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An ethnobotanical study on across different ethnic groups from high-altitude areas of the Northwestern Himalayas

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Abstract. *Khoja AA, Andrabi SAH, Mir RA. 2023. An ethnobotanical study on musculoskeletal disorders across different ethnic groups from high-altitude areas of the Northwestern Himalayas. Asian J Ethnobiol 6: 46-57.* Musculoskeletal Disorders (MSDs) are injuries and disorders that affect the human body's movements. In traditional medicine variety of plant species across the globe are used to treat these diseases. The present study examined to document the plant taxa used for the said diseases in the remote and frontier area (Kupwara) of the union territory of Jammu and Kashmir-India. Extensive surveys were conducted using simple stratified sampling from April 2020 to July 2022. Three different quantitative ethnobotanical indices (Use value, Informant Consensus Factor (ICF), and family use values) were used to interpret the results. A total of N=46 plant species from N=32 families were identified. Asteraceae (N=4) was the dominant family recognized; among the total enlisted species (N=37) were herbs, accounting for most of the life form contributing to treating the maximum number of diseases (80%). Leaf accounted for the majority of all plant parts (N=11), followed by root (N=10); the most popular and effective preparation techniques listed were decoction and paste; maximum UV was calculated for *Geranium wallichianum* D.Don ex Sweet (0.73) and the lowest UV for *Phytolacca acinosa* Roxb. (0.28). The highest FUV was conceived for Geraniaceae (0.68). Joint pain was treated by most species (N=26), and the highest value of ICF was recorded for inflammation (0.45), followed by Muscular pain (0.43). The cross-cultural analysis showed that all commonly used 13 species said selected ethnic groups (Gujjar, Bakarwal, and Kashmiri).

Keywords: Ethnic groups, Musculoskeletal Disorders (MSDs), Northwestern Himalayas

INTRODUCTION

Non-communicable diseases like Musculoskeletal Disorders (MSDs) rapidly increase throughout developed and developing nations (Puntumetakul et al. 2011). These illnesses affect more than 1.7 billion people worldwide and are a leading cause of disability and death (Hignett et al. 2010). According to a recent World Health Organization (WHO) report, MSDs, including osteoarthritis, arthritis, back and neck discomfort, and bone fractures, are the second-most prevalent cause of disability worldwide (Musculoskeletal Conditions 2019). Approximately 20-33% of people worldwide have endured excruciating and incapacitating muscular-skeletal illnesses (Malik et al. 2018). In addition, MSDs can cause impaired mobility and skill, resulting in job loss and diminished social role performance (Musculoskeletal Conditions 2019). Every country in Asia has a high prevalence of arthritis, but India and China are particularly affected (Brennan et al. 2017). One of the world's leading causes of chronic morbidity and disability, Musculoskeletal Disorders (MSDs), which include more than 150 conditions affecting the bones, muscles, ligaments, and other connective tissues, are a significant contributor to the global disease burden, making up 1.7% to 3.4% of it. Because they tend to produce fatigue, which forces workers to leave their jobs before fully recovering, discomfort, and joint deformity, MSDs are the primary cause of activity restriction, loss of function, and long-term disability (De Costa and Vieira 2010). The most incapacitating MSDs include back and neck pain, Osteoarthritis (OA), Rheumatoid Arthritis (RA), and fractures. These conditions significantly impair healthy aging by lowering physical, mental, and functional capabilities (Rabiei et al. 2012). According to the International Labor Organization (ILO), around 2 million women and men worldwide die from illnesses related to their jobs each year, which equates to more than 5,480 fatalities each day. Worldwide, WMSDs are regularly cited as one of the major reasons why workers complain (Lima and Coelho 2011). Moreover, these conditions are the most common health issues experienced by workers in developed countries (Bevan 2015).

Nonetheless, cultural change, particularly the impact of industrialization and the Western worldview, appears to be the greatest threat to local knowledge of therapeutic plants (Haq et al. 2020). In addition, the spread of modern schooling, which has aided in weakening traditional values among the young, may have also contributed to knowledge loss on therapeutic plants (Giday et al. 2002). Numerous medicinal plants have been used to treat various diseases, including muscular discomfort, rheumatism, broken bones, etc., connected to MSDs. In the modern era, ethnobotanical investigations have gained a global reputation due to the selection of plants to treat diseases and develop natural drugs (Haq et al. 2022).

Traditional ethnobotanical knowledge is transmitted orally from generation to generation (Az-Zahra et al. 2021).

This knowledge is vital in primary health care across local communities, especially ethnomedicine (Pieroni and Quave 2005). In India, more than 75% of people in many regions use this knowledge as their primary source of medical care (Qureshi and Abrams 2007; Mahmood et al. 2011). For example, in the valley of Kashmir, which lies in the bosom of the Himalayas, traditional medicine has been practised for centuries, having a vital role in primary healthcare (Hassan et al. 2022; Mir et al. 2022a,b). However, with the ongoing urbanization and the changing mode of life, allopathic medicine is prioritized over traditional medicine. That becomes a potential cause of eroding traditional knowledge. In this regard, our study tried to enlist the taxa used in MSDs from the remotes areas of the frontier administrative district Kupwara with the following objectives: (i) The number of plant species utilized to treat MSDs, (ii) Plant species and families most crucial for treating MSDs. (iii) Plant parts and preparation techniques for treating MSDs.

The results of this study may make it easier to identify and select plant species that can be evaluated for the pharmacological profile so possible molecules or compounds can be obtained with potent medical attribution.

MATERIALS AND METHODS

Study area

Kupwara is an administrative district in the Union territory of Jammu and Kashmir (India) with a population of 870,354. As per the latest census records, the region has a population density of 368 people per km^2, further the area is divided into three tehsils and 362 villages (available at https://www.census2011.co.in, accessed on 11 June 2022). The topography includes high mountains, hills, and plain areas with many high-altitude grassland pastures. Hence, the area mostly has a high altitude. However, a variation is seen across the region, and the average altitude is almost 1,800 m. According to the Köppen classification, the climate is of the *cfa* (Humid subtropical climate) type (Aadil and Andrabi 2021; Hassan et al. 2022). The major water bodies include Talri and Mawar Rivers; Talri originates from the famous Lolab valley and flows from east to west. Agriculture is central to the regional economy, principal crops grown in the area are maize, wheat, and rice, along with beans and peas. According to Haq et al. (2020), the area is known for its dense forests (Himalayan dry-temperate to subalpine forest types), a wide variety of floral species, and abundant medicinal plants.

