



Allium stracheyi (Baker), the endangered and traditionally important herb of Uttarakhand Himalaya, India: A Review

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ABSTRACT

Allium stracheyi (Alliaceae), is the high-altitude growing plant, commonly known as Jamboo, and Dhungar in Uttarakhand, India. It is a good source of income for the tribal communities and cultivars of Uttarakhand with medicinal and economically importance. *A. stracheyi* has higher amount of fibre and protein contents with lower fat and carbohydrates. It is used in various ailments. Considering phytoconstituents studies revealed different types of compounds like hydrocarbons, terpenes, terpenoids and sulfur-containing components as volatile constituents. The present study aimed to provide a general review of the available literature of *A. stracheyi* on phytochemistry, biological activities and pharmacological uses with special reference to traditional and economic importance.

KEY WORDS: *Allium stracheyi*, phytochemistry, pharmacological application, sulfur contents, traditional importance

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INTRODUCTION

India is a hotspot for a wide range of medically important genera and species that are being used in various traditional and modern medicines [1]. It covers more than 45,000 species of flora, on which most of species are not found anywhere else. There are more than 7,000 officially recognized plants in India with extensive medicinal properties [2]. The Indian Himalayan Region comprises only 11% of geographical area of India is well known for its medicinal and aromatic plants diversity [3]. It accounts for about 50% of total forest cover and 40% of the endemic species also [4].

The genus *Allium* is an endangered and ethnobotanically important herb with high medicinal value of Uttarakhand Himalaya. This genus consists of approximately 2685 species worldwide according to The Plant List [5], out of which only 30-36 species are found in India [6, 7]. Traditionally, *Allium* spp. has been used by Bhotia tribal communities as spices from a long time. Generally, it is used in pickles, and treating health problems [8-10].

Allium stracheyi Baker (Alliaceae) is a perennial, small herb, up to 35 cm tall. The stem is leafy at the base, glabrous, leaves linear

and flattened narrow, heads globose, pedicel shorter than the flower, tepals dark pink-reddish in colour [11]. It is locally known as Jamboo, Dhungar (Kumaun region) and Pharan (Garhwal region). This species occurs in Jammu Kashmir, Himachal Pradesh and Uttarakhand (India), Nepal and Pakistan at the elevation of 2500-3625 m [12-14]. *A. stracheyi* grows aside running water or dry open slopes and used as traditional vegetables [15]. *A. stracheyi* and *A. wallichii* with some other species were grown wild in Tibet and its adjoining borders in Uttarakhand (Figure 1) [14].

A. stracheyi has been included in the Red Data Book of Indian plants due to its indiscriminate collection and resulting threat to its existence [16]. Among *Allium* species, *A. cepa* and *A. sativum* are the most common species grown throughout the world. In historical point of view, German chemist T. Wertheim [17] identified sulfur containing oil as diallyl sulfide ($C_6H_{10}S$) from garlic bulb. Later 1-propenyl propyl disulfide [18], allicin [19], and alliin the derivative of the amino acid cysteine [20] with some other compounds were identified. *A. stracheyi* also contains sulfur rich compounds with antioxidant, anti-inflammatory and antimicrobial properties. The sulfur rich compounds are reported in reducing blood cholesterol [21]. Several other investigations have been performed and reported worldwide as

