

Pharmacological review on *Sesbania grandiflora* (Linn)

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Abstract

The plant *Sesbania grandiflora* is an essential tree. This plant is used in Ayurvedic, Unani and Siddha medicine for various ailments. All the parts of the plant namely root, stem, bark, leaves, flowers, fruit are used as medicine, food and for other miscellaneous purposes. Traditionally this plant used for treatment of disease like diarrhea, dysentery, fever, cough and cold, and as tonic, expectorant etc. The antioxidant properties of *Sesbania grandiflora* are due to the presence of diverse types of phytochemical constituents. It also has pharmacological properties like anti-cancer, anti-helminthic, anti-diabetic, anti-ulcer, hepato-protective, anti-bacterial, anti-viral, hypolipidemic, anti-tuberculosis, cardio protective, anti-arthritic, immuno-modulatory, anti-inflammatory, analgesic, wound healing and as a tablet binder. There are various medicinal uses associated with this plant and out of these claims, some claims scientifically studied and reported. These observations are noteworthy for further studied on modern scientific lines.

Keywords: ayurvedic, GC-MS, nutritional, pharmacological review, *Sesbania grandiflora*

Introduction

There is an estimate of World Health Organization (WHO) that in the developing countries, about 80% of people depend almost exclusively on medicine, which are traditional in nature for their basic healthcare needs. (Parwin *et al.*, 2012) [26] India is virtually a herbarium of the world. The basic source of medicine in India is plants because we have enough of them available in our country. The part of our nutrition which depends on herbals is in demand because they supply an added therapeutic effect and *Sesbania* is one of them. An inventory of more than 20,000 species of medicinal plants are recently accepted by the WHO. (Azhar *et al.*, 2016) [3].

Sesbania grandiflora is short lived and fast-growing plant which loose branches and open crown which is commonly known as hummingbird tree. The growth rate of plant of *Sesbania* is remarkably high in the first 3 to 4 years after its plantation, which is its outstanding feature because this is extremely fast growth rate amongst others. Flowers are white (Fig-1) in colour. (Lavanya *et al.* 2017) [16]



Fig 1: Flowers of *Sesbania grandiflora*

There is a specialty in the plants of Agast that it may build up in salty, bleary, saline, low fertility soils. It has tolerance value of acidic soils, pH 4.5. Heavy clay soils are well adaptive in the regions where annual rainfall is between 2,000mm to 4,000mm (millimeter). In some cases, it was found that Agast may also grow successfully in the areas where annual rainfall is as low as 800mm and has dry season of up to 9 months. It can also be adaptive for the meadow tropics up to 800 meters and some time to 10,00m asl environments with annual temperature between 22°C to 30°C. (S. Sarvade *et al.*, 2014) ^[45]

Distribution

The variety of species of *Sesbania* have wide distribution in all around the tropical and even in subtropical regions. This is found in Jharkhand, Assam, Karnataka, West Bengal and northeastern states of India. (Azhar A. Zarkani, 2016, Pimporn *et al.*, 2011) ^[3, 24].

S. grandiflora is originally from India and archipel of Malasia (Ouattara *et al.*, 2011) ⁽¹⁹⁾

Nutritional Value

According to Nutritive Value of Indian Foods, 100g leaves of *Sesbania grandiflora* contains 73g moisture, 12g carbohydrate, 8g protein, 3g minerals, 2g fiber, 1g fat, iron 4g, 1130mg calcium, and 80mg phosphorus.

Nutrient database USDA reports 100g of flower of *Sesbania grandiflora* contains 6.37g carbohydrates, 1.28g protein, 0.38g ash, 0.04 g fat, 184mg potassium, 73mg vitamin C, 30mg phosphorus, 18mg calcium, 15mg sodium, 12mg magnesium, 0.84mg iron, 0.430mg niacin, 0.083mg thiamin, 0.081mg riboflavin, 108µg folate and 0.8µg selenium.

