Exploration of ethno-medicinal knowledge among rural communities of Pearl Valley; Rawalakot, District Poonch Azad Jammu and Kashmir

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Abstract

Background

Medicinal plants are the basic source of health care in the Pearl Valley District Poonch, Azad Jammu, and Kashmir. The basic aim of present study was to record information about the use of plants in herbal preparation and quantification of recorded data.

Materials and methods

The research was conducted with the null hypothesis that there was no differential distribution of knowledge among the communities between genders and among different age groups in the study area and across cultural medicinal uses of the plants are similar. To check these hypotheses information about medicinal plants was collected from 46 laypeople and 18 herbalists by using an open ended and semistructured questionnaire. Different ethnobotanical indices were calculated in order to quantify the knowledge on the medicinal plants reported in the study.

Results

Our study recorded 136 species of medicinal plants belonging to 45 families with Asteraceae (14 species) as the dominant family of the area. Decoction (26 species), juice and powder (24 species each) were most common methods of preparation. Spearman’s correlation analysis showed that age and gender had the significant effect on both numbers of mentioned species and different uses. A number of known medicinal plants and the number of different uses (H: 38.51; p < 0.001) differ significantly as indicated by Kruskal-Wallis tests. These results showed that the knowledge about the plant varies among different age groups, which were the first hypothesis of the present study. The highest use values (UVs) were reported for Berberis lyceum and Ajuga bracteosa (1.13 each) followed by Abies pindrow (1.03). Highest informant consensus factor (ICF) values were recorded for digestive
system diseases (ICF = 0.90) and muscular and skeletal system diseases (ICF = 0.89). The value of Jaccard index ranged from 6.11 to 32.97 with an average value of 19.84, percentage of similarity was highest between study area and Pir Lasura National Park (34.62%).

Conclusion
High similarity might be due to the fact that the communities living in these areas have same sociocultural values and have more opportunities to exchange their traditional knowledge. The present study provides practical evidence about the use of medicinal plants among the inhabitants of the Pearl Valley.

Introduction
Ethnobiological knowledge consists of the body of knowledge, beliefs, traditions, and practices that reflect the perception of the local environment by indigenous communities. Within the field of ethnobiology, several pieces of research have been devoted to the study of plants used for medical purposes, one of the oldest forms of ethnobotanical and ethnomedical research known [1–3].

Quantitative ethnobotany may be defined as "the application of quantitative techniques to the direct analysis of contemporary plant use data" [4, 5]. Quantification and associated hypothesis-testing help to generate quality information, which in turn contributes substantially to resource conservation and development. Further, the application of quantitative techniques to data analysis necessitates refinement of methodologies for data collection. Close attention to methodological issues not only improves the discipline of ethnobotany but also enhances the image of ethnobotany among other scientists ” [4, 5]. This paper attempts to highlight these unexpected patterns of ethnobotanical knowledge across age, gender and method used.

The variables known to affect medicinal plant knowledge include education, occupation, age, gender and psychosocial variables [6–10]. Age and gender are generally the factors most examined for their influence on knowledge about plants. One of the most studied resources is medicinal plant knowledge because it is a structural component of local medical systems [11]; it is the focus of this study. Much of this knowledge is traditional, that is, learned long ago and passed on with varying degrees of faithfulness for at least two or three generations. However, ethnobiological knowledge can change rapidly. Every tradition had a beginning cf. [12], and was itself a new creation in its time. Ecosystems change, new plants and animals arrive, and people learn new ways of thinking; ethnobiological systems change accordingly, and are typically flexible and dynamic. Field-workers have observed new knowledge being incorporated into systems around the world.

Divergences in knowledge and practice between two cultural groups that live within the same ecosystem are intriguing as they can provide insight into how the lens of culture can not only alter human viewpoints of the environment but even guide human interactions with resources embedded in the ecosystem. To explore the question of what role culture plays in shaping the human–nature interface, we conducted field research in Pearl Vellay in Rawalakot that hosts an incredibly rich repertoire of cultural, linguistic and biological diversity. We hypothesize that two distinct cultural groups living in the same ecosystem will share a similar pattern of use of wild flora for daily subsistence and medical practices, and that distinctions will arise only for those taxa that play a key role in culture-specific ritual, food or health practices [13].
Researchers have previously studied the association between ethnobotanical knowledge and socio-economic factors. Among the factors previously studied researchers have focused on the age \([4, 6, 14, 15]\), sex, the educational level, origin, and the occupation and the wealth of informants. Among those, researchers have found that those having a stronger influence on shaping ethnobotanical knowledge distribution are age, sex, education level and wealth.

For example, several studies have found a positive association between age and traditional ethnobotanical knowledge \([14]\), although some other studies have not found such association \([6]\). In contrast, the differences in ethnobotanical knowledge between men and women seem to be more consistent, with studies finding that men have a larger knowledge than women \([6, 14, 16, 17]\), although the trend seems to be inverse in relation to medicinal plants \([18]\). Such differences are generally explained by sexual distribution of work \([19]\). Some research also suggest that ethnobotanical knowledge decreases with the increase of education \([15, 20–22]\) and wealth. Several of those characteristics are also linked to the process of acculturation and the loss of indigenous languages (among indigenous communities) \([15, 20, 22]\). Some studies highlight the importance of occupation on traditional knowledge \([21, 23]\). Martínez-Ballesté et al. \([21]\) find that larger involvement in agricultural activities resulted in a loss of traditional ecological knowledge, as a consequence of the environmental transformation and loss of biodiversity. In contrast, those activities more dependent on the natural environment are associated to maintenance of traditional knowledge.

Given those previous findings, we hypothesize that the distribution of traditional knowledge will be patterned across socio-economic characteristics. Specifically, we expect to find that men, older people, people born in the area, and poorer people will have higher levels of traditional knowledge than people without those characteristics. We also hypothesize that people whose occupation depends on the environment, like people who practice extensive agriculture and stockbreeding, might also have larger levels of traditional knowledge.

Ethnobotanical knowledge in Poonch Valley (an administrative division of Azad Jammu and Kashmir) has been scarcely investigated, with the exception of a few studies \([24–27]\). Local people have developed a rich ethnobotanical knowledge and use medicinal plants for treating several common diseases. In particular, traditional healers or herbalists play an important role in ensuring some health service to 75% of the rural population \([28]\). The study was aimed to record and discuss knowledge on medicinal plant uses in the local traditional practices, including (i) Description of preparation and use of plants as medicines. (ii) The differential distribution of knowledge about plants and medicinal properties among sectors of the society, and (iii) identifying new forms of use compared with those reported for other neighbouring areas.

**Materials and methods**

**Study area**

The study has been carried out in Rawalakot, also known as Pearl Valley, located in the core of Poonch district (Latitude 33° 51’ 32.18”N, Longitude 73° 45’ 34.93”E) “Fig 1”. It is a saucer-shaped valley with an altitude of 1615 m a.s.l. The climate can be classified as subtropical highland (Cwa) under the Köppen climate classification due to high altitude. The average annual temperature is 15.3°C ranging from 38°C during the mid-summer months to –3°C during the winter months. The annual rainfall is very variable year by year and ranges from 500 to 2000 mm, most of which is irregular and falls as intense storms during the monsoon season stretching from July to September. Woodlands, dominated by conifers such as Abies pindrow, Cedrus deodara, Pinus roxburghii, and Pinus wallichiana, and open grasslands, mainly cover the area.
The ethnic composition of the region is quite diverse and complex: Gujjars, Sudhans, Rajputs and Jats are considered to be the major ethnic groups living in the area. Gujjars are the largest group; Rajputs who are spread across the region and Sudhans, mostly settled in Rawalakot, are regarded as the influential ethnic groups in Azad Kashmir. Almost all of them are Muslims. According to the last census in 2014 there are 4,980 households in Rawalakot and each household comprises an average of 7.6 members. This high demographic density can be explained by the higher work opportunities in Rawalakot where most dwellers are engaged, directly or indirectly, with the tourism sector. In contrast, the rural population largely depends on subsistence agriculture, livestock, forestry and formal employment. Agriculture is based on rain-fed cropping system and the main crop of the region is maize.

Ethnobotanical data collection

Fieldwork was carried out from August 2013 to July 2014. Before initiating our survey Ethical approval for the study was obtained from the COMSATS Institute of Information Technology ethics Committee. Legal permission was taken from representatives of the municipality for conducting the interview. All respondents were asked to sign a prior informed-consent form after the objectives and possible consequences of the study had been explained. The prior informed consent (PIC) form was translated into the local Pothwari language. Ethnobotanical information was collected from native inhabitants of the valley by using semi-structured questionnaires. This method allows a large number of participants to be interviewed in a relatively short period of time by asking the same questions within a flexible framework. All the interviews were carried out in the local dialect, Pothohari. A total of 64 informants, ranging in age from 35 to 70 years, were selected by convenience sampling (i.e., a sampling method in which units are selected based on easy access or availability) “Table 1”.

Fig 1. Map of the study area (http://www.pakimag.com/politics/by-election-la-22-sidhnoti-poonch-ajk-assembly.html/attachment/district-ponch-azad-kashmir-detail-map).

