# Folk medicinal uses of *Bergenia ciliata* (Haw.) Sternb. s.l. in traditional healthcare systems

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**Research**

## Abstract

*Background*: *Bergenia ciliata* s.l. is one of the high-value priority medicinal plants found across the Himalayas and widely used in Nepal, India, and Pakistan. It is distributed between 900-4400 m elevation range. This study provides a systematic comparison using a methodologically valid cross-source framework.

*Methods*: Primary data were collected through semi-structured interviews with local people (n=131). Secondary information was collected through published literature. Binary presence/absence data for 19 ailment categories, 5 plant parts, and 6 preparation modes were compiled for the present study (Nepal) and previous literature from Nepal, India, and Pakistan (year 2010-2026; Nepal 27, India 26, Pakistan 14). Pairwise similarity was assessed using the Jaccard Similarity Index, appropriate for sources with heterogeneous denominators.

*Results*: The present study documented uses across 8 ailment categories, 4 plant parts, and 3 preparation modes. Highest similarity with past literature was observed for ailment categories with past Nepali sources (J = 0.67). Seven ailment categories, including digestive, genitourinary, and musculoskeletal diseases, were shared across all four sources, constituting a pan-regional consensus core. Rhizome, leaf, and whole plant were documented in all sources, with rhizome the main part used; paste and powder were universal preparation modes.

*Conclusions*: The Jaccard index revealed a stable cross-regional ethnomedicinal core for *Bergenia ciliata* s.l., supporting pharmacological prioritization of consensus uses and conservation planning focused on destructive rhizome harvesting. High dependency on rhizomes raises conservation concerns. Pharmacological validation of dominant uses and sustainable harvesting practices are urgently recommended.

*Keywords*: Ailment category, Conservation, Ethnomedicine, Jaccard Similarity Index, Medicinal plant

## Background

The available natural resources around us are being utilized since prehistoric times for different purposes, like food, shelter, medicine, decoration, recreation, and many more. The interaction of local people with surrounding nature and environment is studied under ethnoecology, and if the relationship is only with plants, it is ethnobotany (Martin 1995). Individuals have been utilizing plants and plant products for their medical care needs from ancient times, and the history of plant use can be traced back to some 60,000 years ago (Leroi-Gourhan 1975). In past, when there were no other modern technical facilities

like these days, their knowledge was solely based on the experience of their ancestors. The development of modern science especially in the field of biotechnology and biochemistry made life easier than in the past. But still, the indigenous people around the world have rich traditional knowledge about the use of resources (Turner *et al.* 2022).

Ethnobotany seeks to answer the question about the relationship between people and the environment. Ethnobotany is important for conservation of natural resources, indigenous knowledge, and sustainable development. Previously, ethnobotanical work was focused on academic exercises without providing benefits to local people or conservation (Hamilton *et al.* 2003). It should be applied so that it can provide benefits in the conservation of natural resources and knowledge about plant use, the sustainability of wild plant resources, food security, identification and development of new natural products, and drug development.

Ethnomedicine encompasses the approaches used to address diseases and ailments by the indigenous people of various places. The ethnomedicinal practice varies with geography and culture. The traditional healing system was more or less influenced by magico-religious rituals and supernatural powers (Charles 1998). Medical facilities like these days were not available in the past, and everything was based on experience or trial and error methods. People learned the use of plants by carefully observing the self-medication behavior of animals in prehistoric times (Huffman 2003). Very few written documents about the medicinal use of plants were found in ancient times. The Papyrus Ebers is one of the ancient written documents of about 1550 B.C. which documented 876 prescriptions made from more than 500 different substances ranging from minerals to plant and animal substances (Kelly 2009). In medieval times, more refinement works were carried out in the field of traditional herbal medicine. Later on, in the 19$^{th}$ century, bioactive compounds were extracted from medicinal plants, and this enhanced the knowledge of the medicinal use of plants (Furst & Zundorf 2015). At present time several herbal medicines are practiced by various communities around the world, and plants are also used as raw materials for drug production.

Among the 1,762 species with medicinal value in Nepal (Kunwar *et al.* 2022), *Bergenia ciliata* is well known for its medicinal use and is one of Nepal's priority medicinal species (DPR 2006). Both codified and non-codified systems of healing are practiced in Nepal. In codified systems, the knowledge is well documented, and this is further confirmed by analyzing the extraction and secondary metabolites and their biological activities. In non-codified healing systems, the knowledge is transferred by indigenous people from one generation to the next orally, and there is a risk of extinction of knowledge as these are not preserved in a documented form. Also, in some communities, such knowledge is kept as top secret.

*Bergenia ciliata* is widely used for its medicinal value. It is used as a tonic and to treat cough, heart diseases, and stomachache (Gurung & Pyakurel 2017) in Ayurveda. Consumption of *Bergenia ciliata* increases urine production and helps in the removal of kidney stones (Ahmad *et al.* 2018). It is preferred to treat urinary calculi in Unani Medicine (Kapoor & Kapoor 1976). Tibetan practitioners apply leaf paste of *Bergenia* spp. on the skin to be protected from harmful ultraviolet rays (Li *et al.* 2006). *Bergenia ciliata* is well studied in India and Pakistan. Because of the antipyretic property of this plant, its consumption can produce sweat and is hence used to treat fever (Ahmed *et al.* 2023). The plant has a cooling property and is hence used in wound healing (Mir *et al.* 2024). This plant can prevent indigestion and relieves constipation, and is therefore used to treat piles (Kumari *et al.* 2012).

The ethnomedicinal use of this plant is also reported from some districts of Nepal (Bhandari *et al.* 2026, Bhattarai 2018, Budha-Magar *et al.* 2020, Khakurel *et al.* 2022, Kunwar *et al.* 2013, Kunwar & Adhikari 2005, Mall *et al.* 2015, Pangeni *et al.* 2020). In traditional folk medicinal practice *Bergenia ciliata* is used chiefly to treat kidney stones, fever, wounds, diarrhea, dysentery, cuts, toothache, body ache, cough, fracture, gall bladder stone and vomiting by Sherpa, Tamang, Tibetan, Thami, Magar, Magar (Kham), Majhi, Gurung, Limbu ethnic groups of Nepal (Adhikary *et al.* 2011, Bhattarai 2018, Budha-Magar *et al.* 2020, Mall *et al.* 2015, Manandhar 2002, Pangeni *et al.* 2020, Shrestha *et al.* 2016, Sigdel *et al.* 2013). Still, the distribution of this species in all potential districts in Nepal is unknown. In recent years, this plant has also been planted in gardens, but to date, it has not been planted commercially in Nepal.

This study aims to explore and compile the information on folk medicinal use of *Bergenia ciliata* (Haw.) Sternb. s.l. in traditional healthcare systems in Nepal and compare this knowledge with previous literature from Nepal, India, and Pakistan. This study will be helpful in aggregating the scattered medicinal use data of *Bergenia ciliata* s.l. This study applies the Jaccard similarity index to compare use profiles across geographically separated sources. Plant-use information was collected from previously unexplored areas. Further research is necessary to use this plant widely as a raw material in modern allopathic medicinal practice.