Therapeutic Uses of *Sesbania grandiflora* (Linn)

Anti-Cancer Activity

Cancer is one of the leading causes of death in developed and developing countries, responsible for about 9.6 million deaths in 2018. (https://www.who.int/health-topics/cancer#tab=tab_1)³² According to estimates released by the International Agency for Research on Cancer (IARC), the death due to cancer has risen to 10 million. (<https://www.iarc.who.int/news-events/latest-global-cancer-data-cancer-burden-rises-to-19-3-million-new-cases-and-10-0-million-cancer-deaths-in-2020>)³³

Anti-tumor and Anti-proliferative activity due to presence of Nitrile compound (Fig-2) shows in GC-MS analysis of *Sesbania grandiflora* leaves extract. (A. Zahir *et al.*, 2014) ^[6]

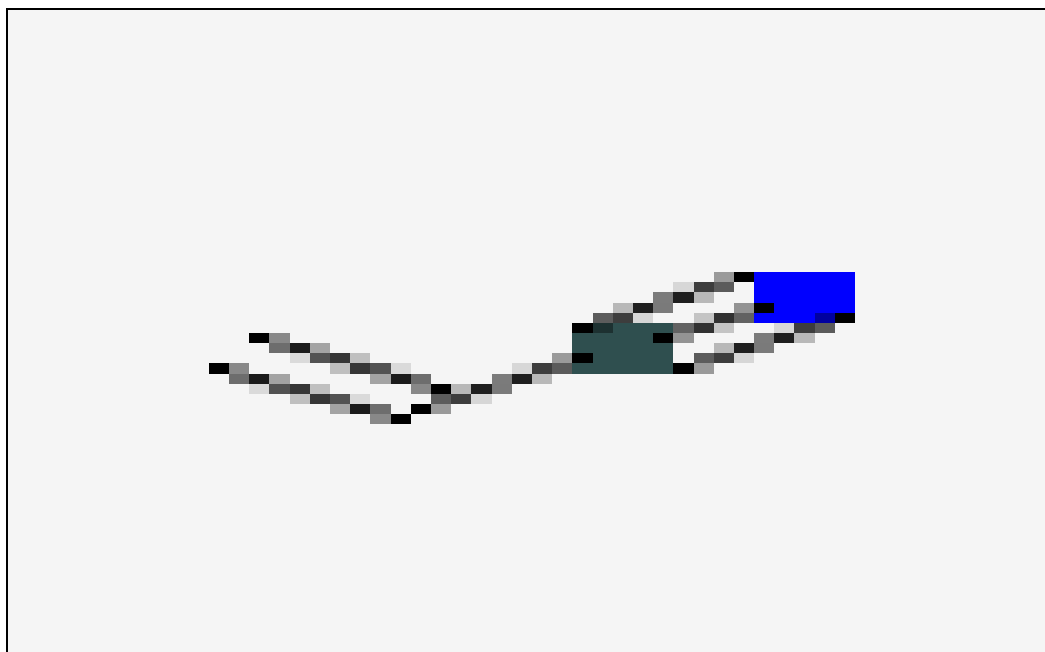


Fig 2: Acrylonitrile (53.06g/mol)

Methanolic extracts of leaves of *S. grandiflora* has revealed potent ant proliferative activity in cancer cell line of human lung (A549) due to activation of caspases, which leads to apoptosis. (Sankar *et al.*, 2014) ^[40]

The extracts from the flowers of *S. grandiflora* namely protein fraction SF2 have some time shows notable anti-cancer and chemo protective efficiency in Dalton lymphoma ascites (DLA) and in the cancer cells of human colon cancer cells (SW-480) under activation of caspase 3, 8 and 9 and dawn regulating Bcl-2, p-Akt and cyclooxygenase-2 in cancer cells. (Krishna *et al.*, 2010) ^[13]

The leaves of *Sesbania grandiflora* show anti-cancer Activity against human larynx carcinoma cell line. The maximum cell viability reduced at concentration 50µg/ml in Aqueous, ethanol and acetone extract. (K. Padmalochana *et al.*, 2015) ^[14]

The aqueous, ethanol and acetone extract of *Sesbania grandiflora* leaves shows anticancer activity against IMR-32 neuroblastoma and HT-29 colon cancer cell line. 50% inhibition reported in 200µg/ml. (M. Ponnanikajamdeen et. al., 2015) [21]

Ant-helmintic Activity

There are about 1.5 billion peoples are infected from helminthic disease. (<https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth>)³⁴

Aqueous extracts of leaves of *S. grandiflora* against *Asaridia galli* have shown ant-helmintic activity and definite efficiency. It has due to presence of phytochemicals such as alkaloids, flavonoids, phenols, saponin, steroids, tannin, terpenoids. (R Jothi et al. 2014) [31]