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| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|-----------------------------------|---------------------|--------|-----------|--------------------------------|---------------------|----------------|----|-----|----|
| 1 Abies pindrow Royle (HF-99)     | Partal, Paluder silver fir, Tree | Pinaceae | Leaf paste | External | Swelling | 48 | 0.75 | 1.03 |
|                                   |                     |        | Juice     | Internal | Antipyretic |                |                |     |     |    |
|                                   |                     |        | Bark Powder | Internal | Cough chronic asthma. |                |                |     |     |    |
|                                   |                     |        | Bark Tea | Internal | Rheumatism |                |                |     |     |    |
|                                   |                     |        | Resin Resin | External | Wounds. |                |                |     |     |    |
|                                   |                     |        | Root Decoction | Internal | Cough, bronchitis |                |                |     |     |    |
| 2 Achillea millefolium L. (HF-77) | Yarrow, Herb | Asteraceae | Flower Extract | Internal | Refrigerante | 24 | 0.38 | 0.33 |
|                                   |                     |        | Leaves Powder | External | Toothache |                |                |     |     |    |
| 3 Achyranthes aspera var. perphyristachya Hook. F. (HF-126) | Puth kanda, Herb | Amaranthaceae | Root Decoction | Internal | Inflammation | 21 | 0.33 | 0.38 |
|                                   |                     |        | Leaves | | Pain |                |                |     |     |    |
| 4 Adhatoda zeylanica L. (HF-139) | Bahkar, Herb | Acanthaceae | Bark Powder | Internal | Stomachache | 35 | 0.55 | 0.59 |
|                                   |                     |        | Leaves | | Constipation |                |                |     |     |    |
|                                   |                     |        | Root | | Asthma |                |                |     |     |    |
|                                   |                     |        | | | Cough |                |                |     |     |    |
| 5 Adiantum capillus-veneris L. (HF-101) | Hansraj, Sraj fern | Adiantaceae | Leaves Decoction | Internal | Cough | 57 | 0.89 | 0.97 |
|                                   |                     |        | | | Boils |                |                |     |     |    |
|                                   |                     |        | | | Asthma |                |                |     |     |    |
|                                   |                     |        | | | Jaundice |                |                |     |     |    |
|                                   |                     |        | | | Fever |                |                |     |     |    |
|                                   |                     |        | | | Diabetes |                |                |     |     |    |
|                                   |                     |        | | | Eczema |                |                |     |     |    |
|                                   |                     |        | | | Measles |                |                |     |     |    |
|                                   |                     |        | | | Chest pain |                |                |     |     |    |
| 6 Adiantum incisum Forssk (HF-120) | Sumbul, Hansraj, Fern | | Leaves Juice | Internal | Scabies | 44 | 0.69 | 0.64 |
|                                   |                     |        | | | Cough |                |                |     |     |    |
|                                   |                     |        | | | Antipyretic |                |                |     |     |    |
|                                   |                     |        | | | Bodyache |                |                |     |     |    |
| 7 Aesculus indica (Wall.ex Camb., Hook.f. (HF-91) | Bankhore, Horsechestnut, Tree | Hippocastanaceae | Bark Infusion | Internal | Tonic | 33 | 0.52 | 0.5 |
|                                   |                     |        | Fruits Eaten | Internal | Colic, Rheumatim |                |                |     |     |    |
|                                   |                     |        | Seed Powder | Internal | Leucorrhoea |                |                |     |     |    |
| 8 Ajuga bracteosa Wall, ex Benth (HF-82) | Ratti booti, Herb | Lamiaceae | Aerial parts Extract | Internal | Blood purifier | 58 | 0.91 | 1 |
|                                   |                     |        | | | Pimples |                |                |     |     |    |
|                                   |                     |        | | | Eruption |                |                |     |     |    |
|                                   |                     |        | | | Inflammation |                |                |     |     |    |
|                                   |                     |        | | | Earache |                |                |     |     |    |
|                                   |                     |        | | | Pain |                |                |     |     |    |
|                                   |                     |        | | | Toothache |                |                |     |     |    |
|                                   |                     |        | | | Boils |                |                |     |     |    |

(Continued)
### Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family          | Part Used | Method of preparation/property | Mode of application | Disease treated          | FC  | RFC | UV |
|-----------------------------------|----------------------|-----------------|-----------|---------------------------------|---------------------|--------------------------|-----|-----|----|
| 9 Albizia lebbeck L. Bth. (HF-89) | Shirin, Tree         | Mimosaceae      | Seeds     | External Inflammation           | Leukoderma          | 97                        | 0.89| 0.83|     |
|                                  |                      |                 | Bark      | Powdered                        | Strengthen spongy gums |                          |     |     |     |
|                                  |                      |                 | Bark and seeds | Extract                          | Haemorrhoids        |                          |     |     |     |
|                                  |                      |                 | Flowers   | Paste                           | Carbuncles          |                          |     |     |     |
|                                  |                      |                 | Seed      | Oil                             | Snake bite          |                          |     |     |     |
| 10 Allium griffithianum Boiss (HF-83) | Piazi, Herb          | Alliaceae       | Aerial parts | Cooked                           | Carminative         | 29                        | 0.45| 0.53|     |
|                                  |                      |                 | Leaves    | Juice                           | Dyspepsia           |                          |     |     |     |
|                                  |                      |                 |           |                                 | Pain                |                          |     |     |     |
| 11 Alysicarpus bupleurifolius L. D.C (HF-84) | Buffalo clover, Herb | Papilionaceae | Leaves    | Juice                           | Blood purifier      | 15                        | 0.23| 0.22|     |
|                                  |                      |                 |           |                                 |                    |                          |     |     |     |
| 12 Anaphalis adnata D.C (HF-20) | Dialect, Herb        | Asteraceae      | Leaves    | Powder                          | Bleeding            | 19                        | 0.3 | 0.42|     |
|                                  |                      |                 |           |                                 | Wound               |                          |     |     |     |
| 13 Androsace rotundifolia Hardwicke (HF-10) | Thandi jari, Herb | Primulaceae     | Rhizome   | Extract                         | Ophthalmic          | 25                        | 0.39| 0.67|     |
|                                  |                      |                 | Leaves    | Infusion                         | Stomachache         | Emetic                    |     |     |     |
| 14 Anemone tetrasepala Royle (HF-61) | Herb                 | Ranunculaceae   | Roots     | Juice                           | Boils               | 12                        | 0.19| 0.34|     |
| 15 Aquilegia pubiflora Wall ex Royle. (HF-61) | Herb                 | Ranunculaceae   | Root      | Paste                           | Snake bite          | 37                        | 0.58| 0.45|     |
|                                  |                      |                 |           |                                 | Toothache           | Emetic                    |     |     |     |
|                                  |                      |                 | Flower    | Paste                           | Skin burns          | Wound                     |     |     |     |
| 16 Artemisia absinthium L. (HF-46) | Afsanthene, Herb     | Asteraceae      | Leaves    | Infusion, paste                 | Anthelmintic        | 51                        | 0.8 | 0.98|     |
|                                  |                      |                 |           |                                 | Cuts                | Wounds                    |     |     |     |
|                                  |                      |                 |           |                                 | Stomach disorders   | Pain                      |     |     |     |
| 17 Artemisia dubia Wall. ex Bess. (HF-17) | Afsanthene, Herb     | Asteraceae      | Seeds     | Cooked                           | Weakness after delivery. | 23                        | 0.36| 0.52|     |
|                                  |                      |                 | Leaves    | Paste                           | Cuts                | Ear diseases              | Wounds |     |     |
|                                  |                      |                 | Aerial parts | External                         | Vermicide           |                           |     |     |     |

(Continued)
| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|-----------------------------------|---------------------|--------|----------|--------------------------------|---------------------|----------------|----|-----|----|
| 18 Artemisia maritime L. (HF-16) | Afsanthe ne, Herb   | Asteraceae | Leaves | Paste                         | External            | Skin infections. | 41 | 0.64 | 0.77 |
|                                   |                     |         | Leaf and stem | Powder                        | Internal            | Intestinal parasites. |   |      |     |
| 19 Asparagus filicinus Ham. in D. Don (HF-23) | Macher ghas, Herb | Liliaceae | Root | Decoction                        | Internal            | Nervous stimulant. | 38 | 0.59 | 0.66 |
| 20 Athyrium tenuifrons Wall.apud Moore ex. R.Sim (HF-123) | Dandasa, Fern       | Adiantaceae | Root | Tea                           | Internal            | Bodyache         | 32 | 0.5  | 0.58 |
|                                   |                     |         | Root | Powder                        | External            | Wound            |    |      |     |
| 21 Berberis aristata DC. (HF-26) | Doody, Indian barberry, Herb | Berberidaceae | Bark | Tooth stick                  | External            | Mouth Inflammation | 21 | 0.33 | 0.38 |
|                                   |                     |         | Leaves | Decoction                        | Internal            | Backache         |    |      |     |
|                                   |                     |         | Fruit | Paste                         | External            | Dental, Prophylaxis |   |      |     |
| 22 Berberis lycium Royle (HF-81) | Sumblu, Shrub       | Berberidaceae | Roots | Extract                        | Internal            | Tonic            | 59 | 0.92 | 0.98 |
|                                   |                     |         |         |                                |                     | Hemorrhoids      |    |      |     |
|                                   |                     |         |         |                                |                     | Diabetes         |    |      |     |
|                                   |                     |         |         |                                |                     | Eye lotion        |    |      |     |
|                                   |                     |         |         |                                |                     | Skin disease      |    |      |     |
|                                   |                     |         |         |                                |                     | Chronic diarrhea  |    |      |     |
|                                   |                     |         |         |                                |                     | Blood purifier    |    |      |     |
|                                   |                     |         |         |                                |                     | Scabies           |    |      |     |
|                                   |                     |         |         |                                |                     | Fracture          |    |      |     |
| 23 Bergenia ciliata (Haw.)Sternb. (HF-18) | Zakhm-e-Hayat, Herb | Saxifragaceae | Aerial parts | Powder                        | Internal            | Urinary tract troubles | 29 | 0.45 | 0.39 |
|                                   |                     |         |         |                                |                     | Ear ache          |    |      |     |
|                                   |                     |         |         |                                |                     | Cough             |    |      |     |
|                                   |                     |         |         |                                |                     | Kidney stones     |    |      |     |
| 24 Calendula officinalis L. (HF-138) | Sadberga, Herb     | Asteraceae | Young branches | Extract                        | Internal            | Kidney stones     | 46 | 0.72 | 0.98 |
|                                   |                     |         |         |                                |                     | Kidney stones     |    |      |     |
| 25 Calotropis procera (Alton) W. T.Alton (HF-59) | Ak, Shurb | Asclepiadaceae | Latex | Latex | External | Aphrodisiacs | 35 | 0.55 | 0.59 |
|                                   |                     |         |         |                                |                     | Boils            |    |      |     |
| 26 Caltha alba var. alba Camb. var. alba (HF-26) | Herb | Ranunculaceae | Aerial parts | Juice | Internal | Antispasmodic | 29 | 0.45 | 0.28 |
|                                   |                     |         |         |                                |                     | Sedative          |    |      |     |
| 27 Campanula benthamii/Wall. (HF-63) | Herb | Companulaceae | Root | Chewing | External | Strengthen heart | 19 | 0.3  | 0.36 |
|                                   |                     |         |         |                                |                     | Ear ache          |    |      |     |
| 28 Carissa opaca Stapf. ex Haines (HF-32) | Garanda, Small tree | Apocynaceae | Fruit | Powder | Internal | Pain            | 35 | 0.55 | 0.59 |
|                                   |                     |         |         |                                |                     | Inflammation      |    |      |     |
| 29 Carthamus tinctorius L. (HF-42) | Kasumba (zafran)    | Astreaceae | Flowers | Rubbing | Internal | Pneumonia       | 29 | 0.45 | 0.66 |
|                                   |                     |         |         |                                |                     | Boil              |    |      |     |
| 30 Castanea sativa Mill. (HF-19)  | Chita sanghara, Chest nut, Tree | Fagaceae | Leaves | Infusion | Internal | Antipiretics | 21 | 0.33 | 0.38 |
|                                   |                     |         | Leaves | Decoction | Internal | Pharyngitis |    |      |     |

