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Traditional knowledge and conservation status of some selected medicinal herbs from Uttarkashi district in Uttarakhand, Western Himalayas

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ABSTRACT: Traditional knowledge has been used throughout the world including India as a practice of using local herbal drugs. Majority of the locals living in the district Uttarkashi of Uttarakhand state have poor connectivity and socio-economic status. These people are known to have indigenous experience about the medicinal plants of the area and use their age-old experiences and perceptions in the treatment and prevention of various ailments. Present paper documents the ethnobotanical information and conservation status of 82 medicinal herbs from the hilly district of Uttarakhand. Information gathered include, local name, plant parts used, mode of preparations, medium of administration, ailments cured along with distribution and conservation status. Majority of these plants were used for their roots and leaves. Most of them are herbs while trees and climbers were less frequently used. People living in remote areas have a vast treasure of knowledge, but they do not disclose it easily to outsiders. During surveys and interactions, it has been noticed that due to over exploitation, some medicinal herbs are at the verge of extinction which need to be conserved at the earliest.

KEY WORDS: Traditional uses; Conservation; India; Medicinal herbs; Uttarkashi District; Uttarakhand; Western Himalayas.

INTRODUCTION

Medicinal plant knowledge has been used throughout the world especially in the developing countries like India as a practice of using traditional herbal drugs available in the form of local plant species. The widespread use of traditional medicine could be attributed to the cultural acceptability, economic viability and efficacy against certain ailments/diseases compared to modern allopathic drugs. Different local/ tribal communities especially in areas which have poor connectivity and socio-economic status have indigenous experience in local medicinal plants and use their age old experiences and perceptions in the treatment and prevention of various diseases. In India, ethnic knowledge of medicinal plants has been accumulated during the last so many years based on different medicinal systems such as, Ayurveda, Unani and Siddha (Fabricant & Farnsworth, 2001). During the last 3-4 decades, a number of field studies have been made by the botanists to explore the ethnopharmocological aspects of wild plants of different regions of North-West Himalayas (Uniyal & Chauhan, 1973, 1982; Uniyal *et al.,* 1982; Kapahi, 1990; Srivastava *et al.,* 1992; Lal *et al.,* 1996; Sharma & Rana, 1999; Sharma & Lal, 2005; Sharma *et al.,* 2003, 2004, 2005; Chandrasekar & Srivastava, 2005; Ballabh *et al.,* 2008; Lal & Singh, 2008; Singh & Lal, 2008; Dhyani *et al.,* 2010; Rani *et al.,* 2013, 2015; Gupta & Sharma, 2013; Kaur *et al.,* 2014; Sharma *et al.,* 2014; Tabin *et al.,* 2016).

The cytologists from this laboratory have been actively engaged in exploring the cytomorphological diversity in the medicinally important plants of high altitudinal and geographically isolated cold deserts of Western Himalayas *viz*. Kinnaur district (Kaur & Singhal, 2016; Kumari & Saggoo, 2016), Pangi Valley (Rana *et al.,* 2014), Solang Valley (Kaur *et al.,* 2017), Lahaul-Spiti (Kumar & Singhal, 2013) and Parvati Valley of Himachal Pradesh (Sharma *et al.,* 2003, 2005; Himshikha *et al.,* 2017). On similar lines, the present study has been aimed at collecting ethnobotanical information from the high hills and remote valleys of Uttarkashi district in Uttarakhand state. Scattered information on some selected medicinally important herbs from the district have been documented earlier by Badoni (1987-1988), Bisht & Badoni (2009), Negi *et al.* (2010, 2011), Rawat & Jalal (2011) and Manikandan & Srivastava (2015). The aims of the present study were to – (i) collect in depth information on herbal remedies used by the local inhabitants/tribals and traditional healers for the treatment of various ailments/diseases (ii) collect information on the distribution and conservation status of medicinal herbs (iii) enlist the plant species which are being over-exploited commercially by the traders, and (iv) identify species which are at the verge of extinction or the ones which have become nearly extinct in the area. The study also aims to identify the socio-demographic variables (age, gender, economic status and education level) that influence medicinal plant knowledge in the area. The present study represents an area that lies in a remote and mountainous region which has sporadic access to modern medical services due to poor communication network and educational awareness. The documented knowledge so gathered will likely to

