

Full Length Research Paper

## Ethnobotanical survey of some threatened medicinal plants of Kashmir Himalaya, India

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An ethnobotanical study was conducted from March, 2011 to October, 2012 to enumerate the diversity of traditionally used threatened medicinal plants in biodiversity rich temperate Himalayan ranges of Bandipora district, Kashmir, India. Ethnomedicinal data was gathered using semi-structured interviews, focus group discussions and walk-in-the-woods with local knowledgeable elders, tribals (*Gujjars* and *Bakkerwals*) and *Bhoeris* (traditional practitioners). Results revealed that 23 threatened plant species belonging to 22 genera and 15 different families were traditionally used for curing various health disorders. *Taxus wallichiana* was a lone gymnosperm while all others were angiosperms. Majority of the species were perennial herbs but reports of biennial herbs and perennial trees were not uncommon. The highest number of medicinal plants were recorded in two families viz. Asteraceae (4 species, 17.39%) and Liliaceae (3 species, 13.04%). The shrinking population of these plants on account of very high demand for medicinal purposes is a matter of great concern as these plants are the backbone of our traditional medicinal system with a large population still depending on traditional medicine. Therefore, the need to conserve these plants is of utmost importance because if necessary conservation measures are not taken at the earliest, the day will not be far away when these God gifted resources will completely deplete from their natural habitats.

**Key words:** Threatened plants, ethnobotany, Bandipora, tribals, Kashmir Himalaya.

### INTRODUCTION

Plants have been used in traditional medicine for thousands of years (Abu-Rabia, 2005). Throughout the world the tribal people and ethnic races have developed their own customs, religious rites, folklore and songs. Numerous wild and cultivated plants play a very important role in these cultures and this relationship has evolved over generations of experience and practice. Tribal primitive societies occupy a large part of Indian

culture. It is interesting to know that the ancient Indians were acquainted with larger number of plants than the natives of any other country of the world. This is clearly evident by the ancient Indian treatises such as *Materia Medica*, *Nighantus* and *Koshas*. According to Ayurvedic *Materia Medica* there is no plant on earth which does not have medicinal value. The tribal societies are closely linked to the forest ecosystem with which they

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traditionally live in harmony. Tribal populations have good knowledge about the use of many plants and believe that all afflictions are caused by supernatural forces. Traditional healers use their eyes, ear, nose and hands to diagnose the diseases. This way of diagnosis is interesting because they live in interior areas and lack the use of modern scientific equipments for treatment. They however treat diseases using medicinal plants (Santhya et al., 2006).

Some 80% of the world's population still relies upon plants for primary health care; even today in Western medicine, and despite progress in synthetic chemistry, some 25% of prescription medicines are still derived either directly or indirectly from plants (Fowler, 2006). Knowledge of the medicinal plants used in the drugs of traditional systems of medicine has been of great significance, especially as a lead for the discovery of new single-molecule medicines for modern system of medicine (Ramawat et al., 2009). It is interesting to note that the ethnomedicinal uses of plants is one of the most successful criteria used by the pharmaceutical industry in finding new therapeutic agents for the various fields of biomedicine (Williams, 2006). For example some outstanding medicinal drugs which have been developed from the ethnomedicinal uses of plants include: Vinblastine and Vincristine from *Catharanthus roseus* G. Don (Periwinkle) used for treating acute lymphoma, acute leukaemias etc., Reserpine from the roots of *Rauvolfia serpentina* Benth. ex Kurz (Indian Sarpagandha) used for treating hypertension, Aspirin from *Salix purpurea* L. (Willow) used for treating inflammation, pain and thrombosis and Quinine from *Cinchona pubescens* Vahl (Cinchona) used for treating malaria (Lone et al., 2013). Thus, medicinal plants are used in crude or purified form in the preparation of drugs in different systems.

Ethnobotanical information on medicinal plants and their uses by indigenous cultures is useful not only in the conservation of traditional cultures and biodiversity, but also for community health care and drug development (Farooq et al., 2014). It is a well-known fact that, worldwide, thousands of plant species are endangered and facing extinction with the current trend of their exploitation and destruction. Indiscriminate resource utilization, increasing population and urbanization is leading to rapid depletion of the plant resources day-by-day. Kashmir Himalaya is known for its economically valued plants and their products, such as medicine, food, fodder, fibre etc. Owing to its rich and unique floristic diversity, a good proportion of plants are used as medicine in one or other form. The ethnic use of these herbs as medicine has been probably the only means of curing and/or protecting the human population from various diseases. Although a number of ethnobotanical studies have been carried out on the uses of medicinal plants in the Indian Himalayan Region (IHR) in general and Kashmir Himalayas in particular, these studies were

mainly focused on the enumeration of medicinal plants and were conducted on scattered basis on different ethnic groups. So far, no such study is carried out on ethnomedicinal utilization of threatened plants. Therefore the aim of present study was to document the threatened medicinal plants of the region and suggest possible conservation measures so as to check the extinction of these God gifted resources from their natural habitats.