(Continued)
| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|-----------------------------------|---------------------|--------|-----------|-------------------------------|---------------------|-----------------|----|-----|----|
| **31 Cedrela serrata Royle. (HF-24)** | Drawa, Tree | Meliaceae | Stem and bark | Paste | External | Round worms. | 54 | 0.84 | 0.83 |
| | | | Root | Juice | Internal | Dyspepsia, Diabetes | | | |
| | | | Leaves | Decoction | External | Refrigerante shampoo | | | |
| | | | Bark | Poultice | Internal | Ulcers | | | |
| | | | Bark | Powder | Internal | Chronic infantile dysentery | | | |
| **32 Celtis caucasica Willd (HF-72)** | Batkaral, Tree | Ulmaceae | Aerial parts | Juice | Internal | Pain, Amenorrhea | 17 | 0.27 | 0.45 |
| **33 Cichorium intybus L. (HF-142)** | Kahsni, Herb | Asteraceae | Roots | Juice | Internal | Antipyretic | 33 | 0.52 | 0.73 |
| **34 Clematis buchananiana DC. (HF-84)** | Langi, Shrub | Ranunculaceae | Leaves | Paste | External | Eczema | 43 | 0.67 | 0.75 |
| | | | | | | Psoriasis (type of skin diseases) | | | |
| | | | | | | Wound | | | |
| | | | Roots | Crushing and wrapping | External | Bleeding | | | |
| | | | Leaves | Juice | Internal | Swellings, inflammation | Peptic ulcers | | |
| **35 Clematis montana Buch. (HF-118)** | Langi, Shrub | Ranunculaceae | Leaves | Extract | Internal | Diabetes | 27 | 0.42 | 0.33 |
| | | | Flowers | Decoction | Internal | Cough | | | |
| **36 Conyza bonariensis (L.) Cronq. (HF-51)** | Buti, Herb | Asteraceae | Aerial parts | Infusion | Internal | Diarrhea | 41 | 0.64 | 0.77 |
| | | | | | | Haemorrhoids | Dysentery | | |
| **37 Cuscuta reflexa Roxb. (HF-131)** | Neela dari, Climber | Cuscutaceae | Whole plant | Juice | Internal | Jaundice | 21 | 0.33 | 0.38 |
| | | | | | | External | Dandruff | | |
| **38 Dalbergia sissoo Roxb. (HF-09)** | Tahli, Tree | Fabaceae | Stem bark | Juice | External | Eczema | 39 | 0.61 | 0.77 |
| | | | Crushed leaves | Juice | Internal | Blood purifier | | | |
| | | | Leaves | Washing | External | Increase hair length | | | |
| **39 Debregeasia salicifolia D.Don Rendle (HF-78)** | Sandari, Shrub | Urticaceae | Aerial parts | Paste | External | Eczema, dermatitis | 15 | 0.23 | 0.41 |
| **40 Desmodium polycarpum DC. (HF-83)** | Mangkith-parang, Shrub | Papilionaceae | Roots | Juice | Internal | Antipyretic | 34 | 0.53 | 0.88 |
| | | | | | | Helminthiasis | Haemorrhoid | |
| | | | | | | Antipyretic | Cough | |
| | | | | | | Cardiac tonic | Diuretic | |
| | | | | | | Loss of appetite | Carminative | |
| | | | | | | Diarrhea | Dysentery | |

(Continued)
Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|------------------------------------|----------------------|-------|-----------|--------------------------------|---------------------|----------------|----|-----|----|
| 41 Desmostachya bipinnata L. Stapf. (HF-13) | Dab, Grass Poaceae | Roots | Tea | Internal | Hypertension | 14 | 0.22 | 0.17 |
| 42 Dicliptera bupleuroides Nees (HF-58) | Kirch, Somni, Herb Acanthaceae | Leaves | Paste | External | Wounds | 52 | 0.81 | 0.86 |
| | | Leaves | Decoction | External | Tonic | | | |
| | | | | | Cough | | | |
| 43 Dioscorea bulbifera L. (HF-57) | Herb Dioscoreaceae | Aerial parts | Juice | Internal | Contraceptive. | 41 | 0.64 | 0.81 |
| 44 Dioscorea deltoidea Wall. ex Kunth (HF-50) | Herb Dioscoreaceae | Rhizome | Taken as raw form | Internal | Insect killer | 36 | 0.56 | 0.48 |
| | | | | | Snake bite | | | |
| 45 Duchesnea Andrews) Focke (HF-84) | Budimewa, Herb Rosaceae | Fruit | Juice | Internal | Eye Infection | 33 | 0.52 | 0.61 |
| | | | | | Tonic | | | |
| 46 Elaeagnus angustifolia L. (HF-92) | Sinjit, Tree Elaeagnaceae | Ripe fruits | Boiled | Internal | Pharyngitis, Antipyretic | 29 | 0.45 | 0.66 |
| | | Fruit | Taken as raw form | Internal | Cough | | | |
| | | | | | Fever | | | |
| 47 Elaeagnus umbellata Thunb. (HF-94) | Chota zaton, Russian olive, Tree Elaeagnaceae | Leaves | Decoction | Internal | Cough | 33 | 0.52 | 0.73 |
| | | Flowers | Decoction | Internal | Heart diseases. | | | |
| | | Seeds | Taken as raw form | Internal | Immunity | | | |
| | | Branch | Exude | External | Toothache | | | |
| 48 Eriobotrya japonica Thumb. Lindler (HF-55) | Loquat, Tree Rosaceae | Leaves | Poultice | External | Swellings. | 44 | 0.69 | 0.89 |
| | | Fruits | Taken as raw form | Internal | Sedative Emetic | | | |
| | | Leaves | Infusion | Internal | Relieve diarrhea. | | | |
| | | Flowers | Infusion | Internal | Refrigerant e | | | |
| 49 Euphorbia helioscopia L. (HF-87) | Dhodhal, Dandlion, Herb Euphorbiaceae | Seeds | Juice | Internal | Cholera | 49 | 0.77 | 0.72 |
| | | Roots | Paste | Internal | Anthelmintic | | | |
| 50 Euphorbia wallichii Hk.f (HF-80) | Dhodhal Dandlion, Herb Euphorbiaceae | Aerial parts | Latex | Juice | Internal | Purgative Dyspepsia | 42 | 0.66 | 0.91 |
| | | | | | Purgative | | | |
| | | | | | Warts | | | |
| | | | | | Skin infections | | | |
| 51 Ficus carica L. (HF-54) | Phagwar, Tree Moraceae | Fruit | Taken as raw form | Internal | Stomachache Haemorrhoids | 52 | 0.81 | 0.95 |
| | | Leaves | Latex | External | Wounds | | | |
| | | Latex | Rubbing | External | Extract thorns from feet or other body organs. | | | |
### Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC  | RFC | UV  |
|-----------------------------------|----------------------|--------|-----------|--------------------------------|---------------------|----------------|-----|-----|-----|
| 52  *Ficus palmate* Forssk. (HF-32) | Phaghwar, Anjir, Tree | Moraceae | Fruit      | Taken as raw form              | Internal            | Demulcent       | 37  | 0.58| 0.84|
| 53  *Fragaria rubicola* Lindl. ex Lacaita (HF-87) | Budi meva, Wild Strawberry, Herb | Rosaceae | Fruit      | Chewed                         | Internal            | Purgative, Mouth infection | 35  | 0.55| 0.5 |
| 54  *Fumaria indica* (Hausskn.) Pugsley (HF-48) | Papa, Herb | Fumaricaceae | Aerial parts | Juice, Paste | Internal | Antipyretic, Skin infection, Purify blood, Pimples, Constipation, Eczema | 48  | 0.75| 0.84|
| 55  *Galium aparine* L. (HF-40) | Lainda, Herb | Rubiacaeae | Aerial parts | Powder | External | Bleeding | 15  | 0.23| 0.31|
| 56  *Galium asperifolium* Wall (HF-80) | Lainda, Herb | Rubiacaeae | Aerial parts | Juice | Internal | Diuretic, Kidney Infections | 22  | 0.34| 0.38|
| 57  *Gerbera gossypina* (Royle) Beauverd (HF-65) | Put Potula, Herb | Asteraceae | Leaves      | Paste | External | Skin diseases, Bone fracture, Wounds and cuts, Pain | 37  | 0.58| 0.66|
| 58  *Hedera nepalensis* K. Koch (HF-112) | Harbumbal epiphyte | Araliaceae | Leaves      | Decoction | Internal | Diabetes | 11  | 0.17| 0.13|
| 59  *Heracleum cachemirica* C.B. Clarke (HF-76) | Tukar, Shrub | Apiaceae | Aerial parts | Juice | Internal | Nerve disorders, Nausea | 18  | 0.28| 0.19|
| 60  *Heracleum candicans* Wall ex. DC (HF-85) | Herb | Apiaceae | Aerial parts | Tea | Internal | Nerve disorders | 12  | 0.19| 0.14|
| 61  *Hypericum perforatum* L. (HF-02) | Herb | Guttiferae | Flowers | Infusion | Internal | Snake bite, Wounds, Swellings, Rheumatism, Sores, Ulcers | 47  | 0.73| 0.61|
| 62  *Ipomoea carnea* Jac. (HF-142) | Jungli bakhir, Shurb | Convolvulaceae | Leaves | Paste | External | Athlete foot | 33  | 0.52| 0.73|
| 63  *Isodon rugosus* (Wall. ex. Benth.) Codd. (HF-35) | Khwangere, Shrub | Lamiaceae | Leaves | Decoction | Internal | Blood pressure, Toothache, Fever, Rheumatism | 37  | 0.58| 0.75|

