

ETHNO-BOTANICAL EVALUATION OF INDIGENOUS FLORA FROM THE COMMUNITIES OF RAJH MEHAL AND GOI UNION COUNCILS OF DISTRICT KOTLI, AZAD JAMMU KASHMIR PAKISTAN

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Abstract. The present study reports ethnobotanical information about plants, which were used by indigenous communities of two union councils of district Kotli AJK. The present study is first report of quantitative ethnobotany from study area. Rajh Mehal and Goi are representative union councils of district Kotli, Azad Jammu and Kashmir having large ranges diversity in habitat and climatic conditions. This district is naturally blessed with highly medicinal plants but unfortunately ethno-botanical information is sporadically known. The study area was surveyed for two consecutive years during moon soon period and ethnobotanical data was collected from 112 local inhabitants using a semi-structured, open ended questionnaire and by free listing method. Several quantitative indices including Informant Consensus Factor, Use Value, Frequency of Citation, Relative Frequency of Citation and Relative Importance Index were used to determine relative usage, benefits and coverage of ethno-medicine. The agreement of homogeneity between the present and previous studies and among the indigenous communities was evaluated using the Jaccard Index. The summary statistics and correlation between use value and relative frequency of citation was calculated in SPSS v 16. The data from free listing method was analyzed by using ANTHROPAC package in R software. Comparison of indigenous knowledge among different genders and age groups was made using Spearman correlation test, the result showed that men had higher information (14.05) about plant uses than females (8.55) in the study area. Male informants reported 63.8% (± 10.18) of total recorded species and 76% (± 4.13) uses while female informants reported 38.8% (± 6.06) species and 68% (± 3.65) uses. Smith's Saliency analysis indicates that most of the plants in the study area were useful against abdominal pain and worms, constipation and pain. Diseases were classified into twelve different disease categories based on International Classification of Diseases (ICD) classification, with Skin and related symptoms (S00-T98) had highest value (0.91) of Informant's Consensus Factor (IC) followed by Circulatory problems (I00-I99) and Diabetes (E10-E14) each having IC value of 0.90. Aerial parts of 21 plant species were utilized in herbal preparations followed by leaves (20 spp.) and oral mode of admiration was most common among inhabitants. Among all the studied species *Zanthoxylum alatum* was found highly important with a relative importance value of 93.75 followed by *Adhatoda zeylanica* with an importance value of 91.67. High dependency of local inhabitants on traditional medicines was confirmed by higher values of informant consensus factor, which showed that people in study area still use herbal medicines as a primary source of their health care. The present study indicated that area was rich in medicinal plant knowledge and there is a need to exploit this information for drug development and pharmacological activities in addition of conservation and management of this valuable plant resource of the area.

Keywords: ANTHROPAC, frequency of citation, relative importance, informants consensus factor, medicinal importance

Abbreviations: prior informed consent (PIC), informant consensus (IC), use value index (UV), relative frequency of citation (RFC), medicinal importance (MI), number of use-reports (Nur), number of species cited (Nt), frequency of citation (FC), international plant name index (IPNI), international classification of diseases (ICD), relative pharmacological properties (PH), relative body system treated (BS), relative importance (RI), oral (Or), tropical (Tr)

Background

One of survey by World Health Organization estimates that about 80 percent of world population depends upon herbal medicines made from approximately 50,000 flowering plants of total world flora (Govaerts, 2001; Schipmann et al., 2002). Effectiveness of plants to cure various ailments is known to humans right from their origin and many herbal drugs are still being utilized in current day herbal system effective against various diseases (Goyal et al., 2014). Indigenous knowledge about plants is an important asset that is gathered from countless activities involving empirical observation, ‘trial and error’ by the indigenous peoples seeking a cure for an ailment (Locher, 2013). Traditionally, ethnobotanists are interested in exploring the effect of different demographic factors, i.e. age, gender, ethnicity and other attributes of indigenous knowledge coupled with quantitative ethnomedicinal documentation of traditional knowledge by employing different statistical tools (Ullah et al., 2013).

Ethnobotanical knowledge is considered to be an integral part of the knowledge for the drug development. It either helps in identifying new drugs or refocusing on the plants earlier reported to have bioactive components (Mahwasane et al., 2013). The indigenous communities residing in Pakistan mostly use herbal therapies to cure their ailments. Resultantly various studies significantly contributed ethno-pharmacological inventories. With reference to Azad Jammu and Kashmir, some ethnomedical studies have been reported from various areas such as Neelum (Mahmood et al., 2011), Poonch valley (Khan et al., 2010, 2012) and Sudhnoti (Ishtiaq et al., 2015). Few papers have been written on ethnobotanical aspects from the District Kotli (Ajaib et al., 2010; Amjad et al., 2015; Amjad and Arshad, 2014); however, these studies are superficial and lack of novelty in terms of quantitative data in addition to traditional phytotherapies. Therefore, the present study was aimed to:

1. Record and discuss knowledge on medicinal plant uses in the local traditional practices including method of preparation and use of plants as herbal medicine
2. The differential distribution of knowledge about plants and medical properties among sectors of the society
3. Identifying novel uses of plants compared to previously reported work
4. Analysis of ethnobotanical data by using different quantitative indices

Methods

The study was organized into three stages (*Fig. 1*).

a) Field work

The study area lies near line of control and is diversity hotspot due to frequent rain and pleasant weather conditions. Being remote and having less literacy rate people in area still depend upon herbal medicines but documentation of this traditional knowledge is very rare. The present study was conducted by interviewing 112 local inhabitants

with age ranges between 40 to 75 years, including herbalists, midwives (*Daai*) and local peoples (male, female). Legal permission was taken from representatives of the municipality for conducting interviews and collection of ethnobotanical data. All respondents were asked to sign a prior informed- consent (PIC) form after the objectives and possible consequences of the study had been explained. The prior informed consent (PIC) form was translated into the local *Pahari* language. The study area was explored for three years (July 2015–September 2016), plant samples were collected and information was gathered by group discussions, interviews and field visits. Sample size was determined by using method developed by Kadam and Bhalerao (2010).

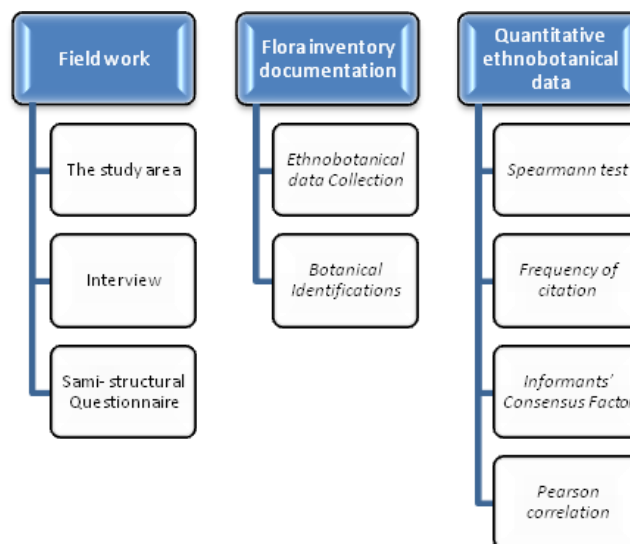


Figure 1. Experimental design for the collection of data

b) Floral inventory documentation

Ethnobotanical information collected through interviews was recorded in a semi-structured questionnaire. Information obtained was cross-checked and compared with existing available literature. Furthermore, the indigenous learning about the plant assets, religious and social perspective, for example, populace density was additionally recorded. The Minimum Standards of Reporting Checklist contains details of the experimental design, and statistics, and resources used in this study. During field surveys, the local/common names of plants were recorded with the help of a local guide or local informants. For taxonomic confirmation of plant was done using different Floras and monographs of the different areas of Pakistan, whereas the International Plant Name Index (IPNI) (www.ipni.org) was also used to obtain the correct botanical name confirmation.

c) Quantitative analyses of ethnobotanical data

Frequency of citation (FC)

The result of FC presented as %age and proportions. Each plant reported by informants with respect to the native use was calculated as frequency of citation (FC). The collected ethnomedicinal information was quantitatively analyzed using relative frequency citation index (RFC) after Vijaykumar et al. (2015) as follows:

$$RFC = FC / N$$

where FC is frequency of citation N is number of informants.

Informants' consensus factor (F_{IC})

IC is utilized to build up the consistency of learning among the sources for each sickness treated and diverse illness categories (Heinrich et al., 1998). Informant consensus factor was drawn to search agreements of the informants against the cures for each diseases category. For this purpose, following formula was used:

$$F_{IC} = \frac{Nur - Nt}{Nur - 1}$$

where *Nur* is the number of use-reports in each group of disease; *Nt* is the number of species cited for the particular disease by all the informants. The F_{IC} values are ranged between 0 and 1, in which '1' shows the maximum level of consensus. Consequently, high F_{IC} can be used in identifying important plants for searching novel bioactive molecules (Carrió and Vallès, 2012).