## MATERIALS AND METHODS

### Study area

Bandipora, with Bandipore town as its administrative headquarter, is one of the 10 districts of Kashmir in northern India. The hilly and mountainous areas of Bandipora constitute an important northern part of Kashmir Himalaya. These areas remain cut off from the rest of the district at least for 2 to 3 months every year due to harsh climatic conditions such as heavy snowfall and low temperature (sometimes below minus 10°C) during winter. Bandipora, with a geographical area of 398 Sq km, is located on the northern bank of the Wular Lake- the largest fresh water lake in Asia. The district lies at 34° 64' N latitude and 74° 96' E longitude and is situated at an average height of 1701 m (AMSL). The district is endowed with breathtaking scenic beauty in the form of snow-capped mountains, sparkling streams and rivers, picturesque Wular lake and lush green forests and meadows. The district is bounded in the west by district Kupwara, in the south-east by district Ganderbal and in the east by district Kargil, Baramulla in the south and on north side it is bounded by line of control (Figure 1). The district has three tehsils (smallest administrative units) namely Gurez, Sonawari and Bandipore. Bandipora is one of the backward districts of Kashmir where usually single crop is grown and most of the cultivable land is under orchards. The total cultivable land in the district is 27,028 hectares while as the area under forest is about 199,396 hectares (Source: Evaluation & Statistics, Ganderbal District & District Credit Plan, Lead Bank Office Bandipora). The district has deciduous vegetation and due to its varied altitude and topography, it is the site of diverse flora. Plants like *Plantinus orientalis* (locally called 'Boin'- State tree), *Crataegus songarica*, *Populus caspica*, *Salix acmophylla*, *Ailanthus altissima*, *Cedrus deodra*, *Ulmus wallichiana*, *Celtis australis*, *Robinia pseudoacacia*, *Abies pindrow*, *Pinus wallichiana*, *Morus nigra*, *Juglans regia*, *Zizyphus jujuba* and other fruit trees (temperate Rosaceae fruit trees- apple, pear, cherry, almond, peach, plum and apricot) grow throughout the district. The climate of the district has its own peculiarities and is usually moderate. The seasons are marked with sudden change and the climate can be divided into six seasons of two months each. These include, spring (16 March to 15 May), summer (16 May to 15 July), rainy season (16 July to 15 September), autumn (16 September to 15 November), winter (16 November to 15 January) and ice cold (16 January to 15 March). All these seasons are locally called *Sont*, *Retkol*, *Waharat*, *Harud*, *Wandh* and *Shishur*, respectively.

### METHODOLOGY

Many regions of the district were surveyed from March, 2011 to October, 2012. Representative informants including local knowledgeable elders and tribals (*Gujjars* and *Bakkerwals*) were sampled during random visits made to houses in the study area. Besides, efforts were made to approach as many as traditional medical practitioners (*Bhoeris*). Ethnomedicinal data was collected using semi-structured interviews, focus group discussions and walk-in-the-woods. In total, 111 informants were randomly selected and

approached whose age ranged from 37 to 98 years. Interviews and discussions were held in Kashmiri language that was understandable in most of the cases. However, Urdu language (official language) was also used in some tribal areas. In order to provide independent information, informants were separately asked to share their traditional knowledge on ethnomedicinal utilization of plants such as plant's local name, plant part(s) used, ailment(s) in which part(s) of the plant is used, mode of administration. With a view to bring an element of accuracy, the information was cross checked with that of others. To ensure further accuracy and to get some more valuable tips regarding ethnobotanical surveys some important works (Jain, 1967, 1995; Khan, 1993) were also consulted.

At the end of each interview session, a guided tour was undertaken with the interviewer in order to collect the medicinal plants cited during interview. Efforts were made to collect the medicinal plants from the natural habitats in their flowering and fruiting stages. For easy identification and habitat recognition field photographs of the plants were taken with the help of a digital camera. Collected plants/plant parts after drying, were mounted on herbarium sheets of standard size (41.25 × 28.75 cm) following standard herbarium procedure (Miller and Nyberg, 1995). Every herbarium sheet was provided with a herbarium label containing information pertaining to botanical name, local name, family, habit, habitat, collection number, accession number, date of collection, place of collection and collector's name. Plant specimens were then accessioned and identified by matching them with the already labelled herbarium specimens lying in the departmental herbarium (KASH Herbarium) of Kashmir University, Srinagar (Jammu and Kashmir), where one copy of every specimen was deposited for authenticity and future use. One more copy of every specimen was later deposited in the herbarium section of the Department of Botany, Government Narmada Post Graduate College, Hoshangabad (M.P), for authenticity and future use. The International Plant Names Index (<http://www.ipni.org>) was followed for the botanical nomenclature of each plant species.

## RESULTS

During plant exploration in this floristically rich Himalayan region, a total of 23 plant species belonging to 22 genera and 15 different families were reported that were traditionally used by local knowledgeable elders, tribals and traditional practitioners for curing various ailments. In the Table 1 given below, all the collected and identified plant species are enumerated alphabetically with their botanical name with author citation, followed by local name, family to which it belongs, accession number, flowering period, habit, plant part(s) used, mode of administration and threat status. Only one plant species namely *Taxus wallichiana* was gymnosperm while all others were angiosperms. Majority of the species were perennial herbs. However reports of biennial herbs (for example, *Hyoscyamus niger*) and perennial trees (for example, *Crataegus songarica* and *Taxus wallichiana*) were also obtained. All the documented medicinal plants were collected from wild and no species from cultivation source. The highest number of medicinal plants were recorded in two families viz. Asteraceae (4 species, 17.39%) and Liliaceae (3 species, 13.04%) followed by families Ranunculaceae, Apiaceae, Lamiaceae (2 species, 8.69% each) while all other families such as

Boraginaceae, Rosaceae, Orchidaceae, Dioscoreaceae, Solanaceae, Scrophulariaceae, Podophyllaceae, Valerianaceae, Taxaceae, and Polygonaceae were monotypic and included only one species, 4.34% only (Figure 2).

