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Research Article

Quantitative Ethno-Veterinary Usage of Plants in the Outskirts of District Malakand, Khyber Pakhtunkhwa, Pakistan

Asghar Khan[1]*, Nasrallah Khan[1], Kishwar Ali[1], Abdur Rauf[2] and Seema Patel[3]

[1]*Laboratory of Plant Ecology, University of Malakand Chakdara, Pakistan*

[2]*Department of Chemistry, University of Swabi Anbar, Khyber Pakhtunkhwa, Pakistan*

[3]*Bioinformatics and Medical Informatics Research Center, San Diego State University, USA*

***Corresponding Author:** Asghar khan, Laboratory of Plant Ecology, University of Malakand Chakdara, Pakistan.

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Abstract

Study Objective: In order to analyze the local importance of medicinal plants and their availability status, a quantitative ethno-veterinary study has been carried out in the outskirts of district Malakand from March 2014 to February 2016.

Materials and Methods: The plant resources with ethno-veterinary usages were evaluated via a semi-structured and open-ended questionnaire. The statistical indices like Frequency of citation (FC), Relative frequency of citations (RFC), use value (UV), Pearson correlation coefficient, informant consensus factor (ICF), Direct matrix ranking (DMR) were calculated to find the relevance and status of the local flora.

Results: It was reported that the community uses 50 plant species to cure 26 types of livestock diseases. The more commonly-utilized plant parts were leaves (41%) followed by seed (23%). The FC and RFC values were both high for Ammi visnaga, while the highest UV was recorded for *Sarcococca saligna* (0.062). The Pearson correlation coefficient for RFC and UV was 0.8516. Based on ICF, the highest values were obtained for the livestock pathologies like gastrointestinal disorders, mastitis, and black quarter disease. Melia azedarach was ranked first by the DMR followed by *Quercus incana, Monotheca buxifolia* and *Butea monosperma*, respectively. Other interesting results were obtained by quantitative interpretation of the interview data.

Conclusion: It can be concluded that the people of the area hold rich ethno-veterinary knowledge to cure livestock pathologies. Due to rapid deforestation, these medicinal plants are threatened, and the availability of drugs is rendering this traditional ethno-veterinary knowledge obsolete. Considering the unsustainability of chemical drugs, these plant resources and treatment methods ought to be preserved. This ethnobotanical study is an effort in that regard.

Keywords: Ethno-Veterinary; Frequency of citation; Relative Frequency of Citation; Informant's Consensus Factor; Direct Matrix Ranking

Abbreviations

FC: Frequency of Citation; RFC: Relative Frequency of Citations; UV: Use Value; PCC: Pearson Correlation Coefficient; ICF: Informant Consensus Factor; DMR: Direct Matrix Ranking; FMD: Foot and Mouth Disease; EHDV: Hemorrhagic Disease Virus (EHDV).

Introduction

Medicinal plants are a good natural resource and safe drugs and have been used for the treatment of health disorders in human and livestock from time immemorable [1]. Approximately 85% of all medications globally used for primary health care are derived from plants which serve a potent medicine for curing various ailments [2]. Evaluation of medicinal plants for therapeutic usage is prerequisite for conservation, protection and development of herbal medicines [3] and play an important role in economic uplifting of deprived societies of the world [4]. Evaluation of plants for therapeutic studies not only shows its importance within the local sociocultural background but preserve the local plant-based knowledge of communities and may also support socioeconomic situations of a region [5]. Moreover, such studies provide a baseline for discovery of new active compounds from the plants and will be used directly as patent medicine. Worldwide, as the relationship between food and health significantly increasing, customers demand healthy tasty and natural functional foods, grown in clean environment. Consequently, most country of the world follows herbs and some traditional drug systems very professionally [6]. Globally, 20 out of more than 20,000 species of wild edible plants provide 90% of our nutrition [7]. Approximately 65–80% of the population in developing countries depends principally on plants for their primary health care [8].

Pakistan is an agrarian country in South East Asia, located at the foothills of the Himalayas has multiple floristic zones [9]. Out of the approximate 6,000 species, about 600 are part of folkloric medicines [Selin 2008]. Majority of rural people of the country deriving their livelihood and sustenance by agriculture and animal husbandry. Most of the Pakistani livestock farmers own five to six animals per family and it is estimated that up to 80% of the population is relying on agriculture and livestock sector [10]. The farmers residing in remote parts of the country and often financially-challenged fail to avail healthcare for the livestock, horses, pigs, and sheep and poultry. In such scenario, the knowledge of locally-available medicinal plants serves great purpose. However, with the easy availability of chemical drugs, and rising human pressure on natural resources, local flora is shrinking rapidly, and the indigenous knowledge is vanishing with the passing way of aging, elders in the communities. Hence, ethnoveterinary studies are very crucial in Pakistan. In recent times, researchers have investigated the ethnobotanically-relevant plants from different regions of this country such as district Karak [11]; Haripur, Abbottabad and Mansehra [12]; Malakand Valley, District Dir [13]. Whereas no such study on ethnoveterinary usage of local plants was previously reported for the district of Malakand, in the border areas of Khyber Pakhtun Khwa province in North West Pakistan. In view of this, the current study was planned with the aim to document the traditional knowledge of local plants being used to cure various ailments of livestock in the area.