The investigation of ethanol, methanol and ethyl acetate crude extract of leaves of *S. grandiflora* was done for finding out their ant-helmintic activity against Indian adult earthworm, *Pheretima posthuma*. Different concentration 10mg/ml to 100mg/ml were studied. The ethanolic extract of the leaves shown higher ant-helmintic property in comparison of other extracts. It was found that the reason for higher ant-helmintic property in the presence of phenol and alkaloids compounds. (Shital et al., 2013) [39]

In a study on various seeds oils of *Sesbania grandiflora*, *Jatropha curucas*, *Passiflora edulis*, *Tinospora cardifolia* and *Sapindus lauridolia* was investigate at three concentrations of 10, 50 and 100mg/ml against *Pheretima posthuma*. It was found that the *S. grandiflora* has highest ant-helmintic activity at 100 mg/ml in comparison to standard drug piperazine citrate. The highest ant-helmintic property of *S. grandiflora* seed oil was in both the condition, paralysis and death. (Sunil et al., 2005) [46]

Anti-diabetic Activity

According to estimates of WHO in 2016 the diabetes has caused 1.6 million deaths, which was 7th leading cause of death. (<https://www.who.int/news-room/fact-sheets/detail/diabetes#:~:text=Almost%20half%20of%20all%20deaths,cause%20of%20death%20in%202016>)³⁵

An investigation was conducted on the ethanolic extracts of leaves of *S. grandiflora* inducing diabetic rats for finding out the anti- diabetic activity. During the investigation, a dose of 45mg/kg of body weight was injected in the rats with STZ and they were treated by the leaves extract for 30 days. It was noticed that there was decrease a ($p < 0.05$) blood glucose, blood urea, glycosylated hemoglobin and uric acid serum. The interesting fact of the investigation is reducing value of AST (aspartate transaminase), ALT (alanine transaminase) and ALP (alkaline phosphatase). (A. Sangeetha, 2014) [4]

Another investigation was done on the aqueous extract of *S. grandiflora* inducing diabetic rats. This investigation shows the reducing balance of glucose, serum, hepatic glycogen, insulin, glycosylated hemoglobin, ALP, ALT, and AST. (Radhika J et al., 2014) [28]

Sesbania grandiflora extracts shows strong α -amylase inhibitory effect when compared to standard drug ascorbase. At concentration 1000µg/ml, Sesbania shows 81% inhibition of blood glucose level, suggesting that this plant is anti-diabetic. (Shreya Kothari et al., 2017) [43]

Sesbania grandiflora ethanolic extract at dose of 100, 200, 300mg/kg lowered blood glucose level when compared to standard diabetic control group (rats). Maximum inhibition reported at 200mg/kg after 28 days. (Veerabhadrapa et al., 2017) [48]

The 70% ethanolic extract of *Sesbania grandiflora* flowers reduced blood glucose level in alloxan induced diabetic rats at a dose of 250mg/kg/day and 500mg/kg/day. Maximum inhibition reported at 500mg/kg/day after 28 days when compared to control group. (Rajit et al., 2015) [29]

Anti-Ulcer Activity

As per a report published by WHO in 2018 the deaths due to peptic ulcer disease has reached 55,560 which is 0.63% of total deaths in India. The death rate adjusted by age has ranked 60th in the world because it has reached 5.58 per 100,000 peoples under populations. (<https://www.worldlifeexpectancy.com/india-peptic-ulcer-disease>)³⁶. When the ethanolic extracts of *S. grandiflora* was left at dose of 250 and 500mg/kg of body weight, it has shown reduction of 50% and 74.22% respectively in the ulcer of adult albino rats, which were induced by ethanol, when compared to control group. The standard drug used in the experiment was omeprazole. (Dayananda Bhoumik, 2016) [7]

The antiulcer activity of ethanolic extracts of bark of *S. grandiflora* had been evaluated at the doses of 36.75 mg/kg on the rats. It was found that the extracts have not changed the volume, pH and HCL contents of gastric secretion and the animals had no symptoms of excitatory, depressive and sleepiness, which suggest that the extract have no antiulcer action probably on centrally acting components. The ethanolic extract has prevented acute gastric injury in the rats. The ethanolic extract had especially prevented stress and non-steroidal anti-inflammatory drug. The result has confirmed that the ethanolic extracts of the bark of *S. grandiflora* had anti-ulcer potential. (Jayme et al., 2001) [10]

