Ethno-veterinary practices for animal healthcare from Sudhanoti Azad Kashmir, Pakistan

Rizwan Taj Khan, Kiran Nasim and Muhammad Jamil Ahmed

Correspondence

Rizwan Taj Khan*, Kiran Nasim and Muhammad Jamil Ahmed

Department of Botany, King Abdullah Campus, University of Azad Jammu and Kashmir (UAJK), Muzaffarabad-13100 Pakistan.

*Corresponding Author: jammumughal.bot86@gmail.com; drrizwantajkhan@gmail.com

Ethnobotany Research and Applications 28:30 (2024) - http://dx.doi.org/10.32859/era.28.30.1-17
Manuscript received: 10/09/2023 - Revised manuscript received: 08/02/2024 - Published: 10/02/2024

Research

Abstract

Background: Medicinal plants have been substantial role for livestock health care system in remote area. This study aims to documents the folklore ethnoveterinary knowledge of medicinal practiced by local inhabitants of District Sudhanoti, Azad Jammu and Kashmir for primary health care management of livestock.

Methods: A total of 70 informants of different age groups were interviewed using semi-structure questionnaire method to collect the data. Data was quantitatively analyzed using Use value, Fidelity level, Informant Census Factor, Relative Frequency of Citation and Jaccard Index. The information regarding plant parts uses, herbal formulation and mode of administration were also recorded.

Results: A total of 48 plant species belonging to 32 families were being used as ethnoveterinary practices in the study area. Leaves were the most preferred part used followed by the stem, bark and fruit. Latex, seeds, pods were among the least used parts. As for as the mode of herbal remedy preparation is concerned, the paste was mostly used (30 %), followed by raw form (26%), and decoction (20%), while oil (2 %) is the least preferred method. The highest ICF values were recorded for respiratory diseases (0.90) followed by toxic effects (0.86) and infectious diseases (0.84) and least for abdominal disorder.

Conclusion: The present study contributes to the documentation and preservation of significant folklore ethnoveterinary knowledge from the local communities of study area. The present findings suggest that plant species with high fidelity level, use value and relative frequency of citation should be screened for phytochemical and pharmacological analysis

Keywords: Indigenous knowledge; Livestock ailments; Remote area; Medicinal plants; Ethnobotanical indices, Sudhanoti

Background

From the history of mankind existence, the medicinal plant species have been used in popular method of herbal treatments for various ailments of human being and their domestic animals (Ayyanar, and Ignacimuthu., 2011; Ahmed *et al.* 2023). The indigenous knowledge and culture practices of herbal medicine have remained much in used in developing countries around the globe (Ahmed *et al.* 2023; Tiwari and Pande, 2010). Moreover, the uses of medicinal plants species, their plant parts by indigenous people preferred owing to important chemicals constituents and bio-compatibility (Mathias, 2004; Phondani, *et*

al. 2010). In addition, the medicinal plants also constitute a major part of ethno-veterinary practices for basic health care of livestock in local communities of remote areas (Ishtiaq *et. al*. 2006). Indigenous people have high reliance on herbal practice due to low per capita income, lack of modern health facilities, remoteness of area and easy access of medicinal plant species (Tiwari & Pande, 2010). Thus traditional practices have been promising tool to cure various diseases of livestock and also for socio-economic developments since the human civilization (Toyang *et al*. 2007, Phondani, *et al*. 2010). Although, the traditional herbal formulation have been considered to be out dated in comparison to modern approach, however, according to WHO, the 80 % people still rely on folklore herbal remedy for treatment of various ailments around the world (Amjad *et al*. 2020).

The ethnoveterinary indigenous knowledge likely to be most vulnerable for extinction because of linked with the elderly people and become lost when they passed away (Toyang *et al*. 2007; Ahmed *et al*. 2015). The local healers, nomads are experienced regarding the ethnoveterinary practices in treatment of diseases, but their indigenous knowledge has not been documented and is declining fast (Lulekal *et al.* 2008; Ahmed *et al*. 2015; Mesfin, 2008). On the other hand, verbally transfer, the anthropogenic pressure, agricultural land expansion, urbanization and modern facilities also poses a substantial risk to folklore knowledge and also for local community, which primarily rely on medicinal plants for basic health care system of livestock (Teklehaymanot *et al*. 2007; Lulekal *et al*. 2008; Giday *et al*. 2009). So, this is a apt attempt to record, uphold and protect the medicinal plants uses by indigenous people around the globe. (Cetinkaya, 2009). Furthermore, the plants are natural potential source of bioactive compounds for scientific discovery of novel modern drugs for sustainable socio-economic development (Cos *et al*. 2006). Now a day, the herbal medicines got much attention all over the world because of minimum risk factors as compared to effects cause by synthetic drugs. Additionally, plant-based animal drugs and herbal preparations are comparatively eco-friendly and cost effective (Raza *et al*. 2014). Researchers from China, Nepal, Bangladesh and India have documented ethnoveterinary data that indigenous people widely use medicinal plant species to treat various livestock ailments and health care system management (Xiong and Long, 2020; Dhakal *et al*. 2021; Sharma and Manhas, 2010; Usha *et al.* 2016).

Pakistan has been bestowed with distinctive species diversity and local communities in these areas have solely depended upon herbal medicine for their basic health care system. Ethnoveterinary investigations have been increasing interest among many researchers and several previous ethnoveterinary studies have been reported in different areas of the Azad Jammu Kashmir and Pakistan (Abbasi *et al*. 2013; Aziz *et al*. 2018; Mussarat *et al*. 2014, Ishtiaq *et al*. 2006, Ahmed *et al*. 2015). The plant extracted herbal products have been widely used as an alternative and sustainable approach in Azad Jammu and Kashmir, Pakistan to cure the different livestock diseases (Ahmed *et al*. 2015). Medicinal plants base herbal formulation has been practiced from a long time owing to presence of bioactive constituents and absence of novel compatible veterinary allopathic drugs (Lucchetti *et al*. 2019). Furthermore, in the rural areas of Azad Kashmir, Pakistan, the agricultural system and animal husbandry is the main source of income generation and uplift of livelihood (Ahmed *et al*. 2023). People especially, in rural regions of Azad Kashmir and Pakistan still rely on their folklore traditional herbal therapies for cure of illness (Ahmed *et al*. 2015; Aziz *et al*. 2018). However, the folklore traditional knowledge is being lost due to rapid cultural transient and urbanization. Moreover, the knowledge of herbal medication is often transferred verbally from indigenous people to younger generation (Amjad *et al*. 2020). However, the transfer of indigenous knowledge among the members of a community becomes difficult due to modernization, personal interest of elderly people and lack of documentation of ethnoveterinary uses of plants. Another important fact is that the younger people are in least fascinated in folklore herbal knowledge of medicine plant species (Aziz *et al*. 2018).

The residents of District Sudhanoti, State of Azad Jammu and Kashmir, inhabited in a mountainous area lies in the Western Himalayas Pakistan. Local communities depend on ethnoveterinary herbal therapies for treatments of livestock ailments. However, few ethnobotanical studies of medicinal plants have been reported in District Sudhanoti for the treatments of human ailments (Ishtiaq *et al*. 2016; Khan *et al*. 2021). The area of District Sudhanoti is rich of ethnobotanical knowledge due to diverse tribal communities and socioeconomic condition (Khan *et al*. 2021). However, ethnoveterinary uses of medicinal plant species have not been yet explored due to remoteness and harsh climate condition. Furthermore, the ethnoveterinary knowledge is locally and culturally variable due to disease epidemiology and species biodiversity. Therefore, if it not documented, the herbal formulation skill and indigenous knowledge over generation to generation may become lost in developing countries due to rapid cultural transient and younger migration for higher education. Now a day, growing scientific interest has been developed accompanied with documentation of the ethnoveterinary practices for providing baseline study leading to novel drug discovery.

