Ethnobotanical notes on *Allium* species of Arunachal Pradesh, India

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Onion and garlic is considered one of the most important ancient cultivated crops of genus *Allium*. Large numbers of *Allium* species has been widely used for various purposes in hilly area of Arunachal Pradesh. Arunachal Pradesh, a state in North east India, harbours a wide range of wild *Allium* species which are being used by natives as for vegetable, spices, condiment and medicine. A total of 9 plant species namely, *Allium cepa*, *Allium chinense*, *Allium hookeri*, *Allium macranthum*, *Allium pratii*, *Allium rubellum*, *Allium sativum*, *Allium tuberosum* and *Allium wallichii* were recorded in different parts of Arunachal Pradesh during June 2012 to July 2013. All the 9 species were consumed as raw or in processed form, as flavours/condiment in preparing food items and as herbal medicine. It was recognized that *Allium chinense*, *Allium hookeri*, *Allium tuberosum* and *Allium macranthum* have high ornamental potential value. Most of the species are locally cultivated and have good market value in areas of occurrence. However, wild *Allium* species of Arunachal Pradesh is largely threatened by several human activities exerted by natives. The present work mainly highlights information on species diversity, distribution and utilization of *Allium* species of Arunachal Pradesh for future cultivation and conservation programmes.

**Keywords:** *Allium* species, Species diversity, Distribution, Utilization, Cultivation and conservation

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Charaka-Samhita, the oldest known Indian Ayurvedic medical treatise, dating from ca. 400 to 200 BC, which attributes many health virtues to garlic and onion plants and their cultivation. In addition to commonly cultivated species of *Allium* in India, other species of less known are grown in selected pockets as semi-domesticated types or wild economic species. The genus *Allium* (Family-Alliaceae) is economically important because it includes several important historical vegetable crops – onion, garlic, etc. as well as many wild ornamental species. *Allium* species are consumed as raw or cooked or as pickle/processed form, as dried condiment and spices/flavours. The taxonomic position of *Allium* and related genera had been a matter of controversy for long period of time. Takhtajan adopted the taxonomical hierarchy of *Allium* as: 1. Class – Liliopsida, 2. Subclass – Liliidae, 3. Superorder – Liliianae, 4. Order – Amaryllidales, 5. Family – Alliaceae, 6. Subfamily – Allioideae, 7. Tribe – Allieae, 8. Genus – *Allium*. The modern classification accepted more than 750 *Allium* species. *Allium* is characterized by superior ovary (characteristic of family Liliaceae) and scapose umbellate inflorescence (flowers borne in a bracted umbel on top of a scape) with membranous bracts (characteristic of family Amaryllidaceae) has been placed in family Alliaceae. Different species have characteristic features of rhizome/ bulb, leaf, inflorescences, odour and taste.

Genus *Allium* is widely distributed in the northern temperate and Alpine regions of the world. About 35-40 species occur in temperate and Alpine regions of Himalaya in India. In recent years, anthropogenic intervention such as indiscriminate felling of trees and large scale harvesting of wild species from natural habitats for trades have posed serious threat and thus these species deserve to be given special attention for sustainable collection and conservation.

In present communication, we attempt to highlight some of the ethnobotanical notes on valued genetic resources of *Allium* in Arunachal Pradesh, India.
which had not been done so far in this state. Arunachal Pradesh spread over an area of 83,743 sq km with altitudinal range from 150-5500 m harbouring different forest type namely, Tropical semi evergreen, Tropical wet evergreen, Sub tropical forest, Pine forests, Temperate forests and Alpine forests. The climatic and ecological diversity of the state promote rich floral and faunal diversity in different types of forest. The state is also rich in ethnic communities and multi-ethnic population has a long tradition of close relation with wild plants. They collect and consume a large number of wild plant species as food and to fulfill many of their basic requirements for livelihood. The potential of Arunachal Pradesh’s Allium germplasm is tried to highlight in order to boost sustainable collection and conservation activities and value addition of the economic products.