(Continued)
### Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|------------------------------------|----------------------|--------|-----------|---------------------------------|---------------------|-----------------|----|-----|----|
| 64 **Jasminum mesnyi** Hance (HF-70) | Pili chambali, Shrub | Oleaceae | Leaves | Powder | External | Dandruff | 51 | 0.80 | 0.67 |
|                                    |                      |        |          | leaves chewing | Internal | Mouth ulcers |    |      |     |
|                                    |                      |        |          | branches ash | External | Headache |    |      |     |
|                                    |                      |        |          | dried flower powder | Internal | Hepatic disorders |    |      |     |
| 65 **Juglans regia** L. (HF-71)     | Akhrot, Khore, Tree | Juglandaceae | leaves | decoction | External | Antispasmodic | 51 | 0.8 | 0.92 |
|                                    |                      |        |          | bark rubbing | External | Lips and gums dye |    |      |     |
|                                    |                      |        |          | seeds oil | External | Rheumatism |    |      |     |
|                                    |                      |        |          | roots and leaves powder | External | Antiseptic |    |      |     |
| 66 **Launaea taraxacifolia** (Willd.) Amin (HF-134) | Hand, Herb | Asteraceae | whole plant | taken as raw form | Internal | Diabetes | 29 | 0.45 | 0.66 |
|                                    |                      |        |          |                |          | Pain |    |      |     |
| 67 **Lepidium sativum** L. (HF-136) | Haleon, Herb | Brassicaceae | seeds | cooked | Internal | Backache | 17 | 0.27 | 0.45 |
|                                    |                      |        |          |                |          | Diarrhea |    |      |     |
| 68 **Lespedeza juncea** L.f. (HF-06) | Herb | Papilionaceae | root | juice | Internal | Kill worms | 38 | 0.59 | 0.41 |
|                                    |                      |        |          |                |          | Dysentery |    |      |     |
| 69 **Ligustrum lucidum** Ait.f. (HF-111) | Guliston, Shrub | Oleaceae | aerial parts | extracts | Internal | Antitumor | 23 | 0.36 | 0.5 |
|                                    |                      |        |          |                |          | Joint inflammation |    |      |     |
| 70 **Malvastrum coromandelianum** (L.) Garcke (HF-03) | Herb | Malvaceae | aerial parts | decoction | Internal | Kill worms | 38 | 0.59 | 0.41 |
|                                    |                      |        |          |                |          | Dysentery |    |      |     |
| 71 **Mellilotus alba** Desr (HF-04) | Herb | Papilionaceae | leaves | paste | External | Joint inflammation | 15 | 0.23 | 0.3 |
|                                    |                      |        |          |                |          |                      |    |      |     |
| 72 **Mentha royleana** subsp. *hymalaensis* Briq. (HF-07) | Podina, Herb | Lamiaceae | leaves | juice, powder to make chattni | Internal | Stomach disorder | 58 | 0.91 | 0.97 |
|                                    |                      |        |          |                |          | Cough |    |      |     |
|                                    |                      |        |          |                |          | Antipretic |    |      |     |
|                                    |                      |        |          |                |          | Cholera |    |      |     |
|                                    |                      |        |          |                |          | Emetic |    |      |     |
|                                    |                      |        |          |                |          | Indigestion |    |      |     |
|                                    |                      |        |          |                |          | Gas trouble |    |      |     |
| 73 **Momordica charantia** L. (HF-129) | Khrelia, Climber | Cucurbitaceae | fruit | juice | Internal | Diabetes | 21 | 0.33 | 0.38 |
|                                    |                      |        |          |                |          | Pain |    |      |     |
| 74 **Momordica dioica** Roxb. ex Wild (HF-152) | Epiphyte | Cucurbitaceae | roots | cooked | Internal | Haemorrhoids | 15 | 0.23 | 0.17 |
|                                    |                      |        |          |                |          | Urinary problem |    |      |     |
| 75 **Myrsine africana** L. (HF-60) | Gorkhan, Chapra, Bebrang, Shrub | Myrsinaceae | fruits | powder | Internal | Stomachach and Purgative | 75 | 0.9 | 0.88 |
|                                    |                      |        |          |                |          | Antihelminthic |    |      |     |
|                                    |                      |        |          |                |          | Parminative |    |      |     |
|                                    |                      |        |          | leaves decoction | Internal | Blood purifier |    |      |     |

(Continued)
Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC  | RFC  | UV  |
|------------------------------------|----------------------|--------|-----------|--------------------------------|--------------------|----------------|-----|------|-----|
| 76 Nepeta erecta (Boyle ex Benth.) Berth. (HF-50) | Herb | Lamiaceae | Flowers Juice | Internal | Cough | 53 | 0.83 | 0.78 |
|                                    | Leaves Juice | Internal | Blood Pressure | Toothache | Flu |  |
|                                    |                                    |            | Antipyretic | Fever | | |
| 77 Nepeta laevigata D.Don Hand (HF-53) | Herb | Lamiaceae | Fruit Infusion | Internal | Dysentery | 17 | 0.27 | 0.22 |
| 78 Nerium oleander L. (HF-37) | Kanair, Tree | Apocynaceae | Leave Paste | External | Cutaneous eruption | 46 | 0.72 | 0.98 |
|                                    | Leave Decoction | Internal | Wounds | Swelling | | |
|                                    | Bark Decoction | Internal | Eczema, leprosy | | | |
|                                    | Roots Powder | Internal | Abortion | | | |
|                                    | Roots Paste | External | Scorpion sting, snakebite | | | |
| 79 Oenothera rosea L. Her. ex. Ait (HF-91) | Buti, Herb | Onagraceae | Leaves Infusion | Internal | Hepatic pain | 45 | 0.7 | 0.64 |
|                                    | | | Kidney disorders | | | |
| 80 Opuntia dillenii Haw. (HF-142) | Thor, Shurb | Cactaceae | Whole plant Paste | External | Joints pain | 33 | 0.52 | 0.5 |
| 81 Parthenium hysterophorus L. (HF-07) | Herb | Asteraceae | Root Decoction | Internal | Eczema | 35 | 0.55 | 0.59 |
|                                    | | | Dysentery | | | |
| 82 Pimpinella stewartii Dunn. E. Nasir (HF-08) | Tarpakki, Herb | Apiaceae | Fruit Taken as raw form | Internal | Stomachache | 12 | 0.19 | 0.3 |
| 83 Pinus roxburghii Roxb (HF-94) | Chir, Tree | Pinaceae | Leaves bark Powder Juice | Internal | Dysentery | 58 | 0.91 | 1.13 |
|                                    | Resin Poulstice | Internal | Ulcer | Tumor | Bleeding | Cough | Snake bite | Wound | |
| 84 Pinus wallichiana A.B. Jackson (HF-58) | Biar, blue pine, Tree | Pinaceae | Resin Poulstice | External | Wound | 42 | 0.66 | 0.84 |
| 85 Pistacia chinensis ssp. Integerima (J. L. Stewart) Rech. f. (HF-22) | Kangar, Tree | Anacardiaceae | Stem gum Powder | Internal | Dysentery | 43 | 0.67 | 0.91 |
|                                    | Bark Paste | External | Cracked heels | Wound | | |
| 86 Plantago lanceolata L. (HF-88) | Ispgol, Herb | Plantaginaceae | Leaves Paste | External | Wound | 53 | 0.83 | 0.91 |
|                                    | Seeds Extract | Internal | Toothache | Purgative | Hemostatic | Dysentery | | |

(Continued)
| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC   | RFC | UV   |
|-----------------------------------|---------------------|--------|-----------|--------------------------------|---------------------|----------------|------|-----|------|
| 87 Poa nepalensis Walls ex. Duthie. (HF-131) | Grass | Poaceae | Leaves | Decoction mixed with water | External | Anti-lice | 29   | 0.45 | 0.42 |
| 88 Podophyllum emodi/Wall ex Royle (HF-87) | Bahanaki Herb | Podophyllaceae | Root | Extract | Internal | Purgative, Liver, Stomachache | 48   | 0.75 | 0.83 |
| 89 Polygonatum multiflorum L. Smith (HF-78) | Herb | Liliaceae | Leave | Paste | External | Wound | 17   | 0.27 | 0.19 |
| 90 Polystichum squarrosum (D. Don) Féé (HF-114) | Gha, Fern | Dryopteridaceae | Root | Decoction | Internal | Pyloric disease | 13   | 0.2  | 0.3  |
| 91 Prunella vulgaris L. (HF-63) | Herb | Lamiaceae | Seeds | Taken as raw form | Internal | Purgative Antipyretic Tonic Eye sight weakness Astama Heart diseases Inflammation Diuretic | 58   | 0.91 | 0.98 |
| 92 Prunus armeniaca L. (HF-24) | Har, Khubani, Apricot, Tree | Rosaceae | Fruit | Taken as raw form | Internal | Purgative | 31   | 0.48 | 0.39 |
| 93 Prunus domestica L. (HF-31) | Lucha, Alu bukharra, Tree | Rosaceae | Fruit | Taken as raw form | Internal | Miscarriage Irregular menstruation debility | 34   | 0.53 | 0.84 |
| 94 Prunus persica L. Batch (HF-49) | Aru, Peach, Tree | Rosaceae | Leaves | Juice | Internal | Chest infection Gastritis Whooping cough Bronchitis Intestinal Anthelmatic Anthelmatic for cattles | 44   | 0.69 | 0.88 |
| 95 Pteris cretica L. (HF-158) | Cretan brake, Fern | Pteridaceae | Leaves | Paste | Internal | Wound | 9    | 0.14 | 0.17 |
| 96 Punica granatum L. (HF-22) | Druna, Tree | Punicaceae | Fruit | Taken as raw form | Internal | Cough, tonic Dysertery | 52   | 0.81 | 1    |