Medicinal importance (MI)

The MI was figured out by utilizing following equation after Baydoun et al. (2015).

$$MI = \frac{\text{No. of use reports for disease category}}{\text{No. of species used}}$$

Use value index (UV)

The use value was calculated by using following formula (Vijayakumar et al., 2015):

$$UV = \sum U_i / N$$

U_i is the number of uses stated by each informant for a given species and N is the total number of sources (informants).

Relative importance (RI)

RI was determined by the formula

$$RI = \frac{\text{Rel PH} + \text{Rel BS} \times 100}{2}$$

$$\text{Rel PH} = \frac{\text{PH of a given plant}}{\text{Maximum PH of all reported plant species}}$$

where PH is pharmacological attributes of the each provided plant and Rel PH is the relative number of pharmacological properties for an individual plant.

$$BS = \frac{\text{BS of a given Plant}}{\text{Maxi. BS of all reported plant species S}}$$

BS is the number of body system healed by single species and Rel PH is relative number of body system treated by a single species.

Smith's salience analysis (SS)

The analysis of agreement and variation in free-lists using cultural domain analysis is described and justified in detail by Puri (2010), Quinlan (2005), Weller and Baer (2002), and several statistical software packages, including ANTHROPAC, can manage and analyze data in this way. The cultural domain analysis using ANTHROPAC was performed using Borgatti's (1996) Methods Manual. The main steps can be briefly summarized free-lists are compiled in an informant by disease matrix, which indicate both the rank order and the presence or absence of items in each informant's list from this, the frequency of items, their average rank in the list, and a measure of salience (based on Smith, 1993) can be calculated. This is essentially a weighted average of the (inverse) rank of an item across multiple free-lists, where the number of items in the list weights each list.

Pearson correlation

Pearson correlation analysis was calculated in order to access the linear relationship b/w the RFC and Use value index (UV) by using SPSS ver. (16, the r^2) also estimated to measure cross species variability in RFC that was described by variance in UV. The r^2 was computed simply taking square of r (Amjad et al., 2017).

Spearman test

To decide if a statistically significant correlation exists between the number of plants mentioned and the age of informant, we used the Spearman test. The Mann-Whiney U and Kruskal-Wallis tests were used to find significant differences among two and 5 groups related groups, respectively, all values set at 0.5 alpha level of significance (Bruschi et al., 2011; Shaheen et al., 2017a).

Results

Demographic data

Ten field visits (to complete regular varieties) were done to accumulate ethnobotanical information related to use of medicinal plants. The aggregate length of the field work was roughly about 3 years i.e. from July 2015 to September 2016 and data was recorded form 112 informants (male 67 and females 45). The informants were divided in to four categories based on their gender, age group, education and profession. Mostly herbalists were present in the age group range between 51-60 while least number of informants had age more than 60 years. Literacy rate of study area was very low as most of informants (about 26.7%) were uneducated and only 5 informants which is 4.46% of total informants had higher education. On average male informants had more information about the plant uses than female informants, male informants on average know 14.05 species than female who know 8.55 species. Similarly uses known

by male and female were different, on average males report 6.12 uses of plant while female reports 5.82 uses of the plant (*Table 1*). Informants of age between 41 and 50 know most plants than other age groups but information about plant use was provided most by informants with age between 51-60 years and more than 60 years as they on average report 6.25 and 9.91 uses of plants. Among educated informants, those having middle (secondary school) education know most of the plant species (20.38) and people with intermediate education (Higher secondary school) know most uses of plant species (7.30) among different professionals' traditional health practitioners know most of the species (23.08 on average) and also reported multiple uses (on average 9.60) of recorded species (*Table 1*). Many examinations have demonstrated that age and sex are two vital variables to be considered while assessing the appropriation of information inside a gathering of sources (Torres-Aviles et al., 2016; Albuquerque et al., 2011). In any case, not many investigations have broken down the impact of these factors on the appropriation of ethno-medicinal information in Pakistan and none of them utilized factual examinations for approval of the gathered information (Ahmad et al., 2014). Spearman's correlation analysis showed significant positive differences between the age and the number of both mentioned species ($r_s = 0.24$; $p < 0.05$) and different uses ($r_s = 0.35$; $p < 0.05$), indicating that there is a trend of older people being more knowledgeable than younger people.

Table 1. Demographic data of informants and knowledge about TAB. F = female; M = male

Informants	#		# Known species		# Cited different uses	
	F	M	F	M	F	M
Total	45	67	8.55±6.06	14.05±10.18	5.82±3.65	6.12±4.13
Age class						
18-30	17		5.50±4.68		5.35±2.64	
31-40	27		10.16±8.55		4.52±2.41	
41-50	23		15.57±12.21		4.52±3.38	
51-60	30		12.32±7.94		6.25±4.91	
> 61	15		12.91±5.16		9.91±3.70	
Education level						
Uneducated	30		7.32±5.09		4.50±2.68	
Intermediate	25		12.39±6.84		7.30±4.86	
Primary	25		12.65±9.50		7.13±4.51	
Graduate	12		7.60±3.69		5.50±3.78	
Middle	15		20.38±13.49		5.23±2.42	
Post graduate	5		12.00±10.58		6.00±2.00	
Profession						
Worker	6		9.40±7.40		7.40±2.30	
Traditional health practitioner	26		23.08±8.86		9.60±4.63	
Retired	10		10.28±2.69		5.71±3.15	
House wife	15		6.15±3.84		3.84±2.30	
Midwifery	9		14.87±5.54		8.00±3.16	
Labour	5		6.00±1.82		3.50±1.91	
Teacher	20		6.29±2.86		3.70±2.05	
Agriculturist	15		6.73±3.45		4.40±2.58	
Student	7		11.58±8.96		5.99±3.90	

different areas. The reason for less similarity among the studies may be due to the existence of different cultural values in communities inhabiting the areas so they use plants differently for their healthcare needs. (Baydoun et al., 2015; Panyaphu et al., 2011). However, the informants were unaware of such concern and they informed only beneficial effects of plants without pointing out any side effects. Different parts were used for preparing herbal recipes. Leaves (31%) were the most used plant part, followed by aerial parts (17%), fruit (14%), roots (12%), bark (8%), flower (6%) and bulb, cone branches, pulp, resins (1% each) (Fig. 5). The preference of leaves in preparing herbal preparations may be due to storage of most of the active ingredients in leaves in order to attain resistance from the herbicides and insects. Furthermore, they are accessible and easy to collect (Panyaphu et al., 2011; Mesfin et al., 2013; Ahmed et al., 2013).

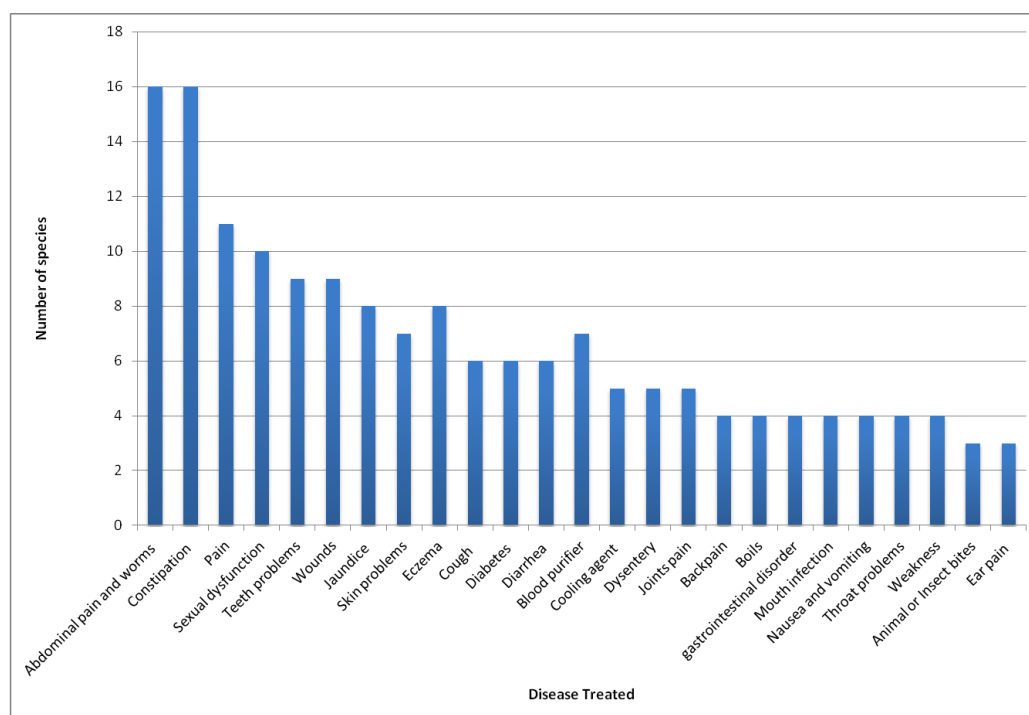


Figure 3. Contribution of ethnoflora for treating different ailments in the study area

