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Diversity and uses of ethno-medicinal plants associated with traditional agroforestry systems in Kumaun Himalaya

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ABSTRACT

Uttarakhand state is bestowed with great diversity of medicinally important plants which are used frequently by the local people/inhabitants to cure various ailments in their daily life. Traditional agroforestry is a common land use pattern in Uttarakhand which supports various indigenous medicinal plants. The present study provides comprehensive information on the diversity and utilization of medicinally important plants in existing traditional agroforestry systems. The information was gathered using semi-structured questionnaires about the types of ailments treated by the traditional use of medicinal plants, preparation of herbal medicine and formulations. A total of 68 plant species belonging to 38 families and 63 different genera, were reported from agroforestry systems of this region. The families; Rosaceae, Asteraceae, and Verbenaceae were represented by more than 3 species each and dominated the floral composition while remaining 35 families were represented by single species. Different plant parts such as roots/rhizomes/bulbs, leaves, bark, fruits, seeds, flowers, stem and whole plant were used for the treatment of various diseases.

Key words: Agroforestry, Biodiversity, Ethno-botany, Indigenous knowledge; Local communities

Plants and plant based products have been used traditionally by native inhabitants in India from ancient times (Bargali *et al*. 2003). In developing countries, a large number of people depend on products derived from plants for curing human and livestock ailments. According to the World Health Organization 80% of the world's population in developing countries uses traditional medicines. Nature has been a source of medicinal treatments for thousands of years, and plant-based system continues to play an essential role in primary health care of 80% of world's population (Gupta 2001). In the beginning, these were the main source of the folk or ethnomedicine (Bargali and Shrivastava 2002). During the last few decades, there has been an increasing interest in the study of medicinal plants and their traditional use in different parts of the world (Al-Quran 2005 and Hanazaki *et al*. 2000). Himalayan region support approximately 1748 plant species of known medicinal value (Rossato *et al*. 1999). In India, since the time of Vedas, human being have been exploring plant for various uses such as fodder, food, medicine, fuel-wood, resin, timber, gums, papers, tannin, spice and beverages (Sammant *et al*. 1998, Bargali *et al*. 2003, 2004, 2009, Kittur and Bargali 2013, Kittur *et al.* 2014). In India, about 40-70% plant species of any ecosystem are in use by the human for himself and in veterinary medicine (Shanker 1996).

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In Uttarakhand state, agroforestry has a long tradition where trees are integrated with the crops and livestock production system according to agro-climatic and other prevailing conditions (Parihaar *et al*. 2015). The medicinal plants of Uttarakhand state has been reported by many workers, i.e. Sammant *et al*. (1998), Bargali *et al*. (2013) but the ethno-medicinal plants in traditional agroforestry systems and their indigenous uses has not been well explored. Therefore, the present study was conducted to explore and to make a data base for ethno-medicinal uses of plants of traditional agroforestry system.

MATERIAL AND METHODS

The Kumaun Himalaya, spread over a geographical area of 51125 km^2 (77°34'to 81°02' E longitude and 28°43 to 31°27' N latitude). The study was carried out in the agroforestry system of Nainital District in Uttarakhand, India. The study area falls in sub-tropical to temperate climate. The agroforestry systems were located at different altitudes of different blocks (Ramnagar, Kotabagh and Ramgarh). The Agroforestry system, Agrisilviculture system (29°25" to 29°39" N latitude and 78°44" to 79°07"E longitude with altitude of 345 m asl.), Agrihorticulture system (29°25" to 29°39" N latitude and 78°44" to 79°07"E longitude with altitude of 545 msl.), Silvipastoral system (29°42" to 29°44" N latitude and 79°55" to 79°56"E longitude with altitude of 2045 msl.), Agrihortisilviculture system (29°25" to 29°39" N latitude and 78°44" to 79°07"E longitude with altitude of 1488 m asl.), Mixed orchard

