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Syzygium samarangense : A Review on its Pharmacognostical, Pharmacological and Phytochemical Profile

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ABSTRACT

The objective of this review is to document briefly about the chemical constituents, pharmacognostical evaluation and biological activities of *Syzygium samarangense* belongs to the family *Myrtaceae.* It is generally called Java Apple, Wax Apple, Blume, Chambekka etc. *Syzygium samarangense* traditionally used as an astringent. It is also used to treat fever and halt diarrhea. The whole plant contains flavonoids, terpenoids, tannins, phenolic compounds, gallic acid, ellagic acid, squalene, botulin, lupeol, sitosterol, mixture of cycloartenol stearate, lupenyl stearate, β-sitosterol stearate, vitamins and minerals which bearing anti-oxidant, anti-microbial, hypoglycemic, anti-inflammatory, Immunomodulatory, CNS, Anti-diarrheal, anthelmintic and cytotoxic activities. In this review, different parts of the plant, their phytochemical constituents and their corresponding biological activities have been explored. The literatures reported that the fruit part contains carotene, anthocyanin and vescalagin which is used as antioxidant, anti-microbial and hypoglycemic effect. The leaf part contains myricetin, strobopinine, epigallocatechin, aurentiacin which bearing anti-inflammatory and immunomodulatory effect. The alcoholic extracts of leaves, seeds, root bearing analgesic, anti-inflammatory effect in lipopolysaccharide, antioxidant, cytotoxic activity against human colon cancer cell, the studies revealed that the extracts showed a potent anti-microbial activity against *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Candida albicans* etc. The aqueous extract of fruit prevents diabetes mellitus in rats.

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INTRODUCTION

Syzygium samarangense, commonly known as Wax apple, Wax jambu, Chambekka belongs to the family *Myrtaceae* and generally it is called as eucalyptus family (Orwa *et al.*, 2009) . Around ten varieties of this plants are distributed all over the world. In south-East Asian countries, Malaysia is the major source of these varieties. It is cultivated entire the year and distributed all over the world for edible purpose. It is also distributed in Thailand, Indonesia and in India, especially in Assam, Bihar Maharstra and costal area of western ghats. In India, most commonly present species are namely Javva Apple regionally it is called Jambhul in Marathi, Jamun in

Hindi, Jam in Bengali, Jambu in gujarathi, Nerale in kannada, neereedu in Teluge, Jaman in Urdu. Navel or chammbakka in Malayalam, Neredam in tamil. Morphological characterization of *Syzygium Samarangense* in different countries having different morphological characters. In India, it is growing in sun growing and sunny shade. It requires normal water and it can tolerate more water content. It is long lived plant, having a special character like quick growing plant, ever green tree, it grows best in humid and warm region, and also it is an ornamental plant. It grows in elevation upto 1350 meters. The tree is around 6-8-meter height, with short and crooked trunk and it spread over 4 to 6 meters.

The wood is reddish in colour, hard and coarse. The leaves are opposite, elliptical to elliptical-oblong, 10-25cm X 5-12 cm, leaves are dark bluish green in colour, coriaceous with a thin margin, pointed pellucid, very aromatic when bruised, 3-5 mm long petiole.

Java apple normally flowers in the dry season in the month of January, February and March. The flowers tend to be self-compatible, pink in colour, the java apple may yield a crop of 700 fruits, it was cultivated two to three times per year.

The fruit are pear shaped, matures 40-50 days after anthesis. It is 10cm long, white to glossy red in colour it is also edible, the raw fruit is crunchy, crispy and juicy, it was prepared as a sauce, wine and pickle.

It is used for various medicinal purpose also (Gurib-Fakim, 2006). It is used as an anti-diarrheal, astringent and treat against fever. In folk medicine, the crushed leaves are chewed for cracked tongue, the leaves are used for bathing purpose and used for the preparation of lotions.

Fruits are used for mouth ulcer, increased urine volume, induced blood flow to pelvic and uterus, abortifacient and febrifuge. The fruit water decoction is also used for fever. The root portion of *Syzygium Samarangense* induces the abortion and stop the mensural cycle.

Root is also used for edema; the powdered root is used for the treatment of itching the skin. The bark and stem are used for the treatment of wounds.

The java apple leaves contain tannins, flavonoids, glycosides, terpenoids, chalcones. It may cause better therapeutic effect against diabetic infections, antioxidant and immunomodulation. The fruit of java apple consist of rich phenolic compounds like flavonoids, tannins etc. The main aim of this review is focused on to provide pharmacognostical and Phyto pharmacological information from the various parts of *Syzygium Samarangense.*

