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Large scale cultivation and commercialization opportunities and constraints of *Allium stracheyi* Baker – An endangered Medicinal Plant of Western Himalaya, India

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ABSTRACT

The Himalaya is a known home for diverse flora and fauna with medicinal properties. For millennia, Himalayan plants are used to treat simple cough to fatal snake bites. Traditional ethno-botanical knowledge (TEK) is an important tool to treat various ailments. Food as medicine is a very essential component to maintain healthy life and extend our life span. Pharmaceutical industries are utilizing about 95% of medicinal plants from the wild populations of Indian Himalayan region. Uttrakhand, one of the herbal state of Himalaya is known as a treasure house of medicinal and aromatic plants (MAPs) because of its distinct ecology and geography. *Allium stracheyi* Baker *one of the important MAP* belonging to the family Alliaceae locally known as Jambu is an endangered red listed species indigenous to Nanda Devi Biosphere Region (NDBR) with deficient information. Therefore, the study was carried out to present a comprehensive overview on the importance of *A. stracheyi* in the Indian Himalayan economy and TEK of tribes, with special emphasis on availability, cultivation and uses. The dominant Bhotiya tribes cultivated *A. stracheyi* during summer season. They have peculiar and specific ethano-botanical knowledge (TEK on medicinal plant propagation and environmental management. *A. stracheyi* leaves, flowers, bulbs and the whole plant are largely used as medicine, spices, condiments, vegetables and ornaments. The total production and monetary equivalent was reported maximum for *A. stracheyi* due to large cultivation. The intense knowledge of *A. stracheyi* has provided much understanding on the importance of medicinal plants and the necessity to conserve them. Wide opportunities are available to explore different cultivation methods and conservation strategies of *A. Stracheyi*. Also policy constraints on the cultivation and commercialization of *A. stracheyi* has been focused in this study.

Key words : *Allium stracheyi, Ethanobotanicals, Western Himalaya, Bhotiya tribe, Scoio-economy, Policy recommendation*

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Introduction

Medicinal and aromatic plants (MAPs) have always been a great source of prosperity for a country. Human race always depends on medicinal plants to prevent and cure ailments. MAPs are widely used in tribal population of various parts of the world by different medicinal practitioners in Ayurvedic, Chinese medicine etc (Rajkumar *et al.,* 2010). World Health Organization has estimated that more than 80% of world's population rely mainly on traditional plant medicine for their primary health care (Bannerman *et al.,* 1983).

India, one among the twelve biodiversity countries in the world has major four biodiversity hotspots in Asia (Kandari *et al.,* 2012). Indian subcontinent is well known for its richness in biodiversity especially in MAPs containing different types of phytochemicals. MAPs has contributed significantly in the development of ancient Indian Materia Medica. Charak Samhita (1000 B.C), one of the earliest treatises on Indian medicine, includes description of 340 drugs of vegetable origin. In India, Himalaya is distinguished as a biodiversity hotspot where ecology and evolutionary factors have favoured huge species diversity with over 1740 species of MAPs (Samant *et al.,* 1998).

The uses of MAPs have been increased distinctly in the last decade. *Allium* is one among those plants reported to have immense ethono-botanical importance. This genus is mainly distributed over the Holarctic, Sub arctic region from the dry subtropical regions to the boreal zone. Few endemic *Allium* species are also found in mountains or highlands (Fritsch and Friesen, 2002). This genus belongs to family Alliaceae, but for many years, it was assigned under Amaryllidaceae and Liliaceae (Purseglove, 1972). It has more than 750 species, making it one of the largest plant genera. (Bujisen 1990; Rabinowitch and Brewster, 1990). *Allium* have been found to show greatest diversity worldwide especially in the region of central Asia including Afghanistan, Tajikistan, Pakistan, India, parts of Siberia and China. India is reported to have 40 species of *Allium*, mostly located in the Himalayan ranges (Stearn, 1947; Polunin and Stainton, 1984; Karthikeyan *et al.,* 1989).