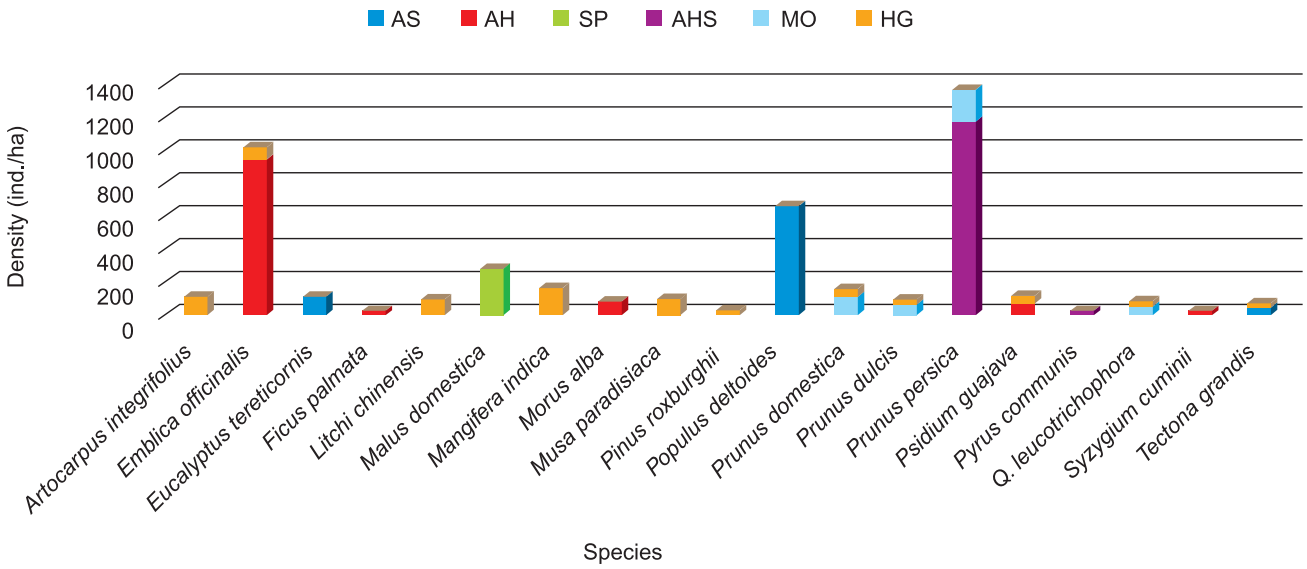

Fig 1 Density of medicinal trees in different Agroforestry system practised in Kumaun Himalaya. (AS = Agrisilviculture, AH = Agrihorticulture, SP = Silvopastoral, AHS = Agrihortisilviculture, MO = Mixed orchard, HG = Homegarden).

(29°47" to 29°60" N latitude and 78°44" to 79°07"E longitude with altitude of 1697 msl.) and Homegarden (at all locations) were located at different altitudes. Field survey have been made in different agroforestry system in 8 villages having different altitudinal ranges in Nainital district of Uttarakhand state during 2012-2013 to gather data on traditional uses of medicinal plants. The Information was collected from the 20 households for each agroforestry system in each village including old persons and farmers (50-75 year old) to know the vernacular names and their medicinal uses. The information was gathered using semi-structured questionnaires (Bargali *et al*. 2007) about the types of ailments treated by the traditional use of medicinal plants and the preparation of herbal formulation. Standard method of collection, preservation and maintenance of specimen in the herbarium were followed (Jain and Rao 1977, Singh and Subramaniyam 2008 and Chandler *et al*. 1979).

RESULTS AND DISCUSSION

Diversity of the medicinal plants

Tree species

In agrisilviculture system maximum density (660 ind./ha) was recorded for *Populas deltoides* followed by *Eucalyptus tereticornis* and *Tectona grandis*. In agrihorticulture system maximum density (950 ind./ha) was recorded for *Emblica officinalis* followed by *Morus alba, Psidium guajava, and Syzygium cuminii*. In silvopastoral system maximum density (260 ind./ha) was recorded for *Malus domestica* followed by *Quercus leucotrichophora* and *Pinus roxburghii*. In agrihortisilviculture system *Prunus*

