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High Altitude Ethnomedicinal Plants of Western Arunachal Himalayan Landscape

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Abstract

Ethnomedicinal uses of high altitude plants have always been less studied, due to tough geographical terrain. Present study recorded 18 plant species and a fungus growing above 3500 m (sub-alpine to alpine regions) used by the tribal people of WAHL in ethnomedicine. These species represents 13 families and 14 genera. Roots were the most common part used in traditional medicines with 17 species. Majority of the recorded plants were found to be effective against respiratory related ailments, stomach related problems, cough, cold and fever. Out of total 19 species recorded, 6 were also reported as edible and 8 were recorded for the first time as ethnomedicine from the region. Ethnobotany on high altitude plants are still to be documented and similar studies should be conducted in other parts of Himalaya also.

***Key words*:** Ethnomedicine, Monpa, Brokpa, high-altitude plants

INTRODUCTION

The state of Arunachal Pradesh, the 'land of down-lit mountain' and 'land of rising sun' is one of the Northeastern states of India with total area of 83,743 km² and located between 26°28' N - 29°30' N latitude and 91°30' E - 97°30' E longitude. It is situated in the transition zone between the Himalayan and Indo-Burmese regions (Mani 1974; Rodgers & Panwar 1988; Singh *et al*. 2007). The state is a part of Indo-Burma Biodiversity Hotspot (Myers *et al*. 2000) and is also among the 200 globally important Ecoregions (Olson & Dinerstein 1998). The entire territory forms a complex hill system with varying elevations ranging from 50 m to about 7000 m, traversed throughout by a number of rivers and rivulets. Forest of different climatic types like tropical, sub-tropical, pine, temperate, sub-alpine and alpine is prevalent in the state. The state is known as hub of medicinal plants with over 800 plant species used in folk medicine (Gajural *et al*. 2003). The state is inhibited by 26 major tribes and 110 sub-tribes, which has its own traditional way of using forest resources for sustaining livelihood (Tag & Das 2004). The *Monpa* is among one of the major tribe of Arunachal Pradesh with a total population of more than 100 Thousands (Anonymous 2011). The *Monpas* are mostly settled in temperate regions of Western Arunachal Himalayan Landscape (WAHL). They are mostly agrarian and perform both shifting as well as settled cultivation. For survival, they mostly depend on some staple crops like Finger millet, Maize, Barley, Rice, Potato, Chili, etc. and domesticated animals like Yak, Gayal, Sheep, Cow and Horse (Tag & Tsering 2012). Among these, Yak (*Bos grunniens* Linnaeus) is economically and culturally most important cattle. Yak herds are locally called as "*Bro*" and people who engaged themselves in herding Yak are called as "*Brokpa*". Due to cold environment adaptation of Yak, *Brokpa*

spends most of their time at sub-alpine to alpine regions (3500 m and above). However, for a short period of time during winter the *Brokpa* along with their cattle migrate to little lower altitude (3000 – 3500 m) due to heavy snowfall at alpine region which restricts grazing. Almost isolated from village sites, the *Brokpa* possess great and unique ethnic knowledge on locally available resources. The other key traditional knowledge holder is the village herbalist, who often collects high altitude plants and minerals for the preparation of medicines.

Many researchers have studied the ethnobotany of WAHL, but mostly focused on temperate and sub-tropical plants (Dam & Hajra 1981, 1997; Tiwari *et al.* 2009; Namsa *et al.* 2011, etc.). Plants of high altitude regions (above 3500 m) received less attention, due to tough terrains and lack of proper local informants. Thus the present study was conducted to record ethnomedicine found in subalpine to alpine regions of WAHL used by the *Monpa* communities with key informants as the *Brokpas* and the village herbalists.

