Short Communication

Medicinal and Therapeutic values of Sesbania grandiflora

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There are around 60 global species belonging to the genus Sesbania which are commonly found to be grown in Africa, Australia, and Asia. The leaves of Sesbania grandiflora have been used in local traditional medicine since ancient times. Major chemical constituents are alkaloids, flavonoids, glycosides, tannin, anthraquinone, steroid, phlobatannins, and terpenoids. Isovestitol, medicarpin, sativan (isoflavonoids) and betulinic acid (tannin substance) are the major constituents responsible for antibacterial and antifungal, antioxidative, anti-convulsant and anxiolytic, and hepatoprotective properties. Also, the plant extract contains alkaloids, phenolics, tannins, triterpenoids, and sterols. All parts of S. grandiflora are used in traditional medicine and phytochemical investigations have been conducted on extracts of the leaves, seeds and roots of S. grandiflora to provide scientific validation of its properties. The paper best finds its interest towards plant medicine researchers who need to explore venues of plant specific information regarding previous research for future path.

Keywords: Sesbania grandiflora, isoflavonoids, Heron flower, bokphool, cardio-protective, Neuroprotective, hepatoprotective.

Abbreviations

Hydroxy Methoxy Benzaldehyde (HMB); Advanced Glycation End Products (AGEs); Polyunsaturated Fatty Acid (PUFA); Low-density lipoprotein (LDL); Triglyceride (TG); multi-drug resistant (MDR); Silver Nanoparticles (AgNPs); Hemoglobin A1c (HbA1c); Tetrachloromethane (CCl4); Michigan Cancer Foundation-7 (MCF-7); Acetylcholinesterase (AchE).

Leaves of Sesbania grandiflora have the potential to be used as a remedy for thrombosis, diarrhea, and inflammatory diseases and against few important bacterial pathogens [3,4]. The juice of the leaves of S. grandiflora has been reportedly used in the treatment of bronchitis, cough, vomiting, wounds ulcers, diarrhea, and dysentery. The flowers have reported antimicrobial activity. Powdered roots of this plant are mixed in water and applied externally as a poultice or rub for rheumatic swelling [5]. The leaves are traditionally used to treat nasal catarrh, nyctalopia and cephalagia. Studies show that, S. grandiflora possess antioxidant, antiurothiatic, anticonvulsive, anti-arthritic, antiinflammatory, anti-helminthic, anti-bacterial and anxiolytic activity [6-8]. Gandhi et.al, 2017 reported that anti-biofilm and antibacterial efficacy of S. grandiflora plays a vital role over biofilm producing pathogens and act as a good source for controlling the microbial population [9]. Saifudinet.al, 2016 reported that flower acts as a promising material to develop the active ingredient of anti-plaque toothpaste as well as mouthwash solution [10]. It has been reported that a biofilm is strongly associated with the drug resistance property [11]. Hence, eradication of biofilm is often considered to be a difficult task and therefore use of plant products to inhibit biofilm may be a viable alternative [12]. Ramesh et.al, 2015 showed brain oxidative damage restored by Sesbania grandiflora in cigarette smoke-exposed rats [13]. Earlier, the lead author and associates presented cardio-protective action of S. grandiflora aqueous suspension that restored the antioxidant status and retained the levels of micronutrients in cigarette smoke-exposed rats [14,15]. Afterwards, Ramesh et.al, 2010 reported that S. grandiflora aqueous suspensions significantly decreased the elevated hepatic, renal and lipid peroxidation markers and ameliorated the diminished anti-oxidant levels while...
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Figure 1. Top View of *Sesbania grandiflora* [1]. Native to tropical Asia, commonly known as vegetable hummingbird, agati or hummingbird tree, is a small tree in the genus *Sesbania*. It is a short-lived, soft-wooded, loosely-branching tree with a rather open crown; it can grow 8 - 15 meters tall.