The general flowering calendar of collected medicinal plants revealed that the maximum number of plants species were in flowering stages during the month of July followed by June, August and May, whereas no plant species was found to flower in the month of January, November and December. It was observed that in majority of plant species various plant parts such as leaves, roots, rhizomes, flowers, seeds, bark and fruits etc., were used, followed by roots and rhizomes to cure various ailments. Mostly plant parts were used for herbal preparations in dried form rather than in fresh form. The dried plant parts were also stored at homes in order to be used in later season especially during winter when life in the entire district becomes very tough and medicinal plants become scarce. In most cases, herbal drugs were prepared from a single species. However some applications were prepared from mixtures of different plants/plant parts with the understanding that synergistic effect of different species of plants could improve the cure rates. The medicinal plants had various preparation forms such as powder, paste, poultice, decoction, infusion, semi-soild balls and smoke. However in this study, paste constituted the highest type of preparation form, followed by powder and infusion. In the preparation of various remedies, water was frequently used as solvent/dilutant but occasionally herbal formulations were prepared with milk, oil or *ghee*-clarified butter made from cow's milk.

Results revealed that the people of Bandipora used these plants for curing various ailments, ranging from simple to highly complicated, such as asthma, diarrhoea, wounds, boils, toothache, urinary disorders, jaundice, indigestion, cough, cold, general body weakness, gaseous bloat, fever, headache, hair fall, skin diseases, gynaecological disorders etc. A few ailments such as cough, cold, fever, headache and those related to joints, were reported to occur more frequently in the study area. In total, 111 informants belonging to age groups 37 to 98 years were interviewed. Results also revealed that a major proportion (75%) of folk medicinal knowledge comes from people who are above the age of 55 years, while a small proportion (25%) of it comes from people who are between the ages of 37 and 50. Gender wise, men especially old ones had more traditional knowledge about medicinal plants and their uses than females. It was also reported that the collectors including 80% men, 10% women and 10% children always carry digging tools to dig out the medicinal plants wherever found. Men usually collected the plants while grazing their livestock at higher altitudes. Since, higher reaches are under the siege of security forces for decades in response to terrorist threats and infiltration, the movement of

**Table 1.** Threatened medicinal plants of Bandipora (Kashmir Himalaya) based on *Red Data Book of Indian Plants* (Nayar and Sastry, 1987, 1988, 1990), CAMP (Conservation Assessment and Management Plan, 2003) workshop, other existing literature (Pant and Pant, 2011; Kumar et al., 2011) and personal observations of the authors.

Plant's Botanical Name/Local Name/Family	AN	FP	H*	Plant Part(s) Used	Mode of administration	TS
<i>Aconitum heterophyllum</i> Wall. "Pivak"/ Ranunculaceae	37804	AU-S	PH	Roots	Paste of dried powdered roots in mustard oil is applied on joints to cure arthritis. Root powder is given with water to cure abdominal pain, dyspepsia, fever, headache, vomiting and gaseous bloat in cattle caused as a result of grazing of "Durhaam" ( <i>Sorghum helepense</i> ) at its juvenile stage	CR
<i>Aconitum violaceum</i> Jacquem. ex Stapf "Mohand"/ Ranunculaceae	37799	AU-O	PH	Roots and flowers	Sundried flower petals and sugar after mixing are crushed. The same is then kept in air tight jar for about 10-15 days for fermentation. This fermented mixture is locally called "KHAMBIR" which is used against cough, cold, fever, stomach problems and liver disorders. Minute dried root pieces are fitted in tooth cavities without swallowing (because it is highly poisonous) for one minute and then thrown out for immediate relief from toothache. Root powder is mixed with oil to make paste which is applied on painful boils and joints to treat them	VU
<i>Ajuga parviflora</i> Benth. "Jan-i-adam"/ Lamiaceae	38849	AP-JN	PH	Leaves	Leaf powder is administered orally with water to cure cough, stomach problems, intestinal infection and general body weakness. Water extract of fresh leaves is given to cattle against weaknesses, indigestion and fever	R*
<i>Angelica glauca</i> Edgew. "Chora"/ Apiaceae	39281	JN-AU	PH	Roots	Root powder is applied over aching teeth. It is also taken with water against stomach disorders. Fresh roots are crushed and given to cattle against cold, diarrhoea and alopecia (in goats)	EN
<i>Arnebia benthamii</i> (Wall. ex G. Don) I.M. Johnst. "Gaozaban"/ "Kahzaban"/ Boraginaceae	38900	JL-AU	PH	Leaves, flowers and roots	Leaves and flower tops the herb form an important ingredient of "SHARBETH" (a combination of several different herbs). The composite decoction of "SHARBETH" is given to cure jaundice, palpitation of heart, cough, cold, chronic constipation, fever and also acts as diuretic and a good blood purifier. Decoction is also given to ladies after child birth to keep them healthy and strengthen their bones. Roots after crushing are applied as poultice over wounds for quick healing	CR
<i>Artemisia absinthium</i> Linn. "Tithwan"/ Asteraceae	37789	JL-AU	PH	Leaves and inflorescence	Fresh leaves and inflorescences are crushed and juice is squeezed from it which is mixed with a glass of lukewarm water or milk and administered orally as a best home remedy against roundworms, abdominal pain, fever and diabetes. Dried leaves after soaking in hot water are crushed and then spread on a cloth which is tied on sprained body parts to relieve their pain and swellings	R*
<i>Bunium persicum</i> B. Fedtsch. "Kala Zeera"/ Apiaceae	38872	MY-JN	PH	Fruits	Dried fruits are used as spice in case of digestive disorders. Fruits are chewed to remove foul breath. Roasted fruits are ground into powder which is mixed with banana to make paste. Paste is given orally for the treatment of joint pain, lumbago and as brain tonic to enhance memory	EN

Table 1. Cont'd.