Methodology

An extensive inventory and frequent field trips for exploration of Allium species was conducted at monthly or fortnightly interval from June 2012 to July 2013 using ethnobotanical and Participatory Rural Appraisal (PRA) methods in 6 districts of the state Arunachal Pradesh, a state in Northeastern India. Herbal healers of age group between 30 and 60 yrs belonging to different communities from 6 districts of the state were interviewed and recorded the information in a prescribed questionnaire. The questionnaire revealed the name, age and address of herbal healer, date of interview, local and botanical names of drug plants, parts used, collected fresh or dried stored material, locality, dose quantity, dose per day, method of drug preparation, care to be taken or the side effects if any and mode of administration. Ethics as well as cultural importance of drug plants were also recorded. Prior informed consent (PIC) was taken from the knowledge providers as per CBD guidelines. Collection and maintenance of plant specimens have been made by following standard methodology. Specimens were collected from wild habitat, cultivated areas and local indigenous market during field survey and herbarium techniques have been followed for the study. Secondary information was also collected through scrutiny of literature, notes on herbarium and systematic studies on this group. Botanical specimens of all the medicinal plants were photographed, collected and identified by referring to the Material for the Flora of Arunachal Pradesh. Voucher specimens were made by using standard plant press, authenticated and deposited at Herbarium centre of the Ecology laboratory, Department of Environmental Science, Tezpur University, Assam.

Results and discussion

Distribution of Allium species in Arunachal Pradesh

Nine species namely, Allium cepa, Allium chinense, Allium hookeri, Allium macranthum, Allium pratii, Allium rubellum, Allium sativum, Allium tuberosum and Allium wallichii were recorded from different areas of 6 districts of Arunachal Pradesh. Maximum of 7 species were recorded from Tawang district, 6 species from Papum Pare district, 4 species from Lower Subansiri district, three species each were recorded from East Kameng and West Kameng districts, and 4 species from Upper Dibang Valley of Arunachal Pradesh (Table 1). Allium sativum L. and Allium cepa L. are common species found in all the study areas. Allium cepa leaves are shorter bears white flowers and swelling bulb. Allium chinense have narrowly linear basal leaves, red purple flowers and bulbs clustered. Leaves of Allium hookeri are slender with prominent midrib, basal linear membranous, white flowers and white fibrous roots. Allium macranthum leaves are many and linear, large dark purple flowers and bulb narrow membranous. Allium pratii have board linear leaves with prominent midrib and bears pink to red flower. Allium rubellum leaves flattish, small rosy flowers, bulb small. Allium sativum leaves are flat, white flowers, bulbs elongate, cylindric with white fleshy root. Allium tuberosum leaves are narrow-linear flat tall compressed, white or pink flowers, bulbs elongate, cylindric with white fleshy root. Allium wallichii leaves are long linear flat, purple flowers, bulbs hardly developed. Altitudinal distribution of species shows a maximum 6 species in the alpine and sub-temperate region (2,500-4,500 m), and 3 species in temperate region (1,500-2,500 m).

Collection and conservation status

Biodiversity provides a foundation for ecologically sustainable development and food security. Indigenous community holds potential knowledge for preserving biodiversity, cultural diversity and maintaining ecological functions. Livelihood of natives of Arunachal Pradesh is greatly dependent on traditionally maintained ecosystems. Their beliefs and
actions are related with the conservation of nature, in terms of resource utilization. Traditional knowledge on *Allium* species has been preserved by the indigenous communities for centuries and this unique traditional knowledge provides precious inputs that can be helpful in conservation of the species. For example, the name of Talle Wildlife Sanctuary (situated in between 27°30′ to 27°40′ N latitude and 93°57′ to 94°12′ E longitude in Lower Subansiri District of Arunachal Pradesh) is derived from the Apatani vernacular ‘Tale’ referring to *Allium hookeri* which grows abundantly at Talle valley situated within the Talle Wildlife Sanctuary. The Sanctuary is the best suitable place for natural conservation of *Allium hookeri*.

