

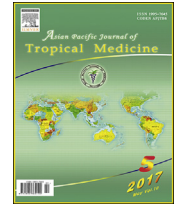
HOSTED BY



ELSEVIER

Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage: <http://ees.elsevier.com/apjtm>Original research <http://dx.doi.org/10.1016/j.apjtm.2017.05.008>

Ethnobotanical profiling of the medicinal flora of Kotli, Azad Jammu and Kashmir, Pakistan: Empirical reflections on multinomial logit specifications

Muhammad Shoaib Amjad^{1,2,✉}, Muhammad Arshad¹, Abdul Saboor³, Sue Page⁴, Sunbal Khalil Chaudhari¹¹Department of Botany, PMAS - Arid Agriculture University, Rawalpindi, Pakistan²Department of Botany, Women University of Azad Jammu & Kashmir, Bagh, Pakistan³Department of Economics, PMAS - Arid Agriculture University, Rawalpindi, Pakistan⁴Department of Geography, University of Leicester, UK

ARTICLE INFO

Article history:

Received 21 Dec 2016

Received in revised form 10 Mar 2017

Accepted 22 Apr 2017

Available online 18 May 2017

Keywords:

Ethnobotany

Medicinal uses

Multinomial logit

Kotli

Azad Kashmir

Pakistan

ABSTRACT

Objective: To report the indigenous people's uses of plants from a multidimensional perspective in a remote area where strong ethnobotanical cultural practices prevail.**Methods:** An ethnobotanical survey was conducted in the field during 2014–2016. Ethnobotanical data were gathered from 182 informants through oral interviews and semi-structured questionnaires. The distribution of plants was explored using both descriptive and graphical methods. Further, a Multinomial Logit Specification was applied to find out the probability of the occurrence of diverse utilization of plants in multipurpose domains.**Results:** The study identified 202 plant species distributed among 71 families and 156 genera. Ethnobotanical data indicate that there are more medicinal (36.96%) uses of plants as compared to all other use categories. The output from the Multinomial Logit Specifications (MLS) model reveals that perennial and non-woody plants are exploited more for medicinal and food uses than annual and woody plants. In the context of ethnomedicinal uses, aerial plant parts particularly leaves are more extensively used for the preparation of herbal recipes as compared to underground parts.**Conclusions:** The results of the study emphasize the need to create awareness among the local communities about the conservation status of plant species in order to maintain a sustainable resource of plant-derived materials into the future. The novel econometric approach employed in this study adds a new insightful methodology to the existing body of literature in the field of ethnobotany. We strongly recommend conservation measures, alongside phytochemical and pharmacological studies on the useful plant species identified in this study in order to ensure their sustainable and effective utilization.

1. Introduction

The use of plants by humans dates back to the beginning of human civilization on earth. Initially, utilization was probably restricted to medication, food and shelter. However with the passage of time, a number of other potential uses for plant resources have developed and humankind's reliance on plants has increased several folds, thereby supporting many aspects of human welfare and prosperity [1,2]. Ethnobotany plays a vital role in our understanding of the dynamic connections between

botanical diversity and sociocultural systems [3,4]. John W. Harsberger was the first to coin the term ethnobotany in 1896 [5,6]. However the discipline of ethnobotanical study was developed by Ford [7] who described the investigation of the collection of useful plants by people along with the description of the uses of those plants. Broadly speaking, ethnobotany is the understanding of knowledge systems through the use of various anthropological methods [8]. Over the course of the most recent century, ethnobotany has emerged as a multidisciplinary field that focuses on people-plant interactions not only by plant collection and documentation of the traditional uses of plants but also focusing on botany, economy, anthropology, public health, pharmacology and other disciplines [9]. Thus the interactions between plants and people may be very broad, encompassing social, religious, commercial, economic, symbolic and artistic relationships [10].

[✉]First and corresponding author: Muhammad Shoaib Amjad, Department of Botany, PMAS - Arid Agriculture University, Rawalpindi, Pakistan.

Tel: +923453812987

E-mail: malikshoaib1165@yahoo.com

Peer review under responsibility of Hainan Medical University.

Ethnobotanical studies can play a critical role in highlighting significant plant species in a specific area. These may be particularly important in the development of new plant-derived drugs; for instance the documentation of indigenous ethnomedicinal knowledge has provided the basis for developing several modern drugs [11]. According to one estimate, 25 percent of modern drugs are obtained from plants while the majority of allopathic drugs are synthetically analogous to natural compounds extracted from plants [12]. Due to the absence of basic health care facilities and the cost of expensive allopathic medicines, 70–80 percent of the population of developing countries still depends upon medicinal plants for the treatment of diseases and ailments, especially in rural areas [13–16]. Thus ethnobotanical studies have an important role to play both in documenting and explaining how plants are used and managed in rural communities that are heavily reliant on natural resources.

Pakistan is blessed with a rich diversity of plants that are used by rural communities for a variety of purposes, but particularly as a source of medicine, both by communities and individuals [17]. About 6000 species of flowering plants have been recorded from Pakistan, of which 12 percent are used in the treatment of different diseases by indigenous communities [18,19]. Various ethnobotanical and ethnomedicinal research studies have been conducted in Pakistan [20–26], however, many parts of the country remain unexplored by ethnobotanists. The autonomous territory of Azad Jammu and Kashmir (AJ&K) is a mountainous region in northern Pakistan that supports a diversity of plant habitats, soil types and climatic conditions, with many plants endemic to Pakistan recorded from this area. Reports on the traditional medicinal uses of plants by the local communities of AJ&K are increasing [27–31], but Kashmir's plant resources still remain largely unexplored, particularly with regard to their ethnobotanical values. The remote, mountainous district of Kotli in central AJ&K is strongly influenced by old customs and traditions. Most of the population in this area is rural with a low literacy rate and no access to modern health facilities. Hence the population is strongly dependent upon natural resources, especially plants, for healthcare needs and to support livelihoods in a region with very low incomes. The local people, especially the old and traditional healers, have acquired their knowledge of plant uses over a long period of time, and this includes their use in treating various illnesses and other ailments. This study explored the detailed ethnobotanical resources of the Kotli District, AJ&K; specifically, it describes and analyzes the indigenous traditional knowledge on the utilization of the most commonly used plants. The primary objective is to document this indigenous ethnobotanical knowledge, particularly in relation to ethnomedicinal plant uses, as well as to quantify plant uses through application of the analytical technique of Multinomial Logit Specifications (MLS) based on the number of positive responses for each plant species and the assessment of frequent uses of native species.

2. Materials and methods

2.1. Study area

Kotli is one of the most biodiverse-rich areas of Azad Jammu and Kashmir (AJ&K) located some 141 km north of Islamabad, the capital of Pakistan (73° 47.180' E to 74° 04.613' E

longitude; 33° 23.069' N to 33° 29.344' N latitude and altitude range 450 m to 1900 m). Map of the area produced by Arc Gis is given in Figure 1. The region is mountainous and covers an area of about 1860 km² and total population is 0.588 million. Climatically, the area is dry, subtropical at lower altitudes and subtropical-humid at upper altitudes with a mean annual precipitation of 1250 mm. The highest average monthly precipitation occurs in July (291 mm), while the lowest average monthly precipitation of 19 mm occurs during November. Temperatures are highest in June and July, with average daily minimum temperatures of 23.5 °C and 23.7 °C respectively and maximum temperatures of 37.1 °C and 33.9 °C respectively, while the coldest months are December and January with mean minimum temperatures of 4.8 °C and 3.9 °C respectively and mean maximum temperatures of 20.8 °C and 18.6 °C respectively. The mean maximum relative humidity of 68.2 percent occurs during August and the minimum relative humidity of 33.2 percent occurs during March (Source: Pakistan Meteorological Department, Lahore). Three different forest types have been described from the area namely subtropical scrub forest, subtropical chir pine forest and subtropical broad leaf humid forest. The ethnic composition of the people is quite diverse, being mainly malik, jatt and gujjar. The primary language is Pahari (Potohari); secondary languages include Urdu and Gojri. There is no formal marketing of medicinal plant in District Kotli which by implication benefits home grown agents (middle man). Thus poor collectors have no share in high profit earning business.