## Materials and Methods

**Study area and data collection**

Ethnobotanical data were collected from eleven hilly districts, namely: Dhankuta, Lalitpur, Makawanpur, Rasuwa, Kaski, Palpa, Gulmi, Arghakhanchi, Pyuthan, West Rukum, and Darchula (Figure 1). These districts were selected for this study, within which *Bergenia ciliata* s.l. is known to occur and has an established history of traditional plant-based healthcare practices. The study area was visited between 2021 and 2024. Knowledge on parts used and mode of preparation was also collected. The information was collected from both males and females of various age groups (22 to 90 years) through interviews (n=131; Male=77; Female=54). Ten to twelve participants from each district were interviewed. Purposive sampling method with snowball referral was applied for selection of informants based on their traditional knowledge on use of *Bergenia* spp. Local healers, collectors, key informants, and traders were interviewed. Focus group discussions were also carried out with knowledgeable community members who were directly or indirectly involved in use, collection, and trade of *Bergenia* spp. The study plant was displayed in front of informants to collect detailed information. Possible available sites of *Bergenia ciliata* were also visited with local people. Informed consent was obtained from all the participants before data collection. Standard floras were followed for plant identification (Akiyama *et al.* 2012, Polunin & Stainton 1984, Shrestha *et al.* 2022). Secondary information was collected from research articles published in different journals, research reports, and books related to Ayurveda, Ethnobotany, Ethnomedicine, and traditional indigenous use of *Bergenia ciliata.* Only publications from 2010 to 2026 were included for secondary information (Nepal-27, India-26, Pakistan-14). Only these three countries are considered because of their overlapping biogeographic zones, shared traditional medicinal systems, and comparable socio-ecological contexts, which allow for meaningful cross-reference of plant use patterns. The temporal range was limited to 2010-2026 to ensure methodological comparability, as quantitative ethnobotanical indices became more widely standardized during this period. Open-access journals are easily available during this period. Systematic searches were carried out in Google Scholar, PubMed, Scopus, and Science Direct, using keyword combinations including "*Bergenia ciliata*," "*Bergenia ligulata*," "*Bergenia pacumbis*," "ethnobotany," "ethnomedicine," and "traditional use," in combination with the country names Nepal, India, and Pakistan. Sources were included if they (i) were published between 2010 and 2026, (ii) reported field-based, primary ethnobotanical or ethnomedicinal data, (iii) explicitly reported the studied taxon as *B. ciliata*, *B. ligulata*, and/or *B. pacumbis*, and (iv) reported the specific plant part used, method of preparation, and/or ailment/use category, allowing extraction of comparable use-report data. Studies were excluded if they (i) reported only phytochemical, pharmacological, or pharmacognostic data without an ethnobotanical/traditional-use component, (ii) were duplicate publications or conference abstracts reporting data already published in an included full-text source, or (iii) did not specify sufficient locational, plant-part, or use-category detail to allow standardized data extraction. Priority was given to peer-reviewed journal articles indexed in the databases. However, given the regional and often locally-published nature of ethnobotanical documentation in Nepal, India, and Pakistan, relevant grey literature (institutional reports, theses, and conference proceedings) and book chapters were also considered, provided they met the same field-based data inclusion criteria described above. Grey literature and book chapter sources were subjected to an additional verification step: each was cross-checked for (i) clear documentation of field methodology, and (ii) consistency of reported plant identification with accepted taxonomic treatments.

Voucher specimens were collected from the study area for further identification and herbarium preparation. The herbarium specimens were deposited (23 specimens of *B. ciliata* and 45 of *B. pacumbis*) at Tribhuvan University Central Herbarium (Accession numbers TUCL 26-5981 to 6048).

**Study species**

Ten species of the genus *Bergenia* Moench (Family: Saxifragaceae) are found throughout the world (POWO 2026), of which only three species of *Bergenia* viz. *Bergenia ciliata*, *Bergenia pacumbis*, and *Bergenia purpurascens* are found in altitudinal range of 900-2500 m, 900-4400 m and 3200-4700 m, respectively, in Nepal (Shrestha *et al.* 2022). *Bergenia ciliata* (Haw.) Sternb. and *Bergenia pacumbis* (Buch.-Ham. ex D.Don) C.Y. Wu & J.T. Pan are two closely related species of the genus *Bergenia*, collectively known as *pakhanbed*. Both of them are native to the Himalayan region and widely distributed across Nepal, northern India, and Pakistan (Akiyama *et al.* 2012, Shrestha *et al.* 2022). These species share a high degree of morphological, phytochemical, and ecological similarity (Shrestha *et al.* 2022). The leaf margins of both species are ciliate. The leaves of *B. ciliata* have hairs on the surface, sometimes very sparse, while *B. pacumbis* does not bear hairs on its leaf surface. These species are widely used in almost similar ethnomedicinal practices in Nepal, India, and Pakistan (Budha-Magar *et al.* 2020, Chauhan *et al.* 2012, Gautam *et al.* 2023, Haq *et al.* 2023). *Bergenia ciliata* is found in western and central Nepal, and *B. pacumbis* is distributed from east to west Nepal (Shrestha *et al.* 2018, 2022). Both of these are treated as the same taxon and reported as *Bergenia ciliata* in most of the previous studies because of their morphological, phytochemical, and ecological similarity and the same functional ethnomedicinal category (Humagain & Shrestha 2009, Manandhar 2002, Rokaya

*et al.* 2010, Shrestha *et al.* 2016). Both taxa were observed during the field survey (*B. ciliata* in Palpa, Gulmi, West Rukum, Arghakhanchi and Pyuthan, and *B. pacumbis* in Palpa, Kaski, West Rukum, Gulmi, Darchula, Makawanpur, Lalitpur, Dhankuta and Rasuwa). The local people use both of them for identical medicinal uses without any distinction.

*Bergenia ciliata* and *Bergenia pacumbis* have a complicated nomenclatural history. The name *Saxifraga ligulata* was first described by Wallich in 1820. Later on, it was found invalid, and Yeo (1966) treated this taxon as *Bergenia ciliata* f. *ligulata*, and this is now considered a synonym (POWO 2026). Several names are now associated with *B. pacumbis* like *B. ciliata* var. *leichtlinii* and *B. himalaica*. Because the taxonomic dispute remains unresolved at the time of writing, and because the majority of ethnomedicinal literature from Nepal, India, and Pakistan has reported these taxa under overlapping or interchangeable names (*B. ciliata*, *B. ligulata*, *B. pacumbis*), we adopt the aggregate concept *B. ciliata* s.l. in this paper. This research paper aims to compare the traditional use of this species across national boundaries.