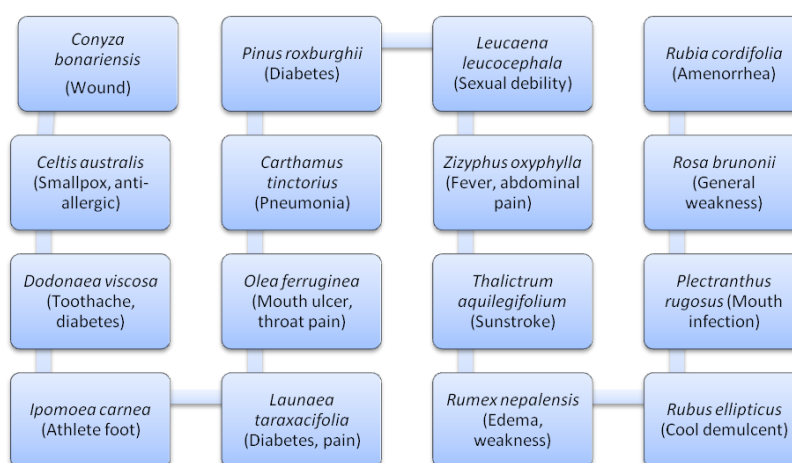



Figure 4. Sixteen plants spp., which have novel uses in the study area













Table 2. Inventory of medicinal plants including families, plant species, specimen numbers, local names, part used, preparation(s), application, properties/ailment treated, quantitative indices and literature












Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Ailment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
1	Acanthaceae	<i>Adhatoda zeylanica</i> Medic./KD-24	Baiker		Powder	Or	Abdominal pain (NI 14), asthma (NI 12), cough (NI 9), rheumatic pain (NI 6), ear infection (NI 13), *insect repellent (NI 5)	59	0.79	83	1.11	0.75	0.83	79.17	[10, 45]
2	Amaranthaceae	<i>Achyranthes aspera</i> var. <i>perphyristachya</i> Hook.f. /KD-47	Puthkanda		Paste, tea	Tr	*Pain and inflammation (NI 7), kidney stone (NI 6), insect bite (NI 2), bleeding (NI 3), fever (NI 5)	23	0.31	59	0.79	0.63	0.67	64.58	[46-49]
3	Amaranthaceae	<i>Amaranthus viridis</i> L./ KD-97	Ghanar		Powder	Tr	*Hot tonic (NI: 14) , piles (NI: 6), gonorrhoea (NI: 7), Stomach problems (NI: 9)	36	0.48	63	0.84	0.63	0.50	56.25	[11, 49, 50]
4	Apiaceae	<i>Daucus carota</i> L./KD-58	Gajar		Juice, extract	Or	Weak eye sight (NI: 17), stimulants of the uterus (NI 4), anemia (NI: 10), blood purifier (NI: 8)	39	0.52	48	0.64	0.38	0.50	43.75	[50, 51]
5	Apocynaceae	<i>Carissa opaca</i> Stapf. ex Haines/KD-43	Garanda		Exude	Tr	*Pain and inflammation (NI 15)	53	0.71	78	1.04	0.75	1.00	87.50	[52, 53]
					Powder	Or	*Abdominal pain (NI 13), jaundice (NI 9), sexual debility (NI 4), skin infection (NI 2), earache (Ni 10)								
6	Asclepiadaceae	<i>Calotropis procera</i> (Aiton) W.T. Aiton/ KD-62	Ak		Latex	Tr	*Dog-bite (NI: 9), back pain (NI: 6), infection (NI: 9) , *sexual problems (NI: 5), ring worm (NI: 2), asthma (NI: 7), insect bite (NI: 4)	42	0.56	61	0.81	0.88	0.67	77.08	[48, 49]
7	Asteraceae	<i>Artemisia absinthium</i> L.	Babuna		Decoction, powder	Or	Stomach pain (NI: 6), earache (NI: 4), kill worms (NI: 2), inflammation (NI: 5)	21	0.28	36	0.48	0.63	0.67	33.33	[47]
							*Insect repellent (NI: 4)								







Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
8	Asteraceae	<i>Carthamus tinctorius</i> L./ KD-93	Kasumba (zafran)		Boiled in oil	Tr	*Pneumonia (NI: 8), fever (NI: 12), cough (NI: 5), throat problems (NI: 6)	31	0.41	52	0.69	0.50	0.50	50.00	[54]
9	Asteraceae	<i>Cichorium intybus</i> L./ KD-61	Kahsni		Juice	Or	Fever (NI 5), abdominal disorders (NI 3), indigestion (NI 4)	12	0.16	26	0.35	0.38	0.33	35.42	[8, 47]
10	Asteraceae	<i>Conyza bonariensis</i> (L.) Cronquist/ KD-152			Powder	Tr	Wound (NI 4), bleeding piles (NI 4), painful menstruation (NI 2)	10	0.13	15	0.20	0.38	0.50	43.75	[55]
11	Asteraceae	<i>Launaea taraxacifolia</i> (Willd.) Amin/ KD-89	Hand		Potherb	Or	*Diabetes (NI: 9), pain (NI 6)	15	0.20	25	0.33	0.25	0.33	29.17	[56]
12	Asteraceae	<i>Sonchus asper</i> (L.) Hill./ KD-81	Hundh		Powder	Or	*Diabetes (NI 7), * body pain (NI 5)	12	0.16	18	0.24	0.25	0.33	29.17	[57]
13	Asteraceae	<i>Tagetes minuta</i> L.	Sadberga		Extract	Or	Kidney pain (NI 5), expel kidney stones (NI 4)	9	0.12	9	0.12	0.25	0.17	20.83	[58, 59]
14	Asteraceae	<i>Taraxacum officinale</i> F.H. Wigg/ KD-26	Khali Hand		Potherb, paste	Or	*Fever (NI 8), jaundice (NI 3), swelling (NI 11), joints pain (NI 5)	27	0.36	64	0.85	0.50	0.50	50.00	[49]
15	Berberidaceae	<i>Berberis lycium</i> DC./ KD-74	Sumbalu		Chewed, paste, extract	Tr	*Mouth inflammation (NI 11), jaundice (NI 9), injury (NI 3), wounds (NI 6), tonic (NI 5), diarrhea (NI 9), rheumatism (NI 7), diabetes (NI 8),	58	0.77	89	1.19	1.00	0.67	83.33	[46, 48, 60] [10]
16	Bombacaceae	<i>Bombax ceiba</i> L./ KD-136	Simble		Powder	Or	Weakness (NI 11), dysentery (NI 7), diarrhea (NI13), impotence (NI 8)	39	0.52	49	0.65	0.50	0.50	50.00	[61, 62]
17	Boraginaceae	<i>Trichodesma indicum</i> (L.) R. Br./KD-125	Handusi		Cooked with sugar, Infusion	Or	*Back pain (NI 14), *weakness (NI 9), swellings (NI 3), *urinary diseases (NI 7), dysentery (NI 8)	41	0.55	62	0.83	0.50	0.67	58.33	[63-65]
18	Brassicaceae	<i>Lepidium sativum</i> L./ KD-28	Haleon		Seeds are boiled in milk	Or	Backache (NI 5), pain (NI 2), abortion (NI 1) *eye cleaner (NI 4)	13	0.17	22	0.29	0.50	0.50	50.00	[66]
19	Cactaceae	<i>Opuntia dillenii</i> Haw./ KD-15	Thor		leaf made into a pulp /Paste	Tr	Ophthalmia (NI 8) *joint pain (NI 10)	18	0.24	35	0.47	0.25	0.33	29.17	[8]
20	Caesalpiniaceae	<i>Cassia fistula</i> L./ KD-09	Amaltas		Juice, decoction	Or	Abdominal pain (NI 12), constipation (NI 7), joint pain (NI 9) respiratory problems (NI10), jaundice (NI 6), piles (NI 5)	49	0.65	79	1.05	0.75	0.83	79.17	[46, 67] [11]











Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
21	Cannabaceae	<i>Cannabis sativa</i> L./ KD-73	Bahng		Paste made with turmeric and rape seed/ smoked	Tr	Swellings NI 4, sedative (NI 7), relief pain (NI 2).	13	0.17	25	0.33	0.38	0.50	43.75	[46, 47, 68, 69]
22	Chenopodiaceae	<i>Chenopodium album</i> L./ KD-119	Ghanari		Potherb, decoction, infusion	Or	Constipation (NI 9), pain in limbs (NI 5), intestinal problems (NI 12), jaundice (NI 8), pile (NI 3), throat and eye problems (NI 9)	46	0.61	56	0.75	0.75	0.83	79.17	[61, 47, 50]
23	Convolvulaceae	<i>Ipomoea carnea</i> Jac./ KD-02	Jungli bakhir		Paste, decoction	Tr	*Athlete foot (NI 5), loose stools (NI 23)	27	0.36	24	0.32	0.25	0.33	29.17	[50, 53]
24	Cucurbitaceae	<i>Momordica charantia</i> L./ KD-22	Khrella		Juice	Or	Diabetes (NI 6), jaundice (NI 4), piles (NI 2)	15	0.20	21	0.28	0.50	0.50	25.00	[11, 70]
					Leaves coated with oil warmed	Tr	Pain/swelling (NI 1)								
25	Cuscutaceae	<i>Cuscuta reflexa</i> Roxb./ KD-114	Neeladari		Decoction, juice	Or	Jaundice (NI 6), blood purifier (NI 9), Hair fall (NI 11), skin disease (NI 4)	38	0.51	62	0.83	0.63	0.67	64.58	[48]
					Paste	Tr	Fractured bones (NI 8)								
26	Euphorbiaceae	<i>Ricinus communis</i> L./ KD-10	Arind		Leaves coated with mustard oil and warmed/ rapped on abdomen of kids, powder, poultice	Tr	Wounds (NI 7), boils (NI 5), swellings (NI 3), Joints pain/inflammation (NI 14), flatulence (NI 9) Increase milk production in females (NI 4)	45	0.60	58	0.77	0.88	0.67	33.33	[48, 50]
					Given with milk	Or	Constipation (NI 3)								
27	Euphorbiaceae	<i>Euphorbia helioscopia</i> L./ KD-42	Dodak		Paste	Tr	Boils (NI 19), female problems (NI 7)	26	0.35	30	0.40	0.25	0.33	29.17	[13]
28	Euphorbiaceae	<i>Mallotus philippensis</i> (Lam.) Muell./ KD-163	Kamilla		Powder mixed with mustard oil	Tr	Hair tonic (NI 4), anti-lice (NI 5), measles mumps (NI 2)	29	0.39	47	0.63	0.63	0.50	25.00	[45, 71]