MATERIALS AND METHODS

Pharmacognostical Evaluation

The pharmacognostical studies of *Syzygium Samarangense* was discussed in many articles. More than thousand tropical species of Syzygium are available. The kingdom of java apple is plantae, sub kingdom is tracheophytes, division of java apple is Magonoliophyta, Class Magonoliopsida, order myrtales, family myrteaceae, genus *Syzygium.* Most of the myrtaceae roots having a polyderm tissue for the protection (Khandaker and Boyce, 2016). It consists of many numbers of polyderm layers and it will protect from the waterlogging hypoxic soil. So that they suggested that the flood or highly water content should not affect the cultivation of Jaava apple (Shü *et al.*, 2011). The fruits are pear shaped, aromatic sweet -sour taste. Seeds are impacted into the fruits, it was upto 8mm in diameter. The fruits are in different colors like pale pink, red and white. It consists of 91 % moisture content, 0.50 gm of proteins, 6.56 gm of carbohydrates, 0.001 gm of iron, 0.21-.27 g of ash, 0.01g of calcium, 0,03 g of phosphorus, 0.17 % of sulphuric acid and 0.15 % of citric acid. The leaves are biracial mesophytic characters (Khandaker *et al.*, 2012). Epidermal cells are irregular shape and arranged as a row and very closely. The upper epidermises are highly thick and many lithocyte are arranged in rectangular to the epidermises. Two layer of palisade parenchyma also appeared the spongy and palisade parenchyma ratio is 1: 3, the bundle sheath was developed by wood fiber and sclerenchymatous cells. It will protect the plant from high temperature and humid. The fruits are 28 g to 100 g in weight, increased total soluble solid content (5.63 ° Brix) may leads to sweetness of the fruits (Khandaker *et al.*, 2012).

Phytochemical and pharmacological evaluation

The whole plant of *Syzygium Samarangense* contains flavanoids, terpenoids, tannins, phenolic compounds. The plant part and its biological activities are listed out in Table 1. From the literature, forty-seven compounds are identified (Edeoga *et al.*, 2005; Peter *et al.*, 2011; Madhavi *et al.*, 2015). The compounds were 2',4'-dihydroxy-3'-methyl chalcone, 2'-hydroxy-4',6'-dimethoxy-3'-methyl chalcone, betulin, squalene, lupeol, sitosterol, cycloartenyl sterate, lupenyl stearte, beta sitosteryl sterate, 24-methylene cycloartenyl sterate, p-hydroxy benzaldehyde, 2-hexenal, cis-3-hexenol, n-hexanol, alpha-thujene, alpha-pinene, beta-pinene, myrcene, alpha-phellandrene, 3-carene, 2-carene, o-cymene, D-limonene, cis-beta ocimene,