<i>Colchicum luteum</i> Baker. "Vir Kim Posh"/ Liliaceae	38894	F-MR	PH	Corms and seeds	An extract obtained by boiling corms thoroughly in water is used for bathing by mothers immediately after child birth to cure body pains. Fresh corms after crushing are mixed with gur (local raw sugar) and then fried in <i>ghee</i> -clarified butter made from cow's milk. It is taken to cure back pain, weakness of bones, fever and cough. Seeds are given against flatulence, constipation and to induce sleep	VU
<i>Crataegus songarica</i> K. Koch "Reng Kul"/ Rosaceae	38853	MY	PT	Fruits	Fruits are fondly eaten for the treatment of palpitation of heart and hypertension	R*
<i>Cypripedium cordigerum</i> D. Don "Pholaan"/ Orchidaceae	38842	JN-JL	PH	Rhizome	Fresh leaves are used as vegetable. Rhizomes are dried, ground into powder and then mixed with wheat flour and sugar. The mixture is then fried in <i>ghee</i> to prepare <i>Halwa</i> . <i>Halwa</i> is given in case of joint pains, heart palpitations and as tonic	R
<i>Dioscorea deltoidea</i> Wall. ex Kunth "Kreth"/"Krees"/ Dioscoreaceae	38847	MY-JL	PH	Tubers	Leaves at juvenile stage are used as vegetable. Tubers are collected, dried and then ground into powder. Powder is used as detergent to wash clothes. Sometimes, powder is mixed with edible oil to make paste which is used by women to kill lice	EN
<i>Hyoscyamus niger</i> Linn. "Bazarbunga"/ Solanaceae	38878	JN-JL	BH	Seeds and leaves	Dried seeds are smoldered to emanate smoke which is inhaled and allowed to remain in mouth without swallowing for half a minute and then expelled as a domestic remedy against toothache. Dried leaf powder is smoked with tobacco as sedative to relieve mental disturbance. Powder is made by grinding seeds which is then mixed with mustard oil to make paste. Paste is massaged on arthritic joints and eyelid abscesses to alleviate pain and their swellings	VU
<i>Inula racemosa</i> Hook.f. "Poshkar"/ Asteraceae	37805	JL-AU	PH	Roots	Dried roots are ground and powder is made. Powder is administered orally with lukewarm water or milk to cure fever, cough and chest pain-by clearing the phlegm from lungs. Paste is made by mixing powder with <i>ghee</i> . It is applied on wounds to avoid infection and stimulate healing	VU
<i>Jurinea dolomiaea</i> Boiss. "Dupha"/"Thandi Jadi"/"Guggal Dooph"/ Asteraceae	37808	AU-S	PH	Roots and leaves	Tea is made by boiling dried root powder in one glass of water with two spoons of sugar and half cup of milk. It is taken in case of cough, cold, headache, thirst and whitening of tongue. Root powder is also mixed with oil and common salt to make paste which is applied on wounds to help them to heal and on boils to help them to ripe and burst. Root decoction is mixed with maize flour and <i>ghee</i> to form a semi-solid mixture. It is considered to be highly energetic and taken orally to cause excessive sweat formation which in turn gives relief from fever and body muscular pains. Besides, at some places leaves are used as vegetable and dried roots are burnt to produce smoke of good smell which is considered to be demon repellent	EN
<i>Notholirion thomsonianum</i> (Royle) Stapf "Salamisri"/ Liliaceae	38843	AP-MY	PH	Bulb	Bulb is sundried and grinded to make powder. Powder is mixed with milk to prepare an infusion which is kept as such for overnight. The infusion is then taken next day early in the morning to cure body muscular pains. Dried bulb decoction is given to ladies to cure frequent menstruation	R*

Table 1. Cont'd

<i>Picrorhiza kurroa</i> Royle "Koud"/"Kutki"/ Scrophulariaceae	37802	JN-AU	PH	Rhizome	Rhizome is dried completely, grinded and converted into powder which is administered orally along with water as a best home remedy against round worms, intestinal infection, and stomach disorders. Powder is also mixed with wheat flour, gur (raw sugar) and water and the mixture is made into semi-solid balls which are given to cattle especially horses against pneumonia, tapeworms, and to keep them healthy during cold season. Sometimes powder is mixed with sugar and packed in bottles which are placed in open sunlight to ripen (undergo fermentation). This fermented powder, locally called "KHAMBIR", is given in case of weakness, whooping cough and joint pains	EN
<i>Podophyllum hexandrum</i> Royle "Banwagan"/"Bankakri"/ Podophyllaceae	37806	MY-JL	PH	Roots and fruits	Ripe fruit juice is taken against stomach ulcers and dyspepsia. Powder obtained from the dried root is administered orally along with water to overcome tumorous growths. Root powder is also mixed with oil to make paste which is used as a remedy to skin diseases such as rashes and eczema	EN
<i>Prunella vulgaris</i> Linn. "Kalaveuth"/ Lamiaceae	37795	JN-JL	PH	Leaves and flowers	The leaves and flowers of this herb form an important ingredient of "LOSSA GHASA". It is thoroughly boiled in water to prepare hot water extract. Ladies, after their deliveries, are advised to have bath with this hot water extract (after dilution with more water) to cure headache, fever, body muscular pains and hair fall. Steam inhalation of this herb is used to cure migraine and to clear phlegm from chest hence reduces chest infections. Dried flower powder is then mixed with edible oil to form paste which is applied on wounds	R*
<i>Rheum emodi</i> Wall. "Pumbchalan"/ Polygonaceae	38899	JN-JL	PH	Rhizome	Leaves are fondly used as vegetables. Rhizome is dried completely and ground to make powder. Powder is sprinkled on ulcers, burns and non-healing wounds for quick healing	EN
<i>Saussurea costus</i> (Falc.) Lipsch. "Kouth"/ Asteraceae	37803	MY-JL	PH	Roots	Dried roots are grinded to obtain powder which is mixed with edible mustard oil to make paste. Paste is then warmed and finally used to cure skin diseases, arthritis and paralysis of body parts through its external massages in exposed sun light. Root powder is mixed with a mixture of crushed onion bulbs, gur (raw sugar), water and finally made into semi-solid balls which are given to cattle especially horses as tonic to keep them healthy during cold season. Root powder is also mixed with sugar and taken orally with water to overcome joint pains, stomach problems and to dissolve kidney stones	CR
<i>Taxus wallichiana</i> Zucc. "Postul"/"Brammi"/ Taxaceae	39285	AP-JL	PT	Bark	Fresh fruits are edible. Dried stem bark is boiled in water to prepare a special kind of tea. Tea is given in case of asthma, headache, giddiness, arthritis and tumours growths	EN
<i>Trillium govanianum</i> Wall "Surmganda"/"Reech Ki Jadi"/ "Tripater"/Liliaceae	37797	JN-AU	PH	Rhizome	Crushed rhizome is given in the form of balls to livestock against worms. It is also used to cure boils by applying externally	R*

