

## Plants used in healthcare practices by *Limboo* tribe in South –West of Khangchendzonga Biosphere Reserve, Sikkim, India

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The study aimed in exploring indigenous knowledge of *Limboo* tribe on plant use practices for local healthcare in Khangchendzonga Biosphere Reserve, Sikkim. Use of 124 ethnomedicinal plants to cure 77 ailments, grouped into 13 broad categories, was recorded. Maximum number of species (31) was used to cure stomach related problems. Oral administration (71.77%) was the common practice. *Artemisia vulgaris* and *Swertia chirayita* (1.00 each) recorded the highest use value. Cut and wound problems recorded the highest Informant Consensus Factor (0.91). Paper also discussed the conservation aspects.

**Keywords:** Indigenous knowledge, Informant Consensus Factor, Khangchendzonga Biosphere Reserve, *Limboo* tribe, Sikkim

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Traditional medicine or ethnomedicine is a healthcare practice that has been transmitted orally from generation to generation through traditional healers and *shamans* with an aim to cure different ailments, and is strongly associated to religious beliefs and practices of the indigenous people<sup>1,2</sup>. However, with the modernization, especially globalization in recent years, many cultures that possess a wealth of knowledge on the utilization of plants are vanishing<sup>2,3</sup>. Indigenous knowledge of medicinal plants and their use by the community people are not only useful for the conservation of cultural traditions and biodiversity, but also for the community healthcare and drug development in present and in the future<sup>4</sup>.

Documenting the plants and their ethnobiological values is essential to evaluate human plant relationships and in understanding the regional human ecology relations to their environment<sup>2,5</sup>. Documenting indigenous knowledge is equally significant for the conservation and utilization of biological resources<sup>2</sup> and that may have impacts from a bioeconomic point of view<sup>6</sup>. Since, the Himalayan region has been experiencing tremendous decline in the indigenous knowledge on plant use in local healthcare, it is high time that we documents this traditional wisdom before such knowledge disappears

for ever<sup>2,7</sup>. This will not only help in preserving our ethnoculture but at the same time strengthening conservation strategies of those useful species.

This study has therefore targeted an indigenous tribe of Sikkim, i.e. *Limboo* tribe inhabiting the transition zone in South-western part of Khangchendzonga Biosphere Reserve (KBR), Sikkim. The major objectives of this study include, (i) valid documentation of the plants used in folk medicinal practices by the *Limboo* tribe in KBR; (ii) comprehensive accounting of the use parts, use pattern, nature of drug preparation, ailments cured, and other ethnocultural knowledge on the plant use among *Limboos* as folk medicine; (iii) determining the relative importance of the species surveyed; and (iv) calculating the informant consensus factor (ICF) in relation to use of medicinal plants. As per published literature, so far, no systematic studies targeting ethnomedicinal practice by the specific tribal community has been made in Sikkim, except by us on *Lepcha* tribe<sup>2</sup>.

### Methodology

#### Territory and the people

Khangchendzonga Biosphere Reserve (KBR) covering 41.31% of the total geographical area of the state of Sikkim, India was established in the year 2000. The Yuksam area (comprising of over 12 villages),

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falling in the transition zone of KBR, is situated at an altitude of 1780 m asl and lies along 27°22'32" N (Lat) and 88°13'29" E (Long), known as the gateway to the Khangchendzonga National Park. The 'Yuksam' bears the historical significance which dates back to some 350 yrs. It was the first capital of Sikkim kingdom, until official merger of Sikkim as 22<sup>nd</sup> state to the Indian Union on 16<sup>th</sup> May 1975. In recent times, Yuksam has emerged as the base trekking point for the famous 'Dzongri – Goeche La trek' in KNP. Yuksam is mainly inhabited by Nepali, Bhutia and Limboo communities. The ethnomedicinal plant survey was conducted in *Limboo* dominated villages in Yuksam area, viz. Khyongtey, Mangsaboong, Mangtaboong, Topsing and Intang.

The *Limboo* or *Tshong* or *Subba* people are indigenous to hill or mountain regions. They have their own script "*Shrijunga Script*", language "*Limbu Kura*" and religion "*Yuma Samyo*" or *Yamaism*". *Limboo* community people have been living a simple and primitive life; they collect wild edibles, medicinal plants, and other nature based bio-resources. Being non-vegetarian, they mostly relish pork. The *Limboos* are very laborious; they practice mixed farming and rearing Goat, Cow, Sheep, Pig and Poultry form the important source of income to them. In Yuksam area, *Limboo* youngsters make huge income by working part time as guides and porters for the tourists and trekkers. With the passage of time, they have emerged as strong competitor to other communities and are holding high administrative and other posts in the state Government as well as in national and international level.

### Data collection

Prior to field survey in the targeted villages in study area, available literatures were extensively reviewed including internet search to form a baseline. Checklist was prepared on ethnomedicinal plants available in the area for cross checking with the information obtained from the respondents. Information was obtained through, (i) random selection of informants (30 respondents in each village) during general conversation by keeping gender diversity, and (ii) informal interviews (semi-structure techniques) and small group discussion<sup>2</sup> with the community people born or having lived most of their lives in the region. Since, the people are well versed in both *Nepali* and *Hindi*, either languages helped to conduct general conversation and personal interviews. During field survey, *Limboo* people were

asked questions related to the use of plants with healthcare purpose. The study focused on folk medical knowledge of local plant based remedies which included the details of collection, ethnomedicinal notes on plants being used by them such as plant parts in use, mode of preparation, mode of administration and ailments cured. Direct questionnaire based formal survey was avoided which could otherwise have negative effect on their enthusiasm and confidence in conversation, as experienced in earlier studies in Dzongu valley<sup>2</sup>. Creating congenial atmosphere and friendly talks helped getting useful information. Special care was taken in collecting information to avoid any unauthentic details. Data were later cross-checked.

Field observations on the enlisted species in surrounding habitats (in wilderness) and semi-natural and agricultural landscapes in and around the villages were made during the survey as well as during several treks performed along altitudinal transect in KBR (1700 – 4500 m asl). Help of the elderly people in villages were taken in recognizing the ethnomedicinal plants used by them in the surrounding areas. Other local folks cooperated in recognizing the plants along higher altitudes, as they were hired as guides and porters during the field trekking. All the respondents belonged to age group between 20 and 80 yrs. Of the total 150 respondents, 30% were female and 70% were male. The men were mostly farmers who had acquired a broad knowledge on medicinal plants from their ancestors and through personal experiences in the wild, while the women were housewives who had acquired such knowledge by way of experimentations with their children, other family members, relatives and community members. The species were identified on the basis of our previous experiences and by consulting standard floras<sup>8,9</sup>. In order to establish originality of the present research, the recorded data were cross-checked with specific literatures<sup>2,10-13</sup>.

