

Traditional plant-based medicines used to treat musculoskeletal disorders in district North Waziristan, Khyber Pakhtunkhwa, Pakistan

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Abstract

Background

This paper provides noteworthy information about the use of therapeutic plants for treating musculoskeletal disorders in a district, in North Waziristan, Pakistan. This survey aimed to document information regarding indigenous uses of plants in basic healthcare practices among rural people in regions, which may guide natural drug discovery and development.

Objective

The present study aims to document indigenous knowledge regarding medicinal plants used against musculoskeletal disorders in North Waziristan.

Methods

In total, 130 informants were interviewed using group discussions and semi-structured interviews. Documented ethnomedicinal data was analyzed using quantitative indices of relative frequency of citation (RFC), used value (UV) and fidelity level (FL).

Results

During the present study a total of 60 plant species belonging to 39 plant families were reported with their medicinal usage to treat musculoskeletal disorders. The most dominant growth form were herbs (56.67%), decoction was preferred method of utilization (32.31%) and leaves were the most used plant part (21.88%). The highest used category was recorded for rheumatism (26 spp.). The highest use value was reported for *Bergenia ciliata* (0.87).

Conclusion

This study provides important information about therapeutic plants practice for musculoskeletal disorders among local communities of North Waziristan, Pakistan. The baseline findings of this study might be valuable in compiling information for future pharmacological and phytochemical screening of plant species leading to natural drug discovery and development.

Introduction

Musculoskeletal diseases are non-communicable disorders and they are rapidly increasing throughout developed and developing countries [1]. These illnesses affect more than 1.7 billion people throughout the world and are a leading cause of death and disability [2]. According to the recent report of the World Health Organization (WHO), Musculoskeletal disorders, such as arthritis, back and neck pain, osteoarthritis, and bone fracture, are the second most cause of disability worldwide [3]. These diseases do not only occur among the old people, but also hit youth people because they work hard all over life. About 20–30% of the people worldwide have experienced painful and disabling muscular-skeleton illnesses [4]. In the USA, one of two adults has suffered from such disorders [3]. In addition, Musculoskeletal disorders (MSDs) are one of the most common cause of severe long-term pains and disabilities, leading to significant healthcare and social role performance [5]. In addition, MSDs can cause limited mobility, and skill, can lead to the loss of job and reduced capability in social roles [3]. In Asia, every country has a high prevalence of arthritis, but China and India are particularly affected [6]. The most important MSDs, such as neck and back pain, rheumatoid arthritis, osteoarthritis and bone fracture. These illnesses significantly harm healthy aging by lowering mental, physical and functional abilities [7]. Furthermore, these illnesses are the most frequent health issues accomplished by workers in developed countries [8].

The use of medicinal plants by indigenous communities to treat various disorders is a practice that has been passed down through many generations of human evolution [9]. Roughly 85% of the global population residing in developing countries relies solely on traditional medicinal plants for their healthcare needs [10, 11]. Ethnic communities residing in proximity to forested regions depend on the collection of medicinal plants from the wild for their primary healthcare. Traditional medicine is an uncoded healthcare system that plays a crucial role in the healthcare of individuals living in remote areas [12]. The traditional knowledge of using medicinal plants is passed down from one generation to the next within local communities [13]. In countries such as India and Pakistan, approximately 75% of the population still relies on traditional indigenous medicine for the treatment of their daily ailments [14]. Local people from various parts of the globe have used a number of therapeutic plant species to treat various diseases, including rheumatism, muscular pain, broken bones, etc., studies in Pakistan [4], and Turkey [15] listed 142 plants, which were traditionally used to treat MSDs, mostly rheumatism. Nonetheless, due to modernization and rapid lifestyle changes, this invaluable knowledge is vanishing from societies [16]. To the best of our knowledge, the current investigation about the use of therapeutic plants to treat Musculoskeletal disorders (MSDs) is the first report from district North Waziristan. The study was planned with the objective to document the indigenous knowledge about medicinal plants used against Musculoskeletal disorders (MSDs).

Materials and Methods

Study area description:

District North Waziristan, Pakistan, is the hilly region that lies between 32° 35' and 33° 20' north latitudes and 69° 25' and 70° 40' east longitude with an altitude of 2143 to 7717 feet. North Waziristan is bounded on the south by district South Waziristan, on the North by District Kurram, District Hangu, and

Afghanistan, on the east by District Bannu, and on the west also by Afghanistan (Fig. 1). The area is irrigated by 3 rivers namely, Tochi, Kurram, and Katu rivers. The annual rainfall is 45cm. The area of North Waziristan under forests is 475000 acres. North Waziristan area contains 4,707 square kilometers (1,817 sq mi). Wazir and Dawar are the major tribes in the research area. Pashto is the major language.

Medicinal plants collection

The ethno medicinal survey was carried out in the Tribal District, North Waziristan from April 2018 to October 2020 to document medicinal plants. Field interviews were conducted from indigenous people including herbalist, professional, shepherd, old age people, Hakeems, and farmer. Many of them were over 60 years old (46.92%), 51–60 years old (40.00%), and 35–50 years (13.08%). A total of 130 local informants were interviewed belonging to different age groups. The data were recorded from local respondents by using semi-structured questionnaires as well as through face to face interviews. During the survey age, gender, education, occupation, vernacular names, family name, growth form, folk uses, use parts, mode of preparation, mode of application and route of administration were documented from the local people of the study area.

Identification and Preservation of Plants

The collected specimens were pressed, dried, poisoned with (1% HgCl_2 solution), and were mounted on standard herbarium sheets. The plants specimens were identified by (Prof. Dr. Rahmatullah Qureshi), and confirmed by using published literature [17]. A voucher number was assigned to all individual species and the specimens were submitted at the herbarium of Hazara University (HU), Mansehra, Dhudial for future references.

Quantitative data analysis

Indigenous knowledge is quantitatively analyzed using different quantitative indices such as Relative Frequency of Citation (RFC), Use Reports (URs), Use Value (UV), and Fidelity Level (FL %).

Fidelity Level (FL %)

Fidelity level (FL) was the percentage of informers who documented the uses of specific plant species to cure a particular disease in the research area. The Fidelity level (FL) was calculated using the following formula [18].

$$\text{FL (\%)} = N_p / N * 100$$

Where N_p is the number of informants that reported a particular use of a plant species to treat a specific disease, where N is the number of informants that use the same plants to cure any given disease.

Relative Frequency of Citation (RFC):

The RFC value for indigenous therapeutic plants is based on the number of informants for each plant species. Relative frequency of citation (RFC) is obtained by dividing a frequency of citation (FC) by the total number of informants in the survey (N). RFC was calculated by using the formula [19].

$$\text{RFC} = \frac{\text{FC}}{N} \quad (0 < \text{RFC} < 1)$$

FC = Frequency of citation

N = Total number of informants taking part in the survey ($N = 130$).

Use Value (UV):

Use value (UV) of a species was carried out by using the following formula [20].

$$\text{UV} = \frac{u}{n}$$

U = Number of use reports documented by the informants for a given medicinal plant.

n = Total number of informants interviewed for a specific medicinal plant.

Results and Discussion

Demographic data of informants

In the present study a total of 130 informants were interviewed (Table 1). Female informants (19.23%) were less in number compared to males (80.77%) because the study area is tribal and there are restrictions on tradition and culture. Most of the informants were 61–75 years (40%), followed by 46–60 years (30.77%), and above 75 years (20%). The vast majority of respondents were herbalists (55.38%), followed by professionals (26.92%) and shepherds (17.69%). It was noted that herbal medicinal plants were practiced only 60% in rural areas and 40% in urban areas. Most of the informants were illiterate (41.54%), followed by primary level (25.38%).