Methods

Description of the study site

The study site Swat Ranizai is a Provincially Administered Tribal Area (PATA), located in District Malakand of Khyber Pakhtunkhwa [14]. The study area is a tourist attraction as it extends from the rocky and partly glaciated mountain ranges of the Hindukush down to Northern edge of the Peshawar basin. It is surrounded on the North by Dir, on Northeast by Swat and on East by Buner district, on the South the area is bounded by Mardan and Charsadda districts and on West by Mohmand and, Bajaur tribal Agencies [15] Figure 1 The study area consists of various narrow valleys surrounded by steep hillsides with rich floristic diversity and holds a pleasant and peaceful atmosphere with pollution free environment [16]. The climate of the study area is of continental type which is hot during summer and cold in winter; vary with the elevation in different localities of the area. The maximum temperature during summer reaches 41°C and minimum in winter (-2°C) respectively. June and July are the hottest months of the year with 40°C and 38°C average temperatures, respectively [17]. The study area has a total population of 260295 with 475 population density per square kilometer and a growth rate of 3.36%, and literacy ratio 41.4%. Pashto is the predominant language being spoken in the area. Another language called Gujro has also been noticed in mountainous villages. Moreover, the livelihood of the inhabitants in the rural is cattle rearing and products of forest resources [18]. Majority of people are Muslim's and the Religion has a great impact on the culture of people. Christians and Hindu community exist in minorities. The trees such as *Olea ferruginea, Acacia modesta, Ficus bengalensis* present in graveyards and saint shrines are considered as sacred symbol and hence protect by the community [19]. Women in rural areas collect fodder for cattle's and make baskets from plant twigs while Men works in agricultural field and earn livelihood. The houses in rural areas are mostly made up of clay and shaped stones collected from nearby mountains whereas in urban area the houses are constructed with bricks and cement. The common flora of the area is *Olea ferruginea, Monotheca buxifolia, Acacia modesta, Dodonea viscosa, Pistacia integrrima, Melia azedarach, Acacia nilotica, Zizyphus mauritiana, Zizyphus nummularia, Morus alba, Eucalyptus cammaldulensis, Pinus roxburghi*. The common wild animals found in the area are Jackal, Rabbit, Monkey and Wolf. In addition, all community groups mostly use herbal drugs to cure different ailments of livestock as these groups are rich with plenty of indigenous knowledge about the use of medicinal plants species.

Figure 1: Map of Swat Ranizai, District Malakand, Khyber Pakhtunkhwa, Pakistan.

Experimentation

The experiment was carried out in the following stages

- Field work
  - Inventory
  - Distribution of questionnaires
- Inventory documentation
- Quantitative analyses of ethno-veterinary data

Field work

TThe study was carried out in the outskirts of district Malakand (Swat Ranizai) by interviewing 200 informants including 160 males and 40 women aged between 40 to 90 years from March 2014 to February 2016.

For collection of traditional ethnoveterinary information and plant material, trips were planned in different season along with local guider with prior approval from representative of the villages. The methodology used for this section was adopted from some of the previous workers i.e. [20,21]. Copies of questionnaire (open-ended and semi-structured) were distributed among different educated community groups with prior permission to collect knowledge of traditional ethnoveterinary practices which they carried in their daily life. Majority of elders in the study area were not well educated, in such cases after getting response from informant the interviewee himself filled questionnaire. The questionnaire was designed into two parts i.e. the first part contained demographic information of the informants i.e. age, profession, education, place of birth, and number of livestock, if any. The second section is devoted to the medicinal plants, frequently used for curing different ailments of the animals.

Botanical identification

During field visits medicinally important plant species were collected, press-dried, preserved and identified with the help of flora of Pakistan developed by a credible reference book [22]. After further confirmation of the plant identities at the University of Malakand, the plant specimens were deposited in the University herbarium. Ethnoveterinary uses, mode of recipes preparation and administration were tabulated using Microsoft excel sheet.

Quantitative analyses of ethno-veterinary data

The reported medicinal plants were further subjected for statistical analysis using the following quantitative indices: Frequency citation (FC), Relative Frequency of Citation (RFC), Pearson correlation coefficient, Informant Consensus Factor (ICF), and Direct Matrix Ranking (DMR).

Frequency citation (FC)

$$Fc = \frac{\text{No. of informants who cited the species}}{\text{Total no. of informants interviewed}} \times 100$$

For the confirmation of healing efficacy of particular plant species FC was calculated following some previously published works [23].

Relative frequency of citation (RFC)

RFC = FC/N

RFC indicates the local importance of each species, where FC = is the number of informants reporting the use of the species divided by the total number of informants participating in the survey (N), without consideration of the use-categories [24]. The value of RFC ranges from zero (where none of the informant cites the plant as useful) to one (where every informant report the plant to be useful) [25].

Use Value (UV)

UV exhibits the relative importance of locally-known plants [26], and can be calculated by the following formula:

UV= ∑Ui /N

Where Ui = is the number of uses reported by each informant for a given species and N is the total number of informants participating in the survey.

Pearson Correlation Coefficient:

Pearson product-moment correlation (PPMCC) is the ratio of the covariance between two variables to their standard deviations [27].

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Where r is the Pearson correlation coefficient for the given sample, x and y are the variables, xi and yi are the values of x and y for the individual. The r value of 0 indicates no association between the X and Y, whereas a value greater than 0 indicates a linear relationship. Larger absolute value signifies higher correlation [28]. The square of correlation (r^2) is the measure of cross species variability in RFC that is explained by the variance in UV [29].

In order to test the null hypothesis of no relationship between the variables (ρ = 0), Z-test was used at the 5 percent level of significance. The value of Z-stat can be obtained by:

In this formula, ρ is the population coefficient. If the ρ - value of Z-stat is less than 5 percent, it means the two variables have a significant linear association with each other. In this case the two variables of interest are the RFC and UV.

Informant consensus factor (ICF)

ICF is used to point plant species of particular cultural importance along with the agreement in the use of plants. This informant's consensus among community and cultural groups indicates the wide use of individual plant and hence, aids in the selection of plant species for phytochemical and pharmacological studies [30]. The ICF can be calculated using the formula as follows:

ICF= Nur - Nt/Nur - 1

Where Nur = number of use citation in each category and Nt = number of species used.

The values of ICF range between zero and 1. The high ICF value (close to 1) indicates for a single or few plants that are used by large proportion of informants to cure a specific ailment. Whereas low ICF (close to 0) values reveals that the informants did not exchange information to which plant to be use or the plants are selected randomly for few or single condition.