### Data analysis

To determine the use variability and importance of the medicinal plants in terms of local use, the first step employed was the calculation of the informant consensus factor (ICF) following Heinrich *et al.*<sup>14</sup>. This factor indicates the differences and similarities in opinion amongst the people in the use of particular medicinal plant species in treating the illness in different categories. The value of this factor ranges from 0 to 1. The value nearing 0 indicates either, the

plants are chosen randomly or the informants do not exchange information about their use; value near to 1 indicates the existence of either a well defined selection criterion in the community or the information is exchanged between informants. Thus, ICF was calculated using the formula  $ICF = (n_{ur} - n_i)/(n_{ur} - 1)$ ; where ' $n_{ur}$ ' indicates number of use citations in each category, ' $n_i$ ' indicates number of species used. The use value (UV), which demonstrates the relative importance or the popularity of a species amongst the informants in treating single or multiple illness, was calculated following Philips *et al.*<sup>15</sup> as:  $UV = \sum U/n$ ; where 'U' indicates number of citations per species, and 'n' indicates number of informants.

## Results

The study explored 124 ethnomedicinal plant species belonging to 68 families and 114 genera used by Limboo tribe for medicinal and general healthcare purposes (Table 1). Except a few, which need extra time and cost for collection, the majority of these ethnomedicinal plants are well known and have widespread distribution in the area; and some (*Allium cepa*, *A. sativum*, *Brassica campestris*, *Heracleum wallichii*, etc.) are cultivated in their home gardens. In terms of collection area, 64.52% of the medicinal plant species used was found to be collected from their farmlands, while 35.48% species collected from the forest. Further, in terms of species collected from the farmland, it was observed that 46.25% of the species used are cultivated one; while, native or weed species composed the non-cultivated category comprises 53.75% of the species use. Of 68 families, the predominating ones in terms of the species use were Asteraceae (8 spp.), Zingiberaceae and Rutaceae (6 spp. each) and Liliaceae (5 spp.). In terms of number of genera used, the predominant families included Asteraceae (8 genera) and Zingiberaceae (5 genera). The number of species and number of genera used as medicine by the Limboo tribe (Fig. 1A) was significantly correlated ( $r = 0.92$ ;  $p < 0.001$ ). As per habits, herbs (47.58%) were the most used ethnomedicinal species followed by the trees (32.26%), shrubs (10.48%) and climbers (9.68%).

The recorded 124 medicinal plant species are used to cure 77 ailments, which were grouped into 13 broad categories (Table 2). On individual disease category basis, the maximum number of species (31 species) was used in curing stomach related

problems, followed by the cough and cold (23 species) and boil and skin related problems (20 species) (Table 2).

The roots, rhizomes and bulbs combined were the most used plant parts (30.65% species; Fig. 1B). Study recorded the destructive harvesting of whole plant from 4.84% of the total species. The other plant parts in greater use were leaves (28.23%), fruit/fruit skin (20.97%), seeds (14.52%), stem/bark (13.71%), etc. (Fig. 1B). Cumulatively, the use of aboveground plant part was much higher (96.77% species) than the below ground part (35.48% species). The study recorded six categories of the use form of plant species, viz. fresh plant parts (52.42%), juice (24.19%), paste (23.39%), dry plant parts (17.74%), decoction (16.13%), and powder (5.65% species). It was also observed that the different parts of a single species were used to cure different diseases or different plants parts mixed to cure a single ailment (Table 1). At species level, the most common use practice was the oral administration (71.77% species) followed by the external application (37.9%), nasal (5.65%), eye (2.42%) and the ear (0.81%).

The knowledge on the use of ethnomedicinal plants varied amongst respondents. Interestingly, 100% respondents reported the local use of *Swertia chirayita* (Fig. 2) and *Artemisia vulgaris*; both species recorded the highest use value, i.e. 1.00 each; however, either species are used to treat different diseases (Table 1). For example, *A. vulgaris* is used to treat nose bleeding, mouth ulcer and skin allergy; while, *S. chirayita* is used to cure fever, cough, cold, stomach pain, gastritis, throat pain, diarrhoea, dysentery, headache, backache, diabetes, etc. *Eupatorium adenophorum* had the second highest use value (0.99), with 96.7% respondents' conformity. Its major use have been found in curing cuts and wounds, as the juice stops bleeding instantly and also serves as antiseptic agent. Some of the respondents also reported its efficacy in reducing swelling in mumps. Species wise contribution to ethnomedicine was highest for the *S. chirayita* and *S. paniculata* (10 ailments each), followed by *Plantago eroasa* (9 ailments), *Acorus calamus*, *Hydrocotyle asiatica*, *Picrorhiza kurrooa*, *Z. acanthopodium* and *Z. alatum* (8 ailments each), *B. ciliata* (7 ailments), *Rubia cordifolia* and *Rumex nepalensis* (6 ailments each), *Aconitum spicatum* (5 ailments), and *A. ferox* (4 ailments), etc.

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India

Botanical name	Family	Common name	Ethnic uses	Use value	Collection locality	Status
<i>Abies densa</i> Griff.	Pinaceae	<i>Gobre salla</i>	Leaf extract used in curing asthma, bronchitis and stomach pain	0.05	Forest	W
<i>Abrus precatorius</i> Linn.	Leguminosae	<i>Lalgeri</i>	Fruit is chewed or fresh root juice is administered orally during throat pain	0.07	Farmland	NC
<i>Acacia pennata</i> (Linn.) Willd.	Leguminosae	<i>Arare</i>	Leaf chewed with sugar and cumin during bleeding gums; leaf juice administered orally in indigestion in infants	0.05	Farmland	NC
<i>Aconitum ferox</i> Wall. ex Seringe	Rununculaceae	<i>Kalo Bikh</i>	After proper curing, the dried rhizome chewed during food poison, diarrhea, cough, cold	0.58	Forest	W
<i>Aconitum spicatum</i> Stapf.	Rununculaceae	<i>Nilo Bikh</i>	After proper curing, the dried rhizome chewed during food poison, diarrhea, cough, cold. Leaf paste applied on forehead during high fever and headache	0.35	Forest	W
<i>Acorus calamus</i> Linn.	Araceae	<i>Bonjo</i>	Small dried rhizome chewed to treat cough and cold, toothache, headache and throat pain. Also used as pesticide. The extract is taken to cure measles. Paste prepared from rhizome applied in skin diseases in humans as well as dogs. Powdered rhizome administered orally to expel intestinal worms in children.	0.90	Farmland	NC
<i>Aegle marmelos</i> Correa ex. Roxb.	Rutaceae	<i>Bel</i>	Fresh root chewed during diarrhea and dysentery; fruits eaten in constipation; fruit paste administered orally during stomach ache	0.08	Farmland	C
<i>Ageratum conyzoides</i> Linn.	Asteraceae	<i>Elame jhar</i>	Flower chewed during throat pain, the tender plant tip chewed during diarrhea and dysentery	0.93	Farmland	NC
<i>Aesandra butyracea</i> (Roxb.) Baehni	Sapitaceae	<i>Chiwri</i>	Oil extract of fruit applied all over the body during winter in place of petroleum jelly	0.18	Farmland	C
<i>Alium cepa</i> Linn.	Liliaceae	<i>Piyaj</i>	Bulb crushed and applied externally over sprained muscles and joints	0.63	Farmland	C
<i>Allium sativum</i> Linn.	Liliaceae	<i>Lasun</i>	Soup taken during altitude sickness, chewed raw brings down the blood pressure, relieves gas; crushed and mixed with water and sprinkled to drive away the snakes	0.89	Farmland	C
<i>Albizia procera</i> (Roxb.) Benth.	Mimosaceae	<i>Seti Siris</i>	The bark crushed into paste and applied on the forehead during fever	0.09	Farmland	NC
<i>Aloe vera</i> (L.) Burm. f.	Liliaceae	<i>Ghiw kumari</i>	Leaf juice applied on the burnt wounds helps in cooling pain	0.79	Farmland	C
<i>Ammora squamosa</i> Linn.	Annonaceae	<i>Sarifa</i>	Root and seed paste applied externally on forehead during headache	0.13	Farmland	NC
<i>Amomum subulatum</i> Roxb.	Zingiberaceae	<i>Bada alaichi</i>	Seeds boiled and the essence used to gargle during teeth and gum infection	0.24	Farmland	C
<i>Ampelocissus barbata</i> (Wall.) Planch.	Vitaceae	<i>Jarila lahara</i>	Plant juice used for sores in mouth and tongue of small milk sucking baby	0.05	Forest	W
<i>Anthocephalus chinensis</i> (Lam.) Rich. ex Walp.	Rubiaceae	<i>Kadam</i>	Fruits consumed during stomachache	0.13	Farmland	NC