Table 1
Demographic information of the informants.

Variable	Categories	No. of Informants N = 130	Percentage (%)
Gender	Male	105	80.77
	Female	25	19.23
Age	30–45	12	9.23
	46–60	40	30.77
	61–75	52	40
	Above 75	26	20
Occupation	Herbalists	72	55.38
	Shepherds	23	17.69
	Professionals	35	26.92
Residence	Rural	78	60.00
	Urban	52	40.00
Education qualification	Illiterate	54	41.54
	Primary level	33	25.38
	Middle level	17	13.08
	Secondary level	10	7.69
	Undergraduate level	9	6.92
	Graduate level	7	5.38

Medicinal plant diversity uses to treat musculoskeletal disorders

In total of 60 plant species belonging to 39 plant families were documented for the treatment of musculoskeletal disorders in North Waziristan, Pakistan (Table 2). Out of these 34 plant species were herbs (56.67%) followed by 17 species of shrubs (28.33%), 8 species of trees (13.33%) and 1 species of sedges (1.67%) (Fig. 2). The herbs are not only dominant in this study but it frequently widespread ecological phenomena all over the globe. The most dominating reported family was Asteraceae (7 species), followed by Solanaceae (4 species), Amaranthaceae, Brassicaceae, Fabaceae, and Zygophyllaceae (3 species) each, Apiaceae, Lamiaceae, Mimosaceae, Plantaginaceae (2 species) each, while the remaining families contribute only 1 species (Fig. 3).

Table 2
Medicinal plants with vernacular and family name, voucher no., growth form, part used, preparation mode, FC, RFC, UV, URs and FL.

Scientific Name/Voucher No.	Local Name	Family	Growth form	Part used	Preparation mode	Recipes	Diseases cured	FC	RFC	UV	URs
<i>Acacia modesta</i> Wall. SR-13196	Palusa	Mimosaceae	Tree	Gum	Paste	The dried gum is crush, mix with egg yolk to make bandage for bones fracture	Bone fracture	37	0.28	0.70	26
<i>Acacia nilotica</i> (L.) Delile. SR-13448	Kekar	Mimosaceae	Tree	Gum	Poultice	The cooked gum is grind and apply	Body pain	35	0.27	0.49	17
<i>Achyranthes aspera</i> L. SR-13311	Phutkanda	Amaranthaceae	Herb	Leaves	Juice	The juice of the herb is given in rheumatism.	Rheumatism	39	0.30	0.74	29
<i>Ajuga brateosa</i> Wall. SR-13425	Varekai boti	Lamiaceae	Herb	Whole plant	Decoction	The herb decoction is given before breakfast for one week	Rheumatism, Body pain	35	0.27	0.60	21
<i>Alhagi maurorum</i> (Camb.) Jaub. SR-13433	Toonda	Fabaceae	Shrub	Whole plant	Juice, decoction, herbal tea	The plant juice is given 2 cups daily	Rheumatism, Backache, muscular pain	21	0.16	0.52	11
<i>Aloe vera</i> L. SR-13472	Zageya	Asphodelaceae	Shrub	Leaves	Powder, paste	The powder of 2 spoons are taken for treatment	Rheumatism, Muscle pain, Broken bone	27	0.21	0.56	15
<i>Amaranthus viridis</i> L. SR-13341	Surmi	Amaranthaceae	Herb	Aerial parts	Decoction	The decoction of 2 cups a daily is given one time a day for 3–4 days	Joint pain, backache	23	0.18	0.61	14
<i>Anagallis arvensis</i> L. SR-13361	Pesho boti	Primulaceae	Herb	Whole plant	Paste	The paste make from the fresh plant materials is applied on affected area to avoid pain.	Rheumatism, joint pain, knee pain	29	0.22	0.55	16
<i>Arisaema flavum</i> (Forsk.) Schott. SR-13268	Mangor boti	Araceae	Herb	Rhizome	Paste	The rhizome paste is applied on affected area for treatment	Crack bone, swellings	31	0.24	0.55	17
<i>Artemisia martima</i> L. SR-13264	Khezbe	Asteraceae	Shrub	Leaves	Decoction	The leaves decoction is used twice a day one cup	Rheumatism	37	0.28	0.62	23
<i>Berberis lycium</i> Royle. SR-13444	Turkha	Berberidaceae	Shrub	Roots, branches	Powder	The roots powder are used for pain	Body pain	44	0.34	0.86	38
<i>Boerhavia diffusa</i> L. SR-13373	Prata betai	Nyctaginaceae	Herb	Whole plant	Paste	The paste make from 6-7g plant and is applied for treatment	Rheumatism, swelling in joints, pain in bones	24	0.18	0.63	15
<i>Bergenia ciliata</i> (Haw.) Sternb. SR-13480	Zakhme khyat	Saxifragaceae	Herb	Rhizome	Herbal tea, decoction	The herbal tea obtained from the dried rhizome is used to relief	Muscular pain, body pain	47	0.36	0.87	41

Scientific Name/Voucher No.	Local Name	Family	Growth form	Part used	Preparation mode	Recipes	Diseases cured	FC	RFC	UV	URS
<i>Brassica nigra</i> L. (Koch). SR-13564	Toor boti	Brassicaceae	Herb	Seeds	Paste, oil	The seed oil is used for mulish to cure	Rheumatism, muscle pain	21	0.16	0.52	11
<i>Cannabis sativa</i> L. SR-13324	Bhanga	Cannabaceae	Herb	Leaves	Herbal tea	8–10 leaves are boiled in 3–4 cups of water. This tea is used to treat	Joint pain, arthritis, backache	20	0.15	0.55	11
<i>Capparis spinosa</i> L. SR-13177	Sre dane	Capparadaceae	Tree	Whole plant	Decoction	Decoction of plant (1 cup) is taken twice a day and is used as a remedy for	Rheumatism	33	0.25	0.48	16
<i>Chenopodium ambrosioides</i> L. SR-13531	Surme	Amaranthaceae	Herb	Roots	Decoction	The crushed roots are boiled in water and add some sugar	Rheumatism	19	0.15	0.42	8
<i>Carthamus tinctorius</i> L. SR-13498	Zergulai	Asteraceae	Herb	Seeds	Oil	The seeds oil is used to cure	Rheumatism	17	0.13	0.41	7
<i>Cichorium intybus</i> L. SR-13334	Ghut khatakai	Asteraceae	Herb	Whole plant	Decoction	The whole plant decoction is used for	Body swelling, joint swelling, joint pain	32	0.25	0.63	20
<i>Cordia myxa</i> L. SR-13476	Lawsera	Boraginaceae	Tree	Fruit	Pulp	The fruit pulp (3 spoons) is orally taken 2 times a day to cure joint pain and has anti-inflammatory property.	Joint pain, anti-inflammatory	40	0.31	0.80	32
<i>Coriandrum sativum</i> L. SR-13468	Dhania	Apiaceae	Herb	Fruit	Infusions	The fruit infusions are used with almonds powder to treat	Rheumatism	25	0.19	0.52	13
<i>Curcuma longa</i> L. SR-13539		Zingiberaceae	Herb	Roots	Paste	The paste is obtained from the crushed roots is used for cure	Joint pain, backache	29	0.22	0.52	15
<i>Cyperus rotendus</i> L. SR-13296	Delgai	Cyperaceae	Sedge	Bulb	Paste	The rhizome paste is applied on affected area to cure	Joint pain, muscle wound	26	0.20	0.42	11
<i>Dalbergia sissoo</i> Roxb. Ex Dc. SR-13540	Tali	Fabaceae	Tree	Bark, roots	Decoction	Decoction of bark and roots is taken twice a day to treat	Joint pain	25	0.19	0.68	17
<i>Daphne mucronata</i> Royle. SR-13440	Sre dane	Thymelaeaceae	Shrub	Aerial parts	Decoction	Decoction of aerial parts is taken twice a day to cure	Rheumatism	34	0.26	0.53	18
<i>Datura stramonium</i> L. SR-13376	Berbaka	Solanaceae	Shrub	Leaves	Paste	Paste of the leaves is topically applied on swelling portion to cure	Swelling of limbs	45	0.35	0.84	38

