Traditional knowledge and economic significance of *Berberis lycium* Royle in the District Dir Lower, Pakistan

Latif Ahmad, Farid Ullah, Andrew J. Semotiuk, Wajid Rashid, Imran Khan, Hammad Ahmad Jan, Rainer W. Bussmann and Imran Ahmad

**Research**

**Abstract**

*Background:* *Berberis lycium* Royle is a well-known medicinal plant, belonging to the family Berberidaceae, and is widely distributed in Lower Dir, Pakistan. Parts of *B. lycium* like rhizomes and berries are used by the local people as medicine and food. This research work focused on two major aspects regarding *B. lycium.* Firstly, to determine the various traditional and medicinal uses of *B. lycium.* Secondly, to document its monetary value at local markets in the study area.

*Methods:* Semi-structured and open-ended ethnobotanical interviews, local market inquiries, field observation, and group discussions were conducted from May 2018 to October 2019 to understand ethno-botanical knowledge of *B. lycium.*

*Results:* In the current study, a total of 61 local people from Dir Lower were interviewed. According to the result of our study, 37% of informants used the *B. lycium* for the treatment of diabetes mellitus, followed by infection (12.5%) and bone repair (10%). In terms of economic value, the fruits and rhizomes of *B. lycium* are also important. Locally the rhizome was sold for prices ranging between $3 and $6 USD per kilogram.

*Conclusion:* This study concludes that local people of Dir Lower have significant medicinal as well as economic information of *B. lycium.* Because of its high medicinal and market value, it is a warning sign that the plant is highly threatened due to overexploitation. Given this, we suggest to the local and district forestry department, governmental organizations, and non-governmental organizations to encourage, motivate, and also create awareness among the local people to conserve the species for future generations.

*Keywords:* Ethnomedicine; Market value; Traditional knowledge; *Berberis lycium*; Dir Lower

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Background

For thousands of years, herbal medicines have significantly contributed to human health and life protection. Throughout history, mankind has depended on plant resources to fulfill their basic needs such as medicine, food, shelter, clothing, and transportation (Ahmad et al. 2006). Especially in rural areas, and in particular, in many tropical countries, the use of plants provides a fundamental source of drugs, and a portion of the population still depends upon them (Shaheen et al. 2019). Traditionally used plants, animals, and fungi with useful secondary metabolites are hopeful agents for modern drug discovery as they play a vital role in herbal medicine (Newman and Cragg, 2007). The WHO reports that about 25% of modern medications have been extracted from botanical resources (Rates, 2001). The use of natural drugs as medication still presents a very crucial role in medical care, especially for people of growing nations (Kloucek et al. 2005). Nowadays, medicinal plants play an important role in the lifestyle of traditional people and numerous regionally produced ethnomedicines are used as household treatments for a wide range of human health issues (Qureshi and Ghufran, 2005). Numerous investigations have been conducted to obtain modern drugs from botanical materials (Rashid and Arshad, 2002; Bhatti et al. 1998). About 12.5% of the 422,000 plant species documented worldwide are reported to have medicinal value. Up to 60% of the drugs prescribed in Eastern Europe consist of unmodified or slightly altered higher plant products (Abbasi et al. 2011).

Globally, the trade of botanical resources extends mainly in the form of patent medicinal products, plant extracts, rhizome, decoction pieces, and products of healthcare (Zhu et al. 2016). The worldwide market of traditional and ethnomedicine based on herbs and their relevant products have seen a considerable increase in the last three decades. Around the globe, demand and trade of botanical products are rapidly increasing day by day (Baydoun et al. 2015). For example, in 2014, the ethnomedicine industrial output value in China reached 730.2 billion yuan; in the US, the 2008 out-of-pocket expenses for natural products were $14.8 billion. While in South Korea, the annual expenditure on traditional medicine was $4.4 billion in 2004 and increased to $7.4 billion in 2009 (Zhu et al. 2016). Similarly, Pakistan also occupies a key position in the international botanical products trade. In the herbal products import, Pakistan has a 9th position (11,350 tons), on another note, the export rank is 10th (8100 tons) (Khan and Rauf, 2014).