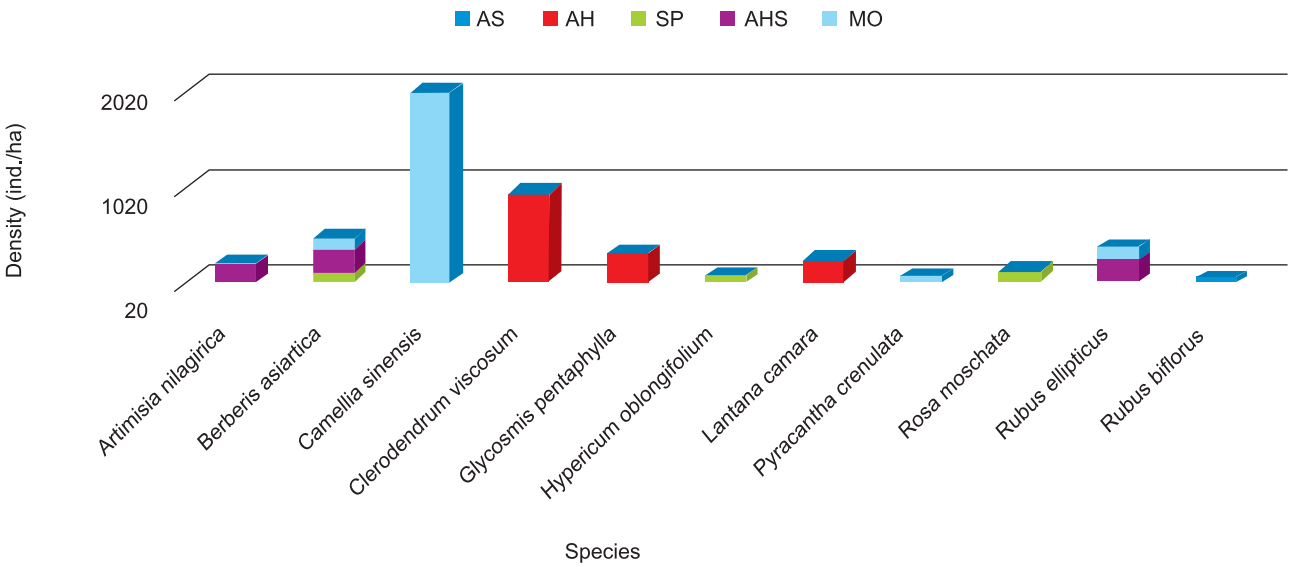

Fig 2 Density of medicinal shrubs in different Agroforestry system practised in Kumaun Himalaya. (AS = Agrisilviculture, AH = Agrihorticulture, SP = Silvopastoral, AHS = Agrihortisilviculture, MO = Mixed orchard, HG = Homegarden).

persica was the single fruit species having the density 1170 ind./ha. In mixed orchard maximum density (200 ind./ha) was recorded for *P. persica,* and followed by *M. domestica, P. dulcis* and *Q. leucotrichophora*. In homestead gardens maximum value of density (160 ind./ha), was recorded for *Mangifera indica,* followed by *Artocarpus integrifolia, Litchi chinensis and Musa paradisiaca* (Fig 1).

Shrub species

In agrisilviculture system shrub layer was absent. In agrihorticulture system maximum density (950 ind./ha) was recorded for *Clerodendrum viscosum* followed by *Glycosmis pentaphylla* and *Lantana camara*. In silvopastoral system maximum density (120 ind./ha) was recorded for *Rosa moschata* followed by *Berberis asiatica* and *Hypericum oblongifolium*. In agrihortisilviculture system maximum density (260 ind./ha) was recorded for *B. asiatica* followed by *Artemisia nilagirica* and *Rubus ellipticus*. In mixed orchard maximum value of density (2010 ind./ha), was recorded for *Camellia sinensis* and followed by *B. asiatica* and *R. ellipticus* (Fig 2).

Herbs species

In agrisilviculture system only one herb *Commelina benghalensis* (density, 6.6 ind./m^2) was recorded. In agrihorticulture system maximum density (28.3 ind./m^2) was recorded for *Ageratum conyzoides* followed by *Bidens pilosa, Campanula wallichii* and *Cynodon dactylon*. In silvopastoral system maximum density (25.2 ind./m^2) was recorded for *Trifolium repens* followed by *Galinsoga parviflora* and *Cyperus rotundus*. In agrihortisilviculture system *Eupatorium perfoliatum* was the dominant species having the highest density (35 ind./m^2) followed by *G. parviflora* and *Oxalis corniculata*. In mixed orchard maximum value of density (33.2 ind./m^2) was recorded for *Drymaria cordata,* followed by *T. repens,* and *Geranium nepalense*. In homestead gardens maximum value of density (21.6 ind./m^2) was recorded for *Eleusine indica* and followed by *Allium sativum, Campanula wallichii* and *Galium aparine* (Table 1).