STUDY AREA

The study was conducted at high altitude regions of Tawang and West Kameng districts [26° 55' to 27° 52' N latitudes and between 91° 32' to 92° 55' E longitudes] of Arunachal Pradesh. The two districts with an area of 9,507 km^2 (Anonymous 2013) consists variety of forest types and shows four different climatic seasons (spring, summer, autumn and winter). Over 1/3rd area of these two districts are located in the altitudinal range of 3500 – 4500 m covered with subalpine to alpine vegetation. The vegetation is scarce, in the form of bushy low lying shrubs, herbs and mosses. Species of *Rhododendron* and *Juniper* are most dominant in this region. The region is inhabited by multiple tribal groups such as *Monpa*, *Sherdukpen*, *Aka*, *Miji*, *Bugun* and *Sartang*. Among them *Monpas* having largest population occupying whole of Tawang and 2/3 part of West Kameng districts (Anonymous 2011). Villages are mostly located in temperate mixed to pine forests (800 – 2800 m) and no permanent human settlement was observed in alpine regions except the *Brokpas*.

MATERIALS AND METHODS

In present study, sub-alpine to alpine forests (above 3500 m) were categorized as high altitude regions, and the Ethnobotanical study was restricted within this region. Following four major steps were followed for the study: 1. Literature survey; 2. Interviewing the key informants; 3. Field study; and 4. Herbarium work. Relevant literatures (Dam & Hajra 1981, 1997; Tiwari *et al.* 2009; Namsa *et al.* 2011; Tag & Tsering, 2012; Norbu 2008) were surveyed and consulted to obtain information on medicinal plants of high altitude and topography of WAHL. For recognition and location of medicinal plants, the village herbalists and the *Brokpas* were interviewed and visited the original location for sample collection. Local name, habitat, range of distribution, flowering, part used, harvesting time and mode of uses for each species were recorded in the Field Note Book. The study was carried out in all seasons during the years 2010 – 2013. However, in later 2 years, field study was limited during May – September to record different species with their flowers and fruits. Plants were identified by consulting 'eFlora of China', 'Standard Indian Flora' and local literatures authored by Chowdhery et al. (1996); Wangchuk (2009); Polunin & Stainton (2009); and Namgyel & Tenzin (2009). Plants were authenticated at ARUN (BSI, Arunachal Pradesh Regional Center, Itanagar) based on availability of herbarium specimens and names in current use were identified from "The Plant List" website. Voucher specimens of each plant were deposited at Herbarium of Department of Botany, Rajiv Gandhi University for future reference.

RESULTS AND DISCUSSION

Altogether 18 species of plants and a fungus belonging to 13 families and 14 genera from high altitude regions of WAHL were identified during the present study. Polygonaceae and Ranunculaceae were represented with 3 species each, Amaryllidaceae and Gentianaceae with 2 species each, and rest with single species. Photographs of 4 locally significant species are presented in photographic PLATE I.

PLATE I: a. *Aconitum ferox*; b. *Alium cepa*; c. *Neopicrorhiza scrophulariiflora*; d. *Ophiocordyceps sinensis*; e. *Potentilla peduncularis*; f. *Rheum nobile*

Reported species are traditionally used in the treatment of various diseases or ailments by the local communities, particularly, the *Monpas*. All 19 species are listed in alphabetical order along with their local name, family, voucher specimen number, flowering time, part used, harvesting time, altitudinal distribution and their ethno-medicinal uses (Table 1). Our study found that a very limited number of high altitude plants (19 species) are being used in traditional medicine system of the *Monpa*, but their importance and demands are much higher than those found at lower altitude. Healers (*Bonpa*) believe that plants from higher altitude contains some substances which may be lacking in plants growing at lower altitude, and using plants from higher altitude as medicine would be more helpful in curing diseases.