2.2. Plant collection and identification

The plant species were collected in triplicate during sampling, carefully dried and mounted on herbarium sheets. The Flora of Pakistan (www.eflora.com) was followed for taxonomic identification [32,33], whereas to obtain the correct botanical names the International Plant Name Index (IPNI) (www.ipni.org) and Tropicos (www.tropicos.org) was used. Confirmation of species identification was carried out at the Herbarium (ISL) of Quaid-i-Azam University, Islamabad and National Herbarium at Pakistan Museum of National History, Islamabad. The fully determined vouchers were deposited in the herbarium of the Department of Botany, PMAS- Arid Agriculture University Rawalpindi, Pakistan.

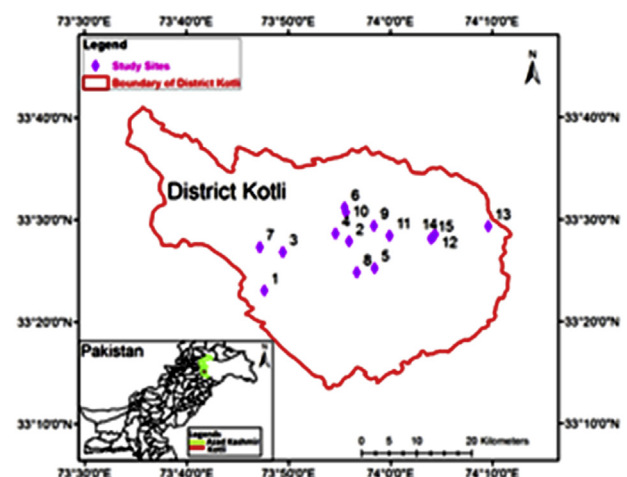


Figure 1. Map showing location of study area and study sites.

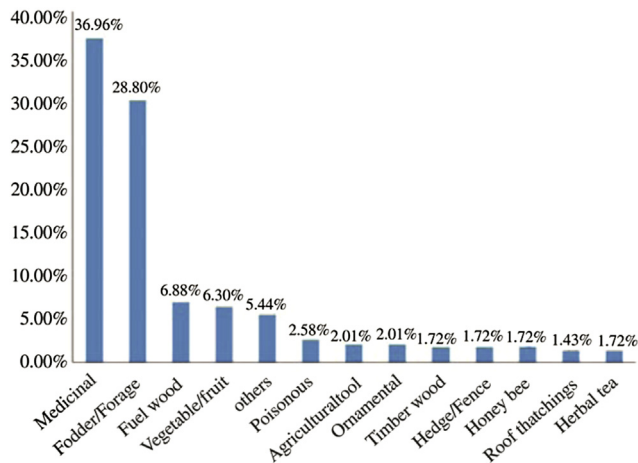


Figure 2. Ethnobotanical uses of flora of Kotli District, AJ&K.

2.3. Field interview

The field work was conducted in fifteen different villages during 2014–2016 following the method of Heinrich and his coworkers [34] to report the indigenous uses of plants by the local inhabitants. A total of 182 (136 male and 34 female; 22 herbalist or traditional healers) informants across different age groups were randomly selected for interviews, with a particular emphasis on older people and rural herbalists who are familiar with indigenous uses of plants. Ethnobotanical data were collected through oral interviews and semi-structured questionnaires [35]. The questionnaires were developed following the methods of Edwards and his coworkers [36]. Field work consisted of plant collection, data documentation and photography. Field trips were conducted during all the four seasons in order to identify all plants used by the local inhabitants of the area (Figure 2).

2.4. Data analysis

2.4.1. Methodology of multinomial logistic approach

Logistic regression is a powerful statistical way of modeling a binomial outcome (i.e. it takes the value 0 or 1 for plants having or not having a medicinal use) with one or more explanatory variables. Generally, it has two specifications (a) binary logit specification (b) multilogit specification. The first specification is used in case the discrete response variable has only two categories. However, in the case of multi-categorical response variables the second specification is used [37–39]. Although in the current study both specifications could be applied, the multinomial logit specification was found to be the most practical because of the multiple uses of plants noted in the study area. There is substantial power of this method in terms of delivering more realistic findings.

Multinomial logistic models have been extensively employed in predicting the relationship of plant utilization to their respective use categories. Multinomial logistic models are particularly useful where the response variables are multi-categorized [38,39]. In this study we examined various plant uses against different plant categories. The response variable has multiple plant uses that were categorized into (1) medicinal, (2) food, (3) combined use of food and medicinal and (4) all other uses of plants. A response is categorized as

medicinal if the use of the plant was medicinal only, food if the use of the plants was as a fruit or vegetable, herbal tea, source of nectar for honey bees and/or fodder, while all other uses of plants included fuel, timber, poison, roof thatching, hedge/fencing, ornamental, agricultural tools etc. The multiple outcomes of the response variable i.e. plant uses require multinomial logistic specification [24] where the individuals are interested in the change in probabilities of plants uses with unit change in the elements of x ceteris paribus, $P(y = j|x)$, $j = 0, 1, \dots, J$. However, in this study, the covariates were also categorical in nature i.e. plant growth-form categories were used in this study (annual or perennial and woody or non-woody) so the model helped in the evaluation of the difference of plant uses for active category than reference category. Therefore, employing a multinomial logistic model directed to evaluate the probability of the alternative j against alternative i for every $i \neq j$. This took the form:

$$\ln \frac{P(Y=j)}{P(Y=0)} = \alpha_m + \sum_{k=1}^K \beta_{mk} X_{ik} = Z_{mi}$$

where $P(Y = j)$ and $P(Y = 0)$ are represented by P_j and P_0 respectively and the model becomes

$$\ln \left(\frac{P_j}{P_0} \right) = \alpha_m + \sum_{k=1}^K \beta_{mk} X_{ik} = Z_{mi}$$

Multinomial regression models do not impose the restrictions of normality, linearity and homogeneity of variances for explanatory variables and is estimated through Maximum Likelihood Estimation (MLE) that follows the chi-square distribution [37,40]. Overall, model fit is assessed by Pseudo R^2 and LR Chi Square. Pseudo R^2 presents the explanatory power of the model but it is not such a reliable measure of goodness of fit hence, instead, a significant LR Chi Square is used to indicate the goodness of fit of the model. Authentic studies justify the application of such a specification [23,24].

3. Results

3.1. Ethnobotanical importance

During the botanical survey a total of 202 plant species belonging to 71 families and 156 genera were recorded. The total number of plant species with a recorded uses were 177 while for the remaining 25 species no uses were reported in the study area. Ethnobotanical use categories for the recorded plant species indicates that the major proportion of plant species are used for medicinal purposes followed by fodder/forage plant species (Figure 1). In the context of ethno medicinal use of plants, leaves were the most commonly used plant part, followed by the whole plants (Figure 3). Detailed ethnomedicinal uses of trees (Table 1), shrubs (Table 2), herbs (Tables 3–6), grasses (Table 7) and climbers (Table 8) reported from indigenous people are given.

