Phytochemical evaluation, pharmacological activities, medicinal and traditional uses of *Syzygium samarangense*

Spoorthi TC[1], Nandana Satheesh BS[2], Anugrah A[3], Doniya Kunjumon[4]

Department of Pharmacology, Bharathi college of pharmacy, Karnataka, India

ABSTRACT

Syzygium Samarangense (jamb) is a 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 rich in volatile oils that are recorded for their usefulness in medicine. The growth and development of this fruit is sometimes very low due to low photosynthates supply at early growth stages. As we know it is most commonly cultivated in Southeastern Asian countries mainly in Taiwan, in Taiwan it is the main fruit crop. The name of the plant and species varies according to the region where it is cultivated, and need adequate rainfall and water to grow, blooms all over the year. It belongs to the family Myrtaceae. Syzygium samarangense is traditionally used as astringent. It is also used to treat fever and halt diarrhoea. These extracts of wax fruits, flower and bark have potent free radical scavenging, anti-oxidation, antimutation and anti-cancer activities. Wax apple is studied for its numerous pharmacological properties such as antidiabetic properties, anti-inflammation and antinociceptive activity, wound healing activity, antiulcerogenic effect, antibacterial, anticancer and also it is potent as an uterotonic agent. This plant shows the presence of flavonoids, terpenoids, saponins, steroids, carbohydrates, sugar, tannins and phenolic compounds. We can observe Anxiolytic activity and Anti-inflammatory activity in whole plant and antidiabetic activity and anti-microbial activity in leaves. This review paper provides detail information about wax apple botany, Phyto chemical studies, pharmacological aspects, main therapeutic uses of the leaves part and medicinal benefits.

KEYWORDS: *Syzygium samarangense, taxonomy, botany, phytochemical constituent, pharmacological activity, medicinal uses*

1. INTRODUCTION

Plants are an essential component of the universe. Human beings have used plants as medicine from the very beginning of time. After various observations experiments medicinal plants were identified as a source of important medicine, therefore, treatment through these medicinal plants, began in the early stages of human civilization. The use of these medicinal plants is increasing in many countries where 35% of drugs contain natural products. Presently we are using thousands of plant metabolites in the treatment of various diseases. The beneficial medicinal effects of plant materials typically result from the combination of secondary product present in the plant such as alkaloids, steroids, tannin, phenol compounds, resins, gums, flavonoids, and fatty acids which are capable of producing definite physiological action on body. The botanical name of wax apple is ***Syzygium samarangense***. Java apple is commonly named as Jaman, black plum, Wax jambu, wax apple. It is widely distributed and cultivated throughout Malaysia, Thailand, India, Indonesia, Laos, Vietnam, Taiwan. The wax apple tree is ever green, semi deciduous growing only at lower altitudes upto1,220m in India (Mortan JF. 1987).

The phytochemical analysis of leaves shows the presence of chalcones, proanthocyanidins, triterpenoids, anthocyanidins, flavanol, glycosides, ellagin tannins. The volatile oil of leaf extract shows high concentration of terpenoids, tannins. The ethanolic extract of leaf shows high antibacterial activity, and also shows astringent

activity for some extent. Wax apple has anti-oxidant activity property, plant extract shows anti-diabetic, anti-hyperglycaemic, anticancer, immunomodulatory activity.

1.1 Vernacular names

English: Jaman, Jambolan, Black plum, Wax jambu, Wax apple (Khandekar, M. M. 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, Telugu: Neereedu, Assam: Jamu, Burma: Thabyebyu, Oriya: Jamo, Jamkuli, Bhotojam, Chuajamo, Jamo, Urudu: Jaman, Phalenda (Sharma, P., and Mehta, P.M, 1969).

1.2 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)

Fig – 1: *Syzygium samarangense* plant

1.3 Taxonomical classification

Table no.2: Taxonomic 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

2. 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 discoloured, 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 is orbicular to spathulate, 10-15mm long and yellow to white in colour 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 flavourfully 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, sub globose seed or a pair of subs globose to hemispherical 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. The date varies from year to year, but the trees have distinct flowering seasons, frequently twice and occasionally three times per year (Tehrani, 2012).

3. PHYTOCHEMICAL EVALUATION

Whole plant of *Syzygium samarangense* contains flavonoids, terpenoids, tannins, phenolic compounds. 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, curcumins, saponins and phenolics (Aung, 2020).

Table no.3: Phytochemicals present in the *Syzygium samarangense* (Jamb)

Plant parts	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, botulinic acid and crotegolic acid.
Fruits	Quercitrin- 3-rhamnosylquercetin.
Pulp	Hyperin.
Seed	Myricitrin, -Myricetin-3-O-α-rhamnoside. Terpenoids, alkaloids, carbohydrates, saponins, tannins, flavonoids, phenolic compounds. Proteins and amino acids.
Roots	Butanol (Jgapat and Bapat, 2010).