Direct matrix ranking (DMR)

DMR is a ranking method based on the respondents personal view on the importance of an object [31]. To compare the use diversity of plants DMR was exercised for nine multi-purpose medicinal plants in eight use categories, based on the data collected from the informants. For this purpose, a total of eight key informants were selected and were asked to assign use values (UV) such as (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used, and 0 = not used) to each taxon. UV is the relative importance of locally known plants calculated using the formula: UV= ∑Ui /N, where, Ui is the number of use mentioned by each informant for a given species and N is the total number of informants [26]. The values assigned to each medicinal plant species were summed up and ranked.

Result

After an interview of a total of the 200 people encompassing 160 men and 40 women, aged between 40-90 years, it was found that the respondents used 50 plant species for the treatment of common ailments of their livestock's. Table 1 catalogues the data of botanical name, plant family, habit, UV, part used, and the ethno-veterinary uses. The identified flora, used for the treatment of various animal disorders comprised of 34 families, 49 genera and 50 species. Among these plant taxa, dicots were the dominant taxonomic group, encompassing a total of 42 (83%) species while monocot contributed to 06 (13%) species which is slightly higher than the 2 gymnosperms species (Table 2). Among the total number of species, 29 (60%) were herbs, 10 (21%) were shrubs, and 11 (19%) were trees (Table 2). As per the analysis herbs constituted the dominant plant forms for traditional ethno-veterinary medicines in comparison to shrubs and trees. This is in concordance with previously published literature [32]. Perennials were the most dominant life form to cure animal diseases, forming 30 (63%) species followed by annuals 13 (27%) species and biennials 05 (10%) species, respectively (Table 2).

Family/Plant botanical name	Local name	Habit	UV	Part used	Ethno-veterinary uses
1. *Acanthaceae*					
Justicia adhatoda L.	Baikar	Shrub	0.013	Leaves	Decoction of dried grinded leaves administered orally to cure cough in animals.
2. *Apiaceae*					
Ammi visnaga Lamk.	Spairkai	Herb	0.041	Fruit	Flour and gurr were gently heated to prepare a syrup locally called (sheera), to them fruit of Ammi visnaga were added and orally given to relive stomach pain in cattle. Fruit grains mixed in ghee pasted flour locally called (paira) given three times a day during hypothermia a local disease known as Charmaikh. Fruit boiled in red tea (soor chay) or mixed in flour syrup (sheera), given orally to cur indigestion and stomach pain.
3. *Apocynaceae*					
Nerium indicum Mill.	Gandairai	Shrub	0.013	Leaves/ Whole plant	Upon eating of leaves caused indigestion in cattle as the leaves were reported to possess poisonous characteristics and upon excessive browsing leads to death of cattle.
4. *Asclepiadaceae*					
Calotropis procera (Willd.) R.Br.	Spalmay	Herb	0.020	Latex/ Leaves	Leaves latex applied topically to cure external wounds. Leaves dried with gentle fire, folded in bread orally given to cure hypothermia a disease locally called Charmaikh
5. *Asphodelaceae*					
Aloe vera (L.) Burm.	Aloevera	Herb	0.013	Leaves	Two or three small pieces of leaves were cut lengthwise, into them added with sodium chloride and given orally to cure stomach disorders in animals.
6. *Berberidaceae*					
Berberis lyceum Royle.	Kwarai	Shrub	0.027	Root bark	Dried grinded root bark boiled in water, obtained extract administered orally for healing internal wounds and body warmth.

7. *Brassicaceae*					
Brassica campestris L.	Sharsham	Herb	0.020	Seed oil	Pasted flour (paira) was prepared after mixing of brassica oil and baking soda in wheat flour, given orally in the form of small boluses, relieved stomach swellings. Extracted brassica oil administered orally to cure foot and mouth disease in animals.
Eruca sativa Mill.	Jumama	Herb	0.007	Seed oil	Took 120 ml oil of *Eruca sativa* mixed with them Sarsoon oil in equal amount, applied topically to remove ectoparasites in cattle.
Lepidiuim sativum L.	Aalum	Herb	0.007	Seed	Soak seeds in desi ghee for a while then gently fried and given orally to cure dysentery.
Sisimbrium irio L.	Aurai	Herb	0.013	Seed	Decoction of seeds was orally given to cure flatulence and whole plant used as fodder for cattle.
8. *Buxaceae*					
Sarcococca saligna (D. Don) Mull	Ladaa	Shrub	0.062	Root	Decoction of root mixed in gurr and flour,a syrup locally called sheera was administered orally to cure wounds, general body weakness and low lactation in cattle. Infusions of root pieces were freeze for a while to become jelly like and given orally thrice a day to cure weight loss and remove retained placenta after birth.
9. *Cannabaceae*					
Cannabis sativa L.	Bhang	Herb	0.041	Leaves	Dried leaf powder mixed in pasted flour (paira), orally administered to cure a disease locally called Charmaikh. Extract derived from fresh leaves was mixed in red tea (Sor Chae) orally given to cure Charmaikh.
10. *Ceasalpiniaceae*					
Cassia fistula Linn.	Laandays	Herb	0.041	Flower	Decoction of flowers orally administered twice a day to cure cough and cold in animals
11. *Chenopodiaceae*					
Chenopodium album L.	Saarmai	Herb	0.007	Leaves	The crushed leaves were wrapped in bread pieces and orally given to warmth body of animals.
12. *Cucurbitaceae*					
Citrullus colocynthis (L.) Schrad	Khro hindwana	Herb	0.048	Fruit	Small pieces of fruit muffled in wheat bread or extract derived in boil water eliminate internal body worms and cure multiple body pain /stomach pain and constipation
13. *Euphorbiaceae*					
Mallotus philippensis (Lam.)	Kambaila	Tree	0.041	Fruit/ Root	Dye obtained from seed was poured into water, administered orally to wash stomach of cattle to remove endo-parasites. Dye was also mixed in Brassica oil, applied topically to remove ectoparasite and heal affected body parts in livestock. Decoction of root was useful to cure constipation.
Ricinus communis L.	Aranda	Shrub	0.007	Seed	The crushed seed or seed oil mixed in fodder used to cure constipation.
14. *Fagacea*					
Quercus incana Roxb., Hort. Beng.	Spin banj	Tree	0.007	Fruit	Grinded fruit are mixed in desi ghee and given in floor paste to cure metritis
15. *Fumariaceae*					
Fumaria indica Hausskn.	Papra	Herb	0.013	Whole Plant	Dried powder of whole plant after mixing in pasted flour boluses or decoction was orally administered to cure diarrhea and Jaundice.
16. *Lamiaceae*					