Scientific Name/Voucher No.	Local Name	Family	Growth form	Part used	Preparation mode	Recipes	Diseases cured	FC	RFC	UV	URS
<i>Dodonaea viscosa</i> (L.) Jacq. SR-13269	Sanatha	Sapindaceae	Shrub	Leaves	Powder	The leaves powder is taken with water twice a day.	Rheumatism	26	0.20	0.46	12
<i>Echinops echinatus</i> Roxb. SR-13541	Azghe	Asteraceae	Herb	Roots	Decoction	Decoction of roots is used for treatment	Joint pain	25	0.19	0.56	14
<i>Elaeagnus hortensis</i> M. Bieb. SR-13313	Sunzala	Elaeagnaceae	Tree	Bark	Powder	The bark powder (one tablespoon) is added to milk (1 glass) and is orally taken thrice a day as a remedy for treatment	Joint pain, rheumatoid arthritis	25	0.19	0.68	17
<i>Euphorbia hirta</i> L. SR-13538	Terkvanai	Asteraceae	Shrub	Whole plant	Juice	The juice of the whole plant is used for lower back pain.	Lower back pain	27	0.21	0.48	13
<i>Ephedra procera</i> Fish. & C. A. Mey. SR-13444	Mova	Ephedraceae	Shrub	Aerial parts	Decoction	Decoction of the aerial part is used to cure	Rheumatism	42	0.32	0.81	34
<i>Fagonia cretica</i> L. SR-13204	Speleghzai	Zygophyllaceae	Shrub	Aerial parts	Decoction	Decoction of the aerial part is taken orally 1 teaspoon twice a day	Swelling of body	31	0.24	0.52	16
<i>Geranium willianum</i> D. Don ex Sweet. SR-13389	Varekai boti	Geraniaceae	Herb	Roots	Decoction	Decoction of roots is taken twice a day for treatment	Rheumatism	26	0.20	0.50	13
<i>Juglans regia</i> L. SR-13457	Matak	Junglandaceae	Tree	Fruit	Oil	The fruit yield oil is used to reduce pain	Rheumatism	29	0.22	0.52	15
<i>Justicia adhatoda</i> L. SR-13233	Bikar	Acanthaceae	Shrub	Leaves	Powder	Powder of leaves is taken orally 3 teaspoons with milk to cure	Rheumatism, body pain	43	0.33	0.84	36
<i>Lepidium didymium</i> L. SR-13320	Salad	Brassicaceae	Herb	Whole plant	Poultice	The poultice of the whole plant is topically applied	Joint pain, muscle cramps	27	0.21	0.56	15
<i>Lepidium sativum</i> L. SR-13320	Beian boti	Brassicaceae	Herb	Seeds	Juice	The seed juice is used daily in early morning	Joint pain	29	0.22	0.55	16
<i>Malvastrum coromandelianum</i> (L.) Garcke. SR-13449	Chechan boti	Malvaceae	Herb	Rhizome	Powder	Rhizome powder (3-4g) is added in 2 cups of water is used for relief of muscular pain.	Muscle pain	30	0.23	0.70	21
<i>Mentha longifolia</i> L. SR-13283	velanai	Lamiaceae	Herb	Leaves	Powder	The dried leaves powder is given for treatment	Rheumatism	34	0.26	0.62	21

Scientific Name/Voucher No.	Local Name	Family	Growth form	Part used	Preparation mode	Recipes	Diseases cured	FC	RFC	UV	URS
<i>Opuntia ficus-indica</i> (L.) Mill. SR-13481	Sapare gul	Cactaceae	Shrub	Fruits	Raw	Fruit is taken daily for	Muscle pain, joint inflammation	38	0.29	0.61	23
<i>Parkinsonia aculeata</i> L. SR-13141	Kikar	Fabaceae	Shrub	Seeds	Oil	The seeds oil is used for mulish to cure	Joint pain, Swelling of body	28	0.22	0.68	19
<i>Peganum harmala</i> L. SR-13163	Sponda	Zygophyllaceae	Herb	Whole plant	Paste	The paste of the whole plant is topically applied for treatment	Rheumatism	47	0.36	0.83	39
<i>Physalis angulata</i> L. SR-13585	Motkai boti	Solanaceae	Herb	Leaves	Decoction	Decoction of leaves are given before breakfast	Muscle pain	32	0.25	0.53	17
<i>Plantago lanceolata</i> L. SR-13210	Khataikai	Plantaginaceae	Herb	Seeds	Oil	The seed oil is used to cure	Muscle pain, rheumatism	27	0.21	0.48	13
<i>Plantago major</i> L. SR-13308	Ispaghol	Plantaginaceae	Herb	Seeds	Juice	The seed juice is used daily before breakfast	Rheumatism	31	0.24	0.55	17
<i>Portulaca oleracea</i> L. SR-13169	Parkhurai	Portulacaceae	Herb	Aerial parts	Decoction	The crushed shoots are a little wormed and applied externally to cure	Joint inflammation	32	0.25	0.56	18
<i>Ricinus communis</i> L. SR-13132	Rinda	Euphorbiaceae	Shrub	Seeds	Oil	The seeds oil is mixed with rape seeds oil and olive oil and then boiled. This oil is used to cure	Lower back pain, Rheumatism	28	0.22	0.50	14
<i>Solanum surratense</i> Brum. F SR-13396	Kwerkundai	Solanaceae	Herb	Fruits, leaves	Paste	Fruits and leaves paste is topically applied to cure	Backache, rheumatism	36	0.28	0.61	22
<i>Stellaria media</i> (L.) Vill. SR-13146	Pest boti	Caryophyllaceae	Herb	Aerial parts	Paste	Paste of the aerial part is applied topically to cure	Bone fracture, rheumatism	27	0.21	0.56	15
<i>Tagetes erecta</i> L. SR-13260	Zenda gula	Asteraceae	Herb	Leaves	Decoction	The leaves are mixed with boiling oil and applied on affected area	Muscular pain	30	0.23	0.57	17
<i>Tamarix aphylla</i> (L.) H.Karst. SR-13215	Ghaz	Tamaricaceae	Tree	Galls	Decoction	The galls are boiled in water and steam is given to affected area	Rheumatism	42	0.32	0.83	35
<i>Taraxicum officinale</i> F.H.Wigg SR-13256	Zer gulai	Asteraceae	Herb	Leaves	Powder	The leaves powder (2–3 tea spoons) is given with milk for 10–15 days.	Joint pain	31	0.24	0.52	16