In agroforestry system, herbs represent the maximum number of plant (36; 52.94%) of ethno-medicinal uses followed by trees (19; 27.94%), shrubs (11; 16.17%) and climbers (2; 2.94%), respectively (Fig 3). Over all herbs/ shrubs showed the maximum number/percent contribution

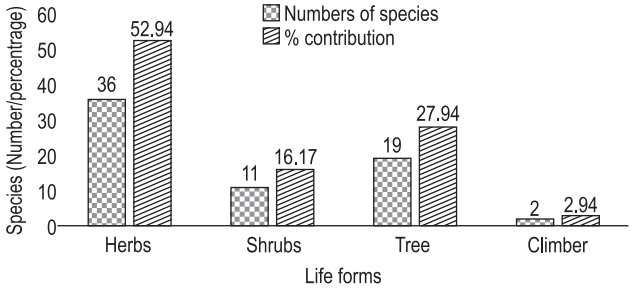

Fig 3 Distribution of ethno-medicinal plants in herbs, shrub, tree and climber.

Table 1 Density of medicinal herbs in different Agroforestry system practised in Kumaun Himalaya.

Species	Agroforestry system shrubs density individual/m^2					
	AS	AH	SP	AHS	MO	HG
Herbs						
Achyranthes aspera L.		9.7	0.2	0.4	2.6	6.8
Ageratum conyzoides L.		28.3		2.8	2.8	8.9
Allium sativum L.		0.4			0.4	18.6
Bidens pilosa L.		26.5		1.9	1.9	3.5
Bidens biternata(Lour.) Merr. &Sherff.		8.1	1.6		1.3	7.8
Biophyton sp.			4.3			9.2
Brassica campestris L.		6.5	0.4		0.5	7.8
Capsicum annuum L.					3.2	6.8
Campanula wallichii Wall.		24.3	1.2			12.1
Commelina benghalensis L.	6.1	9.8		3.7	6.5	9.6
Curcuma longa L.		1.7				3.2
Cynodon dactylon (L.) Pers.		15.5	4.7		0.6	5.8
Cyperus rotundus L.		12.8	21.5	2.6	1.1	7.8
Drymaria cordata (L) Willd. ExR.S.				5.0	33.2	9.8
Eleusine indica (L.) Gaertn.			0.2	6.3	21.6	
E. perfolifatum L.			40	35		
Euphorbia hirta L.		4.6				5.6
Flemingia fruticulosa Wall. Ex Benth.				4.7		5.9
Galinsoga parviflora Cav.			25.2	30.2		3.5
Galium aparine L.			03		0.7	12.1
Geranium nepalense Boiss.			5.6		9.7	6.5
Glycine max (L.) Merr.		0.3		2.3	1.2	
Hibiscus esculentus L.					0.1	6.5
Hedera nepalensis K.Koch			0.-6			3.4
Justicia simplex L.				0.2		6.4
Lepidium ruderale L.				2.8		3.6
Mimosa pudica L.		4.8				9.4
Oxalis corniculata L.		13.1		11.1		2.4
Phaseolus vulgaris L.			0.3	7.1	0.2	
Polygonum nepalense Meissn.				1.6	6.1	3.8
Prunella vulgaris L.			1.1			6.4
Raphanus sativus L.			0.7			5.9
Salvia lanata Roxb.			0.2			3.6
Solanum nigrum L.					01	6.7
Tagetes erecta L.				0.1		2.9
Trifolium repens L.			31.1	3.5	21.6	1.7
Climber						
Ipomoea purpurea (L) Roth.		2.2	0.1			2.4
Melothria heterophylla Lour.			0.3	0.1		7.8

and diversity in medicinally used plants. The aroma and medicinal importance of herbs/shrubs is largely due to the secondary metabolites, which at times suppress the growth of plants in their vicinity (Mathela 1994). The species of family Rosaceae, Asteraceae, and Brassicaceae showed the dominant representation while remaining others were represented by single species (Fig 4). In all the studied