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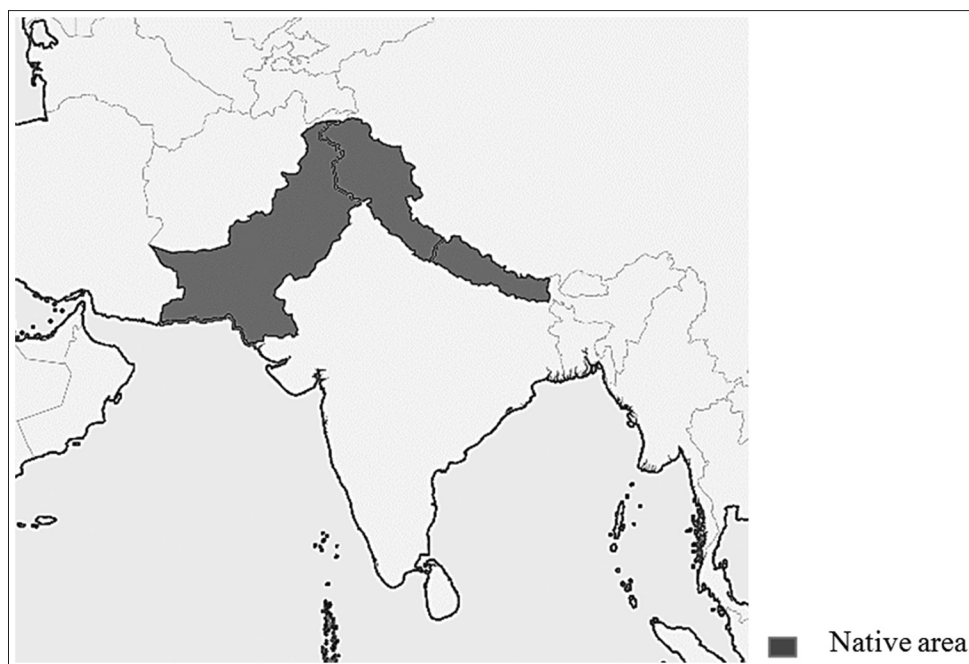


Figure 1: Distribution of *Allium stracheyi* Baker across the Asia including Nepal, Pakistan and West Himalaya (eMonocot, <http://e-monocot.org>, accessed on August 21, 2018)

well as in India to explore *A. stracheyi* significance and proved as medicinal plants. Therefore, this present study aimed to provide a general review of *A. stracheyi* on phytochemistry, biological activities and pharmacological uses along with special reference to traditional and economic repute.

PHYTOCHEMISTRY

The phytoconstituents are non-nutrient plant components or bioactive compounds. Herbal medicine is a complicated system of mixtures. Its preparations for medicinal usage contain different types of secondary metabolites or bioactive compounds. Various chemical and analytical techniques are helpful to understand the quality control and chemical constituents of herbal drugs. *Allium* species has been reported with various biologically active compounds such as phenolic acids, flavonoids, thiosulfinates, alkaloids, fixed oils, phytosterols, sulfur containing compounds and many more [1, 22 – 24].

Nutritional Value

A. stracheyi has high amount of fibres which helpful in maintaining blood glucose levels and its absorption. The nutritive value has the protein (4.26%), fat (0.1%), fibre (79.02%), carbohydrate (3.18%), calcium (0.8 mg), phosphorus (0.05 mg), iron (0.50 mg), magnesium (0.82 mg) and potassium (0.95 mg) per 100 mg [25] respectively.

Volatile and Sulfur-Containing Compounds

The phytochemical constituents of different extracts including petroleum ether, chloroform, methanol and aqueous extracts of *A. stracheyi* leaves figured out the presence of alkaloids,

saponins, fixed oils, phytosterols, phenolics and flavonoids, tannins, and steroids [1, 26]. *A. stracheyi* contains different types of compounds like hydrocarbons, terpenes, terpenoid etc. in which most of the compounds have sulfur as major content like 1,2-bis(methylthio) ethene (1), 2,4-dimethylthiophene (2), dimethyl disulfide (3) and dimethyl trisulfide (4) as the major volatile components (Figure 2) [11].

Another similar study on volatile composition of *A. stracheyi* reported 16-hentriacontanone (50.57%), 4-nitrophenyl ester hexadecanoic acid (31.59%), Heneicosane (28.84%), (Z,Z,Z)-9,12,15-octadecatrienoic acid (24.44%), isobutyl octadecyl ester oxalic acid (47.51%), 1-heneicosyl formate (13.79%), vitamin E (12.85%), Phytol (9.42%), 12-Hydroxydodecanoic acid (8.74%), (2-Bromocyclopropyl) benzene (8.25%), Hexacosane (7.76%), Tricosane (5.37%), 1,5,9,13-Tetradecatetraene (5%), (Z,Z,Z)-9,12,15-Octadecatrien-1-ol (4.14%), 11-Hexacosyne (3.09%) and 3-Phenylthiolane 1,1-dioxide (5) as major constituents [22]. The identified volatile compounds i.e. (Z,Z,Z)-9,12,15-octadecatrienoic acid also has been reported in curing cancer [27], having the anti-inflammatory and antioxidant properties [27, 28], palmitone the anxiolytic-like effect [29] and provide relief in spasmodic and arthritic pain [30].