Scientific Name/Voucher No.	Local Name	Family	Growth form	Part used	Preparation mode	Recipes	Diseases cured	FC	RFC	UV	URs
<i>Trachyspermum ammi</i> L. SR-13206	Sperkai	Apiaceae	Herb	Seeds	Powder	3-8g of powder ash at once per day is given for 5–8 days	Joint pain	41	0.32	0.76	31
<i>Trianthema portulacastrum</i> L. SR-13339	Mardor boti	Aizoaceae	Herb	Whole plant	Juice	The fresh plant juice (1 cup) is used for treatment	Swelling of body	17	0.13	0.35	6
<i>Tribulus terrestris</i> L. SR-13236	Kandalai	Zygophyllaceae	Herb	Aerial parts	Powder	Powder of aerial parts (2–3 teaspoons) is taken with water for 4–7 days is recommended for	Joint pain, back pain	40	0.31	0.75	30
<i>Urtica dioica</i> L. SR-13128	Sezankia	Urticaceae	Herb	Whole plant	Decoction	Decoction of the whole plants are given for 6–7 days to cure	Joint pain	29	0.22	0.45	13
<i>Verbascum thapsus</i> L. SR-13158	Gher bhanga	Scrophulariaceae	Herb	Leaves	Decoction	The leaves decoction is given for 7–9 days to cure	Rheumatism	46	0.35	0.80	37
<i>Vitex negundo</i> L. SR-13171	Sre dane	Verbenaceae	Shrub	Leaves	Paste	Paste of fresh leaves are used as bandage for treatment	Back pain	18	0.14	0.33	6
<i>Withania somnifera</i> (L.) Dunal. SR-13230	Bulbel boti	Solanaceae	Shrub	Roots	Powder	Powder of roots (2–3 tea spoons) is taken orally with water to relief	Joint pain, joint swelling	38	0.29	0.68	26
<i>Ziziphus nummularia</i> (Brum. f.) Wight & Arn. SR-13179	krkana	Rhamnaceae	Shrub	Fruit	Decoction	Fruits decoction is given orally with milk at night time for 5–7 days	Joint pain	29	0.22	0.45	13

Key words

FC = Frequency of Citation, RFC = Relative Frequency of Citation, UV = Use Value, URs = Used Reports, FL = Fidelity level.

Plant parts used, Mode of preparation, and Route of administration

The most commonly used plant parts were leaves (21.88%), followed by whole plant (17.19%), Seeds (14.06%), aerial parts (10.94%), roots (10.94%), fruits (9.38%), rhizome (4.69%), bark and gums (3.13% each), branch, bulb and galls (1.56%) each (Fig. 4).

The methodology used in the preparation of herbal medication may vary according to the type of diseases treated. In this study the most commonly employed method of preparation of herbal drugs were classified into 10 categories. The dominant mode of preparation was decoction (32.31%), followed by paste (20.00%), powder (16.92%), juice and oil (9.23% each), herbal tea (4.62%), infusion (3.08%), poultice, pulp and raw (1.54%) each (Fig. 5).

Regarding the mode of administration, there were different ways of using medicinal plants. Oral ingestion was the most preferred method (65%), followed by topical (35%) (Fig. 6).

Indigenous plants used to treat musculoskeletal disorders

The survey recorded the knowledge that the indigenous people and herbalists in the study area used to treat musculoskeletal disorders. Disorders were classified into 17 categories, the most widely treated category was rheumatism (26 spp.), followed by joint pain (19 spp.), backache (7 spp.), body swelling and muscle pain (6 spp.) each, body pain and joint swelling (5 spp.) each, muscular pain (3 spp.), bone fracture, crack bone, lower back pain and rheumatoid arthritis (2 spp.) each, knee pain, muscle cramps, muscle wound, pain in bones and swelling of limbs (1 spp.) each (Fig. 7). Among various classes of

traditional uses, rheumatism, joint pain and muscular pains predominant, and the maximum number of therapeutic plants have been documented to be utilized to treat such disorders across the globe among various communities.

Relative frequency of citation (RFC):

In this study, maximum RFC value refers to the well-known popularity, use and priority of species documented by the respondents for treating particular ailments that is musculoskeletal disorders. A relative frequency of citation was used to assess the most frequently used therapeutic plants. In the present study, the RFC value ranges from 0.13 to 0.36 (Table 2). The species in the study area with a maximum RFC value were *Bergenia ciliata* and *Peganum harmala* (0.36 each), followed by *Verbascum thapsus* and *Datura stramonium* (0.35 each), *Berberis lycium* (0.34), *Justicia adhatoda* (0.33), *Ephedra procera*, and *Tamarix aphylla*, *Trachyspermum ammi* (0.32 each), and *Cordia myxa* (0.31). The lowest RFC value was reported for *Carthamus tinctorius* and *Trianthema portulacastrum* (0.13 each). The most commonly cited plant species were those that are most valuable and frequently used among the indigenous people for therapeutic purposes. The plant species with maximum RFC value should be subjected to be involved in biological, pharmacological and phytochemical studies.

Use value (UV)

UVs, calculated to compare the importance of different medicinal plants ranged from 0.35 to 0.87 and the use reports (URs) ranged from 6 to 41 (Table 2). The highest use value was reported for *Bergenia ciliata* (0.87), *Berberis lycium* (0.86), *Datura stramonium* and *Justicia adhatoda* (0.84 each), *Tamarix aphylla* and *Peganum harmala* (0.83 each), *Ephedra procera* (0.81), and *Verbascum thapsus* and *Cordia myxa* (0.80 each). The lowest use value was reported for *Vitex negundo* (0.33). In contrast to our research findings; previous studies conducted in various regions and among different communities consistently reported the highest utilization value for *Achyranthes aspera*. It might be due to the poor information regarding the therapeutic properties of the *Bergenia ciliata* or it less availability in the other study regions.

Fidelity level (FL %)

Fidelity level (FL %) is used to categorize the therapeutic plants that are most preferred by the local people for the treatment of particular ailments. The medicinal plants with the highest curing effects have the highest fidelity level of 100%. The therapeutic plants that were reported by a single respondent were not considered for the FL level study. In this study, FL ranged from 52.94–100% (Table 2). Four species viz i.e., *Bergenia ciliata*, *Peganum harmala*, *Verbascum thapsus*, and *Berberis lycium* were used with 100% FL against muscular pain, rheumatism, rheumatism, and body pain respectively, followed by *Tamarix aphylla* (99.35) against rheumatism, *Datura stramonium* against swelling of limbs (97.78%), *Ephedra procera* against rheumatism (96.25%), *Justicia adhatoda* against body pain (95.35%), *Cordia myxa* against joint pain (95.00%), and *Tribulus terrestris* against joint pain (92.50%). The highest fidelity level (FL) value determines the choice of respondents to treat the particular ailment. It is a fact that the higher the plant's uses, the higher will be the FL value.

Discussion

The survey conducted in the North Waziristan region revealed that there is variation in the information regarding plants used to treat musculoskeletal disorders among different respondents. Moreover, the documentation of traditional knowledge in research has been biased towards males. Male dominance within the community of Phytomedicine practitioners may be attributed to traditional and cultural practices that assign men responsibilities for more intricate and labour-intensive tasks, such as grave digging, farming and hunting. There are similar investigation that support this finding [4, 21]. Herbalists' ages ranged between 30 and 75 years, most of them between 61 and 75 years (40%) (Table 1). This survey indicates that the elderly plays a central role in preserving folk knowledge. However, the ageing of older generations poses a significant threat to indigenous knowledge. This finding is similar to those reported by [22]. Based on the data analysis, the vast majority of herbalists were illiterate with a percentage of 41.54%. The prevalence of a poorly educated population suggests that knowledge is primarily transfer from one generation to the next generation, facilitating a gradual transition from illiterate generations to more educated ones. This finding aligns with the results reported by [23]. Nevertheless, the transfer of knowledge from older generations to younger individuals has become increasingly challenging. This is attributed to a lack of trust, particularly among the youth, who do not have faith in traditional medicine. This has resulted in a loss of knowledge concerning medicinal plants [24, 25].