(Continued)
| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC  | RFC | UV  |
|-----------------------------------|----------------------|--------|-----------|--------------------------------|---------------------|----------------|-----|-----|-----|
| 97 Pyrus malus L. (HF-26)          | Saib, Tree           | Rosaceae | Fruit     | Juice, paste                   | Internal            | Rheumatism     | 46  | 0.72| 0.81|
|                                  |                      |         |           |                                |                     | Hypertension    |     |     |     |
|                                  |                      |         |           |                                |                     | Tonic for vigorous body |     |     |     |
|                                  |                      |         |           |                                |                     | Fracails        |     |     |     |
|                                  |                      |         |           |                                |                     | Strengthen bones |     |     |     |
|                                  |                      |         |           |                                |                     | Constipation    |     |     |     |
| 98 Pyrus pashia Ham.ex.D.Don (HF-17) | Butangi, Tree       | Rosaceae | Fruit     | Taken as raw form              | Internal            | Eye dark circles | 49  | 0.77| 0.95|
| 99 Quercus baloot Griff (HF-90)   | Rein, Shah baloot, Oak, Tree | Fagaceae | Bark      | Powder                         | Internal            | Asthma         | 43  | 0.67| 0.86|
|                                  |                      |         | Nut       | Decocction                      | Internal            | Urinary problems, cough, cold |     |     |     |
| 100 Quercus dilatata Royle (HF-68) | Oak, Barungi, Tree   | Fagaceae | Fruit     | Powder                         | Internal            | Tonic          | 47  | 0.73| 0.36|
|                                  |                      |         | Bark      | Decocction                      | Internal            | Dysentery      |     |     |     |
| 101 Quercus incana Roxb. (HF-49)  | Rein, Ban, Rinji, Tree | Fagaceae | Bark      | Powder                         | Internal            | Asthma         | 41  | 0.64| 0.95|
|                                  |                      |         |           |                                |                     | Antypiretic     |     |     |     |
|                                  |                      |         |           |                                |                     | Rheumatism      |     |     |     |
|                                  |                      |         |           |                                |                     | Backache        |     |     |     |
|                                  |                      |         |           |                                |                     | Cough           |     |     |     |
| 102 Ranunculus muricatus L. (HF-76) | Herb                | Ranunculaceae | Aerial parts | Cooked                          | Internal            | Asthma         | 14  | 0.22| 0.19|
| 103 Robinia pseudoacacia L. (HF-83) | Kikar, Tree         | Papilionaceae | Bark     | Chewing                        | External            | Toothache      | 31  | 0.48| 0.8  |
| 104 Rosa brunonii Lindl. (HF-121) | Chal, Tarni, Musk Rose, Shrub | Rosaceae | Flower     | Decocction                      | Internal            | Constipation   | 49  | 0.77| 0.84|
|                                  |                      |         | Flowers   | Powder                          | Internal            | Diarrhea        |     |     |     |
|                                  |                      |         |           |                                |                     | Heart tonic     |     |     |     |
|                                  |                      |         |           |                                |                     | Eye diseases    |     |     |     |
|                                  |                      |         |           |                                |                     | Eczema          |     |     |     |
|                                  |                      |         |           |                                |                     | Wounds          |     |     |     |
| 105 Rubus fruticosus Hk f. non L (HF-50) | Garachey, Shrub | Rosaceae | Leaves    | Infusion                        | Internal            | Diarrhea        | 57  | 0.89| 0.98|
|                                  |                      |         |           |                                |                     | Antypiretic     |     |     |     |
|                                  |                      |         | Bark      | Soaking                         | Internal            | Diabetes        |     |     |     |
| 106 Rubus niveus Thunb. (HF-100)  | Garachey, Shrub     | Rosaceae | Leaves    | Extract                         | External            | Urticaria (skin disease) | 32  | 0.5 | 0.59|
|                                  |                      |         | Leaves    | Powder                          | Internal            | Diarrhea        |     |     |     |
|                                  |                      |         |           |                                |                     | Diuretic        |     |     |     |
|                                  |                      |         |           |                                |                     | Antypiretic     |     |     |     |
|                                  |                      |         | Root      | Decocction                      | Internal            | Dysentery       |     |     |     |
|                                  |                      |         |           |                                |                     | Colic pains     |     |     |     |
|                                  |                      |         |           |                                |                     | Whooping coughs |     |     |     |
|                                  |                      |         |           |                                |                     | Diarrhea        |     |     |     |
| 107 Rumex dentatus L. (HF-101)    | Jangli Palak Herb   | Polygonaceae | Leaves    | Paste                           | External            | Wound           | 41  | 0.64| 0.59|
|                                  |                      |         | Roots     | Paste                           | External            | Eczema          |     |     |     |

(Continued)
| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV  |
|-----------------------------------|---------------------|--------|-----------|---------------------------------|--------------------|-----------------|-----|-----|-----|
| 108 *Rumex hastatus* L. (HF-44)    | Khatimal, Shrub     | Polygonoceae | Roots     | Juice                           | Internal           | Asthma          | 32  | 0.5 | 0.64 |
|                                   |                     |         |           |                                 |                    | Weakness in cattle |     |     |      |
|                                   |                     |         |           |                                 |                    | Antipyretic     |     |     |      |
|                                   |                     |         |           |                                 |                    | Cough           |     |     |      |
| 109 *Salix acmophylla* Boiss. (HF-85) | Beens, Bed, Gaith, Tree | Salicaceae | Leaves | Paste, boiled with *Robinia pseudoacacia* and *Cotula anthemoidis* | Internal           | Boils           | 51  | 0.8 | 0.98 |
|                                   |                     |         |           | Branch                          | Chewing            | Hemia           |     |     |      |
|                                   |                     |         |           |                                 |                    | Antipyretic     |     |     |      |
|                                   |                     |         |           |                                 |                    | Joints          |     |     |      |
|                                   |                     |         |           |                                 |                    | Inflammation    |     |     |      |
|                                   |                     |         |           |                                 |                    | Stomachache     |     |     |      |
| 110 *Salix denticulata* Andersson (HF-79) | Terik, Jangali Bed, Tree | Salicaceae | Stem and root bark | Boiled | Internal           | Headache         | 34  | 0.53| 0.39 |
|                                   |                     |         |           | Leaves, branches                | Paste              | Antipyretic     |     |     |      |
|                                   |                     |         |           |                                 |                    | Paralysis       |     |     |      |
| 111 *Salvia hians* Royle (HF-107) | Herb                | Lamiaceae | Leaves       | Juice                           | Internal           | Cough           | 31  | 0.48| 0.66 |
|                                   |                     |         |           |                                 |                    | Fever           |     |     |      |
|                                   |                     |         |           |                                 |                    | Anxiety         |     |     |      |
| 112 *Salvia lanata* Roxb. (HF-51) | Herb                | Lamiaceae | Leaves | Poultice                         | External           | Eczema          | 27  | 0.42| 0.48 |
|                                   |                     |         |           |                                 |                    | Wound           |     |     |      |
| 113 *Salvia moorcroftiana* Wall. Ex Benth (HF-59) | Kaljari, Herb | Lamiaceae | aerial parts | Juice | Internal           | Diarrhea         | 51  | 0.8 | 0.89 |
|                                   |                     |         |           |                                 |                    | Gas trouble     |     |     |      |
|                                   |                     |         |           |                                 |                    | Cough           |     |     |      |
|                                   |                     |         |           |                                 |                    | Stomachache     |     |     |      |
| 114 *Sambucus wightiana* Wall. ex Wight & Arn. (HF-52) | Gandala, Herb | Caprifoliaceae | Fruit | Taken as raw form | Internal | Stomachache | 19  | 0.3 | 0.5  |
|                                   |                     |         |           |                                 |                    | Anthelmintic    |     |     |      |
| 115 *Sapindus mukorossi* Gaertn. (HF-79) | Ritwa, Soap nut, Tree | Sapindaceae | Seeds | Powdered                         | External           | Antihelmintic   | 47  | 0.73| 0.77 |
|                                   |                     |         |           | Fruits                          | Rubbing            | Stomachache     |     |     |      |
|                                   |                     |         |           |                                 |                    | Anthelmintic    |     |     |      |
| 116 *Sarcococca saligna* D. Don Muell (HF-66) | Bansathra, Shrub | Buxaceae | Leaves and shoots | Decoction | Internal | Joints pain | 23  | 0.36| 0.23 |
|                                   |                     |         |           |                                 |                    | Blood purifier  |     |     |      |
|                                   |                     |         |           |                                 |                    | Purgative       |     |     |      |
|                                   |                     |         |           | Leaves                          | Powder             | Burns           |     |     |      |
|                                   |                     |         |           |                                 |                    | Root             |     |     |      |
|                                   |                     |         |           |                                 | Juice              | Gonorrhea.      |     |     |      |
| 117 *Saussurea candolleana* Wall. Ex. D.C Clarke (HF-84) | Herb | Asteraceae | Roots | Extract                         | Internal           | Tonic           | 23  | 0.36| 0.28 |
| 118 *Skimmia laureola* DC. Sieb (HF-08) | Nazar Panra, Tree | Rutaceae | Leaves | Powdered | External | Smallpox, anthelmintic, colic. | 48  | 0.75| 0.59 |
| 119 *Smilax glaucophylla* Klotroch (HF-115) | Epiphyte | Smilicaceae | Aerial parts | Infusion | Internal | Carminative | 32  | 0.5 | 0.55 |
|                                   |                     |         |           |                                 |                    | Dog bite        |     |     |      |
|                                   |                     |         |           |                                 |                    | Spasm           |     |     |      |
|                                   |                     |         |           |                                 |                    | Antipyretic     |     |     |      |
Table 1. (Continued)

| Scientific Name and voucher number | Local name and habit | Family     | Part Used | Method of preparation/property | Mode of application | Disease treated                        | FC | RFC | UV  |
|------------------------------------|----------------------|------------|-----------|--------------------------------|---------------------|----------------------------------------|----|-----|-----|
| 120 Sophora mollis (Royle) Baker (HF-56) | Buna, Sakina, Shrub | Papilionaceae | Flowers   | Powder                          | External            | Pimples                               | 21 | 0.33| 0.36|
| 121 Swertia ciliate G.Don B. L. Burtt (HF-75) | Herb                | Gentianaceae | Aerial part | Decoction                       | Internal            | Cough                                 | 48 | 0.75| 0.88|
| 122 Taraxacum officinale F.H. Wigg (HF-102) | Handh, Herb         | Asteraceae  | Roots     | Decoction                       | Internal            | Jaundice                              | 56 | 0.88| 0.92|
| 123 Themeda anantha Nees ex Steud.Anderss. (HF-39) | Grass               | Poaceae     | Aerial parts | Poulstice                       | External            | Backache                              | 41 | 0.64| 0.5 |
| 124 Thymus linariar Benth. Subsp. Liniaris Jalas (HF-105) | Herb                | Lamiaceae   | leaves and flowers | Powder | Internal | Strengthen teeth and gum | 32 | 0.5 | 0.64|
| 125 Trichodesma incanum (Bunge) A. DC. (HF-145) | Handusi booti Herb | Boraginaceae | Leaves    | Boiling                         | Internal            | Flu                                    | 31 | 0.48| 0.48|
| 126 Trichodesma indicum (L.) R. Br. (HF-178) | Handusi, Herb       | Boraginaceae | Whole plant | Cooked                          | Internal            | Backache                              | 41 | 0.64| 0.5 |  
| 127 Valeraina jatamansi Joes (HF-77) | Herb                | Valerianaceae | Aerial parts | Oil | Internal | Constipation                           | 19 | 0.3 | 0.41|
| 128 Verbascum thapsus L. (HF-107) | Gider tabacoo Herb  | Valerianaceae | Roots     | Decoction                       | Internal            | Toothache                             | 17 | 0.27| 0.25|
| 129 Viburnum nervosum D.Don (HF-78) | Taliana, Shrub      | Caprifoliaceae | Fruit     | Taken as raw form               | Internal            | Stomachache                            | 15 | 0.23| 0.3 |
| 130 Viburnum cotinfolium D. Don (HF-95) | Taliana, Shrub      | Caprifoliaceae | Fruit     | Taken as raw form               | Internal            | Purgative                              | 31 | 0.48| 0.33|
| 131 Viburnum grandiflorum Wall. ex.DC (HF-47) | Guch, Shrub         | Caprifoliaceae | Seed      | Juice                           | Internal            | Typhoid                               | 25 | 0.39| 0.2 |
| 132 Vincetoxicum hirundinaria Medicres (HF-109) | Herb                | Asclepidaceae | Aerial parts | Decoction                       | Internal            | Boils                                 | 48 | 0.75| 0.8 |
| 133 Viola canescens Wall. ex Roxb. (HF-108) | Banafsha. Herb      | Violaceae    | Leaves    | Juice                           | Internal            | Cough                                 | 51 | 0.8 | 0.84|  

(Continued)
Interviews were carried out complying with the ethics guidelines commonly followed in ethnobotanical studies, and the informants’ written consent was obtained prior to the interviews. In order to ensure that the information was as unbiased as possible, we tried to avoid the presence of other people during the interviews. Participant observation was also used in order to better interpret and analyze the data reported by informants. The information collected concerned both diseases (the most frequent ones, ways of classifying and diagnosing them, etc.) and medicinal plants (local names, indications of use, plant parts used, places/methods/rituals of gathering, utilization and administration).