3.2. Explanation of the results of the multinomial logistic model estimations

Multinomial logistic specification modeled the probabilities of plant uses against plants categories through maximum

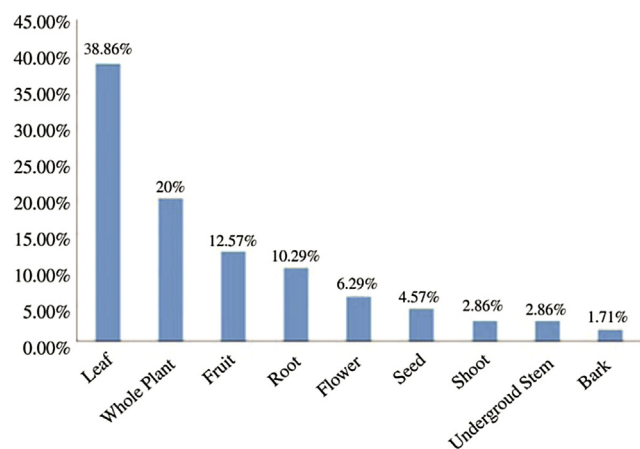


Figure 3. Parts used for ethnomedicinal purpose of flora of Kotli District, AJ&K.

likelihood estimates (MLE) by maximizing the log likelihood function at -209.46 in 5 numbers of iterations. The coefficients obtained through logistic specification for annual plants have positive non-significant effects for medicinal, food and combined use of medicinal and food plants. While woody plants have negative significant effects on medicinal,

food and their combined use. These coefficients show the difference in logit (log of odd ratios) for active category than reference category as the covariates are also categorical in nature. The marginal effects have more useful interpretations than logistic coefficients or Relative Risk Ratio (RRR) (Table 9).

The marginal effect of annual plants is negative for medicinal use of plants showing that perennial plants are used more for medicinal purposes than annual plants. Similarly, non-significant positive marginal effects for food use and combined uses indicate the greater use of annual plants for food and combined uses. These results are consistent with the study by Arshad and others [24] however, these non-significant marginal effects cannot be generalized (Table 9).

Negative significant marginal effects of woody plants reflect the empirical fact that for all uses non-woody plants are more used than woody plants i.e. in the case of medicinal use, woody plants were used 18 percent of less than non-woody plants. Likewise, there was 24.4 percent less food use and 18.5 percent less use for combined food and medicine purposes of woody plants, indicating that non-woody plants have more medicinal, food and combined uses than woody plants. Pseudo R^2 is 12.93 percent which is a significant result, however, the highly significant LR Chi square at less than 1 percent indicates that the overall model has a good fit (Table 9).

Table 1

Ethnomedicinal uses of medicinally important trees of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Acacia modesta</i> Wall./ISL-715	Plai	Fabaceae	Fruit gum is stimulant, aphrodisiac and tonic.
<i>Butea monosperma</i> (Lam.) Taubert/ISL-717	Chechra	Fabaceae	Fruit gum with milk and sugar is tonic for backache in women after pregnancy.
<i>Casearia tomentosa</i> Roxb./ISL-719	Chilla	Salicaceae	No apparent medicinal use
<i>Flacourtia indica</i> (Burm. f.) Merrill./ISL-708	Kankoli	Flacourtiaceae	The fruit is diuretic, appetizer and tonic.
<i>Mallotus philippensis</i> (Lamk.) Mull. Arg./ISL-705	Kamella	Euphorbiaceae	Fruit is carminative, anthelmintic and purgative. Fruit powder with milk or yogurt removes tapeworms. It is externally applied for treatment of skin diseases.
<i>Olea ferruginea</i> Royle/ISL-707	Kao	Oleaceae	Herbal tea of leaves along small piece of bark of <i>Acacia catechu</i> is effective against cold, flue, cough and skin diseases. Leaf decoction is used for toothache and gonorrhoea. Stem bark is astringent used for curing mouth infections.
<i>Pinus roxburghii</i> Sargent/ISL-712	Chirr	Pinaceae	Resin is used for tumors, cough, bleeding wounds and in soap industry. The bark and leaf powder mixed with cold water is used for dysentery.
<i>Prunus persica</i> (L.) Batsch/ISL-714	Arru	Rosaceae	Fruit is used to control cholesterol levels. It helps in healthy vision, healthy teeth and bones. It has anti-aging properties.
<i>Quercus incana</i> W. Bartram/ISL-747	Erian	Fagaceae	The leaf decoction is used for joint pain. It is also used for hemorrhagic septicemia in cattle.
<i>Salix acomophylla</i> Boiss./ISL-725	Bains	Salicaceae	No apparent medicinal use
<i>Ziziphus mauritiana</i> var. <i>spontanea</i> (Edgew.) R.R. Stewart ex Qaiser & Nazim./ISL-726	Jand-beri	Rhamnaceae	Fruit is digestive stimulant and used as blood purifier. Stem bark mixed with honey or milk is used for dysentery/diarrhea.

Table 2

Ethnomedicinal uses of medicinally important shrubs of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Berberis lycium</i> Royle./ISL-703	Komal	Berberidaceae	Powdered root bark paste in water is applied on wounds and bone fractures. Root and stem bark decoction is used in hypertension, dyspepsia and jaundice.
<i>Carissa opaca</i> Stapf. ex. Haines./ISL-704	Garanda	Apocynaceae	Fruits are blood purifier
<i>Colebrookea oppositifolia</i> Smith./ISL-706	Bansa	Lamiaceae	Root decoction is used in ulcer and epilepsy. Leaves are antiseptic, applied on wounds, bruises and fractures. Leaves are used in dysentery.
<i>Cotinus coggygria</i> Scop./ISL-718	Bahan,	Anacardiaceae	Leaves are used for hepatitis, anemia, bacterial and fungal infections. Plant has anti-ageing properties.
<i>Debregeasia salicifolia</i> (D. Don) Rendle/ISL-720	Sindhari	Urticaceae	Fresh leaf powder with mustard oil is used in skin diseases. Leaf infusion is used for jaundice.
<i>Dodonaea viscosa</i> (L.)/ISL-721	Sanatha	Sapindaceae	Leaves are used for healing burns, wounds, buries. They are used for toothache and headache. Bark is anthelmintic and astringent. Wood oil is blood purifier and used in treating paralysis.
<i>Hypericum oblongifolium</i> Choisy/ISL-737	Pinli	Hypericaceae	Leaves and fruits are used for lowering blood pressure, in gastric ulcer and removing prolepsis in cattle.
<i>Indigofera heterantha</i> Wall. ex Brandis/ISL-722	Hiran Charri	Fabaceae	Fruit and leaves are used in hepatitis and respiratory diseases. Leaf powder is vermifuge.
<i>Isodon rugosus</i> (Wall. ex Benth.) Codd/ISL-743	Chitta Manga	Lamiaceae	Leaves are stimulant, carminative, used in flatulence fever and mouth infections.
<i>Jasminum officinale</i> L./ISL-744	Chamba Booti	Oleaceae	Root is used for treating ring worms in animals.
<i>Justicia adhatoda</i> L./ISL-748	Bhaikar	Acanthaceae	Leaf decoction is antispasmodic, expectorant, abortifacient and used in skin diseases and diabetes. Root bark and leaves are used in wound infections.
<i>Lantana camara</i> L./ISL-749	Panchphulli	Verbenaceae	Crushed leaves are antidote against snake bite. Leaf and fruit infusion is used for tetanus, malaria, inflammation and rheumatism.
<i>Lonicera quinquelocularis</i> Hardwicke/ISL-50	Phutt	Caprifoliaceae	The leaf extract is used for improving vision and cataract. Leaves are used for wound healing.
<i>Maytenus royleana</i> (Wall. ex M.A. Lawson) Cufod./ISL-834	Ptaki	Celastraceae	Root extract is abortifacient.
<i>Myrsine africana</i> L./ISL-709	Guggall	Primulaceae	Fruit is laxative and anthelmintic. Leaf juice is used in diabetes and is blood purifier.
<i>Nerium oleander</i> L./ISL-710	Gandeera	Apocynaceae	The plant is an ornamental plant. Leaf paste is externally applied in skin diseases.
<i>Otostegia limbata</i> (Bth.) Bioss./ISL-711	Chiti ptaki	Lamiaceae	The leaf extract is orally taken for treating skin and eye diseases and mouth ulcer.
<i>Punica granatum</i> L./ISL-745	Druna	Lythraceae	Fresh fruit and leaf juice is tonic and used in treating dysentery. The fruit epicarp is used for cough. The ground fruit rind is mixed with sugar and used in diarrhea.
<i>Rhynchosia pseudo-cajan</i> Camb./ISL-746	Lahrr	Fabaceae	Leaves are used in treating stomach.
<i>Rosa brunonii</i> Lindl./ISL-738	Phulwari	Rosaceae	Root is aphrodisiac and externally massaged for treating scabies. Petals of flowers are used in digestive disorders and heart problems.
<i>Rubus fruticosus</i> Hk./ISL-739	Akhray	Rosaceae	Fruit has cooling effect and is carminative. Fruit extract is tonic.
<i>Woodfordia fruticosa</i> (L.) Kurz/ISL-835	Tahvi	Lythraceae	Flowers powder is used for local to ease menstrual cycle and for abortion. It is also used in general bleeding on body.
<i>Zanthoxylum armatum</i> DC./ISL-713	Timbar	Rutaceae	Whole dried plant is used as fuel. Leaf powder is used for digestion. The fruit is carminative used in stomach pain, dyspepsia and piles.