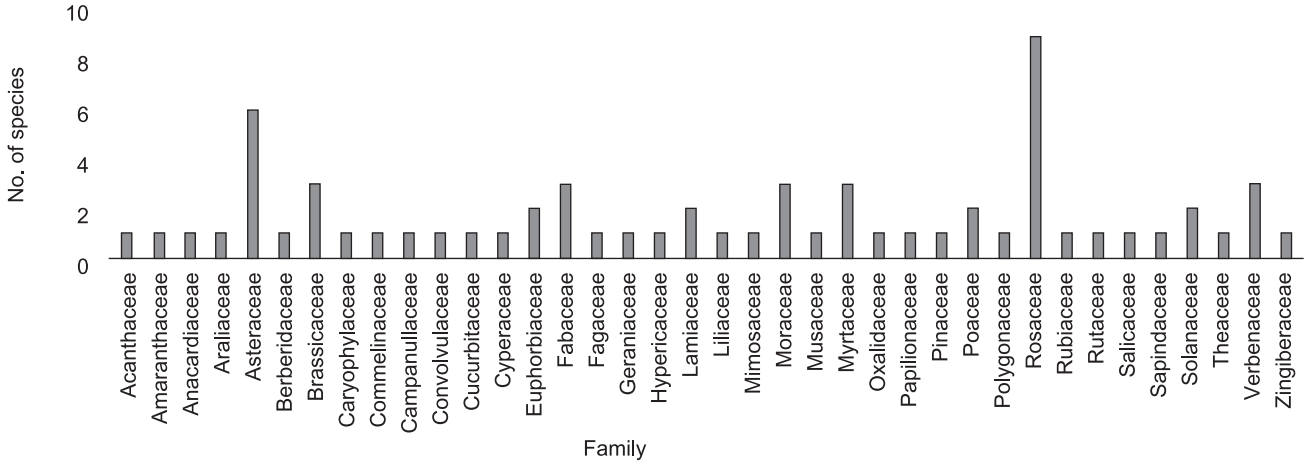

Fig 4 Distribution of ethno-medicinal plants in different families.

agroforestry systems the information was collected on 68 plant species of 63 genera belonging to 38 families. Out of these 38 families, 32 families belong to dicot and 6 to monocot. Rosaceae was the dominant family with 9 species followed by Asteraceae with 6 species, Brassicaceae, Fabaceae, Moraceae, Myrtaceae and Verbenaceae with 3 species each. Lamiaceae, Euphorbiaceae, Poaceae and Solanaceae represented by 2 species each and the remaining 27 families have single species.

Descriptions of plant parts used

Bark was the most widely used plant part (42%) of the reported medicinal plants, followed by flower and rhizome (16%). Some other parts such as roots, seeds, bulbs, fruits and leaves are also used which account for 26.7% (Fig 5). Of various plant parts, whole plant, leaves and fruits are most frequently used (42%, 16% and 16%). The present study discloses an interesting result, that most of the older people or head of the family member has more information of the medicinal plant compared to the young generation, because the young one are more attached to the market goods or western medicine.

A majority of the medicines are prepared in the form of the crude extract from freshly collected plant parts of single species or mixing with other supplement to cure various infirmities. In the present work, the medicinal plants are used to cure different infirmities like anaemia, arthritis, asthma, bronchitis, cough, diabetes, diarrhoea, dysentery, eczema, jaundice, leprosy, piles, skin disease, vomiting and ulcer. About 10 species are used to cure asthma and 8 species are used to cure diarrhoea (Table 2). Chandel *et al*. (1996) described various plant species from different parts of our country and their uses in treatment of various ailments. Kapoor and Mitra (1979) estimated that about 540 plant species are in uses of different formulations in India. Medical science has shown tremendous progress in recent years, but the local people of this area, especially those in remote localities are still dependent upon natural resources available around them for the treatment of ailments. These local people have accumulated a rich knowledge on the use of