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					Powder	Or	*Cough (NI 10), intestinal worms (NI 8)								
29	Gentianaceae	<i>Swertia chirata</i> Ham./ KD-98	Chiraeta		Powder	Or	Nausea (NI 5) and vomiting (NI 8)	13	0.17	29	0.39	0.25	0.17	20.83	[46, 48]
30	Juglandaceae	<i>Juglans regia</i> L./ KD-90	Khor		Paste	Tr	Dermatitis (NI 7)	56	0.75	58	0.77	0.63	0.83	41.67	[10, 61, 67]
					Mixed with corn and crushed in water with sugar	Or	Nerve tonic (NI 11), tooth discoloration (NI 16), kidney stone (NI 12), constipation (NI 10)								
31	Lamiaceae	<i>Otostegia limbata</i> (Benth.) Benth. ex Hook. f./ KD-52	Chitta kanda		Chewed, extract	Tr	Mouth ulcer (NI 15), throat pain (NI 11), asthma (NI 13)	39	0.52	63	0.84	0.38	0.50	43.75	[13, 67, 72]
32	Lamiaceae	<i>Plectranthus rugosus</i> Wall./ KD-92	Safed Manja		Chewed	Tr	*Mouth infection (NI 21)	21	0.28	34	0.45	0.13	0.17	14.58	[14, 60]
33	Lamiaceae	<i>Mentha arvensis</i> L./KD-72	Podina		Decoction	Or	Diarrhea (NI 5), nausea (NI 8), vomiting (NI 5), abdominal pain (NI 18)	36	0.48	64	0.85	0.50	0.33	41.67	[10, 68]
34	Lamiaceae	<i>Mentha longifolia</i> (L.) Huds./ KD-28	Jungli podina		Decoction	Or	Diarrhea (NI 17), dysentery (NI 22)	39	0.52	57	0.76	0.25	0.17	20.83	[53, 73]
35	Liliaceae	<i>Allium cepa</i> L./ KD-85	Piaz		Boiled in rapeseed oil, paste, juice	Tr	Earache (NI 19), boils (NI 16), Cough (NI 9), infection (NI 3)	47	0.63	48	0.64	0.50	0.67	58.33	[10, 48]
36	Liliaceae	<i>Allium sativum</i> L./ KD-61	Thoom		Juice mixed with equal quantity of vinegar and honey	Or	Blood pressure (NI 14), ear pain (NI 8), infection (NI 7)	29	0.39	34	0.45	0.38	0.50	43.75	[74]
37	Meliaceae	<i>Melia azedarach</i> Him./ KD-265	Dharek		Powder	Or	Diabetes (NI 16), jaundice (NI 8)	32	0.43	54	0.72	0.50	0.50	50.00	[10, 51, 61]
					Paste	Tr	*Hair fall (NI 6), small pox (NI 2)								








Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
38	Mimosaceae	<i>Albizia lebeck</i> (L.) Benth./ KD-89	Shrin		Paste	Tr, Miswak	Inflamations (NI 10) , burns (NI 9), toothache (NI 14), strengthens the gums and teeth (NI 4),			73	0.97	0.63	0.50	56.25	[75]
					Powder mixed with mint leaves,	Or	*Sexual debility (11),	48	0.64						
39	Mimosaceae	<i>Leucaena leucocephala</i> (Lam.) de Wit/ KD- 118	Kikar	  	Equal quantity of seeds mixed with <i>Albizia lebeck</i> and made into powdered, oil, decoction	Or	*Sexual debility (NI 14), bacterial infection (NI 7), contraceptive (NI 13)	34	0.45	49	0.65	0.38	0.50	43.75	[76]
40	Moraceae	<i>Ficus palmata</i> Forssk./ KD-168	Phagwara	 	Thin layer wrapped/ eaten	Or	*Wounds (NI 11), constipation(NI 9), extraction of spines from flash (NI 15)	35	0.47	59	0.79	0.38	0.33	35.42	[73, 77]
41	Moraceae	<i>Ficus benghalensis</i> L./ KD-260	Bhojar			Tr	Heel cracks (NI 5)	31	0.41	25	0.33	0.50	0.50	50.00	[11]
					Poured into candy (<i>Batasha</i>)	Or	*Sexual debility (NI 17), premature ejaculation (NI 8), Scurvy (NI 1)								
42	Moraceae	<i>Morus nigra</i> L./ KD-81	Kala toot		Juice is made into syrup, Infusion	Or	Cough (NI 13), throat pain (NI 12), inflammation (NI 9), diarrhea (NI 4), Pain (NI 3), diabetes (NI 5),	46	0.61	64	0.85	0.75	0.83	79.17	[10, 61] [63]
43	Myrtaceae	<i>Eucalyptus camaldulensis</i> Dehnh./ KD- 99			Rubbed and smelled	Tr	Cold (15), cough(12), *condiment (6)	33	0.44	25	0.33	0.38	0.33	35.42	[78]
44	Myrtaceae	<i>Psidium guajava</i> L./ KD-110	Amrood	 	Kept in warm ash for few minutes, chewing, decoction	Or	Flu (NI 9), cough (5), anthelmintic (14), bleeding gums (NI 5), bad breath (NI 4), wounds (2), vaginal irritation and discharges (3)	42	0.56	61	0.81	0.88	0.67	77.08	[67, 79];
45	Nyctaginaceae	<i>Boerhavia procumbens</i> Banks ex Roxb./ KD-235	Budh bail		Decoction	Or	*Refrigerant (NI 6), demulcent drink (NI 6)	12	0.16	31	0.41	0.25	0.17	20.83	[47]
46	Oleaceae	<i>Olea ferruginea</i> Royle/KD-21	Kohu		Chewed, toothbrush	Tr	*Mouth ulcer (NI 17), throat pain (NI 5) , diabetes (NI 4), toothache (NI 8)	53	0.71	64	0.85	0.63	0.67	64.58	[57, 80]

Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
					Oil	Tr	Pain (NI 10), inflammation (NI 9)								
47	Oxalidaceae	<i>Oxalis corniculata</i> L/ KD-193	Jandouro		Crushed with red chilies (<i>Chatni</i>), paste	Or	Lack of appetite (NI 15)	51	0.68	49	0.65	0.63	0.50	25.00	[10, 80]
			Jandouro		Paste, rubbed	Tr	*Pain (NI 12), *pus formation (NI 6), Snake bite (NI 8), wounds (NI 10)								
48	Papilionaceae	<i>Medicago polymorpha</i> Willd./ KD-73	Siree		Potherb	Or	Heart tonic (NI 4), constipation (NI 8), wounds (NI 3)	15	0.20	25	0.33	0.38	0.50	43.75	[49, 57]
49	Papilionaceae	<i>Dalbergia sissoo</i> Roxb. / KD-37	Tali		Oil, Wrapping	Tr	Scabies (NI 3), swelling of the breast (NI 7)	35	0.47	34	0.45	0.75	0.83	79.17	[67, 71] [81]
					Decoction, Juice, powder mixed with oil	Or	*Cooling agent (NI 10), diarrhea (NI 4), dandruff (NI 5), gonorrhea (NI 6),								
50	Papaveraceae	<i>Papaver somniferum</i> L./ KD-187	Post		Roasted fruit ground with <i>Terminalia chebula</i> , <i>Foeniculum vulgare</i> and black salt	Or	Abdominal pain (NI 11), sleeplessness (NI 6)	17	0.23	21	0.28	0.25	0.33	29.17	[47, 68]
51	Pinaceae	<i>Pinus roxburghii</i> Sargent./ KD-203	Chir		Plasters, herbal steam baths	Tr	Ringworm (NI 5), boils (NI 7), rheumatism (NI 6), cough (NI 10), cold (NI 2)	45	0.60	56	0.75	0.88	0.67	77.08	[10, 46, 68]
					Soaked overnight in water (Juice)	Or	*Diabetes (NI 12), kidney and bladder problems (NI 3)								
52	Plantaginaceae	<i>Plantago major</i> L./ KD-109	Chamchapatar		Mixed with curd, Infusion	Or	Dysentery (NI 6), haemoptysis (NI 7)	13	0.17	23	0.31	0.25	0.33	29.17	[61]
53	Plantaginaceae	<i>Plantago ovata</i> Forssk./ KD-16	Ismaghol		Heated leaves	Tr	Wounds (NI 2), toothache (NI 3)	10	0.13	15	0.20	0.38	0.50	18.75	[68]