Hepato-Protective Activity

Hepatotoxicity is related with any clinical defects or condition of liver caused by impairment of its tissues. One of the chief and significant organs of the human body is liver. When high accumulation of toxins or their metabolites occurs in the liver, it results into hepatotoxicity. (Dave Et al., 2020) [8]

Oral administration of ethanolic extract of leaves of *S. grandiflora* at the doses of 200mg/kg of body weight per day for fifteen days produced hepato protection against erythromycin estolate at the doses of 800mg/kg of body weight per day induced hepatotoxicity in rats. It was found that there is increased level of AST, ALT, ALP, bilirubin, cholesterol, plasma thiobarbituric acid reactive substances triglyceride, phospholipids, free fatty acids and hydroperoxide in rats treated with erythromycin estolate but there was decline in rats treated with concomitantly with *Sesbania* extracts and erythromycin estolate. From the above study, it was revealed that erythromycin estolate induced hepatotoxicity can be protected by *Sesbania*. The effect of *Sesbania* was also compared with a reference hepatoprotective drug namely silymarin. (Leelavinothan *et al.*, 2003) ^[17]

A study on the aqueous extract of leaves of *S. grandiflora* have shown hepatoprotective activity in albino rats. A dose of 500mg/kg body weight was orally fed with carbon-tetrachloride to induce liver damage. The treatment shown the decreasing value of SGPT (Serum level of Glutamic Pyruvate Transaminase), ALP, cholesterol and total bilirubin. (Dayananda Bhoumik, 2016) ^[9]

The hepatoprotective activity of petroleum ether extract of fruit of *S. grandiflora* was studied in ethanol induced hepatotoxic rats. The rats were injected with ethanol at dose of 400mg/kg of body weight. A significant decline in level of AST, ALT, ALP and total bilirubin was noticed. The presence of normal lever cells was also noticed in histopathological studies. (Prafulla *et al.*, 2010) ^[25]

Anti-Bacterial Activity

The leaves extract of *Sesbania grandiflora* shows the presence of different antibacterial compound such as Hexadecanoic acid (Fig 3), Malonic acid, ethyl 3-hexyl ester (Fig 4), 3,4,5-Trimethoxyphenol (Fig 5), Nonanoic acid, methyl ester (Fig 6), 3-Hexen-2-one, 3,4-dimethyl- (Fig 7) and 6-Octadecenoic acid, methyl ester (Fig 8). (A. Zahir *et al.*, 2014) ^[6].

The aqueous, methanolic and hydro acetonic extracts of various parts of *S. grandiflora* plants of *S. grandiflora* plant such as leaves, stem, granules, pods of fruits and root had reported good anti-bacterial activity in traditional pharmacopeias in burkinofaso. The test of characterization has found phytochemical groups. The proportioning test of total phenols, flavonoids and tannins quantify it. (Kalpana *et al.*, 2012) ^[12]

Aqueous ethanolic and chloroform extract of *S. grandiflora* against *Staphylococcus aureus*, *S. epidermis*, *S. pyogenes*, *S. pneumonia*, *Bacillus cereus* and *B. subtilis* have shown anti-bacterial activity. Disc agar diffusion method was used in this study. The largest inhibitory zone against *S. aureus*, *S. pneumonia* and *B. subtilis* have been shown by chloroform extract of *S. grandiflora*. (Jothi *et al.*, 2014) ^[11]

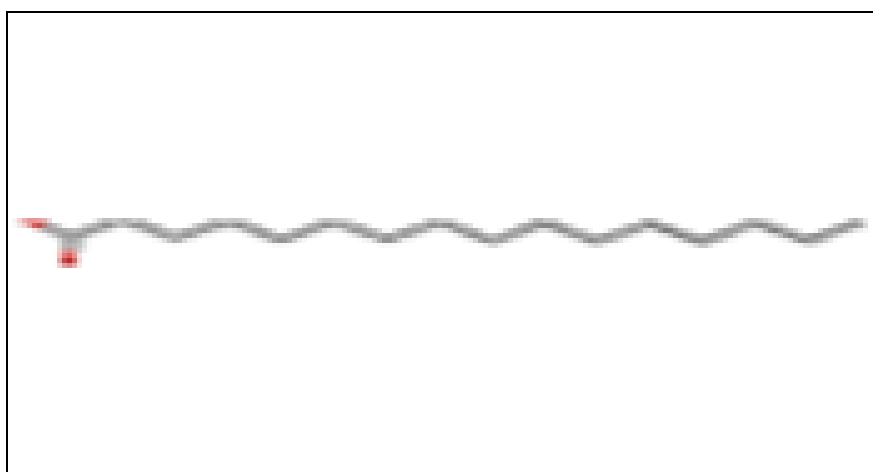


Fig 3: Hexadecanoic acid (256.42g/mol)