Table 1. High altitude ethnomedicinal plants used by the *Monpa* community of WAHL

Name [Family]; Voucher specimen; Local Name	Flowers	Useful part; Harvest time	Altitudinal distribution (in m)	Traditional uses
Aconitum ferox Wallich *ex* Seringe [Ranunculaceae]; JT/HT/198/2012; *Tsando*	May – June	Tuber; October	3600 – 3800	Dried tuber boiled in alcohol to detoxify; a very small peace used as antipyretic, analgesic and anti-inflammatory; also against common ailments like high fever, stomachic, tonsillitis & throat pain, and cheilitis
Aconitum heterophyllum Wallich *ex* Royle [Ranunculaceae]; JT/HT/ 149/2012; *Gonga-karpu*	June – July	Tuber; September – October	3500 – 3700	Dried tuber consumed during toxicities (snake bite, Aconite contamination), stomachic, high fever, & for all unknown diseases
Aconitum hookeri Stapf [Ranunculaceae]; JT/HT/ 444/2013; *Sza-tsando*	June – July	Tuber; August – September	4200 – 4300	Root used as substitute of *A. ferox*
Ajania tibetica (Hooker *f.* & Thomson) Tzvelev [Asteraceae]; JT/HT/313/ 2012; *Otung-karpo*	September – October	Whole plant; October	4200 – 4600	Whole plant used against respiratory related ailments
Allium cepa Linnaeus [Amaryllidaceae]; JT/HT/ 435/2013; *Chong*	July – August	Bulb; June – July	4200 – 4600	Bulb used against cold, cough, flu and bronchitis
Allium hookeri Thwaites [Amaryllidaceae]; JT/HT/ 439/2013; *Maan*	July – August	Whole plant; May – August	3600 – 3900	Whole plant consumed as vegetable to relieve fatigue; also eaten during insomnia
Fritillaria cirrhosa D.Don [Liliaceae]; JT/HT/433/ 2013; *Loshu*	July – August	Bulb; August – September	4000 – 4100	Bulb used in bronchitis and respiratory related ailments; applied to reduce swelling; eaten cooked as health tonic
Gentiana kurroo Royle [Gentianaceae]; JT/HT/ 441/2013; *Panggin-mento*	August – September	Whole plant; August – September	4100 – 4400	Water decoction used during back pain; consumed as vegetables to reduce cough, cold and fever
Gentiana stylophora C.B. Clarke [Gentianaceae]; JT/HT/434/2013; *Shermen*	July – August	Root; August – September	4000 – 4600	Root paste applied as poultice to wounds and swellings
Nardostachys jatamansi (D. Don) Candolle [Caprifoliaceae]; JT/HT/ 307/2012; *Pangpos*	July – August	Rhizome; August – September	4000 – 4300	Rhizome used in respiratory related diseases; water decoction given during insomnia
Neopicrorhiza scrophularii flora (Pennell) D.Y. Hong [Scrophulariaceae]; JT/HT/ 437/2013; *Khongleng*	May – June	Rhizome; June – August	4300 – 4500	Decoction of rhizome consumed to treat stomach worms, fevers and constipation; prescribed during liver complaints, anemia, jaundice and respiratory tract disorders
Ophiocordyceps sinensis (Berk.) G.H. Sung *et al.* [Ophiocordycipitaceae]; JT/HT/301/2012; *Yrar-tsa-gunbu*	April – May	Whole plant; April – May	4400	Whole part eaten raw or cooked as cardiac and reproductive tonic; water decoction consumed during cough, cold, respiratory problems, stress and chronic fever
Oxyria digyna (Linnaeus) Hill [Polygonaceae]; JT/ HT/432/2013; *Lugsho*	July – September	Leaf; July – August	3800 – 4200	Leaf decoction used as purgative, diuretic, digestive and anti-inflammatory; paste applied to treat wounds and cuts
Potentilla peduncularis D. Don [Rosaceae]; JT/HT/ 141/2011; *Gugae*	June – July	Rhizome; July – August	3800 – 4400	Rhizome used in the treatment of diarrhea and pre-menstruation disorders
Rheum acuminatum Hooker *f.* & Thomson [Polygonaceae]; JT/HT/ 404/2012; *Chutzsa*	July – August	Fruit, Root; July – August	3400 – 4200	Pounded fruit used to treat herpes; root used as diuretic and digestive
Rheum nobile Hooker *f.* & Thomson [Polygonaceae]; JT/HT/436/2013; *Dugu-mento*	June – August	Root; July – September	4300 – 5000	Water decoction of root consumed orally to treat of common cold, cough and throat pain
Sinopodophyllum hexandrum (Royle) T.S. Ying [Berberidaceae]; JT/HT/170/2012; *Vomosi*	June – July	Whole plant; July – August	3600 – 4000	Extract of whole plant used in various female reproductive related diseases including irregular menstruation, birth difficulties, fluid discharge, and urinary track problems

