Research Article

Ethnopharmacological Study of Medicinal Plants in Bajwat Wildlife Sanctuary, District Sialkot, Punjab Province of Pakistan

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Bajwat Wildlife Sanctuary is a complex riverine ecosystem and is unique because of the presence of river Chenab, various seasonal streams, lakes, and Head Marala barrage. These ecogeographic conditions provide diverse natural habitats for various plant and animal species to grow uninterrupted and have undocumented ethnopharmacologically important medicinal flora. The present study involves the first-ever extensive investigation to document the ethnopharmacological knowledge on medicinal plants of local healers and inhabitants of the Bajwat Wildlife Sanctuary to treat ailments. The unstructured and semistructured interviews of the local healers and inhabitants were conducted that included 130 individuals. The ethnomedicinal formulations, their method of preparation, mode of administration, parts of the plant used, diseases cured, and their categorization along with species use report (UR) were analyzed. The ethnopharmacological study led to the enlisting of 114 medicinal plant species belonging to 97 genera and distributed among 47 plant families. 2029 URs were collected with 42 general disease categories. Each plant species was reported 18 times to cure various diseases (~18 UR), while ~48 URs were collected on each disease category by local informants. Digestive issues (290 URs, ~14.29%) and skin infections (279 URs, ~13.75%) were found most commonly among the occupants of the area. The oral administration (69%) of herbal drugs and the preparation of plant extracts (32%) were the most common ethnopharmacological strategies. Inhabitants of the area were well aware of the limited use of poisonous plants. 8 (~7%) out of the total 114 medicinal plant species were listed in the IUCN Red List of Threatened Species as Least Concern, while Eucalyptus camaldulensis Dehnh. was enlisted as near-threatened. The results of the present investigation show that the occupants of the Bajwat have sound information about the ethnopharmacological consumption of medicinal plants, and some of the novel ethnomedicinal formulations were reported which provide the basic data for further pharmacological research.
1. Introduction

The traditional herbal medicine system in Pakistan is originated from Ayurveda medicine which has a history of 2500–600 BC [1]. The first documented record of the use of plant medicine in the subcontinent (Indo-Pak) is available in Rigveda (Rigveda is the oldest religious book of the Hindu religion. Many herbal remedies are documented in this book to treat ailments.) and dates to 4500–1600 BC. The herbal medicine system in Pakistan is greatly influenced by the traditional Chinese medicine system, Persian medicines, Greek medicine system [2], and prescriptions from the Prophet Muhammad (PBUH). The Tib- Al-Nabwi or Prophetic Medicine system has 1500-year-old history [3, 4]. These diverse features of the traditional healthcare system of Pakistan embellish it with great potential to use plants to treat various ailments.

The tertiary healthcare system in Pakistan is responsible to provide basic to advanced healthcare facilities to the inhabitants. The rural areas in Pakistan have limited access to primary healthcare services. Rural healthcare communities have facilities in the form of Rural Health Centers (RHCs) and Basic Health Units (BHUs) that contribute to cover a population of 25,000 inhabitants and are responsible to provide primary healthcare and referral services [5, 6]. Most of the rural communities of Pakistan use herbal medicines because of the limited access to primary healthcare services, expensive medicines, and diagnostic tests [7]. Pakistan is blessed with a great number of higher plants (5,700). Out of the enlisted higher plants, 600–700 are enumerated as therapeutic plants utilized by around registered herbalists and homeopaths. The pharmacopeia endorsed by the National Council of Tibb (Herbalist committee) enlisted 900 medicinal plants commonly used in Pakistan to prepare herbal medicines [8, 9].

Bajwat is situated in the district Sialkot (32°62 N and 74°60 E) and on the outskirts of the district Narowal region of Punjab territory in Pakistan (Figure 1). It contains 84 towns or small villages, with a population of 60,000 as indicated by the 2017 survey. The territory is a wetland of universal significance because of the nearness of Marala Headworks (barrage), Munawar Tawi (river), Jammu Tawi (river), and numerous natural streams, lakes, and muddy regions. Bajwat is situated in a transitional zone between the slopes of Jammu in Indian-occupied Kashmir and the plain zone of Punjab. Bajwat Wildlife Sanctuary has an absolute region of 5,464 hectares which provides free space to wildlife flora and fauna [10]. The most common and universally rare vertebrates of the area include the wild pig or wild boar (Sus scrofa L.), deer (Odocoileus virginianus Zimmermann), and nilgai (Boselaphus tragocamelus Pallas) (blue bull, largest Asian antelope) [11]. These special ecogeographic attributes and the presence of important plant and animal species and serious threats to them contributed to getting the special status for the area [12]. The vast floristic wealth and the rich knowledge of the inhabitants of Bajwat require necessary steps to document this traditional ethnopharmacological knowledge which can help forest officials, NGOs, policymakers, local healers, and researchers that are involved in ethnopharmacological research on medicinal plants. There are very few ethnobotanical studies on medicinal plants reported previously from the district Sialkot [13–17]. These studies were performed superficially, do not provide detailed ethnomedicinal knowledge of the district Sialkot, and do not cover Bajwat Wildlife Sanctuary. The importance of the ethnopharmacological consumption of the medicinal plants of Bajwat Wildlife Sanctuary was ignored, and there was no study to document the significance of the conserved flora.

It was hypothesized that the long-term and well-driven ethnopharmacological survey on medicinal plants of Bajwat Wildlife Sanctuary may help us to enlist ethnopharmacologically important medicinal plants of the area. It can be the first-ever study to document the ethnopharmacological knowledge of the local inhabitants and healers to use plants to treat diseases.

1.1. Aim of the Study. The present study was aimed to significantly establish the first-ever inventory of therapeutically important medicinal plants of the Bajwat Wildlife Sanctuary, which is endowed with unique biodiversity and gained a special status to conserve the local flora and fauna. The main objective of this study involves the enlisting of therapeutically significant plant species, their medicinal properties, and methods of preparation of the herbal formulations used by the inhabitants of Bajwat to treat ailments. A bibliographical comparison of the floral diversity of the studied area with the previously published scientific literature from the district Sialkot and with the Herbal Pharmacopeia of Pakistan was performed to determine if the species were reported earlier with similar ethnomedicinal preparations at a regional or national level or if it is reported for the first time in this context.

2. Materials and Methods

2.1. Study Area and Climate. Bajwat is a small village that is located in the district Sialkot, province of Punjab, Pakistan. Sialkot highlights a humid subtropical atmosphere according to the Köppen–Geiger atmosphere classification, with four seasons [18]. The postmonsoon (rainfall season) season from mid-September to mid-November stays hot during the daytime, yet the evenings are cooler with low humidity. In the winter from mid-November to March, days are moderate to cold, with once-in-a-while substantial rainfall. The temperature in winter may drop to 0°C, yet maximum is rarely under 15°C [11]. The precipitation in the region is very high, which sometimes results in flooding and washing of economically important crops. The normal precipitation is 965 mm [12].

The main source of income for the general population is the cultivation of crop plants such as wheat and rice. They also raise livestock for dairy and profit. The people of the Bajwat have their ethnic linkage with the Kashmir province, and the majority of inhabitants are Muslims by religion. Bajwat Wildlife Area was declared as a sanctuary in 1964 by the Government of Pakistan to protect deer, wild pig, and nilgai from hunting and to prevent other serious threats to the flora. The Bajwat Wildlife Sanctuary is enlisted by the
IUCN as a classification IV area, which incorporates a complex of common riverine living spaces, close to the Sialkot along the Chenab River and two of its tributaries, reaching out up to the Indian outskirts (Figure 2). The area is usually inaccessible for a large population and is abandoned due to escalated tensions in the adjacent countries as the east side of the area moves along the Indian border [10]. The main realized danger is the unlawful chasing or hunting of animals, for which the zone has been announced as a Game Reserve and is protected by the Wildlife Department of the Government of Punjab, Pakistan. Below Bajwat is a place where the Chenab (river), Jammu (Occupied Kashmir, India), Tavvi (river), and Manavar Tavvi (river) meet at one spot. The Marala Headworks is situated in Bajwat’s southwest corner, is a reservoir of the Chenab river water, and contributes to divert water in different territories of adjacent areas to irrigate field crops. The territory between these two channels is being created as the Marala Barrage Park [11]. These special ecogeographic attributes along with our interest led us to choose this region for our study.

2.2. Selection of Informants. The informants who had ethnopharmacological knowledge of medicinal plants and used crude formulations in the past or using in routine to treat ailments were selected [19].