Figure 2. Bok phool or Heron flower [2]. The *Sesbania grandiflora* or the humming bird tree bears a big white flower that is heartily used in Bengali cuisine. White flower variety of *S. grandiflora* found to be non-toxic, the purple flower type is highly toxic. The tree’s leaves, fruits and flowers can all be consumed – eaten alone as vegetables and added to curries or salads. Known as bokphool in West Bengal, the flower is commonly consumed by dipping in batter and frying. The flowers and leaves are enriched with vitamins and minerals and have been reportedly associated with anti-inflammatory, analgesic and antipyretic effects. A fraction isolated from flowers, preferentially killed leukemic cells in another study.

restored the hepatic and renal architecture in cigarette smoke-exposed rats [16]. Semwal et.al, 2018 reported significant neuroprotective effect in celecoxib treated mice through the modification in cholinergic system or by the blockage of oxidative stress and inhibition of AchE enzyme. at the doses of 200 and 400 mg/kg in mice [17]. *S. grandiflora* protects the lung from the oxidative damage through its antioxidant potential [18]. Earlier,
Pajaniradje et al. 2014 reported methanolic fraction of *S. grandiflora* was found to exert potent antiproliferative effects especially in the human lung cancer cell line, A549 [19].Bhoumik et al. 2016 reported hepatoprotective activity against CCl4 induced hepatotoxicity in rats by aqueous extract [20]. Plants contain a huge range of active compounds with the most abundant being polyphenols, carotenoids, vitamin (vitamin A, C, riboflavin, nicotinic acid), and minerals like zinc and selenium which form an integral part of antioxidant systems and reduce cellular damages [21,22]. Roy et al. 2013 reported that a fraction isolated from flowers, preferentially kills leukemic cells (particularly those of histiocyte lymphoma) by triggering programmed cell death [23]. In 4 different studies from 2012 to 2016, it was found that the flower, fruit and the whole plant extract reduced blood glucose, cholesterol, TG and LDL, lipid peroxidation and increased superoxide dismutase and catalase of insulin and hemoglobin in experimental animals [24-27]. Afterwards, Prasanna et al. 2018 demonstrated the hydroxy methoxy benzaldehyde (HMB) content as anti-glycogen lead that inhibited formation of early Hba1c and advanced glycation end products (AGEs) [28]. The hypoglycemic activity is thought to be due to increased hepatic metabolism followed by stimulation of synthesis and/or release of insulin from pancreatic beta cells and/or insulin sparing effect. High contents of quercetin, myricetin and kaempferol were identified in a methanolic extract of the leaves and a novel protein fraction was isolated from the fresh flowers, which displayed chemo-preventive effects [29,30]. The ethanol extract of the leaves and flowers were effective in inhibiting the tumor growth in ascitic models and that is comparable to 5-Fluorouracil [31].Chung et al. 2016 reported that silver nanoparticles (AgNPs) synthesized with leaf extracts were demonstrated to be cytotoxic to MCF-7 cancer cells [32,33]. Moreover, the synthesized AgNPs showed potent antibacterial activity against multi-drug resistant (MDR) bacteria such as *Salmonella enterica* and *Staphylococcus aureus* [34]. Later on, several studies revealed antimicrobial potential of *S. grandiflora* synthesized AgNPs [35-40]. Gupta et al. 2018 revealed antioxidant action of flavonoids especially quercetin and hydro-alcoholic extract found to reduce the levels of TNF-α and IL-6 in acetic acid induced ulcerative colitis in mice [41].Sesbania could afford a significant protective effect against erythromycin estolate-induced hepatotoxicity [42]; alcohol and polyunsaturated fatty acid (PUFA)-induced oxidative stress and nephrotoxicity (due to presence of phenolic compounds and anthocyanins) [43]. Also, the leaf juice of *S. grandiflora* showed significant antiulithiatic activity against calcium oxalate-type stones in an older study [44]. The fruits are used for anemia, bronchitis, fever, tumors. They are laxative, and possess intellectually stimulating properties [45]. Fruit extract significantly decreased the levels of blood glucose, cholesterol, TG and LDL, lipid peroxidation and increased superoxide dismutase and catalase in rats [46]. Hasan et al. 2012 first reported of the four compounds (Isovestitol, medicarpin, sativan and betulenic acid) isolated from the root of *S. grandiflora* and their anti-tuberculosis properties [47]. The bark extract has shown the protective effects against the acute and chronic inflammation [48,49]. The bark of *S. grandiflora* is very bitter and considered as an astringent and bitter tonic. Decoctions of leaves and flowers is used to treat leucorrhoea and vomiting of blood. The bark of *S. grandiflora* is used as an astringent and treatment of small pox, ulcers in the mouth and the alimentary canal, infant stomach disorders and scabies [43, 50]. Use of leaf powder as an iron and folate supplement showed improvement in hemoglobin levels of individuals with mild and moderate anemia [51]. Ethanolic extract of *S. grandiflora* significantly inhibited gastric mucosal damage induced by aspirin, ethanol and indomethacin [52]. Methanolic extract of *S. grandiflora* displayed a significant and dose dependent analgesic activity [53]. Also, triterpene containing fraction of *S. grandiflora* exhibits a wide spectrum of anticonvolvulant profile and anxiolytic activity [54].