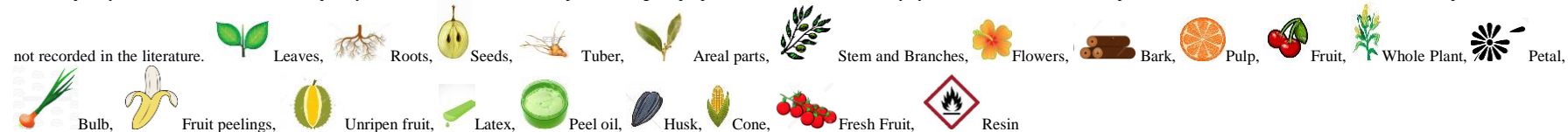
Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
					Mixed with curd	Or	Dysentery (NI 5)								
54	Poaceae	<i>Cynodon dactylon</i> (L.) Pers./ KD-11	Khabal		Infusion along milk, juice,	Or	Piles (NI 8), bleeding from nose (NI 5)	25	0.33	44	0.59	0.50	0.50	50.00	[68, 75]
					Paste, poultice	Tr	Cuts (NI 10), wounds (NI 2)								
55	Polygonaceae	<i>Rumex hastatus</i> D. Don/ KD-121	Ambhi		Potherb, Juice	Or	Headache (NI 9), dyspepsia (NI 5), *flatulence in animals (NI 6), constipation (NI 9), dysentery with blood (NI 8)	37	0.49	33	0.44	0.63	0.33	47.92	[61, 68, 79]
56	Polygonaceae	<i>Rumex nepalensis</i> L./ KD-22	Halfari		Leaves mixed with <i>Nasturtium officinale</i> (Potherb), decoction, paste	Or	*Edema (NI 5), weakness (NI 3), Body pain (NI 2), swollen gums (NI 2)	12	0.16	15	0.20	0.50	0.33	41.67	[82]
57	Punicaceae	<i>Punica granatum</i> var. <i>nana</i> L./ KD-61	Darunna		Powder	Or	* Leucorrhoea (NI 5)	55	0.73	58	0.77	1.00	1.00	100	[13] [83]
					Powder	Or	Diarrhea (NI 9), dysentery (NI 7)								
					Soaked in water overnight (Juice)	Or	Jaundice (NI 12), heart disease (NI 7), blood pressure (NI 6), bleeding from nose (NI 4), expel worms (NI 5)								
58	Ranunculaceae	<i>Thalictrum aquilegifolium</i> L./ KD-230	Beeni		Crushed in water (Juice)	Or	Sunstroke (NI 9), jaundice (NI 5)	14	0.19	25	0.33	0.25	0.33	29.17	[84, 85]
59	Ranunculaceae	<i>Ranunculus arvensis</i> L./ KD-198	Chichumbha		Potherb	Or	Indigestion (NI 22)	43	0.57	67	0.89	0.38	0.33	18.75	[10, 68, 83]
					Boiled in rapeseed oil and ground	Tr	*Boils (NI 18), pimples (NI 3)								
60	Ranunculaceae	<i>Ranunculus scleratus</i> L./ KD-398	Jal dhania		Juice	Or	*Blood purifier (NI 15)	15	0.20	34	0.45	0.13	0.17	14.58	

Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
61	Rhamnaceae	<i>Zizyphus oxyphylla</i> Edgew./KD-312	Ber		Root barks and <i>Achyranthes</i> <i>aspera</i> (Powder)	Or	*Fever (NI 11),* abdominal pain (NI 5), Diabetes (NI 10), pain (NI 2)	28	0.37	32	0.43	0.50	0.67	58.33	[86]
62	Rosaceae	<i>Prunus persica</i> (L.) Batsch./ KD-291	Arwaari		Cooked with rice	Or	Constipation (NI 13), edema (NI 3)	21	0.28	51	0.68	0.38	0.50	43.75	[57, 60, 70, 86]
					powder	Tr	Wounds (NI 4)								
63	Rosaceae	<i>Rosa indica</i> L./ KD- 102	Gulab		Soaked in water overnight (Infusion/Arq- e-Gulab)	Tr/Or	Eye cleaner (NI 12), heart tonic (NI 7)	29	0.39	46	0.61	0.38	0.50	43.75	[61, 72]
					Crushed in sugar and kept few days under moonlight	Or	Constipation (NI 10)								
64	Rosaceae	<i>Rosa brunonii</i> Lindl./ KD- 173	Tarnari		Powder, decoction	Tr	Wounds (NI 7), infections(NI 11), constipation (NI 9)	35	0.47	56	0.75	0.50	0.33	25.00	[60, 67, 87]
					Powder	Or	*General weakness (NI 8)								
65	Rosaceae	<i>Rubus ellipticus</i> Smith./ KD-124	Aakhra		Paste	Tr	Wounds (NI 8)	45	0.60	53	0.71	0.88	1.00	93.75	[57, 61, 70] [72]
					Crushed in water (Juice),	Or	*Cool demulcent (NI 9), vaginal/seminal discharge (NI 6), fever (NI 3), colic (NI 8), coughs (NI 6), sore throat (NI 5).								
66	Rubiaceae	<i>Rubia</i> <i>codifolia</i> Roxb. ex Desv./ KD-109			Crushed in water (Juice)	Or	*Amenorrhea (NI 12), dysentery (5) intestinal worms in animals (2)	19	0.25	32	0.43	0.38	0.50	43.75	[53]

Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
67	Rutaceae	<i>Zanthoxylum alatum</i> Roxb./ KD-356	Timmer		Kept on hand (Asa), powder mixed with <i>Mentha</i> spp. and table salt eaten with boiled egg, decoction	Tr	Piles (NI 9), chest pain (NI 7), *digestive problems (NI 9), fever (NI 5), dyspepsia (NI 6), cholera (NI 8), toothache (NI 6), rheumatism (NI 4)	54	0.72	64	0.85	1.00	0.67	83.33	[10, 61, 68, 72]
68	Rutaceae	<i>Citrus medica</i> var. <i>acida</i> Brandis/ KD-246	Girgal		Juice mixed with the infusion of <i>Rosa indica</i> and glycerin	Or	Softening of skin (NI 15), pain (NI 7), heart tonic (NI 5), dysentery (NI 2), antibiotic (NI 4)	33	0.44	35	0.47	0.63	0.83	72.92	[61, 88]
69	Sapindaceae	<i>Dodonaea viscosa</i> (L.) Jacq./ KD-100	Sanatha		Exude, extracts	Tr	Sore throat (NI 8), *diabetes (NI 11), pain (NI 9), toothache (NI 7), wound (NI 8)	43	0.57	58	0.77	0.63	0.67	64.58	[10, 48, 60, 61]
70	Sapindaceae	<i>Sapindus mukorossi</i> Gaertn. de Fruct./ KD-132	Raintha		Paste	Tr	*Snake/ scorpion bites (NI15), allergy (NI 7), skin freckles (NI 4), inflammation (NI 6), anti-lice (NI 8), dandruff (NI 9)	49	0.65	55	0.73	0.75	0.33	54.17	[10, 70, 79]
71	Scrophulariaceae	<i>Verbascum thapsus</i> L./ KD-200	Giddar tammako		Paste, smoked	Tr	*Joint pain (NI 5), chest complaints (NI 4), asthma (NI 2)	11	0.15	22	0.29	0.38	0.33	35.42	[46, 72, 89]
72	Solanaceae	<i>Capsicum frutescens</i> var. <i>acuminata</i> Fingerh/ KD-301	Mirch		Eaten with bread	Or	*Abdominal worms (NI 5), stomach pain (NI 9), back pain (NI 7)	21	0.28	43	0.57	0.38	0.33	35.42	[89]
73	Solanaceae	<i>Solanum incanum</i> L./KD-26	Mohkari		Paste/ Smoked	Tr	Toothache (NI 6), snake bite (NI 4)	17	0.23	38	0.53	0.50	0.67	58.33	[51]
					Juice	Or	Pneumonia (NI 4), sore throat (NI 3)								
74	Solanaceae	<i>Solanum nigrum</i> L. / KD-69	Kachach		Potherb/ juice	Or	Heart disease (NI 15), fever (NI 8), pain (NI 3)	26	0.35	35	0.47	0.38	0.50	43.75	[47, 50]