Voucher specimens were gathered using the informants’ indications, prepared according to standard taxonomic methods, and conserved in our lab for future reference. For plant identification, we consulted the Flora of Pakistan [www.eflora.com]. Botanical nomenclature is presented in accordance with the International Plant Name Index (IPNI) [www.ipni.org].

### Research hypothesis

The hypothesis for the present study was, older people know more uses of plants than younger, formal education is not predictive of knowledge level about plants, and men tend to know more plant species/users than women. Species of plants are of unequal usage/importance to people. Across the range of species, its importance will vary, even among communities with the same cultural origin. In addition, it was also hypothesized that closely related plants are exploited in the treatment of almost similar diseases in cultures that are not much related thus are more likely to be independent discoveries of similar plant compounds and disease mechanisms.

| Scientific Name and voucher number | Local name and habit | Family | Part Used | Method of preparation/property | Mode of application | Disease treated | FC | RFC | UV |
|------------------------------------|---------------------|--------|-----------|--------------------------------|---------------------|-----------------|----|-----|----|
| 134 Viola pilosa Blume (HF-11)     | Banafsha. Herb      | Violaceae | Leaves    | Decoction                       | Internal            | Pain            | 47 | 0.73| 0.81|
|                                    |                     |         |           |                                 |                     | Antypiretic ulcer|    |      |     |
| 135 Zanthoxylum armatum DC. Prodr (HF-88) | Timbar, Shrub | Rutaceae | Fruit, branches | Juice | Internal | Carminative | 60 | 0.94| 1.13|
|                                    |                     |         |           |                                 |                     | Cholera         |    |      |     |
|                                    |                     |         |           |                                 |                     | Stomachache     |    |      |     |
|                                    |                     |         |           |                                 |                     | Gum, toothache  |    |      |     |
|                                    |                     |         |           |                                 |                     | Indigestion     |    |      |     |
|                                    |                     |         |           |                                 |                     | Haemorroids     |    |      |     |
|                                    |                     |         |           |                                 |                     | Stomachache     |    |      |     |
|                                    |                     |         |           |                                 |                     | Gum problems    |    |      |     |
|                                    |                     |         |           |                                 |                     | Toothache       |    |      |     |
|                                    |                     |         |           |                                 |                     | Chews           |    |      |     |
| 136 Ziziphus nummularia (Burm. f.) Wight & Arn. (HF-88) | Ber, Tree | Rhamnaceae | Fruit | Decoction | External | Dandruff | 51 | 0.8 | 0.98|
|                                    |                     |         |           |                                 |                     | Diarrhea and dysentery |    |      |     |

Key words: FC = Frequency of citation; RFC = Relative Frequency of Citation; UV = Use Value

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Quantitative ethnobotanical data analysis

To determine whether a statistically significant correlation exists between the numbers of plants mentioned and the informant’s age, we used the Spearmann test. The Mann-Whiney U and Kruskal-Wallis tests were used to find significant differences between two and among 5 groups related groups, respectively, all set at 0.5 alpha level of significance.

Some quantitative indices commonly adopted in ethnobotanical studies were used to analyze the data collected through the interviews [29]. Relative frequency of citations (RFC) and use value (UV) was used to access relative importance of plant species cited by informants.

Frequency of citations was estimated as

\[ RFC = \frac{FC}{N} \]

Where FC is the number of informants reporting the use of a particular species and N is the total number of informants.

Use value [30] was estimated as

\[ UV = \frac{\sum Ui}{N} \]

Where Ui is the number of uses mentioned by each informant for a given species and N is the total number of informants.

Informant consensus factor (ICF)

Informant consensus factor was used to identify the most trusted healing plants for those disease categories that were claimed to be most common in the area following the approach of [31] by using the following formula:

\[ ICF = \frac{Nur - Nt}{Nur - 1} \]

Where Nur is the number of use-reports in each disease category and Nt is number of species used.

Jaccard index (JI)

JI was calculated in order to compare data reported in our study with previously published data collected from neighboring regions by using the following formula

\[ JI = \frac{c}{a + b - c} \times 100 \]

Where

a = number of species found only in area A
b = number of species found only in area B
c = number of species common to both areas

Results and discussion

Diversity of medicinal plants in the studied area

A total of 136 medicinal plant species belonging to 98 genera and 45 families were reported “Table 1”. They represent about 19–23% of the pool of medicinal plants that constitute the
pharmaceutical ethnoflora in alpine areas of Pakistan [32]. The most represented botanical family was Asteraceae (14 species, 10%), followed by Lamiaceae (11 species, 8.1%), Fabaceae and Rosaceae (5 species each, 3.7%), and Ranunculaceae (4 species, 2.9%). The other 41 families contributed with less than 4 species; among these 41 families, 26 (58% of all cited families) were represented with only 1 species. These results were in accordance with other ethnobotanical studies carried out in Pakistan [33–35] and were not surprising. In fact, Asteraceae, Lamiaceae, Fabaceae, Rosaceae are large, mostly cosmopolitan families that are known worldwide to be medicinal; for example, Asteraceae and Lamiaceae are rich in essential oils and are widely used in popular medicine around the world [36–38]. Rosaceae is rich in phenols, a group of substances that play an important role as anti-oxidants in the human diet [38]. Ranunculaceae is rich in active secondary metabolites and have a high number of pharmacological properties [39, 40]. On the other hand, all of these botanical families contain some plants commonly found in the Pakistan flora. In terms of the life form, most of the used species were herbaceous (55%) followed by trees (26%), shrubs (17%), and climbers (2%). As is generally found in alpine areas (see for example [24]), the use of herbaceous species is more frequent than the use of perennial woody species. This finding can be related to the composition and the structure of the vegetation of high altitude areas, where tree growth is made difficult by climatic conditions; on the other hand, herbal preparation methods and extraction of active metabolites are easier to carry out with herbaceous plants than woody materials [41].

**Herbal drug preparation and utilization.** Different plant parts are used differently in herbal medicines depending upon the cultural knowledge and availability of those parts to local inhabitants. Similarly to what reported in other studies [42, 43], leaves (31%) were the most common plant part used in herbal preparations followed by roots (15%) and fruits (12%) “Fig 2”. Leaves are the plant part directly involved in photosynthesis, producing several active compounds like sugars but also storing important secondary metabolites like terpenes, alkaloids, cyanogenic glycosides; these chemical substances are involved in complex plant-to-plant and plant-to-animal relations including defense against a variety of pests and predators and allelopathy and most of these substances are of medicinal value. Roots were the favored plant part in many other cases, possibly because hypogeous organs normally have a high content of secondary metabolites [44]. As reported in previous studies conducted in other areas of Pakistan [45, 46], the utilization of fruits is found to play an important role in the local pharmacopoeia; this can be related to the importance that some wild edible fruits assume as nutraceuticals and in preventing nutritional deficiencies. In 67 cases, different parts of the same plant were used to treat different diseases, for example, roots of *Berberis lyceum* were used internally for the treatment of chronic diarrhea, piles, diabetes, pustules and scabies while externally these were used to heal fractured bone and swellings.

The main method of preparation was decoctions (26 species) followed by juice and powder (24 species each), paste (22), chewing (eating in raw form as salad or fruits) (16 species), extract (11 species), infusion (10 species) and poultice (8 species) “Fig 3”. These results were in agreement with those reported in other studies [47–51]. Quantity and dosage of medicinal drugs were found to differ with age, state of health of the patient and severity of the treated disease for example decoction of *Elaeagnus umbellata* for heart diseases if someone is suffering from chronic cardiac problem then he must use this decoction for long time as compare to the patient who was suffering acute cardiac problems. *Ficus carica* is very effective in constipation, for child two to three fruits were effective but for adult four to five fruits were effective for the relief of constipation. The high usage of freshly prepared juice in ethnomedicines was an indication of the high abundance of medicinal plants in the study areas that can be freshly available and harvested anytime for use. The other reasons for the repeated use of fresh plant juice could be the facts that the drying process contributes to the loss of volatile oil and that proteins
Fig 2. Plants parts use in herbal recipes.

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Fig 3. Method of preparation of herbal recipes.

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become denatured at a high temperature. The measurements used to determine the dosages are not standardized and depend on the age and physical appearance of the patient, sociocultural explanation of the illness, diagnosis, and experience of the individual herbalist. Usually, the treatment of the patient is completed within a single day or a couple of days. When patients did not show any indication of improvement from their sickness following the completion of treatment, the physician referred them to a modern health center in an urban area for further examination [46, 52, 53].

Most of the cited plant drugs were administrated (82) as they are, but in some herbal preparations (50) they were mixed with other ingredients like milk, water, honey, oil or butter to treat specific diseases. Few species (4) were used in combination with other herbs, for example, leaves of *Salix acmophylla* boiled with *Robinia pseudoacacia* (leaves) and *Cotula anthemoids* (leaves) to treat fever and *hernia*. As hypothesized in other studies it is possible that interactions among different species involve strengthening of therapeutic effects as well as attenuation of toxicity or of adverse effects of some plants composing the mixture. Most of the herbal preparations were taken internally (68%) while few were also used externally (32%).

Most plants (84; 61.8%) were used in only one (42) or two (42) categories. *Berberis lyceum* and *Prunella vulgaris* were the most versatile species because their use was cited in 8 different medicinal categories followed by *Albizia lebbeck* (7 categories), *Desmodium polycarpum*, *Jasminum mesnyi* and *Pinus roxburghii* (6 categories). Medicinal plants were mainly used to treat digestive disorders (63 species), followed by skin problems (59 species) and respiratory problem.

Among the subcategories mentioned (corresponding to detailed medicinal uses), cough was treated with the highest number of different plants (28 species), followed by eczema (26), constipation (24), and fever (21). Thirty-nine subcategories (36%) were treated with only one species: for example, typhoid was treated with juice extracted from the seeds of *Viburnum grandiflorum*, psoriasis with a paste of leaves of *Clematis buchananiana*, gonorrhea with juice extracted from the roots of *Sarcoococa saligna*, and athlete’s foot with a paste of leaves of *Ipomoea carnea*. According to Albuquerque [54], the presence of a large number of species for the same medicinal use would result in maintenance of that use, i.e., it’s resilience in the local ethnomedical system. On the other hand, categories associated with only one species could be considered more vulnerable to perturbations. As observed by Numa [55] any change leading to the disappearance of that single species could induce a change in local medical practices, such as searching for alternatives for treating that specific illness.