Table 3

Ethnomedicinal uses of medicinally important annual herbaceous species (Therophyte) of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
(a)			
<i>Achyranthes aspera</i> L./ISL-784	Puth kanda	Amaranthaceae	Leaf and root decoction is used in digestive disorders. Leaf paste is externally applied on insect bite. The root powder is used in bloody diarrhea.
<i>Ajuga bracteosa</i> Wallich ex. Benth./ISL-716	Neel Kanthi	Lamiaceae	Leaf decoction is used for treating intestinal ulcer, jaundice, throat infection and lowering blood pressure.
<i>Alternanthera pungens</i> Kunth/ISL-724	Khaki buti	Amaranthaceae	The plant powder is used to treat malaria, jaundice and urinary infections.
<i>Amaranthus viridis</i> L./ISL-742	Ghanarr	Amaranthaceae	Leaves are antidote against scorpion and snake bite. Root controls menstruation.
<i>Anagallis arvensis</i> L./ISL-750	Billi Buti	Primulaceae	Plant is used as fodder for cattle. Leaves are used in stomach inflammation. Leaves antifungal and wormicidal.
<i>Argyrolobium roseum</i> Jaub./ISL-815	Makhni Booti	Fabaceae	Plant is used as fodder for cattle. Leaf and fruit powder is used for treating ulcer and appetite. Leaves are used for treating stomach disorders and jaundice.
<i>Bidens bipinnata</i> L./ISL-751	Bahangra Buti	Asteraceae	Leaf juice is febrifuge.
<i>Bidens biternata</i> (Lour.) Merr. & Sherff./ISL-752	Bahangra Buti	Asteraceae	Leaf juice is febrifuge, used in sore throat. Root paste is used in toothache.
<i>Buglossoides arvensis</i> (L.) Johnston/ISL-774	Kalu	Boraginaceae	Leaf infusion is sedative.
<i>Bupleurum falcatum</i> L./ISL-822	Gill	Apiaceae	The powder of dried plant is taken with warm water for stomach problems. The plant has anti-tumor, anti-allergic, anti-inflammatory properties.
<i>Campanula pallida</i> Wall./ISL-825	Beli	Campanulaceae	Root is laxative. Leaves and flowers are used in heart problems and as tonic.
<i>Capsella bursa-pastoris</i> (L.) Medik/ISL-826	Kangani	Brassicaceae	The whole plant is used in dropsy. Seeds are used in cough, cold and fever. Plant is grazed by animals.
<i>Chenopodium album</i> L./ISL-ISL-758	Bathu	Amaranthaceae	Leaves are anthelmintic and laxative. Seeds are used for unconsciousness.
<i>Commelina benghalensis</i> L./ISL-858	Chura	Commelinaceae	Leaves are used in curing leprosy, inflammation and are laxative.
<i>Conyza bonariensis</i> (L.) Cronq./ISL-757	Kali Buti	Asteraceae	Leaves have healing properties.
<i>Euphorbia helioscopia</i> L./ISL-810	Doodal	Euphorbiaceae	Roots are anthelmintic. Seeds are eaten in constipation. Seed oil is purgative. Latex causes skin irritation.
<i>Euphorbia hirta</i> L./ISL-811	Doodal	Euphorbiaceae	The extract of whole plant is expectorant, diuretic, used for curing pulmonary complaints. Plant powder is mixed with water and used in diarrhea. Its heavy dose cause vomiting.
<i>Euphorbia indica</i> Lam./ISL-812	Doodal	Euphorbiaceae	Plant extract is expectorant and diuretic, used in curing pulmonary disorders and ringworms.
<i>Euphorbia prolifera</i> Buch.-Ham. ex D. Don./ISL-814	Tirvi	Euphorbiaceae	Root is useful for abdominal diseases.
<i>Euphorbia prostrata</i> Ait./ISL-816	Dudhli	Euphorbiaceae	Whole plant with roots used in abdominal diseases and chronic fevers. It is blood purifier used in treating skin diseases. It is also a nerve tonic.
<i>Fumaria indica</i> Pugsley/ISL-770	Papra, Shahtra	Papaveraceae	Whole plant infusion is diaphoretic, antipyretic and blood purifier.
(b)			
<i>Geranium ocellatum</i> Camb./ISL-796	Jandoru	Geraniaceae	Whole plant juice is astringent and diuretic.
<i>Geranium rotundifolium</i> L./ISL-797	Jandoru	Geraniaceae	Plant juice is astringent and diuretic.
<i>Justicia peploides</i> (Nees) T. Anderson/ISL-781	Pasmund	Acanthaceae	Plant is used as fodder for cattle. Leaves are diuretic and effective in gastrointestinal complaints.
<i>Malva parviflora</i> L./ISL-882	Sonchal	Malvaceae	Leaves and flowers are aphrodisiac. Leaf decoction is used for cough, fever and constipation.
<i>Malvastrum coromandelianum</i> (L.) Garcke/ISL-883	Bariar	Malvaceae	Leaves and flowers are aphrodisiac. Flower decoction is used to reduce fever and leaves are used in wound healing.