Table 1 cont'd

<i>Valeriana jatamansi</i> Jones. "Mushkibala"/Valerianaceae	37801	MY-JL	PH	Roots	Roots after complete drying are stored for later use. They are grinded into powder which is taken orally with warm water against abdominal pain, worms, diarrhoea, fever and urinary disorders. Powder is also mixed with oil to make paste which is applied on wounds for healing	VU
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AN- Accession Number; AP- April; AU- August; BH- Biennial Herb; CR- Critically Endangered; EN- Endangered; F- February; FP- Flowering Period; H\*- Habit; JL- July; JN- June; MR- March; MY- May; O- October; PH- Perennial Herb; PT- Perennial Tree; R- Rare; R\*- Rare categories defined based on field observations of the authors; S- September; TS- Threat Status; VU- Vulnerable.

people is highly restricted. Therefore, the local populace doesn't allow the women to graze livestock at higher reaches and the task is carried out only by men especially old ones. Thus women and children collected plants while on their way to work in the fields and surrounding area of their work place. Actually local people of remote hilly areas including *Gujjars* and *Bakkerwals* are involved in the collection and trade of medicinal plants to sustain their basic needs of livelihood as they are poor and needy. They are often unaware of the real market prices of medicinal plant species. Once the plants are collected, they are then sold to some middle man crude drug dealers besides local traders and *Bhoeris*. Local traders buy medicinal plants from local people particularly from *Gujjars* and then sell them to *Bhoeris*. Bought medicinal plants are then prescribed and sold by *Bhoeris* simply by establishing small shops not only in small villages but also in semi-urban and urban areas. Furthermore, *Bakkerwals* were found to carry large amounts of indiscriminately collected plants such as *Trillium govaniatum*, *Aconitum violaceum*, *Aconitum heterophyllum*, *Angelica glauca*, *Jurinea dolomiaea*, *Saussurea costus*, *Arnebia benthamii*, *Rheum emodi*, *Podophyllum hexandrum*, *Picrorhiza kurroa* on the back of their pack animals. Since, *Bakkerwals* move from one meadow to other and from one forest area to other while grazing their livestock, they get easy access to a majority of precious herbs and harvest

them ruthlessly and then store them. They then sell them at high costs to some drug dealers of neighbouring states who in turn sell them to pharmaceutical companies.

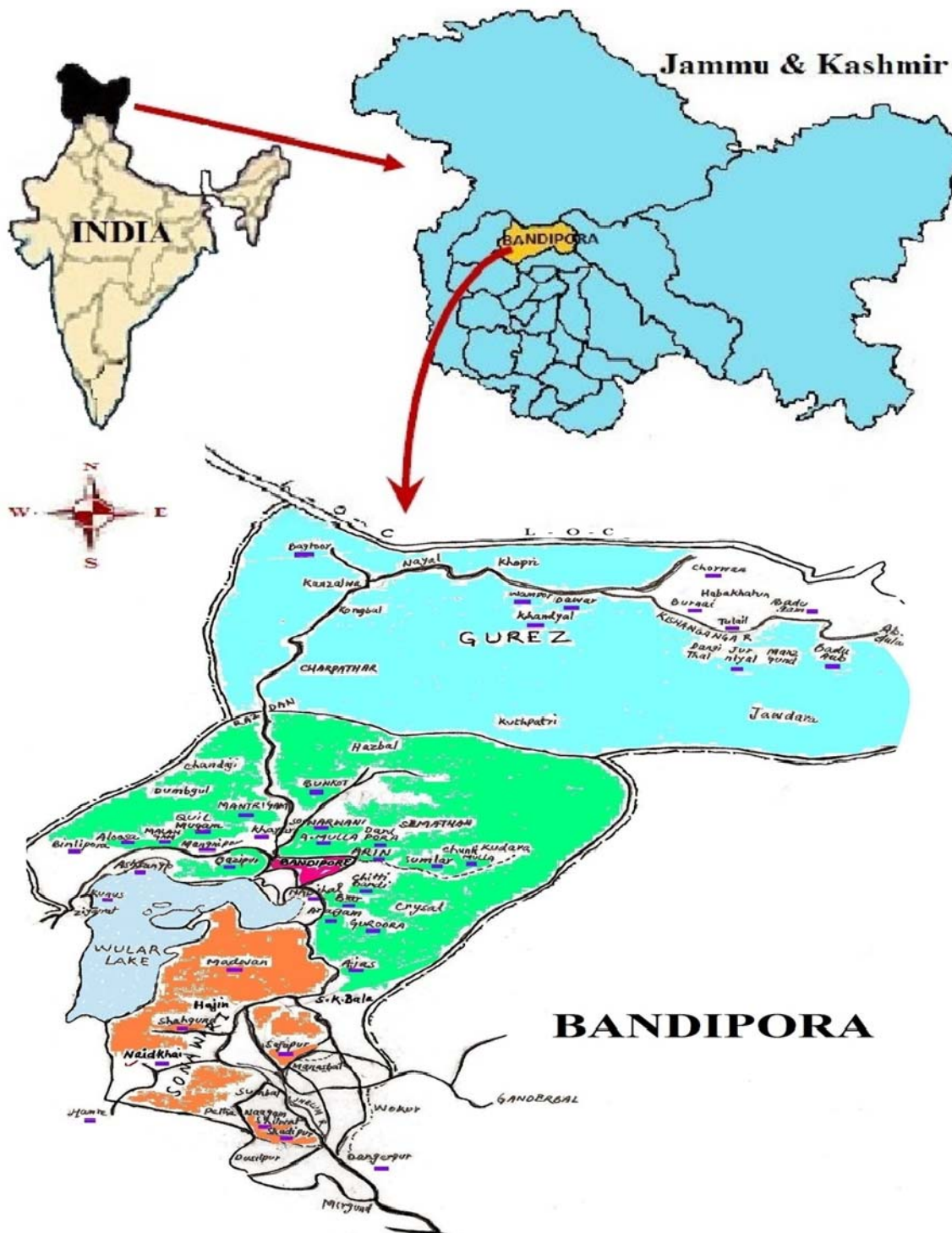
Present study has revealed that medicinal plants still play a vital role in the primary health-care of the people of this region. During surveys, it was observed that more than half of the total number of people questioned regularly used medicinal plants to cure many health disorders. Therefore, this study is important to preserve the knowledge of medicinal plants used by the people in Kashmir Himalayas. Also, it is of significance to exploit novel pharmacological compounds from these plants for the treatment of various diseases.