2.3. Ethnopharmacological Survey on Medicinal Plants and Data Collection. Open meetings were arranged, in which the individuals were met through casual discussion. Every member was interviewed separately, and the data were recorded with great care. The point of open meetings was to evoke people to talk openly, without any stress or anxiety and to collect information about the medicinal attributes of plants that they utilize or have utilized previously. The second step was semiorganized meetings to acquire detailed quantitative and qualitative data and to obtain a wide range of knowledge on explicit issues. The routine activities of the people of Bajwat Wildlife Sanctuary were observed during the study. A composed questionnaire was designed to collect data containing the name, sex, age, and address. In addition, the level of education of the interviewees and the spot and date of the meeting was recorded. The conversation with the interviewees was in Urdu and Punjabi languages. The questionnaires were filled by the researchers. The ethnopharmacological information consisting of the ethnomedicinal properties of the plant, the vernacular name, the plant parts utilized to prepare medicines, plant occurrence, credited therapeutic properties, and the techniques for preparing ethnopharmacological formulations was recorded [20, 21].

2.4. Collection of Plant Samples and Their Identification. The plant samples were collected from the Bajwat Wildlife Sanctuary with the help of local healers, herbalists, sellers, and informants. The study area was surveyed from January to the end of November 2019. The plants were identified by the author Waris Hussain with the help of the Flora of Pakistan. The herbarium sheets containing plant specimens were deposited in the herbarium of the Botany Department of PMAS-Arid Agriculture University, and accession numbers were allotted for future reference [22]. The correct and approved botanical names were enlisted throughout this study after verification from the Pakistan Plant Database (e-Flora of Pakistan) (https://www.tropicos.org/Project/Pakistan) and Plant List (http://www.theplantlist.org/).

2.5. Quantitative Data Analysis. The data collected from Bajwat was loaded on the Microsoft Office® program MS Excel® spreadsheet. The graphs were plotted, and the data were evaluated in the form of percentages and proportions. The species use reports (URs) per herbal formulation were also recorded, and the greater number of informants per herbal formulation was considered as an indicator of excessive use of that plant in crude drug preparations. The use reports are defined as the number of informants per herbal
formulation or ethnopharmacological preparation [21, 23, 24]. Information was considered coherent when it was reported by two individuals at different times. The diseases reported from the Bajwat Wildlife Sanctuary were arranged according to the international disease categories (ICPC-2, International Classification of Primary Care) by WHO (https://www.who.int/classifications/icd/adaptations/icpc2/en/). Reported 114 medicinal plant species were searched in the IUCN Red List of Threatened Species (https://www.iucnredlist.org/) to determine their conservation status.

3. Results and Discussion

Bajwat Wildlife Sanctuary is a protected area that allows a great number of plant and animal species to proliferate freely without any human intervention. The studied area is a complex of different riverine and terrestrial territories that provide a great diversity of ecosystems and environmental conditions for the growth and reproduction of various varieties of plant species. To achieve the study goals and to test the hypothesis, 130 individuals, including 80 male and 50 female participants were interviewed. The local respondents belonged to different age groups ranging from 20–71/above. They had different levels of education from primary to university, while 15% of the informants were enlisted as illiterate (Table 1). The seventh author was originally from one of the villages of Bajwat (Pul-Bajwan). He and his family helped greatly to meet local inhabitants and some known healers of the area. The plant vernacular names are also enlisted in Table 2. The vernacular names were similar in both Urdu and Punjabi languages, and it was not possible to differentiate them based on the language. Ten male herbalists (registered with the National Council of Tibb, Pakistan) were also reported from the studied area. It was observed that the male informants were having more detailed knowledge about the plants’ local names, their identification, and collection, while the female participants were having significant information regarding the method of preparation of herbal formulations, and their mode of administration.

3.1. Medicinal Plants Diversity in Bajwat Wildlife Sanctuary. The ethnopharmacological survey on medicinal plants of the Bajwat Wildlife Sanctuary led to the collection of 47 plant families and 114 medicinal plant species disseminated among 97 genera (Table 2). The distribution of the plant families to be used in ethnopharmacological medicines among the inhabitants of Bajwat Wildlife Sanctuary can be consulted in Figure 3. 10% of the total reported medicinal plant species belong to the family Leguminosae/Fabaceae. Poaceae and Solanaceae occupied the 2nd rank (7%) in the context of the widely exploited medicinal plant species in the Bajwat Wildlife Sanctuary followed by Moraceae (6%), Asteraceae (5%), Apiaceae, Brassicaceae, Cucurbitaceae, Lamiaceae, and Rosaceae (4% each). Caesalpiniaceae was found to be 3% among the reported species. Fabaceae, Poaceae, Solanaceae, and Moraceae account for 30% of the total reported medicinal plant species of the area. The rest of the families were counted as 2%/<2% separately. A similar trend of utilization of medicinal plant families was reported (Farrukh Nisar et al., 2011; Zereen et al., 2013; Rashid et al., 2014) from the flora of Sialkot unlikely the Pakistan Plant Database (Flora of Pakistan) shows Asteraceae as the largest
medicinal plant family countrywide (https://www.tropicos.org/Project/Pakistan).

The lifeforms provide great diversity and physiognomic contrast to the ecological habitat. The most common life forms (Figure 4) are reported in the ascending order for the preparation of herbal medicines such as herbs, shrubs, and trees. Some previous ethnobotanical studies on medicinal plants of the district Sialkot also reported herbs as the extensively utilized plant species to treat ailments of the local inhabitants [13, 14, 16, 17].

3.2. The Traditional Source of Knowledge and Bibliographic Comparison. The inhabitants of the Bajwat have sound traditional ethnopharmacological knowledge of medicinal plants because of the ancestral strong linkages among nearby individuals and families. The individuals acquire traditional knowledge from the seniors of the clans and keep on transferring it from one generation to another generation. Along these lines, nearby individuals gather therapeutic plants and treat themselves at home. Most of the senior people of the family, who practice medicine, help and guide their other family members and neighboring communities in the treatment of ailments. Both the male and female members of the society were playing a promising role in the transmission of ethnopharmacological knowledge to their next generation. The females used to guide their daughters and their daughters-in-law about the method of preparation of ethnopharmacological preparation and their mode of administration, while the male family members were going with their young kids to collect plants.

The traditional healers revealed from the studied area were having sound information on ethnopharmacologically significant medicinal plants, their method of preparation of formulations, and their mode of administration. The bibliographic comparison with the existing data from the district Sialkot led to the enlisting of 85 new medicinal plant species with novel herbal formulations not reported previously in the published scientific literature which makes ~75% of the total collected medicinal plant species (Table 2). The ethnopharmacological comparison of the herbal formulations reported from the Bajwat Wildlife Sanctuary with the Pakistan Herbal Pharmacopeia [8] reported 24 new herbal remedies that make 21% of the total enlisted herbal formulations. The species with similar herbal formulations in different ethnomedicinal studies from the district Sialkot are enlisted in the last column of Table 2.

### 3.3. Plant Parts Used in Herbal Therapy

The different plant parts have different properties which help them to treat therapeutic ailments and likewise have significance in crude herbal formulations. 59% of the plants reported from the studied area were edible medicinal plants which show that these plants can be consumed in different forms to treat ailments, e.g., oral intake of drugs and food supplements to treat malnutrition, etc. while 41% of the medicinal plant species were not edible (Figure 5(a)). It shows that most of the plants of the studied area have their utility as food along with their medicinal applications. Figure 5(b) shows that 51% of reported plant species have their only use in herbal medications while 21% of plants were used as a source of timber followed by 14% of ornamentals in addition to their other medicinal properties. 8% of the plants were utilized as animals’ medicine. Most of the animal medicines were given as fodder to treat animals’ digestive issues. Some plants were given to animals as a food supplement while some plants were reported effective to eradicate malnutrition. A herbal formulation was prepared from *Argemone mexicana* L. root extract and applied topically to treat animals’ skin issues. 6% of the plants of the studied area were exploited as a source of dietary fiber to treat digestive ailments.

The leaves, roots, wood or bark, flowers, herbaceous stem, fruit, and latex were found useful in a multitude of ethnopharmacological drugs, while some herbal formulations involved the use of whole plant material. Figure 5(c) shows that leaves and fruits play a significant role to make herbal remedies and stand out 19% separately from both

| Table 1: Statistic and Socio-cultural factors of Interviewees. |
|--------------------------|------------------|--------------|
| Factors                  | Items           | Numbers (♂ + ♀) | Percentage |
| Gender                   | Male            | 80            | 61.53       |
|                          | Female          | 50            | 38.46       |
| Age groups               | 20–30           | 23 + 7        | 23.07       |
|                          | 31–40           | 27 + 8        | 26.92       |
|                          | 41–50           | 12 + 13       | 19.23       |
|                          | 51–60           | 10 + 10       | 15.38       |
|                          | 61–70           | 6 + 9         | 11.53       |
|                          | 71 and above    | 2 + 3         | 3.84        |
| Herbalist                | Male            | 10            | 7.69        |
| Educational level        | Illiterate      | 12 + 8        | 15.38       |
|                          | Primary         | 20 + 15       | 26.92       |
|                          | Middle          | 5 + 5         | 7.69        |
|                          | High school     | 12 + 8        | 15.38       |
|                          | Higher secondary| 20 + 10       | 23.07       |
|                          | University      | 7 + 3         | 7.69        |
|                          | Others          | 4 + 1         | 3.84        |