Table no.4: Methods and results of qualitative chemical tests

Phytochemicals	Qualitative detection method
Flavonoids	Few drops of 10% $FeCl_3$ solution was added to 1 mL of sample. A green or blue colour would indicate the presence of flavonoids.
Tannin	To 0.5 mL sample and few drops of HNO_3 was added. The reddish to yellow colour of the solution would indicate the presence of tannins.

Cardiac glycosides	0.5 mL of sample were evaporated and dissolved in 1 mL glacial acetic acid. 1 drop of 10% FeCl3 solution followed by 1 mL of Conc. H_2SO_4 was added by the side of test tube. Appearance of brown colour rings at the interface would indicate the presence of cardiac glycosides.
Protein	1 mL of 4% NaOH solution and a few drops of 1% CuSO4 solution were added to 3 mL of sample solution. A violet or pink colour would indicate presence of protein.
Coumarin	Few drops of NaOH solution were added to 1 mL of sample. Yellow coloration would indicate the presence of coumarin
Terpenoid	50 µL sample was evaporated. The remaining was dissolved in chloroform and concentrated H2SO4 was added from the sidewall of test tubes. Formation of red to reddish-brown coloration at the base would confirm the presence of terpenoids.
Steroid	For test of 0.5 mL samples were evaporated and dissolved in 2 mL chloroform. 2 mL of Conc. H_2SO_4 was introduced carefully by the sidewall of the test tube. Formation of red colour ring would confirm the presence of steroid.
Phenol	5 mg $FeCl_3$ was added to 1 mL of sample, followed by vigorous shaking. Green coloration would indicate the presence of Phenol
Starch	Iodine solution wax added drop by drop into the sample. Dark blue coloration would indicate the presence of starch.
Reducing sugar	Benedict's reagent was added to the sample, heated and it turns yellowish-orange. The final colour would confirm the presence of reducing sugar.

4. ECOLOGY AND DISTRIBUTION OF WAX APPLE

The tree is almost unknown outside southeastern Asia and is an economically important fruit crop in Taiwan (Shu et al., 1996). The 'Pink' ('Nun-Young' in Chinese) cultivar represents 99% of the planted area in Taiwan (Wang, 1991). The regular blooming time for 'Pink' is around March in Taiwan (young, 1951). However, 'Pink' blooms and sets fruit almost year- round after flowering (Shu et al., 1996; Wang, 1991). As a result, fruits at different growing stages could be found in different orchards, different trees and even on the same tree. Located at the centre of origin, Indonesia has a huge amount of variety with great diversity. Pale Green, Dark red, Light red and Green are the four major Indonesian varieties. Fruit production is non seasonal; however, the peak periods are in March to April and November to December. Majorly wax apple is cultivated in Thailand, Phet Jin Da, Number one, Phet Sam Phran, Dang Indo, Phet Nam Pueng, Thub thim chan. Fruits can be harvested all the year round. Despite its name, this cultivar produces fruits varying from pink to deep red, depending on environmental and cultural conditions (Shu et al., 2001). It has been also reported that the photosynthetic yield had a strong corelation with the fruit biomass among the three cultivars, Jambu madu red and Masam Manis pink cultivars are comparatively better than 'Giant Green' cultivar if cultivated under South Asian conditions. Wax apple grows best in areas with a fairly long dry season. This does not mean that this species is drought-resistant.

The species needs reliable water supply and are often planted near streams or ponds. Current distribution ranges from India through South east to Pacific Islands (the Malay apple features in Fijian mythology. *S. samarangense* is the most popular among the three species grown in South East Asia (Chang et al., 2003). Now, the tree is cultivated throughout the tropics as far as East of the Hawaii, and Central and South America (Whistler and Craig, 2006). Presently, wax apple cultivated in Indonesia Islands of Java, Philippines, Thailand and other South East Asian countries. China's Guangdong, Hainan, Fujian, Guangxi, Yunnan, and Sichuan, provinces have a small area of cultivation. The black pearl wax apples and black diamond wax have greatest value.

5. PHARMACOLOGICAL ACTIVITY

Table no.5: Pharmacological activities of *Syzygium samarangense*

Plant's part	Activity
Leaves	Antidiarrheal activity, Hepatoprotective activity, Anticholinesterase activity, Immunopharmacological activity, Central nervous system (CNS) activity, Thrombolytic and spasmolytic activity, Antibacterial activity, Antiviral activity, Analgesic and Anti-Inflammatory activity, Antihyperglycemic activity, Cytotoxic activity, Anti-microbial 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.