Asteraceae were the most prominent family for treating MSDs among the North Waziristan community, which agrees with other ethnomedicinal research around the world [11, 26, 27]. The reason behind the dominance of the Asteraceae family is that the family members are familiar for aromatic quality and are easily accessible in wild nature, or might be due to its widespread distribution and richness in the study area [28, 29]. Our findings are similar to the previous research work [30–32]. Leguminosae was found to have the highest number of medicinal plant species used in the treatment of MSDs in northern Pakistan [33]. Leguminosae is another large family, together with Asteraceae, in terms of worldwide numbers of species. Both families have many species that are used to treat MSDs ailments [33].

Herbs and shrubs were the most common growth forms of the plants harvested by the North Waziristan people for traditional medicine for MSDs. Our findings agreed with [22, 34–36]. Herbs are most commonly utilized due to their abundance in the study area and are easily available [37]. Trees were transcendently utilized for MSD treatment in different parts of the globe, for example, India [38], Ghana [39], and South America [40]. Leaves and whole plants were the most used parts in the treatment of MSDs. Leaves were documented as the most used part in several other ethnomedicinal studies of MSDs treatments around the world, such as in India [38], Algeria [41], central Africa [42, 43], and South Africa [44]. The leaves collection and preparations of medicine from leaves are so easy as compared to the other plant parts. For this reason, leaves are commonly used in herbal medication preparation [45]. The removal of leaves from the therapeutic plant species can cause less harm as compared to the removal of other plant parts [18, 46].

The dominant mode of preparation was decoction. This method is common for preparing therapeutic plants in northern Pakistan [33] and around the world, such as in China [47], Central Africa [48], and the Philippines [49]. Decoction is the easiest way to extract bioactive substances from plant materials [50].

Furthermore, sweeteners, like honey or sugar, can be added into the decoction during or after the preparation to reduce the bitterness and adjust the taste of the remedies [50–52]. The preferred mode of administration was oral ingestion. It was observed to be the most predominant route of administration in other studies around the world, such as Thailand [53, 54], and India [38]. Other preferred mode of administration was topical. Therapeutic plants were typically prepared by grinding and applying them directly to the injured parts. Furthermore, when the plants were ground or crushed, they released their secondary compounds [55, 56]. Most plant species were used to treat ailments in the rheumatism category. This finding was similar to reports from other areas [4, 57–59]. The rheumatism category was a dominant MSDs category, and many communities around the globe have used many therapeutic plants to treat it [4, 57].

The UV values rely on use reports and the prevalence of medicinal plants in the vicinity of the study areas. Plant species with high UV values indicated that they have use reports and are frequently found in the studied area [50, 60]. UV could be calculated to assess which plant species were significant to the communities; While RFC determined the extent of traditional knowledge concerning the use of medicinal plants in the study areas. Plant species with high RFC values indicated the widespread popularity, use, and priority of specific species among respondents for the treatment of specific ailments [33]. The most important plant species for treating MSDs among the North Waziristan people was *Bergenia ciliata*. It had both high UVs and RFC values. It was used for treating Muscular pain and body pain. Other plant species with high UV and RFC values were *Berberis lycium*, *Peganum harmala*, *Verbascum thapsus* and *Datura stramonium*. These species were reported in many villages of North Waziristan and were used to treat ailments in many MSDs categories. Plant species with high FL are used for the same curative purpose, whereas those with a low FL value are used for different ailments. In accordance with prior ethnobotanical research, plants having FLs of 80% or more have important curative significance [61]. Nonetheless, certain plant species that have low FL should not be neglected. Instead, we should make concerted efforts to prevent a decrease in their abundance and stop their potential extinction, which could pose risks to future generations [22]. Therefore, in order to scientific support for traditional ethnobotanical practices and ensure their ongoing use, it is essential to evaluate their bioactivity and, ultimately, investigate their Phytochemistry and pharmacological profile [62].

Conclusion

The study focused on indigenous uses related to therapeutic plants used among the local communities of district North Waziristan to treat musculoskeletal disorders. The current investigation was undertaken to explore the traditional knowledge of musculoskeletal disorders and to record therapeutic plant species for future scientific confirmation through pharmacological and phytochemical studies. In this study, 60 therapeutic plants belonging to 39 plant families were reported to be used against musculoskeletal diseases. Leaves were the most commonly part used, and the dominant mode of preparation was decoction. This study was the first report assessment and provides important knowledge about the practice of therapeutic plants for musculoskeletal diseases among the communities of the study area. This comprehensive study helps in pharmacological and phytochemical investigation to screen such therapeutic plants for future drug discovery which gives more interesting information with worldwide interest. Scientific validation of the bioactive compound of the specific therapeutic plants will authenticate the integration and utilization of these natural remedies for basic health care of indigenous communities. It is need of time to develop awareness among the local communities to use these herbal medications and to preserve this ethnomedicinal information for future generation.

Abbreviations

MSDs= musculoskeletal disorders

UV= Use value

RFC= Relative frequency of citation

FL= Fidelity level

Declarations

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Data Availability:

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Competing interests

The authors declare no competing interests.

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Consent for publication: Not applicable.