♂ represents male participants, and ♀ represents female participants.
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|-------------------------------|-----------------------------------------------|--------------|-----------|------------|--------------------------|
| **Adiantaceae/ Adiantum philippense L. (BWS-066)** | Chota kalbatra (ارتبج کٹوھچ) | Leaves, rhizome | Infections, fever/blood purifier | The decoction of the rhizome is used to treat fever and febrile conditions in children (2). Plant extract is used as a blood purifier (2). The juice is applied to skin infections (1). Macerated infusions and juice are used for the treatment of dyspepsia (17), stomach pain (12) and acute catarhal inflammation (10). Macerations are used against snake bites and other stings (15). Used as a condiment and for treatment of dyspepsia (7) and the constant rattling of mucus in bronchi (11). Extract and maceration are used on skin infections and bites (12). Chewing cloves helps to manage hypertension (15). The juice is used for kidney stones (12). | Oral, topical | HB | Rare | * |
| **Alliaceae/Allium cepa L. (BWS-069)** | Piaz, ganda (پیاز, گنڈا) | Leaves, bulb | Dyspepsia, stomach issues, inflammation, diabetes/antiseptic, sting treatment | Macerated infusions and juice are used for the treatment of dyspepsia (17), stomach pain (12) and acute catarhal inflammation (10). Macerations are used against snake bites and other stings (15). | Oral, cataplasm | HB | Common | * |
| **Allium sativum L. (BWS-068)** | Thom (مہوت) | Leaves, rhizome | Diabetes, cholesterol, skin infections, bites of insects, spiders and snakes, hypertension, kidney stones | Extract and maceration are used on skin infections and bites (12). Chewing cloves helps to manage hypertension (15). The juice is used for kidney stones (12). | Oral, cataplasm | HB | Common | * |
| **Amaranthaceae/ Achyranthes aspera L. (BWS-067)** | Putthkanda (پورتکندا) | Whole plant | Blindness, cough, asthma treatment, scorpion bites, kidney stones/antilithic, analgesic | Decoctions are prepared with other medicinal plants used for cough (2) and to relieve pain (1). Leaves are used for UTIs treatment (4). The whole plant is used for kidney stones (3). Extracts are used for eye infections (1). Tinctures and decoctions are used for the mentioned diseases. Decocations are used to induce abortion (1), vomiting (1), fever (2), piles (1), and leprosy (1). The leaf extract is applied to scorpion-sting (4). Decocations are used for digestive issues (6). Fruit induces delivery (2) and juice as a blood purifier (3). | Oral, eye drops, topical | HWB | Common | [13]* |
| **Amaranthus spinosus L. (BWS-070)** | Aamb (آم) | Whole plant | Leucorrhoea, habitual abortion, vomiting, allergic asthma, fever, piles and leprosy | | Oral | HWB | Common | |
| **Anacardiaceae/ Mangifera indica L. (BWS-072)** | Aamb (آم) | Whole plant | Scorpion stings/digestive issues treatment, blood purification, induce child delivery | | Oral, topical | TT | Common | |
| **Apiaceae/*Centella asiatica (L.) Urban (BWS-071)** | Ghhor sumbi (گہور سمبی) | Whole plant | Brain health, digestive disorders | Brain tonic (1), plant tablets are a strong drug for mentally retarded children (3). The plant extract is used for digestive disorder treatment (3). | Oral | CP | Rare | |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|--------------------------------|-------------------------------------------------|-------------|-----------|------------|--------------------------|
| **Coriandrum sativum** *L.* (BWS-062) | Dhannia (دھنی) | Seeds, oil, leaves | Carminative, bile issues and hypertension treatment, skin treatment | Extract and decoctions are used. Dilute aqueous extracts are used as a cooling agent to treat hypertension (10). Leaves extracts and teas are used for digestive disorders (15). Oils and extracts are used to treat dry scalp (10). The seed extract is antibacterial and sedative used in lotions and shampoo (15). Oil is extracted, used for flu (7). Decoctions and the powder are used for stomach treatments (6). Seeds are used as masticatory (7). Leaves and seeds are used for malaria and fever (5). Extracts are prepared and used for the treatment of anemia (20) and the purification of blood (10). Juice and extract are used to improve vision (30). Leaves and seed extract are used in fever (12), liver (2) and digestive complaints (8), seeds cooked in milk increase lactation and nourishment (12). Oil from seeds is vermicide and antimicrobial (12). | Oral, ointments, cataplasm | GH | Common | * |
| **Carum copticum** *L.* (BWS-063) | Daisi ajwain (دیسی آجوین) | Seeds | Stomach trouble, fever, malaria, and flu | | Oral, ointment | GH | Common | * |
| **Daucus carota** *L.* (BWS-065) | Gajar (گاجر) | Roots, seeds | Improve vision, blood purification, anemia treatment | | Oral | HB | Common | * |
| **Foeniculum vulgare** Mill. (BWS-064) | Saunf (سائوس) | Seed, oil, leaves | Infections, fever, liver issues, digestive issues/blood purification | | Oral | HB | Common | * |
| **Apoecynaceae/Nerium indicum** Mill. (BWS-073) | Kanera (کنارک) | Roots, leaves | Promotes abortion | | Oral, ornamental | SH | Rare | * |
| **Catharanthus roseus** (L.) G. Don (BWS-074) | Sadaa bahar (سدا باهر) | Leaves | Digestive disorders | Leaves extracts and decoctions are prepared to relieve constipation (4) and digestive issues (4) | Oral, ornamental | HB | Common | [17]* |
| **Arecaceae/Phoenix dactylifera** L. (BWS-059) | Khajoog (خرج وک) | Leaves, fruit | Aphrodisiacs, hepatic treatment, anemia treatment | Edible fruit, rich in sugar, useful tonic (7). Fruit boiled with goat and cow milk is used as an aphrodisiac (10). Fruit helps to treat anemic conditions (8). Young leaves together with onion and salt are used in snakebite (12). Milky juice cures skin infections (8). Latex is used for the treatment of pneumonia fever (2) and leprosy (2). Poisonous plant. | Oral | MP | Rare | [17]* |
| **Asclepdiaceae/†Calotropis procera** (ait.) ait. f. (BWS-060) | Ak sinn (عک سین) | Leaves, roots, flower | Infections, pneumonia, leprosy/antidote | | Oral, cataplasm | SB | Common | [17]* |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|-------------------------------|------------------------|--------------|--------------------------------|-------------------------------------------------|-------------|----------|------------|--------------------------|
| **Asteraceae/Ageratum conyzoides L. (BWS-001)** | Kasni (کسن) | Roots, leaves | Hepatitis A, B, and C, kidney disorders, digestive disorders | Plant paste is used to stop bleeding (3). | Oral | HB | Common | * |
| **Cichorium intybus L. (BWS-061)** | Bhangra (بھنگرا) | Whole plant | Skin infections, hepatic ulcers | Plant paste is used for the treatment of skin infections (3). The decoction of the leaf is a liver tonic (2). | Oral | HB | Common | [17]* |
| **Eclipta alba (L.) Hassk. (BWS-075)** | Kauri booti (کوری بُوتی) | Leaves, flowers | Diabetes, cold, fever, poisonous plant | Extracts are used for the treatment of diabetes (7) and fever (2). The plant is poisonous and causes various respiratory tract allergies and infections. | Oral | SB | Common | * |
| **Tagetes erecta L. (BWS-056)** | Gutta, jangli satt barga (گٹا، چنگلی سات بگرا) | Leaves, flowers | Wound, injuries, snake bites, UTIs/antiseptic, hepatoprotective | Extracts, decoction, juice and powder are prepared for the treatment of liver (3), kidney stones (3). The paste is applied to the bites of the snake (2). Decoctions are used in the treatment of long-standing malaria (4). Roots are used to treat cancer (3). The juice is used in smallpox (2) and eye ailments (3). | Oral, cataplasm, ointment | HB | Common | |
| **Xanthium strumarium L. (BWS-058)** | Jojra (جوجرا) | Root, leaves, fruit | Smallpox/antimalarial, cancer treatment, improve vision | Decoctions are used in the treatment of long-standing malaria (4). Roots are used to treat cancer (3). The juice is used in smallpox (2) and eye ailments (3). Brances are used as a masticatory and toothbrush. Powder and fresh leaves are chewed to relieve bleeding gums (2) and toothaches (2). Decoctions are used to treat enlarged spleen (3). | Oral, ointments | SB | Rare | [17]* |
| **Bombacaceae/Bombax ceiba L. (BWS-076)** | Simbal, sambal (سَمْبَل، سَمْبَل) | Whole plant and its products | Bleeding gums, toothache and sores in the mouth, enlargement of spleen | The inflorescence is used to treat digestive disorders (6). A branch is used as a toothbrush. Powder and fresh leaves are chewed to relieve bleeding gums (2) and toothaches (2). Decoctions are used to treat enlarged spleen (3). | Oral | TT | Common | [13]* |
| **Bombax spp (BWS-034)** | Barru ghas (بَرَعُ گُھاَس) | Stem and inflorescence | Digestive disorders | Oil is antiseptic (7) and used for joint pain (8) | Oral, other | HB | Common | [13]* |
| **Brassicaceae/Brassica nigra (L.) Koch (BWS-077)** | Saroon (سَروُن) | Leaves, seeds, oil | Antiseptic, joint pains | Oil cake is used as cattle feed to cure digestive ailments (3). | Oral, ointment | HB | Common | |
| **Capsella bursapastoris (L.) Medik. (BWS-079)** | Tara mera, kara bara (تارا مِرَا، کارا بَرَا) | Leaves, seeds, oil | Scabies, dandruff/antiseptic, antiallergic, skin treatments | Infusion from the plant is prepared to treat uterine infections (5). | Oral | HB | Common | |
| **Eruca sativa Mill. (BWS-010)** | | Leaves, seeds, oil | | Seeds oil is highly antiseptic (5); used to cure itching (7), and skin infections (7). Oil cake is used as cattle feed to cure digestive ailments (3). | Topical | HB | Common | * |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|-------------------------------|------------------------|--------------|--------------------------------|-----------------------------------------------|-------------|----------|-----------|---------------------------|
| **Raphanus sativus L.** (BWS-081) | Moodi (مُوءدی) | Leaves, roots, flowers, fruit | Stomach pain, ringworm/ laxative, digestive treatment, kidney stone treatment | The root is eaten as food. Decoctions cure stomach troubles (9). The water of leaves cures ringworm (8). Pods are used as a vegetable. Root water is extracted to cure kidney stones (10). Root bark extracts are used to treat diarrhea (3), dysentery (2), stomach ulcers (2), kidney stones (2) and inflammation (1). Stem bark extract cures biliousness and urinary discharge (1). | Oral | HB | Common | * |
| *Caesalpiniaceae/ Bauhinia racemosa Lamk. (BWS-080) | Vegeative | Whole plant | Diarrhea, dysentery, ulcers, inflammation, biliousness, UTIs | | | | | |
| *Bauhinia variegata L. (BWS-078) | Kachnar (کاچنک) | Bark, leaves, seed, root, flowers | Ulcers, gastrointestinal disorders, and piles | The extract is used to cure stomach ulcer (4) and digestive disorders and piles (2) | Oral | TR | Rare | * |
| *Cassia fistula L. (BWS-002) | Amaltas (الماس) | Fruit, root bark, stem leaves, flower | Skin disease, heart diseases, stomach ulcers and relieve heartburns, tuberculosis | Topical applications treat skin diseases (2). The root extract is useful in tuberculosis treatment (2) and burning sensation (2). Seeds extracts are emetic (1). Fruit extract cures leprosy (2). Pod tea is used to cure cough (7). Plant aqueous extracts are prepared separately or with different plants for treatments. Dried leaves are smoked as narcotics (12). Leaves and flowers are smoked to cure nervous disorders (8). Flowers and buds are used in stomach troubles (6). Seeds are used in hepatic disorders and spleen enlargement (2). Oil kills worms (1). | Oral, topical | TR | Rare | [17]* |
| Cannabaceae/ Cannabis sativa L. (BWS-088) | Bhang (گنہب) | All parts | Narcotic, nervous disorders, e.g., epilepsy, mania, dementia, irritable reflexes | | Oral, inhaled | SB | Common | [17]* |
| Chenopodiaceae/ Chenopodium album L. (BWS-084) | Bathu (وہنہ) | Vegetative parts, seeds, oil | Digestive disorders/ insecticidal, hepatoprotective | | Oral | HB | Common | [13]* |
| Chenopodium ambrosioides L. (BWS-087) | Kurund (کُروند) | Vegetative parts | Insecticidal | Used to kill insects (3) | Oral | HB | Common | |
| Convolvulaceae/ Convolvulus arvensis L. (BWS-085) | Leli (لُلی) | Whole plant | Digestive disorders, respiratory disorders, kidney stones | The whole plant is purgative and extracts are prepared for the treatment of cough (2). Tea is prepared to remove kidney stones (2). Leaves are eaten with common salt to treat kidney stones (5). Juice of leaves is applied to injuries (4) and ringworms (2). | Oral | CP | Rare | [13]* |
| Crassulaceae/ Kalanchoe pinnata (lam.) Pers (BWS-086) | Patthar chat (پٹھر چچن) | Leaves | Kidney stones, wound treatment, ringworms, and other skin disorders | | Juice, cataplasm | HB | Rare | * |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|-------------------------------|------------------------|--------------|--------------------------------|--------------------------------------------------|--------------|-----------|------------|---------------------------|
| Cucurbitaceae/ *Cucumis melo-var agrestis* Naudin. (BWS-083) | Chibra (زَابِج) | Fruit, seeds | Digestive disorders | Fruit and seeds extracts are used to cure digestive malfunctioning (7) | Oral | CP | Common | [17]∗ |
| *Momordica charantia* L. (BWS-082) | Karela (کِرَل) | Fruit | Malaria, skin disorders/dengue treatment, antiseptic | The water of fruit is used as a blood purifier (12) and for dengue (5) treatment. The paste is applied to the skin to treat infections (9). | Oral, topical | CP | Common | ∗ |
| *Citrus latifolia* (thunb.) mats. and Nakai (BWS-089) | Tarbooz, dawana (تَارْبُوُذَ، زَوْبَرَت) | Fruit, seeds | Digestive disorders, fever | The fruit is used as a cooling agent (9). Cotyledons of seed are used to cure digestive disorders (3). | Oral | CP | Common | ∗ |
| *Luffa acutangula* (L.) Roxb (BWS-003) | Kali tori (کَلِی تُری) | Fruit | Digestive disorders/laxative | Extracts are prepared for the treatment of constipation and digestive issues (4) | Oral | CRH | Common |  |
| Cuscutaceae/ *Cuscuta reflexa* Roxb. (BWS-090) | Akash bail (آکاش بِل) | All parts | Kidney stones treatment, hepatic disorders | It is purgative and extracts are used in the liver (4) and kidney disorders (3) | Oral | PE | Common | ∗ |
| *Cyperaceae/*Cyperus rotundus* L. (BWS-009) | Dela (ذِلَّة) | Rhizome | Digestive disorders, fever, cardiac disorders | The tuber is useful in stomach disorders (1). Soup of tuber is useful in diarrhea, dysentery, dyspepsia, vomiting, cholera (1) and fever (1). Whole plant juice is prepared for heatstroke (1). The tuber is useful in stomach disorders (1). Soup of tuber is useful in diarrhea, dysentery, dyspepsia, vomiting, cholera and fever (1). | Oral | RH | Common | [17] |
| *Cyperus scariosus* R.Br. (BWS-028) | Bara dela (بَارَا دِلَا) | Rhizome | Digestive disorders, fever, cholera | The plant is narcotic and a little poisonous. The milky latex is applied to skin infection especially in ringworm disease (4). Extracts are used for digestive disorders (2). Oil and decoctions are used in the treatment of constipation (4), also increase milk production (3) and treatment of painful joints (3). The extract is used for stomach ulcer treatment (6). | Oral | RH | Common | ∗ |
| Equisetaceae/ *Equisetum spp.* (BWS-091) | Baansi booti (بَانْسٍ بَوْتِی) | Whole plant | Cough treatment | Tea is used to treat dry cough (5) | Other | HB | Common |  |
| *Euphorbiaceae/*Euphorbia helioscopia* L. (BWS-004) | Daddar booti (دَادَر بَوْتِی) | Latex, leaves | Ringworm treatment, narcotic, constipation | The plant is narcotic and a little poisonous. The milky latex is applied to skin infection especially in ringworm disease (4). Extracts are used for digestive disorders (2). Oil and decoctions are used in the treatment of constipation (4), also increase milk production (3) and treatment of painful joints (3). The extract is used for stomach ulcer treatment (6). | Oral, topical | HB | Common | ∗ |
| † *Ricinus communis* L. (BWS-006) | Dhola, aim, arind (دُهوْلَ، اِئم، ارْنِذ) | Oil, seed, root | Digestive disorders, joint pains, poisonous plant | Oil and decoctions are used in the treatment of constipation (4), also increase milk production (3) and treatment of painful joints (3). The extract is used for stomach ulcer treatment (6). | Oral, topical | MT | Common | [17]∗ |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|-------------------------------|------------------------|--------------|------------------------------|-----------------------------------------------|--------------|-----------|------------|--------------------------|
| **Fumariaceae/Fumaria indica** (hausskn.) Pugsley (BWS-093) | Shahtara (شہتر) | Whole plant | Blood purification, sweating treatment | Whole herb extract is used as a blood purifier (6). The extract is prepared to treat excessive sweating (3). | Oral | HB | Common | * |
| **Fabaceae/Cicer arietinum L. (BWS-026)** | Ghana (آنگ) | Seeds, leaves | Leucorrhea, animals’ medicine | Roasted grams aqueous extracts are said to be beneficial in leucorrhea (10). Seed coats used as a food supplement for livestock. | Oral | SH | Common | * |
| **Lens culinaris Medik. (BWS-092)** | Massur (مئور) | Seeds | Cold and fever | Seeds are used in the treatment of fever and cold (3). | Other | SH | Common | * |
| **Pisum sativum L. (BWS-005)** | Matar (مشر) | Seeds | Food | Green unripe seeds and ripened seeds are used as pulses and vegetable (3). Seed powder is used in asthma treatment (4). Decoctions are recommended into abdominal ailments (3). | Other | SH | Common | * |
| **Melilotus indica (L.) All. (BWS-011)** | Methri (میتھری) | Leaves | Respiratory disorders, digestive ailments | Seed powder is used in asthma treatment (4). Decoctions are recommended into abdominal ailments (3). | Oral | SH | Common | * |
| **Medicago polymorpha** L. (BWS-094) | Maina (مینا) | Leaves, buds | Infections | Skin infections (5) | Other | SH | Common | * |
| **Trigonella foenum-graecum L. (BWS-027)** | Methy, methry (میتھی، میری) | Leaves, seeds | Respiratory disorders, kidney disorders, fever, joint pain | Seeds are used in asthma (2), fever (1), sore throat (2) and pains in the body (2) | Oral | SH | Common | * |
| **Dalbergia sissoo Roxb. (BWS-012)** | Tahl (تلہ) | Bark and wood | Digestive disorders | Decoctions and juice are prepared from leaves for the treatment of digestive disorders (11) | Oral | TR | Common | [13] |
| **Sesbania sesban** (L.) Merrill (BWS-018) | Janter, jantri (جنتر جنتری) | Fiber, wood, seeds | Animals’ medicine | The seed is used as a food supplement for livestock (7) | Other | SB | Common | |
| **Crotalaria juncea L. (BWS-007)** | Sann (سان) | Stem, fiber | Digestive treatment | Fiber is used as a laxative (10) | Other | SB | Common | |
| **Pongamia pinnata** (L.) Pierre. (BWS-019) | Sukh dan (سکھ مسک) | Shoots | Dental issues, skin disorders | Shoots are used to make toothbrushes (11). The paste is used for the treatment of skin disorders such as ringworms (6). | Oral, tropical | TR | Common | [13] |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|------------------------------|-----------------------------------------------|-------------|----------|------------|--------------------------|
| Lamiaceae/Leucas aspera (willd.) Link (BWS-095) | Piddu (پید) | Leaves, flowers and fruit | Antimalarial, respiratory disorders | Extract of leaves, flowers and fruit are used as an antimalarial drug (4). The extract is used to treat cough (2). Syrup of leaves used in digestive diseases (30). Extracts are used in cosmetic products (24). | Oral | SB | Common | [17]* |
| Mentha arvensis L. (BWS-008) | Podina (پودینا) | Leaves, whole plant | Digestive disorders, dermal treatment | | Oral, topical | SB | Common | * |
| Ocimum basilicum L. (BWS-013) | Niazbo (ویزاہبو) | Leaves, seeds | Headache, fever | Tea is prepared from leaves to relieve headaches (12). Extracts have a potential role to treat fever (12). | Oral | HB | Common | * |
| Salvia splendens yellow ex Schult. (BWS-096) | Sinji (سین) | Whole plant | Animals’ medicine | Used to treat livestock digestive disorders (8) | Other | SH | Common | |
| Liliaceae/Aloe vera (L.) burm. f. (BWS-054) | Kavaar gandal (گن کِن راوک) | Leaves, pulp | Dermal treatment, joint pains | Leaf pulp is a skin tonic and is used in medicines and cosmetics (25). Pulp cooked in milk is useful in joints pain (25). | Ointment, topical, cataplasm | HB | Common | [17]* |
| Linaceae/Linum usitatissimum L. (BWS-024) | Alsi (اُلس) | Seeds, fiber | Gout treatment, rheumatic issues, food, laxative, animals’ medicine | Seeds are used in rheumatic (10) and gout swellings (2). Laxative in the case of hemorrhoids (11). Oil is edible. Oil cake is a cattle food supplement (2). Leaf paste applied in fever (4) and headache (4). Flowers are used for boils (1) and stomach ulcers (2). Seeds are used as a laxative (4). Powder of flowers, fruit and root is used in cough (2) and leprosy (1). | Oral, ointment | HB | Common | |
| Malvaceae/Abutilon indicum (L.) Sweet. (BWS-025) | Muhri booti (مہری بوٹی) | Bark, seed, root | Infections, fever, digestive disorders, respiratory and neural issues | | Oral, topical | HB | Rare | * |
| Hibiscus rosasinensis L. (BWS-020) | Chini gulab (چنی گلاب) | Flower petals | Kidney stones | Extracts are used for the treatment of kidney stones (11) | Oral | SB | Common | [17]* |
| Meliaceae/Azadirachta indica (adr. Juss.) (BWS-014) | Neem (نیم) | Wood, leaves, fruit | Blood purifier, dermal treatment | Leaves are used as skin tonic in cosmetics and skin diseases (40). Extract of leaf purifies the blood (10). The fruit is edible. | Oral, topical, cataplasm | TR | Common | [13]* |
Table 2: Continued.

| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|-------------------------------|-----------------------------------------------|--------------|-----------|------------|--------------------------|
| *Melia azedarach* L. (BWS-015) | Dharek (دھرک)           | Leaves and wood | Blood purifier, infections treatment, dermal disorders, diabetes | Wood and leaf extracts are blood purifier (30), it cures diabetes (20) | Oral, topical, cataplasm | TR        | Common     | [17]*                    |
| *Mimosaceae/Acacia nilotica* (L.) Delile (BWS-055) | Kikri (کیکر)           | Bark, leaf, fruit | Respiratory disorders, digestive issues | The bark is used to cure cough (12) and dysentery (10). Leaves cure stomach ulcers (5). Pods and seeds are also medicinal. Extracts are used for the treatment of various respiratory (5) and digestive ailments (5). Bark and gums are of medicinal values and used as a laxative (6). | Oral | MT        | Common     | [17]*                    |
| *Albizia lebbeck* (L.) Benth. (BWS-023) | Sharin (شرین)           | Bark, gum, wood | Respiratory ailments, digestive disorders, laxative, relieve pain | Oral | TR        | Common     | *                        |
| *Moraceae/Broussonetia papyrifera* (L.) L’Herit. (BWS-053) | Jangli shehtoot (چانگلی شہتوب) | Wood | Respiratory ailments | Used to treat respiratory disorders of livestock (10) and humans (7) | Others | TR        | Common     | *                        |
| *Ficus carica* L. (BWS-021) | Angeer, pakwari (ناچر، پاکواری) | Fruit, latex | Wound treatment, digestive disorders, blood purifier | Milk of plant is anti-microbial and is applied to wounds and injuries (10). The fruit is a tonic and cures digestive diseases (16) fruit is available in fresh and dry form, used as a blood purifier (10) | Oral, topical | MT        | Common     | *                        |
| *Ficus palmata* Forssk. (BWS-016) | Jangli pakwari/Anjeer (چانگلی پکواری/ آنژیر) | Fruit, latex | Wound treatment, digestive disorders | Milk of plant is antimicrobial and is applied to wounds and injuries. The fruit is a tonic and cures digestive diseases. | Oral, topical | MT        | Common (19) | *                        |
| *Ficus glomerata* Roxb. (BWS-017) | Gullar, rumbal (گلر، رمبل) | Wood, fruit | UTIs treatment, dermal disorders, sexual disorders, digestive disorders | The fruit is used in the treatment of urinary discharges (7), leucorhea (4), skin diseases (4) and stomach ulcers (5) | Oral | LT        | Common     |                         |
| *Morus acedosa* Griff. (BWS-022) | Shahtoo (شاہتو) | Fruit, wood | Cough treatment, bronchitis, sputum relieving | Fruit extract and juice are used for respiratory disorders (35) Edible fruit, laxative (10), increase bile production (10), soothe throat sore (9) and pain in tonsils (10) | Oral | TR        | Common     | *                        |
| *Morus alba* L. (BWS-032) | Chitta toot (چٹہ توٹ) | Leaves, fruit, wood | Digestive disorders, hepatic treatment | Oral | TR        | Common     | *                        |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|-------------------------------|------------------------|--------------|-------------------------------|-----------------------------------------------|--------------|----------|------------|--------------------------|
| *Morus nigra* L. (BWS—029)    | Kala toot, toot sia (توت الک) | Leaves, fruit, wood | Food, digestive disorders, hepatic treatment, respiratory disorders | The syrup is made from fruit which cures cough (13) and sore throat (12). Other uses are the same as in the case of *M. alba* | Oral | TR | Common | [17]* |
| Myrtales/ *Psidium guajava* L. (BWS-031) | Amrood (ام رود) | Fruit | Digestive disorders, respiratory infections | Nutritive fruit, good for digestive tracts (20), medicinal in case of diarrhea (12). Ashes of dried fruit are used for the treatment of whooping cough (20). | Oral | TR | Common | * |
| Myrtaceae/ *Eucalyptus camaldulensis* Dehn (BWS-097) | Safeda (سی دے س) | Wood, leaves | Cold, cough, fever | Leave extracts and tinctures are used for the treatment of cough (13) and cold (12) | Oral | TR | Rare | |
| Oleaceae/ *Jasminum grandiflorum* L. (BWS-052) | Chambeli (مچمبی) | Root, leaves, flowers | Dermal issues | The plant is used for healing chronic ulcers (12), skin diseases (12) and poisonous infections. Roots are used for ringworm (12). | Oral, topical | SB | Common | * |
| *Jasminum sambac* (L.) Ait. (BWS-030) | Motia (متوی) | Root, leaves, flowers | Dermal disorders, ringworm treatment, digestive disorders, eye disorders | The plant is medicinal, aqueous extracts cure dyspepsia (4), piles (2), anemia (2), fever (2), dysentery (3) and scurvy (2). Seeds are a source of oil; used as a lubricant (8). Root used in chronic skin diseases (2). Plant juice is used in oedema (2), jaundice (2) and cutaneous infections (2). It is also used for cattle skin diseases (2). | Oral, topical | SB | Common | * |
| Oxalidaceae/ *Oxalis corniculata* L. (BWS-101) | Khatti booti (کھٹی بونچک) | Whole plant | Food, dyspepsia, piles, anemia, fever, dysentery, scurvy | | Oral | HB | Common | * |
| Papaveraceae/ *Argemone mexicana* L. (BWS-098) | Kandiari (کاندیری) | Root, seed, juice and oil | Dermal treatment, hepatic disorders, animals’ treatment | | Oral, topical,ointments | HB | Rare | |
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|--------------------------------|------------------------|--------------|--------------------------------|-----------------------------------------------|--------------|-----------|------------|--------------------------|
| Poaceae/Arundo donax L. (BWS-099) | Narr (نار) | Leaves, stem | Menstrual pain, headache | Extracts are prepared and used to relieve multiple pains (3) | Oral, other | SHS | Common | [14] |
| Avena sativa L. (BWS-100) | Jangli jae, jawi (جنگلی جھیوا) | Vegetative parts | Cardiac disorders, respiratory disorders | Infusions and decoctions are prepared to treat cardiac ailments (4) and respiratory disorders (4) | Oral | HB | Common | * |
| Bambusa arundinacea (retz.) Willd. (BWS-102) | Bans (بناب) | Stem | Joint pain | Powder from stem nodes is used to treat joint pains (12) | Other | LT | Common | * |
| Cynodon dactylon (L.) Pers. (BWS-033) | Khabbal ghas (کھبا جا سی) | Whole plant, leaves | Hemorrhage, anemia, skin infections | Infusion and decoctions are prepared for skin treatment (10). Tinctures are used for the treatment of anemia (12) and hemorrhage (12). | Oral | HB | Common | * |
| *Echinochloa crus-galli (L.) P. Beauv (BWS-103) | Swank ghas (سکان گیا) | Leaves | Skin infection | It is used to treat infections (7) | Other | HB | Common | * |
| Triticum aestivum L. (BWS-050) | Kanak, gandum (کنک، گندم) | Straw, seeds | Antiseptic | Extracts are antiseptic (15) | Oral | CLH | Common | * |
| Saccharum officinarum L. (BWS-035) | Ganna (گنا) | Stem | Food, hepatoprotective | Source of sugar. The juice is used to treat jaundice and hepatitis (16). | Oral | CLH | Common | * |
| Pennisetum glaucum (L.) R.Br. (BWS-051) | Bajra (بجرہ) | Whole plant | Malnutrition, weight loss | Extracts are used for malnutrition and weight loss treatment (9) | Oral | CLH | Common | * |
| Polygonaceae/Rumex dentatus L. (BWS-104) | Jangli palak (جنگلی پالک) | Root and vegetative parts | Respiratory disorders, abortifacient | Used as a cough remedy (11). Leaves extracts are prepared to induce abortion (4). | Oral | HB | Common | * |
| Primulaceae/Anagallis arvensis L. (BWS-107) | Kokoo ghas (کوکو گیا) | Leaves, seeds | Skin disorders, wound healing | Decoctions are used for hydrophobia and dropsy treatment (8). It also cures warts and itching (8). Help to balance nutrients in the body. It increases Cu++ and As++ ions in soil (5). | Topical | HB | Common | * |
| Pteridaceae/Pteris spp. (BWS-105) | Kalbtra (کلبر) | Rachis | Nutrient balance, fertilizer | | Other | HB | Rare | * |
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| Rhamnaceae/Ziziphus mauritiana Lam. (BWS-108) | Ber, beri | Wood, fruit | Digestive disorders, hepatic issues | Edible fruit; laxative (10), increase bile production (6) | Oral | TR | Common | * |
| Ziziphus nummularia (burm. F.) wight and Arn (BWS-109) | Jangli ber | Fruit, shoots | Nourishment | Edible fruit help in malnutrition (11) | Other | SB | Common | * |
| Rosaceae/Rosa alba L. (BWS-106) | Chitta gulab | Flower petals, juice, oil | Antimicrobial, digestive disorders, ornamental, perfumes, food | Rosewater is of medicinal value. It is skin tonic (10), antimicrobial (10) and laxative (10). Leaves of this plant kill worms (10). Extract of leaves is used to kill worms found in wounds of cattle (11). | Oral | SB | Common | * |
| Prunus persica (BWS-110) | Aru | Leaves, fruit, seeds | Digestive disorders, skin disorders, animals’ treatment | Leaves of this plant kill worms (10). Extract of leaves is used to kill worms found in wounds of cattle (11). The ripened fruit is good for the proper functioning of the digestive system (11). The paste is used to enhance the skin glow (20). | Oral, topical | TR | Common | * |
| Rosa indica L. (BWS-111) | Desi gulab | Flower, oil | Skin disorders | The ripened fruit is edible and the extract is used to treat diabetes (16) | Oral, topical | SB | Common | [17]* |
| Rosa damascena Mill. (BWS-038) | Gulab | Flower petals, oil | Skin disorders | Petals are used to treat skin disorders (5) | Tropical | SB | Rare | * |
| Eriobotrya japonica (thumb.) Lindl. (BWS-049) | Lokaat | Fruit | Diabetes | The ripened fruit is edible and the extract is used to treat diabetes (16) | Oral | TR | Common | * |
| Rutaceae/Citrus aurantifolia (christm.) Swingle. (BWS-039) | Nimboo | Fruit | Infections, malaria, fever, cough, skin disorders | Juice of fruit is used in the treatment of fever and malaria (12). Fruit juice and the extract from fruit peel are used to cure acne and black marks on the skin (20). The fruit is used in cosmetics. | Oral, topical | SB | Common | * |
| Citrus maxima (burf.) Merr. (BWS-036) | Chakotra | Leaves, fruit | Diabetes | Fruit juice is useful for diabetic patients (14) | Oral | SB | Common | * |
| Scrophulariaceae/Verbasum thapsus L. (BWS-037) | Gitthar tambako | Leaves | Narcotic, respiratory disorders | The plant is narcotic (4). The smoke of dried leaves is inhaled in bronchitis (3) | Inhaled | SB | Common | * |
| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|--------------------------------|-----------------------------------------------|--------------|----------|------------|--------------------------|
| Solanaceae/Capsicum annuum L. (BWS-048) | Surkh mirch (رس میرچ) | Fruit | Snake bites | Fruit paste is used against bites of insects (8) | Oral, cataplasm | SB | Fruit | * |
| † Datura innoxia Mill. (BWS-042) | Aam dhadura (ع ام دھادورا) | Root, stem, leaves, fruit, seeds | Skin disorders | Flower extract is used for the treatment of skin disorders such as itching, scabies, ulcer, leprosy dandruff (4). The plant is poisonous. Extracts are used for skin treatments such as itching, scabies, ulcer, leprosy dandruff (3). The plant is poisonous. Leave extract is applied on rabid dog-bites (2). | Oral | SB | Rare | * |
| † Datura metel L. (BWS-040) | Kala datura (کلا داتورا) | Root, stem, leaves, fruit, seeds | Skin disorders, treatment of rabid dog-bites | Aqueous extracts and tinctures are laxative (8), tonic, emetic (1), carminative (1), antiseptic (6), sedative (10), and useful in bronchitis and asthma (12). Dried leaves are smoked as narcotics. | Cataplasm | SB | Common | |
| Nicotiana tabacum L. (BWS-041) | Tambaco (تمباقو) | Leaves | Digestive disorders, narcotic, neural issues, respiratory treatment | Oral, inhaled | SB | Common | * |
| Solanum indicum L. (BWS-043) | Bari kandiari (بیڑی کنڈئیارا) | Fruits, seed | Respiratory disorders | Oral | PS | Common | * |
| Solanum nigrum L. (BWS-047) | Makoo, pilk (مکو، پالک) | Leaves, fruit, seeds | ENT issues, digestive disorders, skin disorders and infections treatment | Oral, topical | HB | Common | [17]* |
| Solanum surattense burm. f. (BWS-046) | Chhoti kandiari (چوٹی کنڈئیاری) | Leaves, fruit, seeds | Influenza, fever, difficult urination, bladder stone, sore throat, cardiac diseases and promote fertility in women. | Oral | HB | Rare | |
Table 2: Continued.