Ajuga bracteosa. Wall ex Benth	Gooti	Herb	0.007	Whole plant	Dried leaves powder mixed in pasted flour used to cure abdominal pain. Decoction of whole plant mixed in sugar orally given to relive fever of livestock.
Mentha longifolia (L.) Huds.	Enalai	Herb	0.048	Whole plant	Decoction of leaves of Mentha longifolia and seeds of Cannabis sativa in combination were useful to cure abdominal pain, dental pain and Charmaikh. The grinded leaves of Mentha longifolia and Cannabis sativa after mixing in wheat flour, a half oven dried bread was prepared and orally administered to treat black quarter disease.
Otostigia limbata (Benth) Biass.	Spin azghey	Shrub	0.013	Flowers/ Leaves	Powder obtained from leaves and flowers were mixed in pasted flour (paira) and orally administered to cure internal body wounds.
17. *Lauraceae*					
Neolitsea pallens (D. Don)	Meda Chob	Tree	0.027	Stem bark	Small pieces of peeled stem bark were boiled in water to prepare a tea and orally given to remove retained placenta after birth. Grinded stem bark along with root bark of *Sarccoca saligna* was orally given in bread to cure internal body wounds. Powder of stem bark was mixed in flour Syrup locally called sharia and given orally to keep body warmth.
18. *Liliaceae*					
Allium cepa L.	Piaz	Herb	0.013	Whole plant	Grinded fleshy leaves mixed in pasted flour (paira) used to cure flatulence. Whole fleshy leaves were given orally in insect bites.
Allium sativum L.	Ooga	Herb	0.013	Bulb	Grinded bulb mixed in ghee pasted wheat flour (paira) orally given to initiate heating cycle in livestock.
19. *Meliaceae*					
Melia azedarach L.	Baikyanra	Tree	0.027	Leaves/ stem bark	Eating of shoot bark of *Melia azedarach* by infected animals immediately relieved from swelling and abdominal pain in cattle. Grinded powder of seed, mixed in wheat flour was orally administered to reduce stomach swellings and abdominal pain.
20. *Myrtaceae*					
Myrtus communis linn.	Manro	Shrub	0.007	Leaves	Decoction of leaves was given orally to relieve abdominal pain in cattle.
21. *Papilionaceae*					
Butea monosperma Lain.	Palai	Tree	0.013	Flower	Fresh flowers soaked overnight in water, derived extract (syrup) given orally reduces body heat and causes cooling.
Dalbergia sisso Roxb.	Shwa	Tree	0.007	Leaves	The immature fresh leaves upon grinding were mixed in flour paste (paira) and orally administered to bulls (Jauti ghwaya) who ploughed and caused cooling of body heat.
22. *Pinaceae*					
Cedrus deodara (Roxb.ex D. Don)	Ranzra	Tree	0.007	Stem extract	Oil extract of stem were mixed in buttermilk and given orally to remove internal body worms in animals.
Pinus roxburgii Sargent,	Nakhtar	Tree	0.007	Apical top/ Leaves	Extract derived from apical shoot was given orally to cure mastitis.
23. *Poaceae*					
Sorghum helipense L.	Dadum	Herb	0.007	Leaves	Upon excessive browsing of the whole plant create abdominal pain and lead to death warrant.

Triticum aestivum L.	Ghanum	Herb	0.013	Grain/ Flour	Eating of immature wheat plants causes' stomach swelling in animals, the wheat grains were then fire burnt and orally given to cure swell stomach in animals. Eating of raw wheat flour causes swelling in stomach, the wheat grain or flour were then burnt on fry pan and given along with water to cure swell stomach.
Zea mays L.	Jawar	Herb	0.007	Leaves	Eating of immature leaves caused reduction of lactation in lactating cattle. Fresh cobs were given to increase lactation in lactating cattle.
24. *Polygonaceae*					
Rumex nepalensis spreng. Syst	Tarokai	Herb	0.020	Leaves	The fresh leaves mixed with fodder used to cure diarrhea, constipation and remove worms.
25. *Rhamnaceae*					
Ziziphus nummularia (Burm.f.)	Baira	Tree	0.007	Leaves	Decoction of leaves was orally given in discharging of placenta after birth.
26. *Rutaceae*					
Zanthoxylum armatum DC. Prodr	Dambara	Shrub	0.020	Seed	Grinded seed powder was mixed in flour or fodder to increase body temperature and cure foot and mouth disease locally called tabaq.
27. *Sapinadaceae*					
Dodonaea viscosa (L). Jacqa	Ghwaraskai	Shrub	0.013	Leaves	Grinded immature fresh leaves mixed in flour paste (paira) were orally administered to lower body heat and caused cooling in bulls.
28. *Sapotaceae*					
Monotheca buxifolia (Falc.) A.D.	Gurgura	Tree	.007	leaves	Fresh leaves are mixed with shoot bark of *Melia azedarach* and given directly to relive abdominal pain in goat and sheep.
29. *Solanaceae*					
Capsicum annum L.	Marchakai	Herb	0.007	Fruit Powder	Grinded fruit powder mixed in pasted wheat flour (paira), administered orally to relive stomach pain.
Datura stramonium L.	Bathora	Herb	0.007	Fruit	The fresh fruit was grinded and added to them with sodium chloride to and given orally to cure internal body wounds in livestock.
Solanum surattense Burm.F.	Maraghonai	Herb	0.027	Fruit	Grinded fruit mixed either in pasted flour or orally given in bread pieces to cure abdominal pain and stomach swellings. Grind five to six seed grain, added to them three or four cup gurr syrup applied orally through bottle three nights consecutively to cure abdominal pain, metritis and retained placenta after birth.
Withania somnifera (L. Dunal)	Kotilaal	Shrub	0.041	Root	Decoction of crushed root after cooling was orally administered to cure mastitis and metritis. Root extract after mixing with Ghee used to cure mammary gland blockage and swellings and, also remove retained placenta. Decoction of root were further added by gurr syrup and orally given to cure mastitis, metritis and remove retained placenta after birth.
30. *Umbelliferae*					
Coriandrum sativum Linn.	Dhanya	Herb	0.013	Fruit	Seed powder mixed in pasted flour (paira) administered orally immediately after copulation for two to three days-maintained pregnancy/conception.
Foeniculum vulgare Linn.	Kaga	Herb	0.027	Fruit	Fruit powders upon mixing in wheat flour paste were orally given to treat constipation.
31. *Urticaceae*					
Urtica dioica Linn.	Sezunkai	Herb	0.020	Root	Decoction of crushed root or the crushed paste was wrapped in bread and given orally to treat internal wounds and Charmiakh.