Table 3 (continued)

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Melilotus indica</i> (L.) All./ISL-886	Singi	Fabaceae	Leaf decoction is used for abdominal pain, dysentery/diarrhea and bronchial disorders.
<i>Micromeria biflora</i> (Buch.-Ham.ex D.Don) Benth./ISL-864	Boine	Lamiaceae	Plant decoction is diuretic, used for vomiting, constipation and headache.
<i>Phyllanthus urinaria</i> L./ISL-829	Chota amla	Phyllanthaceae	The fruit and leaf juice is anti-inflammatory, diuretic and tonic.
<i>Physalis divaricata</i> D. Don/ISL-830	Hundusi	Solanaceae	The leaf extract is applied on wounds to stop bleeding and healing foot and heel cracks. Fruit is diuretic and tonic.
<i>Polygala abyssinica</i> R. Br. ex Fresen./ISL-893	Arna	Polygalaceae	Root is antidote for snakebite
<i>Polygonum plebeium</i> R. Br./ISL-853	Hind Raani	Polygonaceae	Plant extract is tonic and used to cure bowel complaints, and pneumonia.
<i>Ranunculus muricatus</i> L./ISL-805	Kor-Kandoli	Ranunculaceae	Plant decoction is used in cough and asthma. Plant extract is antidote for snake and scorpion bite. Fruits and leaves are effective in rooted tumors and bursts.
<i>Sida cordata</i> (Burm.f.) Borss. var. <i>cordata</i> /ISL-895	Kangi	Malvaceae	Leaf powder is applied on cuts and bruises. Leaf extract is used in diarrhea.
<i>Sida cordifolia</i> L./ISL-897	Kangi	Malvaceae	Leaves are cooked and eaten in case of bleeding piles. Leaf decoction is effective in fever. The leaves and fruits are diuretic, demulcent, astringent and used for gonorrhoea. Seeds are aphrodisiac and laxative.
<i>Solanum nigrum</i> L./ISL-820	Mako	Solanaceae	Whole plant extract is abortifacient. Powdered shoot is used in dropsy and jaundice. Leaf extract is effective in kidney disorders, wound healing and tumors.
<i>Sonchus asper</i> (L.) Hill/ISL-857	Dodal	Asteraceae	Fresh plant is used as fodder for cattle, sheep and goat. Dried plant powder is applied on wounds.
<i>Trichodesma indicum</i> (L.) Lehm./ISL-889	Handusi	Boraginaceae	Flower extract is tonic for refreshment of brain. Leaves and roots are diuretic, emollient, depurative and effective against snakebite.
<i>Triumfetta pentandra</i> A.Rich./ISL- 871	Dhamni	Malvaceae	Leaf decoction is used against diarrhea.
<i>Verbascum thapsus</i> L./ISL-898	Gidar tobacco	Scrophulariaceae	Poultice of leaves and flowers is used in pulmonary diseases. Seeds are aphrodisiac.
<i>Vernonia cinerea</i> (L.) Less./ISL-832	Seh Devi	Asteraceae	Plant is used in amenorrhoea, gonorrhoea and female sterility. Seeds are used in pulmonary and skin infections.
<i>Youngia japonica</i> (L.) DC./ISL-873	Chirota	Asteraceae	Leaves are blood purifier and effective in treating constipation.

Table 4

Ethnomedicinal uses of medicinally important perennial herbaceous species (Hemicryptophytes) of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Achillea millefolium</i> L./ISL-783	Jari	Asteraceae	The plant is stimulant, astringent, and effective for treating piles and leucorrhoea.
<i>Anisomeles indica</i> (L.) O. Kuntze./ISL-779	Bengali	Lamiaceae	The whole plant extract is blood purifier. It is used to treat jaundice, hepatitis and cancer. Plants are grazed by animals.
<i>Asparagus capitatus</i> subsp. <i>gracilis</i> (Royle ex Baker) Browicz./ISL-802	Shah Gandal	Asparagaceae	Fruit and root is aphrodisiac. The root extract is used to treat diarrhea/dysentery.
<i>Bergenia ciliata</i> (Haw.) Sternb./ISL-807	Zakham-e-Hayat	Saxifragaceae	Rhizome and leaf powder is used in wound healing. Leaf extract is used in liver disorders, fever, jaundice and muscular pain. It is used as tonic.
<i>Cynoglossum lanceolatum</i> Forssk./ISL-760	Lahndara	Boraginaceae	Plant is used for curing cough, asthma, fever, constipation and heart disorders.
<i>Duchesnea indica</i> (Andrews) Teschem./ISL-848	Surkh Akhra.	Rosaceae	Leaves are diuretic and astringent used in sore throat. Leaves and fruits are used in stomach diseases. Fruits are edible. Fruit extract is slightly laxative, astringent and nerve tonic.

(continued on next page)

Table 4 (continued)

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Erioscirpus comosus</i> (Nees) Palla./ISL-759	Babya	Cyperaceae	Dried plant is fired and ash is used in abdominal and kidney pain. Leaves are used for making ropes.
<i>Geranium nepalense</i> Sweet/ISL-786	Jandorunu	Geraniaceae	Root poultice is used for rheumatic pain. Fruit juice is used for kidney disease, cut and wound healing.
<i>Geranium ocellatum</i> Camb./ISL-796	Jandoru	Geraniaceae	Whole plant juice is astringent and diuretic.
<i>Geranium rotundifolium</i> L./ISL-797	Jandoru	Geraniaceae	Plant juice is astringent and diuretic.
<i>Geum canadense</i> Jacq./ISL-799	Gul e daudi	Rosaceae	The plant is used to stop inflammation and bleeding of mouth. It is used for curing constipation and skin irritation.
<i>Gloriosa superba</i> L./ISL-813	Sanp booti	Colchicaceae	Tubers are sexual stimulant and antidote to cobra bite.
<i>Oenothera rosea</i> L.Herit.ex Ait./ISL-875	Seh Devi	Onagraceae	Plant is used to reduce thrombosis and menopause.
<i>Onosma thomsonii</i> C.B. Clarke/ISL-877	Gao Zuban	Boraginaceae	Root is laxative. Flowers and leaves are tonic for cardiac disorders.
<i>Origanum vulgare</i> L./ISL-820	Sahthar	Lamiaceae	Fresh leaf juice is used to treat epistaxis, toothache, skin infections, cough, asthma, urinary tract infections, sexual weakness, backache, liver and digestive tract disorders.
<i>Oxalis corniculata</i> L./ISL-828	Khathi Buti	Oxalidaceae	Fresh leaf juice is used for jaundice, wound healing, dysentery and fever.
<i>Plantago lanceolata</i> L./ISL-880	Isbagol	Plantaginaceae	Leaf infusion mixed with sugar is used in dysentery. Leaf extract is used for treating wounds, sores and bruises. Seeds are purgative. Plant is grazed by animals
<i>Polygonum aviculare</i> L./ISL-894	Bandky	Polygonaceae	The whole plant is purgative, anthelmintic, astringent and anodyne. The plant juice is expectorant, diuretic and vasoconstrictor.
<i>Ranunculus laetus</i> Wall. ex Royle/ISL-819	Kor-Kandoli	Ranunculaceae	Leaves and fruits are useful on rooted tumors and bursts.
<i>Saussurea heteromalla</i> (D. Don) Handel-Mazzetti/ISL-798	Kuth	Asteraceae	Root is tonic and effective in skin diseases.
<i>Solanum surattense</i> Burm. f./ISL-849	Mohkri	Solanaceae	It is expectorant, diuretic and anticonvulsant. The plant is used as stomachache, against cough, fever and chest pain.
<i>Taraxacum officinale</i> F.H. Wigg./ISL-887	Mithi Hund	Asteraceae	Plant decoction is diuretic. It is tonic used in jaundice, constipation, chronic disorders of kidney and liver. Root tea is effective in heart diseases. Plant is used as fodder for animals
<i>Viola canescens</i> Wall. ex Roxb./ISL-833	Banafsha	Violaceae	Roots are laxative and diuretic. Flowers are diaphoretic, antipyretic and febrifuge. Flowers are effective in nervous disorders.

