Medicinal Properties and Phytoconstituents of *Alstonia scholaris:* A Review

Deena Prakash*, Divya Bisht and Arvind Kumar Shakya
Biochemistry Discipline, School of Sciences,
Indira Gandhi National Open University, New Delhi-110068, India.
*prak.deena@gmail.com

Received: *09.11.2020,* ***Accepted:****02.12.2020*

ABSTRACT

Alstoniascholaris is a traditionally medicinal plant native to India and South Asia. It is reported that this plant is used as anticancer, antimicrobial, antimutagenic, antifertility, anti-inflammatory, antioxidant, hepatoprotective agent. *A. scholaris* is also rich in various phytochemicals like alkaloid, flavonoid, steroids, triterpenoids and phenols which is responsible for its pharmacological activity. Therefore, the aim of this review is compilation of phytochemistry, ethnobotanical and pharmacological use of *A. scholaris* so as to provide better scope for the use of this plant in pharmacological related studies.

KEYWORDS - *Alstoniascholaris*, Phytochemicals, Medicinal properties.

1. INTRODUCTION

*Alstoniascholaris*is an evergreen tree grows in tropical region of Asia. It can grow to hundred meters height with white coloured flowers. 'Scholaris' name has given to this species because its wood has been used for making boards in school. India and china have been known for their traditional methods of medication like Ayurveda, Unani and Siddha. This plant belongs to *Alstonia* genus (Figure 1.1). This genus is reported to be useful in various diseases like malaria, fever, insomnia, chronic diarrhoea, and rheumatic pain (Akhtar and Bano, 2002)

A. scholaris is used in various Ayurvedic preparations like Saptaparnasatvadivati, Saptachadadivati, Saptacchadadikvatha and Saptaparnaghanasara for uses in treating asthma, malaria, cough, jaundice, stomach issues, headache and fever.

2. CLASSIFICATION

Kingdom: Plantae

Order: Gentianales

Family: Apocynaceae

Subtribe: Alstoniinae

Genus: *Alstonia*

Species: *Alstoniascholaris*

(a) (b)

Figure1: (a) Tree and (b) Flower of *Alstoniascholaris*

3. ETHANOBOTANICALUSES

This plant is used as tonic for stomach-ache, reoccurrence of various diseases, stimulant etc. It is also used to treat fever (Rajakumar and Shivanna, 2010) , arthritis (Yusuf et al.., 2006) , impotence, leucorrhoea (Bhandary, 1995), animal bite (Prusti and Behera, 2007) , antidote to poison, malaria, skin diseases (Molliket al., 2010) , leprosy, toe cracks, cellulites (Saikia, 2006) , hypertension (Chhetri, 2005) , swelling (Deb et al.., 2009) , delivery related pain (Sharma and Kumar, 2011). The bark of this plant is used for the treatment for gastro-intestinal problems like diarrhoea, fever, dysentery, jaundice, hepatitis, ulcer. Traditionally, it is used to treat heart related disorders (Singh and Sangwan, 2011). The Medicinal properties of A. scholarisis summarised in the Figure 1.2.