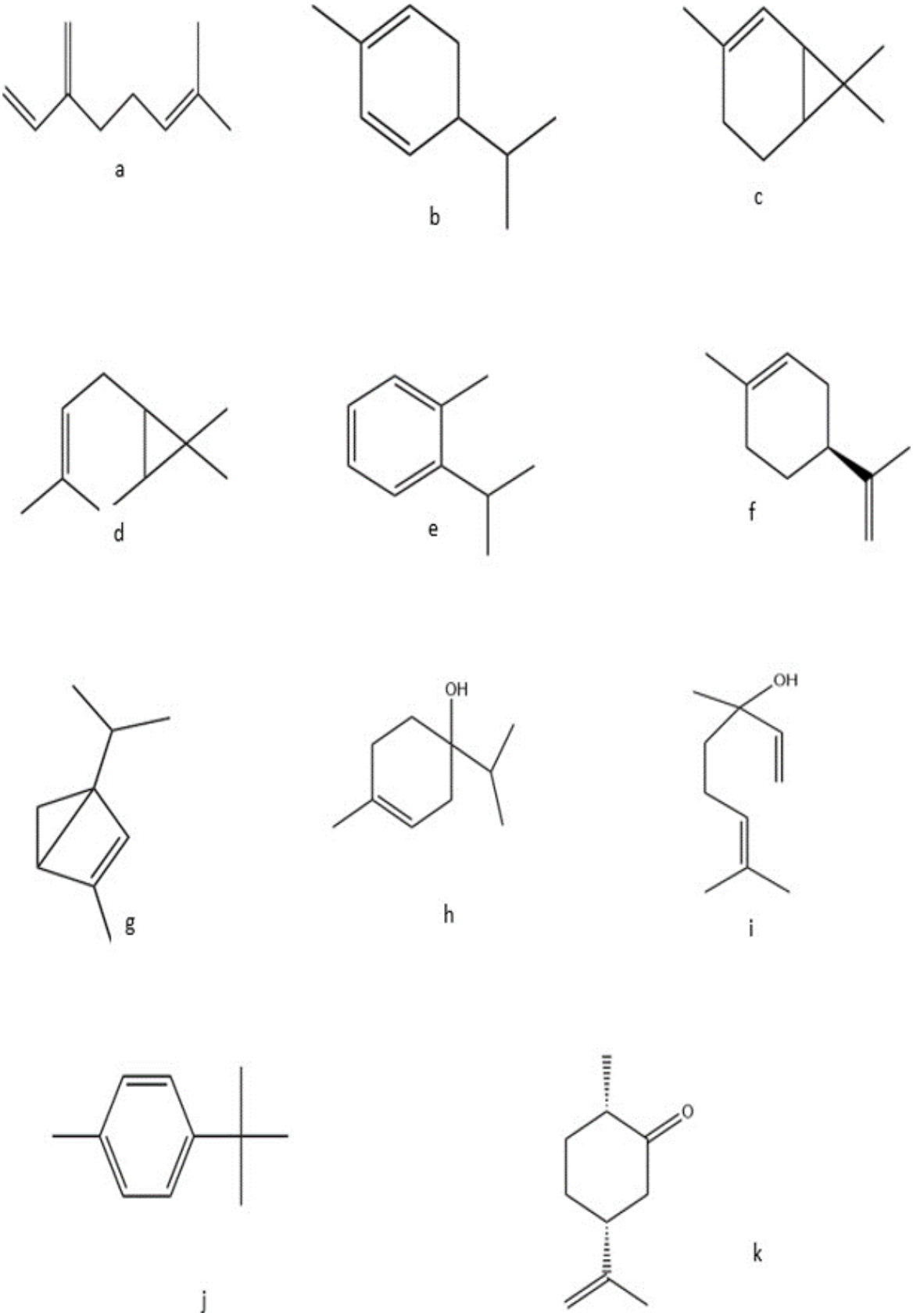

Figure 1: Monoterpenes from *Syzygium Samarangense*

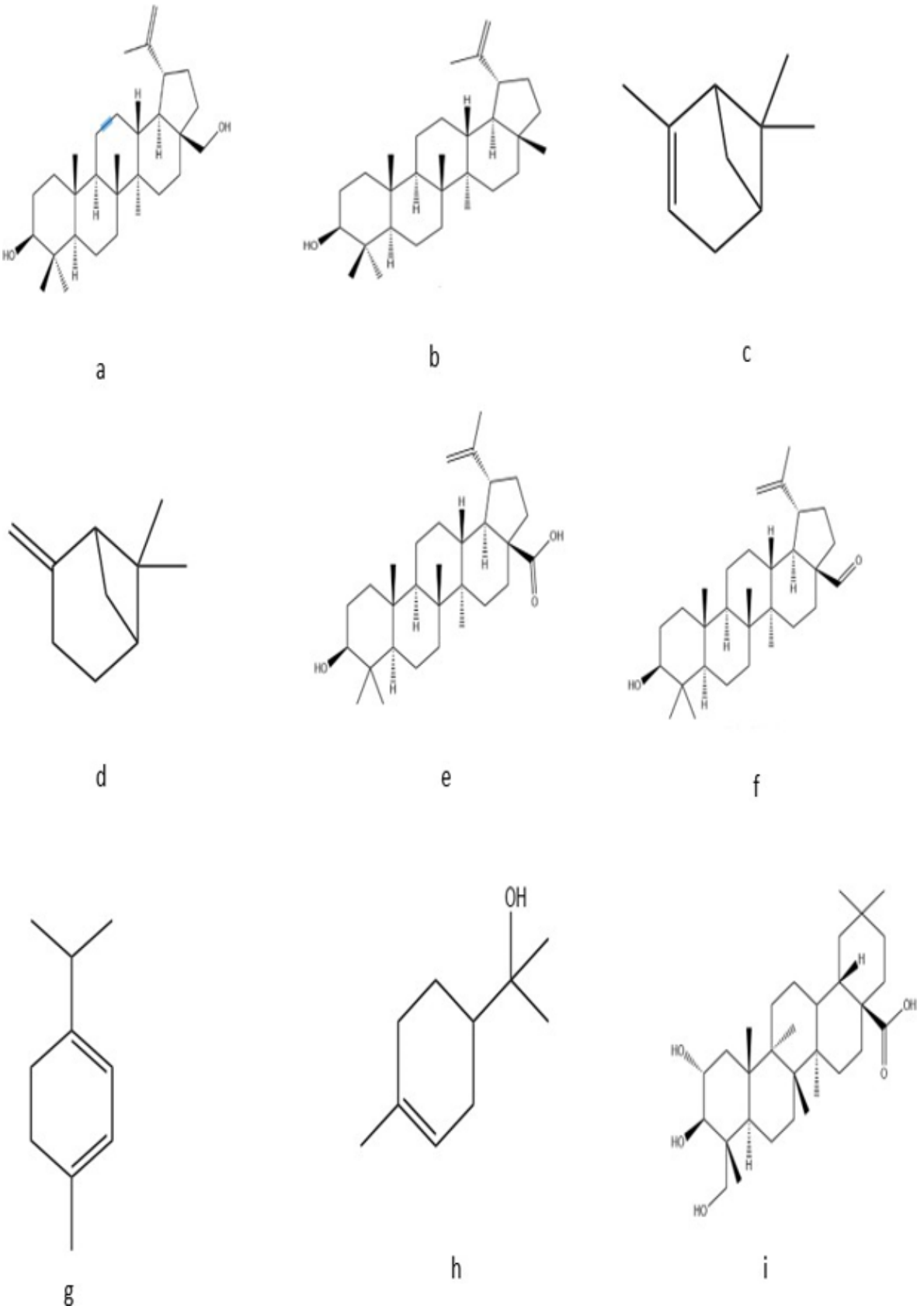

Figure 2: Triterpenes from *Syzygium Samarangense* a)Betulin, b)Lupeol, c)α-pinene, d)β-pinene, e)Betulinic acid, f)Betulinic aldehyde, g)Terpinene, h)α-terpineol, i)Arjunolic acid.