Total Phenolic and Cflavonoid Contents

The total phenolic concentration (TPC) values of *A. stracheyi* extracts of whole plant are in range from 21.366 ± 0.117 to $22.374 \pm 0.117 \mu\text{g GAE/mg}$ extract for hexane extract (100%) and 23.009 ± 0.093 to $24.653 \pm 0.0968 \mu\text{g GAE/mg}$ and total flavonoid content (TFC) ranged from 11.850 ± 0.036 to $12.714 \pm 0.027 \mu\text{g QE/mg}$ extract for hexane extract (100%) and 12.824 ± 0.044 to $13.421 \pm 0.017 \mu\text{g QE/mg}$ extract for 100 % methanol extract. The temperature is not showed any significant effect on

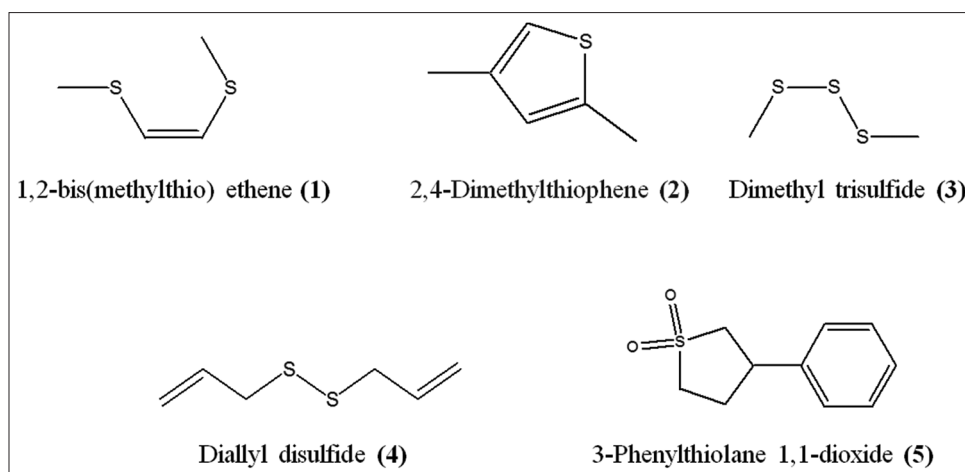


Figure 2: Chemical structures of sulfur containing compounds of *A. stracheyi*

flavonoid concentration ($p > 0.05$) and time showed significant increase ($p < 0.05$) [31].

ANTIOXIDANT ACTIVITY

The antioxidant activity of *A. stracheyi* has been quite extensively studied. It is commonly measured using 1,1-diphenyl-2-picryl hydrazyl (DPPH) radical scavenging assay. Kumar et al. [32] has reported ethyl acetate fraction reported with 85% scavenging activity. Similarly, another study has determined the methanol extract (74.654%) and hexane (15.61%) radical inhibition in Kumaun Himalaya, India cultivar species [31].

ANTIMICROBIAL ACTIVITY

In last few years, the drug resistance in microorganisms is tremendously increased. Only it can be avoided by using plant-based compounds rather than existing synthetic antimicrobial agents [33]. The antimicrobial properties of *A. stracheyi* are quite interesting and still need to explore more against enteric, respiratory bacteria and commensal bacteria. Joshi and Khan [31] has reported the antimicrobial efficacy of hexane extract of *A. stracheyi* against *Bacillus subtilis* and *Escherichia coli* while methanol extract found resistant against *E. coli* at 0.5 mg/ml. The antifungal study against *Monascus ruber* shows no significant inhibition.

ANTI-INFLAMMATORY ACTIVITY

Herbs are an excellent alternative to using anti-inflammatory drugs [34]. Although such drugs have an immediate effect, natural remedies-based herbs are effective over a longer period of time [35]. The anti-inflammatory and analgesic potential of *A. stracheyi* leaf extracts has been demonstrated by some workers. Ranjan et al. [26] reported methanol extract has significant reduction in inflammation (61%) in Wistar rats.