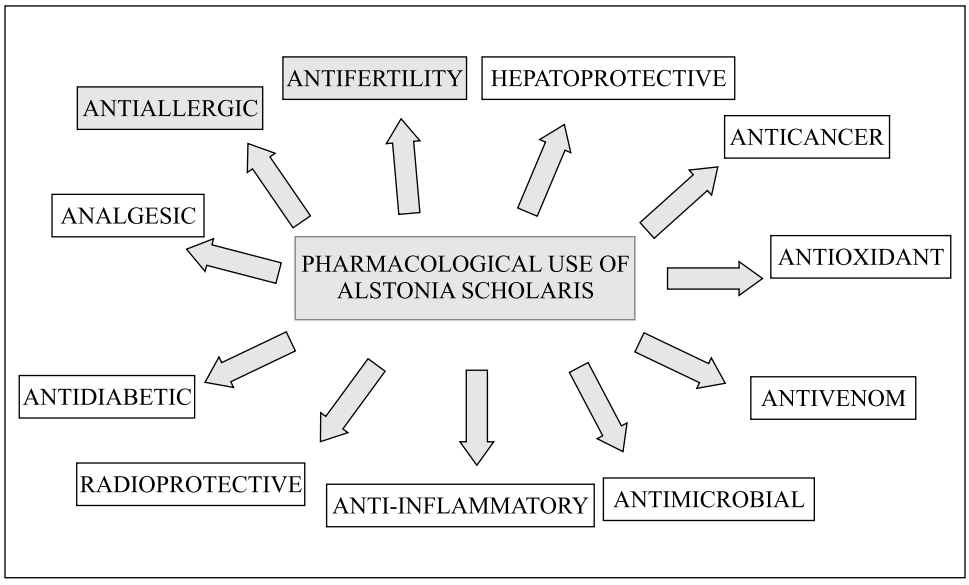

Figure 2: Medicinal Properties of A. scholaris

3. PHYTOCHEMICAL CONSTITUENTS

Chromatographic studies of *A. scholaris*showed various types of phytochemical like alkaloid, monoterpenoids, flavonoids, tannins, triterpenes, sterol, esters etc (Singh *et al.*., 2017). HPLC study of methanolic extract revealed that *A. scholaris* contains variety of phenolic acid like gallic acid, ellagic acid catechin and kaempferol (Shang *et al.*., 2010).Ethanoic acid and 10% aqueous ammonia with acidic solution adjusted to pH 9–10 was extracted to give TA fraction (10g). Scholaricine (6%), 19-epischolaricine (2%), picrinine (10%) and vallesamine (6%) (Zhao *et al.*., 2017) were isolated and showed airways antiallergic effect and down-regulation of inflammatory cells, cytokines, and the balance of antioxidants (Zhao *et al.*., 2017, Zhao *et al.*., 2018, Hadi*et al.*., 2009).Some Phytochemicals have been reported in *AlstoniaScholaris*'s (Figure 1.3).