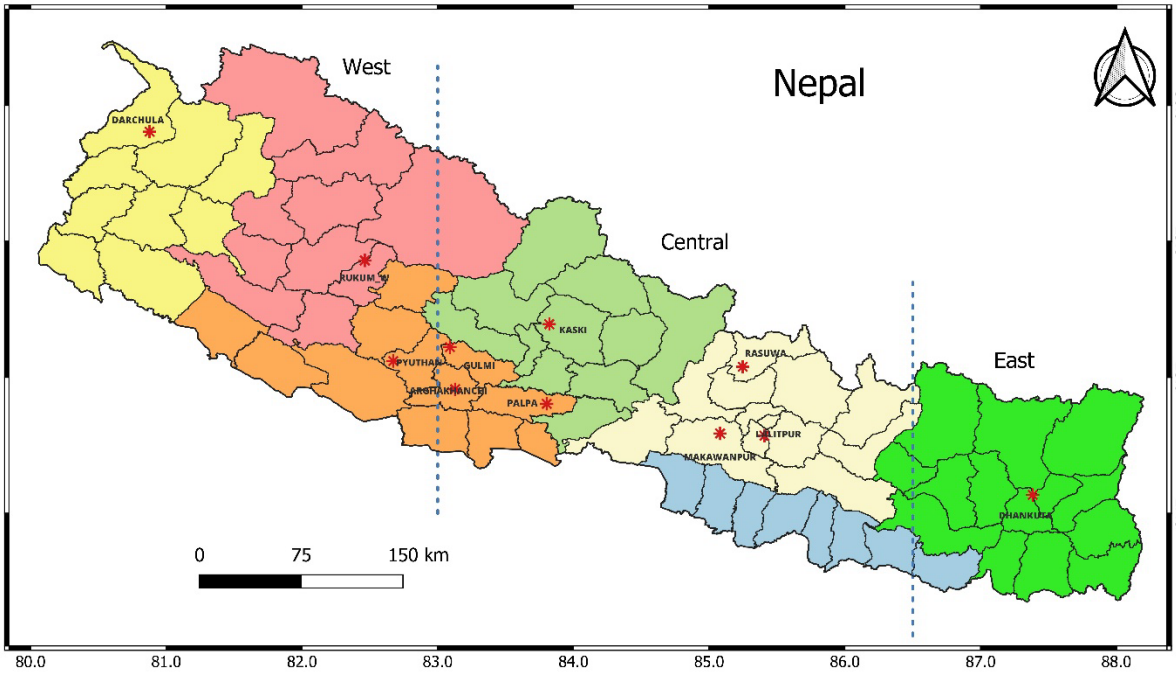


Figure 1. Map of Nepal, showing the study area

**Ailment categories**

The WHO (2026) classified ailments/diseases into 26 categories under the International Classification of Diseases, 11th edition (ICD-11). Reported ailments in this study are classified under 19 disease categories. Notably, ICD-11 itself does not provide a discrete category for non-disease-specific, health-maintenance, or preventive applications, such as general tonics, energizers, or restorative preparations. These are commonly reported in ethnomedicinal literature but do not correspond to a diagnosable disease or disorder. Since several use reports for *B. ciliata* s.l. from the compiled literature specifically described its use as a tonic rather than for treatment of a defined ailment, a separate "Tonic" category was introduced to accommodate these reports without forcing them into a biomedical disease category to which they did not correspond. Each ailment category was assigned a three-letter abbreviation (Table 1).

**Data analysis**

Current observations were compared with published literature of Nepal, India and Pakistan. The Jaccard Similarity Index (*J*) was computed for each pairwise comparison of sources as (Jaccard 1901):

$$J(A,B) = a/(a+b+c)$$

Where, *a* is the number of use categories (ailment categories, plant parts used, or modes of preparation) reported in both source A and source B; *b* is the number of categories present in source A but absent from source B; and *c* is the number of categories present in source B but absent from source A. *J* ranges from 0 (no shared categories) to 1 (identical repertoires). The index was computed separately for the 19 ailment categories, 5 plant parts, and 6 modes of preparation.

All statistical analyses were performed in R version 4.5.2 (R Core Team 2025) using vegan package (Oksanen *et al.* 2026) for calculations and ggplot2 (Wickham 2016) for data visualizations.

## Results

**Vernacular Names of *Bergenia ciliata* s.l. in different languages**

*Bergenia ciliata* (Haw.) Sternb. has two homotypic synonyms, which are *Megasea ciliata* Haw. and *Saxifraga ligulata* var. *ciliata* (Haw.) Hook.f. & Thomson (POWO 2026). Similarly, *Bergenia pacumbis* (Buch.-Ham. ex D.Don) C.Y. Wu & J.T. Pan has two homotypic synonyms, *Bergenia ciliata* var. *pacumbis* (Buch.-Ham. ex D.Don) Sameer Patil & V.S. Raju and *Saxifraga pacumbis* Buch.-Ham. ex D.Don. Both of these species are locally known as *pashanbhed***,** which is of Sanskrit origin. The literal meaning of *pashanbhed* is to break down the stone, and this is the main character of this plant (Verma *et al.* 2014). As *Bergenia ciliata* s.l. is very popular and widely used by various communities for ethnomedicinal purposes, it has various local names. A total of 122 vernacular names are given in 45 different languages as listed below (language is written in bold faced letter):

**Arabian**: Barghienia-mehdiyata, junteyenah; **Assamese**: Patharkuchi; **Baitadeli, Doteli**: Vedaite, silphode, dhungeful; **Balistan**: Schapur; **Bengali**: Himasagara, patharchuri, patharkuchi, patrankur; **Bhutia**: Hong-lem; **Chitrali**: Besabur; **Danuwar**: Simtadi; **Dolpali Nepali**: Salipat, silpari, simpari, simtadi; **English**: Hairy bergenia, rock-foil, stone breaker; **Garo**: Singkhantha; **Gharwal**: Pashanbhet, syalmadi, kaamal; **German**: Steinbrech; **Gujrati**: Pakhanbheda, pashanbheda; **Gurung**: Padambet, pakhanbed, pakombet; **Hindi**: Badmavo, dakachu, dhakochru, dhoklumbo, kaamal, laoo-patra, pakhanbhed, pakhanbheda, pakhenbhed, palfort, pandamdawi, patharchat, patharcua, pushaand, sadpottar, silparo, silpadu, silpbheda, silphara, silphor, silpheda, syalmadi; **Japanese**: Yukinoshita; **Jirel**: Pakhombed; **Kannada**: Alepgaya, hittaga, hittulaka, pahanbhedi, pasanaberu; **Kashmiri**: Batweyaa, pashanbhed; **Kham**: Gatik mukpo; **Khasi**: La Khowang; **Kumaoni**: Pakhanbhed, patharchur; **Magar**: Haangpaat, pakhanbed, hangawo; **Majhi**: Padambet; **Malayalam**: Kallorvanchi, kallurvanchi, kallurvanni; **Marathi**: Pashanbheda; **Meeteilon**: Tatenpiu; **Mizoram**: Khamdamdawi, pandamdawi; **Nepalese**: Bhiniti, dhungri ko jara, dhungri ko jhar, pakanbadha, pakhanbed, silparo, silpu, simpate; **Oriya**: Pasanbhedi, pashanabheda; **Pahari**: Butpawh; **Pakistan**: badmia, kamar panra; **Pashto**: Barmia, batpia, budpiah, but pewa, gatpanra, ghata pana, kamargul, maknar path, qamar panra, shapur, zakham parna; **Persian**: Gashah; **Punjabi**: Batpia, dharposh, kachalu, pashanbhed; **Rai**: Dhaebotam, sediwakthosida; **Sanskrit**: Amabhedaka, ashmabheda, nagbhita, pashanbheda, silabheda; **Sherpa**: Chyucha, chyurpu, hyoma, kopsokpa, silviro; **Sinahalese**: Pahanabeya; **Tamang**: Bhramhendo, bregyal, pakhenved, danmanjyung; **Tamil**: Sirupilai; **Telugu**: Kondapindi, telanurupindi; **Tibetan**: A-ama-bhe-da, gadhur, ghatik mukpo; **Unani**: Mukha; **Urdu**: Kachalu, pakhanabheda, zakhkm-e-hayat; **Walung**: Kopsyokpa (Source: Field observation and secondary literature (Ahmad *et al.* 2018, Budha-Magar *et al.* 2020, Chauhan *et al.* 2012, Dutta 2007, Gautam *et al.* 2023, Ghimire *et al.* 2008b, Gurav & Gurav 2014, Haq *et al.* 2023, Jan *et al.* 2021, Karki *et al.* 2023, Khan & Kumar 2016, Khoja *et al.* 2023, Lama *et al.* 2001, Mall *et al.* 2015, Manandhar 2002, Mir *et al.* 2024, Nand & Naithani 2018, Pal *et al.* 2015, Pangeni *et al.* 2020, Pant & Samant 2010, Rokaya *et al.* 2010, Singh *et al.* 2017, Singh *et al.* 2018, Yaseen *et al.* 2015)).