CONCLUSION

Among very few plants of the world, *S. grandiflora* is the one whose all parts are utilized for the treatment of various types of ailments. Other than this, it has capability to fix atmospheric nitrogen and can be used as green manure to improve soil conditions. It can also be planted as windbreak and shade tree in plantations. The wood is soft and light, used as poles, in floating fishing nets, for fuel and charcoal-making. It is also a major source of pulp for making paper. So, the diversity of use surely demands more research in future regarding its cultivation, adaptation in new environments, impact of environmental factors on its major therapeutic contents, raw material collection, storage conditions and availability sources for regular use in pharmaceuticals.

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REFERENCES

Ajitha B, Ashok KRY, Rajesh KM, Sreedhara RP (2016). Sesbania grandiflora leaf extract assisted green synthesis of silver nanoparticles: Antimicrobial activity. Mater. Today Proc;3:1977–1984. doi: 10.1016/j.matpr.2016.04.099. Available from: https://www.sciencedirect.com/science/article/pii/S2214785316301328?via%3Dihub

Aye MM, Aung HT, Sein MM, Armijos C (2019). A Review on the Phytochemistry, Medicinal Properties and Pharmacological Activities of 15 Selected Myanmar Medicinal Plants. Molecules (Basel, Switzerland), 24(2):293. doi:10.3390/molecules24020293.

Bhoumik D, Mallik A, Berhe AH (2016). Hepatoprotective activity of aqueous extract of Sesbania grandiflora Linn leaves against carbon tetrachloride induced hepatotoxicity in albino rats. Int J Phytomed;8(2):294–299. Available From: https://www.arjournals.org/index.php/ijpm/article/view/1877

binteArfan N, Islam T, Sultana JA, Mohiuddin AK, Alam KS, Khalid LZ (2016). Thrombolytic, Membrane stabilizing, Antidiarrhoeal and Antimicrobial Properties of Bioactive Compounds Isolated from leaf ves of Sesbania grandiflora Naturally Growing in Bangladesh. Iranian Journal of Pharmaceutical Sciences ;12 (3): 31-46. Available from: http://www.ipjs.ir/article_23839.html

binteArfan N, Sultana JA, Mohiuddin AK, Alam KS, Khalid LZ (2016). Medicinal Properties of the Sesbania grandiflora Leaves. Ibnosina J Med BS;8(6):271-277. DOI: 10.4103/1947-489X.210243. Available from: http://www.ijmbs.org/temp/IbnosinaJMedBiomedSci86271-4743857_131038.pdf

China R, Mukherjee S, Sen S, Bose S, Datta S, Koley H, Ghosh S, Dhar P (2012). Antimicrobial activity of Sesbania grandiflora flower polyphenol extracts on some pathogenic bacteria and growth stimulatory effect on the probiotic organism Lactobacillus acidophilus. Microbiol Res;167(8):500-6. doi: 10.1016/j.micres.2012.04.003. Available From: https://www.ncbi.nlm.nih.gov/pubmed/22583547

Chung IM, Park I, Seung-Hyun K, Thiruvengadam M, Rajakumar G (2016). Plant-Mediated Synthesis of Silver Nanoparticles: Their Characteristic Properties and Therapeutic Applications. Nanoscale research letters, 11(1), 40. doi:10.1186/s11671-016-1257-4.

