was followed by water and ethyl acetate extract, in that order (Aung *et al*., 2020). The ethanolic extract of barks was also found to have anti-inflammatory properties in mice. This study used a carrageenan-induced hind paw edoema model and at the dosages of 100 mg/kg and 200 mg/kg, inhibition emerged after four hours in a dose-dependent manner (Mollika *et al*., 2014).

NUTRITIVE/MEDICINAL PROPERTIES:
The nutrient composition of *S. samarangense* fruit per 100 g edible portion was reported as: water 91.5 g, energy 30 kcal, Contains 0.4 g of protein, 0.1 g of fat, 7.8 g of carbohydrates, 0.8 g of fibre, and 0.2 g of ash. Ca 17 mg, P 9 mg, Fe 0.3 mg, Na 2 mg, K 105 mg, b-carotene 0 mg, thiamin 0.03 mg, riboflavin 0.01 mg, niacin 0.3 mg, and ascorbic acid 13 mg are the other components of the supplement. Another analysis conducted in Australia reported that wax jambu had the following food value per 100 g edible portion (Tabassum, 2016), water 90.3%, protein 0.7 g, fat 0.2 g, glucose 2.1 g, fructose 2.4 g, dietary fibre 1.9 g, malic acid 0.10 g, citric acid 0.12 g, oxalic acid 0.02 g, energy 94 kJ, vitamin C 8 mg, thiamin 0.02 mg, riboflavin 0.04 mg, niacin 0.5 mg, K 38 mg, Na 1 mg, Ca 13 mg, Mg 5 mg, Fe 0.8 mg and Zn 0.1 mg. A total of 39 volatile constituents were identified in wax jambu (*S. samarangense*) (Wong and Lai 1996). The volatiles of wax jambu were characterized by the presence of a large number of C9 aldehydes and alcohols. The aerial parts of *Syzygium samarangense* were utilised to isolate ursolic acid, jacoumaric acid, and arjunolic acid employing the original

form of methyl 3-epi-betulinate and 4,6-dihydroxy-2-methoxy-3, 5-dimethyl chalcone as a triterpene (Srivastava *et al*., 1995).

CONCLUSION:

Syzygium samarangense (Blume) Merr. & Perry (Jamb) shows minimum phytochemical and pharmacological activities from various parts of plant like flower, leaves, stem, bark, fruits, pulp, seed and roots has tannins, flavonoids, alakloids, carbohydrates, saponins, terpenoids and amino acids, etc. The leaves, stem, bark, fruits and pulp shows antidiarrhoeal activity, hepatoprotective activity, anticholinesterase activity, immunopharmacological activity, Central Nervous System (CNS) activity, thrombolytic activity and spasmolytic activity, antibacterial activity, antiviral activity, anti-inflammatory activity, antihyperglycaemic activity, cytotoxic activity, antimicrobial activity, analgesic activity, anthelmintic activity, antidiabetic activity, anticancer activity, antioxidant activity, anxiolytic activity and anti-inflammatory activity.

FUTURE PROSPECTS:

From the above information it has been observed that almost every parts of the plants like flowers, leaves, stem, bark, fruits, roots, pulp and seeds shows so many phytochemicals which has a various pharmacological action (acticities) which can be used as a medicinal purpose. Various researches on the medicinal use of plant extract is must in the modern era as many chemically synthesized drugs are highly effective in causing many adverse effects in the humans. The phytochemical and pharmacological investigations carried out on *S. samarangense* validate the immense potential of this plant in the treatment of numerous diseases. Additional researches are needed for the compound isolation and identification for the product development from *S. samarangense* for the future generations. Every medicinal property of many medicinal plants are also to be determined. So, this plant can be exploited as it has a very less activity.

REFERENCES:

1) Adesegun, S. A., Samuel, O. F., Anthony, B. O., Folasade, B. O., & Mary, S. K. (2013). Essential Oil of Syzygium samarangense; A Potent antimicrobial and inhibitor of partially purified and characterized extracellular protease of Escherichia coli 25922. *British Journal of Pharmacology and Toxicology*, *4*(6), 215-221.
2) Ahmad, B., Baider, C., Bernardini, B., Biffin, E., Brambach, F., Burslem, D., ... & Wilson, P. G. (2016). *Syzygium (Myrtaceae): Monographing a taxonomic giant via 22 coordinated regional revisions* (No. e1930v1). PeerJ Preprints.
3) Alam, M. (2017). *A Pharmacological Investigation on CNS Activity of Methanolic Extract of Syzygium samarangense Leaves* (Doctoral dissertation, East West University).
4) Antora, H. H. (2016). *Cytotoxic, antimicrobial & antioxidant activity of Ethyl Acetate Fraction of Syzygium Samarangense leaves extract* (Doctoral dissertation, East West University).
5) Aung, E. E., Kristanti, A. N., Aminah, N. S., Takaya, Y., & Ramadhan, R. (2020). Plant description, phytochemical constituents and bioactivities of Syzygium genus: A review. *Open Chemistry*, *18*(1), 1256-1281.
6) Choironi, N. A., & Fareza, M. S. (2018). Phytochemical screening and antibacterial activity of ethanolic extract of Syzygium samarangense leaves. *Jurnal Kartika Kimia*, *1*(1), 1-4.
7) Chua, L. K., Lim, C. L., Ling, A. P. K., Chye, S. M., & Koh, R. Y. (2019). Anticancer potential of Syzygium species: a review. *Plant Foods for Human Nutrition*, *74*(1), 18-27.
8) Comalada, M., Camuesco, D., Sierra, S., Ballester, I., Xaus, J., Gálvez, J., & Zarzuelo, A. (2005). In vivo quercitrin anti-inflammatory effect involves release of quercetin, which inhibits inflammation through down-regulation of the NF-κB pathway. *European journal of immunology*, *35*(2), 584-592.
9) Gayen, P. R., Al Hossain, A. M., Saifuzzaman, M., & Faroque, A. B. M. (2016). Anthelmintic activity of ethanolic extract of Syzygium samarangense (Blume) Merril & Perry. *Dhaka University Journal of Pharmaceutical Sciences*, *15*(1), 109-111.
10) Hossain, R., Rahman, M. A., Rafi, M. K., Siddique, T. A., Noman, A. A., Makki, A., ... & Tangpong, J. (2020). Pharmacological and ADMET-based pharmacokinetic properties of Syzygium samarangense var. parviflorum leaf extract in in vitro, in vivo and in silico models. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *48*(3), 1155-1175.
11) Jagtap, U. B., & Bapat, V. A. (2010). Artocarpus: A review of its traditional uses, phytochemistry and pharmacology. *Journal of ethnopharmacology*, *129*(2), 142-166.