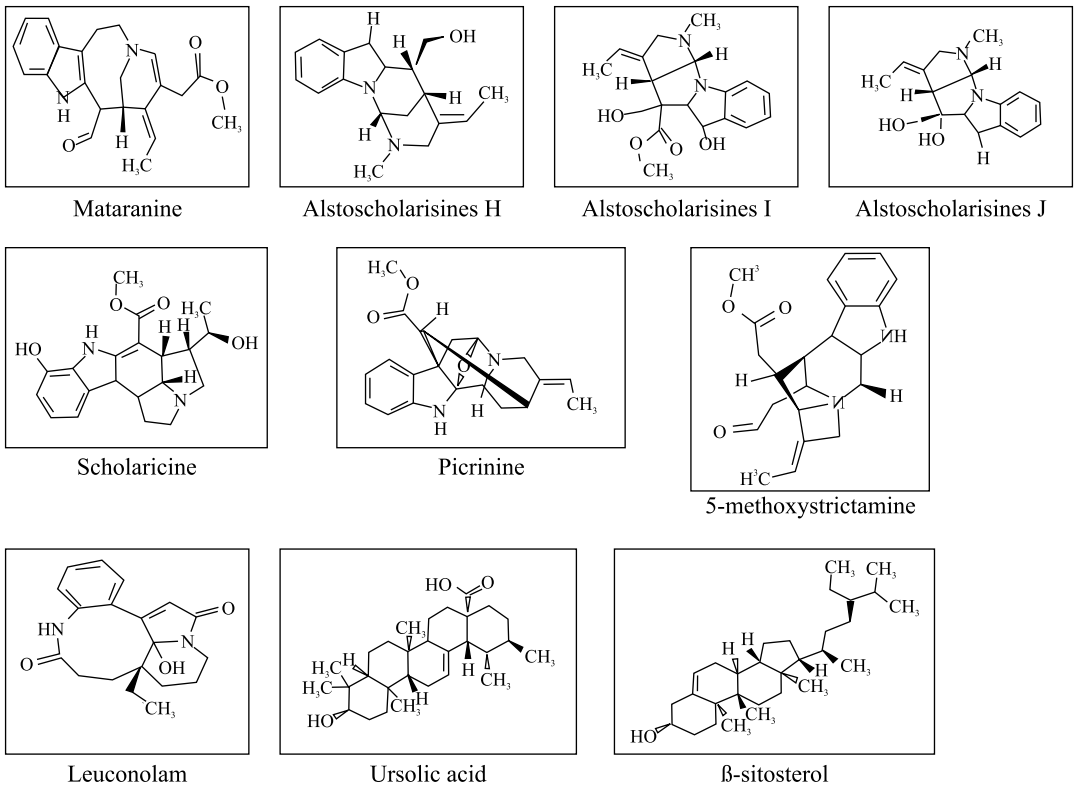

Figure 3: Phytochemicals in *A. scholaris*

4. MEDICINAL PROPERTIES

4.1 Analgesic and Anti-Inflammatory Activities

Invivo studies reported that administration of *A. scholaris* at 200mg/kg significantly reduced pain, mechanical hyperalgesia, heat hyperalgesia, cold by reverting the biochemical changes caused by chronic constriction injury as compared to pregabalin (Singh *et al.*., 2017). Shang *et al..also found the* anti-inflammatory and analgesic properties in *A. scholarisextract.*His team also isolated and fractionised

the alkaloidal extract of *A. scholaris* and found phytochemicals such as Picrinine, Vallesamine and Scholaricine. *In vitro* and *in vivo*studies of this alkaloidal extract reduced nitric oxide, PGE2 and malondialdehyde levels and increased antioxidant level against acetic acid and xylene induced inflammation in mice (Shang *et al.*., 2010). Zhao *et al.*. carried out the airway anti-inflammatory effect of alkaloidal extract from *A. scholaris* in rats. It was found that alkaloids decreased the levels of anti-inflammatory parameters like WBCs, Lactate dehydrogenase, Superoxide dismutase, albumin, alkaline phosphatase in lipopolysaccharide-induced airway inflammation rat model (Zhao *et al.*., 2017, Zhao *et al.*., 2018). Alkaloids also restrained the cytokines production in lung of rat. *A. scholaris*also reduced the allergen specific airway inflammation in rats. It was further claimed that decrease in allergic inflammation was due to intra-nasal route rather than intra-peritoneal route. *A. scholaris* extract at dose of 400mg/ kg was given to acetic induced pain in mice and it was found out that 79% pain was reduced and at the dose of 200mg/kg 73% pain was reduced. Also, Carrageenan induced paw oedema was decreased at 200 and 400 mg/kgdose (Arulmozhi*et al.*., 2007).

4.2 Anti-allergic effect

Alkaloids like scholaricine and vallesamine present in *A. scholaris* could be responsible for the treatment of allergic asthma.. It wasalso noted that *A. scholaris*extract administrated for 3 times a day had significant effect than for single dose daily which could be be due to prolonged retention time and the perpetuated plasma concentration. The reduction in interleukin 4, serum immunoglobulin type E was observed, as these molecules are proinflammatory molecule in asthma (Zhao *et al.*., 2017).

4.3 Anti-fertility activity

The benzene extract of *A. scholaris* bark was given orally for 60 days in wistar rats. With extract given in rats, they observed the decrease in size of prostate gland, epididymites and seminal vesicle. The decrease in the production of spermatids and spermatocytes was observed. There was significant decrease in protein and other biochemical parameters related to testes and seminal vesicle (Gupta *et al.*., 2002).

4.4 Radioprotective or Anti-Mutagenic Effect

The hydroethanolic extract of *Alstoniascholaris*has radioprotective efficacy in radiation induced biochemical and hematological changes (Gupta *et al.*., 2008). Animals with pretreatment of *A. scholaris*extract had significantly higher red blood cells count, hemoglobin values than the irradiated controls. *A. scholaris*also prevented total chromatid breaks at G_2 and G_0 phase in against Bleomycin induced chromosomal damage in cultured human lymphocytes (Mistry *et al.*., 2018).

4.5 Anticancer activity

Jagetia and Baliga has studied the anticancer activity of *A. scholaris*and they found that alkaloid fraction of this plant was cytotoxic to different cancerous cell line like cervical (HeLa), liver (HepG2),leukemic (HL60), epidermal (KB) and breast (MCF-7). Plant alkaloidal fraction was treated to HeLa cells resulted in antineoplastic activity. 240mg/kg dose of this plant was found to be effective against cancer in mice. Alkaloidal extract of this plant caused disease free survival for the longer period of time in animals. They found out that *A. scholaris* has tumoricidal properties (Jagetia and Baliga, 2005). *A. scholarisbark ethanolic extract had also*showed antitumor activity against a mouse transplantable tumor (Jagetia and Baliga, 2004). Methanolic extract of *A. scholaris*was found to effective against two types of human lung cancer cell lines i.e., MOR-P [adenocarcinoma] and CORL23 [large cell carcinoma]. They extracted different phytoconstituents and performed their potential anticancer activity in which phytochemical