Documenting the traditional knowledge is important for the conservation of *Allium* species as well as their sustainable utilization. The need for the integration of local indigenous knowledge for a sustainable management and conservation of *Allium* species receives more and more recognition. It is important to build up indigenous knowledge on which resource poor farmers including tribes have conserved many agricultural crops and ethnobotanical species based on years of informal experimentation and understanding of a particular production system. However, there is a lack of record of collection and conservation status of wild *Allium* species in Arunachal Pradesh. Natives of the state used to collect *Allium* species from wild for various uses. Extraction of *Allium* species from the wild habitats causes ecosystem imbalance and extinction of sensitive plant species. Extensive harvest of the bulbs for economic use has also threatened to the survival of species in wild population. Intensified efforts for exploration, collection and conservation of these species are necessary to determine the conservation status and underline the degree of threat face by the species. Planned cultivation of different *Allium* species in fallow agricultural lands depending on their altitudinal suitability can be introduced as a new approach for conservation and sustainable utilization of the plants. The rich knowledge of local people of the state may be use as indigenous tool and technology for cultivating *Allium* species. Conservation aims at maintaining the diversity of living organisms, their habitat and the interrelationships between organisms and their

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Table 1—Distribution, status of occurrence and use of recorded *Allium* species by ethnic people of Arunachal Pradesh.

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
<th>Occurrence</th>
<th>Status of occurrence</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Allium chinense</em> G. Don</td>
<td>Papum Pare, Upper Dibang Valley,</td>
<td>Frequent and occasionally cultivated</td>
<td>Common</td>
<td>Vegetable, Condiment/Flavour and Medicine</td>
</tr>
<tr>
<td><em>Allium hookeri</em> Thw.</td>
<td>Tawang, Lower Subansiri, West Kameng, Upper Dibang Valley, East Kameng and Papum Pare</td>
<td>Frequent and occasionally cultivated</td>
<td>Common</td>
<td>Vegetable, Condiment/Flavour and Medicine</td>
</tr>
<tr>
<td><em>Allium macranthum</em> Baker</td>
<td>Tawang</td>
<td>Less common and occasionally cultivated</td>
<td>Rare</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
<tr>
<td><em>Allium prattii</em> Wight</td>
<td>Tawang</td>
<td>Less common</td>
<td>Rare</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
<tr>
<td><em>Allium rubellum</em> M Beib.</td>
<td>Papum Pare</td>
<td>Less common</td>
<td>Rare</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
<tr>
<td><em>Allium sativum</em> L.</td>
<td>Upper Dibang Valley, East Kameng and Papum Pare</td>
<td>Occasionally cultivated</td>
<td>Common</td>
<td>Vegetable, Condiment/Flavour and Medicine</td>
</tr>
<tr>
<td><em>Allium wallichii</em> Kunth</td>
<td>Tawang</td>
<td>Less common</td>
<td>Rare</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
<tr>
<td><em>Allium cepa</em> L.</td>
<td>Tawang, Lower Subansiri, West Kameng, East Kameng, Upper Dibang Valley and Papum Pare</td>
<td>Occasionally cultivated</td>
<td>Common</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
<tr>
<td><em>Allium tuberosum</em> Rottler ex. Spreng.</td>
<td>Lower Subansiri, Papum Pare</td>
<td>Frequent and occasionally cultivated</td>
<td>Rare</td>
<td>Vegetable, Condiment and Medicine</td>
</tr>
</tbody>
</table>
environment. There are two approaches for conservation of plant genetic resources, namely in situ and ex situ conservation. In situ conservation involves maintaining genetic resources in the natural habitats where they occur, whether as wild and uncultivated plant communities or crop cultivars in farmers’ field as components of the traditional agriculture system. On the other hand, ex situ conservation involves conservation outside native habitat and is generally used to safeguard populations in danger of destruction, replacement or deterioration. Approaches to ex situ conservation include methods like seed storage, DNA storage, pollen storage, in vitro conservation, field gene banks and botanical gardens. Wild species of Allium that are endemic, rare/threatened/vulnerable; or at risk of genetic erosion due to habitat destruction or over exploitation need to be conserved through suggested ex-situ approach. In-situ conservation of commercially important Allium species could be achieved through participatory approach by involvement of native communities who domesticate wild economic species in their home gardens, backyards and protected habitats for domestic and commercial utilization.

The most important means for conservation, management and protection of plant resources, is through participation of the people at large for example, tribal people, farmers, ecologist, etc. In addition, a coordinated effort would be required which could only be achieved by pooling research and development sectors, research institutions, NGOs and communities together to systematize these efforts towards conservation of plant resources.