HEMOLYTIC PROPERTIES

Hemolytic activity of plant extracts or plant derived compounds is an indicator of general cytotoxicity towards normal healthy

cells [36]. *A. stracheyi* extracts exhibit the hemolysis activity confirmed by few workers. Six extracts including petroleum ether, benzene, n-butanol, ethyl acetate, 85% ethanol and aqueous were reported for their hemolytic property with three different concentrations i.e. 50 μg , 250 μg and 500 μg . The n-butanol extract showed maximum amount of hemolysis whereas, the aqueous extract showed less hemolysis [1].

HYPOGLYCEMIC ACTIVITY

Allium species have effective results in management of diabetes in which it is administered i.e. extracts, juice, powdered, essential oil [37-39]. The ethanolic crude extract has been reported the hypoglycemic effect in alloxan induced male albino rats with significant reduction in blood glucose level, total serum lipids and cholesterol at 300 mg/kg. The literature survey suggests that *A. stracheyi* still needs to explore the hypoglycemic activity.

ANXIOLYTIC ACTIVITY

Anxiety is an unpleasant state of internal trouble, often showed by nervous behavior, somatic complaints and rumination [40]. The benzodiazepines group belongs to anxiolytic substances act via the benzodiazepine receptors which are present on the GABAA pentameric complex. The clinical use of benzodiazepines is very limited with side effects like psychomotor impairment, sedation, myorelaxation, ataxia, amnesia and dependence liability [41 - 43]. Therefore, various medicinally important plants are used for therapeutic purposes to overcome central nervous disorders such as anxiety disorder [44 - 46]. Kumar et al. [47] reported the anxiolytic activity of *A. stracheyi*. The methanolic extract of *A. stracheyi* was studied for its anxiolytic property and the observations indicate that *A. stracheyi* imparts mild anxiolytic activity that affects emotion and cognitive behavior.

GENETICS

Mukherjee and Roy [48] reported the karyotype of some *Allium* species and results showed 8 as basic chromosome

number except *A. stracheyi*. Cultivars of same species did not vary considerably in their karyotypes, although they were morphologically different to each other. In the continuation, RAPD and ISSR markers showed significant role for finding genetic diversity and phylogenetic analysis of *Allium* spp [49].

ECONOMIC IMPORTANCE

Dried leaves of *A. stracheyi* had the highest cost in the market (Rs. 3000 per kg) out of the thirty medicinal plants collected from Uttarakhand, India [50]. However, in local markets of Nepal dried *A. stracheyi* is sold at the rate of Rs. 300-400 per kg [51].

OTHER PHARMACOLOGICAL USES

A. stracheyi contains sulfur rich compounds with antioxidant, anti-inflammatory and antimicrobial properties. Boiled leaves are used for cattle and decoctions of leaves are used in cold and cough [14]. Dried flowers of *A. stracheyi* is used as a spice known as “Pharan” in Uttarakhand. It also acts as a tonic for digestive system and tonify the circulatory system. The boiled and fried bulbs in ghee are eaten for the treatment of cholera and dysentery. *A. stracheyi* have the wound healing properties in skin diseases [52]. Plant juice can be used as moth repellent. It is used also as flavoring agent as Onion flavor and flavor is due to presence of sulfur compounds. In the Kumaun Himalaya region, other *Allium* species is used as spice and condiment and for seasoning purposes.

FUTURE DIRECTIONS

The *Allium* species has been reported with various bioactive compounds such as alkaloid, flavanoids, phenolics, phytosterols etc. and sulfur containing compounds. The *A. stracheyi* and *A. wallichii* are two important medicinal plants used in Ayurvedic medicine and listed in database of Ayurveda plants prepared by Foundation for Revitalization of Local Health Tradition (FRLHT), Bangalore. *A. stracheyi* is a high-altitude growing plant which could be a good source of income for the tribal communities of hilly area and if it is cultivated on large scale through tissue culture and advanced biotechnological approaches, it can be prove as a good source of income for the cultivars. The state government can also play an important role to boost and promote the cultivation of economically important medicinal and aromatic plants in the state by giving the subsidy and training program through master trainers time to time under the skill development program.