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Figures

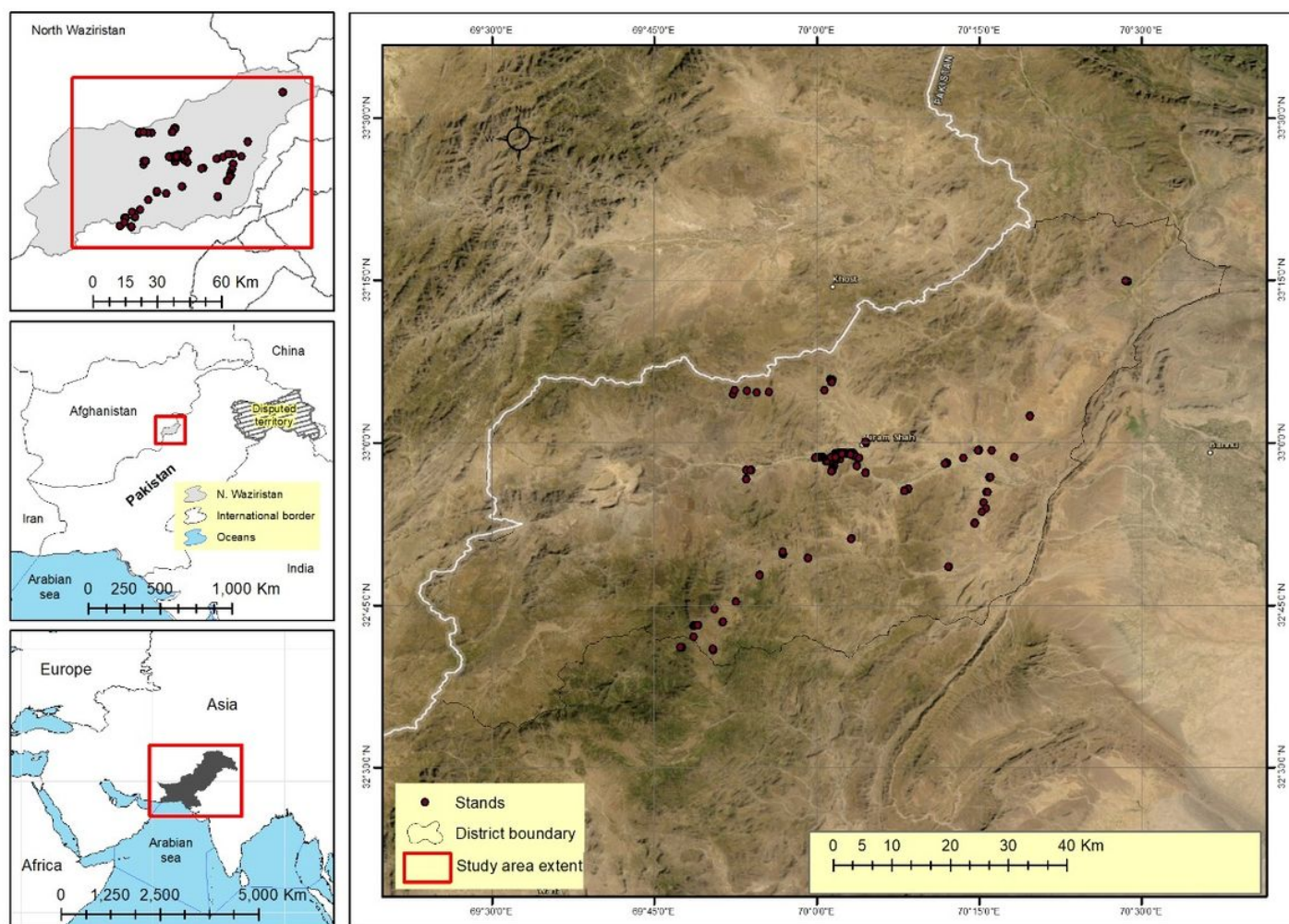


Figure 1

Map of the study area.

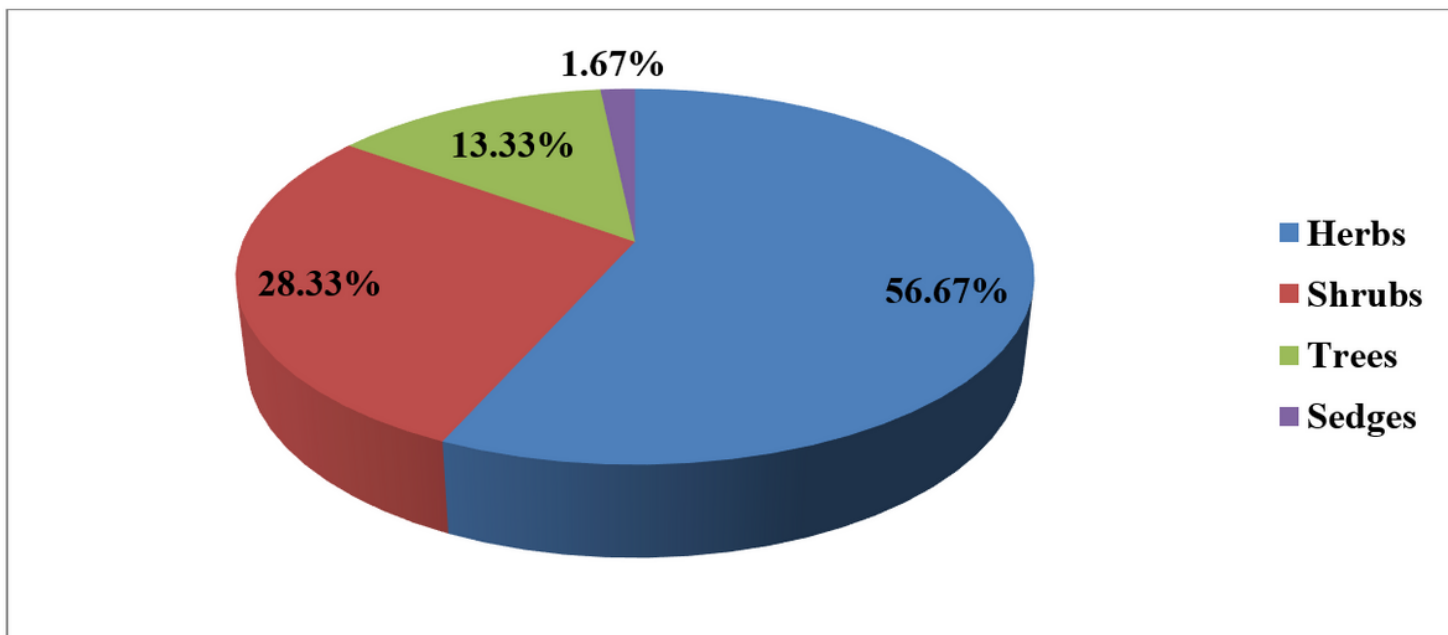


Figure 2

Growth forms of medicinal plants in District North Waziristan, Pakistan.

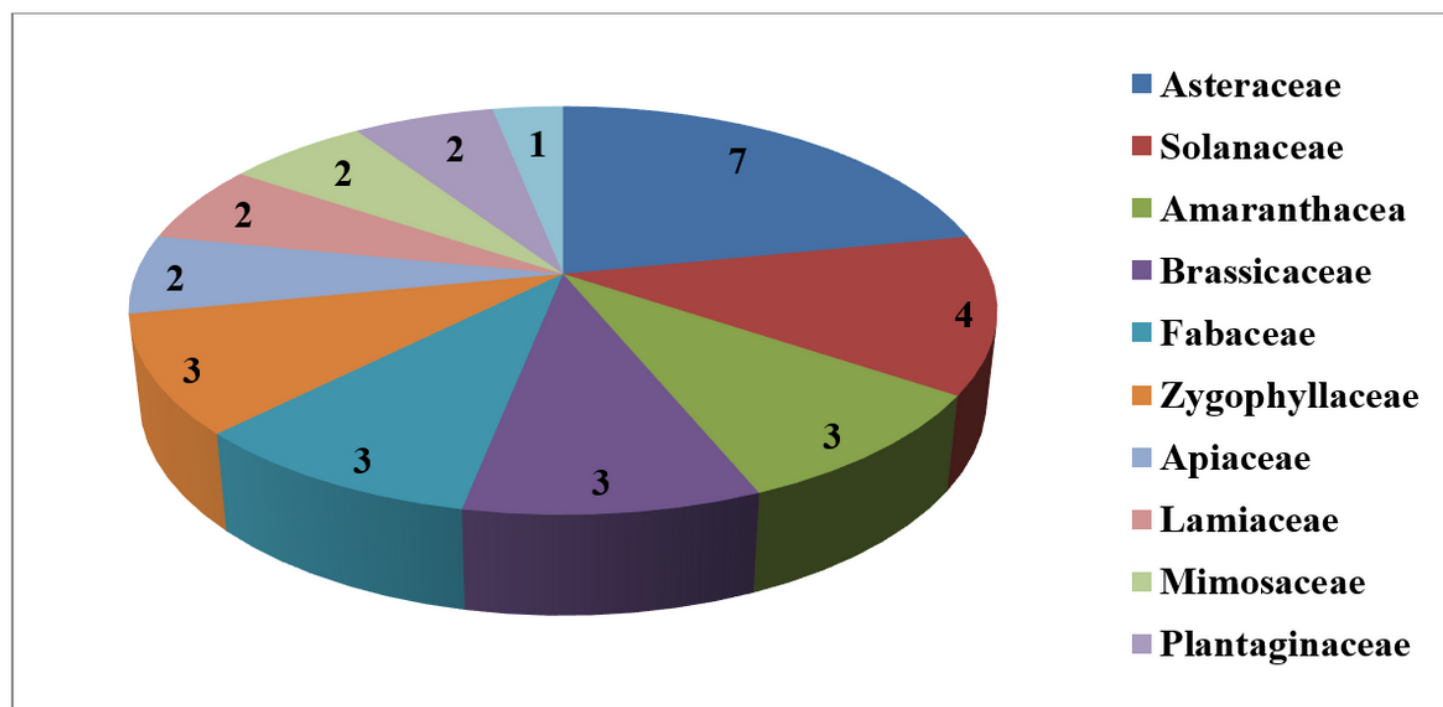


Figure 3

Dominant families of medicinal plants in district North Waziristan, Pakistan.