## DISCUSSION

The practice of using local herbs as medicinal remedies for a variety of health conditions is widely known throughout the world. Kashmir Himalaya harbours diverse habitats which support a rich floristic wealth that has been used as a resource-base by its people since times immemorial. Our present study revealed that about 23 threatened plant species are being used as medicine in one or other form in Kashmir Himalaya. The local people especially tribals living in the fringes of temperate forests depend on medicinal plant resources for their disease treatment. Although during surveys it was

reported that gymnosperms were least used as crude drugs, they formed the dominant component in the forests of the study area on account of congenial physiographic conditions and altitudinal location of the area. Since all the species were collected from wild and no species from cultivation, this indicates that the residents mainly depended on the wild source or natural environment rather than on home/vegetable gardens to obtain medicinal plants, and no activity of cultivation of medicinal plants was reported. It also indicated that the natural forests of Bandipora were over-exploited by *Gujjars*, *Bakkerwals* and also by traditional practitioners (*Bhoeris*) for their medicinal plant composition. The richness of medicinal herbs decreased with increasing altitude but the percentage of plants used as medicine steadily increased with increasing altitude. The reason for this was due to preference given to herbal medicines at high altitude areas as well as having no alternative choices, poverty and trust in the effectiveness of traditional herbal medicines. Similar findings were also reported by Kunwar and Bussmann (2008) and Shaheen et al. (2012) in their ethnobotanical investigations.

Amongst the families, Asteraceae represented the dominant family. Gangwar et al. (2010) and Rinchen and Pant (2014) also reported family Asteraceae as the dominant family in their ethnobotanical investigations. The species in flowering over 9 months of the year first shows an increasing trend reaching maximum in the month of July



**Figure 1.** Map of Bandipora district. Geometric co-ordinates are not shown because the area is highly restricted.

and then falling again. This trend of flowering during summer is perhaps attributable to the physiography of the study area, since a considerable portion of the study area remains covered with snow till the end of June, which prevents seedlings and other vegetative parts from

coming out of the soil. One more reason for frequent occurrence of majority of the medicinal plants species in summer season (May to July) in comparison to other seasons of the year, could be attributed to the suitable temperature, enough moisture and availability of