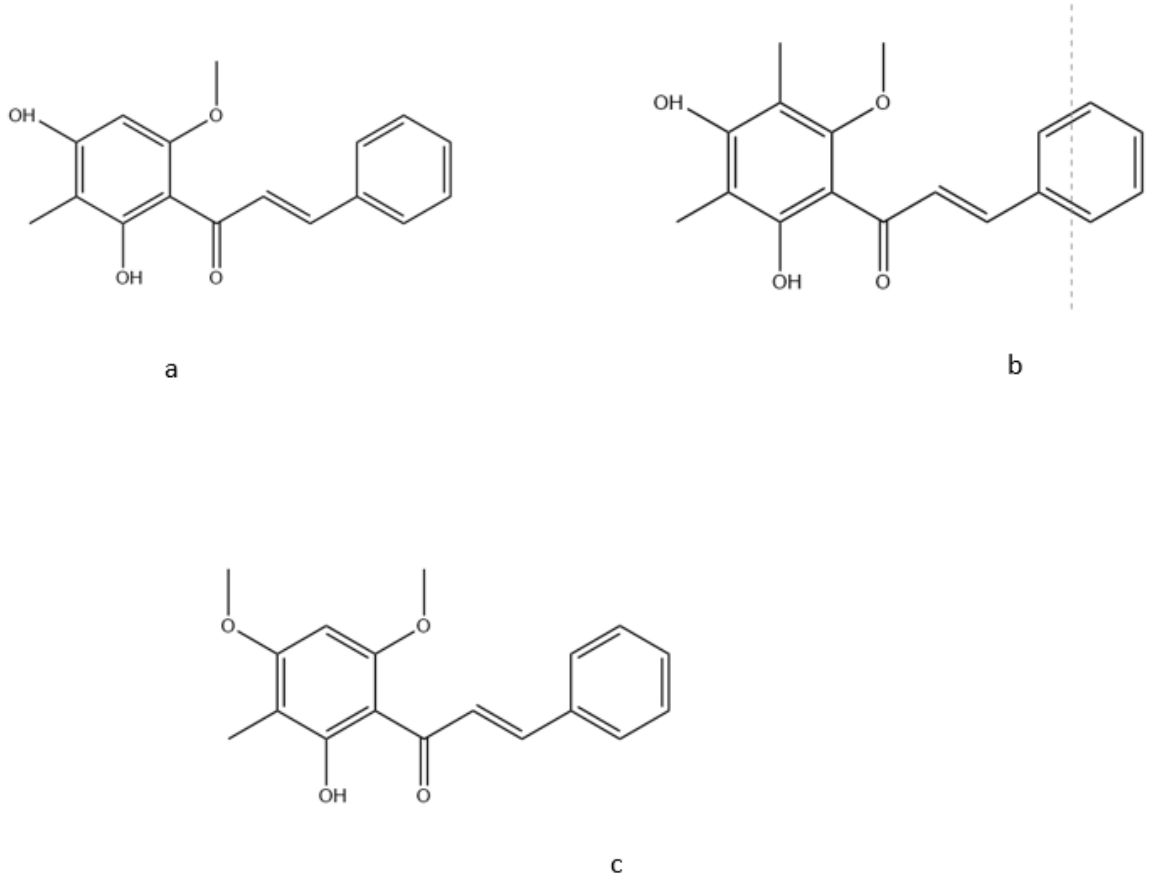

Figure 3: Chalcones from *Syzygium Samarangense* a) 2',4'-dihydroxy-3'-methylchalcone, b) 2',4'-dihydroxy-6'-methoxy3',5'-dimethyl chalcone, c) 2'-hydroxy-4',6'-dimethoxy-3'-methyl chalcone.

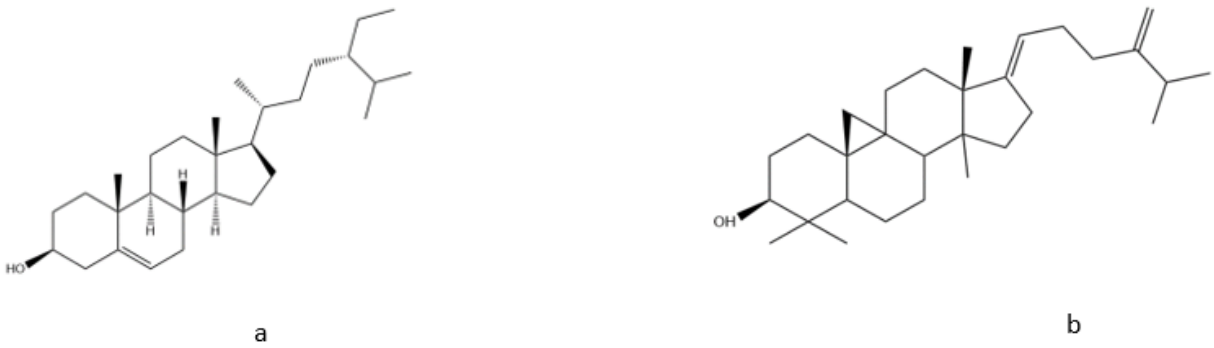

Figure 4: Sterols from *Syzygium Samarangense* a) Sitosterol, b) 24-methyl cycloartenyl stearate.