(Contd.)

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (Contd.)

<i>Artemisia vulgaris</i> Linn.	Asteraceae	<i>Titeypati</i>	Crushed leaves inserted in the nose stops bleeding; tender leaves chewed cures mouth ulcers; crushed leaves mixed with water and taken bath cures skin allergy; Leaf juice work as anti-leech, besides it has religious use	1.00	Farmland	NC
<i>Artocarpus heterophyllus</i> Lam.	Moraceae	<i>Rukh kathar</i>	Latex applied on boils, bone fracture	0.09	Farmland	C
<i>Artocarpus lakoocha</i> Roxb.	Moraceae	<i>Barar</i>	Latex applied on boils, bone fracture	0.11	Farmland	C
<i>Asparagus racemosus</i> Willd.	Liliaceae	<i>Kurilo</i>	Root paste administered orally in fever, cold and coughs. Fruits are eaten to treat pimples.	0.08	Farmland	NC
<i>Astilbe rivularis</i> Ham.	Saxifragaceae	<i>Budiokhati</i>	Root boiled and the water taken during severe back pain. Leaf chewed raw in toothache	0.97	Farmland	NC
<i>Azadirachta indica</i> A. Juss. Linn	Meliaceae	<i>Neempatta</i>	Fresh/dried leaf chewed controls diabetes but overdose may cause hearing problem. Bark powder used as an insecticide	0.43	Farmland	C
<i>Bauhinia purpurea</i> Linn.	Caesalpiniaceae	<i>Tanki</i>	Chewing dried bark cures diarrhea, bark paste applied on boils	0.14	Farmland	NC
<i>Berberis asiatica</i> DC	Berberidaceae	<i>Chutro</i>	Fruit and leaf juice administered orally in diarrhea and dysentery. Bark and root decoction administered orally in jaundice and fever.	0.17	Forest	W
<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae	<i>Pakhanbed</i>	Paste made out of root of <i>Bergenia ciliata</i> , <i>Kaempferia rotunda</i> , <i>Viscum articulatum</i> applied and tied over the fractured bones. 6-7 follow ups set the fractured bones. Paste is also applied over the deep cut wounds. The decoction of root taken in the form of tea during diarrhea and dysentery, cough and cold	0.97	Farmland	C
<i>Bergenia purpurascens</i> (Hook. F. & Thoms.) Engl.	Saxifragaceae	<i>Lek pakhanbed</i>	Dried roots use as substitute for tea by high altitude graziers and believe to give relief from body ache. Crushed roots tied on the fractured bones of the sheep	0.19	Forest	W
<i>Betula utilis</i> D. Don	Betulaceae	<i>Saur</i>	Bark boiled and used for cleaning wounds act as an antiseptic	0.25	Forest	W
<i>Biden pilosa</i> Linn.	Asteraceae	<i>Kuro</i>	Leaf juice applied to eyes and ears helps in reducing the pain	0.09	Farmland	NC
<i>Bombax ceiba</i> Linn.	Bombaceae	<i>Simal</i>	Gums taken during diarrhea and dysentery. Flower paste applied externally on small pox in children.	0.17	Farmland	NC
<i>Brassica campestris</i> Linn.	Cruciferae	<i>Tori</i>	Massaging body with oil relieves muscular pain, joint pain. Oil applied on hair keeps the hair black and shiny and cleans dandruff. Oil applied in nostril in new born and children to prevent the child from catching cold	0.26	Farmland	C
<i>Brassiopsis mitis</i> CB Clarke	Araliaceae	<i>Chuletro</i>	Dried roots administered orally in case of dysentery	0.12	Forest	W
<i>Bridelia retusa</i> (Linn.) Spreng	Euphorbiaceae	<i>Gayo</i>	Paste prepared of bark of <i>Bridelia retusa</i> and <i>Schima wallichii</i> applied externally on deep cut and wounds	0.06	Forest	W

(Contd.)

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (Contd.)