Table 5

Ethnomedicinal uses of medicinally important Geophytic herbaceous species of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Adiantum iniscum</i> Forssk/ISL-761	Pershoofa	Pteridaceae	Leaf infusion is used in cough and bronchitis and for general weakness of body.
<i>Adiantum venustum</i> D. Don/ISL-763	Kakwa	Pteridaceae	The leaves are astringent, diuretic, and tonic. They are used in headache and snake and scorpion stings. The rhizome paste is used to heal cuts and wounds.
<i>Sauromatum venosum</i> (Aiton) Kunth/ISL-795	Sanp Ki Makai	Araceae	The corm powder mixed with butter is used for tumors in body and snakebite. Fresh corm is used for hemorrhagic septicemia and hemoglobin urea in buffalos.
<i>Drimia indica</i> (Roxb.) Jessop./ISL-846	Jangli Piaz	Asparagaceae	Leaves and bulbs are used in treating cough, asthma, bronchitis and edema. It is heart tonic, used as expectorant, abortifacient, emetic, diuretic, and rodenticidal.
<i>Cyperus rotundus</i> L./ISL-771	Mutharr	Cyperaceae	The plant extract is used to treat nausea, fever and inflammation. It is tonic used for muscle relaxation. The plant is also used as fodder for animals.

Table 6

Ethnomedicinal uses of medicinally important Chamaephytic herbaceous species of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Artemisia scoparia</i> Waldst. & Kit./ISL-817	Jhau	Asteraceae	Whole plant is used for fever, cough and heart disorders.
<i>Astragalus leucocephalus</i> Grah.ex Benth./ISL-803	Kuchani	Fabaceae	Leaves are in stomach pain.
<i>Barleria cristata</i> L./ISL-804	Chekal	Acanthaceae	The bent roots are bind on animals to stop abortion especially in goat. The whole plant extract is used in prolepses in cattle.
<i>Evolvulus alsinoides</i> (L.) L./ISL-769	Sunkhpushi	Convolvulaceae	Leaf extract is taken indigestion and constipation.
<i>Indigofera linifolia</i> (L.f.) Retz./ISL-793	Gorakh Pan	Fabaceae	Fruit is tonic and used in treating skin disorders.
<i>Salvia moccroftiana</i> Wall. ex Benth/ISL-812	Gurgana	Lamiaceae	Leaves are vermifugal, used as poultice for itches and skin burns. Seeds are emetic used in dysentery and piles and applied to boils.
<i>Salvia plebeia</i> R.Br./ISL-794	Samundar Sokh	Lamiaceae	Leaves are used in digestive disorders. Seeds are anti-inflammatory, aphrodisiac, used in gonorrhoea and urinary tract infections.
<i>Thalictrum foliolosum</i> DC./ISL-888	Beni	Ranunculaceae	The whole plant juice is blood purifier and used in curing fever.
<i>Zaleya pentandra</i> (L.) C. Jeffrey/ISL-900	Itsit	Aizoaceae	Leaf extract is used for stomach disorders. It is antidote against snake bite.

Table 7

Ethnomedicinal uses of medicinally important climbers (Liana) of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Smilax glaucophylla</i> Klotzsch/ISL-814		Smilacaceae	Whole plant is used to treat skin problems and as tonic.
<i>Tylophora hirsuta</i> (Wall.) Wight/ISL-899	Budhibail	Apocynaceae	Leaves and fruits are used in treating skin diseases and tumours.
<i>Hedera nepalensis</i> K. Koch./ISL-815	Banjali	Araliaceae	Leaves and berries are cathartic, stimulant, diaphoretic and used for curing febrile disorders and rheumatism.
<i>Ipomoea eriocarpa</i> R.Br./ISL-841	Budhi bel	Convolvulaceae	Powder and extract of the whole plant are used for skin disorders and cancer.
<i>Ipomoea hederacea</i> Jacq./ISL-844	Neeli bail	Convolvulaceae	Seeds are purgative, anthelmintic, tonic, aphrodisiac.
<i>Ipomoea pestigridis</i> L./ISL-845	Goj Bahrwa	Convolvulaceae	Leaves and stem are used in skin and eye diseases
<i>Vicia sativa</i> L./ISL-831	Rawarri	Fabaceae	Flowers are febrifuge and diaphoretic, effective in nervous disorders.
<i>Cissampelos pareira</i> var. <i>hirsuta</i> (Buch.-Ham. ex DC.) Forman./ISL-842	Batrarr	Menispermaceae	Whole plant is used for treating dropsy, diarrhea and stomach diseases. The leaves are applied on snake-bites and wounds.
<i>Cissus carnosa</i> Lam./ISL-843	Daakh	Vitaceae	Poultice of roots, leaves and seeds is applied on boils and ulcers. Root is used in stomach diseases, anemic condition and as astringent. Its paste is antidote in snake bite.
<i>Clematis grata</i> Wall./ISL-856	Tootal	Ranunculaceae	Leaf extract is used to kill worms in wounds of cattle.
<i>Boerhavia procumbens</i> Banks ex Roxb./ISL-754	It-Sit	Nyctaginaceae	Root powder mixed with honey is used in cough and asthma. Leaf paste is externally applied for wound healing.
<i>Rubia cordifolia</i> L./ISL-806	Lahndara bail	Rubiaceae	Whole plant juice is used in amenorrhoea, menstruation, convulsion and febrifuge.
<i>Galium aparine</i> L./ISL-879	Lahndara	Rubiaceae	Whole plant juice is diuretic. It is used in curing cancer, dropsy, urinary bladder and kidney infections.

Table 8

Ethnomedicinal uses of medicinally important grasses of Kotli District, AJ&K.

Species/voucher number	Vernacular name	Family	Ethnomedicinal uses
<i>Cynodon dactylon</i> (L.) Pers./ISL-759	Khabal	Poaceae	The plant extract mixed with salt is bandaged on bone fracture. Plant decoction is used to remove poison from body and is diuretic. Plant is used as fodder for animals.
<i>Dactyloctenium aegyptium</i> (L.) Willd./ISL-772	Madhana ghass	Poaceae	Plant extract is used in wound healing.

Table 9

Maximum likelihood estimates for various plants uses.

Plants Categories	Medicinal			Food			Medicinal & food		
	Coefficients	RRR	ME	Coefficients	RRR	ME	Coefficients	RRR	ME
Annual = 1, Perennial = 0	0.145	1.157	-0.043	0.411	1.508	0.021	0.590	1.805	0.089
Woody = 1, Non-Woody = 0	-2.757*	0.064*	-0.183*	-3.989*	0.019*	-0.244*	-2.657*	0.070*	-0.185*
Constant	0.742			0.588			0.642		

Note: all other uses is used as reference outcome; No. of observations was 174, *shows significance level at 1 percent. ME and RRR are Marginal Effects and Relative Risk Ratio/Odd Ratios respectively.

4. Discussion

There was strong relationship between plants and human being since ancient time. The current study results indicate that the local inhabitants in the District Kotli are strongly dependent on the native flora for acquiring basic life requirements such as food, fodder, medicines, fruits, vegetables, fuel, furniture, roof thatching and fencing materials, etc. This can be explained by a major portion of the Kotli district being very rural in nature with most of the local inhabitants having very low annual incomes derived from keeping livestock along with other limited sources of income.