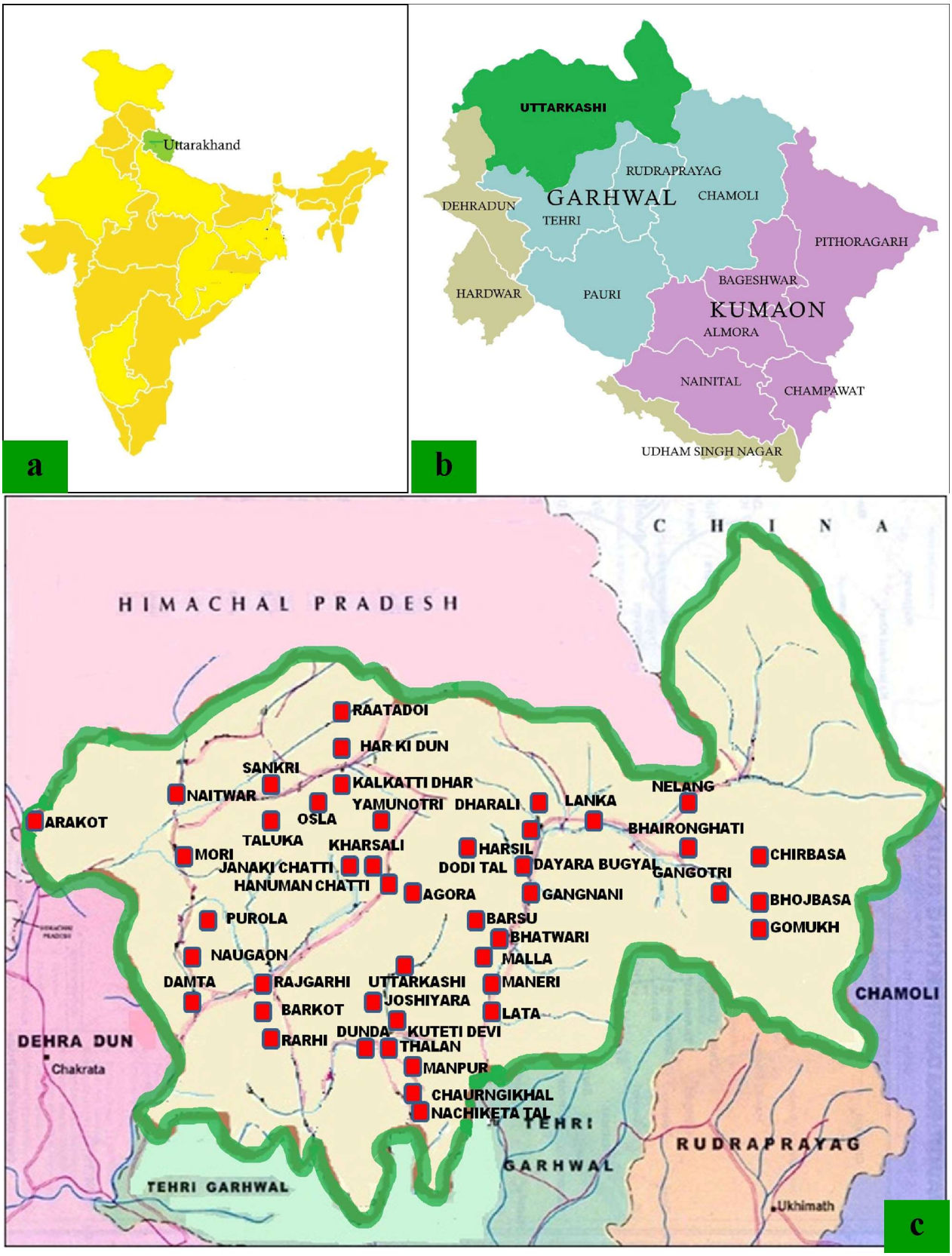

Fig. 1: **a**) Map showing geographic location of Uttarakhand state in India. **b**) Map showing geographic location of district Uttarkashi in Uttarakhand. **c**) Map depicting various localities visited during the present surveys in the district Uttarkashi.

provide a base for future researchers to evaluate the herbs for phytochemical parameters and help in designing *in situ* and *ex situ* conservation strategies for the important herbs which are fast depleting and are at the verge of extinction.

METHODOLOGY

Study area

The study has been carried out during the field surveys for 6 years during 2012-2017 to the higher hills and interior valleys of Uttarkashi district. The district is situated between latitude 30° 43' 49.85" N and longitude 78° 26'45.38" E with an elevation ranges from 900-4000m. Selected villages covered for data collection include, Aleth, Barkot, Barsu, Chaurangikhal, Damta, Dharali, Gangotri, Har-ki-Dun, Harsil, Jakhol, Janaki Chatti, Kharsali, Manpur, Mori, Naitwar, Naugaon, Nelang, Osla, Purola, Rajgarhi, Rana Chatti, Sankri, Seema, Taluka, Uttarkashi, and Yamunotri (Fig. 1A-C, Fig. 2A,B).

Situated in the upper Himalayas, Uttarkashi district harbours varying geographic environments ranging from snow free valleys and outer hills to high altitudinal peaks with perpetual snow and glaciers. The climate and topography is highly varied and supports a wide range of vegetation and forests ranging from sub-tropical, temperate, sub-alpine and alpine types with several species being endemic to the district. Major activity in the district is agriculture and most of the people inhabiting the area have low financial/economic status and poor educational background.

Data Collection

As a part of project allotted to the senior author (Rohit Kumar) to know the cytomorphological status and distribution pattern of the medicinal plants of the group Polypetalae from Uttarkashi district of Uttarakhand state in India, the present study includes ethnobotanical aspects of some selected herbs of the group. Informants or local healers who have obtained rich traditional knowledge were selected for their knowledge about medicinal plants in the area. Prior to the collection of information from knowledgeable traditional healers, vaids/hakims and shepherds particularly the elderly persons, they have been informed about the purpose of study. While collecting any ethnobotanical information, their consent was taken. People who were questioned/ interviewed for the present study were belonging to different age groups (35-80 yrs) and socio-economic status. Standard questionnaires were prepared to gather information regarding local/vernacular names of medicinal herbs, plant part/s used, techniques/s of preparation, modes of application/administration, dosage amount/frequency and the ailments treated.

Questionnaire.

1. Participant name Date
2. Age 3. Sex 4. Profession/occupation
5. Village 6. Educational background
7. Cast/Religion
8. Economic status 9. Vernacular name
10. Plant part/s used Leaves Fruits
    Roots Seeds
    Whole plant
11. Availability seasons/months
12. Diseases/ailments cured by the plant
13. Method of preparation of traditional formulation
14. Mode of administration/application and dosage
15. Used for
16. Distribution status Humans Animals Both

Plant collection and Identification

Interview based data collection was followed by identification of medicinal plants in wild habitats by local experts. Plants were photographed in natural habitats for their easy identification (Fig. 2 E-J). Majority of the plants were identified in field by their vernacular/local names. Names were further confirmed by consulting the regional/national floras (Rana *et al.,* 2003; Pusalkar and Singh, 2012). Besides, the sample plants were also compared to the specimens lying in the herbaria, Department of Botany, Punjabi University, Patiala (PUN); Botanical Survey of India, Northern Circle, Dehra Dun (BSD) and Forest Research Institute, Dehra Dun (DD). On the basis of field observations and information given by the locals, notes have also been prepared on the distribution status of these medicinal herbs.

RESULTS

Ethnobotanical information was gathered on 82 species belonging to sub-class Polypetalae from the hilly district of Uttarkashi in Uttarakhand state (see Table 1). Majority of the species belong to the families Ranunculaceae (14), Rosaceae (12) and Fabaceae (10). Most of the medicinal plants were herbs (70.73%), followed by shrubs/undershrubs (19.51%). The trees (6.10%) and climbers (3.66%) are less frequently used (Fig. 3A). Root was the most frequently plant part used (36.45%), followed by leaves (19.63%), seeds (11.21%), fruits (6.54%), bark and stem (5.61%; see Fig. 3B). For 13 species, whole plants were used for curing ailments.

Herbal medicines were prescribed in different modes, as powder, paste, decoction, juice, and poultice and in some cases as dried plant parts. Formulations were generally prepared from the fresh plant material and some ingredients were also added along with medicinal herb preparation which included honey, milk or ghee to enhance the potency of drugs and to improve the taste.

Table 1. Ethnobotanical information on some selected medicinal plants used by the locals in Uttarkashi District (Uttarakhand).

