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Review Article

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Allium stracheyi (Baker), the endangered and traditional medicinally 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 medicinally 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

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 wildly 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

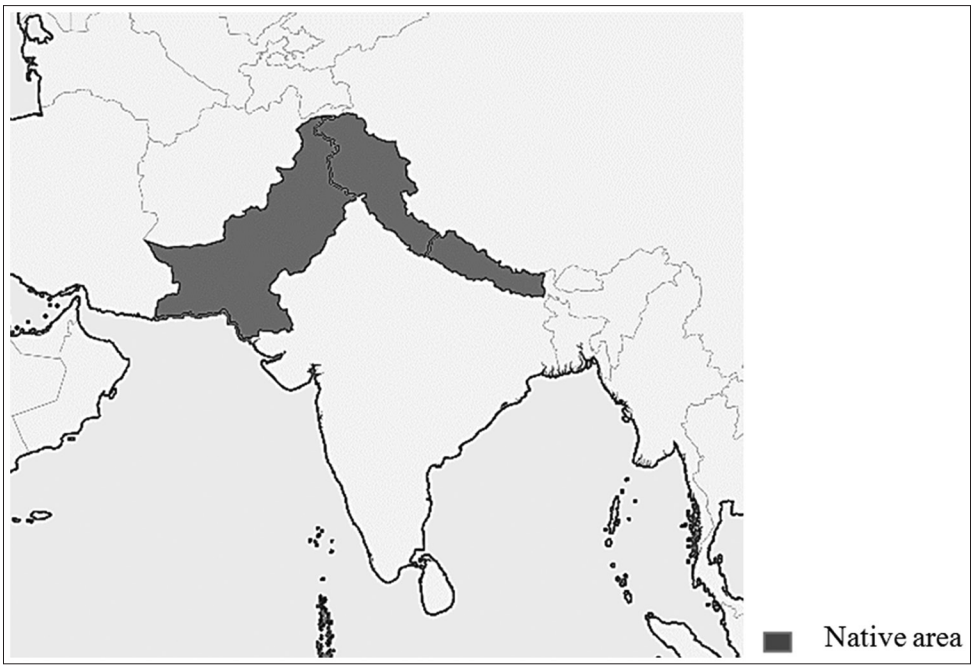

Figure 1: Distribution of *Allium stracheyi* Baker across the Asia including Nepal, Pakistan and West Himalaya (eMonocot, http://e-monocot.org, accessed on August 21, 2018)

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 ± 0.117μg GAE/mg extract for hexane extract (100%) and 23.009 ± 0.093 to 24.653 ± 0.0968 μg GAE/mg and total flavonoid content (TFC) ranged from 11.850 ± 0.036 to 12.714 ± 0.027 μg QE/mg extract for hexane extract (100%) and 12.824 ± 0.044 to 13.421 ± 0.017 μg QE/mg extract for 100 % methanol extract. The temperature is not showed any significant effect on

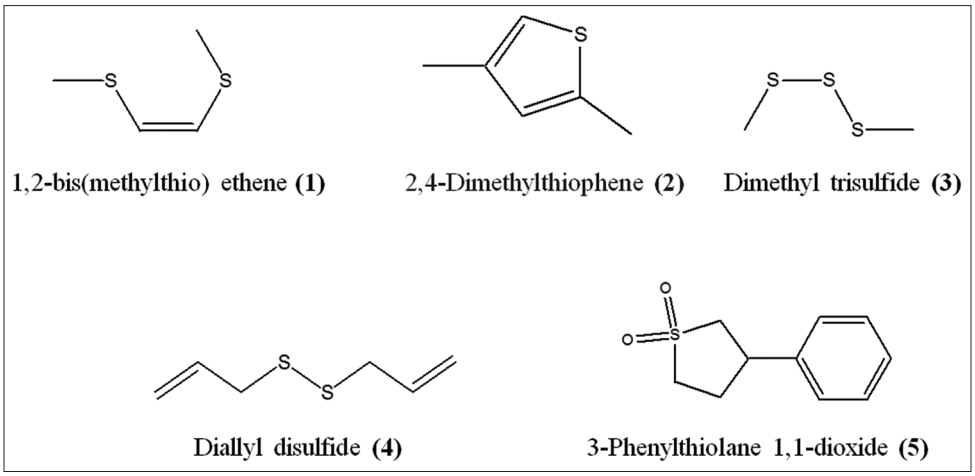

Figure 2: Chemical structures of sulfur containing compounds of *A. stracheyi*

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 pentametric 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.

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