Pakistan has unique biodiversity due to its different climatic zones, including a wide range of wild plant species. The country has a rich flora in which 2,000 plant species are used at one time or another, in one culture or another, for medicinal purposes, but of these 2,000 Pakistani species, about 400-600 are documented and studied for medicinal purposes (Abbasi et al. 2011). According to one report in Pakistan, a total of 1,572 plant genera and about 5,521 species of angiosperms are identified. Among these, nearly 600 plants are known to be important medicinally. Of these plant species, about 400 species of plants are believed to be endemic to Pakistan (Ali, 2008). An explorative survey conducted by the Pakistan Forest Institute determined that 75% of crude ethnomedicine are widely exported while more than 200 are traded locally in Pakistan (Hamayun et al. 2005). In rural areas, ethnomedicine still plays a significant role and is still used as the primary healthcare system. According to an estimate, about 80% of people of remote regions of Pakistan are still dependent on medicinal plants (Qureshi and Ghufran, 2005; Jan et al. 2017).

*B. lycium* Royal is a well-known medicinal plant belonging to the family Berberidaceae. Barberry is the English name of *Berberis lycium*, it is called *Ishkeen* in Urdu, and locally it is known as *Zyar largay/Kwaray* in Pashto. *Berberis* is a large genus with nearly 400 species, widely distributed in...
America, Asia, and the Mediterranean region. In Pakistan, there are about 20 species; most of them distributed in the northern regions of Gilgit, Dir, Hazara, Murree, Kashmir. Hazara, Jhelum Valley, Gilgit, Swat, and Chitral.

*B. lycium* is a spiny shrub, sub-erect or erect, about 6 ft tall. Leaves simple, oblanceolate to oblong and sub-sessile. Flower pale yellow and pedicellate. The edible berries of *B. lycium* 7-8 mm long, 5-6 mm wide, oval-shaped, with acidic taste (Flora of Pakistan, 1989). Several *Berberis* species are well-known as alternate hosts for rust fungi, especially of wheat and some other cereals. The present study had three aims: (i) To determine the traditional and medicinal uses of *B. lycium* Royle in villages of Dir Lower, (ii) To investigate and document the ethnobotanical uses pertaining to different parts of *B. lycium* in Lower Dir regions, and (iii) To identify the local market value of *B. lycium* in Lower Dir.

**Materials and methods**

*Ethnographic and physical description of the study area*

The current research work was carried out in the district of Dir Lower, Khyber Pakhtunkhwa, Pakistan. Dir Lower shares an international boundary with Afghanistan in the west, the district of Bajaur in the south, the district of Swat on its east, and Dir Upper on its north-west and north respectively. It has an area of 1583 square kilometers. Lower Dir lies in the lesser Hindukush range between 35°-10' to 35°-16′N Latitude and 71°-50′ to 71°-83 E Longitudes (Ahmad et al. 2015; Khan et al. 2010). The climate of Lower Dir is temperate and receives its highest rainfall in March and its lowest in July, October, and November. The average elevation of Dir Lower ranges from 700 m to 2,800 m above sea level and the climate largely depends on altitude (Figure 1).

**Field survey**

Regular plant collection trips, field observation, and ethnobotanical surveys were arranged from March 2018 to October 2019 in 30 villages of the district Dir Lower for the purpose to collect and document traditional knowledge from the native peoples regarding *B. lycium*. Before starting the semi-structured and open-ended interview, we informed local participants that it was a student academic project and investigation was only for our research purposes, not for any commercial or other benefits, and obtained their consent for the study.

**Data collection and ethnobotanical interviews**

This ethnobotanical survey was conducted in 30 villages. We contacted 61 respondents for interviews including native elder people, traditional practitioners, Homeopaths, *Hakeems* (local
practitioners), and market vendors who had sufficient knowledge of *B. lycium*. All the ethnobotanical interviews, inquiries, and group discussions with local people were conducted in the local language Pashto. Taking guidance from Martin (1995) and Cotton (1996), in ethnobotanical interviews and group discussions with local respondents, we asked questions regarding the vernacular name of the plant, morphological parts of the plants used, medicinal use, flowering and fruiting period the modes of administration and preparation, complete recipes and drug preparation.

**Plant collection, identification, and deposition**

*B. lycium* specimens were collected from 30 different sites in the district Lower Dir during regular plant collections trips arranged according to the fruiting or flowering season. Fruiting or flowering shoots of *B. lycium* were collected from different sites and we recorded detailed information in our field notebook. After confirming plant identity with informants, the plants were collected and photographed. The collected plants were pressed and dried in the newspapers and blotting papers. The collected plants were later brought to the herbarium in the Department of Botany, Shaheed Benazir Bhutto University Sheringal, and Pakistan.