Keeping in view the medicinal importance of plants, the present study was designed to document the indigenous folklore practices of medicinal plants species for livestock health care system among ethnic communities in the study area. The ethnoveterinary data was also quantitative analyzed using ethnobotanical indices and also determine the novelty index by comparing with previous records of ethnoveterinary uses of medicinal plants.

Materials and methods

Study Area

The District Sudhanoti, of Azad Jammu and Kashmir lies in coordinates ranging from 33° .40'- 33° 50' N latitude and 73.40-73° 50' E longitude. The study area lies in an altitude of approximately 600 to 2100 m.a.s.l. (Fig. 1). This area has both hills and mountains along with small valleys and plains, having a total area of about 5695 km^2. The average temperature ranges between 20 to 35°C in summer and 5°C and 20°C in winter season. The annual precipitation of the year is 154.5 mm. The average maximum rain fall was recorded during month of February, July and August 307.7 mm, 257.5 mm and 204.7 mm respectively. The average minimum rainfall of the year is 92.3 mm and 72.3 mm during month of September and November respectively (Ishtiaq *et al*. 2015).

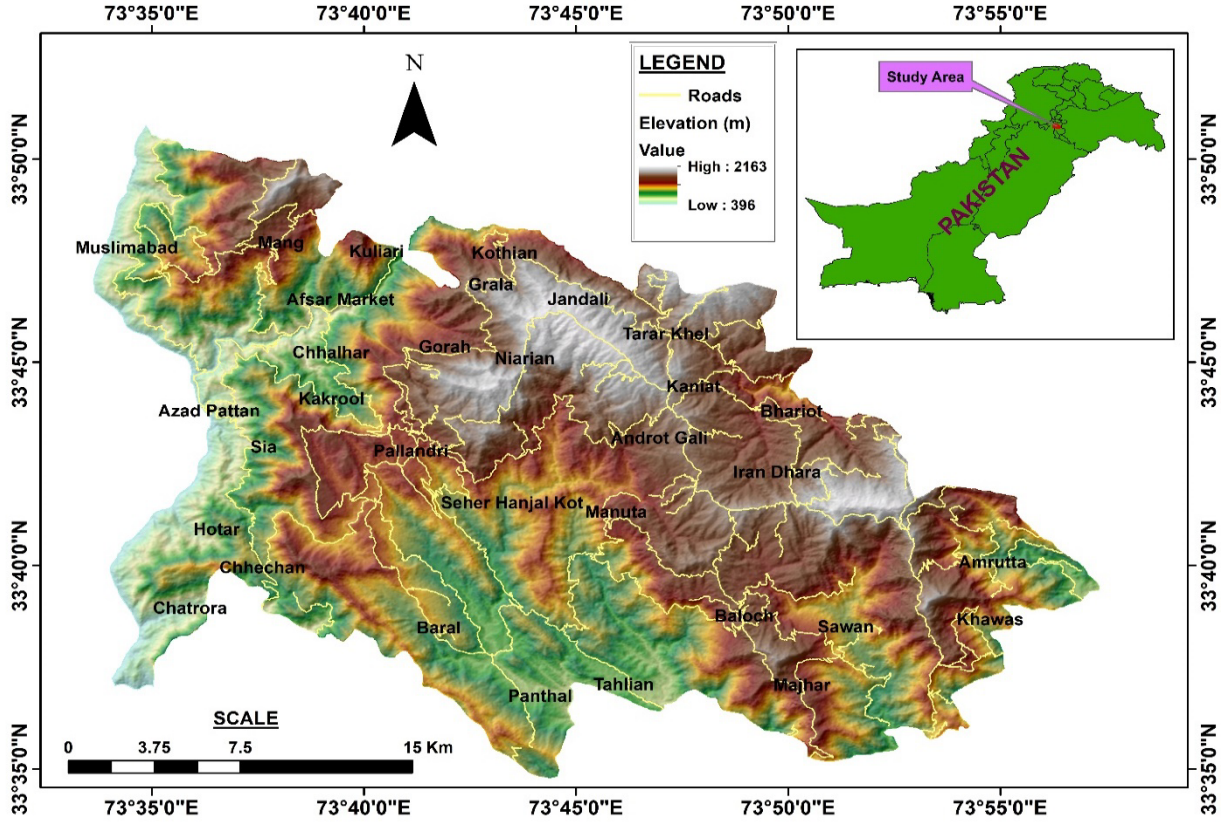

Figure 1. Map of the study area showing sampling locations.

Ethnographic composition

The study area has a distinct tribal composition and major tribe is Sudhan followed by Awans, Gujjars, Syeds and Kashmiris. Almost, mostly majority of human population are living in rural areas and having good knowledge of medicinal plants used for the animal ailments. As the study area has less facility of veterinary hospitals, so majority of the population is still dependent upon herbal medicines and medicinal plants for their livestock healthcare. In the study area, almost each house is holding the livestock like goat, buffalo and a cow. The important crops grown in this district are wheat, maize, rice and vegetables. Agricultural system, poultry and animal husbandry are the main source of income generation. Different classes of farmers exist in this District; most of them belong to the small land holding group. Livestock is kept for generating income to meet daily household expenditures. Milk and eggs are used for basic domestic needs; people are also engaged in the sale of milk, eggs butter and ghee in villages on the outskirts of the town. The area is estimated to have 26500 cattle's, 76700 buffaloes, 69300 sheep's, 43500 goats and 930 horses. The District has 35 veterinary hospitals and 40 veterinary dispensaries (District census report of Sudhanoti 1998-2007; Ishtiaq *et al.* 2015).

Data collection for livestock diseases

The study was undertaken from May 2018 to September 2018. The data was collected from local old peoples, veterinary doctors, traditional healers, Nomads and livestock owners using questionnaires and semi-structured interviews. Prior informed consent was always verbally obtained before conducting interviews followed by ethnobotanical code of conduct. The ethno-botanical survey was conducted in 20 different localities of the District Sudhanoti. The study objective and questions were designed so, that the local people can easily understand. A total of 70 informants were (45 males and 25 females) interviewed in the study area to collect the indigenous knowledge about the medicinal plants uses for animal health care system. Ethnoveterinary data was also collected from tribal and non-tribal communities. Furthermore, for data collection, the extensive field surveys were arranged in the study area. The meeting held with local herbal healers and nomads for gathering folklore information and occurrence of specific medicinal plants in that area. Information recorded by questionnaire included plants species uses, mode of administration of plants for curing particular animal ailments, plant parts, and mode of herbal preparation alone or in combination with other plant species. For this purposes, randomly households and headman, elders, traditional healers, local people and veterinary doctors of the study area were accessed to know the dependence on traditional (herbal) and modern (Allopathic) system. In addition, during survey the perceptions of local community was recorded under different categories of socio-demographic characters such as gender, education, age groups and healing experience, hence, to access their priority for management of traditional animal health care system.

Plant collection and identification

Field surveys were conducted to collect the medicinal plants in the study area. Plant species were collected during the growing season and important data regarding the plants were collected on the spot. Plants were identified by taxonomist and verified using online flora of Pakistan (Ali and Nasir. 2002) and World Flora Online (http:// www.worldfloraonline.org/ accessed on March 2020. The specimens were dried, pressed and submitted in the herbarium (AKASH) of department of botany, University of Azad Jammu and Kashmir, Muzaffarabad.

Quantitative ethnobotanical data analysis

Use value (UV)

Use value is used to determine relative importance of plant species by using formula given as (Ahmed *et al*. 2015) follows:

$$UVi = \Sigma Ui/Ni$$

Where, Ui= number of use reports by each informer for specific plant species in the study area and i. Ni=the total number of informer interviewed for specific plant species.