**Ethnomedicinal Uses of *Bergenia ciliata* s.l.**

In the current study, most of the users use *Bergenia ciliata* s.l. for pain (sprain/joint pain/backbone pain) (45.80%), followed by stone problems (39.69%), cough (29.77%), diarrhea (24.43%), postpartum care (23.66%), gastritis (16.79%), fracture (10.69%), and so on (Figure 2). The least recommended ailment was toothache (0.76%). The high use in relieving pain of this plant may be because of its anti-inflammatory properties (Kumar *et al.* 2002). Another chief use in stone problem may be because of its capacity to break stone because of the presence of secondary metabolites like bergenin, catechin, arbutin and in relieving ache (Chauhan *et al.* 2013, Dhalwal *et al.* 2008, Gautam *et al.* 2023, Nand & Naithani 2018). The other common uses are diarrhea, dysentery, fever, ulcer, wounds, urinary problems, cuts and burns, etc. (Gilani *et al.* 2014, Ruby *et al.* 2012, Singh *et al.* 2018). It is widely used in the pharmaceutical industry to prepare drugs.

Paudel *et al.* (2018) reported that *Bergenia ciliata* is used for the treatment of 104 different types of ailments, and it is highly used for gastrointestinal disorders but is very popular to cure kidney disorders, especially kidney stones. Hasan *et al.* (2013) found *Bergenia ciliata* as one of the most preferred and frequently used species in the Makawanpur district. This is not only used for the treatment of diseases like eye pain, cuts, and wounds but also used for making pickles where flowers are used (17.56%).

**Ailment Categories treated using *Bergenia ciliata***

Previous literature from the Himalayan region documented a broad spectrum of medicinal applications of *Bergenia ciliata*, comprising approximately 93 ailments (19 ailment categories), 5 types of plant parts used, and 6 modes of preparation across Nepal, India, and Pakistan (Table 1). The present study recorded 8 ailment categories, 4 plant parts used, and 3 modes of

preparation within the study area (Figures 3, 4). Published literature from Nepal (Past N) documented uses across 12 ailment categories, 4 plant parts, and 6 preparation modes; past Indian literature (Past I) across 14 ailment categories, 5 plant parts, and 5 modes; and past Pakistani literature (Past P) across 10 ailment categories, 4 plant parts, and 4 modes (Figures 3, 4). This comparatively lower number of ailments in the present study likely reflects the localized nature of contemporary ethnomedicinal knowledge, differences in cultural traditions, and possible erosion of orally transmitted practices due to increasing dependence on modern healthcare systems (Hamilton 2004, Ali *et al.* 2024, 2026). Moreover, the reviewed literature represents cumulative records from diverse ethnic communities and ecological regions, whereas the present study reflects current use patterns within a limited geographical and sociocultural context.

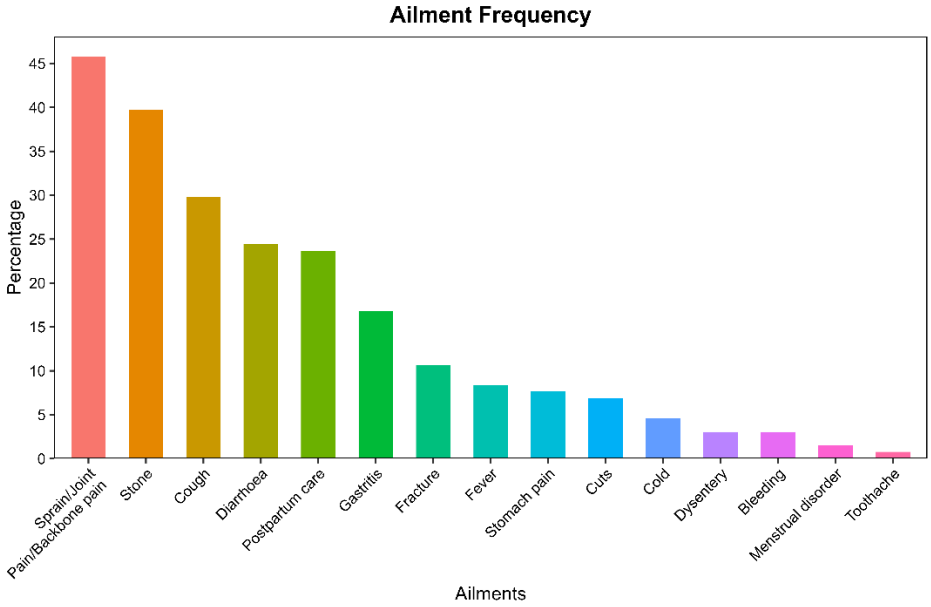


Figure 2. Percentwise use of *Bergenia ciliata* s.l. in different ailments. The values are calculated as (number of informants reporting the use)/(total informants, n=131)

Table 1. Ailment category and use of plant in current and previous study.

| Ailment category | Abb | Ailment (Present) | Ailment (Previous) | Reference |
|---|---|---|---|---|
| Diseases of the digestive system | DDS | Gastritis, stomach pain, toothache | Abdominal sanitation, appendicitis, carminative, constipation, digestive problem, gall bladder stone, gastritis, gum disease, gingivitis, indigestion, intestinal disorder, laxative, liver complaints, mouth sores, oral infection, piles, stomach disease, stomach pain, ulcer, vomiting | Abbas *et al.* 2017, Abbasi *et al.* 2010b, Adhikari *et al.* 2024, Adhikary *et al.* 2011, Adnan *et al.* 2014, Ahmed *et al.* 2023, Begum *et al.* 2014, Bhattarai 2018, Budha-Magar *et al.* 2020, Gaire & Subedi 2011, Gautam *et al.* 2023, Gilani *et al.* 2014, Haq *et al.* 2023, Hasan *et al.* 2013, Idrisi *et al.* 2010, Joshi *et al.* 2011, Khan *et al.* 2014, Khan *et al.* 2013, Kumari *et al.* 2012, Kunwar *et al.* 2013, Mall *et al.* 2015, Mehra *et al.* 2014, O'Neill *et al.* 2017, Pal *et al.* 2015, Rai & Lalramnghinglova 2010, Rai & Bhujel 2012, Rehman *et al.* 2023, Rokaya *et al.* 2010, Shaheen *et al.* 2012, Shrestha *et al.* 2016, Sigdel *et al.* 2013, Singh *et al.* 2017, Singh *et al.* 2012, Tamang *et al.* 2023, Uprety *et al.* 2010 |
| Symptoms, signs or clinical findings, not elsewhere classified | SSC | Diarrhea, fever | Diarrhea, fever, thirst, tiredness | Adhikari *et al.* 2024, Adhikary *et al.* 2011, Adnan *et al.* 2014, Ahmed *et al.* 2023, Bhattarai 2018, Budha-Magar *et al.* 2020, Gaire & Subedi 2011, Gautam *et al.* 2023, Idrisi *et al.* 2010, Karki *et al.* 2023, Kumari *et al.* 2012, Nand & Naithani 2018, Neupane *et al.* 2024, O'Neill *et* |