<i>Buddleja asiatica</i> Lour.	Loganiaceae	<i>Bhimsenpati</i>	Leaves crushed and rubbed over body cures skin rashes and allergy	0.11	Farmland	NC
<i>Callicarpa arborea</i> Roxb.	Verbenaceae	<i>Guenlo</i>	Fruit juice administered orally to cure fever	0.15	Farmland	NC
<i>Cannabis sativa</i> Linn.	Urticaceae	<i>Ganja</i>	Decoction of leaves administered orally in small quantity during severe diarrhea. Seeds pounded and mixed with water taken helps in relieving body pain but should be taken in very less quantity	0.55	Farmland	NC
<i>Carica papaya</i> Linn.	Caricaceae	<i>Mewa</i>	Fruits eaten in jaundice	0.46	Farmland	C
<i>Celosia argentea</i> Linn.	Amaranthaceae	<i>Bhale phul, Sahastrajadi</i>	Leaf juice administered orally in diarrhea and dysentery.	0.33	Farmland	NC
<i>Chenopodium album</i> Linn.	Chenopodiaceae	<i>Bethu saag</i>	Cooked and eaten as vegetable reduces body pain especially back pain	0.63	Farmland	C
<i>Chrysanthemum indicum</i> Linn.	Asteraceae	<i>Gadawari</i>	Dried flowers chewed during stomach ache	0.21	Farmland	C
<i>Cinnamomum tamala</i> (Buch.-Ham.) Nees. & Eberm.	Lauraceae	<i>Sinkoli / Tejpatra</i>	Bark extract used in treatment of intestinal disorder. Leaf used as spice, known to control diarrhea	0.71	Forest	W
<i>Citrus medica</i> Linn.	Rutaceae	<i>Bimbira</i>	Fruits are eaten during indigestion, vomiting, jaundice, typhoid. Dried fruit skin power administered in dysentery	0.10	Farmland	C
<i>Citrus reticulata</i> Blanco.	Rutaceae	<i>Suntala</i>	Paste prepared from the dried fruit skin applied on the face softens and cleans the skin	0.56	Farmland	C
<i>Clematis buchananiana</i> DC	Rununculaceae	<i>Pinasey lahara</i>	Fresh roots/leaves mashed and inhaled through nose cures sinusitis and nose blocks	0.62	Forest	W
<i>Colebrookea oppositifolia</i> Smith	Labiatae	<i>Dhusrey</i>	Leaf juice administered orally in dysentery	0.19	Forest	W
<i>Costus speciosus</i> Smith.	Zingiberaceae	<i>Betlauri</i>	Crushed rhizome mixed with leaf juice of <i>Drymeria cordata</i> , root paste of <i>Bombax ceiba</i> administered orally in case of urinary disorder.	0.54	Farmland	NC
<i>Cucurbita pepo</i> Linn.	Cucurbitaceae	<i>Pharsi</i>	Powdered seeds taken with water act as vermifuge in children	0.73	Farmland	C
<i>Curcuma amada</i> Roxb.	Zingiberaceae	<i>Phacheng</i>	Fresh rhizome cut and rubbed over the whole body cures skin allergy, body itching. Rhizome paste applied externally to sprained joints	0.45	Farmland	C
<i>Curcuma zeodoaria</i> Rose.	Zingiberaceae	<i>Kalo hardi</i>	Dried rhizome chewed to cure bad breath	0.51	Farmland	C
<i>Cynodon dactylon</i> (Linn.) Pers.	Poaceae	<i>Dubo</i>	Juice of plants applied over fresh cuts and wounds.	0.77	Farmland	NC
<i>Dactylorhiza hatagirea</i> (D Don) Soo.	Orhidaceae	<i>Panch aunley</i>	Rhizome paste applied on cuts and wounds. Rhizome powder sprayed on wounds to control bleeding.	0.91	Forest	W
<i>Daphne cannabina</i> Wall.	Thymelaeaceae	<i>Kagate, Kalo algeri</i>	Used as substitute to <i>Aconitum</i> sp. Root decoction causes severe diarrhea and vomiting thus helps in removing the poison	0.12	Forest	W
<i>Datura fastuosa</i> Linn.	Solanaceae	<i>Dhogre</i>	Leaves warmed, placed over swelling at the joints reduces the pain and swelling. Seeds burnt and the smoke inhaled in chronic asthmatic fits. Fruits taken in mad dog bites	0.58	Farmland	NC

(Contd.)

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (Contd.)

<i>Dicentra scandens</i> (D. Don) Walp.	Fumariaceae	<i>Jogi lahara</i>	Dried root powdered, administered orally during gastritis	0.38	Forest	W
<i>Dichroa febrifuga</i> Lour.	Hydrangeaceae	<i>Basak</i>	Leaf juice taken orally during fever	0.64	Farmland	NC
<i>Dolichus uniflorus</i> Linn.	Fabaceae	<i>Gahat</i>	Cooked and juice taken considered good for kidney stone	0.70	Farmland	C
<i>Drymaria cordata</i> Willd. ex Roem & Schult.	Caryophyllaceae	<i>Abijalo</i>	Leaves and plants smouldered over fire and inhaled to get relief from headache, sinusitis and cold.	0.85	Farmland	NC
<i>Elaeocarpus spaericus</i> K. Schum	Eleocarpaceae	<i>Rudrakshe</i>	Seed paste administered orally to cure cough	0.61	Farmland	C
<i>Elatostema platyphyllum</i> Wedd.	Urticaceae	<i>Gaglet</i>	Shoot consumed as vegetable in gastritis	0.31	Farmland	NC
<i>Entada pursaetha</i> ssp. <i>sinohimalensis</i> Grierson & Long	Mimosaceae	<i>Pangra</i>	Seed paste applied externally over the mump help reduce swelling	0.42	Forest	W
<i>Ephedra gererdiana</i> Wall. Ex Stapf	Ephedraceae	<i>Somlata,</i> <i>Sallefari</i>	Ripe fruit are eaten to get relief from altitude sickness and indigestion. Stem powder inhaled to get relief from headache.	0.21	Forest	W
<i>Eupatorium adenophorum</i> Spreng.	Asteraceae	<i>Kalijhar, Kalo</i> <i>banmara</i>	The tender shoot part crushed and the juice applied on the fresh cuts helps stops bleeding, the extract placed and tied over it cures the wound fast and also serve as antiseptic agent; seed paste applied externally on swollen parts in case of mumps	0.99	Farmland	NC
<i>Evodia fraxinifolia</i> Hook. f.	Rutaceae	<i>Khanakpa</i>	The seeds in the chutney form taken during indigestion, increases appetite	0.81	Farmland	NC
<i>Fagopyrum esculantum</i> Moench	Polygonaceae	<i>Phapar</i>	Leaf juice taken orally during stomach ache and gastritis	0.58	Farmland	C
<i>Fragaria nubicola</i> Lindl. ex Lacaita	Rosaceae	<i>Bhuin aiselu</i>	Root paste applied externally to control bleeding. Root chewed in cough and cold.	0.22	Farmland	NC
<i>Girardiana palmata</i> (Forssk.) Gaudich	Urticaceae	<i>Bhangrey sisnu</i>	Root juice taken in skin diseases and kidney problems. Root extract used in toothache. The tender shoot part eaten in the form of vegetable	0.97	Forest	W
<i>Gnaphalium</i> sp.	Asteraceae	<i>Bukiful</i>	Root juice administered orally in indigestion and stomach ache	0.09	Farmland	NC
<i>Gynocardia odorata</i> R. Br.	Flacourteaceae	<i>Gantey</i>	Oleous extract of seed used for massaging infants	0.11	Farmland	NC
<i>Hemiphragma heterophyllum</i> Wallich.	Scrophulariaceae	<i>Kanakmala</i>	Fruit juice administered orally to relieve sore throat	0.06	Farmland	NC
<i>Heracleum wallichii</i> DC.	Apiaceae	<i>Chimping</i>	Taken in chutney form helps in digestion; taken raw during vomiting, stomachache etc., act as stimulant	0.93	Farmland	C
<i>Hydrocotyle asiatica</i> Linn.	Apiaceae	<i>Gol patta</i>	Plant extract taken in pneumonia, skin diseases, toothache and indigestion. Leaf paste used to treat dysentery. Plant juice taken in sore throat, cough and fever.	0.69	Farmland	NC
<i>Imperata cylindrical</i> Cyrill	Poaceae	<i>Siru</i>	Root paste applied on boils. Root juice taken during cough, cold, fever	0.19	Farmland	NC

(Contd.)