No.	Taxon	Vernacular name/s	Habit	Distribution	Part/s used	Methods of preparation	Modes of administration & Dosage	Disease/ Ailments treated	Conser. status
	Apiaceae								
1.	*Angelica glauca* Edgew.	Chora	Herb	In alpine meadows	Roots/ whole plant	Plant/roots decoction	Orally twice a day.	Gastric problems and constipation	EN
2.	*Coriandrum sativum* L.	Dhaniya	Herb	In grass fields and open dry places	Leaves and Stem	Paste of leaves and tender stems	Applied externally for skin diseases. Sauce of leaves given orally.	Skin diseases and Stomach disorder	NE
3.	*Pimpinella diversifolia* DC.	Bazeer	Herb	Along roadsides or trekking routes	Whole plant	Paste of leaves, root and flower	Given with water twice a day	Gastric problems	NE
4.	*Pleurospermum stellatum* (D. Don) C.B. Clarke	Losar	Herb	On open grassy slopes	Flowers	Flowers are ground thoroughly to make into paste.	Applied externally for relieving headache. If taken with cow butter relieves fever	Headache	NE
5.	*Selinum vaginatum* (Edgew.) Clarke	-	Herb	Isolated individuals in alpine meadows	Roots	Root paste	Paste applied externally on skin and other body parts twice a day.	Skin diseases/ inflammations	NE
	Balsaminaceae								
6.	*Impatiens racemosa* DC.	-	Herb	Along roadsides or trekking routes	Seeds	Seeds were roasted and made into powder.	Powder is given orally with honey 3-4 times a day.	Cough & cold	NE
	Berberidaceae								
7.	*Berberis aristata* DC.	Kingore, Chocolate	Shrub	Isolated individuals on partly shaded slopes	Bark and roots	Bark and roots are ground with water and filtered.	Bark juice and root infusion is given orally.	Stomach ache, fever and eye diseases	EN
8.	*B. lycium* Royle	Kingore	Shrub	Along roadsides or trekking routes	Bark	Bark of the plant is dried properly and made into powder. Powder dried bark of stem or root yield local product called '*Rasaut*'.	Powder of bark is given with milk twice a day	Conjunctivitis and mouth blisters	EN
	Brassicaceae								
9.	*Capsella bursa-pastoris* L.	-	Herb	Along roadsides or trekking routes	Roots and leaves	Root decoction Leaves are ground into paste.	Root decoction is given orally twice a day. Leaf paste applied externally on skin.	Gonorrhoea, urinary troubles, cuts and wounds	NE
10.	*Nasturtium officinale* R.Br.	Jairi	Herb	Along water steams or trekking routes	Whole plant	Whole plant decoction and in form of leaf paste.	Given orally twice a day for about one week	Used as blood purifying and to cure urinary problems.	NE
11.	*Thlaspi arvense* L.	-	Herb	Along roadsides or trekking routes	Leaves	Leaf paste	Applied externally on skin	Wounds and cuts	NE
	Caryophyllaceae								
12.	*Gypsophilla cerastoides* D. Don	-	Herb	Isolated individuals on partly shaded slopes	Whole plant	Poultice and paste	Applied externally on inflamed body part	Wounds/boils /inflammations	NE
	Cleomaceae								
13.	*Cleome viscosa* L.	Jakhya/ Hudhud	Herb	Along roadsides	Seeds	Dried seeds along with other plants	Used as spices during cooking food items	Digestive problems	NE
	Crassulaceae								
14.	*Hylotelephium ewersii* (Ledeb.) H. Ohba	-	Herb	Amidst loose boulders, on rocks and crevices	Leaves	Crude leaf juice is prepared.	Given orally twice a day for one week	Boils	NE
	Cucurbitaceae								
15.	*Solena amplexicaulis* (Lam.) Gandhi	Bankakari	Herb	Isolated individuals on partly shaded slopes	Roots	The roots are ground and made into a paste.	Applied externally on throat. Two teaspoonfuls of it is given orally twice a day before meals.	Throatache	NE
	Fabaceae								
16.	*Astragalus candolleanus* Benth.	Vajradanti	Herb	Isolated individuals on partly shaded slopes	Roots	Roots are ground in water and its paste is prepared.	Paste is applied externally.	Toothache, Bleeding gums	NE
17.	*Bauhinia variegata* L.	Kachnar	Tree	Along roadsides	Barks and leaves	Dried bark boiled in half glass of water to make into juice. Paste is prepared by grinding the leaves in water.	Bark decoction is used for gargling with 1/2 glass of water Leaf paste is applied externally	Throatache and skin infections	NE