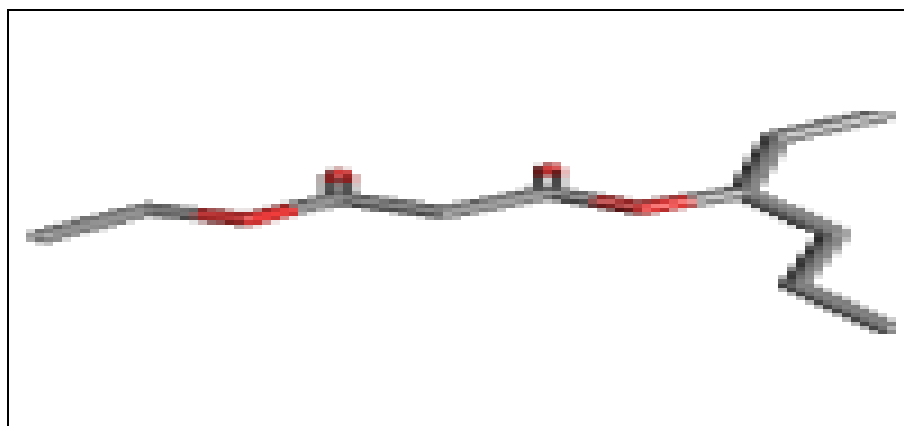


Fig 4: Malonic acid, ethyl 3-hexyl ester (216.27 g/mol)

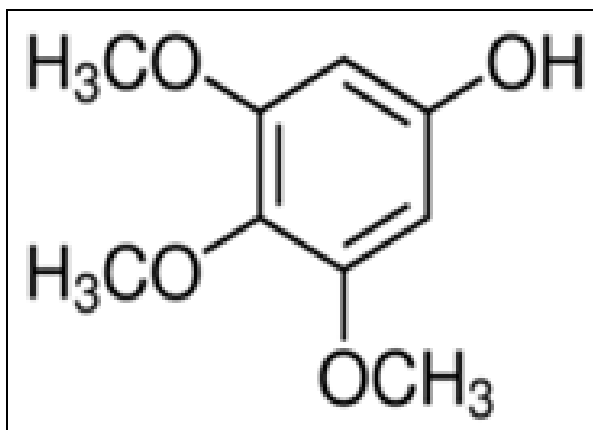


Fig 5: 3,4,5-Trimethoxyphenol (184.19g/mol)

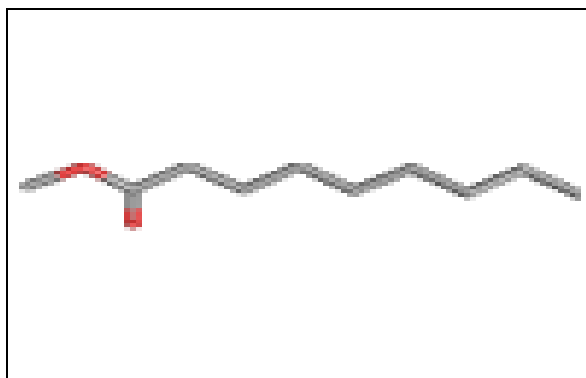


Fig 6: Nonanoic acid, methyl ester (172.26g/mol)

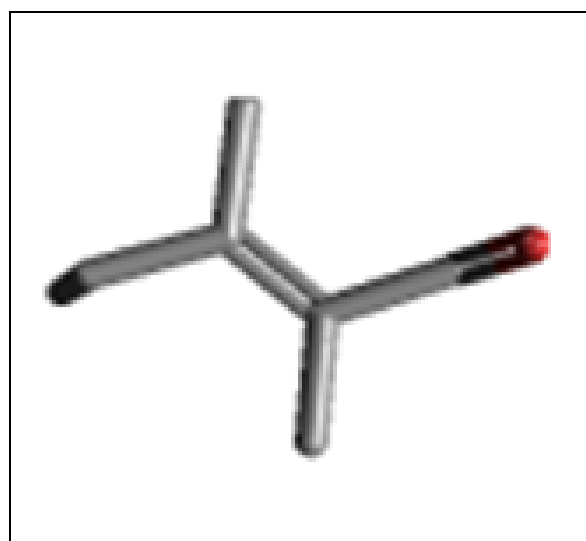


Fig 7: -3-Hexen-2-one, 3,4-dimethyl-(126.20 g/mol)