Sr.#	Family	Plant species/ Specimen number	Local name	^A Part used	^B Preparation	^C Application	^D Properties/Aliment treated	^E FC	^F RFC	^G Ui	^H UV	^I Rel. PH	^J Rel. BS	^K RI	Literature
75	Solanaceae	<i>Solanum surattense</i> Shord Wendl. / KD-37	Mohkari		Paste, smoke	Tr	Pain (NI 9), inflammation (NI 7), piles (NI 8)	53	0.71	39	0.52	0.50	0.50	50.00	[47]
					Cooked in milk (Curry), Decoction with the stem of <i>Tinospora cordifolia</i>	Or	Backache (NI 11), fever (NI 12), phlegmatic Cough (NI 6)								
76	Ulmaceae	<i>Celtis australis</i> L./KD-67	Khirk		Paste, decoction	Tr	*Smallpox (NI 15), anti-allergic (NI 10), dysentery (NI 12), inter menstrual bleeding (NI 7), bacterial infection (NI5).	49	0.65	61	0.81	0.75	1.00	87.50	[60, 69]
77	Urticaceae	<i>Debregeasia salicifolia</i> (D. Don.) Rendle./KD-96	Sindari		Exude/paste mixed with mustard oil	Tr	*Toothache (NI 7), skin rashes (NI 4), infection (NI 10), eczema (NI 9)	30	0.40	43	0.57	0.50	0.33	41.67	[60, 69, 79]
78	Verbenaceae	<i>Vitex negundo</i> Haussk./ KD-59	Banah		Powder, decoction	Or	Abdominal pain (NI 8), dispersing swellings of the joints from acute rheumatism (NI 2), *toothache (NI 12) , ulcers (NI 4), flatulence,(NI 3) fever (NI 3)	32	0.43	53	0.71	0.75	0.50	62.50	[90, 91]
79	Violaceae	<i>Viola canescens</i> Wall. Ex Roxb./ KD-43	Banakhshah		Decoction	Or	Jaundice (NI 24), fever (NI 13), gastrointestinal disorder (NI 8), cough (NI 9)	52	0.69	47	0.63	0.50	0.50	50.00	[10, 82]
80	Xanthorrhoeaceae	<i>Aloe vera</i> (L.) Burm.f./ KD-77	Kunwaargandal		Potherb	Or	*Pain (NI 5),* inflammation (NI 8), wound healing (NI 3),	16	0.21	33	0.44	0.38	0.17	27.08	[60, 79, 92]

FC = frequency of citation, RFC = relative frequency of citation, Rel. PH = relative pharmacological properties, Rel. BS = relative body system treated, RI = relative importance, UV = use value index, Or = oral, Tr= tropical. *Novel use



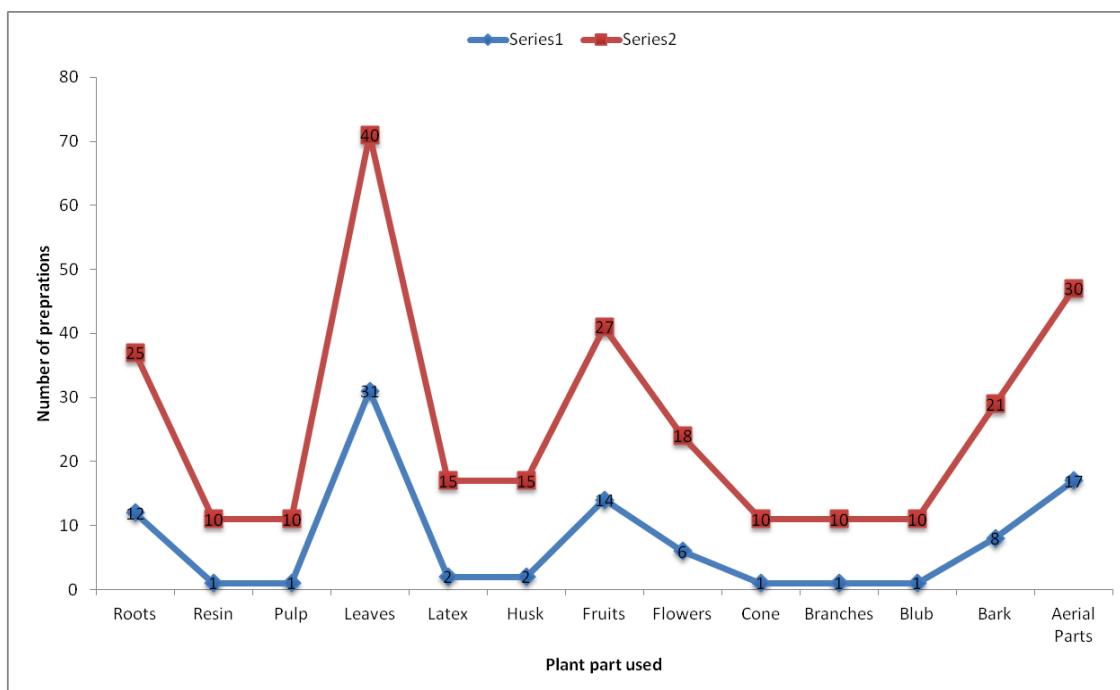


Figure 5. Different plant parts used in herbal preparations

Methods of preparation and administration

Different herbal recipes were prepared from the medicinal plants and method of preparation and application vary based on type of disease treated and actual site of application (Fig. 6). The most herbal recipes were prepared by grounding plant parts into powder about 16.4%. Other methods of preparation and administration include: juice (15%), paste (14%), decoction (11%), chewing (6.3%), potherb (5.7%), infusion (3.8%), extract (3.16%), boiling, smoking, poultice, latex and wrapping (2.53% each), cooking and oil (1.9% each), rubbing (1.27%), herbal bath, smelling and tea (0.63% each). Although most of the preparations were made from a single plant few were made from mixture of more than one plants, for example, seeds of *Leucaena leucocephala* were grounded and mixed with equal amount of powdered seeds of *Albizia lebbeck* to treat sexual debility. Similarly, roasted fruit of *Papaver somniferum* was ground with *Terminalia chebula*, *Foeniculum vulgare* and black salt for the treatment of abdominal pain and sleeplessness. With regard to the method of preparation, the undertaken study was in accordance with the work carried out by Mouterde (1983). Most of the preparations were administered orally (57.58%), followed by tropical (39.62%) and inhalation (2.8%). These results were in accordance with Vijayakumar et al. (2015).

Therapeutic indications

Informant's consensus factor (F_{IC})

In order to check the agreement of informants about the knowledge of plants uses, the recorded 90 diseases were grouped into 12 different disease categories according to IDC. The Informants Consensus Factor (F_{IC}) values ranged from 0.80 to 0.91, showed much homogeneity in nearly all the described disease categories (Table 3). Generally, F_{IC} values range from 0 to 1, in which the high values are good indicator of high

informant consensus on the species used in the treatment of a particular category of illness (Heinrich et al., 1998; Trotter and Logan, 1986). The Informants Consensus Factor (F_{IC}) analysis indicated that among the 12 disease categories skin and related symptoms had the highest F_{IC} values (0.91), treated by a large number of taxa (10 species) and 96 use reports. It was followed by circulatory problems (0.90), diabetes (0.90). The highest value of F_{IC} suggests increased data about the usefulness of plants to cure a specific disease. The most commonly used plants to treat these diseases were *Pinus roxburghii*, *Ranunculus arvensis*, *Albizia lebbeck*, *Lepidium sativum*, *Chenopodium album*, *Otostegia limbata*, *Berberis lyceum*, *Medicago polymorpha* and *Adhatoda zeylanica*. Although the F_{IC} for gastrointestinal disorders (0.88) was less compared to some other ailment categories, however, a maximum number of plants (66 species) were recorded under this category. This category contains wide range of ailments such as abdominal pain, abdominal worms, piles, cholera, constipation, diarrhea, dysentery indigestion, flatulence, stomach disorder, intestinal problems, lack of appetite, nausea, vomiting and stomach pain (Afolayan et al., 2014; Abe and Ohtani, 2013). The plants with high F_{IC} value might contain the high amount of bioactive compounds and can be subjected to further biochemical and pharmacological analysis.