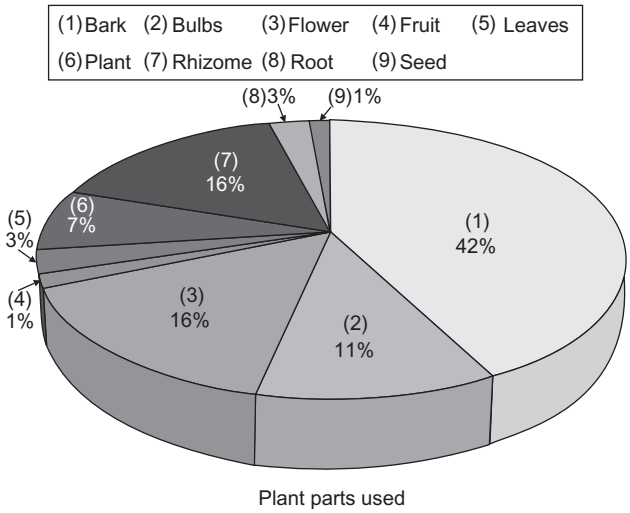

Fig 5 Plants parts used as medicine.

various plants for treatment of various diseases. However the younger generations under the influence of rapid socioeconomic growth has developed tendency to over exploit the economically important species (Bargali *et al*. 2003). Unless this trend is changed and the conservation values of the native flora is recognized, there is a little hope for survival of valuable species and integrity of ecosystem. Present article provides knowledge on the medicinal use of plants supported by different traditional agroforestry systems and are arranged in alphabetical order in Table 2. This study highlights that in the absence of modern healthcare or harmful effect of the western drug, people are dependent on medicinal plants for curing diseases.

We conclude that the importance of the traditional/folk methods of medicines has been realized world-wide. A large number of traditional crops grown in agroforestry systems are valuable for local inhabitants. The structure of traditional agroforestry system and the farming practices allowed a considerable number and variety of useful plants actively by cultivation or passively by encouragement of local farmers through trainings and demonstrations. Many

Table 2 List of important ethno-medicinal plants in agroforestry systems of Kumaun Himalaya.

Botanical name	Local name	Family	Used part	Medicinal value
Trees				
Artocarpus integrifolius L.	Kathal	Moraceae	Plant	Leaf paste is used in skin disease, wounds. Ripe fruit is used in leprosy, ulcer and enrich the blood.
Emblica officinalis Gaertn.	Amla	Euphorbiaceae	fruit	Fruit is used in piles, anaemia, heart disease, vomiting and as a source vitamin C.
Eucalyptus tereticornis Sm.	Lyptus	Myrtaceae	Plant	Leaf oil is used as antiseptic, astringent, skin disease and also used as mosquito repellent, asthma, bronchitis.
Ficus palmata Forsk.	Beru	Moraceae	Fruit	Fruit is used as a diet in lungs and bladder disease. Latex is used as antiseptic.
Litchi chinensis Lam.	Litchi	Sapindaceae	Plant	Unripe fruit is given to children in small pox. Root, bark and flower decoction is used for gargle in throat affections.
Malus domestica Brokh.	Apple	Rosaceae	Fruit	Fruit is used to increase immunity system.
Mangifera indica L.	Aam	Anacardiaceae	Plant	Root and bark is used in vomiting, diarrhoea, dysentery. Leaves are used in piles and smoke is used in Cough.