Utilization

Different ethnic group of Arunachal Pradesh namely, Adi, Apatani, Mompa and Nyishi used all the 9 species in the form of raw or in processed, as flavours/condiment in preparing food items and as medicine for treatment of certain common health problems. Its has been well recorded that wild Allium species have been widely used for consumption as raw or cooked or as pickle/processed form, as dried condiment and spices/flavours in other parts of the country.

It was found that Allium chinense, Allium hookeri, Allium tuberosum and Allium sativum are locally cultivated in small patches in the homegarden (Fig. 1a & b) and have good market value in areas of occurrence. Besides commonly cultivated species of onion and garlic, there are species of minor economic importance that are sporadically cultivated in different parts of world.

Allium as food and condiment/flavour

Generally, leaf, bulb and roots parts have edible value and consumed raw or as cooked vegetables. Young leaves of many wild species are preferred over the mature ones in the form of vegetable, in soups or for raw consumption. Freshly harvested inflorescences, leaves or bulbs (Figs 2 & 3) are occasionally sold in village local markets. A small bunch of fresh leaves of Allium hookeri and Allium tuberosum cost approx. Rs. 20-30. Its availability is found to be abundant during summer rainy season and declines in dry winter season. Market price and availability of fibrous roots, and whole plant of Allium hookeri, inflorescences of Allium chinense and fresh leaves of Allium tuberosum also depends upon growing season of the plants. The leaves and tuberous/fibrous roots are rich in carbohydrates, vitamins and minerals. Cloves of A. chinense are consumed as pickled. Fleshy fibrous roots of A. hookeri are consumed as vegetable, soups and pickles. Fresh leaves of Allium tuberosum is largely use as vegetables, consumed as raw or as cook. Although all Allium species have different aroma (strongly pungent to mildly aromatic) and flavor (onion or garlic like odour) but selective use of the species/plant part is based on utilization and preference by local communities. A. cepa and A. sativum is widely used as flavouring agent and for garnishing purpose. Bulbs, leaves and flowers of A. chinense are commonly used as flavours in various food preparations such as soups, curries, etc. Allium macranthum, Allium pratii, Allium rubellum and Allium wallichii are occasionally taken as favouring agent in small quantity. Sun dried/furnaces dried leaf powder has good shelf-life for off-season consumption and for sale in the market.

Medicinal uses

All the recorded Allium cepa, Allium chinense, Allium hookeri, Allium macranthum, Allium tuberosum, Allium pratii, Allium rubellum, Allium sativum and Allium wallichii have some medicinal properties. Natives of Arunachal Pradesh used leaves, bulb, cloves and roots of these species commonly for treatments of some common health problems like cold and cough and skin rashes. Allium hookeri uses to cure cough, cold and vomiting; also on wounds for
healing\textsuperscript{25,26,27}. Ash of bulb with oil is applied to cure rash or eruption of skin and other skin diseases\textsuperscript{28}. Paste is applied externally for relief from body pain\textsuperscript{26}. \textit{Allium sativum} bulb is taken twice a day in stomach bloating\textsuperscript{29}. Cloves are dried, crushed into a powder and is taken with water for relief from cough, cold and chest congestion\textsuperscript{26}.

\textbf{Allium as ornamental plant}

\textit{Allium chinense}, \textit{Allium hookeri}, \textit{Allium macranthum} and \textit{Allium tuberosum} are used as ornamental plant by native people of Arunachal Pradesh. Use of \textit{Allium} species for ornamental purposes is not very common in India. Recently, \textit{Allium} species have gained much popularity as ornamental in rock gardens, herbaceous beds, perennial borders, pot plant, as decorative items and in dry arrangements\textsuperscript{24,30}. Ornamental value of \textit{Allium} is due to wide range of attractive coloured flowers and persistence of floral or long vegetative cycle. Flower colour in wild \textit{Allium} ranges from white, rose, lilac, purple, violet, blue and yellow. Some wild species of \textit{Allium} have been identified for their potential ornamental value. The potential of ornamental value of wild species in India is yet to be explored for Indian market.