villalstoninehad more significant effect than pleiocarpamine, O-methylmacralstonine and macralstonine(Keawpradub*et al.*., 1997).Cyclophosphamide is a reported drug used in chemotherapy to treat cancer when this cyclophosphamide was given with *A. scholaris*; it showed the enhanced and modulated anticancerous activity of cyclophosphamide in Ehrlich ascites carcinoma-bearing mice (Jagetia and Baliga, 2003). Hydroethanolic extract of *A. scholaris* at dose 4mg/ml was found to be most effective than lesser dose in benzo [a] pyrene induced forestomach carcinoma in female mice. Pre and post treatment of *A. scholaris* did not show any signs of tumor growth (Jagetia*et al.*., 2003).

4.6 Antidiabetic activity-

Aqueous extract of A boonei demonstrated significant antidiabetic and hyperglycaemic activities in dexamethasone-induced hyperglycaemic rats (Nkono*et al.*., 2014). Arulmozhi*et al.*. evaluated the antidiabetic and hyperlipidaemic activity of ethanolic extract of *A. scholaris* against streptozotocin induced animal model for diabetes and they found out that *A. scholaris* significantly reduced the glucose level in blood and reduced lipid peroxidation. Antidiabetic effect of extract was there for 1 week onwards till the end of the study. However, *A. scholaris* did not reverse the streptozotocin induced damage in pancreatic beta cells (Arulmozhi*et al.*., 2010). Aqueous extract of *A. scholaris* bark also showed the antidiabetic effect in streptozotocin induced diabetes in rat. The four-week study was performed in which *A. scholaris* bark extract with dose of 150mg/kg and 300mg/kg significantly decreased blood glucose serum triglycerides, serum cholesterol, glycosylated haemoglobin and liver glycogen in diabetic rat (Bandawane*et al.*., 2011). *A. scholaris*extract was also given to alloxan induced diabetic rat and it was found that the extract was remarkably decreased the diabetes symptoms. (Sonawane and Lohar, 2011).

4.7 Free Radical scavenging activity

Antioxidant activity of any medicinal plant is depicted by the 1,1-diphenyl-2-picryl-hydrazil (DPPH) free radicalscavenging , hydrogen peroxide scavenging, superoxide anion radical scavenging, ferric thiocyanate reducing ability and metal ion chelating. Arulmozhi performed all of the above tests on the various extracts of *A. scholaris* in which Dichloromethane and ethyl acetate fractions possessed significant free radical scavenging activity compared with standard antioxidants like ascorbic acid and butylated hydroxyanisole (BHA) (Arulmozhi*et al.*., 2007).*A. scholaris* was found be the most effective antioxidant among 17 medicinal plants *like Cynodondactylon, Morindacitrifolia ,Tylophora, Ocimum sanctum, Tinosporacordifolia* etc. *A. scholaris*bark extract showed 81% nitric oxide scavenging activity (Ravishankar *et al.*., 2008). Kumar also suggested that *A. scholaris* extract possesses the antioxidant potential. Even its flower also exhibited the free radical like DPPH scavenging activity (Verma *et al.*., 2015).

4.8 Hepatoprotective Activity

Hepatoprotective activity is majorly evaluated on the basis of biochemical, antioxidant (SOD, GSH, MDA, Hydrogen peroxide GPx, GST etc.) and hepatic parameters like AST, ALT ALP, LDH etc. Verma *et al.*. also performed these biochemical parameters in acetaminophen induced hepatotoxicity. They suggested that ethanolic extract of *A. scholaris* had higher hepatoprotective effect as compared to aqueous extract. Oral administration of APAP caused disturbances in normal values of various enzymes in blood and liver but after extract treatment these values were found to be normal (Verma *et al.*., 2015). Lin also evaluated the *A. scholaris* hepatoprotective effect against CCL4, galactosamine, acetaminophen and ethanol induced liver toxicity, post treatment with *A. scholaris* prevented and reversed the damage caused by various toxicants (Lin *et al.*., 1996).