Morus alba L.	Sahatut	Moraceae	Fruit, bark	Fruit is used in fever, small pox, diarrhoea and throat infection. Root is used as tonic.
Musa paradisiaca L.	Kela	Musaceae	Plant	Effective in gastric, ulcer, burning rectum, diarrhoea and increase immunity system.
Pinus roxburghii Sarg.	Chir	Pinaceae	Plant	Plant is used in eye, ear, throat, blood, bronchitis disease and resin in scorpion bite.
Populus deltoides Barter marsh	Poplar	Salicaceae	Bark	Bark decoction is used as a blood purifier and in fracture of bone.
Prunus domestica L.	Plum	Rosaceae	Fruit	The mature fruit is used to increase eyesight, immunity and to prevent asthma and arthritis.
Prunus dulcis L.	khumani	Rosaceae	Fruit, leaves	The ripe fruit is used in the treatment of indigestion, anemic patients, and asthma. The fresh leaf is used in skin disease eczema, itching or sunburn.
Prunus persica L.	Aru	Rosaceae	Leaves, fruit	The leaf is used to kill the germs in the wound of animals and ripe fruit as a vitamin tonic to the brain, enriches the blood, and immune system.
Psidium guajava L.	Amrud	Myrtaceae	Fruit, leaves	Fresh leaves or paste is used in diabetes, toothache, wound, and ulcer. Fruit is used in epilepsy.
Pyrus communis L.	Naspati	Rosaceae	Fruit	Fruit is used in jaundice.
Quercus leucotrichophora A. Camus	Banj	Fagaceae	Seed	Seed powder is used in diarrhoea and asthma.
Syzygium cumini (L.) Skeel	Jamun	Myrtaceae	Fruit seed	Ripe fruit or seed are used in diabetes. Leave juice is used in dysentery.
Tectona grandis L.	Sagwan	Verbenaceae	Plant	Bark decoction is used in dysentery, diabetes, burning sensation, skin diseases. Wood is used in cough, piles, arthritis.
Shrubs				
Artemisia nilagirica (Cl) Pamp.	Pati	Asteraceae	Leaves	The leaf paste is used in blood coagulation, inflammation, and in skin disease. Leaf juice is used in asthma, bronchitis, and anaemia.
Berberis asiatica Roxb.	Kilmori	Berberidaceae	Roots	Roots are used in ulcer, stomach-ache, toothache, asthma and earache.
Camellia sinensis (L.) Kuntze.	Chai	Theaceae	Leaves	The leaf extract with hot water is used to decrease the stress and cure piles.
Clerodendrum viscosum (Vent.) Jard.	Bhant	Verbenaceae	Plant	Leaves are used in leprosy, skin disease, ulcer, cough and malaria fever.
Glycosmis pentaphylla Correa.	Putva	Rutaceae	Root	Roots are used in fever, eczema, diarrhoea and in jaundice.
Hypericum oblongifolium Choisy.	Pyoli	Hypericaceae	Flower	Flowers are used in healing wounds and boils.
Lantana camara L.	Kuri	Verbenaceae	Plant	Leaves are used in healing wounds, cuts, ulcer and eczema.