Das A, Das MC, Sandhu P, Das N, Tribedi P, De UC, Akhter Y, Bhattacharjee S (2017). Antiobiofilm activity of Parkia javanica against Pseudomonas aeruginosa: a study with fruit extract. RSC Adv. 7:5497–5513. Available From: https://pubs.rsc.org/en/content/articlepdf/2017/ra/c6ra24603f

Das J, Paul DM, Velusamy P Sesbania grandiflora leaf extract mediated green synthesis of antibacterial silver nanoparticles against selected human pathogens. Spectrochim Acta A Mol BiomolSpectrosc;104:265-70. doi: 10.1016/j.saa.2012.11.075. Available from: https://www.ncbi.nlm.nih.gov/pubmed/23270884

Doddola S, Pasupulati H, Koganti B, Prasad KV (2008). Evaluation of Sesbania grandiflora for antiurolithiatic and antioxidant properties. J Nat Med;62(3):300-7. doi: 10.1007/s11418-008-0235-2. Available From: https://link.springer.com/article/10.1007%2Fs11418-008-0235-2#citeas

Firdhouse MJ, Lalitha P (2013). Biosynthesis of silver nanoparticles using the extract of Alternanthera sessilis-antiproliferative effect against prostate cancer cells. Cancer nanotechnology, 4(6), 137–143. doi:10.1007/s12645-013-0045-4.

Gandhi AD, Vizhi DK, Lavanya K, Kalpana VN, Devi RV, Babujanarthanam R (2017). In vitro anti-biofilm and anti-bacterial activity of Sesbania grandiflora extract against Staphylococcus aureus. Biochemistry and biophysics reports, 12:193–197. doi:10.1016/j.bbrep.2017.10.004

Ghanshyam P, Chhayakanta P, Shankar MU, Sujata M, Gourishyam P, Kumar AA (2012). Investigation of possible hypoglycemic and hypolipidemic effect of methanolic extract of Sesbania grandiflora. Int Res J Pharm;3:275-80. Available From: https://pdfs.semanticscholar.org/6921/05e57c0e5e2da0785316301328?via%3Dihub

Gomase PV, Gomase PT, Anjum S, Shakil S, Shahnavaj KM (2012). Sesbaniasesban Linn: a review on its ethnobotany, phytochemical and pharmacological profile. Asian. J. Biomed. Pharm Sci;2:11. Available From: http://www.alliedacademies.org/articles/sesbania-sesban-linn-a-review-on-its-ethnobotany-phytochemical-and-pharmacologicalprofile.pdf

Gupta RA, Motiwal MN, Mahajan UN, Sabre SG (2018). Protective effect of Sesbania grandiflora on acetic acid induced ulcerative colitis in mice by inhibition of TNF-α and IL-6. J Ethnopharmacol. 12;219:222-232. doi: 10.1016/j.jep.2018.02.043.

Hasan N, Osman H, Mohamad S, Chong WK, Awang K, Zahariluddin AS (2012). The Chemical Components of Sesbania grandiflora Root and Their Antituberculosis Activity. Pharmaceuticals (Basel, Switzerland). 5(8), 882–889. doi:10.3390/ph5080882.
Hembram KC, Kumar R, Kandha L, Parhi PK, Kundu CN, Bindhani BK (2018). Therapeutic prospective of plant-induced silver nanoparticles: application as antimicrobial and anticancer agent. Artificial Cells, Nanomedicine, and Biotechnology; 46(3):38-51. DOI: 10.1080/21691401.2018.1499262