Ethnobotanical data collection

From April 2020 to August 2022, extensive surveys were carried out in the research region to collect medicinally significant plants used to treat MSD disorders following the International Classification of Primary Care, Second Edition (ICPC-2); disorders were also classified according to specific body systems. Village chiefs were contacted before the study to gain the trust and assistance across the region. A total of 59 visits were made to the selected places in the region (Figure 1): (Sadna top (3,000-3,500 m), Farkan (2,500-3,000 m), Tee-Pee (2,000-2,500 m), Bungus valley (3,000 m), Langate (1,600 m), Tangdar (1,400-2,800 m), Keran (1,400-2,200 m), Rashanpora Dutt (2,800-3,200 m), Thandipora (1,900-2,200 m), and Budnamal (2,100-2,700 m).

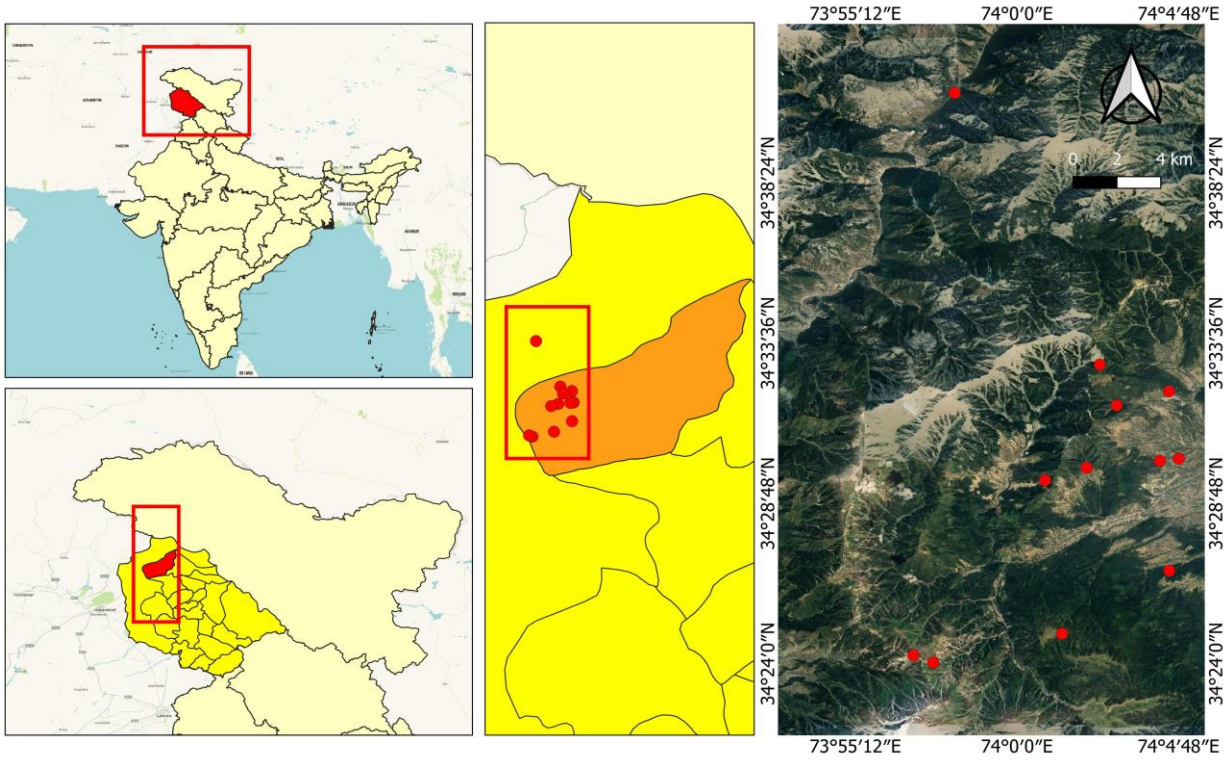

Figure 1. Map of Kupwara District, Jammu and Kashmir, India, showing surveyed villages

Therefore, utilizing simple stratified sampling, informants were questioned employing semi-structured interviews and group discussions (Martin 1995). A translator was hired from the respective places to improve data collecting because the chosen villages are primarily inhabited by the Gujjar, and Bakarwal, with few Kashmir who spoke different languages. Additionally, the gathered data was compared to the existing literature (Gairola et al. 2014; Haq et al. 2019). The International Society of Ethnobiology established rules throughout the study.

For herbarium specimens, plants with fully developed stems, roots, and blooms were gathered, and identification was carried out by comparing the voucher specimens with previously identified specimens placed at the Herbarium University of Kashmir, Srinagar (Acronym KASH). According to The Plant List, the botanical names of the plant species are confirmed.

Data analysis

Three different quantitative ethnobotanical indices, such as species Use Value (UV), Informant Consensus Factor (ICF), and Family Use Values (FUV), were carried out to interpret the obtained results.

Use Value (UV)

The relative importance of the recorded taxa was calculated through the Use Value (UV) (Phillips et al. 1994). It was calculated through the following formula:

$$UV = \Sigma Ui/Ni$$

Where, Ui indicates the number of use reports mentioned by informants for given plant taxa, and Ni is the total number of informants that participated in the study. Use Value is high when there are many use reports for a given medicinal plant species, and use value is low when there are few reports associated with its use.