| Ailment category | Abb | Ailment (Present) | Ailment (Previous) | Reference |
|---|---|---|---|---|
| | | | | *al.* 2017, Pangeni *et al.* 2020, Pant & Samant 2010, Radha & Puri 2019, Rai & Lalramnghinglova 2010, Rokaya *et al.* 2010, Sharma & Sood 2013, Shrestha *et al.* 2014, 2016, Singh *et al.* 2017, Singh 2013, Singh & Rawat 2011, Singh *et al.* 2012, Siram *et al.* 2023, Tamang *et al.* 2023, Uprety *et al.* 2010 |
| Diseases of the genitourinary system | DGS | Bleeding, kidney stone, menstrual disorder | Bladder infection, bleeding, burning sensation of urination, calculus disease, hypermenorrhea, kidney stone, leucorrhea, menstruation disorder, painful urination, renal infection, stomach ache during menstruation, stone problem, urinary problem, vaginal flowing of white water | Acharya 2012, Budha-Magar *et al.* 2020, de Rus Jacquet *et al.* 2014, Gautam *et al.* 2023, Haq *et al.* 2023, Hussain *et al.* 2023, Irfan *et al.* 2023, Juyal & Ghildiyal 2013, Khan *et al.* 2013, Khursheed *et al.* 2026, Kumari *et al.* 2012, Mehra *et al.* 2014, Nand & Naithani 2018, Neupane *et al.* 2024, O'Neill *et al.* 2017, Pant & Samant 2010, Parajuli 2013, Rai & Lalramnghinglova 2010, Rehman *et al.* 2023, Samal *et al.* 2010, Shaheen *et al.* 2012, Shrestha *et al.* 2014, Sigdel *et al.* 2013, Singh *et al.* 2017, Singh *et al.* 2012, Siram *et al.* 2023 |
| Injuries, poisoning or certain other consequences of external causes | IPC | Cuts, fracture | Burns, cuts, fracture, wounds | Abbasi *et al.* 2010a, Abbasi *et al.* 2010b, Adhikari *et al.* 2019, Bhattarai 2018, Chettri & Chowdhury 2018, Hasan *et al.* 2013, Idrisi *et al.* 2010, Khan *et al.* 2014, Khoja *et al.* 2023, Khursheed *et al.* 2026, Mir *et al.* 2024, O'Neill *et al.* 2017, Pant & Samant 2010, Shaheen *et al.* 2012, Shrestha *et al.* 2016, Singh *et al.* 2017, Singh *et al.* 2018, Siram *et al.* 2023, Summer *et al.* 2025, Tamang *et al.* 2023 |
| Diseases of the musculoskeletal system and connective tissue | DMS | Back bone pain, joint pain, sprain | Analgesic, antispasmodic, arthritis, back bone cure, back pain, body ache, inflammation, joint ache, pain, rheumatism, sprain, swollen joints | Abbasi *et al.* 2010b, Acharya 2012, Adhikari *et al.* 2019, Bhattarai 2018, de Rus Jacquet *et al.* 2014, Khan *et al.* 2014, Khoja *et al.* 2023, Mir *et al.* 2024, Nand & Naithani 2018, O'Neill *et al.* 2017, Pangeni *et al.* 2020, Radha & Puri 2019, Shaheen *et al.* 2012, Sharma & Sood 2013, Shrestha *et al.* 2014, 2016, Thapa 2012 |
| Infectious and parasitic diseases | IPD | Dysentery | Abscesses, cholera, dysentery, parasites, roundworm infestation, sexually transmitted infection, typhoid | Abbasi *et al.* 2010b, Adhikari *et al.* 2024, Adhikary *et al.* 2011, Budha-Magar *et al.* 2020, Gaire & Subedi 2011, Gubhaju & Gaha 2019, Juyal & Ghildiyal 2013, Khan *et al.* 2014, Kumari *et al.* 2012, Mir *et al.* 2024, O'Neill *et al.* 2017, Pangeni *et al.* 2020, Rokaya *et al.* 2010, Saha *et al.* 2011, Shrestha *et al.* 2014, Siram *et al.* 2023, Uprety *et al.* 2010 |
| Diseases of the respiratory system | DRS | Cold, cough | Asthma, bronchitis, cold, cough, pharyngitis, pneumonia, pulmonary affection, throat infection, tonsil | Haq *et al.* 2023, Idrisi *et al.* 2010, Karki *et al.* 2023, Khursheed *et al.* 2026, Kumari *et al.* 2012, Neupane *et al.* 2024, O'Neill *et al.* 2017, Radha & Puri 2019, Rehman *et al.* 2023, Shaheen *et al.* 2012, Shrestha *et al.* 2014, 2016, Singh & Rawat 2011, Siram *et al.* 2023, Subba *et al.* 2023 |
| Diseases of the skin | DOS | - | Boils, hair problem, skin diseases | Kumari *et al.* 2012, O'Neill *et al.* 2017, Singh *et al.* 2017, Singh *et al.* 2012 |
| Tonic | TNC | - | Stimulant, tonic | Acharya 2012, Bhandari *et al.* 2026, de Rus |

| Ailment category | Abb | Ailment (Present) | Ailment (Previous) | Reference |
|---|---|---|---|---|
| | | | | Jacquet *et al.* 2014, Karki *et al.* 2023, Rai & Lalramnghinglova 2010 |
| Pregnancy, childbirth, and the puerperium | PCP | Post-partum care | Hemorrhage, lactation, post-delivery, post-partum complication, pregnancy | O'Neill *et al.* 2017, Pangeni *et al.* 2020, Shrestha *et al.* 2016 |
| Endocrine, nutritional, and metabolic diseases | ENM | - | Antiscorbic, diabetes | Begum *et al.* 2014, Rai & Lalramnghinglova 2010, Yaseen *et al.* 2015 |
| Diseases of the circulatory system | DCS | - | Heart disease, lymphatic system | O'Neill *et al.* 2017, Rehman *et al.* 2023 |
| Diseases of the nervous system | DNS | - | Headache | Budha-Magar *et al.* 2020, Uprety *et al.* 2010 |
| Diseases of the visual system | DVS | - | Eye pain, red eye problem | Adhikari *et al.* 2024, Hasan *et al.* 2013 |
| Conditions related to sexual health | CSH | - | Sexual incapability | Acharya 2012 |
| Diseases of the blood and blood-forming organs | DBB | - | Blood health | O'Neill *et al.* 2017 |
| Diseases of the ear and mastoid process | DEM | - | Earache | Rai & Lalramnghinglova 2010 |
| Diseases of the immune system | DIS | - | Allergy | O'Neill *et al.* 2017 |
| Neoplasms (cancers and tumors) | NCT | - | Anticancerous | Gilani *et al.* 2014 |

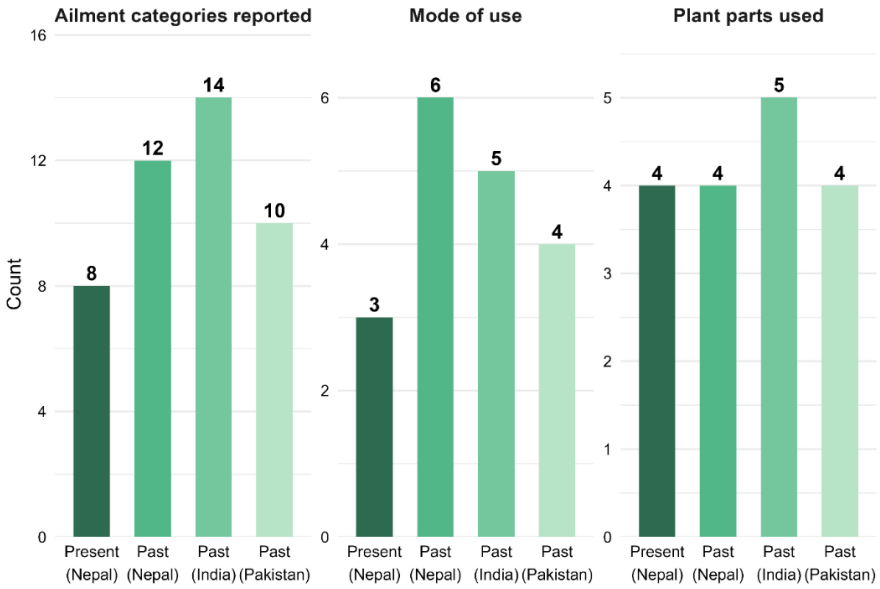


Figure 3. Coverage by study; ailment categories reported, mode of preparation and plant parts used in present and published literature (total ailment =19, total mode of preparation = 6, total plant parts used = 5)