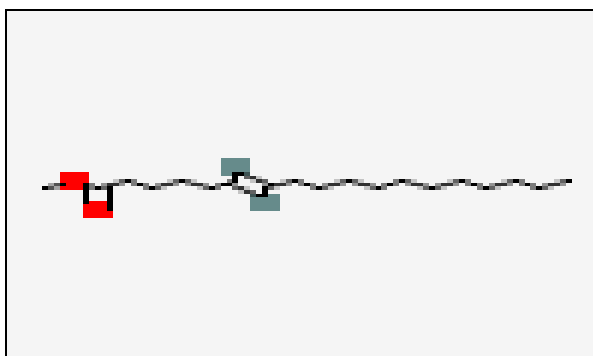


Fig 8: -6-Octadecenoic acid, methyl ester (296.5g/mol)

A study on anti-bacterial activity of ethanolic and aqueous extract of *S. grandiflora* leaves against *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *Bacillus subtilis* and *Pseudomonas aeruginosa* was conducted using agar diffusion method. The ethanolic extract of *S. grandiflora* exhibited significant anti-bacterial activity against *Escherichia coli* and *Staphylococcus*. (Lakshmi T, 2011) ^[15]

The polyphenolic extract of *S. grandiflora* flower as screened for their anti-microbial activity against *Vibrio cholera*, *E. coli*, *Salmonella typhi*, *Shigella flexnesi* and *Staphylococcus aureus* using two techniques namely in-vitro and in- situ method. The study using in-vitro method showed inhibitory effect. *Staphylococcus aureus* was more sensitive amongst all these microbes because at the concentration of 0.013mg/ml, it has shown minimum inhibition. (Ratna *et al.*, 2012) ^[30]

Within 1.5 hours, butanolic and ethanolic extract of *S. grandiflora* stem inhibit the growth of *S. typhi* and *S. sonnei*. Butanolic extract show complete inhibition at 6 hours and by ethanolic extract more than 6 hours against both the strain, which suggests this plant have antimicrobial activity. (Pimporn *et al.*, 2011) ^[24]

Sesbania grandiflora aqueous leaves extract are effective against *S. aureus* when compared to standard drug ampicillin. (Arumugam *et al.*, 2017) ^[2]

Anti-Viral Activity

The methanolic extract of flowers of *S. grandiflora* was screened for their antiviral activity against herpes simplex-1, herpes simplex-2, vaccinia, vesicular stomatitis and coxsackie. The study showed antiviral activity because of flavonoid content. (Saravana *et al.*, 2012) ^[41]

Hypolipidemic Activity

In the last 40 years, a fourfold rise of coronary heart disease prevalence was seen in India. These are over 30 million cases of coronary heart disease (CHD) was observed in this country in epidemio-logical studies. (M. N. Krishnan, 2012) ^[20]

Coronary heart disease was the greatest risk factor for hyperlipidemia. At the present time the drugs of hyperlipidemia have number of side effects, but the herbal treatment had no, or less side effects and they are relatively cheap and available easily. There is a claim in a literature that hyperlipidemia can be reduced by flavonoids. A dose of 20µg/kg parts of *S. grandiflora* administered to the triton induced hyperlipidemic rats, which shows a good decline in the levels of serum cholesterol, triglyceride, phospholipid, VLDL, LDL. It also showed an increased level of serum HDL at the same dose. Hypolipidemic activity was studied in aqueous extract of *S. grandiflora* leaves when it was investigated on triton induced hyperlipidemic profile because it has shown a growth level of serum HDL and decline in the serum level of total cholesterol. (A. Saravanakumar, 2010) ^[5]

Anti-Tuberculosis Activity

In 2019, 1.4 million people died due to tuberculosis (TB). The death due to TB comes under the top 10 causes of death in the world and it is the leading cause, which happens due to a single infectious agent. ([https://www.who.int/news-room/fact-sheets/detail/tuberculosis#:~:text=Key%20facts,with%20tuberculosis\(TB\)%20worldwide](https://www.who.int/news-room/fact-sheets/detail/tuberculosis#:~:text=Key%20facts,with%20tuberculosis(TB)%20worldwide)) ^[37]