The high proportion of plants used to support a local health system is similar to the findings reported from other remote areas of Azad Jammu and Kashmir such as Districts Mirpur [6], Bimber [10], Neelum [29], Poonch [28] and Muzaffarabad [41]. Due to the growing demands of pharmaceutical industries, however, medicinal plants have been drastically exploited from these areas leading to the extinction of these important species. As a result of over-exploitation, most of the preferred medicinal plants can now only be found under the thickest of shrubby plant species or at higher altitudes which are not easily accessible to the native people of the area. The rapidly increasing population in the region has also increased the pressures on medicinal plants, resulting in both the species numbers as well as the populations of medicinal plants decreasing. At higher altitudes, nomad communities extensively collect medicinal plants in a non-scientific way to supplement their incomes. They uproot the whole plants instead of just collecting the particular medicinal parts of the plant. Prior to the current study, very little information was available on the medicinal plants of the whole area. But in addition to over-collection, we identified that overgrazing deforestation and soil erosion are also contributing factors responsible for a reduction in the medicinal and other economical plants in the study area. In particular, overgrazing by the livestock of the inhabitants of Kotli district were responsible for grazing on most of the medicinal plants leading to their potential extinction from the area. Thus effective strategies for the conservation of medicinal plants are urgently needed. These should include measures to ensure that plant collection correlates with their phenology. Specifically, the plants which are under the greatest anthropogenic pressure due to overgrazing, fuel wood collection or over exploitation for medical purposes have less regeneration potential. Similarly, the plants which are exploited for underground parts like roots, rhizomes, corm or bulbs are more threatened because the shoot of the plants will be unable to develop flowers or seeds and hence to propagate.

The second major utility of plants in the study area is as forage for fodder purposes which indicates that the area is well suited as livestock rangeland. This mountainous area has a poor

vegetation cover and a cold and moist climate at higher altitude while drier hotter conditions occur at lower altitudes. Thus the area does not support agriculture very well and there is a dependence on pastoralism. In addition to forage uses, the local people of Kotli district also exploit the vegetation to fulfill their fuel and timber requirements. Particularly during the cold winter season, the local people burn large amounts of fuel wood to heat both their homes and their animal shelters. In combination, heavy grazing and overexploitation for medicinal and fuel wood purposes have led to forests becoming open and degraded. In addition, 22 plant species were identified during the survey that are used as wild edible fruits or vegetables; but owing to over-exploitation, these species have shown a decreasing trend over the last few years.

Plant materials are also used for making the roofs of houses and animal shelters. Plants such as *Pinus roxburghii*, *Quercus incana*, *Hypericum oblongifolium*, *Myrsine africana*, *Punica granatum* are used for this purpose. Another important ecological problem in the area is harvesting of wood for timber purpose which in turn results in the creation of barren areas. The most valuable plant species for this purpose include *Pinus roxburghii*, *Acacia modest*, *Ailanthus altissima*, *Pinus roxburghii*, *Quercus incana*, *Salix acomophylla*, and *Zizyphus mauritiana* due to their high sale price.

Meetings and interviews with the local inhabitants of the area disclosed the fact that indigenous knowledge was mostly limited to older people and herbalists (traditional healers), with far less knowledge amongst the younger generation. The social setup has been totally changed due to recent advancements in science and technology, with young people moving far away from local customs and traditions [23]. Moreover, the survey results showed that female informants had more ethnomedicinal knowledge as compared to the male informants. This may be due to their significant role in household management and disease treatment to maintain the health of their family members. Similar findings were also reported by Ahmed and his coworker from the Chail valley [42]. In common with the findings of other studies, we noted that the rural Kotli district communities were more enriched with ethnobotanical knowledge as compared to urban people [20]. The district is very remote from urban areas and the long history of dependence on plant-derived resources, which in this area stretches back to the time of the Mughal emperors, is reflected in the richness of the ethnobotanical knowledge, particularly amongst the older generation. The potential for rapid loss of this knowledge, which is not being passed on to future generations, combined with vegetation degradation, e.g. through overgrazing, means that there is an urgent need to document the entirety of the ethnobotanical knowledge of AJ&K so that valuable species can be protected and utilized for future generations, including for research purposes. Despite of this urgency, the local

inhabitants are still ignorant of the importance of biodiversity. We therefore strongly recommend further study projects and comprehensive surveys to create awareness among the local inhabitants about the need to document ethnobotanical knowledge and to identify its significance to the local communities. Pastoralism is the major land use and therefore effective efforts are required to conserve the area as a major rangeland and wildlife conservation unit. This will indirectly contribute to the conservation of the overall plant resources and vegetation of the area. But direct efforts are required to control the immense biotic pressures that the vegetation is under due to rapid deforestation and severe grazing, both resulting in soil erosion on steep slopes, and the overexploitation of fuel wood and medicinal plant species. Awareness of these issues needs to be raised amongst the local community with actions to support sustainable utilization, conservation and management of plant resources.

The present study portrays the strong dependence on and traditional affiliation of rural people with the medicinal flora of the study area. A composite profile of the ethnobotanical uses of the flora of the Kotli district was developed and subsequently verified through application of an empirical methodology. The results indicate that plants are frequently utilized by the local inhabitants, especially for healthcare. The probability of medicinal use of plants is associated with species features such as life form, texture and nature of the plant. Non-woody plants are more likely to be directly associated with medicinal and food uses as compared to woody plants. Perennial plants have a higher tendency toward medicinal and food uses as compared to annuals with medicinal and food use of plants in the surveyed ecosystem. Aerial parts, particular leaves, are more commonly used for the preparation of recipes as compared to underground parts. The findings of the current study can provide base line information to inform policies for biodiversity conservation and community development. The plant resources of the area are highly affected by severe deforestation, intense grazing, over exploitation of medicinal and fuel wood species and soil erosion. There is an urgent need to create awareness about the usefulness of the flora among the local people and to take strict actions to conserve this natural resource. To relieve the pressure on medicinal flora the cultivation of threatened medicinal plants should be encouraged by the indigenous communities. The present study reveals that changes in traditional culture will surely result in the loss of ethnobotanical knowledge as this valuable natural asset is restricted to the indigenous culture, and particularly to the older generation. Therefore, there is a pressing need to fully document this hidden treasure of ethnobotanical knowledge so as to avoid its extinction and the present study is a part of this effort. The identified plant should be taken in to consideration for further conservation, pharmacological and phytochemical studies to use them in a more sustainable and effective way. The process should be replicated in other remote areas of Pakistan where medicinal flora exists.

Conflict of interest statement

The authors declare that they have no competing interests.

Acknowledgments

This paper is the part of PhD research work of first author. The authors are thankful to people of District Kotli who share their value able information during the study. Taxonomic

assistance provided by Dr. Mushtaq Ahmed and Dr. Muhammad Ilyas are also greatly acknowledged.