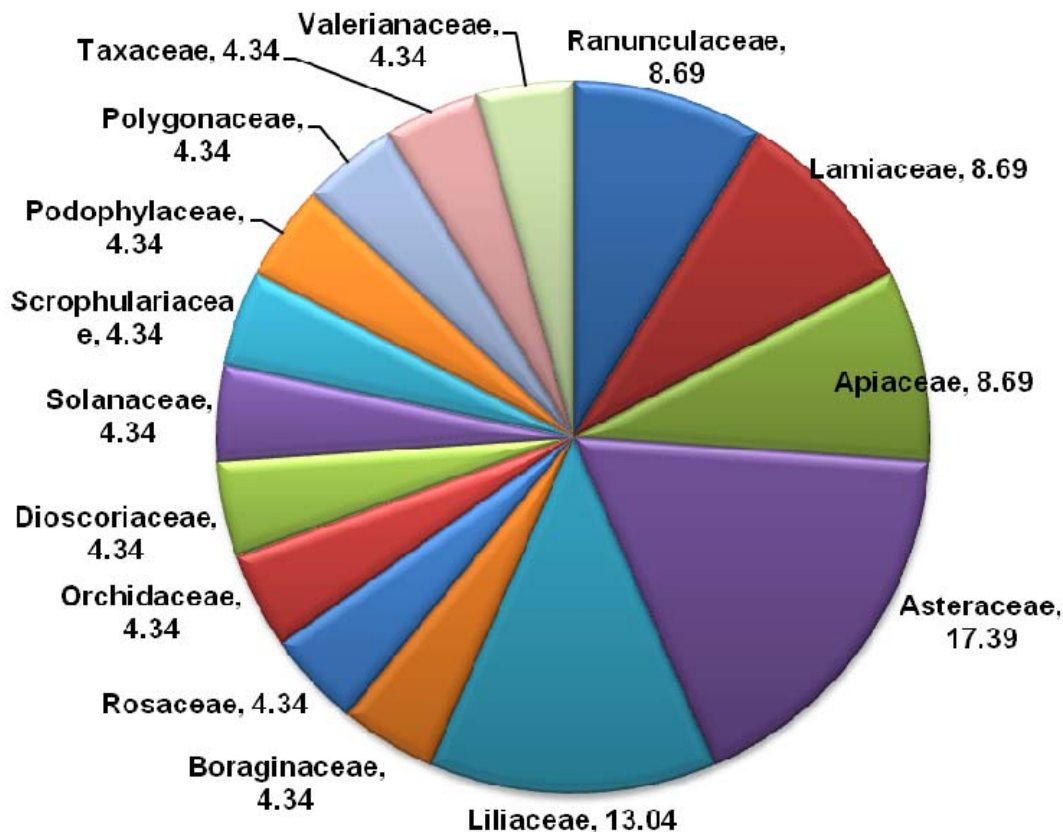


Figure 2. Percentage of collected plant species among different families.

macronutrients (Ahmad et al., 2009). The extended flowering period of certain herbaceous annuals is because of their extended distribution along altitudinal gradient.

Since there is gradual decrease of temperature as the altitude increases, the growth of certain plants triggers earlier at lower levels (Singh and Kachroo, 1994) as compared to the species growing at higher elevations. The reason for the dominance of herbaceous medicinal plants could be because of their abundance and year round availability in the study area. As underground parts such as roots and rhizomes were most commonly used plant parts for herbal preparations in the area. Such practice of harvesting underground parts from widely distributed area which are important for survival of plants may pose a negative influence on the survival and continuity of useful medicinal plants and hence affect sustainable utilization of plants. Large proportion of herbal prescriptions from root sources was also reported by many workers (Lulekal et al., 2008; Rout et al., 2009; Dangwal et al., 2010) in their ethnobotanical investigations. The argument that majority of the herbal drugs were prepared from mixtures of different plants/plant parts with the understanding that synergistic effect of different species of plants could improve the cure rates, is strengthened by the previous reports of Dilshad et al.

(2009) and Gertsch (2011).

The frequent occurrence of some of the ailments in the study area could be attributed to their high prevalence. According to local people ailments such as cough, cold, fever, headache and those related to joints occur frequently during winter months when entire district remains under intense grip of cold. All identified plant species were used for the treatment of more than one disease and thus it is very difficult to assess which plant is actually effective in curing a particular disease. Therefore only clinical trials on these plants can give some indications.

As mentioned earlier, men had more traditional knowledge about medicinal plants and their uses than females (Lulekal et al., 2013). This may also be attributed to two reasons. Firstly, because of the involvement of males in collection and trade related activities (Qureshi et al., 2006). Secondly, higher reaches are under the intense seizure of security forces for many decades in response to terrorist threats, thus posing biggest hindrances in the movement of women. Informants below the age of 50 years were reported to be less aware of the potential of medicinal plants than their older counterparts who had also gathered knowledge from the point of view of their traditional healthcare and their day to day practices. This difference in the perception of the two age classes will

likely result to the knowledge loss over time. Discussions with local people, especially *Bhoeris*, indicated that the attitude of the younger generation was not towards continuing this traditional practice because they realized less opportunity in this tradition for getting immediate benefits mainly in terms of cash in the form of money.

People in the study area preferred medicinal plants from wild sources because they believed that wild plants are pure and grow in untouched forests free from disturbances of man himself. Hence, there was great pressure on collected plants leading to rapid depletion of medicinal plant resources in the area. During the course of surveys, various factors were reported that were imposing pressure on these plants. The major factors claimed were increasing population, over-grazing, indiscriminate harvesting, deforestation, agricultural expansion, lack of job opportunities, increased marketing pressure, trading of charcoal and firewood, and uses of medicinal plants for purposes other than medicinal value. Similar threatening factors were also reported during ethnobotanical exploration of Rajouri district of Jammu and Kashmir (Rashid et al., 2008). During summer, tribals (*Gujjars and Bakkerwals*) let their livestock graze upper lands. In this way, the lush green pastures are subjected to intensive overgrazing and are ultimately converted to barren lands at the end of the season. Similar observations were reported by Rawat and Uniyal (1993) for the alpine meadows of Jammu and Kashmir, where overgrazing resulted in great loss to vegetation cover and wide occurrence of unpalatable weedy species.

During surveys the work on a mega power project namely 330 MW Kishenganga Hydro Electric Power Project by Hindustan Construction Company (HCC) in the lap of dense forests of Bandipore, was found going on. The company was reported violating the environment conservation norms and not only destroying the scenic topography but also causing destruction of valuable plant resources including beautiful coniferous trees and other crucial medicinal plants. There is no doubt that the continued environmental degradation of medicinal plant habitats will bring the depletion of medicinal plants and associated knowledge.

It would be appropriate to mention here that besides all cited threats, there is one more important threat, namely unregulated research work that has also an adverse impact on medicinal plant populations. The unregulated research work in different institutes of the state has also rendered some of these medicinal plants threatened. The researchers need a lot of plant material particularly for phytochemical studies. Hence this threat has also brought some of the medicinal plants on the verge of extinction. Indiscriminate harvesting for smuggling/illegal trade has also brought some of the medicinal plants on the verge of extension. The tribal people extract all these identified plants and smuggle them at an alarming rate.