CONCLUSIONS

Keeping the reference of present comprehensive literature studied, it can be concluded that *A. stracheyi* is a therapeutically as well as economically important herb of Uttarakhand. There is a need for propagation by tissue culture techniques so that it can be produced on large scale. The training towards cultivation, conservation and proper documentation of traditional knowledge can prevent its exploitation. Therefore, it is an urgent need for conservation, cultivation and sustainable

exploitation of *A. stracheyi* as the precious resource of Uttarakhand Himalaya.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

AUTHOR'S CONTRIBUTION

MM and SSG participated in designing the study, collecting the literature and drafted the manuscript. SZH analyzed the literature data and PS conceived and designed the review study.

REFERENCES

- Mukherjee A, Rajasekaran C. In vitro hemolytic activity of *Allium stracheyi* Baker. J Pharm Res. 2010;3(5):1160-1162.
- Sharma PC, Bhatia V, Bansal N, Sharma A. A review on Bael tree. Nat Prod Rad. 2007;6(2):171-178.
- Samant SS, Butola JS, Sharma A. Assessment of diversity, distribution, conservation status and preparation of management plan for medicinal plants in the catchment area of Parvati hydroelectric project stage-III in north-western Himalaya. J Mt Sci. 2007;4(1):34-56.
- Saxena KG, Rao KS, Sen KK, Maikhuri RK, Semwal RL. Integrated natural resources management: approaches and lessons from the Himalaya. Conservation Ecology 2001;5:1-14.
- The plant list – *Allium* species. Available from: <http://www.theplantlist.org/tpl1.1/search?q=allium+species> Last accessed on 02 August, 2018.
- Santapau H, Henry AN. A Dictionary of the Flowering plants in India. Pub. & Inf. Directorate CSIR, New Delhi; 1973.
- Karthikeyan S, Jain SK, Nayar MP, Sanjappa S. Flora Indicae Enumeratio: Monocotyledonae. Flora Indica 4. Botanical Survey of India. Howrah; 1989.
- Kumari P, Singh BK, Joshi GC, Tewari LM. Veterinary ethnomedicinal plants in Uttarakhand Himalayan region, India. Ethnobot. Leaflets. 2009; 13:1312-1327.
- Nautiyal S, Rajan KS, Shibasaki R. Environmental conservation vs compensation: explorations from the Uttaranchal Himalaya. Environ Inform Arch. 2004;2:24-35.
- Samal PK, Dhyan PP, Bollo M. Medicinal plant resources in Nanda Devi biosphere reserve in the Central Himalayas. Indian J Tradit Know. 2010; 9:140-144.
- Shah NC. Status of cultivated & wild *Allium* species in India: a review. The Scitech. 2014;1(9):28-36.
- Dasgupta S. Fascicles of Flora of India, Fascicle 23. Botanical Survey of India. In: Singh NP, Sanjappa M (Eds.), 2006; pp 1-48.
- Rawat GS, Adhikari BS, Tiwari UK, Chandola S, Raut N. Medicinal plants of Garhwal region Uttarakhand: a baseline on the status and distribution. Wildlife Institute of India and Uttarakhand Forest Development Corporation, Dehradun, India; 2016.
- Tiwari UK, Adams SJ, Begum SN, Krishnamurthy KV, Ravikumar K, Padma V. Pharmacognostic studies on two Himalayan species of traditional medicinal value: *Allium wallichii* and *Allium stracheyi*. Not Sci Biol. 2014;6(2):149-154.
- Hanelt P. *Alliaceae* In Mansfeld's Encyclopedia of Agriculture and Horticultural Crops, Hanelt, P, Eds.; Springer-Verlag, Vienna. Vol. 4(3); 2001. ISBN: 3-540-41017-1.
- Bisht VK, Negi JS, Bhandari AK. Check on extinction of medicinal herbs in Uttarakhand: no need to uproot. Natl Acad Sci Lett. 2016;39(3):233-235.
- Wertheim T. Investigations on garlic oil. Ann Chem Pharm.