Jeyaraj M, Sathishkumar G, Sivanandhan G, MubarakAli D, Rajesh M, Arun R, Kapildev G, Manickavasagam M, Thajuddin N, Premkumar K, Ganapathi A (2013). Biogenic silver nanoparticles for cancer treatment: an experimental report. Colloids Surf B Biointerfaces; 106:86-92. DOI: 10.1016/j.colsurfb.2013.01.027. Available From: https://www.ncbi.nlm.nih.gov/pubmed/23434696

Kapila S (2018). Flowers on the menu. Media India (Lifestyle). Available From: https://mediaindia.eu/lifestyle/flowers-in-the-menu/

Kasture VS, Deshmukh VK, Chopde CT (2002). Anxiolytic and anticonvulsive activity of Sesbania grandiflora leaves in experimental animals. Phytother Res; 16(5):455-60. DOI: https://doi.org/10.1002/ptr.971. Available From: https://onlinelibrary.wiley.com/doi/abs/10.1002/ptr.971

Kumar R, Janadri S, Kumar S, Dhanajaya DR, Swamy S (2015). Evaluation of antidiabetic activity of alcoholic extract of Sesbania grandiflora in alloxan induced diabetic rats. Asian J. Pharm. Pharmacol; 1:21–26. Available from: http://aipp.in/uploaded/p03.pdf

Kumaravel M, Karthiga K, Raviteja V, Rukkumani R (2011). Protective effects of Sesbania grandiflora on kidney during alcohol and polysaturated fatty acid-induced oxidative stress. Toxicol Mech Methods; 21(5):418-25. DOI: 10.3109/15376516.2010.550015. Available From: https://www.tandfonline.com/doi/abs/10.3109/15376516.2010.550015?journalCode=itxm20

LAKSHMI T, “Hadga (Sesbania Grandiflora Linn.) – A Unique Ayurvedic Remedy” (2011). Int. J. Drug Dev. & Res., 3(4): 1-3. Available from: http://www.ijjdr.in/drug-development/hadga-sesbania-grandiflora-linn-a-unique-ayurvedic-remedy.pdf

Laladhas KP, Cheriyant VT, Puliappadamba VT, Bava SV, Unnithan RG, Vijayammal PL, Anto RJ (2010). A novel protein fraction from Sesbania grandiflora shows potential anticancer and chemopreventive efficacies in vitro and in vivo. Journal of cellular and molecular medicine, 14(3), 636–646. doi:10.1111/j.1582-4934.2008.00648.x. Available From: m.nih.gov/pubmed/23434696

Mishra RR, Savith A, Purushotham S, Geethanjali G (2016). Sesbania Grandiflora (Humming Bird Tree) in the Management of Anemia. Int. J Cont. Med. Res.; 3(10):3060-3062. Available From: https://www.ijcmr.com/uploads/7/7/4/6/77464738/ijcmr_1013_nov_5.pdf

MJF, PL (2015). Apoptotic efficacy of biogenic silver nanoparticles on human breast cancer MCF-7 cell lines. Progress in biomaterials, 4(2-4), 113–121. doi:10.1007/s40204-015-0042-2.

Munde-Wagh KB, Wagh VD, Tosliwal S, Sonawane BR (2012). Phytochemical, antimicrobial evaluation and determination of total phenolic and flavonoid contents of Sesbania grandiflora flower extract. Int. J. Pharm. Sci., 4:229–232. Available From: https://innovareacademics.in/journal/ijpps/Vol4Issue4/4868.pdf

Mustafa RA, Abdul Hamid A, Mohamed S, Bakar FA (2010). Total phenolic compounds, flavonoids, and radical scavenging activity of 21 selected tropical plants. J Food Sci; 75(1):C28-35. doi: 10.1111/j.1750-3841.2009.01401.x. Available From: https://www.ncbi.nlm.nih.gov/pubmed/23434696

Otunola GA, Afolayan AJ (2018). In vitro antibacterial, antioxidant and toxicity profile of silver nanoparticles green-synthesized and characterized from aqueous extract of a spice blend formulation. Biotechnology & Biotechnological Equipment; 32(3):724-733, DOI: 10.1080/13102818.2018.1448301. Available From: https://www.tandfonline.com/doi/full/10.1080/13102818.2018.1448301

Pajariradje S, Mohankumar K, Pamidimukkala R, Subramanian S, Rajagopalan R (2014). Antiproliferative and apoptotic effects of Sesbania grandiflora leaves in human cancer cells. BioMed research international, 2014, 474953. doi:10.1155/2014/474953.