32. *Verbenaceae*					
Vitex negundo L.	Marwandai	Shrub	0.007	Leaves	Grinded leaves paste was applied thrice a day for one week to cure foot and mouth disease.
33. *Zingiberaceae*					
Curcuma longa Linn.	Kurkaman	Herb	0.013	Rhizome	Dried rhizomatous powder mixed in Desi ghee were gently heated, administered orally and topically to cure external and internal body wounds and cuts in livestock.
Zingiber officinale Roscoe, Trans. Linn.	Adrak	Herb	0.007	Rhizome	The grinded rhizome macerated in water given orally to relive cough in livestock.
34. *Zygophylaceae*					
Fagonia cretica L.	Azghakai	Herb	0.013	Whole plant	The extract derived after immersion of whole plant in one and half liter water for about 10 hours, orally administered to reduce body heat.

Table 1: Plant species commonly reported by the community in outskirt of District Malakand (Swat Ranizai) for the treatment of livestock diseases.

Parameters	Taxon	No.	%
Taxon	Family	34	-
	Genus	49	-
	Species	50	-
Taxonomic group	Dicot	42	83
	Monocot	06	13
	Gymnosperm	02	04
Habit	Herb	29	60
	Shrub	10	19
	Tree	11	21
Life span	Annual	13	27
	Biennial	05	10
	Perennial	32	63

Table 2: Taxonomic diversity of plants reported in ethno-veterinary practices in Swat Ranizai, District Malakand.

The family that contributed highest number plant species for the traditional ethno-veterinary medicines were Solanaceae (04) and Brassicaceae (04) followed by Poaceae (03). Two species from each of Lilliaceae, Euphorbiaceae, Lamiaceae, Papilionaceae (Fabaceae), Pinaceae, Umbelliferae and Zingiberaceae family featured in the catalogue (Figure 2). Remaining families contribute 01 species each (Table 1) shows the pertinent data. Previous studies in other geographical regions of the world have also reported the frequent mention of Solanaceae [33,34], and Brassicaceae [35] family. Papilionaceae is a common family with ethnoveterinary usages [12,20].

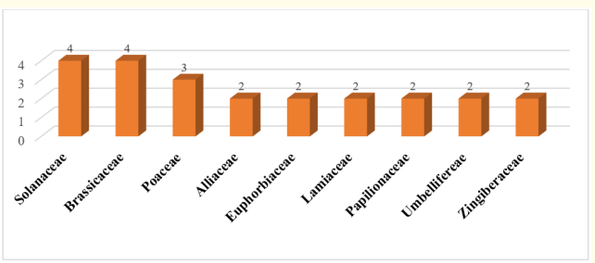

Figure 2: Shows contribition of plant families with more than one species in prepartion of veterinary medicines by local community in Swat Ranizai, District Malakand.

The ethno-veterinary medicine recipes were made from fresh as well as dried plant parts like leaves, roots, flowers, bark, seed, apical top, fruits etc. It was observed that the most used plant parts were leaves 41% (21 species) followed by seed 23% (11 species),fruit 8% (5 species), flower and root 6% (03 species each) while the rhizome, latex and bulbs were recorded at 4% (in 02 species each) respectively (Figure 3).

Figure 3: Relative proportion of plants parts used by people in making of veterinary medicines.

AAccording to the cattle-rearing communities, the principal plant parts in terms of preparation of traditional ethno-veterinary medi- cines were leaves and oil seed (Figure 3). Another study has re- ported the most used plant parts for cattle diseases are roots and leaves [36]. Yet another study reports the leaves being the most used plant parts [20] It might be because these plant parts possess active therapeutic constituents.