Informant consensus factor (ICF)

Informant consensus factor (ICF) was recorded for disease category to identify the agreements of the informants on the reported ailments. ICF was calculated as using the formula (Heinrich, 2009).

$$ICF = nur\text{-}nt / nur\text{-}1$$

Where: nur is number of used citations in each disease category and nt is the total number of plant species used for that specific disease.

Fidelity level (FL)

Fidelity level was noted as percentage of informant, who reports the uses of a plant species for an ailment and was determined using formula (Ali-Shtayeh *et al*. 2000).

$$FL\ (\%) = Np/N \times 100$$

Where: Np is the number of participants who reported the use of a plant for a specific purpose and N is the total of participants who claimed the use of a plant species for any purpose. High level of FL indicates the high use of plant species for particular disease in the study area.

Frequency of citation (FC)

The primary data was examined using Use Reports (URs). UR denotes the citation of a single plant or plant part by a single informant. For the frequency of citations, the total citations or UR for a species were summed together (FC) (Khajuria *et al*. 2021).

Relative frequency of citation (RFC)

This parameter is used to set up the priority among the recorded plant species and its value depends upon the number of participants mentioned the plant species as a significant medicinal plant, which shows its significance. It is calculated by the formula (Friedman *et al.* 1986).

$$RFC = FC/N$$

Where, FC is the number of contributors who claimed a specific plant species as an excellent medicinal plant and N is the total number of contributors in the study area.

Jaccard index (JI)

Jaccard index was used to compare the data presented in our study with the already published data in the adjacent areas of Azad Jammu & Kashmir by assessing the reported species and their medicinal uses taken as percentage (Njoroge & Bussmann, 2006).

$$JI = C \times 100/A+B-C$$

Where the number of plants species in an area A, B is the number of plants species in area B and C is the number of plants common to area A and B.

Results and Discussion

Demographic features of informants

In present study, total 70 (45 male and 25 female) informants were interviewed in different locations of District Sudhanoti, Azad Kashmir. The informers were nominated on the base of their knowledge about the traditional usage of therapeutic plants for veterinary purposes and number of domestic animals they have. The male informants were literate up to graduation, intermediate, metric, some were primary and some were illiterate. The female informants were having primary education and mostly were illiterate (Table 1).

Ethnoveterinary use of the local plants in the mountainous populations of the Sudhanoti, Azad Jammu and Kashmir shows an central role in the curing of livestock ailments and support in livelihood. Local people prefer to use the ethno-medicines over the allopathic medications because they are freely available and economical in use. In different regions of Azad Kashmir, the previous studies reported that the different medicinal plants have been practices as ethnoveterinary medicine for livestock care (Ishtiaq *et. al*. 2006; Ahmed *et al*., 2015; Khan *et al*. 2021). An important point noted during the current study that the aged informants (65 %) have more traditional knowledge than the females (35 %) and young ones. It is suggested that the younger ones have less folklore knowledge due to cultural transition and migration of younger to city for education purposes and earning. Previous studies have been reported that the younger people were seemed less interest in traditional knowledge and motivated towards the allopathic mode of livestock treatment (Amjad *et al*. 2020; Ahmed *et al*. 2015; Usha *et al.* 2016).

Furthermore, elderly people have better responsiveness and knowledge than females, which are reluctant in interaction with male interviewers. Our findings are in good agreement with results of Ishtiaq *et al.* (2015), who described that maximum of the respondents were of old age and young population was least interested in the treatment of livestock by traditional means.

Diversity of ethnoveterinary plant species

The current study revealed ethnoveterinary remedies in the Dsitrict Sudhanoti comprises of 48 therapeutic plants species belonging to genera 28 and 32 families. A detail of their systematic names, families, local names, parts uses and mode of application treat, different diseases of cattle and their use value, use report, fidelity level, frequency of citation and relative frequency of citation **is** given in the table 2. The highest members of the plant species (04) belonging to families Fabaceae , Poaceae followed by the Moraceae (03) and Amaryllidaceae, Apiaceae, Apocynaceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Meliaceae, Ranunculaceae (02 each) and remaining families were represented by 01 species each. The great diversity of medicinal plants species revealed that the communities of the study was familiar with ethnoveterinary uses of plants. Similarly, previous studies reported the Fabaceae, Poaceae, Moraceae, Amaryllidaceae, Apiaceae, Apocynaceae, Araceae, Brassicaceae, Euphorbiaceae, Asteraceae, Boraginaceae, Lamiaceae, Meliaceae, Ranunculaceae have been in practices as ethnoveterinary and ethnomedicine in different area of Azad Jammu and Kashmir (Ahmed *et al.* 2015; Istiaq *et al.* 2015; Khan *et al.* 2021; Ahmed *et al*. 2023; Rafique *et al*. 2021; Ishtiaq *et al*. 2006).

Table: 1. Demographic composition of the study area.

Variable	Demographic categories	Numbers	Percentage
Gender	Male	45	64%
	Female	25	35 %
Education	Uneducated	16	23%
	Primary	19	27%
	Metric	13	18%
	Intermediate	10	14%
	Graduation	12	17%
Marital status	Unmarried married	7	10 %
		63	90 %
Age groups (years)	20 to 30		
	31 to 40	3	4%
	41to 50	13	19%
	51 to 60	9	12%
	60 to 70	11	15%
		34	49 %

In addition, the present investigation documented highest number of plants species, when compared to previous studies in District Sudhanoti, which represent only one or two species as ethnoveterinary usage (Ishtiaq *et al*. 2015; Khan *et al*. 2021). Furthermore, the present study revealed that the herbaceous plant species were mostly used as ethnoveterinary medicine followed by trees and shrubs. The major utilization of herbs species for ethnoveterinary purposes might be due to great diversity, accessibility and easy procedure for herbal preparation. Other factors was observed during the study that deforestation, livestock grazing pressure and illegal extraction of medicinal plants creates huge burden on the species diversity resulted in decreased in biodiversity of the study area. Similar results were reported from previous literature, that herbaceous cover decrease due to climatic change and anthropogenic pressure (Khan and Hanif, 2006, Ahmed *et al.* 2015; Khan *et al.* 2021).

Plant parts used and mode of preparation

The result showed that the different parts of plant were being used to make the diverse recipes. As revealed in the Fig. 2, leaves were the frequent chosen part of the plant (36.36 %) followed by the stem, bark (13.64 %), root (10.61 %) and fruit (9.09 %). While latex (1.52 %)is the least used as ethnoveterinary herbal formulation. Previous findings revealed that the leaves, stem/bark were commonly used as therapeutic herbal formulation around the world (Khan *et al*. 2021; Khajuria *et al.* 2021; Ahmed *et al*. 2015). A previous study reported that assemblage of leaves have no substantial danger for the life of the plant as linked to the roots and barks and entire plant (Yirga, 2012). In addition, higher usage of a precise plant part shows its robust medicinal importance, but its biochemical and pharmacological screening is important to verify the indigenous knowledge.

As for as concerned the method of preparation of herbal formulation, the plant paste was highly preferably used (30 %), followed raw form (26 %), and decoction (20 %), while oil and milky latex was least used form of herbal preparation (Fig. 3).Similar results reported in the literature the paste, powder form, decoction, infusion were most common methods of herbal preparation (Ahmed *et al.* 2015; Ishtiaq *et al*. 2015; Rehman *et al.* 2022) and latex, oils are least used practices (Khan *et al.* 2021). It is suggests that the mode of herbal preparation depends on diseases specificity and procedure efficacy for obtaining bioactive constituent in plant materials. In addition, paste is commonly used due to high frequency of skin diseases of cattle in the study area. Oral mode is preferred for internal diseases categories because of providing quick relief and effective bio-absorption of herbal ingredients into blood streams (Xiong and Long, 2020; Usha *et al.* 2016).