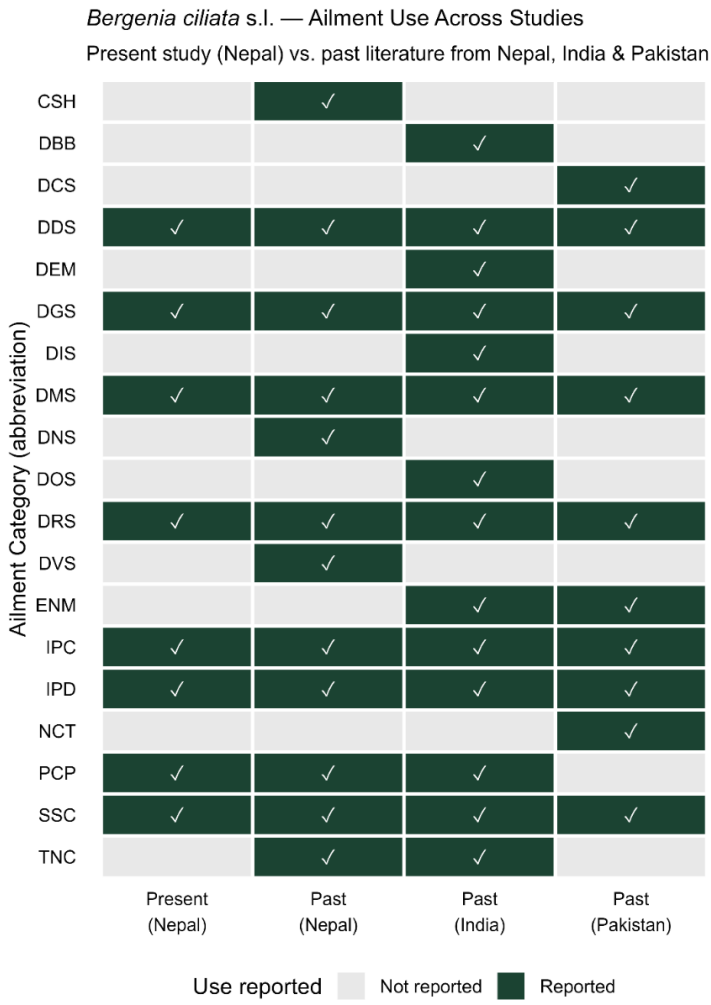


Figure 4. Country wise heat map showing 19 ailment categories (CSH = Conditions related to sexual health, DBB = Diseases of the blood and blood-forming organs, DCS = Diseases of the circulatory system, DDS = Diseases of the digestive system, DEM = Diseases of the ear and mastoid process, DGS = Diseases of the genitourinary system, DIS = Diseases of the immune system, DMS = Diseases of the musculoskeletal system and connective tissue, DNS = Diseases of the nervous system, DOS = Diseases of the skin, DRS = Diseases of the respiratory system, DVS = Diseases of the visual system, ENM = Endocrine, nutritional, and metabolic diseases, IPC = Injuries, poisoning or certain other consequences of external causes, IPD = Infectious and parasitic diseases, NCT = Neoplasms (cancers and tumors), PCP = Pregnancy, childbirth, and the puerperium, SSC = Symptoms, signs or clinical findings, not elsewhere classified, TNC = Tonic)

**Jaccard Similarity: Ailment Categories**

Pairwise Jaccard similarity values for the 19-category ailment matrix are presented in Figure 5. The present study showed the highest similarity with past Nepali literature (J = 0.67), followed by past Pakistani literature (J = 0.64) and past Indian literature (J = 0.57). All values fall within the moderate similarity range ($0.50 \leq J < 0.75$), indicating meaningful but partial overlap between the present study and each regional past source. Among past literature pairs, Nepal-India similarity (J = 0.53) exceeded both Nepal-Pakistan (J = 0.47) and India-Pakistan (J = 0.50), with the Nepal-Pakistan pair showing the lowest similarity in the entire matrix.

The highest similarity between the present study and past Nepali literature (J = 0.67) is expected and ecologically coherent: both sources document *Bergenia ciliata* use within the same national geographic context, the same altitudinal and ecological zones, and among communities sharing related cultural and linguistic traditions (Uprety *et al.* 2010, Rokaya *et al.* 2010). This temporal concordance within Nepal suggests that the core ethnomedicinal knowledge associated with *Bergenia ciliata* s.l. has been relatively stable and the knowledge is being transferred to next generation, although some peripheral applications have been lost or underreported in contemporary surveys. The lower similarity with Indian and Pakistani literature may reflect differences in disease burden, local ailment terminology, and how the studies grouped ailments.

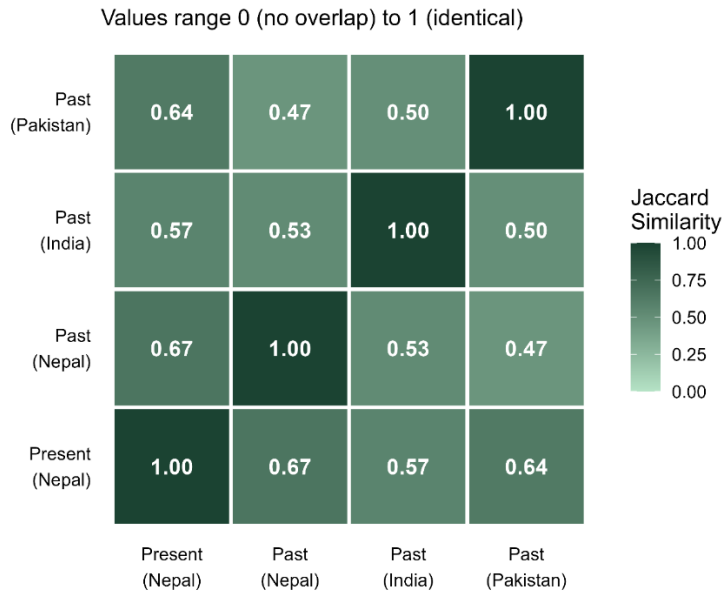


Figure 5. Jaccard similarity index for 19 ailment categories between current use in Nepal and previous work from Nepal, India, and Pakistan

Seven ailment categories were present in all four sources simultaneously: diseases of the digestive system (DDS), symptoms and signs not elsewhere classified (SSC), diseases of the genitourinary system (DGS), injuries and poisoning (IPC), diseases of the musculoskeletal system (DMS), infectious and parasitic diseases (IPD), and diseases of the respiratory system (DRS). This set can be termed the pan-regional ethnomedicinal consensus core for *Bergenia ciliata* across the Hindu Kush-Himalayan (HKH) region. These seven categories account for 87.5% (7/8) of all uses documented in the present study, confirming strong alignment between contemporary Nepali practice and the broader regional tradition. Cross-regional convergence on the same therapeutic applications across geographically, culturally, and linguistically distinct communities is widely interpreted in the ethnobotanical literature as a reliable indicator of pharmacological validity (Heinrich *et al.* 1998, Leonti *et al.* 2003). This interpretation is supported by the known pharmacological profile of *Bergenia ciliata* s.l. rhizome: bergenin and arbutin demonstrate documented diuretic and antiurolithic activity relevant to DGS applications and bergenin demonstrates anti-inflammatory activity relevant to DMS and IPC applications (Aggarwal *et al.* 2014, Bashir & Gilani 2009).