- 1844;51:289-315.
18. Semmler FW. Essential oil of Onion (*Allium cepa* L.). Arch Pharm. 1892;230:443-448.
 19. Cavallito CJ, Buck JS, Sulter CM. The antibacterial principle of *Allium sativum*. II. Determination of the chemical structure. J Am Chem Soc. 1944;66:1952-1954.
 20. Stoll A, Seebeck E. *Allium* compounds I. Alliin, the true mother compound of garlic oil. Helv Chim Acta. 1948;31:189-210.
 21. Abuajah CI, Ogbonna AC, Osuji CM. Functional components and medicinal properties of food: a review. J Food Sci Technol. 2015;52(5):2522-2529. doi: 10.1007/s13197-014-1396-5.
 22. Joshi S. Studies on supercritical fluid extraction of organic compounds from *Allium stracheyi* Baker. PhD Thesis, Aligarh Muslim University, Aligarh, India; 2016.
 23. Goncharov N, Orekhov AN, Voitenko N, Ukolov A, Jenkins R, Avdonin P. Organosulfur compounds as Nutraceuticals. In Nutraceuticals. Efficacy, Safety and Toxicity. 2016; pp 555-568. doi: 10.1016/B978-0-12-802147-7.00041-3.
 24. Kuete V. *Allium cepa*. In Medicinal Spices and Vegetables from Africa. Therapeutic potential against metabolic, inflammatory, infectious and systemic diseases. 2017; pp 353-361. doi: 10.1016/B978-0-12-809286-6.00014-5.
 25. Dobhal R. *Allium Stracheyi* Baker. In spices of Uttarakhand. Uttarakhand State Council for Science & Technology, Uttarakhand, India, 2015; pp 45.
 26. Ranjan S, Jadon VS, Sharma N, Singh K, Parcha V, Gupta S, Bhatt JP. Anti-inflammatory and analgesic potential of leaf extract of *Allium stracheyi*. J Appl Sci Res. 2010;6(2):139-143.
 27. Kim SJ, Chung WS, Kim SS, Ko SG, Um JY. Antiinflammatory effect of *Oldenlandia diffusa* and its constituent, hentriacontane, through suppression of caspase-1 activation in mouse peritoneal macrophages. Phytother Res. 2011;25(11):1537-1546. doi: 10.1002/ptr.3443.
 28. Agoramoorthy G, Chandrasekaran M, Venkatesalu V, Hsu MJ. Antibacterial and antifungal activities of fatty acid methyl ester of the blind-your-eye mangrove from India. Braz J Microbiol. 2007; 38(4):739-742. doi: 10.1590/S1517-83822007000400028.
 29. Gonzalez-Trujano ME, Martinez AL, Reyes-Romirez A, Reyes-Trejo B, Navarrete A. Palmitone isolated from *Annona diversifolia* induces an anxiolytic-like effect in mice. Planta Med. 2006;72(8):703-707. doi: 10.1055/s-2006-931598.
 30. Carballo AI, Martinez AL, Gonzalez-Trujano ME, Pellicer F, Ventura-Martinez R, Diaz-Reval MI, Lopez-Munoz FJ. Antinociceptive activity of *Annona diversifolia* Saff. leaf extracts and palmitone as a bioactive compound. Pharmacol Biochem Behav. 2010;95(1):6-12. doi: 10.1016/j.pbb.2009.11.017.
 31. Joshi S, Khan MA. Ultrasound assisted extraction technique: Study of the biological properties of *Allium stracheyi* Baker. Internat J Proc & Post Harvest Technol. 2016;7(1):85-95. doi: 10.15740/HAS/IJPPHT/7.1/85-95.
 32. Kumar S, Pangti J, Thakur S, Upadhyay N, Jain M. Antioxidant and wound healing potential of standardized ethyl acetate fraction (AS-3) of *Allium stracheyi* in Rats. Int J Biol Pharm Allied Sci. 2015;4(12):6467-6480.
 33. Shah PM. The need for new therapeutic agents: what is in the pipeline? Clin Microbiol Infect. 2005;11:36-42. doi: 10.1111/j.1469-0691.2005.01141.x.
 34. Rupasinghe HPV, Arumuggam N, Amaraathna M, De Silva ABKH. The potential health benefits of haskap (*Lonicera caerulea* L.): Role of cyaniding-3-O-glucoside. J Funct Foods. 2018;44:24-39. doi: 10.1016/j.jff.2018.02.023.