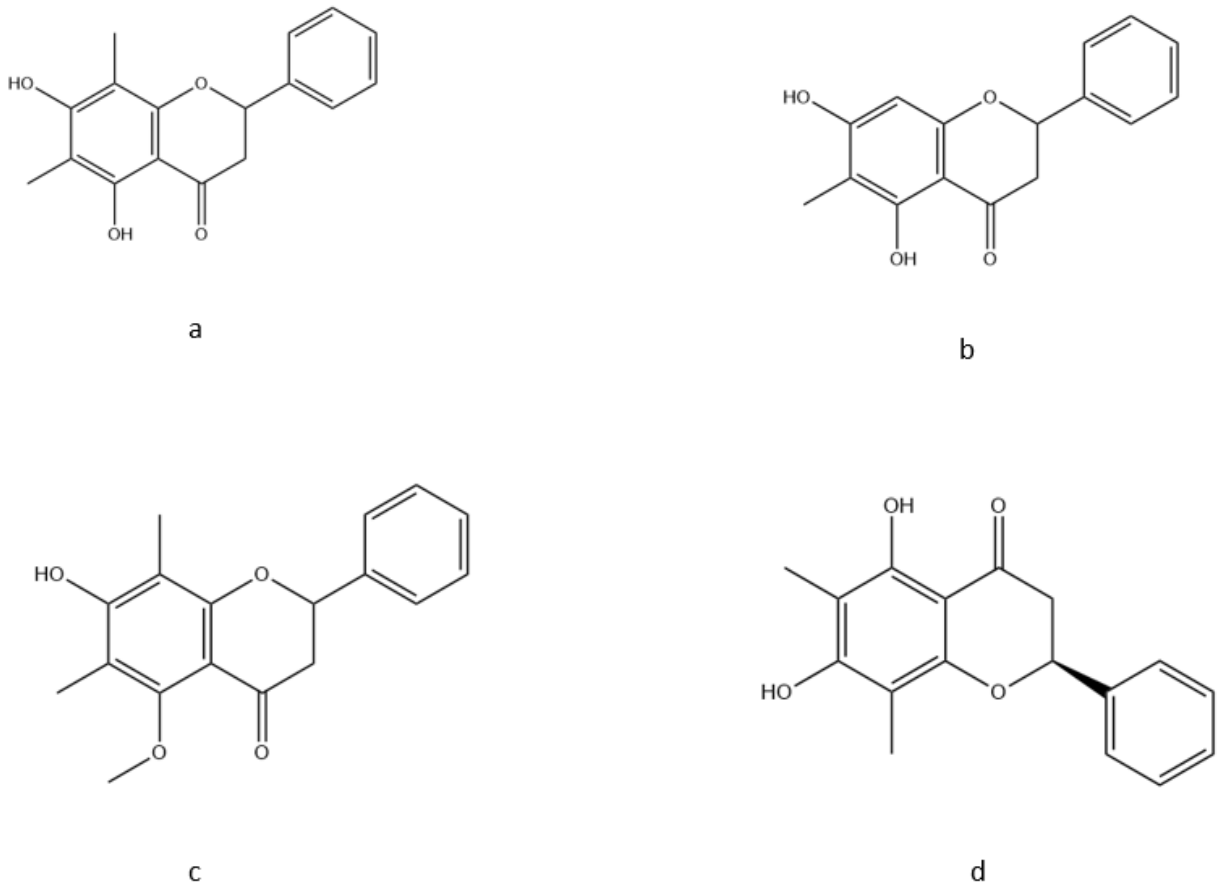

Figure 5: Flavanoids from *Syzygium Samarangense* a) 5,7-dihydroxy-6,8-dimethylflavanone, b) 5,7-dihydroxy-6-methyl flavanone, c) 5,7-dihydroxy flavanone, d) Desmethoxy matteucinol.