These plant species are extracted at the time of flowering and when asked why the herb was being dug at this

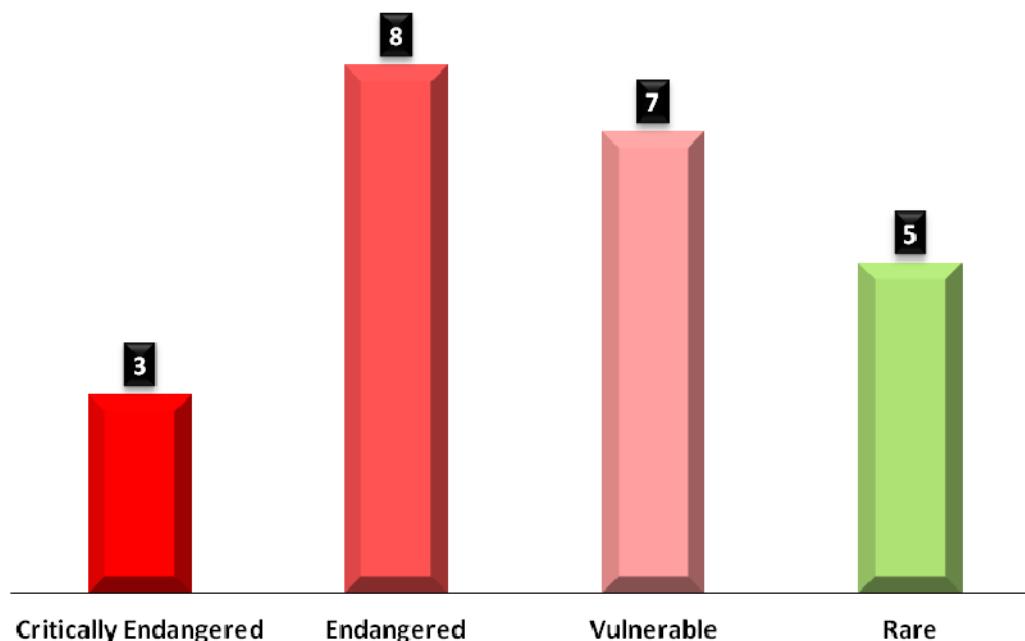
stage they told us that they had been instructed by the crude drug dealer/local trader. This practice not only removes the plant from its natural habitat, it also reduces the chances of the seed formation thus hampering increase in plant population. Moreover, due to increasing demand of raw materials at local, national and international markets, these plants are being indiscriminately harvested for commercial purposes. The trade of this kind will continue, till the existence of a seller and a buyer. Thus such malpractices have posed these plants at the brink of extinction (Ved et al., 1998; Dhar et al., 2000; Kala, 2000).

It is therefore evident from the present investigation that all the identified medicinal plants of present study belong to different threat categories according to the Red Data Book of Indian Plants (Nayar and Sastry, 1987, 1988, 1990), CAMP (2003), other existing literature (Pant and Pant, 2011; Kumar et al., 2011) and field observations of the authors. Using new criteria of International Union for Conservation of Nature and Natural Resources (IUCN), out of 23 plant species, 3 species are critically endangered, 8 species are endangered, 7 species are rare and 5 species are vulnerable (Figure 3). Among the 7 rare species, 6 plant species with asterisk are designated so, based on the field observations of authors keeping in view the valuable information regarding plant abundance, distribution, localities of their maximum availability, exploitation level and various threats. In the present investigation, only two plant species are categorized as endemic (Dar et al., 2012). These include: *Saussurea costus* and *Aconitum heterophyllum*. Thus all these plants are indiscriminately harvested on account of their very high demand for medicinal purposes. The shrinking population of these medicinal plants is a matter of great concern as these plants are backbone of our traditional medicinal system with a large population still depending on traditional medicine. In addition, extinction of these plant species may also lead to ecological imbalance. Therefore, the need to conserve these threatened plants is of utmost importance. Hence if necessary conservation measures are not taken at the earliest, the day will not be far away when such plants will completely deplete from their natural habitats. Actively involving stakeholders, especially local people of the area, in implementation, planning, evaluation and monitoring processes of plans and projects may prove fruitful in the conservation of such species, as they are the beneficiaries of the area.

## CONCLUSION AND RECOMMENDATIONS

The following efforts need to be made to conserve the various threatened plant species:

1. The thinking of people must be changed about current indiscriminate harvesting practices which can be done by skill development, training and attitudinal change.



**Figure 3.** Number of medicinal plants in different threat categories.

2. Blanket ban must be imposed by the government on indiscriminate and uncontrolled grazing.

3. Domestication of all these medicinal plants should be undertaken, which will augment the income of the tribal people and in turn help in the conservation of the species.

4. Efforts should be made to promote the vegetative propagation of these medicinal plants through grafting, layering, cuttings and also by employing various propagules such as roots, rhizomes, bulbs, corms and buds.

5. Hawk-eye vigil should be maintained by the concerned authorities on the activities of *Bakkerwals* since they up-root crucial medicinal plants clandestinely for commercial purposes.

6. Local people must be involved as leaders of activities geared towards environmental conservation awareness and this can be done by local organizations. It would be better, if local school teachers and religious leaders are involved in such awareness programmes.

7. Lessons learnt from success stories should also be implemented at wider scale to train local people for the cultivation of these medicinal plants.

8. Small domestic industries such as beekeeping, gardening, handicrafts etc., must be encouraged through social organizations within the local communities so that the pressure on medicinal plants for their trade can be reduced to a great extent.

9. A regulatory mechanism is needed at the institutional level, particularly at the time of assigning research problem to the student, and it is also the duty of Departmental Research Committees (DRCs) to evaluate the synopsis and also see the pros and cons of the assigned

research problem.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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