The different compound isolated from the roots of *S. grandiflora* showed less anti-tuberculosic activity, these compounds are isoflavonoids, isivestitol, medicarpin and sativum along with another known compound betulinic acid. Spectroscopic techniques were used for characterizing their structures. The tested compound shows much less anti-tuberculosic activity of 50ug/ml than methanolic extract which shows 625ug/ml of anti-tuberculosic activity against *M. tuberculosis*. (Noviany *et al.*, 2012) ^[23]

Cardio-Protective Activity

The number one causes of death in all over the world are cardiovascular diseases. There was an estimate by the WHO that 17.9 million death are causes by these diseases. (https://www.who.int/health-topics/cardiovascular-diseases#tab=tab_1) ^[38]

A study was undertaken to evaluate the cardio-protective effects of *S. grandiflora* against cigarette smoke induced oxidative damage in rats. Adult male wistar-kyoto rats were exposed to cigarette smoke for a period of 90 days and consecutively treated with *S. grandiflora* aqueous suspension (SGAS, 1000mg/kg body weight per day orally) for a period of three weeks. Lactate dehydrogenase activity in serum and cardiac lipid peroxidation product level were significantly increased while the activities of cardiac superoxide dismutase, catalase glutathione, peroxidase, glutathione reductase, glutathione-s-transferase and glucose-6-phosphate dehydrogenase then the levels of reduced glutathione, vitamin- C and vitamin- E were significantly decreased in rats exposed to cigarette smoke. Besides copper level was elevated, while zinc, manganese, selenium levels are significantly diminished in the heart of rats exposed to cigarette smoke. (Thiyagarajan *et al.*, 2008) ^[47]

Anti-Arthritic Activity

Rheumatoid arthritis is a chronic systematic disease. It strikes the person when they are at the age of 20 to 40 years, which are the most productive years of adulthood. It causes a chronic pain and deformity. (Neha Chaurasia *et al.*, 2020) ^[22]

An inhibitory activity at 200-1000 μ g/ml was shown by ethyl acetate extract of *S. grandiflora* by inhibiting denaturation of proteins. The effect of the result was compared with standard drug diclofenac sodium. It was found that denaturation of proteins was caused by auto antigen production in rheumatoid arthritis. This study shows that the reason behind anti-arthritic activity in ethyl acetate extract of *S. grandiflora* was the presence of flavonoids, phenols, polyphenols and steroids. (Sripradha *et al.*, 2015) ^[44]

Immuno-Modulatory Activity

A study was undertaken to investigate the immune-modulatory activity of *S. grandiflora* on cellular and humoral immunity. Methanolic extract of *S. grandiflora* flower in mice was administered, dose of which has enhanced the production of titer (circulating antibody) in response to Sheep Red Blood Cells (SRBC). It has most significantly enhanced the delayed type of hypersensitive activity as compared to sensitized. Aqueous extract of *S. grandiflora* has significantly increased phagocytic activity in carbon clearance assay and lowered by cyclophosphamide drug. Aqueous extract at 250mg/kg dose level has not shown any immune modulatory activity, at 500 mg/kg has shown potential activity. However, it was also less in comparison to both doses of methanolic extract. (Malik Arunabha, 2014) ^[18]

Anti-Inflammatory Activity

The anti-inflammatory activity of *Sesbania grandiflora* due to presence of carotenoid and Oxazole derivative compounds such as phytofluene (Fig 9) and 4-methyloxazole (Fig 10). (A. Zahir *et al.*, 2014) ^[6]

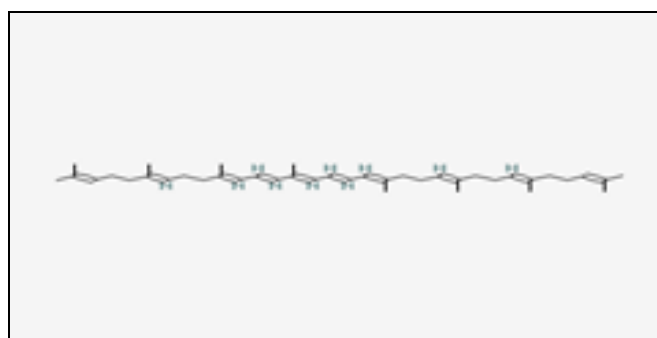


Fig 9: Phytofluene (542.9g/mol)