Informant Consensus Factor (ICF)

ICF highlights plants of particular cultural relevance and agreement in using taxa. It helps to identify the variability of the medicinal plants and determine the plant taxa of particular interest. The diseases treated by the enlisted plant taxa were grouped into categories to analyze ICF; hence more ethnopharmacological interesting plant taxa might be identified. ICF was calculated using the formula proposed by (Heinrich et al. 1998), which is used to test the hypothesis of knowledge homogeny as follows:

$$ICF=Nur-Nt/Nur-1$$

Where, Nur is the number of use reports (citations) in each ailment category, and Nt is the number of plant taxa employed for particular ailments. The ICF always ranges from 0 to 1. A high range (nearest to 1) means many people employ relatively few taxa. In contrast, a low range means participants disagree on the taxa employed within a particular category of diseases (Gazzaneo et al. 2005).

Family Use Value (FUV)

FUV helps to identify and signify the use-value of a given medicinal plant family used as a medicine flora in a particular locality. The family use-value was calculated using the formula of Hoffman and Gallaher (Nadaf et al. 2019): High FIV value demonstrates rich knowledge among the informants, while low FIV values show less awareness regarding the use of the family.

$$FUV \quad \sum UVs/ns$$

Where; UVs is the species use value of the plants cited by informants and ns represents the total number of plant taxa documented in the family.

RESULTS AND DISCUSSION

Demographic characteristics of the respondents

Furthermore, 90 informants from three ethnic groups (Gujjar, Bakarwal, and Kashmiri) were selected, among which the majority were males (58 males and 32 women). The dominance of male informants in the study was due to cultural limitations (young females are reluctant to meet unknown males due to religious obligations), which can be ascribed to the possible bias of the current study. The selected informants were categorized into different professional groups and age groups. Their education status was also comprised, although younger individuals have higher levels of education than older ones (Table 1). Urdu, Kashmiri, Phari, and Gujri are the four different types of languages spoken in the study area.

Table 1. Demography of respondents from the study area

Demographic features	Number	Percentage
Ethnic groups	Gujjar, Bakarwal, Kashmiri	
Language	4 (Urdu, Kashmiri, Phari, Gojeri)	
Education		
Illiterate	48	53.33
Primary education	22	24.44
Secondary education	12	13.34
Higher education	8	8.89
Age range		
Young (18-26)	16	17.78
Middle (27-50)	30	33.33
Old (51-85+)	44	48.89
Profession		
Hakeem (traditional healers)	11	12.22
Skilled/semi-skilled worker	14	15.56
Cultivator/agricultural laborer	20	22.22
Herders	17	18.89
Govt. Employees	8	8.89
Housewives	15	16.67
Shopkeepers	5	5.56
Gender		
Male	58	64.44
Female	32	35.56
Religion	Islam	100

Medicinal plant diversity used to treat musculoskeletal disorders

A total of N=46 plant species from N=32 families were identified and used to treat musculoskeletal problems (Table 2). Most of the enlisted species belonged to the family: Asteraceae (N=4, 9%), followed by Ranunculaceae, Polygonaceae, and Solanaceae families (N=3, 7% each), Berberidaceae, Lamiaceae, Geraniaceae, Plantaginaceae, and Liliaceae families (N=2, 4% each), while the remaining 24 families only contribute (N=1, 2% each). The relationship between species and families (Y= 0.024x + 1.848; R^2=0.085) can be seen in (Figure 2A). Table 2 contains information on the examined species, including botanical names, families, common names, life forms, parts used, preparation and administration methods, and diseases treated. The dominance of families was also analogous to research done in other Himalayan regions, where numerous studies noted that the main family was Asteraceae (Abdullah and Andrabi 2021; Altaf et al. 2021; Asif et al. 2021; Nafeesa et al. 2021). According to Haq et al. (2023a), Asteraceae family members adapt to arid, dry environments quickly and easily due to their vast ecological.

Among the total enlisted species (N=36) were identified as herbs, accounting for most of the life forms; it contributed to treating a maximum number of diseases (80%). Next, followed by shrubs (9%), trees (7%), and climbers (4%) (Figure 2B). The maximum usage of herbs can be attributed to the easy collection, traditional faith in ethnomedicine, and maximum familiarity from Pakistan, (Adnan et al. 2014; Haq et al. 2021; Khoja et al. 2022a,b,c) from Kashmir Himalayas revealed that the maximum usage of herbs is due to high amount of bioactive chemicals and stronger medical effects than other plants form.

Plant parts used in the preparation of Herbal recipes

The present study recorded different plant parts employed to treat various ailments. Leaf accounted for the majority of all plant parts (N=11, 26%), followed by root (N=10, 24%), tuber use (N=6, 14%), seed, whole plant (N=4, 10% each), aerial part use (N=3, 7%), fruit (N=2, 5%), bark use (N=1, 2%) and stem (N=1, 2% each) (Figure 3). Our results are in line with (Hassan et al. 2022; Khoja et al. 2022 a, b). In addition, the difference in plant part consumption could be due to differences in species variety and bioactive compounds found in different plant parts (Appiah 2019).

Therefore, different approaches are employed in producing and administering herbal medicines depending on the ailment being treated. The most popular and effective preparation techniques listed were decoction (35%), paste (28%), followed by infusion and oil (11% each), tea (6%), vegetable (7%), and powder (2%). (Figure 4). Our results of the most preferred method of preparation and utilization are consistent with comparable ethnobotanical studies abroad from District Mastung of Balochistan Province-Pakistan and Turkey (Gürdal and Kültür 2013; Bibi et al. 2014). Most herbal medications have a bitter flavor, so certain sweet components like honey and sugar are included when making the medications to lessen the bitterness (Ayyanar and Ignacimuthu 2011; Balangcod and Balangcod 2011). Most medicinal plants (*Saussurea costa, Geranium wallichianum, Aconogonon rumicifolium, Rumex nepalensis* are boiled in water. The obtained water is used for cooking rice. In the whole process, the usage of plants is maximum; however, in the case of *S. costa*, the usage of the part is very less; this less usage is due to the belief that maximum usage can cause paralysis (Khoja et al. 2022a,b,c). The total documented plant species from the study area were found to inhibit in different altitudes; the maximum species were reported from the area with an altitude ranging between 2,000-2,500 m followed by an altitude range of 1,501-2,000 m (Figure 4B, Table 2). Some of the plant preparations are mostly used to treat MSDs in the study area are shown in Figure 5. Figure 5A is the paste of *Trigonella foenum-graecum*, which is applied topically on fractured bone, Figure 5B describes the crushing of medicinal plants used to treat MSDs, as most of the medicinal plants are crushed before use. Cooking medicinal plants using the extract of *Rheum webbianum, G. wallichianum,* and *R. nepalensis* to Cook rice (Figure 5E). Then, which is taken later on along with vegetables or a non-vegetarian diet, dhesi ghee is mixed with rice while eating it.