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (Contd.)

<i>Juglans regia</i> Linn.	Juglandaceae	<i>Okhar</i>	Stem bark decoction taken to cure arthritis, rheumatism, skin diseases and toothache. Dried young shoot bark taken as anthelmintic.	0.50	Farmland	C
<i>Juniperus indica</i> Bertol.	Cupressaceae	<i>Dhupi</i>	Fruit powder is put on the glowing red fire coal and the scent is smelt which reduces headache and blood pressure; The graziers mixes the dried fruit powder with tea or milk and drinks to get relief from cough and cold in high altitude. It has religious significance.	0.85	Forest	W
<i>Kaempferia sikkimensis</i> (King ex Baker) K. Larsen	Zingiberaceae	<i>Bhuin champa</i>	Paste prepared of rhizome mixed with other such as <i>Bergenia ciliata</i> (rhizome), <i>Viscum articulatum</i> etc., applied and the extract tied over the fractured bones, bone dislocation helps in curing the problem; rhizome paste applied externally to sprained joints, on burns.	0.11	Farmland	C
<i>Lantana camara</i> Linn.	Verbinaceae	<i>Banmara</i>	Leaves crushed and the juice applied over the fresh cuts immediately stops bleeding and the extract placed over the wound as an antiseptic agent	0.39	Farmland	NC
<i>Litsea citrata</i> Blume	Lauraceae	<i>Siltimmur</i>	Dried fruits chewed during nausea and giddiness. Taken in chutney form increases appetite	0.77	Forest	W
<i>Lycopodium clavatum</i> Linn.	Lycopodiaceae	<i>Nagbeli</i>	Spores applied externally on wounds	0.08	Farmland	NC
<i>Mahonia nepalensis</i> DC	Berberidaceae	<i>Kesari</i>	Bark juice applied in the eyes during eye inflammation	0.16	Forest	W
<i>Mangifera indica</i> Linn.	Anacardiaceae	<i>Aanp</i>	Tender shoots chewed during cough, sore throat	0.11	Farmland	C
<i>Mentha arvensis</i> Linn.	Lamiaceae	<i>Padina</i>	Fresh leaves chewed during gastritis and acidity	0.54	Farmland	C
<i>Momordica charantia</i> Linn.	Cucurbitaceae	<i>Tite karela</i>	Fruit juice taken for blood purification, helps control diabetes	0.19	Farmland	C
<i>Morus indica</i> Linn.	Moraceae	<i>Kimbu</i>	Tender leaves chewed helps in curing inflammation of vocal cord, hoarse voice.	0.05	Farmland	C
<i>Mucuna monosperma</i> Wall.	Papilionaceae	<i>Baldengra</i>	Seeds act as expectorant in cough	0.13	Forest	W
<i>Nasturtium officinale</i> R. Br	Cruciferae	<i>Simrayo</i>	Eaten in the form of vegetable relieves back pain, considered important source of iron and prescribed for pregnant women	0.24	Forest	W
<i>Nyctanthes arbortristis</i> Linn.	Oleaceae	<i>Parijaat</i>	Leaf juice taken orally during fever	0.11	Farmland	C
<i>Ocimum sanctum</i> Linn.	Labiatae	<i>Tulasi</i>	Leaves chewed cures mouth ulcers	0.21	Farmland	C
<i>Oroxylum indicum</i> (L.) Kurz	Bignoniaceae	<i>Totola</i>	Root bark boiled and the juice taken during loss of appetite, cures vomiting sensation; seed burnt and powdered and mixed with lime and applied externally to relieve throat pain; fresh seed chewed to relieve menstrual pain in women	0.26	Farmland	NC
<i>Osyris arborea</i> Salz. ex Dacne.	Santalaceae	<i>Nundhiki</i>	Stem bark paste applied externally on fracture and sprain bone	0.11	Forest	W
<i>Oxalis corniculata</i> Linn.	Geraniaceae	<i>Chari amilo</i>	The aerial part chewed during cough, diarrhoea, dysentery; it also increases appetite	0.58	Farmland	NC

(Contd.)



Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (Contd.)

<i>Panax pseudo ginseng</i> Wall.	Araliaceae	<i>Mangan</i>	Dried roots chewed act as aphrodisiac	0.07	Forest	W
<i>Perilla frutescens</i> Britt.	Labiatae	<i>Silam</i>	Dried seeds if chewed cures cough and nausea	0.24	Farmland	C
<i>Phyllanthus emblica</i> Linn.	Euphorbiaceae	<i>Rukh amala</i>	Fruit edible, increases appetite, cures cough and dysentery. Fruit juice applied on scalp blackens and strengthens the hair	0.14	Forest	W
<i>Phytolacca acinosa</i> Roxb.	Phytolacaceae	<i>Jaringo</i>	Eaten in the form of vegetable relieves body pain. Root juice dropped in the nose to cure sinusitis	0.25	Farmland	C
<i>Picrorhiza kurrooa</i> Royle ex Benth.	Scrophulariaceae	<i>Kutki</i>	Dried rhizome soaked overnight in water and water taken during cough, cold, fever, stomach ache, throat pain, diarrhea, dysentery, headache	0.51	Forest	W
<i>Piper longum</i> Linn.	Piperaceae	<i>Pipla</i>	Powdered dried roots taken with water serve as vermifuge in children, relieves from stomach ache. Fruits taken during diarrhea and dysentery	0.23	Forest	W
<i>Plantago eroasa</i> Wallich	Plantaginaceae	<i>Isabgol</i>	Flower and fruits used to cure cough and cold, indigestion, diarrhea and dysentery. Root paste applied externally on boils, joints, during fever and headache.	0.21	Forest	W
<i>Potentilla fulgens</i> Wall. ex. Hook.	Rosaceae	<i>Bajradanti</i>	Brushing with root powder heals toothache. Root paste taken with milk cures diarrhea.	0.13	Forest	W
<i>Psidium guajava</i> Linn.	Myrtaceae	<i>Ambak</i>	Tender shoots chewed during cough, sore throat	0.47	Farmland	C
<i>Rheum acuminatum</i> Hook. f. & Thomson	Polygonaceae	<i>Khokim</i>	Root paste applied on forehead during severe headache. Juice from shoot portion is taken in dysentery and intestinal problems. Petiole is eaten as an appetizer.	0.41	Forest	W
<i>Rhododendron arboreum</i> Smith	Ericaceae	<i>Gurans</i>	Fresh or dried petal chewed in diarrhea, blood dysentery and throat pain. Young leaf chewed to get relief from headache	0.62	Forest	W
<i>Rosa sericea</i> Lindl.	Rosaceae	<i>Banko gulab</i>	Decoction of leaf used to wash wounds. Flower paste taken to cure headache	0.04	Forest	W
<i>Rhus semialata</i> Murray.	Anacardiaceae	<i>Bhakimlo</i>	Fruit juice administered orally during blood dysentery	0.15	Farmland	C
<i>Rubia cordifolia</i> Roxb. ex Fleming	Rubiaceae	<i>Manjito</i>	Leaf and root juice are taken during fever, stomachache and dysentery. Fruit is taken to lower the body temperature; decoction of leaves and stems used as a vermifuge. Root mashed and the juice obtained applied on cuts and wounds.	0.58	Forest	W
<i>Rumex nepalensis</i> Sreng.	Polygonaceae	<i>Halhaley</i>	Massaging with root paste relieves body pain, cures skin disease and if applied on scalp reduces hair loss. Leaf extract used in cuts and wounds, and swellings.	0.43	Farmland	NC
<i>Sapindus mukorossi</i> Gaertn.	Sapindaceae	<i>Rittha</i>	Fruit used to wash wounds and wash scalps cures dandruff	0.34	Forest	W
<i>Schima wallichii</i> (D.C) Korth.	Theaceae	<i>Chilauney</i>	Bark paste with bark of <i>Bridelia retusa</i> applied externally on deep cut and wounds	0.05	Farmland	NC
<i>Sejjesbeckia orientalis</i> Linn.	Asteraceae	<i>Kuro</i>	Leaves applied externally as poultice on sores	0.03	Farmland	NC