Table 1. Continued

No.	Taxon	Vernacular name/s	Habit	Distribution	Part/s used	Methods of preparation	Modes of administration & Dosage	Disease/ Ailments treated	Conser. status
18.	*Caesalpinia decapetala* (Roth) Alston	Karanj	Shrub	Along roadsides	Seeds	Seeds are ground and paste is prepared made by mixing root powder with water.	Applied externally on infected on forehead	Fever	NE
19.	*Crotalaria prostrata* Willd.	Chunchui	Herb	Along roadsides	Roots	Root decoction	Givenorally twice a day.	Dysentery	NE
20.	*Glycine max* (L.) Merill.	Soyabean	Herb	Around crop fields	Seeds	Seed paste	Applied externally	Eyesores	NE
21.	*Indigofera gerardiana* Wall. ex Baker	-	Shrub	Along roadsides	Leaves	Leaf paste	Given orally	Dysentery and cough	NE
22.	*Macrotyloma uniflorum* (Lam.) Verdc.	-	Herb	Isolated individuals on partly shaded slopes	Seeds	Dried seed decoction	Taken orally	Gall stones and intestinal problems	NE
23.	*Medicago edgeworthii* Siraj.	Indrajoy	Herb	On alpine slopes and in meadows	Roots	Roots are boiled in water.	Applied externally on the infected areas.	Boils/Syphilis	NE
24.	*Parochetus communis* L.	Almori	Herb	Along roadsides and trekking routes	Leaves	Leaves are crushed thoroughly and watery juice is extracted	1-2 drops of leaf extract are poured in ear after evening meals	Earache	NE
25.	*Senna septemtrionalis* (Viv.) H.S. Irwin & Barneby	Kashmardh/ Kasanti	Shrub	Along roadsides	Seeds	Seeds are ground into paste.	Paste mixed with honey is given orally twice a day	Cough in children	NE
	Fumariaceae								
26.	*Corydalis casimiriana* Duthie & Prain	Yajurvanti	Herb	On moist shaded slopes as a forest undergrowth	Whole plant/roots	Whole plant or roots are ground to prepare decoction	Applied directly twice a day for a month. Root decoction is given orally twice a day	Syphilis	NE
27.	*C. comuta* Royle	-	Herb	On moist or dry open slopes	Roots	Roots are ground in water to prepare a juice/decoction and paste.	Paste is applied externally on infected areas. Decoction is given orally.	Inflammation and fever	NE
28.	*C. govaniana* Wall.	Indrajata	Herb	On open alpine slopes	Roots	Decoction of roots is prepared in water.	Given orally twice a day.	Stomachache, fever and toothache	NE
	Geraniaceae								
29.	*Geranium mascatense* Boiss.	Almori	Herb	Along roadsides	Fruits	Fruit paste	Applied externally on cuts.	Healing wounds/cuts	NE
30.	*G. nepalense* Sweet	Choti laljari	Herb	Along roadsides	Whole plant	Whole plant is ground in water and paste is prepared.	Applied externally.	Wounds healing/ fractured bones	NE
31.	*G. wallichianum* D. Don ex Sweet	Ratanjot/Laljari/ Ratijari	Herb	On moist or dry open slopes	Roots	Roots paste is made in water.	Given orally	Cough, Dysentery, headache, rheumatism and eye troubles. One gram of dried root is taken with tea to relieve headache and rheumatic pain. Root paste is given in stomach disorder of infants and also applied on breakage of horn of cattle.	NE
	Hydrangeaceae								
32.	*Deutzia staminea* R.Br. ex Wall.	-	Shrub	Along roadsides	Leaves	Waterextract of leaves	Given orally twice a day	Stomachache in children	NE
	Hypericaeae								
33.	*Hypericum elodeoides* Choisy	Vasanti	Herb	On moist or dry open slopes	Leaves and roots	Leaves are ground into paste while roots are used as decoction.	Paste applied externally. Root decoction is given orally twice a day.	Fever and indigestion	NE
	Juglandaceae								
34.	*Juglans regia* L.	Akhor	Tree	In open places	Bark, twigs seeds and gums	Dried bark is powdered into paste.	Paste applied externally. Twig and dried bark is used for cleaning teeth and curing pyorrhoea.	Toothache/ Pyorrhoea	NE
	Malvaceae								
35.	*Abutilon indicum* (L.) Sweet	Kanghe	Undershrub/ Shrub	Along roadsides	Leaves and bark	Leaves and bark are groundthoroughly and paste is made.	Applied externally for a week	Fever and dysuria	NE
36.	*Malva verticillata* L.	Sochali	Herb	On open slopes and in waste places along roadsides	Roots	Root extract	Root extract is applied on hairs for a week	Hair dandruff and hair shining, for curing whooping cough Cough and Cold.	NE

Table 1. Continued

No.	Taxon	Vernacular name/s	Habit	Distribution	Part/s used	Methods of preparation	Modes of administration & Dosage	Disease/ Ailments treated	Conser. status
37.	*Sida acuta* Burm.f	-	Undershrub	Along roadsides	Leaves and roots	Leaves and roots are ground and decoction is prepared.	Decoction is given twice a day for two months	Urinary problems and Leucorrhoea	NE
38.	*S. cordata* (Burm. f.) Borss.-Waalk.	Bhiyuli	Undershrub	Along roadsides	Leaves and roots	Leaves and bark of roots are used for preparing decoction	Boiled leaves applied externally as poultice on affected joints and body parts. Bark decoction is given twice a day	Gonorrhoea and spermatorhoea	NE
	Meliaceae								
39.	*Melia azedarach* L.	Bakain	Tree	In open places	Leaves and seeds	Seed oil, boiled leaves and root decoction	Boiled leaves applied directly as poultice and seed oil on affected joints and body parts. Bark decoction is given twice a day.	Skin diseases and rheumatic pains	NE
	Menispermaceae								
40.	*Cissampelos pareira* L. var. *hirsuta* (Buch.-Ham. ex DC.) Forman	-	Climber	On moist slopes	Leaves and roots	Paste is made of leaves and roots.	Paste is applied externally on body parts. Root decoction is given twice a day for cough and cold.	Snake-bite, cough and Cold	NE
41.	*Stephania glabra* (Roxb.) Miers.	-	Climber	On moist slopes	Tuber	Tuber of this plant is ground thoroughly.	Powder is given with water twice a day	Asthma and fever	NE
	Onagaraceae								
42.	*Epilobium royaleanum* Hausskn.	-	Herb	On open or partly shaded moist slopes	Whole plant	Whole plant is ground with rock candy.	Given orally twice a day for blood purification. Paste applied externally on wounds/cuts.	Blood purifier, wounds/ cuts	NE
	Oxalidaceae								
43.	*Oxalis corniculata* L.	Chalmori/Chilmodi	Herb	Along roadsides	Whole plant	Whole plant is ground and its paste is mixed with rock candy. Also used as aqueous extract	Paste applied externally on wounds/cuts. The aqueous extract of plant is applied externally once a day for the treatment of psoriasis and ringworms up to 14-28 days.	Wounds/cuts psoriasis and ringworms	NE
	Paeoniaceae								
44.	*Paeonia emodi* Wall. ex Royle	Chandra	Herb	On open or partly shaded moist slopes	Roots	Roots are ground and made into paste and powder. Root infusion is also prepared in water.	Root paste is given for whooping cough, diarrhoea, intestinal spasms and cuts. Root infusion used in eczema. Root powder applied to ulcers to kill maggots.	Whooping cough, diarrhoea, eczema and ulcers	NE
	Podophyllaceae								
45.	*Podophyllum hexandrum* Royle	Bankakri	Herb	Among rocks and as forest undergrowth	Roots	Paste.	Applied externally on cuts and wounds	Wounds/cuts	CR
	Ranunculaceae								
46.	*Aconitum heterophyllum* Wall. ex Royle	Atis	Herb	Isolated individuals in alpine meadows	Roots	Root paste	Root paste is given orally with 4-5 g of honey twice a day for a month.	Respiratory diseases, Helps in the secretion of gastric juice and increasing liver function. Also helps in controlling blood sugar level in diabetic patients	EN
47.	*A. lethale* Griff.	Mitha	Herb	In alpine meadows	Roots	Root paste	Applied externally	Snakebites and rheumatism	CR
48.	*Actaea acuminata* Wall. ex Royle	-	Herb	On open or partly shaded moist slopes	Roots	Root powder and root decoction	Root powder is given to children orally twice a day for cough. Root decoction is given for asthma.	Asthma and Cough	NE
49.	*Anemone obtusiloba* D. Don	-	Herb	As isolated individuals in alpine meadows or on open slopes	Fruit and roots	Fruit are ground thoroughly and made into paste. Root decoction is made.	Applied externally on teeth. Decoction is given twice a day	Toothache and diarrhoea	NE
50.	*A. rivularis* Buch.-Ham. ex DC.	Daipha	Herb	In open or partly shaded places	Roots and leaves	Root and leaf paste	Applied externally on forehead twice a day	Headache, fever and wounds/cuts	NE
51.	*A. vitifolia* Buch.-Ham.	-	Herb	Along roadsides or trekking routes	Roots and leaves	Roots and leaves paste mixed with cow-urine.	Applied externally twice a day up to three weeks.	Eczema and ringworms	NE
52.	*Aquilegia pubiflora* Wall. ex Royle	-	Herb	Along roadsides or trekking routes	Whole plant	Whole plant is ground and made into watery solution.	Applied externally and also used in form of spray.	Insect repellent /killer	NE
53.	*Delphinium denudatum* Wall. ex Hook. f. & Thoms.	Nirvishi	Herb	Along roadsides or trekking routes	Roots	Root paste	Paste is applied on skin against snakebite and on teeth for relieving toothache. Leaf paste is also taken orally twice a day for one week with milk for one week relieves intestinal pain.	Toothache, relieving snakebite and intestinal pains.	CR