Panigrahi G, Panda C, Patra A (2016). Extract of Sesbania grandiflora Ameliorates Hyperglycemia in High Fat Diet-Streptozotocin Induced Experimental Diabetes Mellitus. Scientifica, 2016, 4083568. doi:10.1155/2016/4083568.

Pari L, Uma A (2003). Protective effect of Sesbania grandiflora against erythromycin estolate-induced hepatotoxicity. Therapie. 58(5):439-43.

Patil RB, Nanjwade BK, Marvi FV (2010). Effect of Sesbania grandiflora and Sesbaniasesban Bark on carrageenan induced acute inflammation and adjuvant-induced arthritis in rats. Pharma Sci Monitor: An Int J PharmaceutSci;1:75-89. Available From: https://www.cabdirect.org/cabdirect/abstract/20103325077

Prasanna G, Hari N, Saraswathi NT (2018). Hydroxy methoxy benzaldehyde from Sesbaniagrandiflora inhibits the advanced glycation end products (AGEs)-mediated fibrillation in hemoglobin. J Biomol Struct Dyn. 36(4):819-829. doi: 10.1080/07391102.2017.1300543. Available From: https://www.tandfonline.com/doi/abs/10.1080/07391102.2017.1300543

Rajagopal PL, Premaletha K, Sreejith KR (2016). Anthelmintic activity of the flowers of Sesbania grandiflora Pers. J. Innov. Appl. Pharm. Sci;1:8–11. Available From:
http://www.jiaponline.com/VolumeArticles/FullTextPDF/14_JIAPSV11202.pdf

Ramesh T, Begum VH (2008). Protective effect of Sesbania grandiflora against cigarette smoke-induced oxidative damage in rats. J Med Food;11(2):369-75. doi: 10.1089/jmf.2006.205. Available From: https://www.liebertpub.com/doi/abs/10.1089/jmf.2006.205

Ramesh T, Mahesh R, Sureka C, Begum VH (2008). Cardioprotective effects of Sesbania grandiflora in cigarette smoke-exposed rats. J Cardiovas Pharmacol; 52(4):338-43. doi: 10.1097/FJC.0b013e3181888383. Available From: https://insights.ovid.com/pubmed?pmid=18791462

Ramesh T, Sureka C, Bhuvana S, Begum VH (2015). Brain oxidative damage restored by Sesbania grandiflora in cigarette smoke-exposed rats. Metab Brain Dis;30(4):959-68. doi: 10.1007/s11011-015-9654-4. Available From: https://www.ncbi.nlm.nih.gov/pubmed/25620659

Roy R, Kumar D, Chakraborty B, Chowdhury C, Das P (2013). Apoptotic and autophagic effects of Sesbania grandiflora flowers in human leukemia cells. PloS one. 8(8). doi:10.1371/journal.pone.0071672.

Saifudin A, Forentin AM, Fadhilah A, Tirtodiharjo K, Melani WD, Widyasari D, Saroso TA (2016). Bioprospecting for anti-Streptococcus mutans: the activity of 10% Sesbania grandiflora flower extract comparable to erythromycin. Asian. Pac. J. Trop. Biomed;6:751-56. doi:10.1016/j.apbimb.2016.03.018. Available From: https://www.sciencedirect.com/science/article/pii/S221169115300029