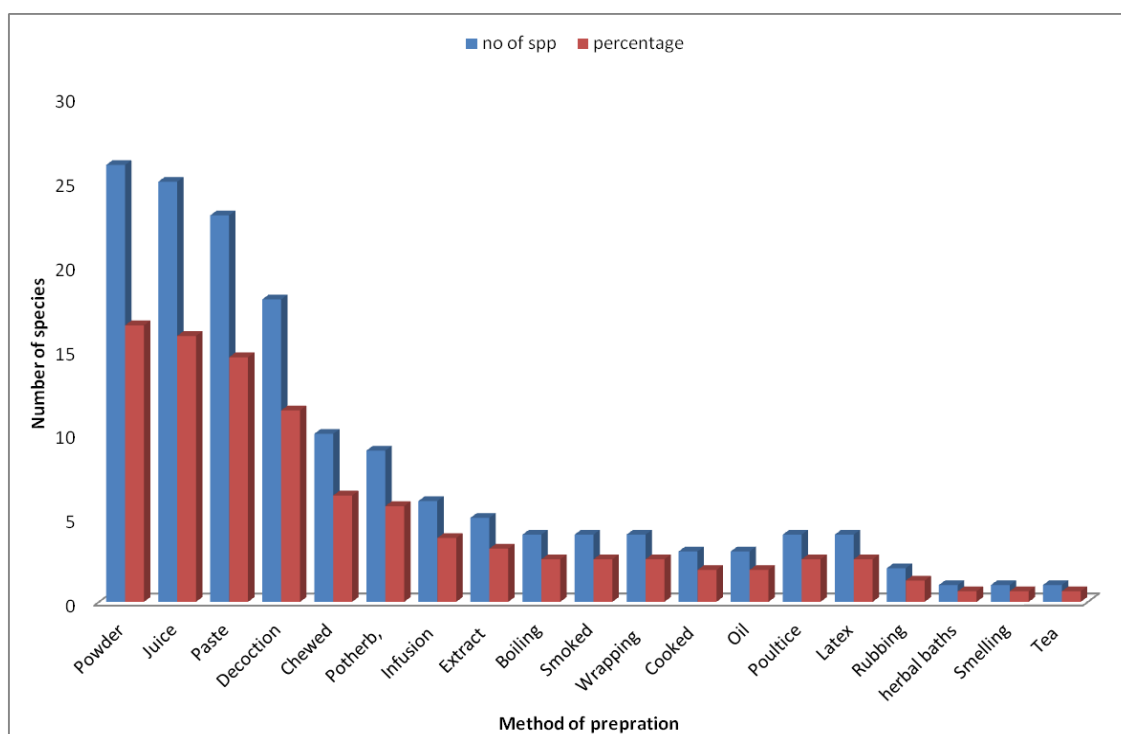


Figure 6. Various herbal preparations/formulations from the native flora of Rajh Mehal

Medicinal importance (MI)

The medicinal importance (MI) values can be used as a sign of the relative medicinal relevance of mentioned plant species (Table 3). These values can be used in finding variability among the pharmacological, environmental and cultural determinants between the investigated species and areas (Baydoun et al., 2015). The MI and F_{IC} values were higher for skin and related symptoms (9.6) because weather conditions in study area quit severe dry and prolong winter; that is why people in the study area suffer

skin problems very commonly. After skin diseases circulatory problems (8.93) were common, then diabetes (8.8) and digestive system problems, mouth, ear and oral disease (8.45). These values were closer to the findings of Baydoun et al. (2015) and higher than the MI values reported by Carrió and Vallès (2012).

Table 3. International classification of diseases (ICD) classification and disease categories along with various diseases versus reports, number of taxa, total reports and FIC

Sr. no	Disease category	Symptoms	No. of taxa	Use reports	FIC	MI
1	Circulatory problems (I00-I99)	Anemia (10), blood pressure (20), blood purifier (32), heart disease (15), heart disease (29), edema (3), heart tonic (16)	14	125	0.90	8.93
2	Digestive system problems (K00-K93), (R00-R99)	Abdominal Pain (92), abdominal worms (5), piles (45), cholera (8), constipation (87) diarrhea 61 digestive problem (9) dysentery (110) indigestion (37) flatulence 18 stomach disorder (8) intestinal problems (12) lack of appetite (15) nausea and vomiting (26) stomach pain (24) scurvy (1) jaundice (94)	66	558	0.88	8.45
3	Respiratory System (J00-J99)	Asthma (45), bad breath (4), chest complaints (4), chest pain (7), flue and cold (26), cough (94) haemoptoy (7) pneumonia (4)	25	191	0.87	7.64
4	Diabetes (E10-E14)	Diabetes (88)	10	88	0.90	8.8
5	Musculoskeletal (M00-M99)	Back pain (43) body pain (7) joints pain (2) inflammation (69) joint pain (43) pain (76) pain and inflammation (22) swelling (33) fractured bones (8), rheumatic pain (23)	48	326	0.86	6.79
6	Infections (A00-A09)	Bacterial infection (12), ear infection (13), infection (40), skin infection (2), pus formation (6), Fever (73)	10	73	0.88	7.3
7	Skin and related symptoms (S00-T98)	Boils (65), burns (9), measles/ mumps (2), pimples (3), Small pox (7)	10	96	0.91	9.6
8	Dermatological problems (L00-L99)	Dermatitis (7), heel cracks (5), eczema (9), ringworm (7), scabies (3), skin disease (4), skin freckles (4), skin rashes (19), allergy (17) athlete foot (5)	13	60	0.80	5.8
9	Others (Tonic, cool demulcent drinks, sedative)	Cool demulcent (25), hair tonic (4), hot tonic (14), nerve tonic (11), refrigerant (6), tonic (5), uterus tonic (5), tooth and gum tonic (4), sedative (7), ulcers (4), heat stock (9)	13	94	0.87	7.4
10	Antidotes T36-T50	Dog-bite (9) Insect bite (15) snake bite (27)	8	51	0.86	6.38
11	Worm insect related diseases	Anthelmintic (14) antibiotic (4) anti-lice (12) expel worms (5) intestinal worms (10) kill worms (2)	8	47	0.85	5.88
12	Oral, dental, hair and ENT	Bleeding from nose (9) bleeding gums (5) earache (41) tooth discoloration (16) eye cleaner (16) weak eye sight (22) mouth infection (21) mouth inflammation (11) mouth ulcer (32), ophthalmia (8), toothache (63), weakness (31), throat pain (38), swollen gums (2), dandruff (14) hair fall (17) headache (9), sore throat (16)	66	558	0.88	8.45

FIC = informants' consensus factor, MI = medicinal importance

Relative importance (RI)

The highest RI value was obtained for *Adhatoda zeylanica* (93.75) *Zanthoxylum alatum* (91.67), *Berberis lyceum*, *Juglans regia* (87.50 each) *Punica granatum*, *Olea ferruginea* (83.33 each), and *Solanum surattense* (79.17) which indicated that these plants possess strong pharmacological properties and are used more frequently in the study area. The important and most commonly cited plants belonged to Asteraceae, Lamiaceae, Solanaceae and, Rosaceae. These finding agrees with the early reports by Carmen Juárez-Vázquez et al. (2013), Yaseen et al. (2015) and Alonso-Castro et al. (2012).

Smith's salience analysis (SS)

Salience analysis (Smith, 1993) accounted for frequency of mention; on an average 60 illnesses were listed. In free-listing we interview 112 informants but for Salience analysis and ranking of illness 10 most informative informants were chosen. The Table 4 shows salience estimates for each illness, indicating both the number of people who mentioned the illness and the order of their responses. In Smith's Salience analysis abdominal pain and worms had the highest overall salience index, mentioned by 73.21% of informants. Constipation was the second most salient illness had 70.54% of informants and Pain was the third most cited illness treated by the plants in the study had 67.8% frequency. Sleeplessness, uterus disease, weak eyesight and bleeding gonorrhoea were the less salient diseases. Composite Salience was another step to reinforcement the results of Smith's Salience by narrow down the informant numbers, result was draw the on the base of ten key informants.

Table 4. Results of ANTHROPAC analysis of Illness free-lists and Smith's salience index along with composite salience

S. No	Illness	Frequency (%) N = 112	Inverted rank/total listed = Smith's salience index										Illness Σ	Composite salience Σ/n (n = 10)	
			SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10			
1	Abdominal pain and worms	82 (73.21)	60/60=1		58/60=0.96				53/60=0.883			52/60=0.867	51/60=0.850	4.56	0.4560
2	Constipation	79 (70.54)		60/60=1							53/60=0.883			1.883	0.1883
3	Pain	76(67.86)	58/60=0.96											1.827	0.1827
4	Sexual dysfunction	72 (64.29)				56/60=0.933								0.933	0.0933
5	Teeth problems	71 (63.39)	56/60=0.933	58/60=0.96										1.893	0.1893
6	Wounds	70 (62.50)					52/60=0.867			1/60=0.017				0.867	0.0867
7	Jaundice	69 (61.61)												0.883	0.0883
8	Skin problems	69 (61.61)	51/60=0.850						53/60=0.883					0.85	0.0850
9	Eczema	68 (60.71)											50/60=0.833	0.833	0.0833
10	Cough	67 (59.82)	50/60=0.833							1/60=0.017				0.833	0.0833
11	Diabetes	67 (59.82)		1/60=0.017	48/60=0.800									0.8	0.0800
12	Diarrhea	67(59.82)	46/60=0.767				1/60=0.017							0.767	0.0767
13	Blood purifier	66 (58.93)				46/60=0.768				1/60=0.017			1/60=0.017	0.768	0.0768
14	Cooling agent	66 (58.93)	46/60=0.769				5/60=0.083				46/60=0.770			1.539	0.1539
15	Dysentery	65 (58.04)		1/60=0.017					46/60=0.770			1/60=0.017		0.77	0.0770