(Contd.)

Table 1—Plant species used for curing different ailments by *Limboo* tribe in South-West Khangchendzonga Biosphere Reserve in West Sikkim, India (*Contd.*)

<i>Solanum khasianum</i> C.B. Clarke	Solanaceae	<i>Boksi kanra</i>	Burnt fruit administered orally to check tooth decay	0.25	Farmland	NC
<i>Swertia chirayita</i> (Roxb. Ex Flem.) H. Karst.	Gentianaceae	<i>Chirowto</i>	Whole plant soaked in water overnight and water is taken during fever, cough, cold, stomach pain, gastritis, throat pain, diarrhea, dysentery, headache, back ache, diabetes	1.00	Forest	W
<i>Swertia paniculata</i> Wall	Gentianaceae	<i>Chirowto</i>	Used as substitute to <i>Swertia chirayita</i> and bears the same properties to some extent	0.09	Forest	W
<i>Symplocos theifolia</i> D.Don	Symplocaceae	<i>Kharaney</i>	Fruit juice in diluted form administered orally in case of diarrhea	0.13	Farmland	NC
<i>Tagetes patula</i> Linn.	Asteraceae	<i>Sayapatri</i>	Chewing dried flowers cures sore throat, cough, and mouth ulcers	0.37	Farmland	C
<i>Terminalia chebula</i> Retz.	Combretaceae	<i>Harra</i>	Fruit consumed during cough and sore throat, vomiting sensation, hiccups.	0.89	Forest	W
<i>Terminalia myriocarpa</i> Haurck & Muell – Agr.	Combretaceae	<i>Pani saaj</i>	Bark juice applied externally on cuts and wounds	0.13	Forest	W
<i>Thysanlaena maxima</i> (Roxb.) O. Kutze.	Poaceae	<i>Amliso</i>	Root paste applied externally as a poultice on sores and boils	0.18	Farmland	C
<i>Toona ciliata</i> M. Roem.	Meliaceae	<i>Tooni</i>	Stem bark taken to cure toothache. Fruit used for chest pain, fever and measles	0.13	Farmland	NC
<i>Tricosanthes lepiniana</i> (Naudin.) Cogn.	Cucurbitaceae	<i>Indreni</i>	Oleous extract of seed applied externally to cure skin diseases	0.59	Farmland	NC
<i>Tupistra nutans</i> Wall.	Liliaceae	<i>Nakima</i>	Cooked and eaten as vegetable increases appetite	0.56	Forest	W
<i>Urtica parviflora</i> Roxb.	Urticaceae	<i>Patley sisnu</i>	Root juice taken in skin diseases and kidney problems. Root extract used in toothache. The tender shoot part eaten in the form of vegetable controls high blood pressure	0.81	Forest	W
<i>Viscum articulatum</i> Burm. f.	Loranthaceae	<i>Harchur</i>	Root paste prepared along with others ( <i>Bergenia ciliata</i> , <i>Kaempferia sikkimensis</i> , etc) applied over the fractured/dislocated bone cures the problem. Paste applied externally on wounds and boils	0.77	Forest	W
<i>Zanthoxylum acanthopodium</i> DC	Rutaceae	<i>Bokey timmur</i>	Fruit used as appetizer and cures bad breath. Fruit and stem barks taken in indigestion and tooth decay. Decoction of fruits used in cold and stomachache and as anthelmintic. Crushed leaves rubbed over the body act as anti leech agent	0.93	Forest	W
<i>Zanthoxylum alatum</i> Roxb.	Rutaceae	<i>Bhaley timmur</i>	Bears same properties as <i>Z. acanthopodium</i>	0.85	Forest	W
<i>Zingiber officinale</i> Rose.	Zingiberaceae	<i>Aduwa</i>	Rhizome crushed and boiled with sugar, turmeric powder and milk and is taken hot during severe cough. Roasted rhizome chewed with salt during severe dry cough	0.90	Farmland	C

\*W = wild, NC = not cultivated, C = cultivated

The highest informant consensus factor (ICF) was linked to the problems of cut and wound (0.91) followed by diarrhoea and dysentery (0.87) and children related problems (0.85) (Table 2). By reporting only 12 species, there were 138 citations for cut and wounds. Similarly, for diarrhoea and

dysentery, with 79 citations, there were 11 species in use. Others category included diseases such as pneumonia, altitude sickness, blood pressure, nose bleeding, diabetes, typhoid, jaundice, pain reliever, ear problems, etc., for which the ICF value was 0.66.