Table 1. Continued

No.	Taxon	Vernacular name/s	Habit	Distribution	Part/s used	Methods of preparation	Modes of administration & Dosage	Disease/ Ailments treated	Conser. status
54.	*D. vestitum* Wall ex Royle	Luna	Herb	On open or partly shaded alpine slopes	Twigs	Decoction is prepared from the flowering twigs.	Given orally.	Eye infection in cattle	NE
55.	*Ranunculus arvensis* L.	Chambul	Herb	In alpine meadows	Whole plant	Whole plant is used and paste is prepared	Applied externally	Fever, asthma, skin disease	NE
56.	*R. laetus* Wall. ex Royle	Kodkoda	Herb	Along roadsides or trekking routes	Roots	Roots are made into fine paste. Watery solution is also prepared from whole plant.	Applied externally on skin. Solution is given orally	Snakebites	NE
57.	*R. sceleratus* L	-	Herb	Along roadsides	Whole plant	Root paste	Applied externally	Act as vermifuge and cure skin disorders	NE
58.	*Thalictrum foetidum* L.	Mamiri	Herb	On open slopes and in partly shaded places	Roots	Root paste	Applied externally	Earache and eyeache	NE
59.	*T. foliolosum* DC.	Makori/ Paanglajari	Herb	On open slopes	Roots	Root paste	Applied externally	Gouts and rheumatism	VU
	Family: Rosaceae								
60.	*Cotoneaster microphyllus* Wall. ex Lindl.	Bhedda	Shrub	On rocky walls and open slopes	Fruits	Decoction is prepared in 60-120 ml of water	Given orally twice a day.	Uterine bleeding	NE
61.	*Fragaria nubicola* (Lindl. ex Hook. f.) Lacaita.	-	Herb	On open slopes and in partly shaded places	Leaves/ whole plant	Leaves are powdered and mixed with leaves of *Berberis lycium* made into paste. Whole plant decoction	Applied externally. Decoction is given twice a day.	Gastric ulcers, wounds and fever	NE
62.	*Duchesnea indica* (Andr.) Fock.	-	Herb	Along roadsides or trekking routes	Fruits	Fruits are edible and eaten raw.	Eaten empty stomach twice a day.	Diarrhoea and leucorrhoea	NE
63.	*Potentilla argyrophylla* Wall. ex Lehm.	Bhumla	Herb	On open slopes and in partly shaded places	Roots	Root paste	Paste is given with mother's milk in case of children.	Throatache and dysentery	NE
64.	*P. fulgens* Wall. ex Hook. f.	Akrada/ Vajradanti	Herb	On open places and partly shaded slopes	Roots and leaves	Roots are groundthoroughly and powder is prepared. Decoction is also prepared from roots. Leaves are made into paste.	Powder applied externally on wounds made by both men and cattle. Leaf and root decoction given twice a day for curing pyorrhoea and toothache. Root powder is taken orally for curing diseases of eyes, blood and spleen enlargement	Tiger bite, toothache, pyorrhoea	CR
65.	*P. gerardiana* Lindl. ex Lehm.	-	Herb	On open slopes and in partly shaded places	Roots	Rootpaste	Applied on wounds directly	Wounds	NE
66.	*P. nepalensis* Hook. f.	Bhumlitter	Herb	On open slopes and in partly shaded places	Roots and leaves	Root and leaf paste	Applied on wounds directly	Cuts, wounds and dog bite	NE
67.	*Prinsepia utilis* Royle	Bhaikal	Shrub	On open slopes and in partly shaded places	Roots	Root paste	Applied on wounds directly	Wounds	NE
68.	*Prunus armeniaca* L.	Chulee	Tree	Cultivated in high hills	Seeds	Seeds are ground into paste. Oil obtained from seeds is also used.	Seed paste is mixed with water is given to children to cure stomachache. Seeds oil is used as massage oil after delivery to get relief from body pain.	Stomach ache and body pains	NE
69.	*Pyrus pashia* Buch.-Ham. ex D.Don	Molu	Tree	On open slopes and in partly shaded places	Fruits	Fruits and juice	Fruits are eaten directly or taken as juice.	Eye injuries and mouth sores	NE
70.	*Rosa macrophylla* Lindl.	Jangali gulab	Shrub	On open slopes and in partly shaded places	Roots	Root decoction	Given twice a day	Bilious infections	NE
71.	*Rubus ellipticus* L.	Katradro /Kala hinsar	Shrub	On open slopes and in partly shaded places	Roots	Roots are grounded into powder.	Dried root powder is given with honey and milk to children to prevent bed-wetting.	Enuresis	NE