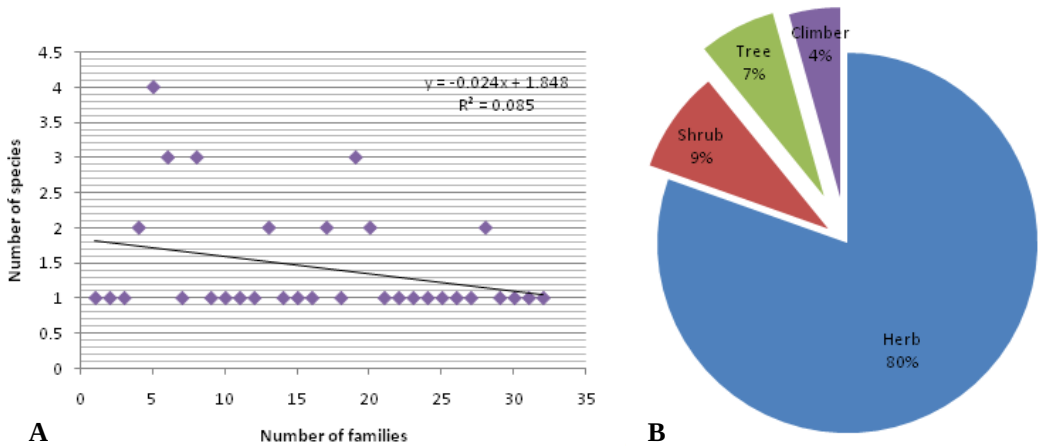

Figure 2. A. Contribution of various families to ethnomedicinal flora in the study area. B. Contribution of life forms in the study area

Table 2. Medicinal plants used to treat Musculoskeletal Disorders (MSDs) in the northern part of Kashmir Himalayas, India

Scientific name	Coll. code	Family	Common name	Part used	Life form	Altitudinal range	Preparation	Mode of administer.	Disease treated	∑U	UV	Ethnic groups		
												G	B	K
Abies pindrow (Royle ex D.Don) Royle	2965-KASH	Pinaceae	Bunder	Bark	Tree	2100-2800	Bark of the tree is boiled for a half hour to make tea	Internal	Rheumatic pain, inflammation	38	0.42	Y	Y	N
Aconitum heterophyllum Wall. ex Royle	4049-KASH	Ranunculaceae	Patris	Tuber	Herb	2500-3200	Dried tubers are soaked in water overnight to make an infusion	Oral	Back pain	42	0.47	Y	Y	Y
Aconitum violaceum Jacquem. ex Stapf	-	Ranunculaceae	Itees	Tuber	Herb	2500-3000	Bark of the tree is boiled for a half hour to make an infusion	Oral	Rheumatic pain	35	0.39	Y	Y	N
Aconogonon rumicifolium (Royel ex Bab.) Hara	7091-KASH	Polygonaceae	Safeed-abij	Roots	Herb	2900-3500	Roots are boiled in water and later cooked along with rice	Oral	Rheumatic pain, joint pain	60	0.67	Y	Y	Y
Actaea spicata var *acuminata* H.Hara	6242-KASH	Ranunculaceae	Hapat fal	Roots	Herb	2000-2500	Dried roots are boiled in water and taken upon cooling	Oral	Arthritis, joint pain	40	0.44	Y	N	N
Adiantum venustum D.Don	4104-KASH	Pteridaceae	Guewtheer	Whole plant	Herb	1500-2000	Whole frond is soaked in water and kept outside overnight	Oral	Muscular pain	35	0.39	N	Y	N
Aesculus indica Colebr. ex Wall	4111-KASH	Sapindaceae	Handoon	Fruits	Tree	2000-2500	Fruits are crushed to extract oil	External	Rheumatic pain	41	0.45	Y	Y	N
Ajuga parviflora Benth	4095-KASH	Lamiaceae	Jain-adam	Whole plant	Herb	1500-2000	Leaves are soaked in water overnight	External	Arthritis	46	0.51	N	Y	Y
Allium victorialis L.	3812-KASH	Amaryllidaceae	Jungle-rohan	Aerial part	Herb	2000-2500	Leaves are cooked as a vegetable	Oral	Joint pain	37	0.41	Y	Y	N
Amaranthus caudatus L.	6245-KASH	Amaranthaceae	Ganhar	Leaves, seeds	Herb	1000-2000	Leaves and seeds are cooked as a vegetable	Oral	Joint pain, back pain	46	0.51	N	N	Y
Artemisia absinthium L.	4020-KASH	Asteraceae	Tethwan	Aerial part	Herb	1500-2500	Dried leaves are crushed into a paste	External	Inflammation, bone fracture	53	0.59	Y	Y	Y
Aralia cachemirica Decne	4245-KASH	Araliaceae	Kutki	Roots	Herb	2000-2300	Roots are boiled in water to collect the extract, later used to cook rice	Oral	Rheumatic pain	30	0.33	Y	N	N
Atropa acuminate Royle ex Lindl.	4252-KASH	Solanaceae	Brand	Leaves	Herb	2000-2500	Paste of leaves is mixed with mustard oil	External	Rheumatic pain, muscular pain	36	0.40	N	Y	N
Berberis lyceum Royle	4102-KASH	Berberidaceae	Chockchrey	Roots	Shrub	1500-2000	Roots are crushed into powder and taken along with water	Oral	Arthritis, muscular pain	46	0.51	Y	Y	N
Berberis aristata DC.	6247-KASH	Berberidaceae	Sumbal	Roots	Shrub	1500-2000	Roots are crushed into powder and taken along with water	Oral	Joint pain, bone fracture	39	0.43	N	Y	Y
Bergenia ciliate (Haw.) Sternb.	4213-KASH	Saxifragaceae	Palfort	Roots	Herb	2500-3200	Dried roots are used to make tea	Oral	Joint pain, bone fracture	56	0.62	Y	Y	Y
Cascuta reflexa Roxb.	4082-KASH	Convolvulaceae	Kukliport	Whole plant	Climber	1500-2000	Whole plant is crushed into a paste along with dhesi ghee	External	Joint pain, inflammation	29	0.32	Y	N	Y