Table 2—Informant consensus factor (ICF) by disease categories for *Limboo* tribe in South-West part of Khangchendzonga Biosphere Reserve (west Sikkim, India)

Ailments	Species use	(%) All species	Use citations	(%) All use citations	ICF
Body ache and backache	7	5.65	19	12.67	0.67
Boil and skin related problems	20	16.13	23	15.33	0.14
Children related problems	13	10.48	81	54.00	0.85
Cough and cold	23	18.55	97	64.67	0.77
Cut and wound	12	9.68	138	92.00	0.91
Diarrhoea and dysentery	11	8.87	79	52.67	0.87
Fever and headache	16	12.90	67	44.67	0.77
Mouth and throat related problems	14	11.29	47	31.33	0.72
Muscle and bone related problems	10	8.06	27	18.00	0.65
Nose and eye related problems	6	4.84	11	7.33	0.50
Stomach related problems	31	25.00	75	50.00	0.59
Teeth and gum related problems	10	8.06	33	22.00	0.72
Others	32	25.81	91	60.67	0.66

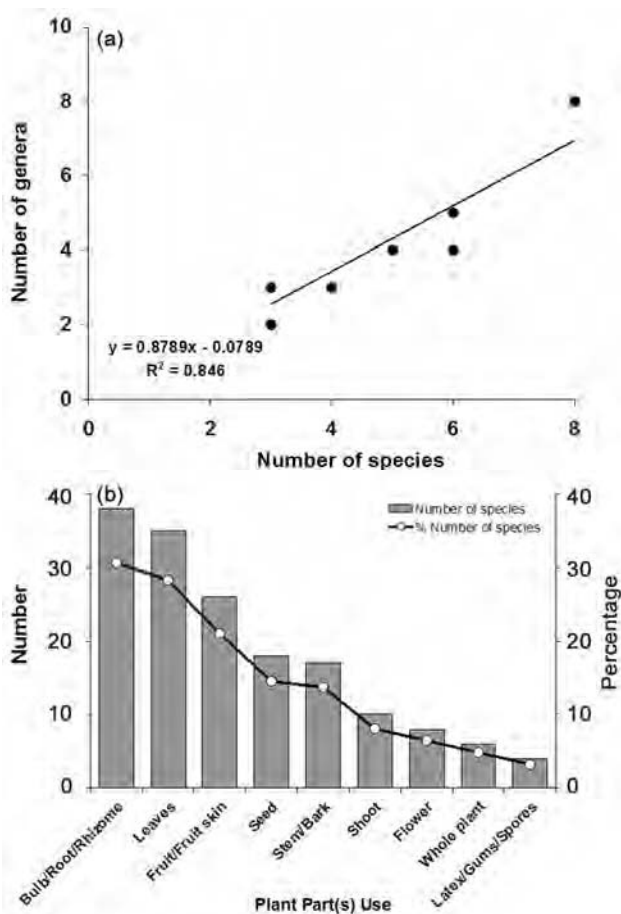


Fig. 1 a) Relationship between number of species and number of genera of medicinal plants used by *Limboo* tribe in South-west Khangchendzonga Biosphere Reserve, West Sikkim; b)—Use frequency of parts of medicinal plant species by *Limboo* tribe in South-west Khangchendzonga Biosphere Reserve, West Sikkim, India

## Discussion

The present study explored widely accepted traditional system of medicine for the primary healthcare, practiced by the *Limboo* tribe in KBR. In spite of prevailing dominance of allopathic system of medicine every where these days<sup>2</sup>, the *Limboo* community still use, both, ethnomedicinal plants along with present day pharmaceuticals. Although, the *Limboo* tribe has maintained their ethnomedicinal knowledge till date, the present experience suggests that the folk phytotherapy today has considerably reduced and plunging towards abandonment and is limited to minor ailments like skin diseases, stomach problems, fevers, headache, cold, cough, etc. This is due to the wide scale prevalence of pharmaceutical technology<sup>16</sup> in addition to the death of a person or practitioner having traditional knowledge. Simultaneously, it was encouraging to note that the youths in the study area uphold good knowledge on the use of plants as medicine. As, majority of them are involved in agriculture, farming, etc. and many works as part time porters and guides which gives them ample opportunity to learn about plants, through experimentation, during their trips to forest and high altitude landscapes in KBR.

Irrespective of the on-going depletion in ethnomedicinal practices worldwide, it is worth mentioning that there are many herbs like *A. vulgaris*, *C. dactylon*, *E. adenophorum*, *G. palmata*, *H. wallichii*, *S. chirayita*, *U. parviflora*, etc. which appears to have been in use persistently at local level by the *Limboo* community, either for their multiple

medicinal properties or religious or cultural values or due to their considerable availability in the area. However, of the total species recorded, only 47.58% had persistent use (frequency of citation: over 50), which indicates that the popularity of the plant use is diminishing and likely to be lost in near future and the collection of data on the folk plant use may soon be highly difficult<sup>2,17</sup>. These circumstances strongly advocate for the immediate documentation of the folk medicinal knowledge to restrain further loss of knowledge that can be precious to the development of new useful phyto-products. The maximum number of species use belonging to family Asteraceae in the present study area is similar to that of the *Apatani* tribe of eastern Himalaya<sup>18</sup> and local communities of Bumdeling wildlife sanctuary, Bhutan<sup>19</sup>, indicating Asteraceae as the most dominant family of ethnomedicinal plants in North-eastern states of India<sup>20</sup> as well as in Bhutan.

An important observation in the present study was the high use of herbs as medicine by the *Limboo* tribe, similar high use of herbs as ethnomedicine have been reported to be used by Irula tribe from Tamil Nadu, India<sup>21</sup>. The *Limboos* believes that the underground parts contain more healing power than other parts in general, which was reflected in the data we procured, viz. 31% species' harvesting for roots/rhizomes/bulb, followed by leaves (28%) and fruits/fruit skin (21%). Our previous study<sup>2</sup> supports present results, where we explored the root/rhizome being the most harvested part used by the *Lepcha* tribe followed by leaves and fruits.

The oral remedies are taken with water, skimmed milk, honey, sugar and sometimes as such in the raw form. Medicine is taken in both ways, as a single or in mixed ingredients. The mixture is not changed depending on the person, but at the same time, the dosages of plant medicine are not specific, which could be dangerous sometimes, however, the children are suggested to take small dosage compared to the elders<sup>2</sup>. The plants are used mostly in raw form depending on the availability in the vicinity. For example, *A. vulgaris*, *E. adenophorum*, *G. palmata*, *R. nepalensis*, *U. parviflora*, etc. are weed species and are available in plenty; these species can be acquired whenever needed. However, species such as, *Aconitum ferox*, *A. spicatum*, *Dactylorhiza hatergeria*, *Juniperus indica*, *Panax pseudo ginseng* (Fig. 3), *Picrorhiza kurroo*, *Rheum acuminatum* (Fig. 4), etc. are available at the higher altitudes, so, these need

to be stored in advance and used in dried form. Similarly, the species, viz. *V. articulatum*, parasitic in nature, is available on the trees and often not very easy to spot, so they collect this species on sighting, in huge quantity. The study revealed that a wide variety of medicinal plants from higher elevations are collected by the *Limboos*; however, in small quantities for their personal use only. From conservation point of view, such small quantity collection is considered sustainable.