Study area

Nanda Devi Biosphere Reserve: A profile

Nanda Devi Biosphere Reserve (NDBR) is one of the UNESCO recognised World Heritage Site. It reserves an uniqueness in the Indian Biosphere Reserve system of the high altitude Himalayan regions. It has combination of mixed temperate forest, meadows, peaks and glaciers (Rawat *et al.,* 2010). NDBR covers an overall area of 2,236.74 km^2 in the northern part of Himalayas with 624.62 km^2 core zone and 1,612.12 km^2 buffer zone. Before the creation of NDBR, the Nanda Devi National Park occupied the core zone and the buffer zone was located in the districts of Chamoli, Pithoragarh, Bageshwer of Uttarakhand, forest reserve area, civil forests and village managed Panchayat forests. In geographical point of view, the buffer zone covers the entire Richi Ganga catchments encircled by the Himalayan peaks. Among that Nanda Devi ranks as the second highest peak located at the northern part of the reserve (Fig. 1).

Climatic conditions of study area

Totally 17 villages are reported in the buffer zone of NDBR. In that 10 villages lie in the Garhwal division (district Chamoli) and 7 villages lie in the districts of Pithoragarh and Bageshwer region belonging to Kumaon division of Uttarakhand. Among this, at present 4 villages are not habitated. In the current scenario, the study was performed in 10 buffer zone villages situated in Chamoli district of Garhwal region consisting of a total population of 2253. The rural people are distributed up to 2200 and 3600 msl. It has three distinct climatic seasons namely summer season (April- June), rainy season (June-Sept) and winter season (Oct- Feb). Among annual mean rainfall of 928.81 mm, 47.3% rainfall pours between two months (July – Aug) annually displaying a strong monsoonic pressure. The Monthly temperature range falls between a maximum of 24.0 °C-14.0 °C and minimum of 7.5 °C –3.0 °C, respectively. The area is covered by the crystalline rock including Granetiferous Mica Schists, Garnet Mica Quartz Schists and Mica Quartzite. In general, the soil type is deep as well as black in colour in agricultural land and loam to sandy loam to allow excessive draining.

Socio economic profile of buffer zone village community

The village people of Bhotia fit into two ethnic groups namely Indo-Mongoloid (Bhotiya Tribal) and Indo-Aryan. The people living in the buffer zone villages of NDBR belong to Tolchha community, a sub community of the Bhotiyas. The residents