4.9 Antimicrobial activity

Antimicrobial activity of *A. scholaris* was studied with different parts of the plant like stem bark leaves and root bark against gram positive and gram-negative bacteria (Khyade and Vaikos,2009, Goyal and Varshney, 1995). It has been reported that phytochemical present in *A. scholaris* provides the antimicrobial activity. Various extract with different solvents like butanol, methanol, distilled water, chloroform showed the broad-spectrum antimicrobial activity against test organism like *Escherichiacoli. Candida and Pseudomonas aeruginosa, Mycobacterium tuberculosis* (Antony *et al..*, 2012, Khan *et al..*, 2003). Different phytochemicals of *A. scholaris* have shown different antimicrobial activity against *Bacillus subtilis, Escherchia coli, Shigella aureus. Staphylococcus albus, Proteus vulgaris* and *Pseudomonas pyocyanea, Klebsiella* and *Shigella dysentriaelike sterols were more active than hydrocarbon chains against* gram-negative bacteria *extracted from A. scholaris and hydrocarbon were more active against gram*-positive and gram-negative bacteria. α-amyrin and lupeol were not active against *Bacillus subtilis, Escherchia coli but active against Shigella aureus. Staphylococcus albus, Proteus vulgaris* and *Pseudomonas pyocyanea, Klebsiella* and *Shigella dysentriae (Antony et al.., 2012, Khan et al.., 2003, Misraet al.., 2011,* Thankamani*et al..*, 2011, Varshney and Goyal, 1995*).*

4.10 Antivenom Activity

Gosh*et al..*investigated the venom neutralising potential of *A. scholaris*where he found that when the bark extract of this plant was administered to viper snaked poisoned swiss albino mice models,itsignificantly reduced the biochemical and histopathological changes like apoptosis,,vacuole formation in cytoplasm, cell size changes in liver and kidney tubule necrosis. Local symptoms related with snake poison envenomation are characterized by pain, swelling, haemorrhage and necrotic damage at the site of the bite and these symptoms are significantly decreased by aqueous *A. scholaris*extract at 200mg/kg BW (Gosh *et al..*, 2018).

5. CONCLUSION

The plant *A. scholaris*has ethnobotanical uses which have been validated in few pharmacological investigations. Various parts of this plant like bark, stem, root, and leaves have been reported to have anticancer, antimicrobial, hepatoprotective activity. *A. scholaris* has been found to be rich in phytoconstituents. Phytochemicals isolated from this plant may possess pharmacological potential which need to be studied in *in silico*, *in vitro* and *in vivo* model.

REFERENCES

Akhtar, MS, Bano, H. 2002.Hypoglycemic effect of powdered *Alstoniascholaris* [Satona]. *Professional Med J*, 9: 268-271.

Antony, M, James, J, Misra, CS, Sagadevan, L.D.M, Veetti, A.K.T, Thankamani V. 2012.Antimycobacterial activity of the plant extracts of *Alstoniascholaris*. *Int J Curr Pharm Res*, 4: 40-42.

Arulmozhi, S, Mazumder,P.M, Ashok, P, Narayanan, L.S. 2007. Anti-nociceptive and anti-inflammatory activities of *Alstoniascholaris* Linn. R.Br. *Pharmacogn Mag,*3: 106- 111.

Arulmozhi, S, Mazumder, P.M, Ashok, P, Narayanan, L.S. 2007.In Vitro Antioxidant and Free Radical

Scavenging Activity of *Alstoniascholaris* Linn. R.Br. *IJPT*, 6: 191-196.

Arulmozhi, S, Mazumder, P.M, Lohidasan, S, Thakurdesai, P. 2010. Antidiabetic and antihyperlipidemic activity of leaves of *Alstoniascholaris* Linn. R.Br. *Eur J Integrative Med*, 2: 23-32.

Bandawane,D, Juvekar, A, Juvekar, M. 2011.Antidiabetic and Antihyperlipidemic Effect of *Alstoniascholaris* Linn Bark in Streptozotocin Induced Diabetic Rats. *Ind J Pharm Edu Res,* 45: 114-120.

Bhandary, M.J, Chandrashekar, K.R, Kaveriappa, K.M. 1995. Medical ethnobotany of the Siddis of Uttara Kannada district, Karnataka, India. J Ethnopharmacol, 47:149-158.