The highest ICF value for ailments, such as, cut and wound, diarrhoea and dysentery, children related problems, cough and cold, and fever and headache may be related to the common nature of ailments existing in the village life in every part of the world, and is the result of great agreement on the use of same species by *Limboos* in the study area. For example, 100% respondents agreed on the use of *Swertia chirayita* in treating diarrhoea and dysentery, cough and cold, and fever and headache. For the back pain, 97.33% *Limboos* responded on the use of *Astilbe rivularis*, a common weed. However, difference in use pattern was reported for *A. rivularis*; some respondents mentioned that the crushed root (raw) is boiled and the decoction is taken, while some shared that the root is dried, cut into small pieces, stored and is chewed during backache. Similarly 92.67% and 90% of the respondents agreed on the use of *Ageratum conyzoides* and *Acorus calamus* for treating diarrhoea and dysentery and cold and cough. It was observed that the *Limboo* women keep good knowledge on the diseases associated with the children especially, stomachache, diarrhoea, dysentery, intestinal worms, cold and cough, and fever, etc. because the rate of exchange of information is high amongst the women. Nevertheless, in respect to the knowledge on ethnomedicinal plants, the female were found lagging behind the male, which might be either because the traditional knowledge in the family or community is passed from the male parent to his first-born son<sup>22</sup> or due to their greater involvement in works away from home and family.

The use of species for treating different ailments depends on its availability on the surroundings as well as time and space needed for plant collection. The widespread availability of species, viz. *A. vulgaris*, *S. chirayita*, *E. adenophorum*, *A. rivularis*, *B. ciliata* and *G. palmata*, either in the farmlands or forest fringe relates to their high use value. *B. ciliata* is exception to above relationship, which is

Fig. 2—*Swertia chirayita*Fig. 3—*Panax pseudo-ginseng*Fig. 4—*Rheum acuminatum*

also a garden plant in Sikkim, offers capability to cure multiple problems and choice for limited extra efforts in the collection. Species such as *A. cepa*, *A. sativum*, *H. wallichii*, etc. grown in the kitchen garden and frequently used in adding flavour to the food, cure the problem before appearing. Similarly, the use value of *Juniperus indica*, a high altitude species, was comparatively high (0.85) because it is very helpful in treating headache and blood pressure, as this is the common problem after reaching the high altitude areas. Further, *Juniperus indica* (common name: *Dhupi*) along with *Rhododendron anthopogon* (popular name: *Sunpati*; a threatened taxa) is used as incense especially by the Buddhists (*Bhutias*, *Lepcha* and the *Sherpas*; *authors' personal observation*); so they are collected in huge quantity when the people are on their trip to high altitude areas. Some of them make their way to high altitude areas particularly for collecting these species as the incense bears high market price; however, in recent years, such large quantity extraction has significantly being checked and reduced due to several restrictions by KBR management. Also, people have reported its use in curing indigestion, stomachache, vomiting sensation and other problems associated with the attack from some so-called evil forces. It would be important to note here that, either species bear high value in the international market and are under immense pressure which called for immediate conservation attention.

Some of the ethnomedicinal plants, documented, like *Rubia cordifolia*, *Swertia chirayita*, *Piper longum* and *Picrorhiza kurrooa* have very high demand in the Indian pharmaceutical markets<sup>23</sup> and are largely imported from Nepal<sup>24</sup> in order to fulfill the increasing demand. Along with those, the species, viz.

*Aconitum ferox*, *A. spicatum*, *Aloe vera*, *Dactylorhiza hatagirea*, *B. ciliata*, *Acorus calamus*, etc. have high potential for commercialization in Sikkim due to their high pharmaceutical value. These species can be considered for the large scale cultivation to fulfill the ever increasing need of the Indian pharmaceutical companies. Hitherto, this can be used as an encouraging tool for *in-situ* conservation as well as to improve socio-economic status of the local inhabitants<sup>23</sup>, as the monetary output/input ratio for the medicinal plant cultivation is higher compared to cash crops and horticultural crops<sup>25,26</sup>, comparatively.

#### Significant observation related to Limboo tribe in KBR

It was assessed that the use pattern of several plant species differs within the state of Sikkim as well as other regions in India and neighbouring country Nepal. For example, in the present study area, the leaf extract of *Abies densa* is used to cure asthma, bronchitis and stomachache by the *Limboo* tribe; which is used to cure fever and stomachache by *Lepcha* tribe<sup>2</sup>; such use of the species is not reported from other regions<sup>18,26</sup>. Similarly, *Rubia cordifolia* is used by the *Limboo* tribe in treating fever, stomachache, dysentery etc.; however, the use pattern for the same species is different in southern India, viz., it is used to cure scorpion sting and dizziness<sup>21</sup>. There were species viz., *Abrus precatorius*, *Aegle marmelos*, *Aloe vera*, *Astilbe rivularis*, *Bidens pilosa*, *Ocimum sanctum*, *Panax pseudo ginseng*, etc., which were observed to be used only by the *Limboo* tribe when compared with other Himalayans tribes of India<sup>2,18,26</sup>. Different groups use many herbs like *Acorus calamus* to cure broad range of ailments; the

species is used to cure 8 ailments by the *Limboo* tribe (present study) and 5 ailments by the *Lepcha* tribe<sup>2</sup> in KBR (Sikkim), 6 ailments by the residents of Dolpa, Nepal<sup>27</sup>, and 4 ailments by *Apatani* tribe of NE India<sup>18</sup>. The 100% response on the use of *Swertia chirayita* by *Liboos* is unique and suggestive of high presence of species.

### Conclusion

The present investigation on 124 ethnomedicinal plant species used alone by the *Limboo* tribe in Yuksam area of South-West part of Khangchendzonga Biosphere Reserve and previous assessment of 118 ethnomedicinal plant species used by the *Lepcha* tribe<sup>2</sup>, over a previous reporting of 31 medicinal plant species used in Yuksam area<sup>19</sup>, indicates that the Sikkim Himalaya is still under-explored in terms of ethnomedicinal knowledge. Therefore, it is highly recommended to take up the detailed investigation on persisting ethnomedicinal knowledge among different ethno-cultural groups in Sikkim, before such valuable knowledge entirely vanishes. The present investigation on the ethnomedicinal plants used by the *Limboo* tribe fills up the existing lacunae and should help in identifying species having potential of developing herbal medicine, which can be supportive in curing different diseases around the globe along with the conservation of traditional ethnomedicinal knowledge<sup>2</sup>. At the same time, biochemical analysis, pharmacological evaluation and isolation of active ingredients of the ethnomedicinal plants used by the different ethno-cultural groups in Sikkim may throw some light on unexplored scientific information and towards discoveries of noble molecules. The KBR management may play an important role in encouraging the local folk in maintaining and carrying forward the indigenous knowledge on the use of medicinal plants by motivating them to develop herbal gardens in transition zone; however, the scientific guidance from locally established research organizations would be immensely useful for the same.

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