| Family/species (accession no.) | Vernacular (Urdu name) | Part(s) used | Disease(s) treated/other uses | Mode of preparation(s) (UR against each disease) | Mode of adm. | Life form | Occurrence | Similar use(s) references |
|--------------------------------|------------------------|--------------|-------------------------------|--------------------------------------------------|--------------|-----------|------------|---------------------------|
| *Withania somnifera* (L.) Dunal (BWS-112) | Asgand (دنوش) | Roots, fruit, seeds | Diabetes, insomnia treatment | Leaves and roots are used for restful sleep. The extract is prepared from leaves and roots to treat diabetes (6). | Oral | HB | Common | [17]* |
| Tamaricaceae/ *Tamarix aphylla* (L.) Karst. (BWS-113) | Pilshi (پیلسح) | Shoots, wood | Anti-infectious | The smoke of the shoot is antimicrobial (5). | Inhaled | MT | Rare | [17] |
| Verbenaceae/ *Vitex negundo* L. (BWS-114) | Bannaa (ارباب) | Leaves, young twigs | Respiratory disorders, nervous disorders | Leaves are heated with mustards oil and applied to the chest in case of bronchitis (8). Young twigs are eaten to cure cough (8), asthma (8), fever (4), eye diseases (6), inflammatory (2), intestinal worms (3), ulcers (3), nervous disorders (3) and leprosy (3). | Oral, topical, cataplasm | MT | Common |  |
| *Lantana camara* L. (BWS-045) | Punj phuli (پنج پھولی) | Whole plant | Hepatoprotective | Extracts are used for the treatment of jaundice (3) | Oral | SB | Common | * |
| Vitaceae/ *Vitis vinifera* L. (BWS-044) | Angoor (گونر) | Fruit | Cough, digestive disorders | The fruit is nutritive, tonic and medicinal (2) | Oral | LC | Rare | * |