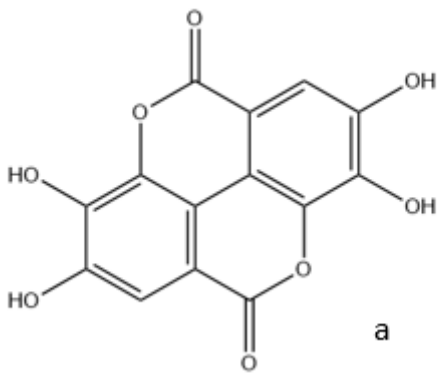

Figure 6: Phenolic acid from Java Apple

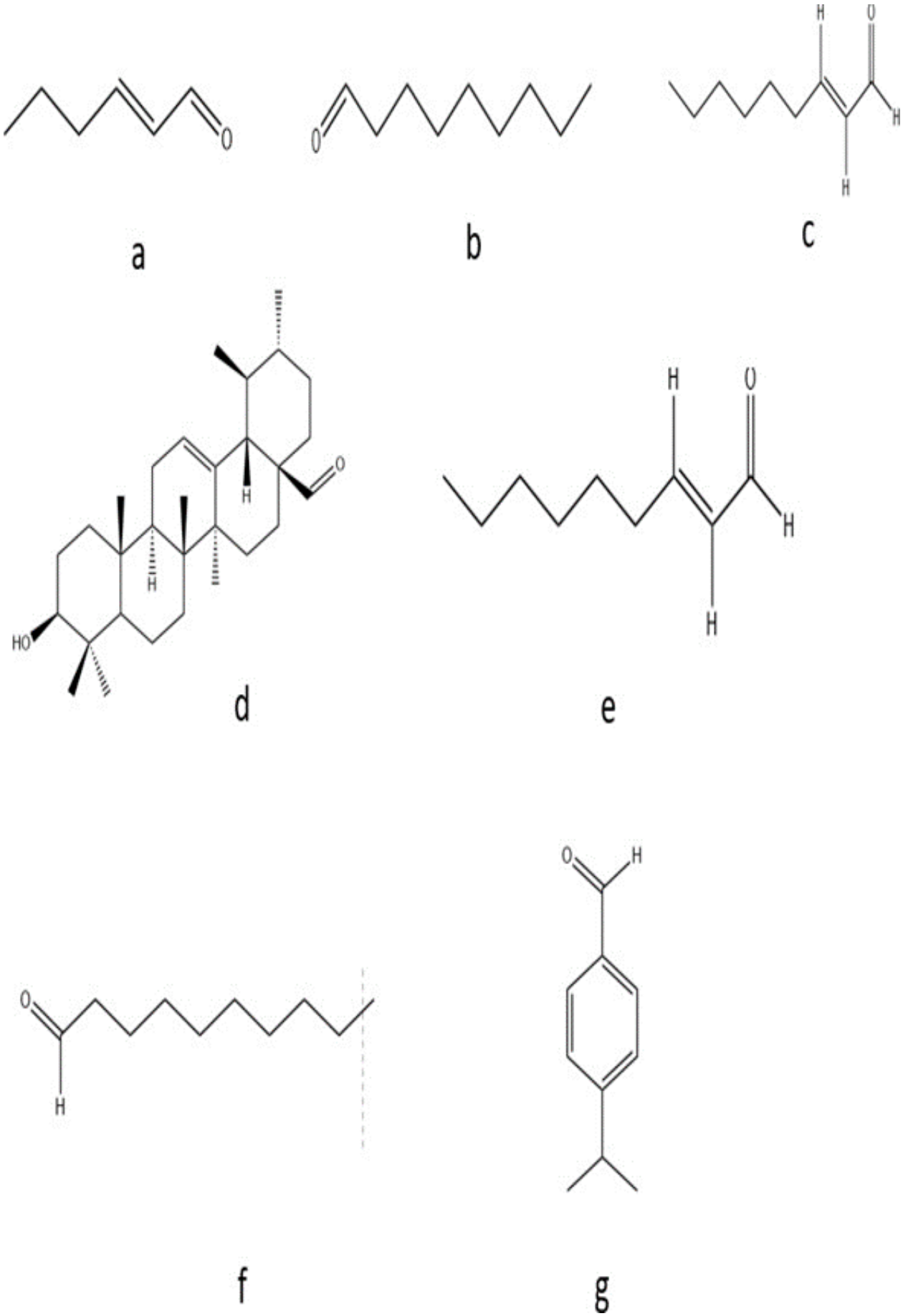

Figure 7: Aldehydes from *Syzygium samarangense*

Table 1: Chemical constituents isolated from different extracts and biological activities of various parts of *Syzygium Samarangense*

Sl.no	Plant part	Chemical constituent	Extract	
1	Fruit	Vescalagin	Water	Hypoglycemic effect
2	Leaves	Aurentiacin	Water	Anti-inflammatory
3	Leaves	Strobopinine	Ethyl acetoacetate	Immuno modulatory
4	Leaves	Pinocembrin	Ethyl acetoacetate	Immuno modulatory
5	Leaves	8- methyl pinocembrin	Ethyl acetoacetate	Immuno modulatory
6	Leaves	Dimethoxy matteucinol	Ethyl acetoacetate	Immuno modulatory
7	Leaves	Myrigalon H	Ethyl acetoacetate	Immuno modulatory
8	Leaves	Quercetin	Ethyl acetoacetate	Immuno modulatory
9	Leaves	Myricetin	Ethyl acetoacetate	Immuno modulatory
10	Leaves	Epigallocatechin 3-o-gallate	Ethyl acetoacetate	Immuno modulatory
11	Leaves	2',4'-dihydroxy-6'-methoxy -3'-methyl chalcone	Ethyl acetoacetate	Immuno modulatory
12	Leaves	2',4'-dihydroxy-6' methoxy -3',5'-dimethyl chalcone	Ethyl acetoacetate	Immuno modulatory
13	Leaves	2'hydroxy-4',6' dimethoxy-3' methyl chalcone	Ethyl acetoacetate	Immuno modulatory
14	Leaves	5,7-dihydroxy-6-methyl flavanone	Ethyl acetoacetate	Immuno modulatory
15	Leaves	5,7-dihydroxy-6,8-dimethyl flavanone	Ethyl acetoacetate	Immuno modulatory
16	Leaves	5,7-dihydroxy flavanone	Ethyl acetoacetate	Immuno modulatory
17	Leaves	7-OH,5-Methoxy 6,8-dimethyl flavanone	Ethyl acetoacetate	Immuno modulatory
18	Fruits	Ellagic acid	Methanol	Antioxidant
19	Fruits	Gallic acid	Methanol	Antioxidant
20	Fruits	Reynoutrin	Methanol	Antioxidant
21	Fruits	Guaijaverin	methanol	Antioxidant
22	Fruits	Octanol	methanol	Antioxidant
23	Fruits	Nonanal	methanol	Antioxidant
24	Fruits	Trans-2-nonenal	methanol	Antioxidant