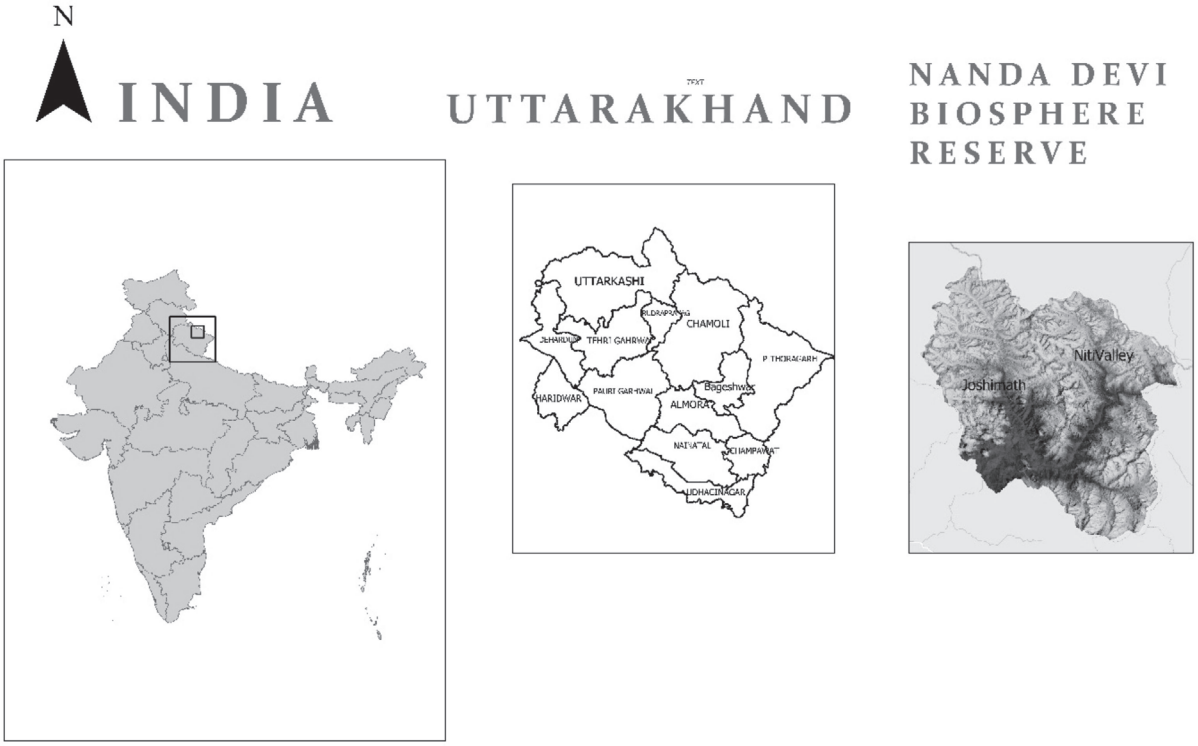

Fig. 1. Geographical location of study area – Niti Valley

of Tolchha- Bhotiya households (excluding residents of Reni, Peng, Lata and Tolma villages) have 2 permanent residents, one in the high altitude between 2,400 and 3,500 msl and other in the lower valleys (outside the buffer zone of the NDBR) between 800 – 1,500 msl. This community follows its own culture, rituals and religious believes. The major occupation of this community is cattle farming, where agriculture takes the lead in contemporary time. In the 10 buffer zone villages, the total number of households were recorded as 419 with a total population of around 2,253 with an adult ratio of male to female around 872:721 and 752 children are found to be below 15 years of age. The average family size counts about 5-6 persons have the literacy rate of 38.7%. Rainfed terraced slope cultivation method is practiced in the altitude of 2,000- 3,500 msl as an elevation zone. The main occupation of the households are agriculture through subsistence farming. Other than agriculture, 11% of households are doing business, 31% in government and semi government services and the remaining people are working as labours for daily wages.

Livestock farming practices involves cattles like cows, bullocks, sheeps, goats, horses and mules. Each family holds an average of 19.5 animals. The entire households depend totally on forests for fuel, fodder, timbers and leaf litters for organic manure. Many plant species found in the forest zone are used in traditional health care system to cure ailments. The major source of income for the households are cultivated crops. The other minor sources of income include bamboo made handicrafts, medicinal plants, wools and milk products.

Allium stracheyi

In India, among 40 species of *Allium*, few wild species are found in higher Himalayan region (Pandey *et al.,* 2008; Maragheh *et al.,* 2019). There are seven species of *Allium* distributed in NDBR *A. stracheyi* Baker is a multipurpose and vulnerable species found in that region (Fig. 2). *A. stracheyi* is one among the 81 medicinal plants used for industrial trading purpose. It is a perennial herb locally known as jambu or pharan (Ranjan *et al.,* 2010). The plant is generally cultivated as a wild variety in large areas and can be collected near Bhotiya summer villages (Figure 2 & 3a-b). Some farmers also

cultivate this species on small scale in Niti valley and traded either locally or by middle man (Bhatt 1999; Tiwari *et al.,* 2010).

Fig. 2. Juvenile phase of *Allium stracheyi*

Systematic Position of *A. stracheyi*

Kingdom	Plantae
Phylum	Angiosperms
Class	Monocots
Order	Asparagales
Family	Alliaceae
Genus	*Allium*
Species	*Stracheyi*