Occur, occurrence; Adm, administration; URs, use report; Rpt, reported, HB, herb; SB, shrub; TR, tree; PE, parasitic epiphyte; BT, bushy tree; TT, tall tree; BSH, bushy shrub; MP, medium palm; GH, glabrous herb; HWB, herb woody base; CP, creeping herb; RH, rhizobious herb; MT, medium tree; SH, small herb; SHS, shrub with hallow stem; CLH, cultivated herb; PS, prickly shrub; LC, large climber; CRH, climbing herb; * indicates species enlisted in the IUCN Red List of Threatened Species; † represents poisonous plants, * indicates plants enlisted in Pakistan Herbal Pharmacopeia. References from previous ethnomedical studies from district Sialkot and comparison with Pakistan Herbal Pharmacopeia that reported similar formulations to treat similar ailments are decorated as well.
categories which make 38% in total. The great proportion of leaves and fruits in herbal formulations show their significance because of the presence of various phytochemicals that are present in these plant parts, while another reason is the ease of availability of these parts. Wood or bark (12%), latex (10%), and flowers (10%) were reported likewise followed by roots (7%) and herbaceous stems (7%). 11% of the formulations reported the use of the whole plant body, while 5% reported the use of plants as a source of dietary fibers. Some formulations also reported the use of rhizomes or bulbs for the preparation of medicines. Some studies on the ethnomedicinal flora of Sialkot also reported the use of different plant parts in various herbal medicines dominated using leaves, fruits, and herbaceous stems, which is in favor of our study [13, 14, 16, 17].