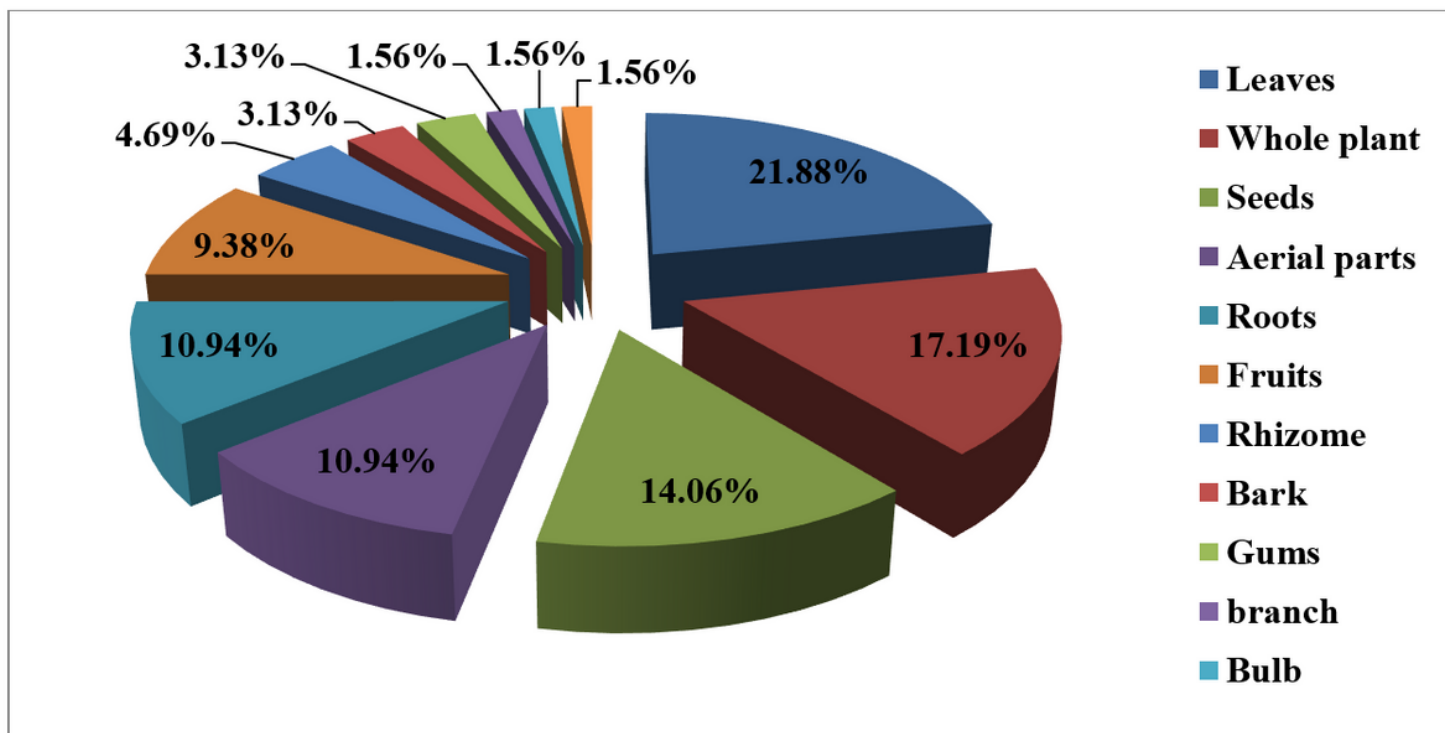


Figure 4
Plant parts used in remedies preparations in district North Waziristan, Pakistan.

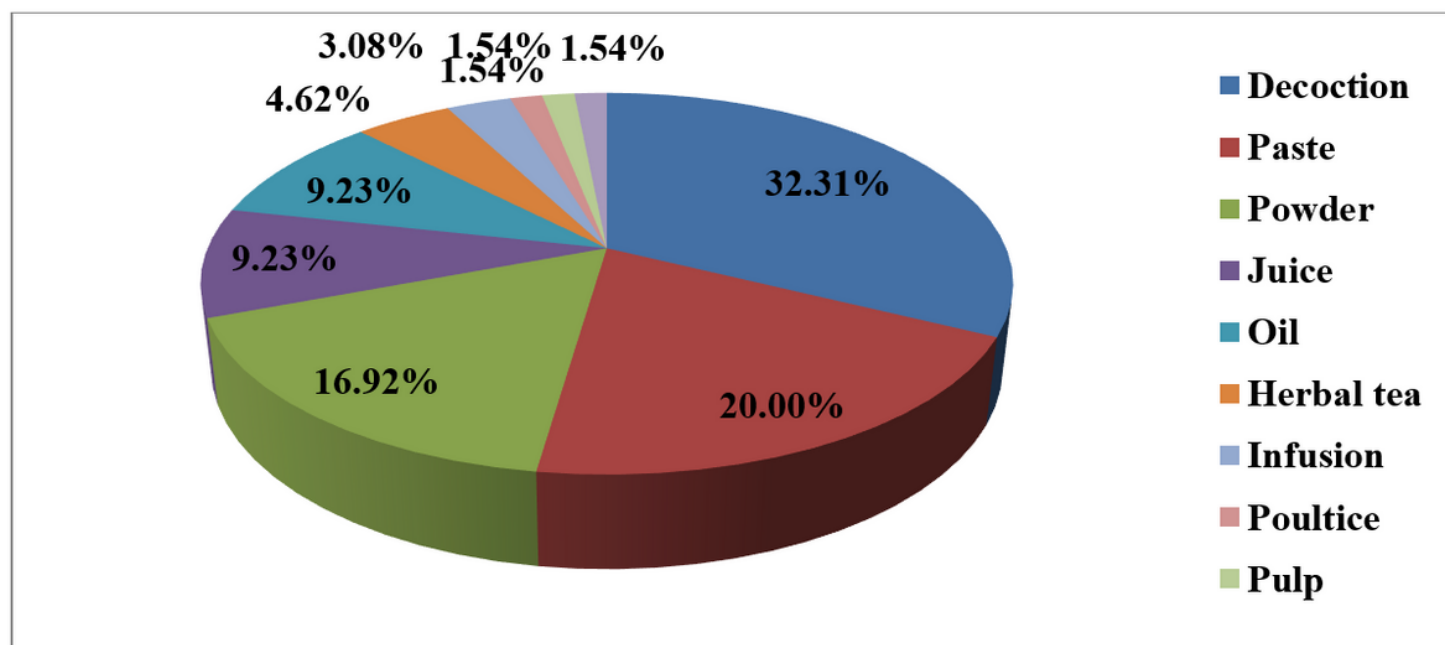


Figure 5
Mode of preparation of remedies in district North Waziristan, Pakistan.