According to other studies conducted in neighboring areas [56–58] and in our research most species (28) were used to treat a cough and related respiratory problems. Climatic factors, such as rarefied air due to the reduction in oxygen found at high altitudes and low-temperature regime experienced throughout the year, combined with high demographic density and poor housing conditions, could explain the high prevalence of contagious diseases. Moreover, the lack of awareness about personal hygiene and cleanliness practices is probably responsible for the high number of plants (26) reported to treating skin problems “Fig 4”.

**Quantitative indices**

The relative frequency of citation (RFC) shows the local importance of each species with reference to informants who cited these medicinal plant species. We found that the species with the highest RCF values in the study area were *Zanthoxylum armatum* (0.94), *Berberis lyceum* (0.92), *Ajuga bracteosa* (0.91), *Prunella vulgaris* (0.91), *Pinus roxburghii* (0.91), *Adiantum capillus-veneris* (0.89), *Rosa brunonii* (0.89), *Albizia lebbeck* (0.89), *Cedrella serrata* (0.84), *Punica granatum* (0.81) and *Jasminum mesnyi* (0.80) “Table 1”. Use value (UV) is an index commonly
adopted to measure the relative importance of a given species known within a local community. It is high when many uses are reported (i.e., when a species is frequently quoted by informants in the treatment of various diseases) and approaches zero when few uses are mentioned. In this study, the highest use values were reported for *Berberis lyceum* and *Ajuga bracteosa* (1.13 each), *Abies pindrow* (1.03), *Prunella vulgaris* and *Adiantum capillus-veneris* (1.00 each), and *Desmodium polycarpum* and *Pinus roxburghii* (0.98 each) “Table 1”. Because these plants were native and recorded as very common in the area, they combine the cultural value pointed out by our study with a high ecological and landscape importance. These findings were also in accordance with the “appearance hypothesis” [59]: the more common a plant is in an area, the greater the folk knowledge about its use; that is, more common plants would allow local people to have more experience of their properties and consequently would have a greater probability of being introduced into the local culture. UV is dynamic and changes between different areas and even within the same area over time. For example, *P. roxburghii* was found to be one of the least cited medicinal plants (UV = 0.01) in the Sudanhoti district (AJK), although the use of this plant for timber, fuel, and construction was well known in the area [59]. On the other hand, *Achyranthes aspera* and *Momordica charantia* had among the highest UVs in the study by [60], while showing low UVs (0.38) in our study. According to some authors [29, 61, 62], medicinal plant species with high RFCs and UVs should be tested to assess and prove their pharmacological activity. On the other hand, plants with low UVs are not necessarily unimportant, but their low values indicate that locals are not aware of their uses, and this could put knowledge about their use at the risk of not being transmitted [19].

**Informant consensus factor**

The informant consensus factor (ICF) calculated for each category ranged from 0.69 to 0.90 with a mean value of 0.87. The highest values were recorded for digestive system diseases (ICF = 0.90), muscular and skeletal system diseases (ICF = 0.89), and mouth/pharynx diseases and diabetes (ICF = 0.86 each). The lowest ICF value was found for the hair care category (0.69) “Table 2”. ICF values are influenced by the number of informants and are more significant when calculated for uses cited by many informants. In general, ICF values were high in
Table 2. Informant consensus factor (ICF) of Pearl Valley Tehsil Rawalakot, District Poonch AJ&K.

| S. NO. | Diseases                                      | Detailed categories                                                                 | Ntax | Nur  | ICF  | Most Used Plants                                                                                                                                 |
|-------|-----------------------------------------------|-------------------------------------------------------------------------------------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Colds, respiratory tract diseases             | Asthma, breathing difficulties, bronchitis, chest pain, cough, expectorant, flu, lung diseases | 41   | 236  | 0.83 | Mentha royleana, Polygonatum multiflorum, Punica granatum, Pyrus pashia, Salvia moorcroftiana, Prunella vulgaris                                    |
| 2     | Digestive system disorders                    | Anthelmintic, Cholera, constipation, diarrhea, dysentery, dyspepsia, flatulence, gastritis, jaundice, liver and bile diseases, nausea, stomachache, typhoid, vomiting | 114  | 1162 | 0.90 | Mentha royleana, Zanthoxylum armatum, Berberis lyceum, Eriobotrya japonica, Punica granatum, Ziziphus numelaria, Artemisia absinthium            |
| 3     | Urinary and sexual-reproductive system diseases | Abortion, amenorrhea, aphrodisiac, contraceptive, diuretic, gonorrhea, irregular menstruation, kidney diseases, kidney stones, leucorrhoea, menorrhagia, miscarriage, urinary tract diseases | 16   | 91   | 0.83 | Aesculus indica, Prunus domestica, Bergenia ciliata, Galium asperfolium, Oenothera rosea, Eriobotrya japonica,                                     |
| 4     | Muscular and skeletal system diseases         | Antispasmodic, bone fracture, backache, body and joint inflammations, cramps, muscular pains, joint pains, paralysis, rheumatism | 11   | 100  | 0.89 | Hypericum perforatum, Juglans regia, Pyrus malus, Pyrus malus                                                                                   |
| 5     | Nervous system diseases                        | Convulsions, depression, general pain, headache, nervous problems, sedative, toothache | 16   | 86   | 0.82 | Juglans regia, Pyrus malus, Heracleum candicans                                                                                                 |
| 6     | Circulatory system diseases                   | Bleeding, hemorrhoids, heart diseases, heart tonic, hypertension, pressure            | 6    | 25   | 0.79 | Rosa brunonii, Oenothera rosea, Viola kanscens, Adiantum capillus-veneris, Desmostachya bipinnata, Pyrus malus                                     |
| 7     | Blood and lymphatic system                    | Anemia, blood purification                                                          | 15   | 76   | 0.81 | Dalbergia sissoo, Rosa brunonii, Berberis lyceum, Vibernum nervosum,                                                                            |
| 8     | Skin diseases, burns and wounds               | Athlete foot, boils, burns, carbuncles, cracked heels, cuts and wounds, dandruff, eczema, eruption, freckles, itching and allergy, leprosy, leukoderma, measles, not specified skin problems, pimples, scabies, skin parasites, smallpox, sun burns, swellings, ulcers, urticaria, warts | 47   | 306  | 0.85 | Fumaria indica, Adiantum incisum, Euphorbia wallichii, Gallium asperfolium, Rosa brunonii                                                      |
| 9     | Fever                                         | Fever                                                                               | 32   | 138  | 0.77 | Smilax glaucocephylia, Abies pindrow, Castanea sativa, Cichorium intybus, Elaeagnus angustifoli, Quercus incana                                |
| 10    | Mouth-pharynx diseases                        | Gum infection, mouth infection and inflammation, pyorrhea, sore throats, strengthening of spongy gums, teeth cleaning | 42   | 306  | 0.86 | Berberis aristata, Juglans regia, Thymus linarianis, Castanea sativa, Pistacia chinensis ssp, Integerrima, Zanthoxyllum armatum, Ajuga bracteosa |
| 11    | Antidote                                      | Dog bite, scorpion sting, snake bite                                                 | 8    | 31   | 0.77 | Nerium oleander, Dioscorea delftoida, Hypericum perforatum                                                                                     |
| 12    | Ear and eye diseases                          | Earache, eyes diseases, eye sight weakness                                           | 38   | 186  | 0.80 | Rosa brunonii, Androsace rotundifolia, Bergenia ciliata                                                                                         |
| 13    | Hair care                                     | Hair washing, hair conditioner                                                       | 9    | 27   | 0.69 | Juglans regia, Poa nepalensis                                                                                                                  |
| 14    | General weakness in men and animals           | Weakness, loss of appetite, tonic                                                   | 45   | 258  | 0.83 | Fumaria indica, Asparagus filicinus, Castanea sativa, Viola kanscens, Trichodesma indicum, Punica granatum, Berberis lyceum, Ligustrum lucidum |
| 15    | Diabetes                                      |                                                                                        | 6    | 36   | 0.86 | Berberis lyceum, Clematis montana, Rubus fruticosus,                                                                                           |
| 16    | Others                                        | Demulcent, body temperature, cooling agent, immunity, tumor                         | 15   | 58   | 0.75 | Pinus roxburgii, Ligustrum lucidum, Cedrela serrata, Viola kanscens, Ficus palmate, Elaeagnus umbellata                                          |

Key words: Ntax = Number of taxa; Nur = Number of use Reports; ICF = Informant consensus factor

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our study, revealing that the informants tend to agree on which plants to use in the treatment of common illnesses. According to Heinrich [63], high ICF can help in identifying potentially effective medicinal plants. It must be highlighted that in our study the highest agreement level
was recorded for diseases reported as the most widespread in rural communities of the Poonch district and other areas of Pakistan [64]. The prevalence of gastrointestinal disorders in the study area may be attributed to the low availability of hygienic food and drinking water. According to the District Census Report carried out in 1998, the population with access to safe drinking water inside the house was 16.28%; in 2005 the water access, although improved (21%), was still strongly lacking. This situation was compounded by the devastating earthquake, in which several water-supply schemes were damaged and the drinking water supply was obtained from contaminated surface water sources [65].