Importance of *A. stracheyi*

Medicinal uses

Allium stracheyi flowers, leaves, roots, bulbs and whole plant are traditionally used as spices, condiments and medicine by tribes (Pandey *et al.,* 2008). The leaves and bulbs are used locally to cure inflammation and painful conditions (Farooquee and Majila, 2004). Sulphur rich compounds in *A. stracheyi* have antimicrobial, antioxidant and anxiolytic properties (Ranjan *et al.,* 2010a; Tiwari *et al.,* 2014; Kumar *et al.,* 2015). The presence of organosulphur and alkaloid compounds can explain the traditional and local uses of this plant as have antinociceptive property and analgesics (Ranjan *et al.,* 2010). Cloth dipped in leaf decoction is applied on wound for healing (Samal *et al.,* 2010). It is ground into powder along with the root of *Saussurea costus* and fried with ghee to cure stomach ache (Semwal *et al.,* 2007). The plant is also traditionally used as medicine for jaundice, cold and cough (Tiwari *et al.,* 2010).

Culinary uses

Leaves and inflorescence of *A. stracheyi* are used as seasoning agents. Young leaves of *A. stracheyi* are mixed with potato or used as potherb in Pithoragarh region of Uttarakhand. In North Western Himalaya, the fleshy fibrous roots of *A. stracheyi* are consumed as vegetable, soup, and pickles (Pandey *et al.,* 2008). It has mild onion flavour, therefore used as flavouring agent and for garnishing purpose. Dried leaves of *A. stracheyi* are primarily used for garnishing, seasoning vegetables and curries (Negi and Gaur, 1991).

Ornamental uses

During the festival of Makarsakranti and Krishna Janmasthami, the Bhotiya tribes decorate their doors with mature flowers of *A. stracheyi* and alternately with alpine flowers Kukri Bankuri along with the mix paste of cow dung and clay. It is the faith that the seeds of MAPs including *Allium* species originated from the divine cow Kamdhenu's dung.

Cultivation and Propagation

A. stracheyi is 35-40 centimetres in height, flowers are white in colour. It is mainly distributed in the Alpine Himalayas of Uttarakhand, found at 2500-3000 msl between Kashmir to Kumaon (Semwal *et al.,* 2007). It prefers moist, dry rock with steep slopes and sunny site. It has a late seed maturation time and thus it gets severely hampered by winter conditions. In Jelum, few famalies cultivate *A. stracheyi* on their house roofs thatched with the barks of *Betula utilis* (Fig. 3a & b). These houses are specially made for the cultivation purpose (Bhatt, 1999). Cultivation of this plant requires dry cold climate. The main mode of propagation is through rootstocks during the monsoon period. It has been seen that in a properly ploughed field, huge quantity of organic manure (300 quintal fresh weight/ha) consisting mainly of humus and leaf litter collected from the forests are required during transplanting.

Bulb of *A. stracheyi* should be planted fairly deeply with 3-4 inches spacing between the rootstocks and density of 1,80,000-2,70,000 plants/ha. It requires frequent weeding, at least three to four times per year. The crop is harvested thrice in a year, in the month of April, second in June and third in September-October. Under open conditions, maximum shoot and rhizome length was observed. Plants grown under shade had maximum height,

Fig. 3. (a) Cultivation (b) Processing and drying of *Allim stracheyi* leaves by Bhotia Tribes at Tolma Village, Nanda Devi Biosphere Region

circumference, fresh weight and dry weight, when compared to the open conditions. *A. stracheyi* seedlings occurred mainly in open patches in dry cold humidity exposed sites (Maikhuri *et al.*, 2000). Seed and bulbs of *A. stracheyi* are mainly used for propagation. The production from seed supply is nonetheless influenced or controlled by microclimatic conditions of the region, both *in-situ* and *ex-situ*. The bulbs are generally collected in the month of August. Bulbs were cut longitudinally from the top of auxiliary bud in two and four pieces of 5-7 cm length leaving some intact fraction of basal plate and auxiliary buds in each segment for *in-vitro* propagation. Sometimes the plant may contain hard seed coat. In hard seeded species, the seeds are impermeable when initially dispersed. The seed coat may ruptured at 40 °C and bring down to room temperature that allows the embryo to become moist (Tran and Cvanagh 1984) and enhances the germination (Maikhuri *et al.*, 2003). Germination can also be regulated by hormonal and environmental factors like water availability, temperature, oxygen and light. Phytohormones regulate and integrate the overall growth, development and reproduction in plants.