References

- [1] Judith H. *Information resources on human-animal relationships past and present. Resource series no. 30.* Beltsville: AWIC (Animal Welfare Information Center); 2005.
- [2] Ali H, Qaiser M. The ethnobotany of Chitral valley, Pakistan with particular reference to medicinal plants. *Pak J Bot* 2009; **41**(4): 2009-2041.
- [3] Husain SZ, Malik RN, Javaid M, Bibi S. Ethnobotanical properties and uses of medicinal plants of Morgha biodiversity park, Rawalpindi. *Pak J Bot* 2008; **40**(5): 1897-1911.
- [4] Mahmood A, Mahmood A, Tabassum A. Ethnomedicinal survey of plants from district Sialkot. *Pak J App Pharm* 2011; **2**(3): 212-220.
- [5] Campbell MJ, Hamilton B, Shoemaker M, Tagliaferri M, Cohen I, Tripathy D. Antiproliferative activity of Chinese medicinal herbs on breast cancer cells in vitro. *Anticancer Res* 2002; **22**: 3843-3852.
- [6] Mahmood A, Qureshi RA, Mahmood A, Sangi Y, Shaheen H, Ahmad I, et al. Ethnobotanical survey of common medicinal plants used by people of district Mirpur, AJK. *Pak J Med Plants Res* 2011; **5**(18): 4493-4498.
- [7] Asch DL, Asch NB. The economic potential of *Iva annua* and its prehistoric importance in the Lower Illinois Valley. In: Ford RL, editor. *The nature and status of ethnobotany.* Michigan: Museum of Anthropology; 1978, p. 300-341.
- [8] Shengji P. Ethnobotany and modernization of traditional Chinese medicine. In: Thomas YA, Karki M, Gurung K, Parajuli D, editors. *Proceeding of Himalayan medicinal and aromatic plants, balancing use and conservation, December 15–20, 2002.* Nepal: Government of Nepal, IDRC, WWF, People and Plants; 2002, p. 70-78.
- [9] Gomez-Beloz A. Plant use knowledge of the Winikina Warao: the case for questionnaires in ethnobotany. *Econ Bot* 2002; **56**: 231-241.
- [10] Ishtiaq CM, Khan MA, Hanif W. An ethnomedicinal inventory of plants used for family planning and sex diseases treatment in Samahni valley, (A.K.) Pakistan. *Pak J Biol Sci* 2006; **9**: 2546-2555.
- [11] Cox PA. Will tribal knowledge survive the millennium. *Science* 2000; **287**: 44-45.
- [12] Malik RN, Husain SZ, Nazir I. Heavy metal contamination and accumulation in soil and wild plant species from industrial area of Islamabad. *Pak J Bot* 2010; **42**(1): 291-301.
- [13] Pie SJ, Manadhar NP. Source of some local medicines in the Himalayan regions. *Himal Ecos* 1987: 77-112.
- [14] Anonymous; WHO Scientific Group. The burden of musculoskeletal conditions at the start of the new millennium. Geneva: WHO Technical Report Series No. 919 *Int J Epidemiol* 2005; **34**(1): 228-229.
- [15] Unnikrishnan P. Role of traditional medicine in primary health care: an overview of perspectives and challenges. *Yokohama J Soc Sci* 2010; **14**: 57-77.
- [16] Ikram AU, Nadia BZ, Zabta KS, Mohammad Q. Ethnomedicinal review of folklore medicinal plants belonging to family Apiaceae of Pakistan. *Pak J Bot* 2015; **47**(3): 1007-1014.
- [17] Bibi S, Husain SZ, Malik RN. Pollen analysis and heavy metals detection in honey samples from seven selected countries. *Pak J Bot* 2008; **40**(2): 507-516.
- [18] Ali SI. Significance of flora with special reference to Pakistan. *Pak J Bot* 2008; **40**(3): 967-971.
- [19] Shinwari ZK. Medicinal plants research in Pakistan. *J Med Pl Res* 2010; **4**(3): 161-176.
- [20] Qureshi R, Bhatti GR. Ethnobotany of plants used by the Thari people of Nara Desert Pakistan. *Fitoterapia* 2008; **79**: 468-473.
- [21] Sher Z, Khan ZU, Hussain F. Ethnobotanical studies of some plants of Chagharzai valley, district Buner. *Pak J Bot* 2011; **43**(3): 1445-1452.
- [22] Amjad MS, Mf Qaem, Ahmad I, Khan SU, Chaudhari SK, Zahid Malik N, et al. Descriptive study of plant resources in the context

- of the ethnomedicinal relevance of indigenous flora: a case study from Toli Peer National Park, Azad Jammu and Kashmir, Pakistan. *PLoS One* 2017; **12**(2): 1-31.
- [23] Ahmad E, Arshad M, Saboor A, Qureshi R, Mustafa G, Sadiq S, et al. Ethnobotanical appraisal and medicinal use of plants in Patriata, New Murree, evidence from Pakistan. *J Ethnobiol Ethnomed* 2013; **9**: 13.
- [24] Arshad M, Ahmed M, Ahmed E, Saboor A, Abbas A, Sadiq S. An ethnobiological study in Kala Chitta hills of Pothwar region, Pakistan: multinomial logit specification. *J Ethnobiol Ethnomed* 2014; **10**: 13.
- [25] Khan SM, Ud Din N, Ilyas M, Sohail Ur Rahman I. Ethnobotanical study of some medicinal plants of Tehsil Kabal, district Swat, KP, Pakistan. *Med Aromat Pl* 2015; **4**: 189.
- [26] Ahmad K, Pieroni A. Folk knowledge of wild food plants among the tribal communities of Thakhte-Sulaiman Hills, North-West Pakistan. *J Ethnobiol Ethnomed* 2016; **12**: 17.
- [27] Dar M. Ethno botanical uses of plants of Lawat district Muzaffarabad, Azad Jammu and Kashmir. *Asi J Pl Sci* 2003; **2**: 680-682.
- [28] Khan MA, Khan SA, Qureshi MA. Ethnobotany of some useful plants of Poonch valley Azad Kashmir. *J Med Plant Res* 2011; **5**: 6140-6151.
- [29] Mahmood A, Riffat NM, Zabta KS, Aqeel M. Ethnobotanical survey of plants from Neelum, Azad Jammu and Kashmir, Pakistan. *Pak J Bot* 2011; **43**: 105-110.
- [30] Shaheen H, Shinwari ZK, Qureshi RA, Ullah Z. Indigenous plant resources and their utilization practices in village populations of kashmir himalayas. *Pak J Bot* 2012; **44**: 739-745.
- [31] Rashid S, Ahmad M, Zafar M, Sultana S, Ayub M, Khan MA, et al. Ethnobotanical survey of medicinally important shrubs and trees of Himalayan region of Azad Jammu and Kashmir. *Pak J Ethnopharmacolo* 2015; **26**(166): 340-351.
- [32] Nasir E, Ali SI. *Flora of Pakistan*. Karachi: Pakistan Agriculture Research Council Publisher; 1970-1989.
- [33] Ali SI, Qaiser M. *Flora of Pakistan nos. 194–220*. Karachi: Pakistan Agriculture Research Council Publisher; 1993-2015.
- [34] Heinrich M, Edwards S, Moerman DE, Leonti M. Ethnopharmacological field studies: a critical assessment of their conceptual basis and methods. *J Ethnopharmacol* 2009; **124**: 1-17.
- [35] Martin GJ. *Ethnobotany: a people and plant conservation manual*. London: Chapman and Hall; 1995, p. 268.
- [36] Edwards S, Nebel S, Heinrich M. Questionnaire surveys: methodological and epistemological problems for field-based ethnopharmacologists. *J Ethnopharmacol* 2005; **100**: 30-36.
- [37] Truglia RP. *Applied econometrics using STATA*. Boston: Harvard University Press; 2009, p. 106-117.
- [38] McFadden D. Conditional logit analysis of qualitative choice behaviour. In: Zarembka P, editor. *Frontiers in econometrics*. New York: Academic Press; 1974, p. 105-142.
- [39] Clark L. *IDRISI Taiga*. Worcester: Clark University Press; 2009.
- [40] Bruderi J. *Applied regression analysis using STATA*. USA: STATA Press; 1989, p. 43-51.
- [41] Saghir IA, Awan AA, Majid S, Khan MA, Qureshi SJ. Ethnobotanical studies of Chikar and its allied area of district Muzaffarabad. *J Biol Sci* 2001; **1**: 1165-1170.
- [42] Ahmad M, Shazia SS, Hadi SFH, Hadda TB, Rashid S, Zafar M, et al. An ethnobotanical study of medicinal plants in high mountainous region of Chail Valley. *Swat J Ethnobiol Ethnomed* 2014; **10**(36); <http://dx.doi.org/10.1186/1746-4269-10-36>.