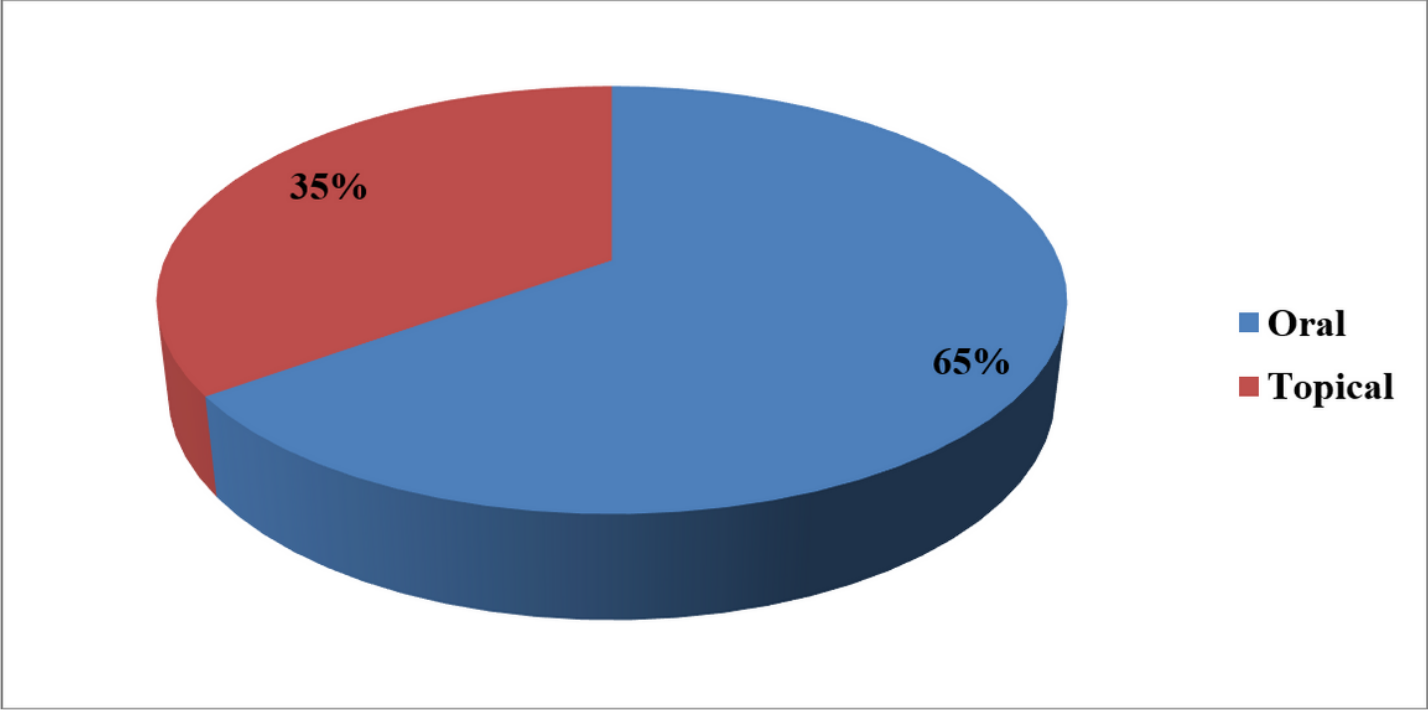


Figure 6
Routes of administration in district North Waziristan, Pakistan.

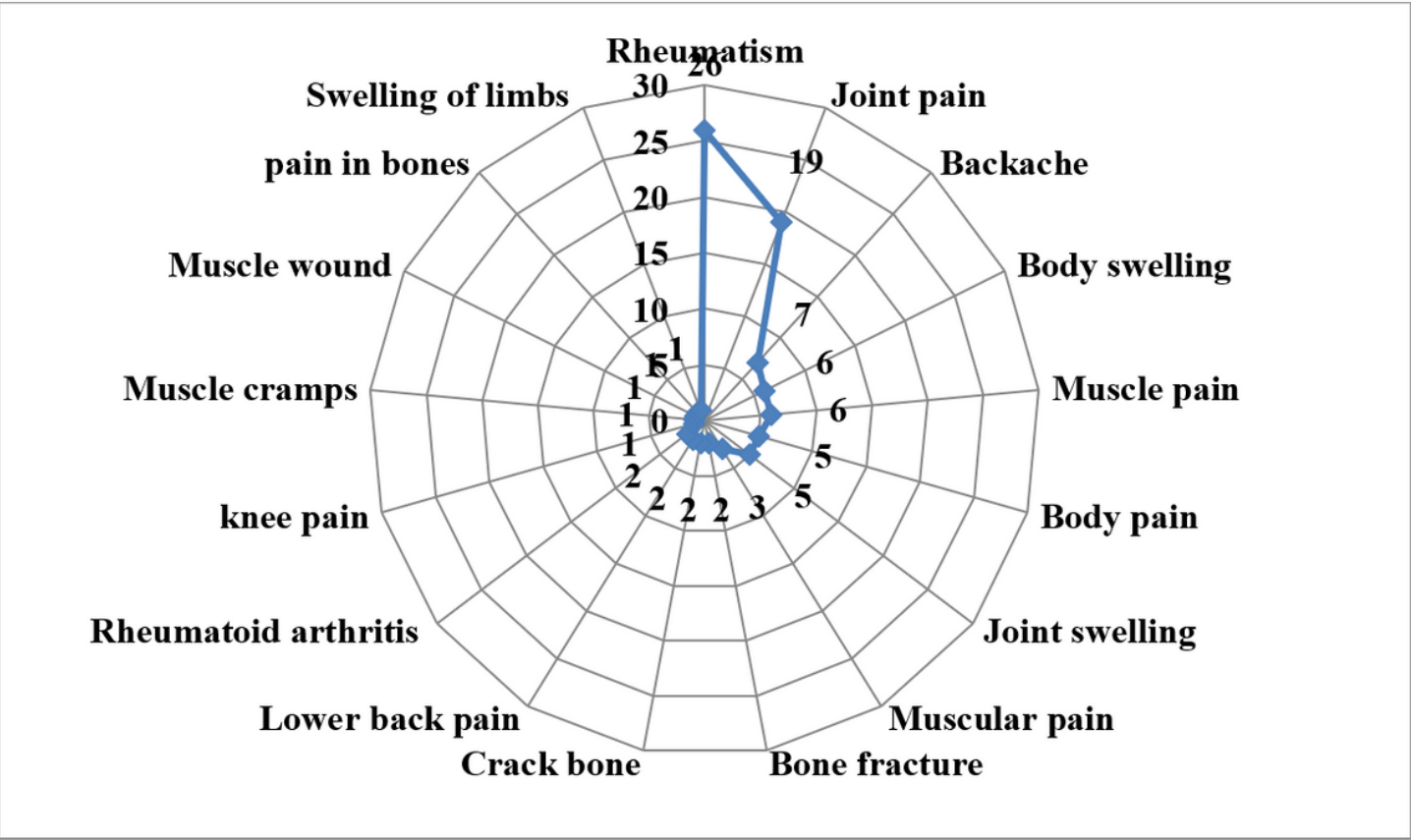


Figure 7
Number of species used for the treatment of different musculoskeletal disorders in North Waziristan.