12) Khandaker, M. M. (2012). *Growth, development and quality of wax apple (Syzygium samarangense [Blume] Merrill & LM Perry) fruits as influenced by selected horticultural techniques* (Doctoral dissertation, University of Malaya).
13) Kirtikar, K. R. and Basu, B. D. (1988). Indian Medicinal Plants. Dehradun: International Book Distributors.
14) Lakshmi, V. J., Manasa, K., & Ranajit, S. K. (2021). Various Phytochemical Constituents and Their Potential Pharmacological Activities of Plants of the Genus Syzygium. *Ajptr*, *11*(2), 68-85.
15) Lawal, O. A., Ogunwande, I. A., Bullem, C. A., Taiwo, O. T., & Opoku, A. R. (2014). Essential oil composition and in vitro biological activities of three Szyzgium species from Nigeria. *New Developments in Terpene Research (Jinnan, H. ed.), Nova Science Publisher Inc, New York*, 93-112.
16) Lim, T. K. (2012). Syzygium samarangense. In *Edible Medicinal And Non Medicinal Plants* (pp. 778-786). Springer, Dordrecht.
17) Liu, J. (1995). Pharmacology of oleanolic acid and ursolic acid. *Journal of ethnopharmacology*, *49*(2), 57-68.
18) Madhavi, M., & Ram, M. R. (2015). Phytochemical screening and evaluation of biological activity of root extracts of *syzygium samarangense*. International journal of research in pharmacy and chemistry, 5(4), 753-763.
19) Mengoni, F., Lichtner, M., Battinelli, L., Marzi, M., Mastroianni, C. M., Vullo, V., & Mazzanti, G. (2002). In vitro anti-HIV activity of oleanolic acid on infected human mononuclear cells. *Planta Medica*, *68*(02), 111-114.
20) Mini, R., Vimaladevi, K., Prabhu, V., Anusuya, M., & Saranya, K. S. (2019). In vitro cytotoxicity potential of ethanol extract of Syzygium samarangense (Wt.). *Kongunadu Research Journal*, *6*(1), 30-32.
21) Molika S., L., Nesa, S., Munira, M., Islam, W., Sayem and N., Parvin (2013). Evaluation of analgesic , anti-inflammatory and CNS activities of the methanolic extract of Syzygium Samarangense bark. 3:11, 12-13.
22) Mollika, S., Islam, N., Parvin, N., Kabir, A., Sayem, M. W., & Luthfunnesa, S. R. (2014). Evaluation of analgesic, anti-inflammatory and CNS activities of the methanolic extract of Syzygium samarangense leave. *Global J Pharmacol*, *8*(1), 39-s46.
23) Morton, J. (1987). Java apple. In: Morton, J. F. (Ed.), Fruits of Warm Climates. Miami, FL., Inc., Wintervine, NC, 381-382.
24) Nigam, V., Nigm, R., and Sing, A. (2012). Distribution and medicinal properties of Syzygium species. *Current Research in Pharmaceutical Sciences*, 73-80.
25) Peter, T., Padmavathi, D., Sajini, R. J., & Sarala, A. (2011). Syzygium samarangense: a review on morphology, phytochemistry & pharmacological aspects. *Asian Journal of Biochemical and Pharmaceutical Research*, *1*(4), 155-163.
26) Rakesh R Shukla, (2013). JAMBU (*Syzygium cumini*) - A FRUIT OF GODS.2:86-91.
27) Resurreccion-Magno, M. H. C., Villaseñor, I. M., Harada, N., & Monde, K. (2005). Antihyperglycaemic flavonoids from Syzygium samarangense (Blume) merr. and perry. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, *19*(3), 246-251.
28) Sharma, P., & Mehta, P.M, (1969). Dravyaguna vignyan: Part II and III. *Varanasi: The Chowkhamba Vidyabhawan*, 586.
29) Simirgiotis, M. J., Adachi, S., To, S., Yang, H., Reynertson, K. A., Basile, M. J., ... & Kennelly, E. J. (2008). Cytotoxic chalcones and antioxidants from the fruits of Syzygium samarangense (Wax Jambu). *Food chemistry*, *107*(2), 813-819.
30) Sobeh, M., Youssef, F. S., Esmat, A., Petruk, G., El-Khatib, A. H., Monti, D. M., ... & Wink, M. (2018). High resolution UPLC-MS/MS profiling of polyphenolics in the methanol extract of Syzygium samarangense leaves and its hepatoprotective activity in rats with CCl4-induced hepatic damage. *Food and Chemical Toxicology*, *113*, 145-153.
31) Srivastava, R., Shaw, A. K., & Kulshreshtha, D. K. (1995). Triterpenoids and chalcone from Syzygium samarangense. *Phytochemistry*, *38*(3), 687-689.
32) Tabassum, K. S. (2016). *Phytochemical and Pharmacological Investigation on Syzygium samarangense Leaf* (Doctoral dissertation, East West University).
33) Tarigan, C., Pramastya, H., Insanu, M., & Fidrianny, I. (2021). Syzygium Samarangense: Review of Phytochemical Compounds and Pharmacological Activities.
34) Tehrani, M. (2012). *Postharvest physiological and biochemical characteristics of Syzygium samarangense fruits* (Doctoral dissertation, University of Malaya).

35) Van, H. T., Tran, Q. T., Tran, T. T. H., Tran, N. B., Huynh, N. T., Nguyen, K. B., ... & Phan, U. T. X. (2020). Chemical Constituents and Bacterial Activity of Essential Oils of Five Wax Apples (Syzygium samarangense) from Dong Thap Province, Vietnam. *Agriculturae Conspectus Scientificus*, *85*(2), 145-152.
36) Veeresham, C. (2012). Natural products derived from plants as a source of drugs. *Journal of advanced pharmaceutical technology & research*, *3*(4), 200.
37) Wong, K. C., & Lai, F. Y. (1996). Volatile constituents from the fruits of four Syzygium species grown in Malaysia. *Flavour and Fragrance Journal*, *11*(1), 61-66.
38) Wrigley, J. W., & Fagg, M. (2013). *Australian native plants: cultivation, use in landscaping and propagation*. Reed New Holland.
39) Yang, J., Su, J. C., Lei, X. P., Huang, X. J., Zhang, D. M., Ye, W. C., & Wang, Y. (2018). Acylphloroglucinol derivatives from the leaves of Syzygium samarangense and their cytotoxic activities. *Fitoterapia*, *129*, 1-6.
40) Zhang, Y. J., Zhou, T., Wang, F., Zhou, Y., Li, Y., Zhang, J. J., ... & Li, H. B. (2016). The effects of Syzygium samarangense, Passiflora edulis and Solanum muricatum on alcohol-induced liver injury. *International Journal of Molecular Sciences*, *17*(10), 1616.