Contd.

Table 2 *(Continued)*

Botanical name	Local name	Family	Used part	Medicinal value
Pyracantha crenulata (D.Don.) M. Reom.	Ghingharu	Rosaceae	Fruit	Fruit juice is used in earache problem.
Rosa moschata Herrm.	Jangaligulab	Rosaceae	Plant	Plants are used in diarrhoea, eye disease and asthma.
Rubus ellipticus Sm.	Hisalu	Rosaceae	Plant	Plant is used in diarrhoea, cough, fever and dysentery.
Rubus biflorus Buch. Ham. Ex Sm.	Hisalujangali	Rosaceae	roots	Roots are used in diarrhoea.
Herbs				
Achyranthes aspera	Chirchita	Amaranth-aceae	Plant	Plant is used in cough, boils, skin problem, ulcer and dysentery.
Ageratum conyzoides	Gamulva	Asteraceae	Leaves	The leaf juice is used in the coagulation of blood, healing wounds and diarrhoea.
Allium sativum	Lahasun	Liliaceae	Bulbs	Bulb's extract is used in arthritis, joints pain and in cold to increase the immunity.
Bidens biternata	Kumaar	Asteraceae	Leaves, roots	Leaves are used to coagulate the blood and healing the wounds and cuts.
Bidens pilosa	Kumaar	Asteraceae	Plant	The plant is used in cough, leprosy, skin disease, stop bleeding and diarrhoea.
Biophyton sp.	Putki	Euphorbea-ceae	Plant	The plant paste is used as antiseptic and healing wounds.
Brassica campestris	Sarsoo	Brassicaceae	Seed	Seed oil is used in earaches, dandruff, stomach-aches and in skin disease.
Capsicum annuum	Mirch	Solanaceae	Fruit	The fruit is used to release in mystical activities.
Campanula wallichii	Tootipat	Campanul-aceae	Plant	Plant extract is used in healing wounds or cuts.
Commelina benghalensis	Pitli ghass	Commeli-naceae	Plant	The plant is used in fever, diarrhoea, leprosy, or in dysentery.
Curcuma longa	Haldi	Zingiberaceae	Rhizome	The root powder is used in internal wounds, skin disease, as painkiller and as antiseptic.
Cynodon dactylon	Doov	Poaceae	Plant	The leaf juice is used to stop nasal bleeding, anaemia and in dysentery.
Cyperus rotundus	Muthia	Cyperaceae	Roots	Root tubers are used as carminative,
Drymaria cordata	Pitli	Caryophyll-aceae	Plant	Plant is used in skin disease, headache, burns, wound and for cooling properties.
E. perfoliferum	Kala basa	Asteraceae	Leaves	Leaf juice is used in coagulating blood and wounds.
Eleusine indica	Jharua	Poaceae	Plant	Plants are used in the stomach problem and retention of urine.
Euphorbia hirta	Dhudhia	Euphorbiaceae	Plant	Plant is used in worms, cough, ulcer, cuts and latex is used in dysentery or asthma.
Flemingia fruticulosa	Atisar	Fabaceae	Root	The plant roots are used in the menstrual disorder.
Galinsoga parviflora	Khusari	Asteraceae	Plants	Plants are used in skin disease, earache, wound and in the scorpion bite.
Galium aparine	Kura	Rubiaceae	Plant	Plant paste is used in eczema, swelling, kidney stone and irritation.
Geranium nepalense	Bhand	Geraniaceae	Plant	Plant's leaves are used in jaundice, ulcer, fever, itching, and eczema or in toothache.
Glycine max	Soyabean	Fabaceae	Seed	Seed oil or seed are used to increase the immunity system.
Hibiscus esculentus	Bhindi	Malvaceae	Fruit	The unripe fruit is used in preventing anaemia, diabetes, hair problems or in weight loss diet programs.
Hedera nepalensis	Arambal	Araliaceae	Leaves	The leaf extract are stimulant and externally used in sores, ulcer, and inflammations.
Justicia simplex	Vasa	Acanthaceae	Plant	Plants are used in fever, asthma, queasiness and in jaundice.
Lepidium ruderale	Halim	Brassicaceae	Seed	Seed paste is used in the treatment of external abrasions.
Mimosa pudica	Chhui-mui	Mimosaceae	Root	Root or root paste is used in the treatment of jaundice or cough (2 month baby), leprosy and abdominal warms.
Oxalis corniculata	Khattimitthi	Oxalidaceae	Plant	The plants used in skin infection, diarrhoea, anaemia, loads or in dysentery.
Phaseolus vulgaris	Chimmi	Papilioneaceae	Leaves	The leaf paste mix with juggary and applied on the disk worms.
Polygonum nepalense	Ratnala	Polygonaceae	Leaves	Leaf paste is used in the swelling.

Contd.

Table 2 *(Continued)*

Botanical name	Local name	Family	Used part	Medicinal value
Prunella vulgaris	Phulari	Lamiaceae	Plant	Fresh leaves are used in the jaundice, piles, boils, skin irritation, headaches or in hypertension.
Raphanus sativus	Muli	Brassicaceae	Root	The fresh root is used as a salad in gastric, jaundice and in diabetes.
Salvia lanata	Paniya	Lamiaceae	Plant	Plants are used in loose motion, simmers, itching, worms and wounds.
Solanum nigrum	Makoi	Solanaceae	Plant	Decoction of leaves is used in rabies, liver and skin diseases. Fruits are used to treat eye diseases, dysentery and fever.
Tagetes erecta	Hazari	Asteraceae	Flower	Flower is astringent, carminative and used in blood purifier, disease of eye, piles, kidney problem, scorpion poison and earache.
Trifolium repens Climber	Satphal	Fabaceae	Leaves	Leaves are used as astringent and as ointment in gout.
Ipomoea purpurea	Neikalmi	Convolvulaceae	Plant	The plant is anti syphilitic and emetic.
Melothria heterophylla	Madkakri	Cucurbitaceae	Plant	Plant juice is used in hiccough, asthma, nausea, incisions, fever or in bronchitis.

of these plants used by the local inhabitants are unconventional and not known by the people outside. Therefore, there is an urgent need to retain the indigenous knowledge related to management and utilization of plants to cure various diseases/ailments.

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