**Results and Discussion**

**Demographic distribution of the participants**

During ethnobotanical surveys, a total of 61 considerable respondents who used *B. lycium* in the context of local traditional practices and knowledge were interviewed. Among the 61 informants, 45 were men and 16 were women (Table 1). After the inquiry, the data were divided on the basis of people’s ages into four groups. Of these, the majority of respondents belonged to the age range 51-70 years (34% informants) followed by 30-50 age (31%), 71-80 age (23%), and 81-90 (12%) years of range (Figure 2). The lesser number of female respondents was due to cultural norms in the study area. Women are reluctant to talk with people outside of their family (Ahmad et al. 2015). Furthermore, female informants were mainly involved in preparation of herbal recipes in the home. During ethnobotanical interviews, it was observed that mostly male informants were involved in *B. lycium* collection, market trading, and herbal formulation.

**Part of the plant used and treatment of human health issues**

During the ethnobotanical interviews, it was confirmed that only rhizome and fruit of *B. lycium* were used for the treatment of different kinds of human health problems (Figure 3). About 60% of informants confirmed used the rhizome for different human health issues. Forty percent of the local people used the berries of *B. lycium* for the treatment of diabetes mellitus and also as an antipyretic (Table 2).

The rhizomes of *B. lycium* contain the alkaloid berberine which has significant antibacterial activities. It was found that inhibitory activity was shown by the components present in the root extracts of *B. lycium* and not by the solvents used for extraction (Irshad et al. 2013). Anamaya and Hasanuzaman (2006) report that the berries of *B. lycium* are a purgative and cooling, and also used for the release of intestinal colic and pharyngitis. Fruit decoction of *B. lycium* is also used in typhoid fever.

| Study area | Adeni | Timergara | Khal | LalaQilla | Munda | Samarbagh | Balambat | TOTAL |
|------------|-------|-----------|------|-----------|-------|-----------|----------|-------|
| Total Informants | 5     | 9         | 9    | 9         | 11    | 11        | 7        | 61    |
| Male Respondents |       |           |      |           |       |           |          |       |
| Local elders | 2     | 4         | 5    | 4         | 3     | 4         | 4        | 26    |
| Hakeem | 1     | 2         | 1    | 2         | 1     | 1         | 1        | 9     |
| Market vendor | 1     | 2         | 2    | 2         | 1     | 1         | 1        | 10    |
| Female Respondents |       |           |      |           |       |           |          |       |
| Local elders | 1     | 1         | 1    | 1         | 6     | 5         | 1        | 16    |
| Education Level |       |           |      |           |       |           |          |       |
| Illiterate | 3     | 2         | 3    | 3         | 2     | 5         | 2        | 20    |
| Elementary school | 2     | 1         | 3    | 1         | 2     | 2         | 2        | 13    |
| Secondary school | 1     | 1         | 2    | 1         | 1     | 2         | 1        | 9     |
| High school | 1     | 2         | 0    | 2         | 2     | 3         | 1        | 11    |
| University | 1     | 0         | 2    | 1         | 0     | 1         | 3        | 8     |
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Table 2. Identified medicinal and market value of Berberis lycium in Lower Dir.

| Study site          | Part Used | Mode of Preparation | Mode of Administration | Medicinal uses                                                                 | Market price (US $/Kg) |
|---------------------|-----------|---------------------|------------------------|---------------------------------------------------------------------------------|-----------------------|
| **Sumer Bagh Tehsil** |           |                     |                        |                                                                                 |                       |
| Kambat Rhizome      | Decoction | Oral               | Diabetes mellitus, repair of bone, chest infection | 2.50                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| Shahi Rhizome       | Poultice  | Oral               | Cancer, clean of blood, infection of eye | 3.00                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| **Timergara Tehsil** |           |                     |                        |                                                                                 |                       |
| Timergara city Rhizome | Powder  | Externally          | Ulcer, heart burn, and also for serum glutamic pyruvic transaminase (SGPT) | 5.00                                                                            |                       |
| Fruit               | Direct    | External           | Diabetes mellitus      |                                                                                  |                       |
| Khongay Rhizome     | Decoction | Oral               | Skin and stomach complaints | 4.50                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| Tarry Rhizome       | Decoction | Oral               | Diabetes mellitus mouth and throat infection | 3.50                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| **Lalqilla Tehsil** |           |                     |                        |                                                                                 |                       |
| Maidan Rhizome      | Powder    | Externally          | Repair of bone, throat infection | 3.50                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| **Munda Tehsil**    |           |                     |                        |                                                                                 |                       |
| Main-Kelly Rhizome  | Decoction | Oral               | Treatment of mouth, and SGPT | 3.00                                                                            |                       |
| Fruit               | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| Band Fruit          | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| **Balambat Tehsil** |           |                     |                        |                                                                                 |                       |
| Khaima Fruits       | Direct    | Externally          | Diabetes mellitus      |                                                                                  |                       |
| Rhizome Powder      | Direct    | Externally          | Diarrhea, infection of eye | 5.50                                                                            |                       |
| Kandaro Fruit       | Direct    | Externally          | Diabetes mellitus      |                                                                                  |                       |
| Rhizome Powder      | Direct    | Externally          | Stomach and eye infection |                                                                                  |                       |
| **Adenzai Tehsil**  |           |                     |                        |                                                                                 |                       |
| Talash Rhizome      | Powder    | Externally          | Used for chest infection, and SGPT | 6.00                                                                            |                       |
| Fruits Powder       | Direct    | Externally          | Diabetes mellitus      |                                                                                  |                       |
| Chakdara Rhizome    | Decoction | Internally, oral    | Used for repair of bone | 6.50                                                                            |                       |
| Fruits Powder       | Direct    | Oral               | Diabetes mellitus      |                                                                                  |                       |
| **Khal Tehsil**     |           |                     |                        |                                                                                 |                       |
| Rabat Rhizome       | Decoction | Oral               | For diarrhea, and for cancers | 3.75                                                                            |                       |
| Fruits Direct       | Oral      | Oral               | Diabetes mellitus      |                                                                                  |                       |
According to the result of our study, most of the informants used *B. lycium* for the management of diabetes mellitus, followed by bone repair 10%, diarrhea 5%, and liver issues serum glutamic pyruvic transaminase (SGPT) (7.5%) (Figure 4).