Name [Family]; Voucher specimen; Local Name	Flowers	Useful part; Harvest time	Altitudinal distribution (in m)	Traditional uses
Swertia hookeri C.B. Clarke [Gentianaceae]; JT/HT/346/2012; *Tiktah*	July – August	Whole plant; August – September	3600 – 4400	Root of matured plant used as anti-poison
Silene himalayensis (Rohrbach) Majumdar *Lungara* [Caryophylla ceae]; JT/HT/438/2013	June – July	Whole plant; July – August	3600 – 3800	Whole plant used against skin infections

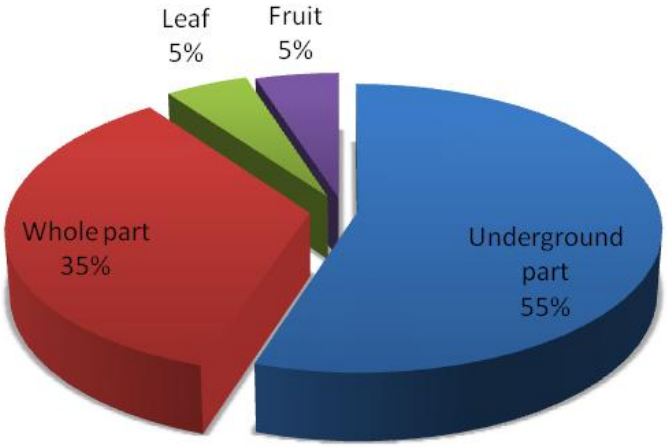

Figure 1: Percentage distribution of useful parts of ethnomedicinal plants (WAHL)

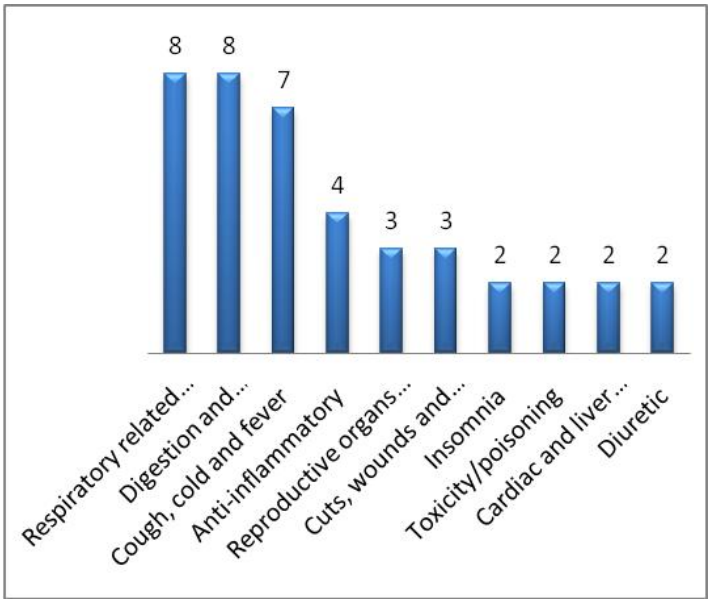

Figure 2: Number of species used for various categories of ailments

Out of 19 species, underground parts including tuber, rhizome and bulb were the major parts used in traditional medicine with 11 species or 55 % (Figure 1), followed by whole plant (7 sp.), leaf (1 sp.) and fruit (1 sp). 8 species were found to be effective against respiratory related ailments, 8 against digestion and stomach related problems, 7 against cough, cold & fever, and 4 as anti-inflammatory. Other ailments treated by high altitude medicinal plants

were reproductive organs related diseases, cuts, wounds and skin infections, insomnia, toxicity, cardiac and liver ailments, as anti-inflammatory and as diuretic (Figure 2). Each plant has potential for treating many ailments but local herbalist doesn't recommend single plant based drug for treatment except in cases of cuts and wounds. For treatment of any diseases/ ailments, herbalists prepare traditional medicines by combining many crude drugs of both plant and animal as well as some mineral origin. Most of the herbal medicine prepared by local herbalist is composed of at least 5-10 crude drugs. Some important plants growing at lower altitudes (below 3500 m) which are generally adulterate with most formulations are fruits of *Litsea cubeba, Terminalia bellirica, Terminalia chebula*, etc.