Antioxidant Activity

The ethanolic extract of *Syzygium samarangense* exhibit good anti -oxidant activity this can be evaluated by DPPH method when compared with standard ascorbic acid and also than the total phenolic content and co relation studies (Khandaker et al., 2012). From the results we can conclude that fruit have higher anti-oxidant activity than leaf extract and increased phenolic content have better free radical scavenging effect (Majumder et al., 2017). This anti-oxidant activity may be due to presence of Chalcones, Quercetin compound, Hyperin, myricitrin, quercitrin, quercetin, and guaijaverin. One flavanone –(s)- pinocembrin, two phenolic acids – gallic acid and ellagic acid. Leaves were fractionated by using hexane, ethyl acetate and methanol.

Anti- microbial activity

The anti -microbial screening of *Syzygium samarangense* fruit is evaluated by different methods.

The methanolic extract of *S. Samarangense best* antimicrobial activity against all bacterial strains (bacillus cereus, staphylococcus aureus, E. coli, pseudomonas aeruginosa). Antimicrobial activity of bark, leaves, fruits of *S. Samarangense* was identified (Khandaker et al., 2012; Napish et al., 1970). Ethanolic extract of bark have more activity than others.

Anti- diabetic activity

The leaf extract of methanol of *Syzygium samarangense* have more hyper glycaemic activity the Chalcones present in the leaves of *Syzygium Samarangense* have anti -diabetic activity (Resurreccion -Magno et al., 2005).

Cytotoxic activity

Syzygium samarangense exhibit cytotoxic activity against SW-480 human colon cancer cell line and human mammary adenocarcinoma MCF-7 and SKBR-3 (Simirgiotis et al., 2008b; Yang et al., 2018). They have done the extraction process using methanol and partitioned with hexane, ethyl acetate and n-butanol. The studies identified four cytotoxic chalcone compounds such as 2',4'-dihydroxy, 3'5'-dimethyl 6'-methoxy chalcone, stercurensin, cardamonin and (S) -pinocembrin. Acylphloroglucinol derivates such as samarone A, B, C, D from the leaf extract of Syzygium Samarangense tested for their cytotoxic effects on HePG2 and MDA-MB-231 cells (Yang et al., 2018).

Anti-diarrheal and Anti-helminthic activity

The hexane leaf extract of *Syzygium samarangense* leaf proved. The extract was subjected to isolated rabbit jejunum smooth muscle which was contracted by k+ channel and the relaxation in dose dependent manner (Boltan, 1979). Anthelmintic activity was done in clean matured round worm Haemonchus contortus using ethanolic extract *Syzygium samarangense* bark. Albendazole was used as standard drug showed paralysis of parasites.

CNS Depressant Activity

The methanolic extract of leaves of *Syzygium samarangense* shows anti-inflammatory and CNS depressant. Methanol extract of *Syzygium samarangense* shows suppressed licking activity. The methanolic extract can be used as alternative herbal remedy for the treatment of analgesic, inflammatory and depressant disease.

6. MEDICINAL AND TRADITIONAL USES

The plant of S. Samarangense have many medicinal properties. It can be used in dry coughs. The, flowers which contain tannins, desmethoxymatteucinol, 5-O-methyl-40-desmethoxymatteucinol, Oleanic acid and b-sitosterol, are used to treat fever and halt diarrhoea (Mortan JF., 1987). Fruits can be used as tonic for brain, liver problems, as an astringent, digestive in India (Kritikar and Basu, 1988). The root and bark decoction can be used to treat dysentery and amenorrhea and abortifacient. Root is diuretic and used to treat oedema. Dry root can be used to treat itching, most commonly used by Malayans. Powdered leaves are used to treat cracked tongue. Leaf juice is employed in baths, lotions. Other uses are as follows headaches, diabetes, cough, cold, itches, waist

pain, mouthwash, solutions for treatment thrush and its juice to cure wounds. Decoction of stem for diarrhoea (Peter et al., 2011).

7. CONCLUSION

Syzygium samarangense (blume) Merr. & Perry (Jamb) shows satisfying pharmacological activity and its phytochemical constituents are found to be flavonoids, tannins, cardiac glycosides, phenolic compounds, starch, protein, terpenoid, coumarin, starch, steroid. It is commonly grown in sunny season and it is main crop of South Asia countries. Whole plant is useful in the medicinal field the plant part which show the activity are root, leaves, fruit, bark, stem, pulp. The main activities which are promising are Antidiabetic activity, antimicrobial activity, CNS depressant activity, Cytotoxic activity, antidiarrheal activity, anthelmintic activity, antioxidant activity. The ethanolic extract of the leaf shows more activity when compared to ethanolic activity.

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