Previously it was well established that *B. lycium* is highly medicinal plant. In recent study, the crude methanol extract of *B. lycium* has anxiolytic, central nervous system depressant, and analgesic activities (Samiullah et al. 2020). According to Katare et al. (2020), the alkaloid berberin in the *B. lycium* is a potential candidate for COVID-19. In another study, different parts of the plant are used for bone fracture, and also used as carminative, diuretic, antiseptic (Ijaz et al. 2020). In the study conducted by Hu et al. (2020) methanolic extract of *B. lycium* shown excellent cytotoxic, brine shrimp lethality, and antioxidant activities. The plant is also have indicating the potential of this plant against colorectal and breast cancer. The methanolic extract of *B. lycium* is mentioned in the study by Yousaf et al. (2018) show antiviral activity against Hepatitis C Virus. According to the ethnopharmacological study conducted by Ahmad et al. (2015), the rhizome of *B. lycium* is used for the treatment of hypertension.

Besides the rhizome of *B. lycium*, fruits is also medicinally important to be hypoglycemic, anti-inflammatory, anti-carcenogenic, and antipyretic especially in diabetic patients. It may also be beneficial in iron deficiency (Madiseh et al. 2014; Sood et al. 2010). Sher (2011) reported that the plant is used for cut and wound healing. According to Khan et al. (2010), dried powdered bark of *B. lycium* is used for internal wounds, dysentery, and throat pain.

**Methodology of herbal formulation and administration**

About 65% of ethnomedicine were administrated orally, while 35% used as external ways. In the survey, local informants described three different methods for drug preparation to treat various kinds of human ailments. The most common was decoction followed by powder, eating, and poultice (Figure 5). Most of the respondents, dried rhizome (500 mg) is boiled in 4 cups (100 mL) of water for 15 minutes, the liquid is filtered with a piece of cloth and stored in a glass bottle in clean bottle. This decoction is given to patients suffering from diarrhea, stomachache, jaundice, etc.

![Figure 4. Different parts of *B. lycium* used to treat various human ailments.](image-url)
Local market values
Local herbal markets are cultural places for the native people where a variety of herbal drugs are marketed and traded. Furthermore, these herbal markets also represent the botanical diversity of a specific area (de Albuquerque et al. 2007). The derived income from the sale of B. lycium plants is very important for lower-income households to fulfill their basic needs because the people of Lower Dir have a monthly personal cash income of 12,000 to 16,000 rupees or lower, and the area is mostly undeveloped (Ahmad et al. 2017). Native people of district Lower Dir collect rhizome and fruit of B. lycium and sell it in local markets, thus earning their income (Figure 6). The economic values for B. lycium available in local markets were determined in the Pakistani currency and converted to US dollars.

Berberis lycium status in the study area
During ethnobotanical interviews, it was observed that 40% of informants were directly involved in the collection B. lycium. Of these, 20% of respondents collected rhizomes at 10 kg per capita per month, 35% at 3 kg per capita per month, 45% at 2 kg per capita per month. Moreover, 25 respondents were also found to collect fruits of Berberis for market value as well as for medicinal purposes. According to the questionnaire results, 30% of the respondents used B. lycium as ethnomedicine due to ease of availability for suggested human ailments, 20% low price, 17% absences of basic health facilities, and 15% suggestion from the elder’s people of the family.