3 species of *Aconitum* (*A. ferox*, *A. heterophyllum* and *A. hookeri*) were found to be used in traditional medicinal formulation as well as in treatment of minor ailments like fever, stomachic, tonsillitis, throat pain and cheilitis. *A. ferox* is a highly poisonous plant and paste of tuber applied on arrows is used for hunting. *A. ferox* is locally called as *'Tsandu'* and local people are much aware of its toxicity and use values. Most of the family keeps dried tuber of *A. ferox* in their homes to use against minor ailments like fever, stomachic, tonsillitis, throat pain, cheilitis and also believes that it may keep deities away. Due to high toxicity, *A. ferox* keeps yak products and other stuffs safely in their herds from intruders and are called as friend of herdsmen.

During the study, *Aconitum ferox* and *A. heterophyllum* were located at lower belt of sub-alpine grassland, while *A. hookeri* grows well near lakes and moist soil of alpine region. Wild variety of *Alium cepa* was found growing along rocky mountain at an altitude above 4200 m. *Alium hookeri* was found in subalpine meadow between 3600-3900 m. Both the *Alium* species are cultivated in many tropical and temperate regions of the world, however, existence of wild variety in high altitude mountains is a matter of evolutionary concern. Also, the North East India and Arunachal Himalayan Region have already been identified as Indian centre for origin of cultivated crops and wild land races (Vavilov, 1926). Wild variety of both *Allium* species is considered more effective medicine than cultivated by village herbalist, and are used for medicinal purpose only.

Rheum nobile commonly known as Rhubarb was located from highest altitude out of 19 species (between 4300-5000 m). Rhubarb is considered rare by the *Brokpas* as it grows only on rocky steep mountains which receive sufficient sunlight of approximately 8-9 hours per day. Rhubarb is eaten by Yaks and is another factor for declining its population. Out of total 19 species, following 7 species were found only from alpine region i.e. above 4000 msl (*Aconitum hookeri, Fritillaria cirrhosa, Gentiana kurroo, Gentiana stylophora, Nardostachys jatamansi, Picrorhiza kurroa* and *Rheum nobile*).

During the field survey, some medicinal plants were reported to be edible. These includes *Aconitum heterophyllum* (leaves), *Gentiana kurroo* (flowers/stems), *Ophiocordyceps sinensis* (whole), *Potentilla peduncularis* (roots), *Rheum acuminatum* (petiolets) and *Fritillaria cirrhosa* (bulbs). The flowers of *Gentiana kurroo* is considered a highly valued crude drugs which are often consumed as vegetables. *Fritillaria cirrhosa* and *Ophiocordyceps sinensis* are consumed either raw or cooked as reproductive health tonic. The high demand of *Fritillaria cirrhosa* and *Ophiocordyceps sinensis* within and outside the state had lead to over harvesting, making it a great thread of extinction. Also, 8 species including *Aconitum hookeri, Ajania tibetica, Gentiana stylophora, Oxyria digyna, Potentilla peduncularis, Rheum acuminatum, Swertia hookeri* and *Silene himalayensis* are reporting for the first time as ethnomedicine.

CONCLUSION

The above result revealed that traditional knowledge about the habitat distribution, harvesting time, part used and mode of uses of most ethnomedicinal species is still maintained among the local healers and the *Brokpas*. The preservation of this knowledge appears to be the result of continued reliance of local communities on the traditional self care medicine system. Finding 8 species as ethnomedicine for the first time indicates that there are still many more unreported useful plants in high altitude regions which need to be properly studied.