Table 1. Continued

No.	Taxon	Vernacular name/s	Habit	Distribution	Part/s used	Methods of preparation	Modes of administration & Dosage	Disease/ Ailments treated	Conser. status
	Rutaceae								
72.	*Skimmia laureola* Franch.	Kedarpati	Shrub	On open slopes and in partly shaded places	Leaves, roots and bark	Leaves and bark paste Leaves infusion Root decoction Bark powder	Leaf infusion and root decoction is taken for treatment of headache. Leaf paste is applied externally on affected area to relieve inflammations. Bark powder is applied externally.	Headache, general fever, rheumatism, burns and wounds	NE
73.	*Zanthoxylum acanthopodium* DC.	Timru	Shrub	In open or partly shaded places	Bark and seeds	Bark and seeds powder	Bark and seeds powder are applied directly on teeth and gums.	Toothache and tooth decay	NE
74.	*Z. armatum* DC.	-	Shrub	In open or partly shaded places	Stem and seeds	Bark and seeds powder.	Powder applied directly on teeth and also used to intoxicate fish.	Toothache and fishing	NE
	Sapindaceae								
75.	*Aesculus indica* L.	Paangar	Tree	Along roadsides and trekking routes	Fruit, seeds and bark	Fruit pasteSeed powder or paste Seed oil Bark paste	1/2 teaspoon of seed powder given with watertwice a day for 6 months for leucorrhoea. Seeds paste used for 7-14 days to remove dandruff. For arthritis seed oil is applied once a day for a month Paste applied externally on goats throat.	Throat ache, rheumatism, leucorrhoea, arthritis and sore throat in goats	NE
	Saxifragaceae								
76.	*Bergenia ciliata* (Haw.) Sternb.	Silpada	Herb	Amidst rocks, on moist walls along roadsides	Rhizome	Decoction of rhizome	Decoction is taken empty stomach in the morning.	Cough, cold, haemorrhoids, asthma, fever, diarrhoea and urinary problems	NE
77.	*B. stracheyi* (Hook. f & Thoms.) Engl.	Pashnbed	Herb	Amidst rocks, on moist walls and boulder-strewn slopes	Rhizome	Decoction of rhizome	The decoction is taken empty stomach in the morning	Urinary problems, inflammations, kidney and gall stones and internal wounds	NE
	Violaceae								
78.	*Viola betonicifolia* Sm.	Banafsha	Herb	In moist shaded places and rock shades along roadsides	Leaves and flowers	Boiled leaves and flowers Extract, decoction and paste is also prepared.	Boiled leaves and flower served with tea. Extract of whole plant is given approximately half teaspoon twice a day, early in the morning and night after meals for 14-28 days for the treatment of leucorrhoea, headache fever and regulating menstruation. Paste applied directly on cuts and wounds act as antiseptic.	Cold, cough, asthma, leucorrhoea, fever, headache, bronchial asthma and cuts and wounds	NE
79.	*V. biflora* L.	Banafsha	Herb	As isolated individuals on moist slopes and in the moist places along streams	Leaves, flowers and fruits	Leaves and flowers are boiled with tea leaves and served as tea. Fruits are ground into paste.	A misxture of boiled leaves and flower served with tea. Fruit paste is consumed with water.	Pneumonia, Intestinal pains and expulsion of phlegm	NE
80.	*V. pilosa* Blume	Banafsha	Herb	Isolated individuals on partly shaded slopes along roadsides	Leaves	Leaf paste.	Applied directly on cuts and wounds.	Cuts/wounds	NE
81.	*V. epipsiloides* A. Love & D. Love	Banafsha	Herb	Isolated individuals on partly shaded slopes	Leaves and flowers	Leaves and flowers paste.	Applied directly on cuts and wounds	Cuts/wounds	NE
	Vitaceae								
82.	*Parthenocissus semicordata* (Wall.) Planch.	Lagora	Climber	Isolated individuals in partly shaded places	Stem	The stem is cut into 7-10 cm long pieces.	A piece of stem is put near the eyes of cattle and air blown into it so that 3-4 drops go from stem in eyes. It is done twice a day until the eyes are cured.	Cataract in cattle	NE

Abbreviations: EN= Endangered**; VU**= Vulnerable**; CR**= Critically endangered**; NE**= Not evaluated. (as per IUCN red data list)