Chhetri, R. 2005.*International journal of the society of Ethnobotany*,CCRAS, Vol.-17, pp.-98

Cimanga, R.K., Nsaka, S.L., Tshodi, M.E., Mbamu, B.M., Kikweta, C.M., Makila, F.B., *et al.*. 2019. In vitro and in vivo antiplasmodial activity of extracts and isolated constituents of *Alstoniacongensis* root bark. *J Ethnopharmacol,* 242.

Das, A.K., Dutta, B.K., Sharma, G.D. 2008. Medicinal plants used by different tribes of Cachar district, Assam. *Indian J TraditKnowl,* 7, 446–454.

Deb, S., Arunachalam, A., Das,A.K..2009.Indigenous knowledge of Nyishi tribes on traditional agroforestry systems. *Indian J tradit know*, 8: 41-46.

El-Askary, H.I., El-Olemy, M.M., Salama, M.M., Sleem, A.A., Amer MH. 2012.Bioguided isolation of pentacyclic triterpenes from the leaves of *Alstoniascholaris* [Linn.] R. Br. Growing in Egypt. *Nat Prod Res,* 26, 1755–1758.

Gosh, R., Mana, K., Sarkhel, S. 2018. Ameliorating effect of *Alstoniascholaris* L. bark extract on histopathological changes following viper envenomation in animal models. *Toxicol Rep*, 5: 988-993.

Goyal, M.M., Varshney, A. 1995. Effects of natural products isolated from three species of *Alstonia*on some gram-positive and gram-negative bacteria. *Indian Drugs*, 32: 69-72.

Gupta, R.S., Sharma, R., Sharma, A., Bhatnager, A.K., Dobhal, M.P., Joshi, Y.C., *et al.*. 2002. Effect of *Alstoniascholaris* bark extract on testicular function of Wistar rats. *Asian J Androl*, 4: 175-178.

Gupta, U., Jahan, S., Chaudhary, R., Goyal, P.K. 2008. Amelioration of Radiation- induced Hematological and biochemical alterations by *Alstoniascholaris* [a Medicinal plant] extract. *Integr Cancer Ther*, 7: 155-Q61.

Hadi, S. 2009.Mataranine a and b: a new diastomeric indole alkaloid from *Alstoniascholaris* R. Br. Of Lombok island. *Indo J Chem*, 9: 505-508.

Hirasawa, Y., Miyama, S., Kawahara, N., Goda, Y., Rahman, A., Ekasari, W.,*et al.*. 2009.Indole alkaloids from the leaves of Alstoniascholaris. *Heterocycles*, 79, 1107–1112.

Jagetia, G.C., Baliga, M.S., Venkatesh, P. 2003.Effect of Sapthaparna [*Alstoniascholaris* Linn] in

modulating the benzo [a] pyrene-induced forestomach carcinogenesis in mice. *Toxicol Lett*, 144: 183-193.

Jagetia, G.C., Baliga, M.S. 2003. Modulation of antineoplastic activity of cyclophosphamide by *Alstoniascholaris* in Ehrlich ascites carcinoma-bearing mice. *J Exp Ther Oncol,* 3: 272-282.

Jagetia, G.C., Baliga, M.S. 2005.The effect of seasonal variation on the antineoplastic activity of *Alstoniascholaris* R. Br, in HeLa cells. *J Ethnopharmacol,* 96: 37-42.

Jagetia, G.C., Baliga, M.S. 2004.The evaluation of Nitric Oxide Scavenging Activity of Certain Indian Medicinal Plants In Vitro: A Preliminary Study. *J Med Food*, 7: 343-348.

Ravi Shankar, K., Ramesh, K.V., Naveena, P.2008.Free radical scavenging activity of the flower and fruit extracts of *Alstoniascholaris*. *BiosciBiotechnol Res Asia*, 5: 493-494.

Keawpradub, N., Houghton, P.J., Eno-Amooquaye, E., Burke, P.J. 1997. Activity of extracts and alkaloids of Thai Alstonia species against human lung cancer cell lines. *Planta Med*, 63: 97-101.

Khan, M.R., Omoloso, A.D., Kihara, M. 2003. Antibacterial activity of *Alstoniascholaris* and Leeatetramera. *Fitoterapia*, 74: 736–740.

Khare, C.P. 2007.Indian Medicinal Plants: An Illustrated Dictionary. Springer-Verlag, Heidelberg, Berlin, 38–39.