Capsella bursa pastoris L.	4250-KASH	Brassicaceae	Kralmond	Leaves	Herb	1000-2000	Leaves are crushed into a paste and mixed with mustard oil	External	Inflammation, muscular pain	41	0.45	Y	N	Y
Cynoglossum nervosum Benth.	7109-KASH	Boraginaceae	Richola	Roots	Herb	2000-2200	Roots are boiled in water, and the extract is used for cooking rice	External	bone fracture	48	0.53	Y	Y	N
Cichorium intybus Linn.	4222-KASH	Asteraceae	Hand	Leaves	Herb	1000-2000	Dried leaves are boiled and crushed into a paste and then fried	External	Inflammation, bone fracture	65	0.72	Y	Y	Y
Colchicum luteum Baker	6251-KASH	Colchicaceae	Virkumpoash	Tuber	Herb	2000-2800	Dried tubers are crushed into powder and mixed with mustard oil	External	Joint pain	42	0.46	Y	Y	N
Cynodon dactylon (Linn)	7101-KASH	Poaceae	Druab	Whole plant	Herb	1000-2000	Whole plant is crushed into a paste	External	Muscular pain, inflammation	34	0.38	N	Y	Y
Datura stramonium L.	4085-KASH	Solanaceae	Datur	Leaves	Herb	1000-1500	Leaves are crushed into a paste along with water	External	Inflammation	37	0.41	Y	Y	N
Dioscorea deltoidea Wall. ex Griseb.	6237-KASH	Dioscoreaceae	Shingle-mingle	Roots	Climber	1500-2000	Roots are boiled in water	Oral	Joint pain	43	0.48	Y	Y	N
Fragaria nubicola Lindl. ex Lacaita	4087-KASH	Rosaceae	Ringrish	Roots	Herb	1500-2300	Dried roots are boiled for a half hour to make tea	Oral	Joint pain	48	0.53	Y	Y	Y
Fritillaria roylei Hook.	-	Liliaceae	Sheetkhar	Tuber	Herb	3000-.3500	Dried tubers are crushed into powder and taken along with water	Oral	Joint pain, arthritis	64	0.71	Y	Y	Y
Geranium wallichianum D.Don ex Sweet	4112-KASH	Geraniaceae	Ratanjog	Roots	Herb	1500-2500	Dried roots are boiled in water, and the extract is used for cooking rice	Oral	Arthritis, back pain, joint pain	66	0.73	Y	Y	Y
Geranium pretense L.	4098-KASH	Geraniaceae	Ratanjog	Roots	Herb	2000-3000	Dried roots are boiled in water, and the extract is used for cooking rice	Oral	Joint pain, back pain	57	0.63	Y	Y	N
Hypericum perforatum L.	4089-KASH	Hypericaceae	Chai-kul	Roots	Herb	1000-1500	Roots are boiled in the water	Oral	Joint pain	41	0.45	N	N	Y
Hyoscyamus niger L.	4107-KASH	Solanaceae	bazarbang	Leaves	Herb	2000-2300	Leaves are crushed into a paste and mixed with mustard oil	External	Inflammation, joint pain	38	0.42	N	Y	N
Juglans regia L.	-	Juglandaceae	Doon	Seeds	Tree	1000-2300	Seeds are crushed to extract oil	External	Arthritis, joint pain	49	0.54	Y	N	Y
Lilium polyphyllum D.Don	6236-KASH	Liliaceae	Pland	Tuber	Herb	2000-2300	Dried tubers are boiled in water, and the extract collected is used to make rice	Oral	Joint pain	37	0.41	Y	Y	N
Parrotiopsis jacquemontiana (Decne.) Rehder.	6258-KASH	Hamamelidaceae	Poah	Stem	Shrub	1500-2300	A dried stem is put in the utensil, and a small hole is made at the bottom. Another utensil is placed under and buried in the soil. Then a fire is burnt outside to collect the oil	External	Joint pain, arthritis	31	0.34	Y	N	N