Relative frequency of citations (RFC)

The RFC displays the significance of single plant species in the study area for ethnoveterinary uses and major health maintenance of animals for their productivity. RFC usually ranged between 0.00 to 0.99 (Table 2). The highest, RFC amount was recorded for *Berberis lyceum* (0.84) and other high RFCs include the *Trachyspermum ammi* (0.82), *Calotropis procera* (0.78), *Melia azedarch* and *Zanthoxylum armatum* (0.71), *Morus alba* (0.70), *Cannabis sativa* and *Mentha arvensis* (0.67). The result of RFC enlightens the point, that the medicinal plants were recognized to their native inhabitants over a long time and used as ethno-veterinary therapeutic agent for health care of their domestic animals. On the other hand, *Populus alba* (0.04)*, Hordeum vulgare* (0.07) and *Pinus roxburghii* (0.1) showed minimum RCF value in the study area.

Moreover, the variable value of the RFC indicates that it varies from region to region around the world and it rest upon the traditional information of the local communities. It is important to mention that plants with little RFC value are not of least importance (Vendruscolo, 2006). The low RFC standards might show the little information of the indigenous persons particularly the youth, who are least conscious of the medicinal usages of the plant types. It has been perceived that plants having RFC high value represent high richness in the area and local persons are much acquainted with them. They were being preferred in use due to accessibility and constructive health contribution of these plants. Our results are in accordance with the supposition that resident persons have maximum information on medicinal plants therapeutic uses (Tariq *et al.* 2014).

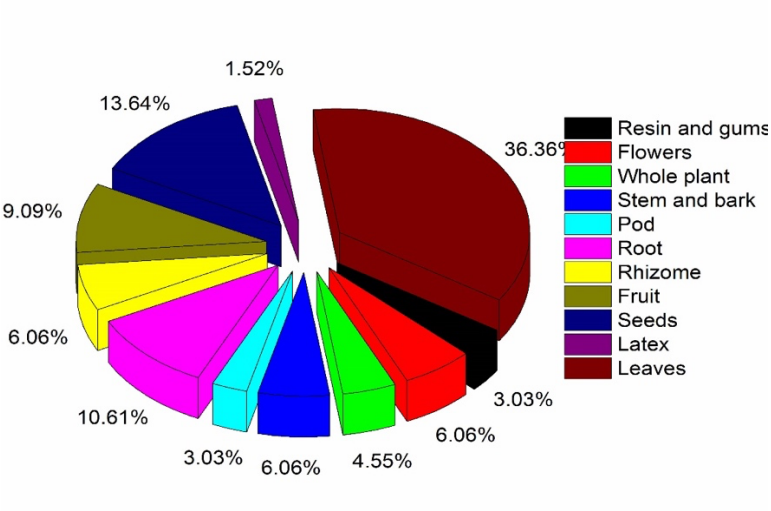

Figure 2. The percentage of plant parts used for veterinary uses in Sudhanoti Azad Kashmir.

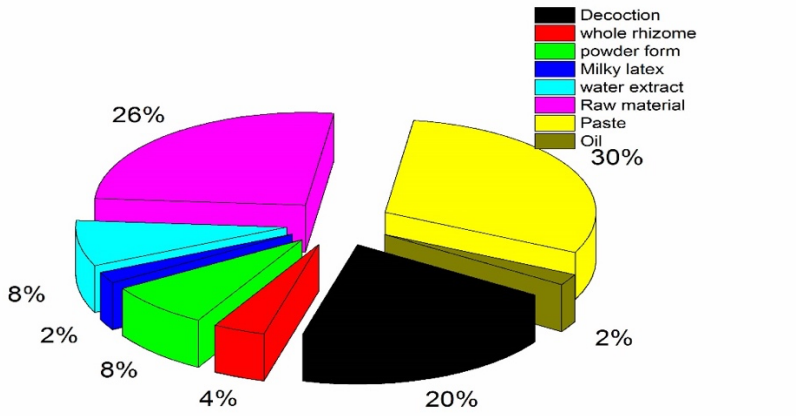

Figure 3. Methods of herbal preparation for veterinary uses in Sudhanoti Azad Kashmir.

Use value

The use value is also a significant criterion to recognize the plant classes, which are widely used in the selected study area. The range of use value data is recorded between 0.14 to 0.85 and species with major use values were *Trachyspermum ammi* and *Berberis lyceum* (0.85), *Zanthoxylum armatum* (0.84), *Cannabis sativa* (0.82), *Calotropis procera* (0.81), *Brassica compestris* (0.80), *Mentha longifolia* and *Morus alba* (0.78), *Cassia fistula* and *Ricinus communis* (0.74) (Table 2).

Plant species with high use value showed it consistent usage as ethnoveterinary medicine by local communities and higher usage reports by informers also reflects that the local communities were well aware about local uses of pant diversity (Majeed *et al.* 2020). Furthermore, the low UV and RCF value of plant species may show lack of awareness of ethnoveterinary usage by younger generation (Kumar *et al.* 2017; Tanzin *et al*. 2010). In the study area, the plant species *Hordum vulgare*, *Triticum aestivum* and *Pinus roxburghii* have lowest use report and use value, however *Pinus roxburghii* was found among the most dominating plant in the study area. It is suggested the local inhabitant trend for *Pinus* and other species with lowest UV and UR might be for timber, fuel wood, food and other ethnobotanical usage rather than ethnoveterinary. The results show accordance with previous ethnoveterinary findings (Ahmed *et al*. 2015; Ishtiaq *et al*. 2006, Rehman *et al.* 2022).

Fidelity level

Fidelity level of 12 significant plant classes fluctuated between 63-100 (Table 2). *Cannabis sativa, Trachyspermum ammi* and *Calotropis procera* showed 100% fidelity level for abdominal worms, appetite stimulant and scabies respectively. Other plants species with high fidelity were *Zanthoxylum armatum* (96%) for digestive disorders, *Allium cepa* (90%) for diarrhea, *Ficus religiosa* (85%) for retention of placenta, *Angelica glauca* (80%) for indigestion (Table 2). The greater fidelity level of a plant species displays its dominance in area and occurrence of that particular ailment in the study region.

The present study was the first quantitative ethnoveterinary investigation of plants in the study area. The previous ethnobotanical investigation revealed only two species as ethnoveterinary usage in the study area (Ishtiaq *et al.* 2015; Khan *et al.* 2021). The present findings showed good aligned with previous reported literature, that a species with high fidelity score in the study area shows the prevalent of a particular disease and therapeutic usage of plant species by native people (Mussarat *et al.* 2014; Akhtar *et al.* 2000).

Veterinary disease category

A total of 48 plants of 32 families were commonly used as ethnoveterinary herbal formulation to treat various diseases of livestock in the study area. The ICF value recorded in the study range from 0.61 to 0.90 (Table 3). The gastrointestinal, respiratory, skin and wounds were among the most predominant diseases in the study territory. A common problem examined in the area was the low sanitation and hygienic environments. The main cause related to abdominal and gastrointestinal discomfort, is the unhealthy and contaminated food along with unclean drinking water. The domestic animals, goats, cattle were raised freely, not confined to particular habitat. As there is abundant vegetation in the hilly areas of the Azad Kashmir, so due to free movement of the domestic animals, they become easily prone to the different insects, parasites, flies, which cause them skin wounds and other diseases. During the monsoon season due to heavy rains, the animals frequently drop from mountains and become seriously wounded and some even die.

The present findings revealed a total of 18 plant species were described for digestive and abdominal glitches of livestock with high use reports. The maximum (0.90) ICF value was noted for respirational diseases followed by toxic effects (0.86) and infectious diseases (0.84) (Table 2). The highest ICF value indicates that the native inhabitants exchanges opinions, thoughts, and folklore tradition knowledge about outdated herbal medicines and vice versa (Sharma *et al.* 2015). The ICF quantitative calculation is an important tool, which shows the agreement of the indigenous persons on a precise plant species and the effectiveness of that plant species for particular disease category (Teklehaymanot *et al.* 2007).