Eleven ailment categories were absent in the current study but documented in at least one past literature source. These include tonic use (TNC: present in Past N and Past I), diseases of the nervous system (DNS: Past N only), visual system diseases (DVS: Past N only), conditions related to sexual health (CSH: Past N only), skin diseases (DOS: Past I only), endocrine and metabolic diseases (ENM: Past I and Past P), circulatory diseases (DCS: Past P only), blood diseases (DBB: Past I only), ear diseases (DEM: Past I only), immune system diseases (DIS: Past I only), and neoplasms (NCT: Past P only). The absence of these uses in the present study may be due to temporal erosion of specialist or low-frequency ethnomedicinal knowledge since the time of past surveys, or to geographic variation in use practices between the communities surveyed. Notably, no ailment category was exclusive to the present study. All eight documented uses were also present in at least one past source, which confirms that the present study does not identify novel applications but validates a consistent subset of the broader regional knowledge system.

**Jaccard Similarity: Plant Parts used**

Jaccard similarity for the five plant part categories ranged from 0.60 to 1.00 (Figures 6, 7). The highest value in the entire study was recorded between past Nepali and past Pakistani literature (J = 1.00), reflecting perfectly identical plant part use between these two sources. Both countries document rhizome, root, leaf, and whole plant use, but neither documents flower use. The present study showed the highest similarity with past Indian literature (J = 0.80) and identical, moderate similarity with past Nepali and past Pakistani literature (J = 0.60).

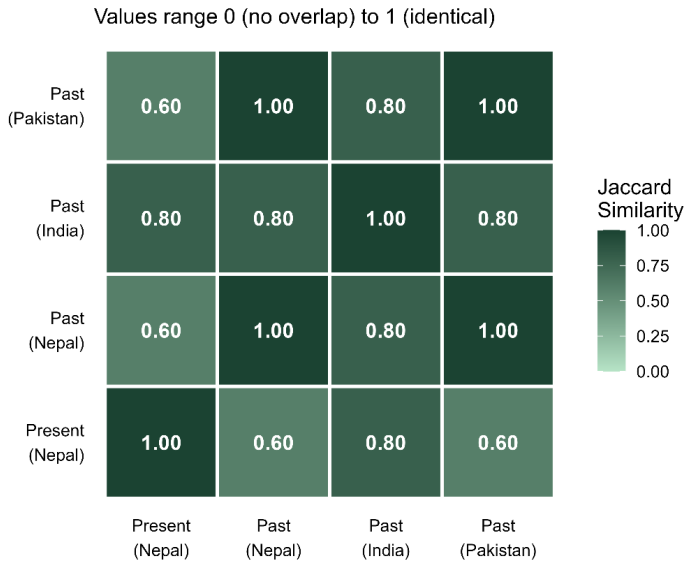


Figure 6. Jaccard similarity index for five plant parts used between current use in Nepal, India, and Pakistan

The reduced similarity of the present study with past Nepali and Pakistani sources (J = 0.60 in both cases) is attributable to a single discrepancy: root use is documented in all three past literature sources but absent from the present study's records. This absence most plausibly reflects terminological conflation between 'root' and 'rhizome' in local Nepali vernacular, where both organs are commonly referred to by related terms (*jara*, *gaano*), and informants may describe rhizome use without clearly distinguishing it from root use (Manandhar 2002, Uprety *et al.* 2010). Future surveys should use photographic or physical vouchers of both organs at the point of interview to resolve this ambiguity. Flower use, documented in the present study and past Indian literature but absent from Nepali and Pakistani past sources, likely reflects differential awareness and utilization of aerial plant parts across survey contexts and seasonal collection windows.

Rhizome, leaf, and whole plant were documented in all four sources simultaneously, and rhizome is the primary medicinal organ of *Bergenia ciliata* s.l. (Figure 7) across the entire HKH region. This preference may be because of the highest concentrations of bergenin, gallic acid, catechins, and arbutin among all plant parts (Dhalwal *et al.* 2008, Kumar & Tyagi 2013). Rhizome harvesting is inherently destructive, frequently resulting in plant mortality or severe damage (Rai *et al.* 2000) in comparison to other parts like flower and leaf.

*Bergenia ciliata* and *Bergenia* pacumbis, both are categorized as 'Least Concern' on the IUCN Red List (Plummer 2019a, 2019b). But regional assessments reported these as vulnerable and near to threat in several Indian states (Gowthami *et al.* 2021). These are also threatened in Nepal owing to unsustainable collection for local and international trade. Trade surveys in western Nepal have recorded *B. ciliata* as one of the highly traded medicinal plant (Pyakurel *et al.* 2017). Harvesting of the rhizome is destructive, and its high demand is creating a serious and growing pressure on wild populations. National reassessment of the species and the promotion of cultivation and sustainable-harvest protocols may reduce the pressure in wild habitat.

**Jaccard Similarity: Modes of Preparation**

Jaccard similarity for the six preparation modes ranged from 0.40 to 0.83 (Figures 8, 9), with the present study showing the lowest similarities in this dimension across all comparisons. The highest similarity was between past Nepali and past Indian literature (J = 0.83), followed by India-Pakistan (J = 0.80) and Nepal-Pakistan (J = 0.67). The present study's similarity with past literature sources was consistently lower: India (J = 0.60), Nepal (J = 0.50), and Pakistan (J = 0.40).

The low similarity between the present study and past sources for modes of preparation is driven by the complete absence of juice, decoction, and infusion in the present study's documentation, despite all three being recorded in past Nepali literature and decoction being particularly prominent in past Pakistani sources. The dominance of decoction in Pakistan (and its secondary presence in Nepal and India literature) reflects a strong preference for aqueous extraction methods. The absence of these preparation modes in the present study may indicate a genuine contemporary shift toward simpler dry preparations (paste, powder, chewing).

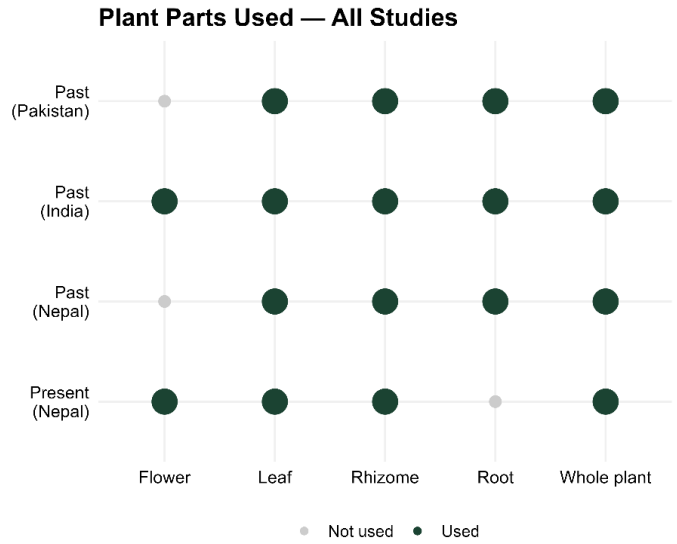


Figure 7. Plant parts used of *Bergenia ciliata* for different ailments in Nepal, India, and Pakistan