3.4. Preparation of Ethnopharmacological Formulations.
Preparation of crude plant formulations involves the use of potential phytometabolites to treat ailments. The potency of a herbal drug to cure disease depends greatly on the method of preparation that in actual is the manipulation of the
phyto-secondary metabolites to transfer their full potential from the plant part to the perilous part of the body. Table 2 reports the use of medicinal plants in crude herbal formulations against various pathophysiological conditions. This ethnopharmacological survey reported (Figure 6) the use of plant extracts (32%) as a major method for the preparation of herbal drugs, while 11% of the herbal formulations were prepared in the form of decoctions. Some of the herbal remedies were used in the form of food (10%), oil (10%), and fresh plant materials (6%), while other herbal formulations involved cooking (5%) in the the form of food. The preparation of the ethnopharmacological formulations by the inhabitants of the studied area shows that the food medicinal portion is essential to treat the ailments. The people of Bajwat reported that the consumption of crude herbal drugs as food plays a significant role to treat ailments. The inhabitants of Bajwat were adding crude herbal formulations in their routine food and sometimes were preparing special formulations separately to treat ailments. Some of the inhabitants reported the inhalation of smoke (2%) of wood or other plant material to treat respiratory disorders such as bronchitis, cough, and asthma. A similar number (2%) of plant materials were used for the preparation of tincture. 8% of the total reported plant species were used in animal medicine because of their medicinal importance. Some of the plant species were given to animals as fodder to treat digestive disorders of livestock, to eradicate malnutrition, and used as a food supplement. Few herbal medicines were prepared and applied to animals’ skin to cure dermal issues. There is no study reported previously from district Sialkot to determine the mode of preparation of herbal formulations by local inhabitants. Our results are contrary to some previously performed work from different territories of Pakistan that reported powder [25] as the best method for the preparation of herbal formulations because of fewer contamination chances of the powder and easy to preserve and reuse. The people of the Bajwat Wildlife Sanctuary claimed that the preparation of the extract is the most feasible and quick strategy that involves the simple method to prepare formulations and its consumption as fresh can increase the efficacy of a drug in case of any severe ailment.

3.5. Administration of the Ethnopharmacological Drugs. Some of the inhabitants of Bajwat were well aware of the mode of administration and its significance. According to inhabitants, the mode of administration helps to deliver the drug efficiently and timely to the suffering part of the body. Figure 7 encodes various modes of administration of herbal formulations reported by the local inhabitants and healers. The oral route stands up with 69% of the total formulations reported. The oral route reported the ingestion of the fresh plant material powder, using teas, tinctures, or decoctions prepared from different plant parts. People of Bajwat also used oils as a laxative to cure digestive disorders, or sometimes different oils were taken orally to enhance vitality and to reduce feebleness and promote vigor. The oral intake of oil from some plant species was also reported as an aphrodisiac (e.g., Phoenix dactylifera L.). The second most common mode of administration was reported as the topical application (15%) of the plant crude drug. The topical administration of the plant material in the form of paste prepared from different plant parts was most common among the inhabitants of Bajwat to treat skin disorders such as acne, skin microbial infections, ringworms, and eczema and to treat burn marks. The topical administration also involved the cosmetic enhancement of the skin glow that includes the use of the paste of Aloe vera, Mentha arvensis aqueous extract spray, and Azadirachta indica paste to cure acne and other skin ailments. The cataplasm makes 7% of the total reported plant species from the study area that involves the maceration of different plant parts such as root, stem, and leaves and applied on the skin to treat different types of skin wounds and different degrees of burns and disorders. The cataplasm was also reported to play a futile role to act as an antidote against the stings of snakes, insects, and other organisms. The ointments also contribute to 7% of the reported mode of administration. Most of the ointments were extracted in the form of oils and massaged on the skin surface to cure joint pain and to promote strength among bones and muscles. Very few of the plant materials were smoked (2%) to cure various respiratory disorders such as asthma, cough, bronchitis, and emphysema. Some of the plant parts such as leaves and flowers were smoked as a narcotic and for recreation such as Nicotiana tabacum, while some were used as tranquilizers.
and sedatives. The oral administration was reported extensively in Pakistan Herbal Pharmacopoeia as the major mode of administration of herbal formulations [8]. Some studies performed in the nearby territories of Pakistan [26, 27] also reported oral administration as the most common method of administration of herbal drugs.