Phytolacca acinosa Roxb.	4253-KASH	Phytolaccaceae	Hapat brand	Leaves	Herb	1500-2000	Leaves are boiled in water and dried, later cooked as a vegetable	Internal	Joint pain	26	0.28	Y	Y	N
Plantago lanceolata L.	6249-KASH	Plantaginaceae	Gull	Seeds	Herb	1000-2000	Seeds are crushed to collect oil	External	Joint pain, inflammation	34	0.38	N	Y	Y
Plantago major L.	4118-KASH	Plantaginaceae	Boad gull	Seeds	Herb	1000-2000	Seeds are crushed to collect oil	External	Inflammation, muscular pain	46	0.51	Y	N	Y
Polygonatum cirrhifolium (Wall.) Royle	4229-KASH	Asparagaceae	Salapmesri	Tuber	Herb	1500-2000	Tubers are crushed into powder and taken along with water	Oral	Rheumatic pain	35	0.39	Y	N	Y
Rhododendron arboreum Sm.	7097-KASH	Ericaceae	Rantola	Leaves	Shrub	3000-3400	Leaves are boiled in water	Oral	Rheumatic pain	31	0.34	N	Y	N
Rheum webbianum Royle	4212-KASH	Polygonaceae	Pambchalan	Roots	Herb	2800-3200	Roots are boiled in water, and the extract collected is used for cooking rice	Oral	Back pain, joint pain	58	0.64	Y	Y	Y
Rumex nepalensis Spreng.	6261-KASH	Polygonaceae	Abij	Roots	Herb	1000-2500	Roots are boiled in water, and the extract collected is used for cooking rice	Oral	Joint pain, arthritis, bone fracture	60	0.67	Y	Y	Y
Saussurea costa (Falc.) Lipsch.	4211-KASH	Asteraceae	Kouth	Roots	Herb	2800-3300	Roots are boiled in water, and the extract collected is used for cooking rice	Oral	Joint pain, bone fracture	63	0.70	Y	Y	Y
Stellaria media (L.) Vill.	4249-KASH	Caryophyllaceae	Nick-haakh	Aerial part	Herb	1000-1500	The aerial part is crushed into a paste	External	Bone fracture, rheumatic pain	41	0.46	Y	N	N
Taraxacum officinales (L.) Weber ex F.H.Wigg	6259-KASH	Asteraceae	Heand	Leaves	Herb	1000-2000	Dried leaves are boiled and crushed into a paste and then fried.	External	Joint pain, bone fracture, rheumatic pain	62	0.69	Y	Y	Y
Trigonella foenum-graecum L.	4248-KASH	Lamiaceae	Meath	Seeds	Herb	1000-1500	Dried seeds are roasted and then crushed into powder and mixed with egg white, and applied	External	Bone fracture, joint pain, inflammation	59	0.66	Y	N	Y
Urtica dioica L.	4219-KASH	Urtiaceae	Soi	Roots	Herb	1000-3000	Roots are boiled in the water, and the extract is used for cooking rice	Oral	Arthritis, joint pain	46	0.51	Y	Y	Y
Verbascum thapsus L.	4242-KASH	Scrophulariaceae	Badur-tond	Leaves	Herb	1000-2800	Leaves are boiled, and water and the extract are used for cooking rice	Oral	Rheumatic pain	39	0.43	Y	Y	N

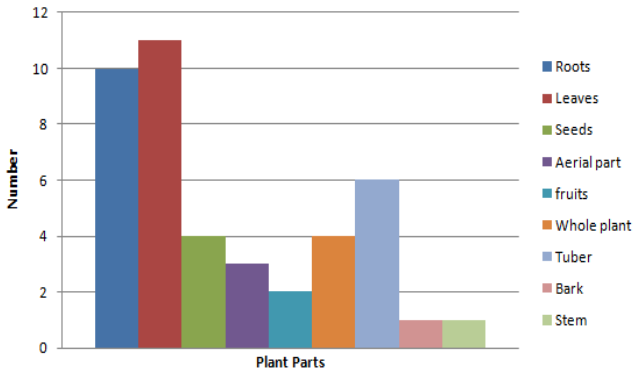

Figure 3. Contribution of plant parts used to treat musculoskeletal diseases

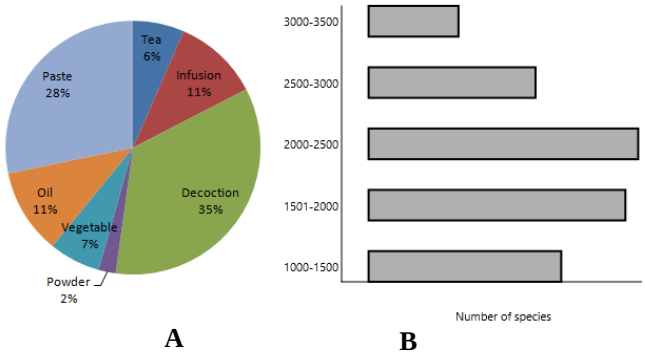

Figure 4. A. Modes of preparation of medicinal plants in the study area. B. Altitude level of the documented species

Use Value (UV)

The value (UV) reveals the significance of the plant species to the informants and the traditional medicinal system in the region. In the present study, UV ranged between 0.28 to 0.73. The species with the maximum UV was *G. wallichianum* (0.73), and the lowest UV was *Phytolacca acinosa* (0.28). The highest UV values of *G. wallichianum* are due to its widespread distribution and the fact that the local population is well aware of its therapeutic applications (Khoja et al. 2022a,b,c). Additionally, it's simple to use, and a wide range of medicinal benefits are some other reasons for maximum UV. The complete inventory of UV is presented in Table 2. For example, the low UV of *P. acinosa* may be caused by a lack of awareness about its medicinal applications and availability in other study areas. Also, the fact that it is toxic and has serious adverse effects. The leaves of *P. acinosa* must first be dried, then boiled, and finally dried once more and kept for 2-4 months before being eaten as a vegetable.

Family Use Value (FUV)

The most ethnobotanically significant plant family in any given region is represented by Family Usage Value (FUV). Table 3 enlists the usage values of the families represented by more than one plant Taxon. The highest FUV was observed for Geraniaceae (0.68), followed by Asteraceae (0.67), Polygonaceae (0.67), Solanaceae (0.61), and Ranunculaceae (0.43). Many significant informants also highlighted these taxa because of their high importance in folkloric medicine. Similar results were reported by (Nadaf et al. 2019; Khoja et al. 2022a,b,c).

Quantitative ethnomedicinal analysis

Based on the informants' information, we categorized the different diseases into seven categories by following the international classification of primary care with certain modifications. Joint pain was treated with most species (N=26), followed by bone and rheumatic pain and inflammation (N=14, 14% each), arthritis and bone fracture (N=10 each), back pain (N=5), and muscular pain (N=5) (Fig. 6). Similar results were reported by (Asif et al. 2021) from Kashmir Himalayas. According to numerous research completed in the past (Haq et al. 2020, Haq et al. 2021), topical application is a significant way of herbal medicine administration used in the treatment of various external ailments, including MSDs diseases.