The plant *Olea europaea, Zanthoxylum armatum, Trachyspermum ammi,* and *Zingiber officinale* were commonly practices for stomach disorder, while *Melia azedarach, Aesculus indica* and *Trigonella foenum-graecum* used against respiratory disorder in the study area. Furthermore, the high rate of comparable plant usages may show the similar practices of culture amongst the societies, similar floral diversity and climatic conditions in allied ranges (Ahmed *et al.* 2017). This has also been published that adjoining local communities have sharing of more common traditional usages of therapeutic plants in order to treat the diverse sicknesses and it is more due to public trade and distribution of ethnomedicinal information amongst allied groups (Esakkimuthu *et al.* 2018; Usha *et al.* 2016). Another studies argued that the higher value of ICF may be the indication of the specific plant's importance for particular disease category, owing to the active bioactive ingredients of that plant species (Cakilcioglu *et. al*. 2011; Kadir *et. al*. 2012).

Table 2. Disease categories with use reports and ICF values.

Disease category	Total no. of species (Nt)	Number of use reports (Nur)	ICF
Abdominal disorders	18	45	0.61
Skin diseases and injuries	9	49	0.83
	5	22	0.80
Breast diseases and Milk deficiency			
Respiratory disorders	4	33	0.90
Infection diseases	7	40	0.84
Reproductive disorders	6	30	0.82
Toxicity	6	39	0.86

Table 2. List of ethnoveterinary practices of important plants in District Sudhanoti, Azad Jammu and Kashmir.

Family/Botanical name	Local name	Status	Disease	Part used	Application	Animal treated	UR	UV	FL	FC	RFC (%)
Acanthaceae *Justicia adhatoda* L.	Bhakker	Shrub	Intestinal disease	Roots and leaves	Paste	Goats, sheep	31	0.44	80	25	0.35
Amaryllidaceae *Allium sativum* L	Thoom	Herb	Snake bite,	Leaves, Rhizome	Whole Rhizome	cows, buffaloes, donkey goats	37	0.52	85	30	0.42
Amaryllidaceae *Allium cepa* L.	Paiyaz	Herb	Poisoning, sexual desire in males, skin diseases, diarrhea. Snake bite	Leaves	Whole Rhizome, paste	Sheep, cows, buffaloes	52	0.74	90	45	0.64
Apiaceae *Angelica glauca* Edgew	Choru	Herb	indigestion	Roots	Decoction	Sheep, cows	33	0.47	63	22	0.31
Apiaceae *Trachyspermum ammi* L.	Ajwain	Herb	bloating of stomach, indigestion, appetite stimulant	Seeds	Decoction	buffaloes, cow, sheep, goats	60	0.85	100	58	0.82
Apocynaceae *Carissa carandas* L.	Granada	Shrub	Foot and mouth disease	Roots and leaves	Decoction	Sheep, cows, goats	37	0.42	76	26	0.37
Apocynaceae *Calotropis procera* (Aiton) W.T. Aiton	Aak	Shrub	Scabies, bone fracture, anaplasmosis	Flower, Leaves and latex	Extract	Buffaloes, goats	57	0.81	90	55	0.78
Araceae *Arisaema flavum* (Forssk.) Schott	Hathbis	Herb	Milk deficiency	Rhizome	Raw with flour mixed	Sheep, cows, buffaloes, goats	40	0.57	100	30	0.42
Asteraceae *Saussurea heteromalla* (D.Don) Hand.Mazz	Koth	Herb	Horse bite	Seeds	Whole seeds	Buffaloes, donkey goats	45	0.64	68	32	0.45
Berberidaceae *Berberis lyceum* Royle	Sumbal	Shrub	Myiasis, ulcers, to heal the internal wounds	Roots	Powder with flour mixed	Sheep, cows, buffaloes, goats	60	0.85	94	59	0.84
Boraginaceae *Trichodesma indicum* L.	Kalar bouti	Herb	Snake bite, mastitis	Root	Paste	Buffaloes, cows	32	0.45	52	15	0.21
Brassicaceae *Brassica compestris* L.	Sarsoon	Herb	Milk deficiency	Seeds and flower, oil of seeds	Powdered seeds with flour	Cows, buffaloes	56	0.80	88	45	0.64

Brassicaceae *Raphanus sativus* L.	Muli	Herb	Dysentery	Rhizome	Raw	Sheep, goats	50	0.71	57	33	0.47
Cannabaceae *Cannabis sativa* L.	Bhang	Herb	Abdominal pain, abdominal worms, constipation	Leaves	Paste and water extract	Sheep, goats, buffaloes	58	0.82	72	47	0.67
Chenopodiaceae *Chenopodium album* L.	Ghanari	Herb	Skin disease, for sexual heat	Leaves and whole plant	Raw form	cows, buffaloes	44	0.62	60	15	0.21
Ebenaceae *Diospyros lotus* L.	Amlok	Tree	Lesions, on foot and mouth disease	Bark	Paste	Sheep, cows, buffaloes, donkey goats	30	0.42	46	10	0.7
Euphorbiaceae *Ricinus communis* L.	Harnoli	Tree	Stomach problem, constipation	Leaves & Seeds	Seeds oil	Sheep, goats	52	0.74	55	35	0.50
Euphorbiaceae *Euphorbia congnata* L.	Dodail	Herb	Goat scabies	Stem & leaves	Latex	Cows, buffaloes, donkey, goats	42	0.60	58	26	0.37
Fabaceae *Trigonella foenum-graecum* L.	Methi	Herb	Pneumonia	Leaves	decoction	Sheep, cows, buffaloes	37	0.52	61	15	0.21
Fabaceae *Acacia modesta* Wall.	Phulai	Tree	Urinary infection, bloating, scabies	Leaves	decoction	Goats, cows, buffaloes,	25	0.34	76	12	0.17
Fabaceae *Cassia fistula* L.	Amaltas	Tree	Constipation	Pod	Raw	Sheep, donkey goats	52	0.74	80	29	0.41
Fabaceae *Acacia nilotica* (L.) Willd. ex. Delile	Kikar	Tree	Foot and mouth ulcer, constipation	Seeds, gums, leaves	Paste	Sheep, cows, buffaloes, goats	22	0.31	65	5	0.07
Fabaceae *Lathyrus aphaca* L.	Jangli matar	Herb	Fever, increasing lactation	Pods	Whole plant in Raw	Buffaloes, cows	34	0.48	61	20	0.28
Lamiaceae *Mentha arvensis* L.	Podina	Herb	Dysentery	Leaves	Paste and Raw	Sheep, cows, buffaloes, goats	48	0.68	100	47	0.67
Lamiaceae *Mentha longifolia* L.	Safeed podina	Herb	Throat infection, indigestion	Leaves and roots	Paste and Raw	cows, buffaloes,	55	0.78	87	44	0.62