\textbf{New findings/Traditional Knowledge associated with Allium plants uses and new plants parts uses}

Traditional knowledge (TK) is the information that people in a given community, based on experience and adaptation to a local culture and environment, have developed over time and continues to develop. New findings are extracted from documented questionnaire of the field survey. It is found that natives of Arunachal Pradesh use \textit{Allium macranthum} as ornamental plant and leaves and bulbs of \textit{Allium macranthum}, \textit{Allium pratii}, \textit{Allium rubellum} and \textit{Allium wallichii} were taken as medicines and as favouring agent in small quantity.

\textbf{Traditional significance of study to the society, farmers and researchers}

All nine \textit{Allium} species have high commercial value for food, flavour and medicine. Food gathering
and harvesting of forest product is a common activity of the local communities. Efficient use of these resources would not only supplement the food storage but also would contribute the necessary nutrients requirement of the people and improve the economy of the region. This study also highlight the fact of some *Allium* species used in the traditional medicine as well as to a variety of other uses as for food and vegetables, condiments and spices. There is a need for systematic incorporation of information on current use of wild *Allium* species for food resources in any programmes dealing with sustained food security and rural development for the benefit of the local people. Investigation on edible wild *Allium* species locally used for consumption reveals, potential to become valuable staple foods and important alternatives to the usual cultivated agricultural crops.

These species are easy to grow in homegardens for domestic consumption. At present hybrid varieties of onion and garlic give tough competition to all nine species available in this region. Some of the *Allium* species have a great trade potential in the medicinal plants market. Some plants are of high value species which could be cultivated on a large scale in the favourable agro-climatic conditions of the area. As the wild resources are the main source of nutrients and medicine for remote dwellers, these could be domesticated for self-sustenance through settled cultivation.

Investigation on edible wild *Allium* species used locally for consumption reveals potential to become valuable staple foods and important alternatives to the usual cultivated agricultural crops. Selection for potential species can be done, based on the local priority and nutritional content, as most of the wild edible species have high nutritional values. An emphasis on the sustainable harvesting of wild edible *Allium* species will help to enhance and maintain the regional biodiversity.

An attempt could now also be made to test the scientific knowledge, by investigating the curative principles and the active phytochemical constituents and to test their efficacy in the healthcare needs. The recovery of the knowledge and practices associated with these plant resources may be placed as an important strategy linked to the conservation of biodiversity.

**Conclusion**

A total of nine *Allium* species (*Allium cepa, Allium chinense, Allium hookeri, Allium macranthum, Allium tuberosum, Allium prattii, Allium rubellum, Allium sativum* and *Allium wallichii*) were recorded in Arunachal Pradesh during the study period. Further extensive survey may increase the richness of *Allium* species in the state. All the nine species of *Allium* have their commercial value for food, flavour and medicine. These species occurs in natural habitat or grown in the small scale in home gardens. Research and development efforts need to be focus towards sustainable harvesting of wild *Allium* species and their management. Evaluation of the decorative characters of wild/potential species is desirable for their commercial ornamental use. Suitable strategies for conservation, assessment of domestication potential for commercialization and value addition would widen the scope of utilization of wild *Allium* species in India. Information on phytogeographical distribution range, status of occurrence, collection and conservation of germplasm and utilization of the wild species may be employ for formulation of better management plan of germplasm of *Allium* species in the state.

Proper and detailed study about *Allium* species of the states is urgently needed because degree of biodiversity loss is unknown to this region of the world. It may happen that before being documented properly we may lose some of the wild *Allium* species of the state. Research and development efforts need to be focus towards sustainable harvesting, management and conservation of *Allium* species in Arunachal Pradesh, India. Evaluation of the decorative characters of wild *Allium* species is desirable for their commercial ornamental use. Suitable strategies for conservation, assessment of domestication potential for commercialization and value addition would widen the scope of utilization of wild *Allium* species. In view of the above facts, it is felt that it is the prime need of the hour to establish a full-fledged multidisciplinary Institute of Ethnobiology, in Arunachal Pradesh, which will monitor all such ethnobiological researches and take care that such reports should be taken up seriously and ensure that the ethnic communities get their legitimate dues for sharing their ethnic knowledge with the scientists.
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