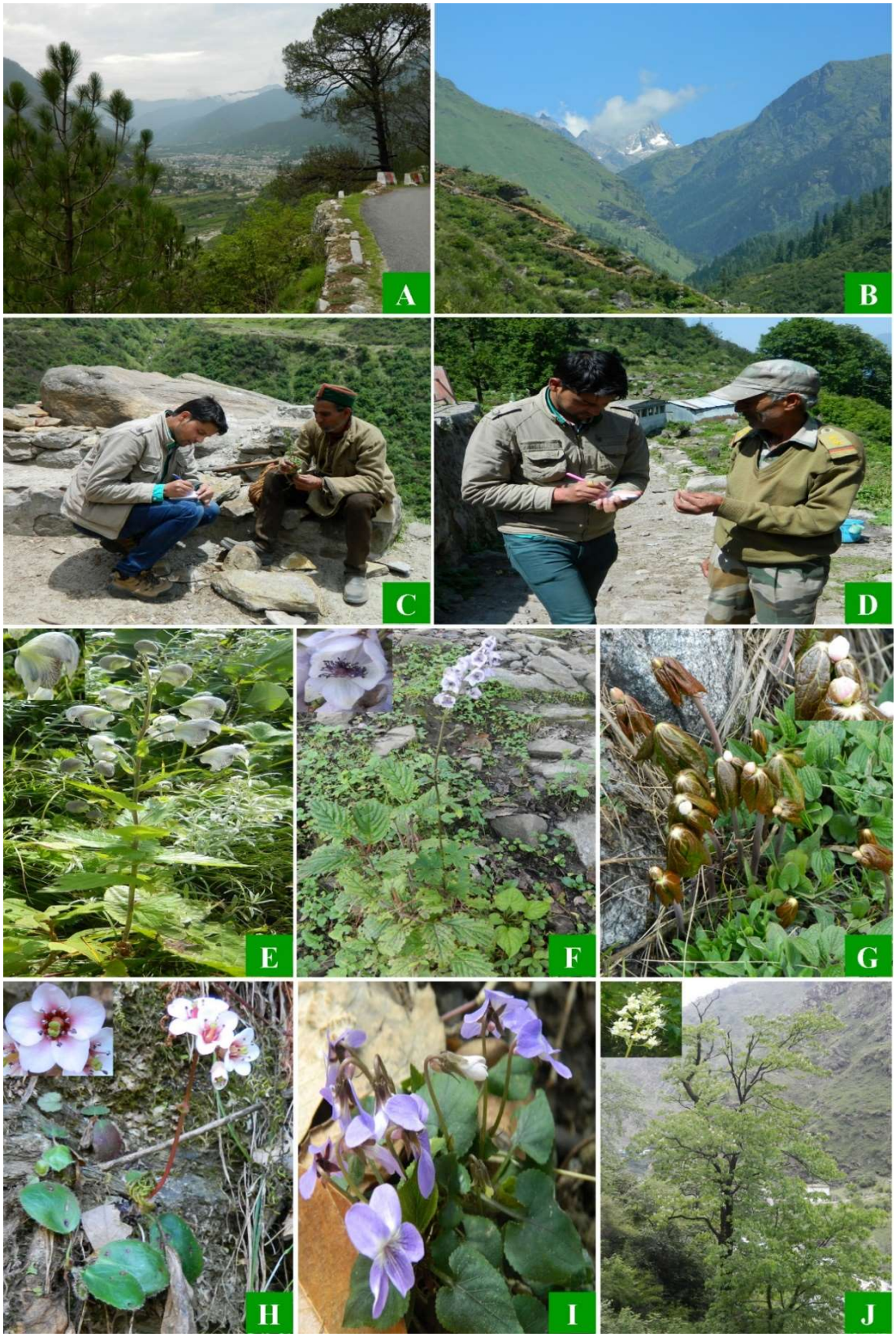

Fig. 2. Ethnobotanical data collection: **A-B**) Localities visited during ethnobotanical surveys. **C-D**) Collecting and preparing ethnobotanical information from local people. Photographs of some medicinal Plants. **E**) *Aconitum heterophyllum*. **F**) *Aconitum lethale*. **G**) *Podophyllum hexandrum*. **H**) *Bergenia ciliata*. **I**) *Viola pilosa*. **J**) *Aesculus indica*.

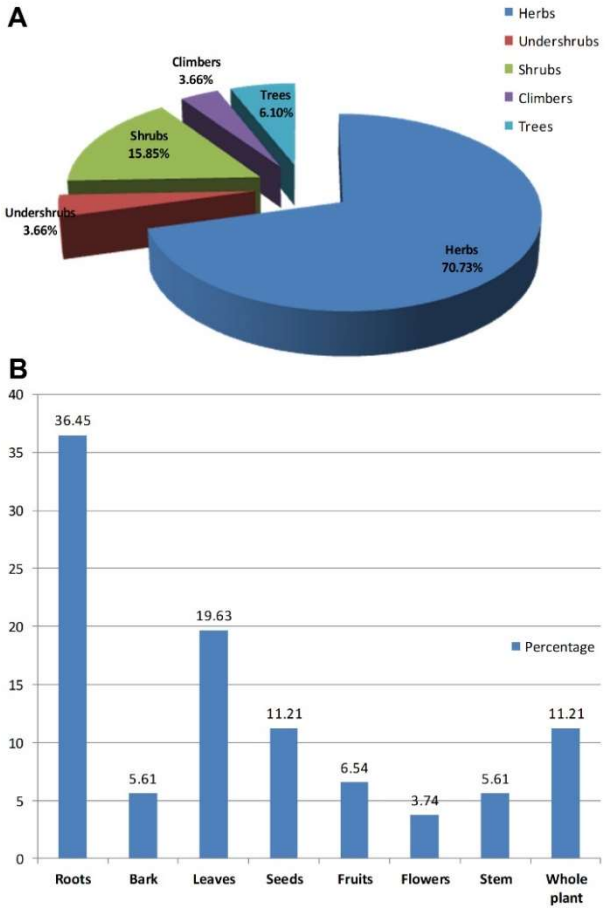

Fig. 3. **A**) Pie chart showing categories of the plant used with their percentage. **B**) Histogram showing percentage of plant parts used.

Oral mode of administration was noticed to be the favoured one. But to heal wounds/cuts, skin diseases, and inflammations and pains, formulations were applied externally on the affected body part/s. Decoctions were prepared by boiling plant parts in water for 1-3 hrs depending upon the species and part used, as bark is to be boiled for longer duration compared to leaf, stem or roots. Patients were advised to take the formulation either before or after the meals. Also, dosage amount and duration were prescribed to the patients.

People were cautioned to discontinue the drugs if they develop any drug toxicity or side effects. There are 56 species which are used for treating more than one ailment. Among 17 different ailments cured by using these herbal preparations (Fig. 4), the most commonly treated ailments are cuts/wounds/boils (20 species), followed by digestive disorders (16 species), headache and fever (13 species), skin related problems (11 species) and cough and cold (10 species). As per the observation made as the distribution pattern of analyzed medicinal herbs is concerned, *Aconitum heterophyllum, A. lethale, Angelica glauca* and *Podophyllum hexandrum* either become endangered or rare due to mass collection by the traders/locals. The situation is noticed to be more serious in cases where underground parts are of medicinal value. Furthermore, it has also been noticed that majority of these herbs (63.4%) were uprooted from their habitats irrespective of their parts used.

DISCUSSION

The present study reveals that indigenous people dwelling in remote hilly areas are the custodian of ethnic knowledge associated with wide range of utilization of plant resources of their surroundings for addressing their day- to-day health problems. It was noticed that herbs were the most commonly used in curing various ailments as has been reported in majority of the surveys carried out by different scientists from other parts of India and world (Ibrar *et al.,* 2007; Jan *et al.,* 2011; Kumar & Singhal, 2013; Ahmad *et al.,* 2014; Rana *et al.,* 2014; Talukdar & Gupta, 2014; Modak *et al.,* 2015; Kaur & Singhal, 2016; Himshikha *et al.,* 2017; Kaur *et al.,* 2017; Adhikari *et al.,* 2018). Among plant parts used, roots and leaves were the most frequently used in the preparations of different drugs. Such a high frequency of use of roots and leaves in preparing herbal preparations for treating ailments has also been reported earlier in several ethnobotanical studies (Anonymous, 2001; Nasir and Ali 2002; Mahishi *et al.,* 2005; Abo *et al.,* 2008; Cornara *et al.,* 2009; Gonzalez *et al.,* 2010; Telefo *et al.,* 2011; Kadir *et al.,* 2012; Rana *et al.,* 2014; Kaur & Singhal, 2016; Parthiban *et al.,* 2016; Adhikari *et al.,* 2018; Kaur *et al.,* 2017; Himshikha *et al.,* 2017).

The most commonly used plants for the preparation of herbal drugs of the area are *Aconitum heterophyllum, Bergenia ciliata*. *B. stracheyi, Geranium wallachianum* and *Skimmia laureola*. These plants have been used in the treatment of various ailments. Other less frequently used herbs in the area are, *Aesculus indica, Berberis aristata, Capsella bursa-pastoris*, *Corydalis govaniana, Delphinium denudatum, Geranium nepalense*, *Malva verticillata*, *Paeonia emodi, Skimmia laureola, Viola betonicifolia, V. biflora,* etc. On the other hand, *Cotoneaster microphyllus, Parochetus communis, Parthenocissus semicordata, Prinsepia utilis, Rosa macrophylla* and *Rubus ellipticus* are rather frequently used for curing limited ailments.