Significance of this plant

In NDBR , 34% of the villagers want to use *A. stracheyi* for rehabilitation of degraded lands which is the maximum utilization assigned for medicinal plants. It has already been established that bench-terracing microsites with a soil depth of 30 cm or more than that are treated with 18 tonnes/ha of organic manure (Saxena *et al.*, 2001). It is one among the most dominant cultivated medicinal species, accounting for 70% of the total land area (86% of the families) in which medicinal plants were grown. The total production and monetary equivalent was reported maximum for *A. stracheyi* because the cultivation area is larger. The total monetary equivalents from all these cultivated species was estimated to be around Rs. 3,71,155/year. The income expenditure ratio of medicinal plants is tabulated in Table 1.

Policy constraints in cultivation and conservation of MAPs in Uttarakhand

- Due to variety of factors, the ecological and indigenous knowledge of the region would face danger of vanishing. Therefore, initiatives of protecting TEK from patent issues should be given high priority and non-codified information to be codified for the future use
- Providing subsidies and loans for agro-techniques, particularly for MAP cultivators could enhance the area under cultivation besides en-

Table 1. Total income of per ha. production and price for various medicinal plants (Source: Maikhuri *et al.*, 2000)

Botanical name	Local name	Expenditure (Rs/ha)	Income (Rs/ha)	Profit (Rs/ha)	Income/ Expenditure ratio
Allium humile	Ladum haran	2957	37620	34663	13.0
Allium stacheyi	Jimbu pharan	2618	29220	20702	9.0

gaging many farmers in this activity
- Organizing field level demonstrations with respect to cultivation, production and marketing of MAPs can be an ideal approach for the conservation and development of medicinal plant sector
- Technical aspects, like training the farmers, improving the infrastructure, and implementing new ideas and innovations, need to be prioritized for sustainable socio-ecological development
- Farmer-to-farmer training programmes need to be organized at frequent intervals on cultivation of MAPs. Farmers involved in cultivation of MAPs using cost effective technologies have to be encouraged to demonstrate their experience and skills to other farmers
- Forest conservation policies should have been made and focus on MAPs cultivation with conservation and local economic development
- Un availability of quality seeds/seedlings (planting materials)

Recommendations

- Develop appropriate mechanism to control illegal collection and exploitation of MAPs
- Identify potential NGOs and farmers for nursery development of valuable MAPs
- *Allium sp*. and few economically important species are targeted for large scale cultivation
- Insurance to be provided to interested farmers in case of crop failure
- Speed up action of oriented activities in the field of MAPs
- A simple mechanism to be developed to issue the license to the interested MAPs cultivators/ farmers of the region

Previously our research team has established the antioxidant, antimicrobial, hemolytic and cytotoxic properties of this plant (Mukherjee and Rajasekaran, 2010). Pure compound responsible for the bioactivities from this plant has also been isolated and identified from the dried leaves. This plant is a natural choice of research, has high medicinal value with phytocomponents such as alkaloids, tannins, flavonoids, phenolics and others, which produce a definite physiological action on the human body (Koche *et al.*, 2010). Thus a systematic search for useful bioactive phytocompounds from MAPs is now considered to be a rational approach in the field of nutraceutical, pharmaceutical and can open a new horizon in the area of drug development.

The above mention policy constraints to be eliminated and recommendation should be implemented for the large scale cultivation of *A. stracheyi.* This will be an advantage for Bhotiya tribes of Uttrakhand to improve the socio-economic status and sustainable harvest.

Conclusion

To conclude, the NDBR provides an optimum habitat nich for the vegetative propagation of *A. stracheyi*. Based on this study, we recommend the adequate supply of stock materials and proper training of cultivation techniques to the tribals will enhance the large scale cultivation of this therapeutically as well as economically important herb of Uttarakhand and improve the livelihood of Bhotiya tribes. The cultivation method of *A. stracheyi* for large scale production and distribution for commercial utilization strategies can be developed to conserve the wild population from being extinction.

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