Status of traditional practitioners
In Pakistan, there are about 130000 homeopaths, 455 Voids and 3584 Hakems (traditional practitioners) registered. Nearly 457 Tibbi-e-Unani clinics and dispensaries are providing human healthcare facilities. Approximately 300-350 herbal medicines producing industries, and 300 homeopathic drug-producing companies are present (Hussain et al. 2009). In the present explorative study, we interviewed 61 respondents, of these, 18 were Hakems and 12 were Pansaries (herbal product sellers). According to our ethnobotanical interviews, questionnaires, and inquiries, 15 Hakems informed us that they gained the traditional knowledge about B. lycium from their family elder, while 12 of them were involved in the collection of B. lycium for economic reasons, and 3 were including the fruits in their diet for nutritional purposes.

Conservation status
Over-exploitation for phytochemical and economic purposes threatens the richness of the medicinal flora in Pakistan. The increase in the human population is straining these resources (Malik et al. 2005). In Pakistan Berberis has important eco-commercial, cultural, traditional and livelihood roles in hilly regions (Khan et al. 2016). Overharvesting of B. lycium is largely caused through population pressure and associated factors: an increase in demand for cultivation land, the population of livestock, and forest utilization to meet increasing demands for fodder, timber, and fuelwood, as well as
the local demand for market and medicinal value. Lower Dir is harboring a large number of Afghan refugees who are completely dependent on herbal medicine for their health issues. “Twenty years ago B. lycium was very abundant in the district. The local people collected it when they needed it at home for the treatment of human health issues and at that time there was no market value” (Personal Communication with Local elder). Now B. lycium has completely vanished from most regions in the district.

![Figure 6. Prices of rhizomes and fruits of *Berberis lycium* sold in Lower Dir local markets](image)

According to the well-established medicinal and market importance, this species urgently needs to be conserved for future generations. The species needs an ex-situ conservation program at the botanical garden, nurseries, and farms. In in-situ conservation, the plants are protected in their native habitats; this type of conservation is aimed at keeping intact the ecological relationships between species and, in some cases, the cultural relationship between people and wild species. This kind of strategy may involve a formal protected area recognized by governments, such as sacred groves, springs and mountains and reserves for medicinal plants where communities have decided that no other extractive activities are allowed (Shabbir and Jabeen, 2012). Furthermore, widespread informal conservation such as leaving plants to reproduce, not treading on their habitat and sustainable management practices would provide a benefit. Co-ops that spread seeds or plants sharing or designating habitats such as parks and other public areas could benefit the species population and awareness by locals also. This leads to ideas for future, applied research on the feasibility of establishing a formal conservation strategy.

**Conclusions and future perspective**

The following conclusions are obtained in light of the present study. The present research was carried out to study the different features of *B. lycium* plants, where 37.5% of people used it for diabetes mellitus, for bone repair 10%, diarrhea 5%, cancer 5%, clearing of blood 2.5%, SGPT 7.5%, eye infection 7.5%, stomach infection 2.5%, chest infection 2.5%, ulcer 2.5%, heartburn 2.5%, skin disease 2.5%, and for mouth and throat infection 12.5%. According to 25% of interviewed people, *B. lycium* survives mostly in inaccessible areas. According to the opinion of 30% of people, the plant is facing threat due to deforestation, road, and building construction. The older participants (over 60 years of age) had more information about the plant. In this traditional knowledge of the local respondents can be used as an effort to promote the conservation of *B. lycium* in the district Dir Lower. The current ethnobotanical survey concludes that the populations of Dir Lower have enough information regarding the medicinal and economic benefits of this important medicinal plant, but this knowledge is often not transferred to the younger generation. Given this, we suggest to the local and district forestry department, governmental organizations, and non-governmental...
organizations to encourage, motivate, and also create awareness among the native people, herbalists, harvesters, farmers, elder people, herders, hakeems, pastoralists, pansaries, transporters, and market vendors who use this ethnomedicine to prevent and conserve the naturally potent medicinal plants from overexploitation.

Declarations

Ethics statement: All participants provided prior informed consent before any interviews were conducted.
Conflict of interests: The authors declare that they have no competing interests.
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Authors' contributions: Authors' contributions in this article are; LA, FU, and IK collected the plant species. LA prepared the first draft of the manuscript. FU and IA carried out the field survey. LA conceived and designed the research and identified the collected sample. AJJS, WR, HAJ and RB gave counsel and revised the manuscript. All authors read and approved the final manuscript.

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