Lythraceae *Punica granatum* L.	Druna	Tree	Maintain internal system after birth, bleeding control	Fruit coat	powder	Buffaloes, cows, and goats	30	0.42	88	17	0.24
Malvaceae *Bombax ceiba* L.	Sambal	Tree	To control the bleeding after birth	Flower	Whole raw	Sheep, goats	48	0.68	65	30	0.42
Meliaceae *Azadirachta indica* Juss.	Neem	Tree	Fever and anthelmintic	Leaves	Water extract	Sheep, goats	51	0.72	89	43	0.61
Meliaceae *Melia azedarach* L.	Darake	Tree	Stomach flatulence Fever & cough	Seeds & leaves	Whole fruit and extract	Sheep, cows, buffaloes, goats	53	0.75	96	50	0.71
Moraceae *Ficus religiosa* L.	Peepal	Tree	Retention of placenta, stomachic	Leaves	Leaves	Sheep, cows, buffaloes, goats	45	0.64	81	34	0.48
Moraceae *Morus alba* L.	Chita toot	Tree	Heal wounds Laxative	Leaves	Paste and raw	Goats, cows, sheep	55	0.78	80	49	0.70
Moraceae *Morus nigra* L.	Kala toot	Tree	Dysentery, trypanosomiasis	Fruits	Whole fruits	Goats, cows, sheep, buffaloes	39	0.55	82	33	0.47
Oleaceae *Olea europaea* L.	Kaho	Tree	Indigestion, anthelmintic	Leaves, seeds	decoction	Sheep, cows, buffaloes, goats	35	0.50	80	22	0.31
Pinaceae *Pinus roxburghii* Sarg.	Chir	Tree	Skin infection, cough & asthma	Resin & needles	decoction	Buffaloes, cows,	20	0.28	88	7	0.10
Piperaceae *Piper nigrum* L.	Kali march	Climber	Indigestion	Fruit	Paste	Sheep, cows, buffaloes, goats	30	0.42	54	19	0.27
Poaceae *Cynodyon dactylon* L.	Khabal	Herb	Wound healing	Whole plant	Paste on wound	Cows, buffaloes	39	0.55	73	33	0.47
Poaceae *Hordeum vulgare* L.	Barley	Shrub	Stomach disorders	Leaves, Seeds	decoction	Sheep, goats, horses	10	0.14	78	5	0.07
Poaceae *Triticum aestivum* L.	Gandam	Herb	Dysentry	Grains	decoction	Goats, sheep	20	0.28	88	10	0.14
Poaceae *Zea mays* L.	Makai	Shrub	Urinary inflammation	Stigma	Mixed with flour	Cows, Buffaloes, horse	33	0.47	75	24	0.34
Ranunculaceae *Aconitum heterophyllum* Wall. ex Royle	Ptress	Herb	Fever and flu	Roots	decoction	Cows, buffaloes, goats	36	0.51	90	16	0.22

Ranunculaceae *Ranunculus muricatus* L.	Baree	Herb	Wound healing	Whole plant	Raw	Sheep, cows, buffaloes,	33	0.47	90	22	0.31
Rosaceae *Prunus persica* L.	Arwari	Tree	To kill Worms on wound	Leaves	Paste	Sheep, goats, cows, buffaloes	39	0.55	72	20	0.28
Rutaceae *Zanthoxylum armatum* DC.	Timber	Shrub	Fascioltasis, Digestive problems	Bark, leaves and fruit	Paste	Cows, buffaloes, horse, goats	59	0.84	95	50	0.71
Salicaceae *Populus alba* L.	Safada	Tree	Hemorrhoid	Shoots and leaves	Raw and Paste	Cows, buffaloes, horses	18	0.25	59	3	0.04
Sapindaceae *Aesculus indica* (Wall. ex Camb.) Hook	Bunkhor	Tree	Chest disease, pneumonia	Fruit	Decoction	Sheep, cows, buffaloes, donkey, goats	30	0.42	45	22	0.31
Solanaceae *Capsicum annuum* L.	Surkh march	Herb	Stomach disorder	Fruit	Raw	Sheep, cows, donkey, goats	30	0.42	84	15	0.21
Urticaceae *Debregeasia salicifolia* (D.Don) Rendle	Sindari	Shrub	Diarrhea, boils	Leaves	Leaves paste	Sheep, cows, buffaloes	34	0.48	76	12	0.17
Zingiberaceae *Zingiber officinale* (L.) Roscoe	Adrak	Herb	Poisoning of saliva from mouth, indigestion, retention of placenta	Rhizome	Decoction	buffaloes, cows, goats	40	0.57	92	30	0.42

Legends; UV: use value, **UR:** use report, **FL:** fidelity level, **FC:** frequency of citation, **RFC:** relative frequency of citation

Jaccard index

The Jaccard index (JI) has been used to show an association among this study and already research performed in the other areas of Azad Jammu and Kashmir, and neighbors countries for finding the novelty in the ethnobotanical traditional knowledge. In contrast of our work to rest of studies from Azad Kashmir, the Jaccard index values calculated ranging from 2.58 to 13. The maximum value 13 was recorded with earlier report study by Rehman *et al*. (2022) from North Waziristan KPK, Pakistan and lowest 2.58 from the study area of Neelum valley Azad Kashmir, Pakistan (Table 4). Plants with similar uses from Samhani Bhimber, Azad Kashmir were 08 and 04 from North Waziristan, KPK, 03 from Punjab, Pakistan and 02 from neighbor country region of India and Bangladesh was reported. It seemed that the climate of the study area matches with the one having higher JI value, while differences may be found due to variable climatic data, socioeconomic and cultural values.

In contrast, a low Jaccard index values indicate that there is a low sharing of knowledge of medicinal plants among the people and least social interaction in the past, which has resulted in difference in ethnobotanical practices (Heinrich *et al*. 1986; Rehman *et al*. 2022). Low values of JI in our study conducted in one region of Neelum AJK and other studies conducted KPK and Punjab, Pakistan have high value of Jaccard index might be due to the socioeconomic, cultural differences as well as climatic differences (Rehman *et al*. 2022; Khan and Hanif, 2006; Hassan *et al*. 2014). The literature reviewed, showed that similar and different ethno-veterinary practices of many therapeutic plants in the different societies around the world (Manganelli *et al.* 2001; Rehman *et al*. 2022; Ahmed *et al*. 2015; Usha *et al* . 2016).

Furthermore, previous investigations from Azad Kashmir documented from the temperate and subalpine and alpine regions, while the study was conducted in the subtropical zone to allied area. The topography changes the vegetation pattern of both areas, which ultimately shows the uses of dissimilar plants for the same sicknesses. It was also observed that the *Melia azedarach* is reported to be used for gassiness, cough, and fever likewise previous studies reported multiples uses of that species (Monteiro *et al.* 2011; Khan *et al*. 2010). On the other hand, it was also perceived that most of the plants were being used in amalgamation with the other materials and vectors like milk, sugar and flour, which may change the flavor of preparations. It was argued in a previous investigation that the herbal preparation in milk, sugar and flour may be dilutes or reduces their potency efficacy of medicinal plant (Jabbar *et al*. 2006).

Novelty of the study

The literature survey revealed similarity in the most of the ethnoveterinary uses with the past studies that validated our findings and established the novelty of the present study. However, a few ethnobotanical investigations were conducted in District Sudhanoti, which exposed a single medicinal plant such as root of *Trichodesma indicum* is used for inflammation (Khan *et al*. 2021), *Mallotus philipiensis* documented to treat stomach disorder of livestock (Ishtiaq *et al*. 2015). The present study reported new folklore herbal usage of important medicinal plants such as, *Angelica glauca, Arisaema flavum¸ Aconitum heterophyllum , Aesculus indica, Azadirachta indica, Trachyspermum ammi*, *Cannabis sativa, Morus alba, Mentha longifolia, Berberis lyceum*, *Brassica compestris*, *Euphorbia congnata, Saussurea heteromalla, Trichodesma indicum and Zanthoxylum armatum*.

Conclusion

For the first time, a detail documentation of ethno-veterinary practices was recorded in District Sudhanoti, Azad Jammu and Kashmir. The herbs were mostly usage plant followed by trees and shrubs among the 48 plant species. The present findings indicate that the folklore indigenous knowledge is mainly confined to old age people especially male than female and younger generation. There is increasing decline was observed in ethnoveterinary traditional knowledge with the passage of time and cultural transition. Thus, the current study was a start up to preserve this valuable folklore information. The study also reflects variable usage of plants parts and herbal formulation, mode of administration, plant species usage for multiple disease categories. It may be due to differences in socio-economic, cultural and environmental condition around the world. Some of these important plants are *Angelica glauca, Arisaema flavum¸ Aconitum heterophyllum , Aesculus indica, Azadirachta indica, Trachyspermum ammi and Zanthoxylum armatum.* The present findings suggest that plants species with high use report might be screen for bioactive compounds by pharmacological and chemical studies. The safe use of these ethnoveterinary medicines also requires the determination of their toxicological effects by *in-vivo* and *in-vitro* method.