Khyade, M.S., Vaikos, N.P. 2009.Phytochemical and antibacterial properties of leaves of *Alstoniascholaris* R. Br. *Afr J Biotechnol*, 8: 6434-6436.

Kirtikar, K.R., Basu, B. D. 1918.In: Sudhindra Nath Basu, M. B.[Ed.],Indian Medicinal Plants, vol. II. Indian Press, Allahabad, India, 786–790.

Lin, S.C., Lin, C.C., Lin, Y.H., Supriyatna, S., Pan, S.L. 1996. The protective effect of *Alstoniascholaris* R.Br. on hepatotoxin induced acute liver damage. *Am J Clin Med,* 24: 153-164.

Misra, C.S., Pratyush, K., Sagadevan, L.D.M., James, J., Veettil, A.K.T., Thankamani, V. 2011. A comparative study on phytochemical screening and antibacterialactivity of roots of *Alstoniascholaris* with the roots, leaves and stem bark. *Int J Res Phytochempharmacol*, 1: 77-82.

Mistry, D., Pithawala, M. 2018. Protective effect of *Alstoniascholaris* Linn. R. Br. against Bleomycin induced chromosomal damage in cultured human lymphocytes, in vitro. *Drug Chem Toxicol*, 41: 162-168.

Mollik, M.A.H., Hossan, M.S., Paul, A.K., Taufiq-Ur-Rahman, M., Jahan, R., Rahmatullah, M. 2010. A Comparative Analysis of Medicinal Plants Used by Folk Medicinal Healers in Three Districts of Bangladesh and Inquiry as To Mode of Selection of Medicinal Plants. *Ethnobotany Research & Applications*, 8:195-218.

Nadkarni, A.K., Nadkarni, K.M. 1976. Indian Materia Medica, Vol. I, Popular Prakashan, Bombay, 80-83.

Nkono, B.L., Sokeng, S.D., Désiré, D.D.P., Kamtchouing, P. 2014. Antihyperglycemic and Antioxidant Properties of *Alstoniaboonei* De Wild. [Apocynaceae] Stem Bark Aqueous Extract in Dexamethasone-Induced Hyperglycemic Rats. *J Diabetes Res*, 3: 27-35.

Pan, Z.Q., Qin, X.J., Liu, Y.P., Wu, T., Luo, X.D., Xia, C.F. 2016.Alstoscholarisines H−J, Indole Alkaloids from *Alstoniascholaris*: Structural Evaluation and Bioinspired Synthesis of Alstoscholarisine H. *Org Lett,* 18; 654-657.

Prusti, A.B., Behera, K.K. 2007. Ethnobotanical exploration of Malkangiri district of Orissa, India. *Ethnobot Leaflets,* 11: 122-140.

Rahman, A.U., Alvi, K.A., Abbas, S.A., Voelter, W. 1987. Isolation of 19,20-Z Vallesamine and 19, 20- E-Vallesamine from *Alstoniascholaris*. *Heterocycles*, 26, 413–420.

Rajakumar, N., Shivanna, M.B. 2010.Traditional herbal medicinal knowledge in Sagar taluk of Shimoga district, Karnataka, India. *Indian J Nat Prod Resour*, 102-108.

Sahu, P.K. 2011.Plants used by Gond and Baiga women in ethno gynaecological disorders in Achanakmar wild life sanctuary, Bilaspur, C.G. *Int J Pharm Life Sci*, 2, 559–561.

Saikia, A.P., Ryakala, V.K., Sharma, P., Goswami, P., Bora, U. 2006.Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmetics. *J Ethnopharmacol*, 106: 149-157.

Saraswathi, V., Mathuram, V., Subramanian, S., Govindasamy, S. 1999. Modulation of the impaired drug metabolism in sarcoma-180-bearing mice by echitamine chloride. *Cancer BiochemBiophys*, 17: 79-88.

Shang, J.H., Cai, X.H., Feng, T., Zhao, Y.L., Wang, J.K., *et al.*.2010.Pharmacological evaluation of *Alstoniascholaris*: Anti-inflammatory and analgesic effects. *J Ethnopharmacol*, 129: 174–181.

Sharma,R., Sharma, H.K. 2010. Ethnomedicines of Sonapur, Kamrup District, Assam. *Indian J TraditKnowl*,9, 163–165.

Sharma, H., Kumar, A. 2011. Ethnobotanical studies on medicinal plants of Rajasthan [India]: A review. *J Med Plants Res*, 5: 1107-1112.