Continued on next page

Table 1 continued

Sl.no	Plant part	Chemical constituent	Extract	
25	Fruits	Terpinene-4-ol	methanol	Antioxidant
26	Fruits	p-cymen-8-ol	methanol	Antioxidant
27	Fruits	Alpha terpineol	methanol	Antioxidant
28	Fruits	Methyl chavicol	methanol	Antioxidant
29	Fruits	Arjunolic acid	methanol	Antioxidant
30	Fruits	Oleanolic acid	methanol	Antioxidant
31	Root	Terpinene	Methanol	Antioxidant
32	Root	Terpinolene	Methanol	Antioxidant
33	Root	Terpinene-4-ol	Methanol	Antioxidant
34	Root	Alpha terpineol	Methanol	Antioxidant
35	Leaves	3,5-di-o-methyl gossypetin	methanol	Antioxidant
36	Leaves	Alpha thujene	Dichloro methane	Anti- microbial
37	Leaves	Alpha pinene	Dichloro methane	Anti- microbial
38	Leaves	Beta pinene	Dichloro methane	Anti- microbial
39	Leaves	Myrcene	Dichloro methane	Anti- microbial
40	Leaves	Alpha phellandrene	Dichloro methane	Anti- microbial
41	Leaves	3-carene	Dichloro methane	Anti- microbial
42	Leaves	2-carene	Dichloro methane	Anti- microbial
43	Leaves	o-cymene	Dichloro methane	Anti- microbial
44	Leaves	D-limonene	Dichloro methane	Anti- microbial
45	Leaves	Cis beta ocimene	Dichloro methane	Anti- microbial
46	Leaves	Beta linalool	Dichloro methane	Anti- microbial
47	Leaves	p-cymen-8-ol	Dichloro methane	Anti- microbial
48	Leaves	Cis dihydro carvone	Dichloro methane	Anti- microbial
49	Leaves	Pulegone	Dichloro methane	Anti- microbial
50	leaves	Methyl chavicol	Dichloro methane	Anti- microbial

terpinene, 1-octanol, terpenolene, beta-linalool, n-nonalal, trans-2-nonenal, terpinene-4-ol, p-cymen-8-ol, alpha-terpineol, cis-dihydrocarvone, methyl chavicol, n-decanal, pulegone, cuminyl aldehyde, ursolic aldehyde, betulinic aldehyde, betulinic acid, 5,7-dihydroxy6-methyl flavanone, 5,7-dihydroxy-6,8-dimethyl flavanone, 5,7-dihydroxy flavanone, 7-hydroxy,5-methoxy,6,8-dimethyl flavanone, arjunolic acid, mearnsitrin, gallic acid, ellagic acid, oleanolic acid, des-methoxy matteucinol (Srivastava *et al.*, 1995; Wong and Lai, 1996). The structures of the isolated compounds from *Syzygium Samarangense* are listed out in Figures 1, 2, 3, 4, 5, 6 and 7.

RESULTS AND DISCUSSION

Antioxidant Activity

The ethanolic extract of *Syzygium Samarangense* fruit of different colors (red, pink, green) showing a good anti-oxidant activity by DPPH method by rabbit erythrocytes hemolysis method when compared with a standard Ascorbic acid and also they studied that the total phenolic content and correlation studies between phenolic content and anti-oxidant activity (Khandaker *et al.*, 2012; Stratil *et al.*, 2007). The results showed that bark and fruits having higher antioxidant activity than leaves extract. The correlation results showed that the increased phenolic content having better free radical scavenging effect and reported that it consists of 0.78 % to 0.83 % of citric acid in this fruit (Majumder *et al.*, 2017). Methanolic extract of *Syzygium Samarangense* fruit and seed portion having higher antioxidant activity (Simirgiotis *et al.*, 2008a). It was determined by DPPH and ferric reducing antioxidant power (FRAP) assay. This antioxidant activity is showed may be due to the presence of chalcones, Quercetin glycosides such as reynoutrin, 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.

It was subjected to antioxidant activity by DPPH method and the Endophytic fungi also isolated from the ethyl acetate fraction (Budiono *et al.*, 2019). Due to the presence of these compounds, it showed antioxidant activity. Both invitro and in vivo antioxidant efficacy of methanolic extract of *Syzygium Samarangense* leaf by DPPH method and phosphomolybdenum method and in vivo study was done in Wistar rats and compare with ascorbic acid (Majumder *et al.*, 2017; Soubir, 2007). The results showed that lipid peroxidation (LPO), enzymatic (CAT, SOD) and non-enzymatic (GSH) antioxidant systems are reduced. Ethanolic extract of *Syzygium Samarangense* fruit showed antioxidant activity by checking the IC_{50} value of 200μg/ml (Soubir, 2007).

Anti-microbial activity

The anti-microbial screening of Syzygium *alternifolium and Syzygium Samarangense* fruits using different extracts were evaluated (Arifullah, 2014; Abdullah *et al.*, 2012).