Table 4. Jaccard Index data for ethnoveterinary medicinal plants.

Study area	Region	Ref.	TRS	CPBA	PPAA	PPSA	PSU	PDU	%SU	%DU	JI
Neelum valley, AJK	AJK Pakistan	Khan *et al*. 2021	39	3	36	45	0	3	0	0	2.58
Behri, Muzaffarabad AJK	AJK Pakistan	Ahmed *et al*. 2015	24	3	21	45	0	3	0%	12.5%	4.34
Samahani Bhimber AJK	AJK Pakistan	Khan and Hanif, 2006	53	13	40	35	8	5	15%	9.4%	12.87
North Waziristan KPK	KPK Pakistan	Rehman *et al*. 2022	56	12	44	36	4	8	7%	14%	13
Punjab Pak	Punjab Pakistan	Majeed *et al.* 2020	149	4	145	44	3	1	2%	0.6%	2.07
Lower Dir, KPK	KPK Pakistan	Hassan *et al*. 2014	28	6	22	42	3	3	10%	10%	8.57
Karnataka India	India	Kumar *et al*. 2017	36	7	29	41	2	5	5.5%	13.88%	9.07
Netrakona	Bangladesh	Tanzin *et al*. 2010	42	5	37	43	2	3	4%	7%	5.26

Note: TRS: Total reported species, **CPBA:** Common plants of both areas, **PPAA:** Plants only present in the aligned area. **PPSA:** Plants only present in the study area, **PSU:** Plants with similar uses, **PDU:** Plants with different uses.

Declarations

List of abbreviation: *UV*: Use value, Ui: number of use reports by each informer., Ni: the total number of informer interviewed., *ICF:* Informant consensus factor, Nur: is number of used citations, nt: is the total number of plant species., FL: Fidelity level, Np: is the number of participants., RFC: Relative frequency of citation., FC: frequency citation, N: is the total number of contributors in the study area., J: Jaccard index, a : denote the number of plants species in an area A, b: is the number of plants species in area b , c: is the number of plants common to area A and B., TRS: Total reported species, , CPBA: Common plants of both areas, PPAA: Plants only present in the aligned area., PPSA: Plants only present in the study area, PSU: Plants with similar uses, PDU: Plants with different uses.

Ethics approval and consent to participate: This study did not involve the export of any animal or plant material. Information was obtained from the participants. All informants gave oral prior informed consent.

Consent for publication: Oral permission was taken from all the authors.

Availability of data and materials: The manuscript contains all the data.

Competing interests: We declare that there is no conflict of interest.

Funding: No funding

Authorship contributions: KN and RT perceived, designed the experiments and conduct experiments and recorded data. MJA participated in the analyses of data. RT wrote the original draft. MJA review, edit the final draft.

Acknowledgements

We are thankful to the local community, healers and nomads of District Sudhanoti, Azad Jammu and Kashmir, Pakistan for sharing the indigenous knowledge of medicinal plant regarding primary health care system management for the treatments of animal's diseases in the study area.

Literature cited

Ahmad R, Ahmad N, Naqvi AA, Shehzad A, Al-Ghamdi MS. 2017. Role of traditional Islamic and Arabic plants in cancer therapy. Journal of Traditional Complementary and Alternative Medicine 7:195- 204. doi: 10.1016/j.jtcme.2016.05.002 PMID: 2841709

Ahmed MJ, Murtaza G. 2015. A study of medicinal plants used as ethnoveterinary: harnessing potential phytotherapy in Bheri, District Muzaffarabad (Pakistan), Journal of Ethnopharmacology 159:209-214.

Ahmed MJ, Akhtar T. 2016. Indigenous knowledge of the use of medicinal plants in Bheri, Muzaffarabad, Azad Kashmir. Pakistan. European Journal of Integrative Medicine 8 560-569.

Ahmed F, Dar MEUI, Ahmed MJ, Habib T, Khan LA. 2023. Multipurpose plants utilization and resource management in Musk Deer National Park, Western Himalayas of Kashmir. Environment, Development and Sustainability 1-17.

Akhtar MS, Iqbal Z, Khan MN, Lateef M. 2000. Anthelmintic activity of medicinal plants with particular reference to their use in animals in the Indo-Pakistan subcontinent. Small Ruminant Research 38: 99-107.

Ali-Shtayeh MS, Yaniv Z, Mahajna J. 2000. Ethnobotanical survey in the Palestinian area: a classification of the healing potential of medicinal plants. Journal of Ethnopharmacology 73:221-232.

Ali SI, Nasir E. 2002. Flora of Pakistan, National Herbarium, NARC, Islamabad and Department of Botany, University of Karachi, Karachi. Fasc. No. 1-207 (1970- 2002).

Ayyanar M, Ignacimuthu S. 2011. Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats. India. Journal of Ethnopharmacology 134:851-864.

Cetinkaya G. 2009. Challenges for the maintenance of traditional knowledge in the Satoyama and Satoumi ecosystems, Noto peninsula, Japan. Human Ecology Review 16:27-40.

Cos P, Vlietinck AJ, Vanden Berghe, D, Maes L. 2006. Anti-infective potential of natural products: How to develop a stronger in vitro 'proof - of concept'. Journal of Ethnopharmacology 106:290-302. Dhakal A, Khanal S, Pandey M. 2021. Ethnoveterinary practice of medicinal plants in Chhatradev Rural Municipality, Arghakhanchi District of Western Nepal. Nusantara Bioscience13:29-40.

Esakkimuthu S, Sylvester SD, Mutheeswaran S, Gabriel MP, Pandikumar P, Ignacimuthu S. et al. 2018. A study on food-medicine continuum among the non-institutionally trained siddha practitioners of Tiruvallur district, Tamil Nadu, India. Journal of Ethnobiology and Ethnomedicine 14- 45. doi: 10.1186/s13002-018-0215-x PMID: 29444678

Friedman J, Yaniv Z, Dafni A, Palewitch D. 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. Journal of Ethnopharmacology 16:275-287. doi: 10. 1016/0378-8741(86)90094-2 PMID: 3747566.

Giday M, Asfaw Z, Woldu Z. 2009. Medicinal plants of the Meinit ethnic group of Ethiopia: An ethnobotanical study. Journal of Ethnopharmacology 124:513-521.

Hassan, ul-H. Murad, W. Tariq, A. Ahmad, A. (2014). Ethnoveterinary study of medicinal plants in Malakand Valley, district Dir (lower), Khyber Pakhtunkhwa, Pakistan. Irish Veterinary Journal 67:1-6.

Heinrich M, Ankli A. Frei B, Weimann, C, Sticher, O. 1986. Medicinal plants in Mexico: Healers' consensus and cultural importance. Society Science and Medicine 147:1859-1871. doi: 10.1016/s0277-9536(98)00181-6 PMID:9877354

Heinrich M, Edwards HS, Moerman DE, Leonti M, 2009. Ethnopharmacological field studies: a critical assessment of their conceptual basis and methods. Journal of Ethnopharmacology 124:1-17.

Ishtiaq M, Khan MA, Hanif W. 2006. Ethnoveterinary medicinal uses of plants from Samahni valley District Bhimber, (AJK). Asian Journal of Plant Sciences 5:390-396.

Ishtiaq M, Mahmood A, Maqbool M. 2015 Indigenous knowledge of medicinal plants from Sudhnoti district (AJK), Pakistan. Journal of Ethnopharmacology 168:201-207.

Jabbar A, Raza MA, Iqbal Z, Khan N. 2006. An inventory of the ethnobotanicals used as anthelmintics in the southern Punjab (Pakistan). Journal of Ethnopharmacology 108: 152- 154. Jain SC, Sharma R, Jain R, Sharma RA. 1996. Antimicrobial activity of *Calotropis procera*. Fitoterapia 67:275-277.