Medicinal plant knowledge

Each informant mentioned on average 3.75 (± 2.96; minimum: 1; maximum: 15) species and 11.84 (± 10.52; minimum: 2; maximum: 39) different uses. Many studies have shown that age and gender are two important factors to consider when evaluating the distribution of knowledge within a group of informants [66, 67]. However, very few studies have analyzed the effect of these variables on the distribution of ethnomedicinal knowledge in Pakistan (see, for example, Ahmad et al. [48] and none of them used statistical analyses for validation of the collected data. 58% of the 64 informants reporting the use of medicinal plants were over 40 years old (37 informants); of these, 17 (26.5% of the informants) were aged between 41 and 50 while 20 (31.5%) were over 50 (Table 1). Spearman’s correlation analysis showed significant positive differences between the age and the number of both number of mentioned species (rs = 0.49; p < 0.05) and different uses (rs = 0.45; p < 0.05), indicating that there is a trend of older people being more knowledgeable than younger people “Table 3”. When we analyzed the age groups individually, significant differences were observed only among some groups “Table 3”. The youngest informants (from the ages of 19 to 30) knew fewer species (1.33 ± 0.55) and uses (3.00 ± 1.11) than other groups. The informants belonging to the 41–50 and 51–60 age groups cited a higher number of species and uses than the other groups “Table 3”. This trend is widely

| Informants | # | # Known Species | # Cited Different Uses |
|------------|---|-----------------|-----------------------|
|            | F | M               | F                     | M                     |
|            | F | M               | F                     | M                     |
| Total      | 25 | 39              | 2.32±1.43             | 4.66±3.31             | 5.08±4.72             | 15.72±11.40           |
| Age class  |   |                 |                       |                       |                       |                       |
| 19–30      | 9 |                 | 1.33±0.55             |                       |                       |                       |
| 31–40      | 18|                 | 3.38±2.99             |                       |                       |                       |
| 41–50      | 17|                 | 4.53±3.02             |                       |                       |                       |
| 51–60      | 20|                 | 4.50±3.03             |                       |                       |                       |
| Education level | | | | | | |
| Uneducated | 21| 2.29±1.27       |                       |                       |                       |                       |
| Primary school | 14| 5.50±4.31       |                       |                       | 14.36±11.51           |                       |
| Intermediary school | 8 | 3.00±1.52      |                       |                       | 10.50±9.28           |                       |
| Middle school | 12| 5.08±3.14       |                       |                       | 20.0±14.01           |                       |
| University degree | 9 | 3.33±2.18       |                       |                       | 10.88±8.49           |                       |
| Profession | | | | | | |
| Traditional healers and midwives | 20| 7.15±2.96       |                       |                       | 25.03±8.00           |                       |
| Housewives  | 8 | 1.87±0.83       |                       |                       | 5.00±2.98            |                       |
| Teachers   | 13| 2.38±0.87       |                       |                       | 6.15±3.16            |                       |
| Farmers    | 10| 2.10±1.10       |                       |                       | 5.50±2.81            |                       |
| Other      | 13| 2.30±1.37       |                       |                       | 5.92±4.42            |                       |
observed in literature; on the other hand, elderly people are expected to have accumulated more experiences about the uses of medicinal plants for a longer period of time than others. It might also be hypothesized that young people are not interested in learning the use of medicinal plants as a consequence of the socio-economic transition occurring in Pakistan. Comparing the knowledge held by men and women, men had much higher knowledge on medicinal plants \( (Z = 3.20; p < 0.01) \) and their uses \( (Z = 3.96; p < 0.001) \); they reported 4.66 \( (±3.31) \) species and 15.72 \( (±11.40) \) uses, while women 2.32 \( (±1.43) \) species and 5.08 \( (±4.72) \) uses. There is no consensus in the literature about the effect of gender, though women are generally shown to hold a wider competence concerning medicinal plants than men [66]. Ahmad et al. [48], studied medicinal resources in the mountainous region of Chail valley (Pakistan), observed that females had a higher knowledge about the preparation and administration of herbal drugs compared to males. Similar was observed by [67] in a study concerning the ethnobotanical knowledge of Fulni-ô in north-eastern Brasil, our finding could be explained considering the harvesting dynamics, in which men are the main collectors of medicinal plants growing in the local forest. As for education level, 21 informants (33% of all informants) were uneducated, 8 (12%) received only some primary education 20 (31%) had attended middle or intermediary school and 9 (14%) held a university degree. The education level of informants proved to be significantly associated with both the number of species \( (H = 10.09; p < 0.05) \) and the number of uses \( (H = 38.58; p < 0.001) \). Informants who were less educated (from primary to middle education level) had highest medicinal plant knowledge “Table 3”. It’s important to note that this result is affected by the relationship existing between the education grade and the work activities of the informants: traditional healers having higher level of medicinal knowledge (see below) belonged to the group with lower education level; on the contrary housewives, knowing the lowest number of species and uses, were all uneducated. Informants with higher education were the less knowledgeable: it’s possible to presume that a better scholastic career may expose people to the influence of the academic knowledge and to the allopathic medicinal practices. During the study, seventeen traditional healers having ages ranging from 45 to 60 years were interviewed. Most of the healers were involved in healing practices from more than two to five years and were vastly experienced while only five healers had more than 10 years of experience. When grouped according to profession, Kruskal-Wallis tests show that there is a significant difference among informants in both the number of known medicinal plants and the number of different uses \( (H: 38.51; p < 0.001) \). As we expected, both the mean number of species and the mean number of uses resulted higher for “professional” healers (traditional healers + midwives) vs laypeople “Table 3”. Yet, in Rawalakot even the knowledge held by laypeople appears more considerable: lay villagers also reported 42% of the species mentioned by healers. The role of laypeople in preserving and transmitting the ethnomedicinal knowledge has been pointed out by some studies (see for example Bruschi et al. [68]), in particular, laypeople were reported to know and use medicinal plants mainly to treat common ailments such as digestive troubles, injuries and wounds, cough, headache. People turn instead to healers for other diseases considered more severe.

**Comparison with other studies in neighboring regions and Novelty**

When we compared the data from this study with the findings of other studies carried out in neighboring areas, we observed a percentage of similarity in uses of plant species ranging from 13.33% [69] to 34.62% [70] with an average value of 22.53%. The percentage of dissimilarity ranged from 43.20 [71] to 20.00 [72] with an average value of 37.03 “Fig 5”. The maximum level of similarity was found with studies conducted by Ch et al. [69] and Kayani et al. [71], which showed JI values of 32.97 and 19.39, respectively, while the lowest index of similarity
was found with the study conducted by Khan et al. [26] which had a JI of 6.11. As observed in other studies [71, 73–75], villagers inhabiting neighboring areas tend to use the same medicinal plants. Presumably, the plant communities occurring in closer areas have more similar plant uses than the communities of more distant areas. A high level of similarity might also be attributed to the fact that the communities living in nearby areas have the same sociocultural values and have more opportunities to exchange their traditional knowledge. The results of this survey provide new insights into the knowledge about medicinal plants of Pakistan: 60% of the plant uses recorded in this research have not been previously reported for AJ&K. Moreover, some of the uses reported by our informants were unknown in the worldwide’s literature “Table 4” Examples include the use of *Opuntia dillenii* for the treatment of joint pain, of *Dalbergia sissoo* for hair growth, and of *Pistacia chinensis* ssp. *integerrima* for wound healing. Species listed in “Table 4” could be appropriate candidates for further studies addressed to the development of new drugs. The number of first time reported plants in the present study indicated a high degree of ethnobotanical novelty for the studied area and confirmed the importance of ethnomedicinal research, also when dealing with already known medicinal plants.

The annual temperature in Pearl Valley was 38°C during summer and –3°C during the winter and rainfall ranged from 500 to 2000 mm. Due to huge variation in climatic conditions the region is biodiversity hotspot and contains representative of almost all life forms. The study areas selected for comparision with present study had low temperature during in winter and moderate temperature during summer. Geographic distance, climatic conditions and cultural

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**Fig 5. Heat map showing percentage similarity, dissimilarity and Jaccrad Index (JI) of Pearl Valley with neighbouring areas.**

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values of Pir Lasura National Park are similar to study area so there are more chances of exchange of knowledge between these areas. The argument was supported by highest value of similarity index 34.62% between two areas. Similarly, the areas that are far apart from study area had least similarity in uses, thus plant the present in these areas with similar uses and methods of preparations to those of plants in study area, should be considered to have higher potential than other plants that may be used for a particular disease in only one culture.

Conservation status of the plants

Projects aimed to safeguard and enhance ethnobotanical knowledge about medicinal plants must be associated with to specific strategies for the conservation and sustainable use of plants in order to ensure the convergence of development and conservation goals [76]. Extractive activity can play an important role in local health care systems, but a high collection rate of medicinal plants can lead to over-exploitation and can have a strong impact on local plant diversity. According to the IUCN Red List (version 3.1), *Pinus roxburghii* and *Zanthoxylum armatum* were reported as vulnerable (VU), while *Punica granatum* was indicated as endangered (EN); people living in the area use different parts of these plants not only as medicine but also for more destructive uses such as fuelwood, construction, and furniture. Several other plants shown in Table 2 are reported to be of least concern (LC). The most important factors considered by local informants as threats to the survival of the flora were deforestation, agricultural expansion, overgrazing, fire, and drought. The continuous environmental degradation of the collection habitats could hasten the depletion of medicinal plants and the rarefaction of the associated knowledge. In recent years, some traditional practitioners have started to cultivate medicinal plants in their home gardens, but this effort seems to be insufficient given that only 18% of the medicinal plants reported in this study were cultivated.

Conclusions

This study was the first to document the uses of medicinal plants in the District Rawalakot area. Our data show that medicinal plants are an important source for local people (136 species reported by 64 informants) and point out that both traditional healers and laypeople have developed a rich knowledge base on their experience. In more remote areas, where health services have struggled to reach, this knowledge can provide first aid for treating the most
common diseases occurring in the area. The plants having high values of UV and RFC are biologically active and had good healing potential for specific ailments. A study area was located at higher altitude so respiratory problems were most common diseases in the area, similarly due to low temperature during most of the days of year skin problem were ranked second among different cited diseases. A significant effect of gender and age on the distribution of ethnobotanical knowledge was recorded during an interview and was confirmed statistically. Spearman’s correlation analysis depicted that there is positive differences between the age and the number of both number of mentioned species ($rs = 0.49; p < 0.05$) and different uses ($rs = 0.45; p < 0.05$), indicating that there is a trend of older people being more knowledgeable than younger people. When we compare the knowledge held by men and women, men showed a much higher knowledge on medicinal plants ($Z = 3.20; p < 0.01$) than women. The distance between areas was the main determinant of change in jaccard index value. Areas located closer to each other have more opportunities for exchange of traditional knowledge and similarities among neighboring areas also depend upon environmental factors. The highest similarity between the study area and Pir Lasura National Park may be due to the sharing of a similar flora and the cross-cultural exchange of medicinal plant knowledge in past and present. Less similarity between the areas may be because they are so distantly related that they are very unlikely to have communicated medicinal plant uses to each other, they are disconnected through mountain ranges and other cultural variations. Any related plants used by these areas to treat related diseases are independent discoveries. We believe that results of the present study may represent useful information that could contribute to preserving the local indigenous knowledge about the use of medicinal plants and also attract the future generations toward the traditional healing practices. Moreover, this study provides baseline information for further studies aimed at the identification and isolation of bioactive molecules that can serve as starting materials in the discovery of new plant based drugs and also create awareness about the conservation and protection of biocultural diversity.

Supporting information

S1 File. Sample of Questionnaire used during field survey for obtaining ethnobotanical information.

(DOCX)

S2 File. Table of Jaccard’s Index (JI) of pearl valley Tehsil Rawalpindi, District Poonch AJ&K.

(DOCX)

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