The respondents of the area reported a total of 26 different major types of livestock disorders (Table 3). These ailments were with 50 plant species, out of which 35 (73%) species are gathered from wild source, 09 (19%) are cultivated, whereas 4 (8%) are obtained from commercial market. These statistics suggest that the rural population largely depend upon the wild plant resources, for the health management of their domestic animals. In 93% cases, the mode of administration of medicinal plants was oral whereas in 7% cases it is applied topically. The oral mode of medicinal plant administration is either in the form of decoction, infusion, flour paste mixture (locally called 'paira') or in jaggery ('gur') syrup and

bbread etc. Such practices are common for other chemical, botanical or fungal-origin medications to cattle [37]. For topical usage, the plant parts are used as powder, paste or poultice. The dermal treatments are meant to cure ectoparasites, eczema, skin allergy, swellings etc. The powder is mixed with mustard (*Brassica campestris*) oil or arugula oil (*Eruca sativa*). The outer body swellings and broken joints are covered by poultice (a piece of cloth wrapped with plant parts) leaves of a soap berry plant *Dodonaea viscosa* (hopbush) or oil-soaked powder of turmeric (*Curcuma longa*) to cure the injuries (Table 1). *Dodonaea viscosa* has been previously validated to exert antimicrobial, antiprotozoal and hepatoprotective property [38-39]. It was learned that the interviewees used herbal preparations until they observed improvement in the health of their animals.

No.	Ailments categories	Number of plant species used in treatment of each category
1	Abdominal Pain	*Ammi visnaga*, *Berberis lycium*, *Calotropis procera, Cannabis sativa*, *Capsicum annum, Citrullus colocynthis, Mentha longifolia, Melia azedarach, Myrtus communis, Foeniculum vulgare, Cassia fistula, Solanum surattense, Aloe vera, Monotheca buxifolia*
2	Bloating	*Brassica campestris, Triticum aestivum, Withania somnifera, Melia azedarach, Solanum surattense*
3	Flatulence	*Allium cepa, Melia azedarach, Butea monosperma, Foeniculum vulgare, Sisimbrium irio*
4	Dysentery	*Lepidiuim sativum*
5	Diarrhea	*Ammi visnaga, Citrullus colocynthis, Mallotus philippensis, Melia azedarach, Foeniculum vulgare, Fumaria indica, Rumex nepalensis*
6	Constipation	*Ammi visnaga*, *Mallotus philippensis*, *Cassia fistula*, *Ricinus communis*, *Rumex nepalensis*
7	Indigestion	*Mentha longifolia, Cassia fistula*
8	Mastitis	*Sarcococca saligna*, *Withania somnifera*, *Urtica dioica, Pinus roxburgii*
9	Retained placenta	*Citrullus colocynthis, Sarcococca saligna*, *Withania somnifera*, *Neolitsea pallens, Solanum surattense*, *Ziziphus nummularia, Urtica dioica*
10	Metritis	*Mallotus phillipensis*, *Solanum surattense*, *Withania somnifera, Quercus incana*
11	Foot and Mouth Disease	*Brassica campestris*, *Vitex negundo*, *Zanthoxylum armatum*
12	Black quarter	*Cannabis sativa*, *Citrullus colocynthis, Mentha longifolia*
13	Worm infestation	*Citrullus colocynthis, Mallotus philippensis, Cedrus deodara, Cassia fistula, Rumex nepalensis*
14	Hypothermia	*Ammi visnaga*, *Calotropis procera*, *Cannabis sativa, Citrullus colocynthis, Sarcococca saligna Urtica dioica, Xanthoxylum armatum*
15	Dental pain	*Cannabis sativa*, *Mentha longifolia*
16	Wound healing	*Berberis lycium, Calotropis procera, Sarcococca saligna, Withania somnifera, Urtica dioica, Neolitsea pallens, Curcuma longa, Datura stramonium, Otostigia limbata*
17	Fever	*Ammi visnaga*, *Berberis lyceum*, *Brassica campestris*, *Cannabis sativa*, *Dalbergia sisso*, *Fagonia* cretica, *Mentha longifolia*, *Butea monosperma*, *Ajuga bractiosa, Chenopodium album*
18	Infertility	*Allium sativa,Coriandrum sativum*
19	Skin allergy	*Mallotus phillipensis*, *Eruca sativa*
20	Cough	*Neolitsea pallens, Justicia adhatoda*, *Zingiber officinale*
21	Toxic (cause death)	*Nerium indicum*, *Sorghum helipense*
22	Low lactation	*Sarcococca saligna*, *Withania somnifera, Zea mays*
23	Insect bite	*Allium cepa*
24	Impotence	*Sarcococca saligna*
25	Bone fractures/swelling	*Dodonaea viscosa*
26	Jaundice	*Fumaria indica*

Table 3: Common ailments categories reported by people of Swat Ranizai, District Malakand, cured by one or more medicinal plant species.

In order to investigate the healing efficacy, FC of the total recorded 50 plant species were calculated, and a range between 0.68 to 10.34 % was obtained. Out of the total plant species, 2 species have a higher FC citation value greater than 10 whereas, 7 species have a FC value equal to 5 or greater than 5. The FC value for the rest of 44 species were lesser than 05. *Ammi visnaga* (toothpick-plant) was recorded with the highest RFC (15), followed by *Citrullus colocynthis* (bitter apple) (10), *Sarcococca saligna* (Sweet box) (09), *Mallotus philippensis* (08), *Withania somnifera* (08), *Mentha longifolia* (07), *Cannabis sativa* (06), *Neolitsea pallens* and *Melia azedarach* each with (05), *Berberis lycium* (04), *Curcuma longa* (04), *Justicia adhatoda* (04), *Brassica campestris* (03), *Butea monosperma* (03), *Calotropis procera* (03), *Foeniculum vulgare* (03) and *Solanum surattense* (03) respectively (Figure 4). It was recorded

that *Ammi visnaga* has the highest FC, as it is used to cure wide array of illnesses like abdominal pain, diarrhea, constipation, fever, and worm infestation. *Citrullus colocynthis* was reported to be effective in the cure of black quarter, worm infestation, the removal of retained placenta after birth, abdominal pain and diarrhea. *Sarcococca saligna* was described to be more effective in mastitis, wound, hypothermia, post-birth retained placenta, lower lactation and general body weakness. Dye obtained from the fruit of *Mallotus philippensis* was used against skin allergy, constipation, metritis, and worms. *Withania somnifera* was useful in curing mastitis, metritis, bloating, retained placenta after birth and wounds. *Mentha longifolia* and *Cannabis sativa* was found to be effective against the diseases like indigestion, black quarter, dental pain and fever. *Neolitsea pallens* was reported for the first time from the study area and the community mostly used its stem bark to cure cough, wound healing and removal of placenta after birth. The shoot and stem bark of *Melia azedarach* was reported to cure bloating, abdominal pain, flatulence by causing motions in animals like cows, goats and buffaloes.