Khan, M. I. C. M. Hanif, W. 2006. Ethnoveterinary medicinal uses of plants from Samahni valley dist. Bhimber,(Azad Kashmir) Pakistan. Asian Journal Plant Science 5(2):390-396.

Khan SM, Ahmad H, Ramzan M, Jan MM. 2010. Ethnomedicinal plant resources of Shawar valley. Pakistan Journal of Biological Sciences 10:1743- 1746. Kumar VL, Roy S. 2007. *Calotropis procera* latex extract affords protection against inflammation and oxidative stress in Freund's complete adjuvant-induced monoarthritis in rats. Mediators of Inflammation, 47523, 1- 7.

Khan, MF. Mashwani, Z. Mehmood, A. Qureshi, R. Sarwar, R. Ahmad, KS. Quave, CL. 2021. An ethnopharmacological survey and comparative analysis of plants from the Sudhnoti District, Azad Jammu and Kashmir, Pakistan. Journal of Ethnobiology and Ethnomedicine 17:14. doi: 10.1186/s13002-021-00435-2

Khajuria AK, Manhas RK, Kumar H, Bisht NS. 2021. Ethnobotanical study of traditionally used medicinal plants of Pauri district of Uttarakhand, India. Journal of Ethnopharmacology 276:114204. doi: 10.1016/j.jep.2021.114204

Liu YC, Dao ZL, Yang CY, Liu YT, Long CL. 2009. Medicinal plants used by Tibetans in Shangri-la, Yunnan, China. Journal of Ethnobiology and Ethnomedicine 5:15.

Lucchetti L, Zitti S. Taffetani F. 2019. Ethnobotanical uses in the Ancona district (Marche region, Central Italy). Journal of Ethnobiology and Ethnomedicine 15:1-33. doi: 10.1186/s13002-019-0288-1

Lulekal E, Kelbessa E, Bekele T, Yineger H. 2008. An ethnobotanical study of medicinal plants in Mana Angetu District, southeastern Ethiopia. Journal of Ethnobiology and Ethnomedicine 4:1-10.

Mabona U, Van Vuuren FS. 2013. Southern African medicinal plants used to treat skin diseases. South African Journal of Botany 87:175-193.

Majeed, M. Bhatti, K. H. Amjad, M. S. Abbasi, A. M. Bussmann, R. W. Nawaz, F. Ahmad, K. S. 2020. Ethno-veterinary uses of Poaceae in Punjab, Pakistan.PloS one 15:(11):e0241705.

Manganelli, R.U., Camangi, F., Tomei, P., 2001. Curing animals with plants: traditional usage in Tuscany (Italy). Journal of Ethnopharmacology 78, 171- 191.

Mathias E. 2004. Ethnoveterinary medicine: harnessing its potential. Veterinary Bulletin 78:27- 37.

Mesfin F, Demissew S, Teklehaymanot T. 2009. An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia. Journal of Ethnobiology and Ethnomedicine 5:28.

Monteiro MVB, Bevilaqua CML, Palha MDC, Rbraga R, Schwanke K, Rodrigues ST, Alameira O. 2011. Ethnoveterinary knowledge of the inhabitants of Marajó Island, Eastern Amazonia, Brazil. Acta Amazon 41:233-242.

Mussarat S, Amber R, Tariq A, Adnan M, Abd Elsalam NM, Ullah R. et al. 2014. Ethnopharmacological assessment of medicinal plants used against livestock infections by the people living around Indus river. BioMed Research International 1- 14. doi: 10.1155/2014/616858PMID:25544941

Njoroge GN, Bussmann RW. 2006. Herbal usage and informant consensus in ethnoveterinary management of cattle diseases among the Kikuyus (Central Kenya). Journal of ethnopharmacology. Journal of Ethnopharmacology 108: 332-339.

Phondani PC, Maikhuri RK, Kala CP. 2010. Ethnoveterinary uses of medicinal plants among traditional herbal Healers in Alaknanda catchment of Uttarakhand, India. African Journal of Traditional and Complementary medicine 7:195-206.

Rafique Khan, S. M. Akhter, T. Hussain, M. (2021). Ethno-veterinary practice for the treatment of animal diseases in Neelum Valley, Kashmir Himalaya, Pakistan.PLoS one 16(4):e0250114.

Rehman, S. Iqbal, Z. Qureshi, R. Rahman, I. U. Sakhi, S. Khan, I. Ijaz, F. (2022). Ethnoveterinary Practices of Medicinal Plants Among Tribes of Tribal District of North Waziristan, Khyber Pakhtunkhwa, Pakistan. Frontiers in Veterinary Science 9:815294.

Sharma R, Manhas RK. 2015. Ethnoveterinary plants for the treatment of camels in Shiwalik regions of Kathua district of Jammu & Kashmir, India. Journal of Ethnopharmacology 169:170- 175.

Tanzin, R., Ghosh, K. C., Jahan, R., Khatun, A., & Rahmatullah, M. (2010). An ethnoveterinary survey of medicinal plants used to treat cattle diseases in Birishiri area, Netrakona district, Bangladesh. Advances in Natural and Applied Sciences 4(1):10-14.

Tariq A, Mussarat S, Adnan M, AbdElsalam NM, Ullah, R, Khan AL. 2014. Ethnoveterinary study of medicinal plants in a tribal society of Sulaiman range. Scientific World Journal 1-10.

Teklehaymanot T, Giday M. 2007. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. Journal of Ethnobiology and Ethnomedicine 3:12. doi: 10.1186/1746-4269-3-12

Tiwari L, Pande PC. 2010. Enthnoveterinary medicine in Indian perspectives: Reference to Uttarakhand, Himalaya. Indian Journal of Tradition Knowledge 9:611-17.

Toyang NJ, Mertens H, Otterloo-Butler S. 2007. Ethnoveterinary Medicine: A Practical Approach to the Treatment of Cattle Diseases in Sub-Saharan Africa. 2nd ed. Technical Centre for Agricultural and Rural Cooperation. Agromisa, Wageningen, Netherlands. p1-87.

Usha S, Rajasekaran C, Siva R. 2016. Ethnoveterinary medicine of the Shervaroy Hills of Eastern Ghats, India as alternative medicine for animals. Journal of Traditional and Complementary Medicine 6:118-125.

Vendruscolo G, Mentz A. 2006. Ethnobotanical survey of the medicinal plants used by the community of Ponta Grossa neighborhood, Porto Alegre, Rio Grande doSul, Brazil. Iheringia Serie Botanica 61:83-103.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. 2013. Traditional knowledge on medicinal and food plants used in ValSan Giacomo (Sondrio, Italy) an alpine ethnobotanical study. Journal of Ethnopharmacology 145:517-529. doi: 10.1016/j.jep.2012.11.024.

Xiong Y, Long C. 2020. An ethnoveterinary study on medicinal plants used by the Buyi people in Southwest Guizhou,China. Journal of Ethnobiology and Ethnomedicine 16:1-20.

Yirga G, Teferi M, Gidey G, Zerabruk S. 2012. An ethnoveterinary survey of medicinal plants used to treat livestock diseases in Seharti-Samre district, Northern Ethiopia. Afr. Journal of Plant Sciences 6:113-119.

Yousafzai SA, Khan N, Iqbal A, Wahaba M, Siddique F. 2010. Ethnoveterinary study of Marghazar valley district Swats, Pakistan. International Journal of Biology and Biotechnology 7: 273-279.

Zia-ud-Din S, Zafar I, Khan MN, Jonsson, NN, Muhammad S. 2010. Documentation of ethnoveterinary practices used for treatment of different ailments in a selected hilly area of Pakistan. International Journal of Agriculture Biology 12:353- 358.