The ICF demonstrates the ascension among informants on using plants for a particular disease category, highlighting taxa that can potentially treat a specific disease. In the current study, we grouped all documented diseases into seven categories, presented in Table 4. The ICF values ranged from 0.33 to 0.45. The highest value of ICF was recorded for inflammation (0.45), followed by Muscular pain (0.43), arthritis (0.40), joint pain (0.38), bone fracture (0.36), and rheumatic pain (0.35). In addition, the lowest ICF values were recorded for back pain (0.33) (Table 4).

Cross-cultural usage

The present study evaluated the use of documented species across three ethnic communities (Gujjar, Bakarwal, and Kashmiri). The cross-cultural analysis showed that all commonly used 13 (*R. nepalensis, Bergenia ciliata, Fritillaria roylei, Artemisia absinthium, A. rumicifolium, Aconitum heterophyllum, Fragaria nubicola, Taraxcum officinale, Cichorium intybus, Urtica dioica, G. wallichianum, Saussurea costus*, and *R. webbianum*) were commonly used by all said ethnic groups (Figure 7, Table 2). This common usage was due to a wide distribution in all valley areas. Also, the faith of local people in traditional medicinal systems uses various species of flora to treat health disorders (Figure 6). A total of four species (*Actaea spicata* var *acuminata, Stellaria media, Parrotiopsis jacquemontiana,* and *Aralia cachemirica*) were idiosyncratic to Gujjar, four species (*Atropa acuminata, Rhododendron arboreum, Hyoscyamus niger,* and *Adiantum venustum*) to Bakarwal and two species (*Hypericum perforatum* and *Amaranthus caudatus*) to Kashmiri (Figure 7, Table 2). The highest number of characteristic species for Gujjar and Bakarwal is because both communities are less urbanized and mostly depend upon natural resources and traditional medicinal systems. The said communities lack health facilities; both communities are backward, listed by Govt of India.

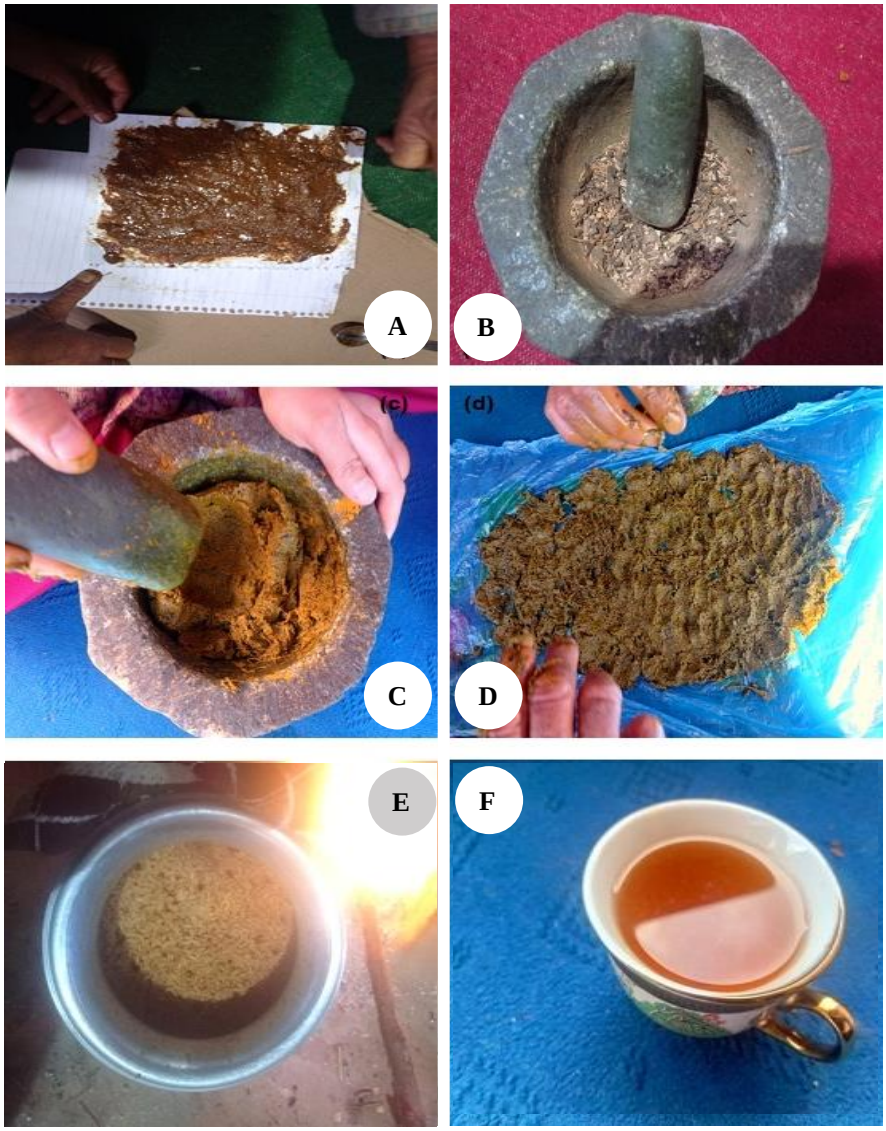

Figure 5. A. Paste of *Trigonella foenum-graecum*, B. The crushing of medicinal plants, C. Paste of *Taraxacum officinales*, D. Paste of *Cichorium intybus*, E. Extract of *Rheum webbianum, Geranium wallichianum, Rumex nepalensis* Cooked along with rice, F. Tea of *Bergenia ciliate*