Sharma, H.K., Chhangte, L., Dolui, A.K. 2001.Traditional medicinal plants in Mizoram, India. *Fitoterapia,* 146–161.

Shrisha, D.L., Koteshwara, A., Nagabhushan, R., 2011.Bioprospecting of selected medicinal plants for antibacterial activity against some pathogenic bacteria. *J Med Plants Res*, 5, 4087–4093.

Singh, B., Sangwan, P. 2011.Taxonomy, ethnobotany and antimicrobial activity of *Alstoniascholaris* [L.] R. Br., *Carissa carandas* L. and *Catharanthus roseus* [L.] G. Don. *Int J Biotech &Biosci*, 1:102-112.

Singh, H., Arora, R., Arora, S., Singh, B. 2017. Ameliorative potential of *Alstoniascholaris* [Linn.] R. Br. against chronic constriction injury-induced neuropathic pain in rats. *BMC Complement Altern Med*, 17: 1-9.

Singh, M.P., Panda, H. 2005. Medicinal Herbs with Their Formulations. Daya Publishing house, Delhi, 88-90.

Sonawane, J.M., Lohar, P.S. 2011. Evaluation of hypoglycaemic activity of some medicinal plants of Satpuda forest on alloxan induced diabetes in rats. *J Ecobiotech*, 2: 30-33.

Thankamani, V., James, J., Veettil, A.K.T., Sagadevan, L.D.M. 2011. Phytochemical screening and antimicrobial activity of *Alstoniascholaris* flowers [L] R.BR. Fam: Apocynaceae. *Int J of Pharm Res and Development*, 3: 172-178.

The Wealth of India, Raw Materials, Vol. I, CSIR, New Delhi. 2004; 50 – 51.

Varshney, A., Goyal, M.M. 1995. Phytochemical study on the leaves of *Alstoniascholaris* and their effects on pathogenic organisms. *Anc sci life*, 15: 30–34.

Verma, K.P., Raina, R., Sultana, M., Singh, M. 2015. Modulatory Effects of *Alstoniascholaris* on Biochemical and Antioxidant Parameters in Experimentally Induced Hepatotoxicity in Wistar Rats. *J Med Plant Res*, 9: 406-416,

Wang, C.M., Yeh, K.L., Tsai, S.J., Jhan, Y.L., Chou, C.H. 2017. Anti-Proliferative Activity of Triterpenoids and Sterols Isolated from *Alstoniascholaris* against Non-Small-Cell Lungs Cells. *Molecules*, 22: 1-13.

Christophe, 2006. Medicinal Plants of the Asia-Pacific: Drugs for the Future. World Scientific Publishing Co. Pte. Ltd., Singapore, 447–450.

Wongseripipatana, S., Chaisri, L., Sritularak, B., Likhitwitayawuid, K. 2004.Indole alkaloids from the fruits of Alstoniascholaris. *Thai J Pharm Sci*, 28,173–180.

Yang, J., Fu, J., Liu, X., Jiang, Z.H., Zhu, G.Y. 2018. Monoterpenoid indole alkaloids from the leaves of *Alstoniascholaris* and their NF-κB inhibitory activity. *Fitoterapia*, 124:73-79.

Yusuf, M., Wahab, M.A., Chowdhury, J.A., Begum, J. 2006.Ethnomedico botanical knowledge from Kaukhali proper and Betbunia of Rangamati district. Bangladesh. *J Plant Taxon*, 13: 55-61.

Zhao, L., Cao, J., Shang, J.H., Liu, Y.P., Khan, A., *et al.*.2017.Airways antiallergic effect and pharmacokinetics of alkaloids from *Alstoniascholaris*. *Phytomedicine*, 27: 63-75.

Zhao, Y.L., Yang, Z.F., Shang, J.H., Huang, W.Y., Wang, B., Wei, X., *et al.*.2018.Effects of indole alkaloids from leaf of *Alstoniascholaris* on post-infectious cough in mice. Jethnopharmacol, 218: 69-75.Zhu, X.X., Fan, Y.Y., Xu, L., Liu, Q.F., Wu, J.P., *et al.*.2019.Alstonlarsines A−D, Four Rearranged Indole Alkaloids from *Alstoniascholaris*. *Org Lett*, 21: 1471-1474.