Sangeetha A, Prasath GS and Subramanian S (2014) Antihyperglycemic and antioxidant potentials of Sesbania grandiflora leaves studied in STZ induced experimental diabetic rats. Int J Pharm Sci Res; 5(6): 2266-75. doi: 10.13040/IJPSR.0975-8232.5(6).2266-75. Available from: http://ijpsr.com/bft-article/antihyperglycemic-and-antioxidant-potentials-of-sesbania-grandiflora-leaves-studied-in-stz-induced-experimental-diabetic-rats/?view=fulltext

Semwal BC, Murti Y, Verma M, Yadav HN (2018). Neuroprotective Activity of Semba - Nia grandiflora Seeds Extract Against Celecoxib Induced Amnesia in Mice. Pharma cogJ:10(4):747-52. Available From: https://www.phcogj.com/sites/default/files/pharmaco gnJ-10-747.pdf

Shah S, Akram M, Riaz M, Munir N, Rasool G (2019). Cardioprotective Potential of Plant-Derived Molecules: A Scientific and Medicinal Approach. Dose-response: a publication of International Hormesis Society, 17(2), 1559325819852243. doi:10.1177/1559325819852243.

Sharmili A (2016). PHYTOCHEMICAL ANALYSIS OF Aervalanata, Adathodavasica, Pisonia alba, Sesbania grandiflora AND Indigoferaapalathoides. Innovare Journal of Ayurvedic Sciences, 4(3), 12-15. Retrieved from: https://innovareacademics.in/journals/index.php/ijas/article/view/11987.

Sreelatha S, Padma PR, Umasankari E (2011) Evaluation of anticancer activity of ethanol extract of Sesbania grandiflora (AgatiSesban) against Ehrlich ascites carcinoma in Swiss albino mice. J Ethnopharmacol;134(3):984-7. doi: 10.1016/j.jep.2011.01.012. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21251969

Srividavas S, Singh P, Jha KK, Mishra G, Srividavas S, Khosa RL (2012). Evaluation of anti-arithmetic potential of the methanolic extract of the aerial parts of Costusspeciosus. Journal of Ayurveda and integrative medicine, 3(4), 204–208. doi:10.4103/0975-9476.104443.

Sureka C, Ramesh T, Begum VH (2015). Attenuation of erythrocyte membrane oxidative stress by Sesbania grandiflora in streptozotocin-induced diabetic rats. Biochem Cell Biol;93(4):385-94. doi: 10.1139/bcb-2015-0039. Available From: https://www.ncbi.nlm.nih.gov/pubmed/25620659

Tropical Plant Catalog. Sesbania grandiflora, Agati grandiflora. Available From: https://topropicals.com/catalog/uid/Sesbania_grandiflora.htm

Uddin MMN, Amin MR, Basak A, Shahriar M (2014). Analgesic and Neuropharmacological Investigations on Sesbania Grandiflora. Int J Pharm; 4(2): 179-182. Available From: http://pharmascholars.com/abstractview/analgesic-and-neuropharmacological-investigations-on-sesbania-grandiflora

Velusamy P, Kumar GV, Jeyanthi V, Das J, Pachaiappan R (2016). Bio-Inspired Green Nanoparticles: Synthesis, Mechanism, and Antibacterial Application. Toxicological research, 32(2), 95–102. doi:10.5487/TR.2016.32.2.095.

Venkatesan J, Kim SK, Shim MS (2016). Antimicrobial, Antioxidant, and Anticancer Activities of Biosynthesized Silver Nanoparticles Using Marine Algae Ecklonia cava. Nanomaterials (Basel, Switzerland), 6(12), 235. doi:10.3390/nano6120235.

Vimala G, Gricilda SF (2014). A review on antiulcer activity of few Indian medicinal plants. Int J Microbiol.;2014:519590. doi: 10.1155/2014/519590.
Epub 2014 May 25. Review. PubMed PMID: 24971094; PubMed Central PMCID: PMC4058214. Zarena AS, Gopal S, Vineeth R (2014). Antioxidant, antibacterial, and cytoprotective activity of agathi leaf protein. Journal of analytical methods in chemistry, 2014989543. doi:10.1155/2014/989543