The most important factors that have played an important part and bringing about the medicinal plant knowledge were age and socio-economic status of the inhabitants. In this hilly area, the elders know more than younger generations as has also noticed during several earlier studies (Voeks and Leony, 2004; Srithi *et al.,* 2009; Alcenar *et al.,* 2014; Pérez-Nicolás *et al.,* 2017). This clearly reflects that young people had little interest in herbal cure and rely more on modern drugs (Srithi *et*

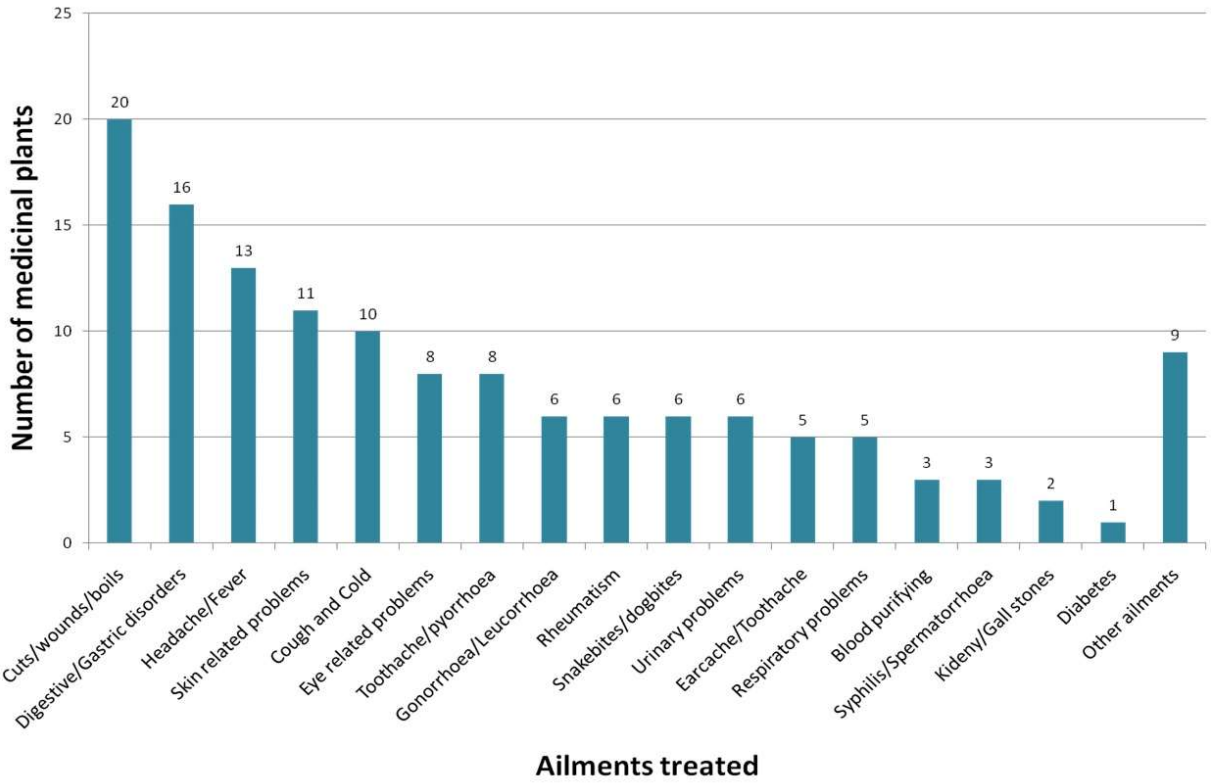

Fig. 4. Histogram showing various ailments treated by number of medicinal plants.

al., 2009; Pérez-Nicolás *et al.,* 2017). It has been realized that the ethnic people living in the remote hilly areas with poor economic status possessed a vast treasure of knowledge regarding the herbal cure but they do not disclose it to others particularly to outsiders as there is a general belief that if the information about the use of herbs is revealed/shared it will lose its healing power. As far as sex/gender is concerned, women are rarely involved in the practice of herbal drugs. Further, it a has been noticed during the surveys and interactions that majority of the women feel shy and rarely came forward for sharing any information regarding the use of local herbal drugs.

On the basis of information gathered it has been noticed that some of the medicinally important herbs e.g. *Aconitum heterophyllum, A. lethale, Angelica glauca* and *Podophyllum hexandrum* in the area are being over-exploited not by the locals but by the traders who are engaged in mass collection through employing the locals. And majority of these are left in the form of few individuals only. The problem gets aggravated in species like, *Aconitum heterophyllum*, *A. lethale, Angelica glauca, Berberis aristata, Delphinium denudatum, Geranium wallachianum, Paeonia emodi, Podophyllum hexandrum* and *Thalictrum foliolosum,* where roots/underground parts are used or collected for drug purposes. The present surveys also identify some of the medicinally important species which could not be located by the authors in spite of repeated intensive and extensive surveys and as per the local people these have become almost extinct in the area *viz*. *Aquilegia fragrans, A. nivalis, Aralia cachemirica, Astragalus strictus, Berberis petiolaris, Cotoneaster acuminatus, Dictamus albus, Eriocapitella rupicola, Meconopsis latifolia, Piptanthus nepalensis, Pleuropspermum candollei* and *Trachyspermum ammi.* Further, it has been noticed that majority of the important medicinal herbs of the area have not been listed/included in any of the conservation plans initiative by the state/central Government agencies.

Keeping these facts in mind, immediate curative steps need to be taken on priority basis to preserve this ethnic knowledge about the locally used herbal drugs. It is also suggested that we should follow the UNEP theme of World Conservation Day as "***Go Wild for Life***". It envisages you to enlist those species that are under threat and should take measures of your own to safeguard for future generations. Furthermore, restrictions must be imposed on grazing activity particularly in alpine and sub-alpine regions above 3500m. Also, the high altitudinal regions should be identified in the Uttarkashi district for the establishment of nurseries/areas for *in-situ* conservation of species which are facing the threat of immediate extinctions. To restrict the entry of tourists/pilgrims, recently Govt. of India has imposed a ban on the entry of people to the Gomukh Glacier point of origin of sacred Ganges.

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