3.6. Diseases and Pathological Conditions. The digestive disorders were reported most common ailments of the inhabitants of Bajwat which account for 21% of the total disorders cured (Figure 8). Commonly reported digestive disorders include diarrhea, stomach pain, heart-burning issues, nausea, constipation, abdominal bloating, dyspepsia, and vomiting. Different ailments were categorized according to the WHO International Classification of Primary Care, 2nd Edition, which is used worldwide. Skin disorders were found common among the inhabitants to be treated by crude formulations, and 16% of the total ailments cured marked to this category. The most common skin ailments among the inhabitants of Bajwat were reported to be eczema, skin boils, acne, skin burns, skin infections, ringworm, and warts. 14% of respiratory disorders were cured such as cough, asthma, bronchitis, emphysema, and shortness of breath. The rest of the different ailments including fever and malaria (12%), urinary disorders (10%), hepatic ailments (9%), reproductive disorders (7%), cardiac disorders (6%), and neurological disorders (5%) were cured by using different herbal formulations.

Table 3 shows that a total of 2029 URs were collected from 130 informants against 42 pathophysiological groups by using 114 medicinal plant species, and on average, 48 URs were collected against each disease category. Each medicinal plant species was mentioned ∼18 times to cure the health issues of the local inhabitants (∼18 UR per plant species). 290 URs (∼15%) were reported from 32 plant species to treat digestive disorders which shows that digestive disorders are the most common ailments prevailing among the inhabitants of the Bajwat Wildlife Sanctuary, while 279 URs (∼14%) from 27 plant species were mentioned that involved the preparation of different extracts, ointments, and paste for
Table 3: Diseases, use report and number of species.

| ICPC-2   | Disease/action                     | Use reports | No. Of species |
|----------|------------------------------------|-------------|----------------|
| W83      | Abortion induced (abortifacient)   | 10          | 3              |
| B82      | Anemia                             | 42          | 4              |
| A26      | Cancer                             | 3           | 1              |
| K84      | Cardiac disorders                  | 16          | 3              |
| R09      | Catarrhal inflation (sinus infections) | 10        | 1              |
| D12      | Constipation                       | 63          | 9              |
| R05      | Cough                              | 115         | 13             |
| S24      | Dandruff                           | 10          | 2              |
| W99      | Delivery issues                    | 16          | 2              |
| D19, D82 | Dental ailments                    | 20          | 3              |
| T89, T90 | Diabetes                           | 70          | 4              |
| D29      | Digestive issues                   | 290         | 32             |
| D07      | Dyspepsia                          | 36          | 4              |
| F73      | Eye infections                     | 15          | 2              |
| A03      | Fever/febrile/cold                 | 102         | 18             |
| A10      | Hemorrhage/wounds/stop bleeding    | 49          | 8              |
| K86, K87 | Hypertension                       | 40          | 8              |
| F05      | Impaired vision                    | 30          | 1              |
| A08      | Inflammation                       | 17          | 4              |
| A78      | Infections (antimicrobial)         | 95          | 11             |
| D13      | Jaundice                           | 18          | 5              |
| U14      | Kidney stones                      | 46          | 8              |
|          | Leprosy                            | 19          | 5              |
| D97      | Liver issues                       | 65          | 9              |
| A73      | Malaria/dengue                     | 62          | 5              |
| T91      | Malnutrition                       | 28          | 3              |
| P85      | Mental retardation                 | 3           | 1              |
| N99      | Neurological disorders             | 50          | 7              |
| A01      | Pain reliever (analgesic)          | 21          | 5              |
|          | Piles                              | 2           | 1              |
| W17, W18 | Postpartum issues/recovery         | 5           | 1              |
| R83      | Reproductive disorders             | 54          | 6              |
| R96      | Respiratory disorders/asthma       | 27          | 6              |
| L99      | Rheumatism                         | 48          | 3              |
| Y08      | Sexual disorders                   | 10          | 2              |

Figure 8: The diagram showing the percentage of different disorders cured by using plant formulations.
oral and topical administrations to treat skin disorders. There was no study performed previously to report the health disorders of the people of the district Sialkot or inhabitants of the Bajwat Wildlife Sanctuary.

3.7. Side Effects of Poisonous Medicinal Plants. The inhabitants of Bajwat reported that most of the plants of the sanctuary do not have any harmful effects. A few species anyway were having dangerous impacts and the nearby individuals keep up broad information about the distinctive poisonous and nonharmful medicinal plants. For instance, the juice of the seeds of Parthenium hysterophorus L. was reported to have poisonous impacts on both humans and livestock, for example, Calotropis procera (Ait.) and Euphorbia helioscopia L. The latex of the two plants causes harmful impacts through eye and skin contact. Some studies reported that the use of the limited dose of the latex of Euphorbia is beneficial to treat warts and wounds, but excessive and unlimited use of latex can be carcinogenic [21]. Parthenium hysterophorus L. was also reported to be a poisonous plant by local healers and some inhabitants and can cause severe respiratory ailments and was found growing excessively along the roadsides. Although some people in the local market were found using Parthenium hysterophorus L. to decorate flower bouquets, Maleki and Akhani [21] also reported some of the plants mentioned above as poisonous plants from Mountain Tafftan, Iran, which is located at the border of Pakistan’s southwestern province, Balochistan. The Royal Botanical Garden’s annual report [31], stated 8% of poisonous plants out of the total documented plant uses. However, in the Bajwat Wildlife Sanctuary only 6 plants were reported poisonous which makes 5.26% of the total reported plant species of the study area.

3.8. Plants Enlisted in the IUCN Red List of Threatened Plant Species. The IUCN Red List of Threatened Species provides significant information about the evidence-based extinction and risk assessments of individual plant species. It also contributes to understanding the forces that are responsible for the extinction of species and also helps in management interventions to overcome or delay the extinction. Despite critical evaluation of species at risk of extinction, it is believed that many plant species will be extinct before they have been recognized as being at risk of extinction [32]. Determination of plant species’ current status in the IUCN Red List of Threatened Species can greatly help to protect the threatened ethnomedicinal flora of a region. According to the IUCN Red List of Threatened Plant Species, more than 3200 species are threatened with extinction, which makes about 27% of the total assessed species. Eight out of the total 114 plant species were listed in the IUCN Red List as least concern (LC), including Bauhinia variegate*, Cyperus rotundus L., Cassia fistula L.*, Centella asiatica (L.) Urb.*, Echinocloa crus-galli (L.) P. Beauv, Eclipta prostrata L.*, Vitis vinifera L.*, and Vitex negundo L. while Eucalyptus camaldulensis Dehn.* was enlisted as near-threatened (NT). The occurrence of plant species in Bajwat Wildlife Sanctuary was also observed, and 19 species were found rarely distributed, which makes 17% of the total reported plant species, while 5 species (* placed at the end of their name) out of 19 rarely distributed species were enlisted in the IUCN Red List of Threatened Species (Table 2).

4. Conclusion

This study involves the first-ever extensive ethnomedicinal investigation to report the medicinal plants of the Bajwat Wildlife Sanctuary, which is a complex riverine biological ecosystem. We have reported 114 medicinal plant species. The extract preparation (32%) was reported as the most basic strategy for making herbal formulations, while oral intake (69%) was observed most common for the administration of drugs among the local community. The highest number of URs against digestive disorders (290–15%) and skin disorders (279–14%) show that these are the most common problems among the local inhabitants. The stomach-related issues were seen generally regular among local people and were cured by crude ethnomedicinal formulations. This study embraces the ethnopharmacological knowledge of local healers and inhabitants and reports the exchange of data from generation to generation because of strong communication in families and neighboring communities. The investigation of the ethnomedicinal information and their comparison with past reports from the district Sialkot, and Pakistan Herbal Pharmacopeia endorses the enlisted knowledge of local healers and inhabitants to prepare formulations against multiple disease categories. About 75% of the enlisted medicinal plant species were not reported previously in

| ICPC-2 | Disease/action   | Use reports | No. Of species |
|--------|------------------|-------------|----------------|
| S11, S76 | Septicemia (blood purifier) | 83 | 8 |
| A77 | Skin infections/disorders | 279 | 27 |
| S12 | Small pox | 2 | 1 |
| D87 | Snake bites and other stings | 39 | 4 |
| U99 | Stomach pain/issues | 77 | 13 |
| D10 | UTIs | 40 | 9 |
| Total | 2029 | 263 |

ICPC-2: International Classification of Primary Care-2nd Edition.
research reports from Sialkot, while 21% of novel herbal formulations were documented in comparison with the Pakistan Herbal Pharmacopeia. This study likewise explains the importance of the studied zone and the incredibly assorted diversity of plants and its status to help plant species to develop unreservedly without human mediation.

Data Availability

The data used to support the findings of this study are included within the article.

Ethical Approval

This study does not involve any human or animal experiments. The study was approved by the University Bioethical Committee, and the data were recorded from local inhabitants/participants after oral consent.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors’ Contributions

BJ, WI, MS, HABA, and WH devised the study, collected and identified plant specimens, and interviewed inhabitants. BJ wrote and revised the manuscript and analyzed data. BJ, WI, MS, HABA, AS, and ZRM were added to the subsequent drafts. The authors read and finalized the manuscript for submission. Sidra Ahsan Shah, Wajeeha Iqbal, Muneeba Sheraz, and Bilal Javed are equally contributed first authors.

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