It was also found that plant species with greater citation value is facing over-exploitation. This may lead to endanger status, or even extinction of the plant species. The present study revealed that plants with 5 or greater than 5 values of FC were mostly col- lected from wild source, some from cultivation and few from com- mercial market like *Ammi visnaga* etc. Population of plant species like *Sarcococca saligna, Withania somnifera* and *Neolitsea pallens*, are highly affected due to their massive collection of roots and stem bark for multiple purpose ethno-veterinary treatments.

The RFC values varied from 0.007 to 0.1034. *Ammi visnaga* (0.10) was ranked first, followed *Citrullus colocynthis* (0.06), *Sarcococca saligna* (0.06), *Withania somnifera* (0.05), *Mallotus philippensis* (0.05), *Mentha longifolia* (0.04), *Cannabis sativa* (0.04), *Neolitsea pallens* (0.03) and *Melia azedarach* (0.03) (Figure 5).

The UV for the medicinal plants was determined to be in the range from 0.007 to 0.062. The highest UV was recorded for Sarcococca saligna (0.062), followed by *Mentha longifolia* (0.048), *Citrullus colocynthis* (0.048), Ammi visnaga (0.041), Cannabus sativa (0.041), *Mallotus philippensis* (0.041), *Withania somnifera* (0.041), *Berberis lycium* (0.027) *Foeniculum vulgare* (0.027) *Melia azedarach* (0.027), *Neolitsea pallens* (0.027) and *Solanum surattense* (0.027) (Table 1). In a previous study, the leaves of this plant having anti-diabetic, anti-headache and febrifuge properties have been reported [40]. The medicinal plant species with lower UV revealed that a little consensus over its ethno-veterinary knowledge existed. This may be due to its other unknown medicinal usages or where therapeutic usage is known, but livestock herders disagree with its healing efficacy. Given such discordance, this study recommends the need for pharmacological evaluation of these low UV species. This study reports 12 species (Table 1) with highest UV interims of the treatment of livestock ailments (Table 1). These findings are in agreement with that from RFC and reinforce the idea that these plant species are most important for the inhabitants of the study area (Figure 6).

Figure 5: Relative frequency of citations (RFC) of plant taxa used to cure ailments in Distt: Malakand.

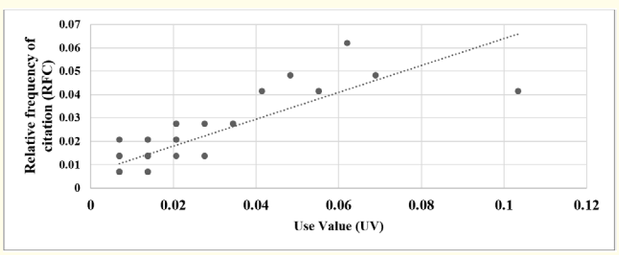

Figure 6: A linear relationship between relative frequency of citation and use value of plants in making of traditional veterinary medicine.

The Pearson correlation coefficient (r) between RFC and UV exhibited a strong linear correlation (r = 0.8516 p > 0.001). On the other hand, the r2 value was 0.7128 which is the coefficient of determination and is comparatively less than that of correlation coefficient (r). A scattered plot was drawn between RFC and UV, which resulted in a straight line (Figure 6). The linear relation indicated a robust relation between the two statistical indices [24].

The livestock ailments in the study area were clustered into 10 major categories based on ICF. The ICF value ranged from 0.2 to 0.678 respectively. The highest value of ICF was recorded for gastrointestinal disorders (ICF = 0.678), mastitis (ICF = 0.6), black quarter (ICF = 0.6) and fertility disorders (ICF = 0.571). Whereas, for general body weakness (ICF=0.5), respiratory disorders (ICF=0.4), wound healing (ICF=0.36), worm infestation (ICF = 0.33), FMD (ICF = 0.33) and fever (ICF= 0.22). Table 5 shows the data. It means that the gastrointestinal disorders in the study area were more frequent and ranked first. Published literature on the alimentary problem being the topmost illnesses among livestock exists [41]. Whereas mastitis (ICF= 0.6) and black quarter (ICF= 0.6) ranked as second major ailment categories with respect to ICF values. Besides, fertility disorders (ICF= 0.571) and general body weakness (ICF= 0.5) were ranked as third major ailments categories. The gastrointestinal disorders were classified into sub-categories like abdominal pain, bloating, flatulence, dysentery, diarrhea, constipation and indigestion. The fertility disorders include metritis, retained placenta after birth and lactation. Respiratory disorders comprised of cough and nasal discharges. The disorders

accounted for highest number of ethno-veterinary plant remedies were abdominal /stomach pain (14 plant species), fever/heat (10 plant species) and wound healing 09 species respectively. For the alleviation of diarrhea, retained placenta after birth and hypothermia, 7 species each were used. For bloating, flatulence, worm infestation 5 species and, for mastitis 4 species were used. Black quarter, metritis, cough, FMD was managed with 03 species. For indigestion, lower milk production, skin allergy, infertility and dental pain, 2 species used. Remaining livestock disorders were treated with a single plant species. Moreover, two plant species (*Nerium*) were reported as poisonous (Table 1). Low or near zero ICF value was can occur due to random selection of plants or when the informants do not inform the usages of a plant. The high ICF value of one or close to one is achieved when the usage information is provided and the selection criteria are well-defined. It was observed that a single plant species can be utilized for multitude of illnesses. *Sarcococca saligna* (Himalayan boxwood) member of the family *Buxaceae* was reported to cure six different types of livestock diseases such as wounds, mastitis, worm infestation, low lactation, retained placenta after birth and poor weight (Table 1). *Withania somnifera* (Indian ginseng), a member of family Solanaceae family is reported to cure six different types of animal disorders like bloating, metritis, mastitis, low lactation, retained placenta after birth and wounds (Table 1) Similarly, *Citrullus colocynthis* (bitter melon) from the family Cucurbitaceae was reported to cure black quarter, retained placenta after birth, hypothermia, and worms (Table 1).