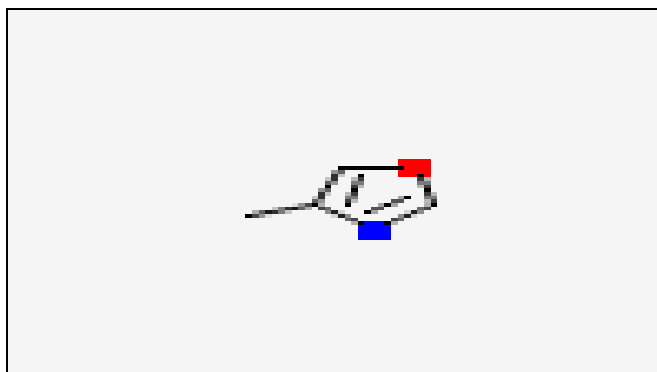


Fig 10: 4-methyloxazole (83.09g/mol)

Analgesic Activity

An investigation of petroleum ether, ethyl acetate and ethanol were subjected on the flowers of *S. grandiflora* for evaluating their analgesic activity on the albino rat using tail flick method. It was found that the ethyl acetate extract has shown better analgesic antipyretic activity in comparison to extracts of petroleum ether and ethanol. (Vijay *et al.*, 2009) ^[49]

Wound Healing Activity

Wound healing activity of methanolic extract of *S. grandiflora* bark had been evaluated by using excision wound model in Wister albino rats. methanolic extract showed significant wound healing activity at 10% w/w dose when compared to 1% of standard drug framycetin sulphate. It has shown that methanolic extract of *S. grandiflora* bark has significant wound healing activity. (Karthikeyan *et al.*, 2011)^[27]

An investigation was conducted to evaluate wound healing activity of methanolic extract of leaves of *S. grandiflora* by using excision wound model in rabbits. In excision model, treatment was continued till the complete healing of wound. Methanolic extract showed significant wound healing activity at 2% and 4% w/w dose when compared to 0.2 w/w of standard drug nitrofurazone. The results confirmed that methanol extract of leaves of *S. grandiflora* showed significant wound healing activity. (Aijaj A. Sheikh, 2011)^[1]

As a Tablet Binder

Binding activity of hydrophilic mucilage from the seeds of *S. grandiflora* was studied. The aim of the study was to isolate the hydrophilic mucilage from the seeds of *S. grandiflora* to find out the potential of mucilage in formulation of tablet as a binder. No chemical interaction was shown by the DSC thermo gram of the drug (drug mucilage mixture). The different variants of *S. grandiflora* (SG-I, SG-II, SG-III, SG-IV and SG-V) was formulated as tablet by using different percentage (2%, 4%, 6%, 8% and 10%) of mucilage in which lactose are used as diluents, diclofenac sodium as model drug, 2% of talc using magnesium stearate as a lubricant and glidant. The wet granulation technique was used on granules to evaluate the granules property such as flow rate, hausner ratio, angle of repose and car index which was compared with starch using it as standard binder at the concentration of 10%. The tablet was compared, and it was evaluated that what was the various parameters of weight variation friability, *in vitro* dissolution, disintegration and hardness. This study shows that the granules is having an excellent flow property and the tablet prepared using 8% and 10% of mucilage has a drug release over a period of 5 hours. The tablet using other formulation are not so hard like the tablet prepared using 8% and 10% of mucilage. (Shaikh *et al.*, 2014) ^[42]

Conclusion

Since ancient time, people have been using plants in many ways as a source of medicine. In recent years, ethnomedicinal studies received much attention as this brings to light the numerous little known and unknown medicinal features especially of plant origin. The presented review on *S. grandiflora* suggests a significant biological potential of this plant. This plant is native to Asia and is now widespread in most humid tropical regions of the world. The leaves, flowers and pods of *S. grandiflora* are eaten as vegetables in Southeast Asia. In Ayurveda, the various parts of the plant are used as human aliment for treating cancer, helminthic disease, diabetes, ulcer, hepatotoxicity, microbial infection, viral infection, hyperlipidemia, tuberculosis, cardiovascular disease and arthritis. This plant also has different property such as immunomodulatory, anti-inflammatory, analgesic, wound healing and as a tablet binder. From the above discussion, it is concluded that this ethno medicinal plant have immense potential to attract the researchers for their research work as well as to solve the different problems of human body using the herbal medicine which prepared from this plant. Preparation of herbal medicine from this plant is the prospects for further researchers.

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