Table 3. Family use value (FUV) of the documented species in the study area

Family	Taxon	Total use reports (URs)	Use value (UV)	Family use value (FUV)
Ranunculaceae	*Aconitum heterophyllum* Wall. ex Royle, *Aconitum violaceum* Jacquem. ex Stapf, *Actaea spicata* var *acuminata* H.Hara	117	1.30	0.43
Polygonaceae	*Aconogonon rumicifolium* (Royle ex Bab.) Hara, *Rheum webbianum* Royle, *Rumex nepalensis* Spreng.	178	1.98	0.66
Lamiaceae	*Ajuga parviflora* Benth, *Trigonella foenum-graecum* L.	105	1.17	0.58
Asteraceae	*Artemisia absinthium* L., *Cichorium intybus* Linn., *Saussurea costa* (Falc.) Lipsch., *Taraxacum officinales* (L.) Weber ex F.H.Wigg,	243	2.70	0.67
Solanaceae	*Atropa acuminate* Royle ex Lindl., *Datura stramonium* L., *Hyoscyamus niger* L.	111	1.23	0.61
Berberidaceae	*Berberis aristata* DC., *Berberis lyceum* Royle	85	0.94	0.47
Liliaceae	*Fritillaria roylei* Hook., *Lilium polyphyllum* D.Don	101	1.12	0.56
Geraniaceae	*Geranium wallichianum* D.Don ex Sweet, *Geranium pretense* L.	123	1.36	0.68
Plantaginaceae	*Plantago lanceolata* L., *Plantago major* L.	80	0.89	0.44

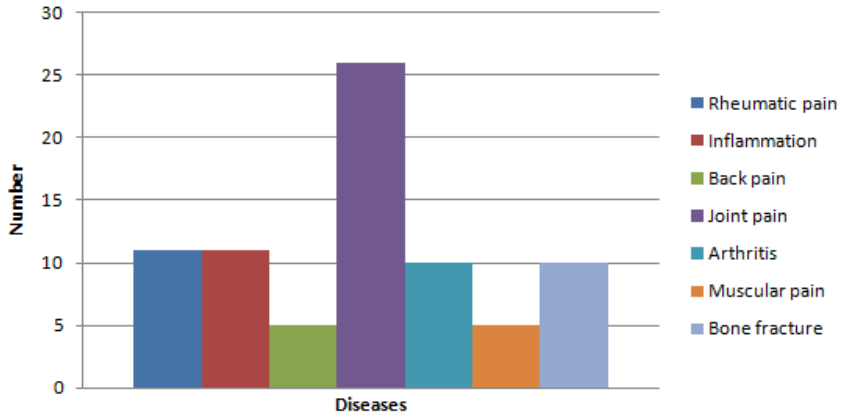

Figure 6. Plants used for the treatment of various disorders in the district of Kupwara, India

Table 4. Recorded ICF for musculoskeletal disorders in the Northern part of Kashmir Himalayas

Disease categories	No. of plant species used (nt)	Use citations (nur)	ICF
Rheumatic pain	11	318	0.35
Inflammation	11	247	0.45
Back pain	5	149	0.33
Joint pain	26	682	0.38
Arthritis	10	253	0.40
Muscular pain	5	117	0.43
Bone fracture	10	280	0.36

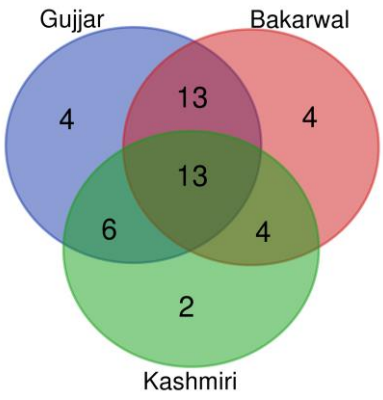

Figure 7. Venn diagram showing the cross-cultural uses of species

While evaluating the similarity between the ethnic groups (Figure 7), In between three groups, maximum homogeneity was between Gujjar and Bakarwal ethnic groups (13 species), followed by Gujjar and Kashmiri (6 species) and Bakarwal and Kashmiri (4 species). And have same activities: graze their animals in pastures, engage in extensive transhumance pastoralism, and travel through various ecological landscapes, gaining sufficient experience with certain plants and retaining more knowledge. In addition, the Bakarwal and Gujjars raise animals and have extensive traditional ecological knowledge of natural resources. They are particularly closely connected to nature due to their greater economic disadvantage and reliance on medicinal plants. The Bakarwal and Kashmiri ethnic groups show an overlap in-plant use. The dissimilarity in medicinal plants in terms of use reports may indicate certain sociocultural gaps. This has prevented the sharing of traditional knowledge among the respective ethnic groups, especially since they do not intermarry (even though they share the same faith). This study found that Gujjar and Bakarwal were more similar in species use; we listed 13 common species for ethnic uses. That includes (*Aesculus indica*, *Colchicum luteum*, *Geranium pretense*, *Datura stramonium*, *Berberis lycium*, *Cynoglossum nervosum*, *P. acinosa*, *Verbascum thapsus*, *Dioscorea deltoids*, *Lilium polyphyllum*, *Allium victorialis*, *Aconitum violaceum*, and *Abies pindrow*). In comparison, the least similarity was found between Bakarwal and Kashmiri, with only four species (*Plantago lanceolata*, *Cynodon dactylon*, *Berberis aristata*, and *Ajuga parviflora*) common. The maximum similarity between Gujjar and Bakarwal is because both communities are associated with the same livelihood and are exogamous to each other. Furthermore, one of the important deciding factors, i.e., Religion, is also the same between both groups, which has an important role in the selection of the species for various purposes in today's life (Table 1). The last similarity between Bakarwal and Kashmiri can be ascribed to communities having socioeconomic, language, and geographic (Table 1) and reported the similarity of Gujjar and Bakarwal on the plant usage from Jammu and Kashmir. The decreased traditional knowledge in the Kashmiri ethnic group is due to less knowledge, economic and social transition, and they feel inferior in using traditional medicine.

In conclusion, the study reveals that the high-altitude areas of the Northwestern Himalayas have traditional repositories directly produced from nature, having the potential to treat bone-related disorders. Local people have developed a potent relationship with nature via generations and have developed vital assets of knowledge, which is very important to present in the scientific domain due to the ongoing cultural encroachments across the globe. Furthermore, the said knowledge can be used to elucidate some novel compounds with potent medicinal attribution. At the same time, the obtained knowledge can be verified

by employing the scientific approach; hence can be proven more beneficial by regulating the basic criteria like dosage and lethality. The present study further reveals the association of cultures with nature, disclosing that Gujjar and Bakarwal are more associated with natural resources than Kashmiri. Therefore, our study will further help the locals to cherish their natural wealth.

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