 35. Furst R, Zundorf I. Plant-derived anti-inflammatory compounds: hopes and disappointments regarding the translation of preclinical knowledge into clinical progress. Mediators Inflamm. 2014;Article id:146832. doi: 10.1155/2014/146832.
 36. Da Silva E, Shahgaldian P, Coleman AW. Haemolytic properties of some water-soluble para-sulphonato-calix-n-arenes. Int J Pharm. 2004;273(1-2):57-62.
 37. Eidi A, Eidi M, Esmaeili E. Antidiabetic effect of garlic (*Allium sativum* L.) in normal and streptozotocin-induced diabetic rats. Phytomedicine. 2006; 13:624-629. doi: 10.1016/j.phymed.2005.09.010.
 38. Akash MSH, Rehman K, Chen S. Spice plant *Allium cepa*: Dietary supplement for treatment of type 2 diabetes mellitus. Nutrition. 2014;30:1128-1137. doi: 10.1016/j.nut.2014.02.011.
 39. Mohamed SM, Jaleel GAA, Abdallah HMI, Bashandy SAE, Salama AB, Mahmoud AH. Hypoglycemic, hypolipidemic and antioxidant activities of *Allium porrum* leaves extract in streptozotocin-induced diabetic rats. Int J Pharmtech Res. 2016;9(11):187-200.
 40. Seligman MEP, Walker EF, Rosenhan DL. Abnormal psychology, 4th Ed. New York: W.W. Norton & Company; 2000.
 41. Czobor P, Skolnick P, Beer B, Lippa A. A multicenter, placebo-controlled, double-blind, randomized study of efficacy and safety of ocinaplon (DOV 273, 547) in generalized anxiety disorder. CNS Neurosci Ther. 2010;16 (Suppl 2):63-75. doi: 10.1111/j.1755-5949.2009.00109.x.
 42. Emamghoreishi M, Khasaki M, Aazam MF. *Coriandrum sativum*: evaluation of its anxiolytic effect in the elevated plus-maze. J Ethnopharmacol. 2005;96(3):365-370.
 43. Doukkali Z, Taghzouti K, Bouidida EH, Nadjmouddine M, Cherrah Y, Alaoui K. Evaluation of anxiolytic activity of methanolic extract of *Urtica urens* in a mice model. Behav Brain Funct. 2015;11:19. doi: 10.1186/s12993-015-0063-y.
 44. Verma R, Hanif K, Sasmal D, Raghurib R. Resurgence of herbal antihypertensives in management of hypertension. Curr Hypertens Rev. 2010;6(Suppl 3):190-198. doi: 10.2174/157340210791936705.
 45. Carlini EA. Plants and the central nervous system. Pharmacol Biochem Behav. 2003;75:501-512. doi: 10.1016/S0091-3057(03)00112-6.
 46. Faustino TT, Almeida RB, Andreatini R. Medicinal plants for the treatment of generalized anxiety disorder: a review of controlled clinical studies. Rev Bras Psiquiatr. 2010;32(Suppl 4):429-436.
 47. Kumar S, Joshi H, Chandra JNNS, Bahuguna P, Kedia VK, Kumar R. Effect of *Allium Stracheyi* on behavior of Zebrafish: a pharmacological approach. Sch J App Med Sci. 2015;3(9D):3356-3363.
 48. Mukherjee A, Roy SC. Karyotype analysis of five species of *Allium*. Indian Journal of Fundamental and Applied Life Sciences. 2012;2(2):374-383.
 49. Mukherjee A, Sikdar B, Ghosh B, Banerjee A, Ghosh E, Bhattacharya M, Roy SC. RAPD and ISSR analysis of some economically important species, varieties, and cultivars of the genus *Allium* (Alliaceae). Turk J Bot. 2013;37:605-618.
 50. Kala CP. Medicinal Plants in Active Trade at Haridwar City of Uttarakhand State in India. Medicinal and Aromatic Plants. 2015;4:204. doi: 10.4172/2167-0412.1000204.
 51. Chhetri HB, Gupta VNP. A survey of non-timber forest products (NTFP) in upper Mustang. Scientific World. 2007;5:89-94. doi: 10.3126/sw.v5i5.2663.
 52. Uttara B, Singh AV, Zamboni P, Mahajan RT. Oxidative stress and neurodegenerative diseases: a review of upstream and downstream antioxidant therapeutic options. Curr Neuropharmacol. 2009;7(1):65-74. doi: 10.2174/157015909787602823.