No.	Ailment category	ICF
1	Gastro intestinal disorders	0.678
2	Fertility disorders	0.571
3	Worm's infestation	0.333
4	Wound healing	0.363
5	Fever	0.222
6	Respiratory disorder	0.4
7	Mastitis	0.6
8	Black quarter	0.6
9	Foot and mouth disease	0.333
10	Weakness	0.5

Table 4: Respondents' consensus about major ailment categories in Swat Ranizai, Distt: Malakand.

Taxa	Medicinal	Food	Fence	Firewood	Forage	Charcoal	Construction	Furniture	Total	Mean	Rank
Melia azedarach	4	0	3	5	2	2	4	3	23	2.87	Ist
Monotheca buxifolia	3	3	4	4	3	1	2	0	20	2.5	2nd
Qeurcus incana	2	1	4	5	1	2	4	1	20	2.5	2nd
Neolitsea pallens	5	1	1	5	2	2	3	0	19	2.37	3rd
Butea monosperma	3	3	2	3	3	2	3	0	19	2.37	3rd
Berberis lycium	4	1	3	4	1	2	2	0	17	2.12	4th
Dodonaea viscosa	3	0	3	5	1	1	4	0	17	2.12	4th
Mallotus philippensis	3	1	3	4	3	1	2	0	17	2.12	4th
Sarcococca saligna	4	1	3	4	1	1	1	0	15	1.87	5th

Table 5: Mean scores for direct matrix analysis of selected medicinal plants based on a general UV.

Based on the DMR ranking, it was noted that Melia azedarach ranked first; *Quercus incana* and *Monotheca buxifolia* ranked second; *Butea monosperma* and *Neolitsea pallens* ranked third; *Berberis lycium*, *Mallotus philippensis*, *Justicia adhatoda, Dodonaea viscosa* ranked fourth, while *Withania somnifera*, *Sarcococca saligna*, *Myrsine africana* ranked fifth, respectively (Table).

The results show that these plant species are highly exploited for firewood and fencing purposes, without much attention to their medicinal relevance (Table). As, cutting down these plants can lead to their depletion, awareness ought to be raised for their sustainable usage. These results are evidence that the fragile flora require urgent and proper conservation.

Discussions

This ethnoveterinary study resulted in several insights, which have been discussed below. As the reliance on local vegetation for healthcare of the domestic animals has been the way of life in remote areas, and effective so, ethnoveterinary knowledge should be documented. Unregulated harvesting of these plants threatens the propagation of these plants, which must be restrained [42]. Bilateral information exchange between the traditional knowledge holders and mainstream scientists can prevent overexploitation of medicinal flora and lead to the identification of pharmacophores [43].

The mechanisms of the plant parts in the healing of the animal pathologies are similar to that of human illnesses. Nourished by

the local vegetation, the animals have evolved, so they can benefit from the plant extracts. However, if the pathologies of the ruminants emerge from rather new causes like fertilizers, pesticides, and hormones additives, the plant parts might not be sufficient to treat the health issue. Unfortunately, the chemicals have invaded the remote areas as well, exposing the animals to their adverse effects. The cattle epidemic like bovine spongiform encephalopathy (BSE) arising from risky feeds are often fatal [24].

As plants are the diet of the ruminants, most of them are harmless and of nutritional value to them. However, some species as *Nerium indicum* and *Sorghum helipense* are poisonous to them as observed in this study. Apart from them, other plants like *Parthenium hysterophorus*, an Asteracae family member has been known to be toxic to cattle [44].

Literature search has revealed the efficacy of plants from the genus *Rumex, Allium, Aristolochia, Euphorbia, Plantago, Polygonum, Rubus, Lippia, Saussurea, Senecio* as ethnoveterinary medicine [45]. Plants from these genera might be investigated for possible ethnoveterinary relevance in the study area.

It should be investigated if the plant products are substitute for or complement of chemotherapeutics. It is important for adverse interactions of herb- drugs has manifested as allergy, edema, and endocrinopathies in human [46].

As the valuable traditional knowledge are dwindling rapidly, efforts should be made to preserve those information [45]. This study though well-designed and well-executed has deficiencies. Interviewing of more subjects might have led to the reporting of more plant species for veterinary purposes. In a published study from the same study site i.e. Malakand, plant genus like Acacia (*A. modesta, A. nilotica*), *Armisia, Tribulus (T. terrestris)*, and Malva have ethnobotanical importance [21]. Bigger interviewee size could have led to the mention of plant species from these genera. Despite the lacunae this study was a success in documenting fast-vanishing ethnoveterinary knowledge.

Conclusion

This study is the first scientific communication regarding the ethno-veterinary practices used by the inhabitants of Swat Ranizai. The statistical analysis showed that the local people hold strong ethno-veterinary knowledge. For the promotion of plant-based therapies and economic uplift of the rural community, medicinal plant diversity conservation and farming should be introduced in this area. These botanical therapies are inexpensive, locally-available, are free of side-effects. The soil of the studied site is fertile and will support such types of healthy practices.

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Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

A.K, N.K initiated and designed the research, A.K, N.K and K.A performed the experiments, A.K, N.K and K.A analyzed the data and wrote the manuscript S.B and A.R revised and edited the manuscript and also provided advice on the experiments.

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