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LITERATURE CITED

Anonymous, 2011. *CENSUS report: Arunachal Pradesh*. Ministry of Home Affairs, Government of India.

Anonymous, 2013. Annual Report, District Statistical Office, Tawang, Arunachal Pradesh.

Chowdhery, H.J.; Giri, G.S.; Pal, G.D.; Pramanik, A. & Das, S.K. 1996. *Materials for the Flora of Arunachal Pradesh*, Vol-1. Botanical Survey of India, Government of India.

Dam, D.P. & Hajra, P.K. 1981. Observation on ethnobotany of *Monpas* of Kameng district, Arunachal Pradesh. In S. K. Jain (ed.), *Glimpses of Indian Ethnobotany*. IBH & Co. New Delhi. Pp. 107 – 114.

Dam, D.P. & Hajra, P.K. 1997. Observation on ethnobotany of *Monpas* of Kameng district, Arunachal Pradesh. In S.K. Jain (ed.), *Contribution to Indian Ethnobotany*, Scientific Publisher, Jodhpur, India. Pp. 153 – 160.

Gajural, P.R.; Rethy, P. & Singh, B. 2003. Preliminary studies on wild edible plants resources of Dihang Debang biosphere reserve. Abstract & souvenir of 13th annual conference of IAAT and international symposium on plant taxonomy: advances & relevance, TM Bhagalpur University, Bihar, 14 – 15th Nov.2003, pp 79.

Mani, M.S. 1974. *Ecology and Biogeography in India*. The Hague. Dr. W. Junk Publishers.

Myers, N.; Mittermeier, R.A.; Mittermeier, C.A.; da Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853-858.

Namgyel, T. & Tenzin, K. 2009. *A Photo Guide to flowers of Bhutan*. WWF Bhutan, Thimphu, Bhutan.

Namsa, N. D.; Mandal, M.; Tangjang, S. & Mandal, S. C. 2011. Ethnobotany of the *Monpa* ethnic group at Arunachal Pradesh, India. *J. Ethnobiol. Ethnomed.* 7: 31.

Norbu, T. 2008. *The Monpas of Tawang: Arunachal Pradesh*. Director of Research, Department of Cultural Affairs, Arunachal Pradesh.

Olson, D.M. & Dinerstein, E. 1998. The global 200: A representation approach to conserving the Earth's most biologically valuable ecoregions. *Conserv. Biol.*, 12: 502-515.

Polunin, O. & Stainton, A. 2009. *Concise Flowers of the Himalaya*. Oxford University Press.

Rodgers, W.A. & Panwar, H.S. 1988. *Planning wildlife protected area network in India*, vol I & II. A report prepared for the Department of Environment, Forests & Wildlife, Government of India, Wildlife Institute of India, Dehradun.

Singh, R.K.; Singh, A & Sureja, A.K. 2007. Traditional foods of *Monpa* tribe of West Kameng, Arunachal Pradesh. *Indian J. Trad. Knowl.*, 6(1): 25-36.

Tag, H. & Das, A.K. 2004. Ethnobotanical notes on the *Hill Miri* tribe of Arunachal Pradesh, India. *Indian J. Trad. Knowl.* 3(1): 80-85.

Tag, H. & Tsering, J. 2012. *Ethnobotanical Study and Nutritional Analysis on Middle and High Altitude Wild Edible Flora of West Kameng and Tawang Sector of Arunachal Pradesh for Defence Food Security*. Technical Report, Defence Research Laboratory, DRDO, Ministry of Defence, Government of India.

Tiwari, U. L.; Kotia, A. & Rawat, G. S. 2009. Medico-ethnobotany of *Monpas* in Tawang and West Kameng districts of Arunachal Pradesh, India. *Pleione*, 3(1): 1-8.

Vavilov, N.I. 1926. *Studies in the Origin of Cultivated Plants*. Institute of Applied Botany and Plant Breeding, Leningrad, pp. 20-150.

Wangchuk, 2009. *A Pictoral Guide to the Wild Flowers of Bhutan*, Pekhang Enterprises, Thimphu, Bhutan.