S. No	Illness	Frequency (%) N = 112	Inverted rank/total listed = Smith's salience index										Illness Σ	Composite salience Σ/n (n = 10)	
			SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10			
16	Joints pain	65 (58.04)	44/60=0.733											0.733	0.0733
17	Backpain	65 (58.04)			44/60=0.734		9/60=0.150							0.734	0.0734
18	Boils	64 (57.14)	44/60=0.735			9/60=0.150				1/60=0.017				0.735	0.0735
19	Gastrointestinal disorder	64 (57.14)			9/60=0.150			43/60=0.717						0.717	0.0717
20	Mouth infection	63 (56.25)							3/60=0.050			42/60=0.700		0.7	0.0700
21	Nausea and vomiting	63 (56.25)	42/60=0.701			42/60=0.700								1.401	0.1401
22	Throat problems	62 (55.36)			41/60=0.683					42/60=0.700				1.383	0.1383
23	Weakness	61 (54.46)	39/60=0.650						42/60=0.700					1.35	0.1350
24	Animal or insect bites	60 (53.57)				39/60=0.651						1/60=0.017		0.651	0.0651
25	Ear pain	60 (53.57)					42/60=0.700						39/60=0.652	1.352	0.1352
26	Flatulence	59 (52.68)			37/60=0.617					42/60=0.700				1.317	0.1317
27	Hair fall	58 (51.79)	36/60=0.600											0.6	0.0600
28	Indigestion	57 (50.89)				34/60=0.567			1/60=0.017					0.567	0.0567
29	Inflammation	56 (50.0)		33/60=0.550								1/60=0.017		0.55	0.0550
30	Piles	55 (49.11)			31/60=0.517			1/60=0.017						0.517	0.0517
31	Swellings	54 (48.21)	30/60=0.500										1/60=0.017	0.5	0.0500
32	Urinary diseases	53 (47.32)				27/60=0.450			5/60=0.083					0.45	0.0450
33	Cold and flu	52 (46.43)	26/60=0.433											0.433	0.0433
34	Eye cleaner	51 (45.54)			24/60=0.400			5/60=0.083						0.4	0.0400
35	Heart tonic	50 (44.64)	22/60=0.367									5/60=0.083		0.367	0.0367
36	Pimples	49 (43.75)				20/60=0.333				3/60=0.050				0.333	0.0333
37	Abortion	48 (42.86)	18/60=0.300											0.3	0.0300
38	Amenorrhoea	47 (41.96)			17/60=0.283							3/60=0.050		0.283	0.0283
39	Anorexia	46 (41.07)	17/60=0.284										2/60=0.033	0.284	0.0284
40	Antilice	46 (40.18)			3/60=0.050				15/60=0.250					0.25	0.0250
41	Asthma	45 (40.18)	12/60=0.200					3/60=0.050						0.293	0.0293
42	Athlete foot	41 (36.61)		4/60=0.067		11/60=0.183								0.25	0.0250
43	Blood pressure	39 (34.82)	10/60=0.167											0.567	0.0567
44	Dandruff	36 (42.14)			9/60=0.150			1/60=0.017						0.167	0.0167
45	Edema	32 (28.57)	9/60=0.151									1/60=0.017		0.168	0.0168
46	Hot tonic	30 (26.79)					1/60=0.017			9/60=0.152				0.169	0.0169
47	Infection	30 (26.79)	7/60=0.117		1/60=0.017				1/60=0.017					0.151	0.0151
48	Injury	25 (22.32)		6/60=0.100				2/60=0.033						0.133	0.0133
49	Leucorrhoea	23 (19.64)	6/60=0.101						3/60=0.050					0.151	0.0151
50	Nerve tonic	22 (19.64)				6/60=0.102						1/60=0.017		0.119	0.0119
51	Ophthalmia	20 (17.86)					27/60=0.450			5/60=0.083				0.45	0.0450

S. No	Illness	Frequency (%) N = 112	Inverted rank/total listed = Smith's salience index										Illness Σ	Composite salience Σ/n (n = 10)	
			SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10			
52	Pneumonia	15 (13.39)			1/60=0.017								5/60=0.084	0.101	0.0101
53	Pus formation	14 (12.50)				4/60=0.067								0.067	0.0067
54	Ringworm	13 (11.61)							4/60=0.067					0.067	0.0067
55	Sedative	12 (10.71)	3/60=0.050											0.05	0.0050
56	Sleeplessness	10 (8.93)			3/60=0.050									0.05	0.0050
57	Uterus disease	10 (8.93)	2/60=0.033											0.033	0.0033
58	Weak eye sight	9 (8.04)								2/60=0.033				0.033	0.0033
59	Bleeding	5 (4.46)											1/60=0.017	0.017	0.0017
60	Gonorrhea	3 (2.68)	1/60=0.017											0.017	0.0017

Use value index (UV) and relative frequency of citation (RFC)

The use value (UV) shows the range to which a species can be used and the species with high UV values were mostly exploited in the area to cure a specific ailment. *Zanthoxylum alatum* (1.19), *Olea ferruginea* (1.11), *Solanum surattense* (1.05) and *Juglans regia* (1.04) possessed the higher use values. Table 2 showed high values of UV and RFC of different plant species. It is evident from the results that *Adhatoda zeylanica*, (0.79) *Berberis lyceum* (0.77), *Juglans regia* (0.75) and *Punica granatum var. nana* (0.73) and *Zanthoxylum alatum* (0.72) were the most cited species in the research area. On the bases of RFC and UV we concluded, since these species are very commonly available in the area, therefore the inhabitants mostly cited these. Moreover, these species were native to that area and were present for decades, so their properties to cure different disease got popularized among the indigenous peoples. A strong significant and positive correlation ($r^2 = 0.60$) was recorded between UV and RFC showing that by increase in number of informants the knowledge about plant use in herbal medicine will also increase. These results indicate that the study can make a significant contribution to folk knowledge on the use of medicinal plants and further laboratory-based investigations could help in identifying the active ingredients of the most commonly exploited plants. The variation in data can be explained by coefficient of determination and in present study the value of R^2 was 0.36 reflecting that 33% variation in use value can be explained in terms of relative frequency of citation (Table 5).

Table 5. Pearson correlation between UV and RFC

		UV	RFC	Mean \pm std. deviation
UV	Pearson correlation	1	0.606**	0.6034 \pm 0.23249
	Sig. (2-tailed)		0.000	
	N	80	80	
RFC	Pearson correlation	0.606**	1	0.4250 \pm 0.19266
	Sig. (2-tailed)	0.000		
	N	80	80	

$$r^2 = 0.36$$

Discussion

This study documented the good diversity of medicinal plants coupled with their therapeutic use and medicinal importance in the indigenous communities of Rajh Mehal, AJK. The ethnobotanical inventory consists of an ample therapeutic indication of 80 medicinal plants distributed in 12 disease categories that revealed a good picture of the health disorders of the native population. The natives mostly prefer single species based preparations instead of mixtures. The high Informant Consensus (F_{IC}) suggests that current use and knowledge of medicinal plants are still strong and local inhabitants have a high dependency on medicinal plants in meeting their primary health care. Many novel uses of plants were documented after comparing with the previously published literature. Most of the documented species possessed similar uses; however, 16 species possessed various novel uses which were not previously recorded. These include: *Conyza bonariensis* (Wound), *Carthamus tinctorius* (Pneumonia), *Celtis australis* (Smallpox, anti-allergic), *Dodonaea viscosa* (Toothache, diabetes), *Ipomoea carnea* (Athlete foot), *Launaea taraxacifolia* (Diabetes, pain), *Leucaena leucocephala* (Sexual debility), *Olea ferruginea* (Mouth ulcer, throat pain), *Pinus roxburghii* (Diabetes), *Plectranthus rugosus* (Mouth infection), *Rosa brunonii* (General weakness), *Rubia cordifolia* (Amenorrhea), *Rubus ellipticus* (Cool demulcent), *Rumex nepalensis* (Edema, weakness), *Thalictrum aquilegifolium* (Sunstroke) and *Zizyphus oxyphylla* (Fever, abdominal pain). In Smith's Saliency analysis indicated that abdominal pain and worms had the highest overall saliency index, mentioned by 73.21% informants. Constipation was the second most salient illness had 70.54% of informants and Pain was the third most cited illness treated by the plants in the study had 67.8% frequency but Sleeplessness, uterus disease, weak eyesight and bleeding gonorrhoea were the less salient diseases. Composite Saliency was another step to reinforcement the results of Smith's Saliency by narrow down the informant numbers, result was drawn on the basis of ten key informants. On the basis of RFC and UV we can say that, these species are very commonly available in the area, therefore the inhabitants mostly cited these. Moreover, these species were native to that area and were present for decades, so their properties to cure different diseases got popularized among the indigenous peoples.

Conclusion

The present study can serve as the best baseline study to search active ingredients of plants which are being utilized as herbal medicine in the study area, particularly plants with novel uses. These plants might be subjected to further lab and clinical analysis for validation of results from the present study. This traditional knowledge together with scientific studies can lead to powerful discovery for newer, safer and affordable medicines. Furthermore, this study could be helpful in the conservation of the traditional knowledge of medicinal plants of the remote areas like Rajh Mehal for the uplift of a good life standard and livelihood of the local communities is indispensable. High dependency of local communities on local flora is resulting in the extinction of medicinal plants, so steps should be taken for conservation and management of these valuable plant resources of this territory.

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Conflict of interests. We declare that we have no conflict of interests.

Ethics approval. Before initiating of 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 Pahari language.

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