Among that, the methanolic extract of *Syzygium Samarangense* showed best anti- microbial activity against all bacterial strains (*bacillus cereus, staphylococcus aureus, Escherichia coli, pseudomonas aeruginosa, klebsiella pneumoniae, candida albicans*). The antimicrobial activity of bark leaves and fruits of three cultivars of *Syzygium Samarangense* was identified (Khandaker *et al.*, 2012; Napish *et al.*, 1970) . The extract was prepared by using methanol and ethanol. After checking the antibacterial assay, they found out ethanolic extract of bark portion having more anti- fungal activity than the other extract. So that they followed the fractionation procedure using water and ethyl acetate. Among that water fraction was more active against *S.Aureus* with inhibition zone 18 cm. Anti-fungal activity also reported in literature reviews. So that instead of synthetically prepared medicines such as azoles and amphotericin B, we can use phytoconstituents for better results because of the cytotoxic side effects of such medicines (Alex *et al.*, 2018; Sathianarayanan *et al.*, 2017; Choironi and Fareza, 2018).

Anti-diabetic activity

The methanolic extract of leaf portion of this plant having more anti- hyperglycemic activity compared to other plants like *Averrhoa Carambola* and *Ficus Hispida* (Shahreen *et al.*, 2012). In this activity they have done in 15-20g weighed male Swiss albino mice using glucose tolerance test method. The maximum anti-hyperglycemic activity was shown in the dose of 400mg.kg^{-1} with 59.3% of inhibition. The chalcones present in the leaves of *Syzygium Samarangense* shown anti- diabetic activity (Resurreccion-Magno *et al.*, 2005; Shen *et al.*, 2013). The compound s-2′,4′-dihydroxy3′,5′-dimethyl-6′-methoxychalcone shows anti- hyperglycemic activity in 18-28g of Swiss Webster mice by using oral glucose tolerance test. By checking the body glucose level before and after glucose administration, they found out that this chalcone compound decreasing the glucose level.

Immunomodulatory Activity

The immunomodulatory effect of *Syzygium Samarangense* leaves was performed (Kuo *et al.*, 2004).

They have done the effect in acetone extract. First, sixteen flavonoids were isolated from the acetone extract of the leaves. Then the isolated flavonoids were evaluated for immunopharmacological activity. The target cell they have used was Human peripheral blood mononuclear cells (PBMC) and cell proliferation was determined by H- thymidine uptake. Among them, strobopinine, myricetin-3-O (2"-O-galloyl -α- rhamnopyranoside), (-)-epigallocatechin 3-O-gallate and myrcetin 3-O-α-rhamnopyranoside with IC 50 values 36.3, 11.9, 28.9, and 75.6μm showed inhibitory potency on PBMC proliferation.

Cytotoxic Activity

Syzygium Samarangense seed portion displayed cyto toxic 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. After checking the free radical- scavenging capacity, the ethyl acetate portion was subjected for isolation. They have identified four cytotoxic chalcone compounds such as 2',4'-dihydroxy- 3',5'- dimethyl 6'-methoxy chalcone, stercurensin, cardamonin and (S)- pinocembrin with IC_{50} values 10, 35 and 35μm. Acylphloroglucinol derivatives such as samarone A, B, C, D from the leaf extract of *Syzygium Samarangense* tested for their cytotoxic effects on $HePG_2$ and MDA- MB- 231 cells (Yang *et al.*, 2018; Amor *et al.*, 2007). All the tested compounds displayed potent cytotoxic activities with IC_{50} values ranging from 1.73- 32.90μm and 4.02- 37.85μm.

Anti-diarrheal and Anthelmintic Activity

Calcium antagonist activity of hexane extract of *Syzygium Samarangense* leaf has been proved (Ghayur *et al.*, 2006; Farre *et al.*, 1991; Karaki and Weiss, 1988). The extract was subjected to isolated rabbit jejunum smooth muscle which was contracted by k^+ channel and observed the relaxation in dose dependent manner (10-3000μg/mL) (Bolton, 1979).

The median effective concentration of smooth muscle relaxant activity was found to be 355.5 $\pm$ 89.6 μg/mL similar to that produced by verapamil, a standard spasmolytic agent. Anthelmintic activity was done in clean matured round worm Haemonchus contortus (Nematoda) using ethanolic extract of *Syzygium Samarangense* bark (Gayen *et al.*, 2016; Ali *et al.*, 2012). Albendazole was used as a standard drug. 25, 50, 100 and 200 mg/ml concentrations showed paralysis of parasites at 23.42, 12.34, 5.25, 3.24 min and death times were found at 29.34, 21.33, 9.3, 6.3 min respectively.

CNS depressant activity

The methanolic extract of leaves of *Syzygium Samarangense* shows anti- inflammatory as well as CNS activity (Mollika *et al.*, 2013; Kim *et al.*, 2012). In this study, swiss albino mice were used for assessing biological activity. The animals were divided into different groups of 5 and each group of mice given by water diclofenac and methanolic extract of Syzygium Samarangense leaf. After doing the formalin test, they found out that the methanol extract administered mices shows suppressed licking activity. CNS depressant activity was done by hole cross test. From those results, they concluded that the methanolic extract can be used as an alternative herbal remedy for the treatment of analgesic, inflammatory and depressant disease.

CONCLUSIONS

This review reviewed that the *Syzygium Samarangense* traditionally used as an astringent, to treat fever, and halt diarrhea. Different parts of the plant, for their phytochemical constituents and their corresponding biological activities have been explored. This plant parts are scientifically proved their anti-inflammatory, anti- microbial and immune modulatory activities. This literature review concludes that *Syzygium samarangense* extracts and its phytoconstituents beneficial for the human health and may serve as lead molecule development in the pharmaceutical preparation which could offer possible alternative medicine.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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