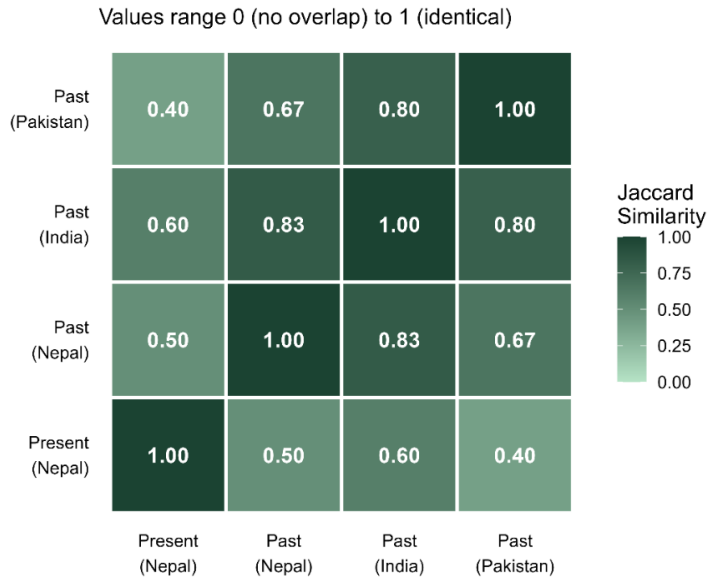


Figure 8. Jaccard similarity index for six modes of preparation between current use in Nepal, India, and Pakistan

Paste and powder were the only preparation modes documented in all four sources, representing the universal and temporally stable preparation mode for *Bergenia ciliata* s.l. rhizome throughout the HKH region. Their universality likely reflects the simplicity of their production, requiring only grinding or pounding of dried rhizome without specialized equipment, making them accessible to all community members regardless of specialist ethnomedicinal training (Martin 1995). Chewing was recorded in the present study and in past Nepali and Indian literature, but not in past Pakistani literature, confirming it as a secondary but regionally consistent preparation mode.

**Overall Regional Ethnomedicinal Coherence**

The overall Jaccard similarity pattern across all three analytical dimensions reveals a coherent and interpretable structure. The present study is most similar to past Nepali literature for ailment categories (J = 0.67), confirming within-country temporal continuity of core ethnomedicinal knowledge, whereas it is most similar to past Indian literature for plant parts (J = 0.80) and modes of preparation (J = 0.60). The moderate similarity values with Indian and Pakistani sources reflect geographic and cultural differentiation in peripheral applications, preparation traditions, and plant part preferences. At the same time, the pan-regional consensus core (seven shared ailment categories, universal rhizome use, and universal paste and powder preparation) demonstrates the deep cultural and pharmacological entrenchment of *Bergenia ciliata* s.l. ethnomedicine across the broader HKH region.

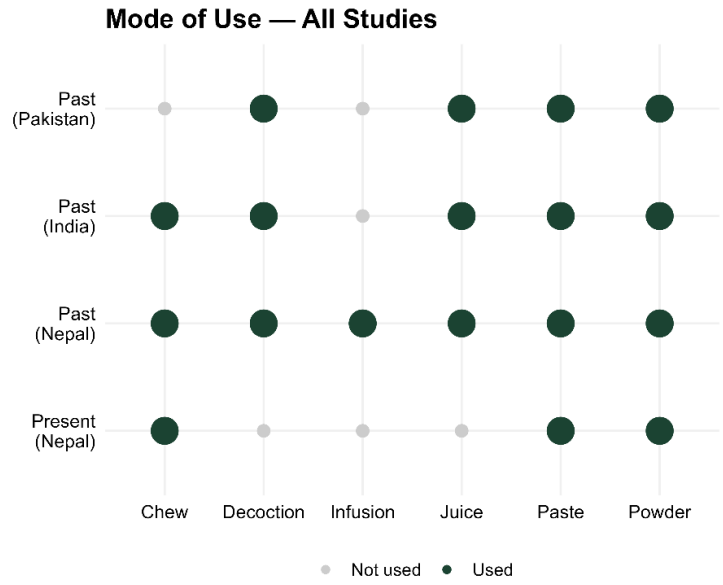


Figure 9. Mode of preparation of *Bergenia ciliata* for different ailments in Nepal, India, and Pakistan

This structure, a stable shared core surrounded by geographically and temporally variable peripheral uses, is characteristic of ethnomedicinal species with long histories of use across broad biogeographic regions and has been documented for other major Himalayan medicinal plants including *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora* (Ghimire *et al.* 2004, Uprety *et al.* 2010). The identification of this structure through the Jaccard index provides a reproducible, methodologically transparent baseline for longitudinal monitoring of *Bergenia ciliata* s.l. ethnomedicine across the HKH region, enabling future surveys to formally track changes in both the core and peripheral use repertoire over time.

The highest dependency of local collectors on rhizome raises a significant conservation concern. Rhizome harvesting is destructive and, where it is practiced without regard to regrowth capacity, may lead to localized population decline and reduced growth rate (Ghimire *et al.* 2008a). The complete absence of root use in the present study may reflect terminological conflation between 'root' and 'rhizome' among Nepalese informants. At the regional scale, Pan-Himalayan assessments identify mountain and transboundary landscapes as priorities for targeted conservation intervention (Ali *et al.* 2024), while projected habitat shifts and protection gaps among threatened South Asian plants support climate-adaptive conservation planning (Ali *et al.* 2026).

## Conclusion

Humans have benefited from plants since ancient times. Plant resources and plant products are used frequently in different regions of the world based on past experiences of ancestors.

This study presents a cross-regional ethnobotanical comparison of *Bergenia ciliata* s.l. across Nepal, India, and Pakistan using the Jaccard Similarity Index, applied across three analytical dimensions: ailment categories treated, plant parts used, and modes of preparation. The binary nature of the Jaccard index renders it uniquely appropriate for this comparison, enabling methodologically valid cross-source analysis where heterogeneous denominators, primary field informant data versus secondary publication level records, preclude the use of quantitative similarity metrics such as Bray-Curtis dissimilarity.

The analysis identified moderate similarity between the present study and all three past literature sources for ailment categories (J = 0.57-0.67), with highest concordance with past Nepali literature, confirming temporal continuity of core ethnomedicinal knowledge within Nepal. Seven ailment categories constituted a pan-regional consensus core shared across all four sources, supported by convergent pharmacological evidence for bergenin's anti-inflammatory and antiurolithic properties. Rhizome, documented across all sources together with leaf and whole plant, represents both the primary pharmacological resource and the principal conservation concern given the destructive nature of its harvest. Paste and powder emerged as the only preparation modes common to all sources, while the absence of decoction and juice in the present study suggests a contemporary shift in preparation practice relative to historical documentation.

These findings establish a reproducible, transparent baseline for longitudinal monitoring of *Bergenia ciliata* s.l. ethnomedicine across the Hindu Kush-Himalayan region, with direct implications for pharmacological prioritization of pan-regional consensus uses and conservation planning for this commercially significant medicinal species.

## Declarations

**Ethics approval and consent to participate:** Oral consent was obtained from the local people prior to the interview to collect information about plant use. Written permission was received from the Department of National Park and Wild Life Conservation, Department of Forest and Soil Conservation, and Department of Plant Resources to conduct the present research work.

**Consent for publication:** Oral permission was taken for this from the informant informing that their personal information would not be revealed.

**Availability of the data:** The data supporting the findings of this study are available from the corresponding author upon reasonable request. Data containing potentially identifiable or sensitive information are not publicly available to protect participant confidentiality.

**Competing interests:** The authors confirm that they have no competing interests.

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**Author contributions:** SKG designed the study plan. MRG collected the field data, conducted the analysis, and prepared the manuscript. The final manuscript was edited and approved by both authors.

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