Ethnomedicinal knowledge on the precise use of herbal medicine - An interview-based study on traditional healers from Jaunsar-Bawar region of Uttarakhand

Deepak Kumar Semwal, Ankit Kumar, Ashutosh Chauhan, Ruchi Badoni Semwal, Ravindra Semwal, and Sunil Kumar Joshi

Research

Abstract

Background: Jaunsar-Bawar region of Uttarakhand is well-known for its rich biodiversity. In continuation of our previous field survey on traditional medicinal plants used in diabetes mellitus, this study was designed to gather traditional knowledge about when and how the herbal remedies are used for different ailments by the tribal people.

Methods: Information about the use of medicinal plants was collected from different folk healers of the region. The plant specimens were collected from their natural habitat and authenticated in the laboratory of Materia Medica and Taxonomy.

Results: Out of the 200 plants, 41 species belonging to 27 families have been explored in this study based on their availability and potency. Most of the selected plants were found to be used topically while a few were suggested for oral use. These plants have been found effective in curing cuts, wounds, boils, bone fracture, muscular pain, inflammation, fever, mouth ulcer, stomach ache, headache and many other conditions.

Conclusion: The study concludes that these plants have the potential to treat various health conditions. Exploration of these plants scientifically will be a great addition to the field of herbal medicine.

Keywords: Ethnomedicine, anti-fungal activity, traditional knowledge, Ayurveda, herbal medicine

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Background

According to the World Health Organization, the Traditional Health Care System is considered to be the best for curing diseases, and is used by 70% of the world population (WHO 2019). In many cases like chronic conditions, traditional medicine has proved its potential over modern biomedicine. Various research reports proved that synthetic drugs have many side effects both acute and chronic while herbal treatment is considered safe. Besides, herbal medication is comparatively cheaper than synthetic drugs, and hence, considered more economical for all. As a result, people from all over the world are again shifting back to herbal medicine due to economic and safe. Indian Traditional Systems of Medicine, such folk medicine and as the codified Ayurveda use monoherbal and polyherbal formulations that can be prepared by the patients themselves without depending on a practitioner (Semwal *et al*. 2019).

The folk medicinal system of Uttarakhand uses a large variety of medicinal plants. To date, about 1500 folklore plants including Ayurvedic herbs have been reported in Uttarakhand with an area of 53,483 square kilometres. With varied agro-climatic region, Uttarakhand is rich in Medicinal and Aromatic Plants (MAPs) and is counted among the mega biodiversity regions of the world. Uttarakhand has a long history of folk medicines which are generally used for most of the ordinary ailments and mainly used by the tribal population of the region such as Jaunsari, Tharu, Raji, Buksa and Bhotiya tribes (Shah 1982). Likewise, the western hilly part of Nepal, an adjacent area to Uttarakhand state, is also known for its rich biodiversity and traditional knowledge. The climate of this area favours to growth of a variety of medicinal plants of industrial value that include *Acacia catechu, Bacopa monnieri, Bombax ceiba, Drymaria diandra, Rauvolfia serpentina* and *Tribulus terrestris* (Shrestha & Dhillion 2003; Singh *et al.* 2012; Adhikari *et al.* 2019).

The present study area Jaunsar-Bawar (Fig. 1), is situated in the Dehradun district of Uttarakhand and comprised of hill areas. This area lies in the border with Himachal Pradesh, with river Yamuna in the east and river Tons in the west, while Uttarkashi district is situated at its northern part. Kalsi, Sahiya, Chakrata, Debvan, Hanol, and Lakhamandal are among the most popular places in this region. In the past, many surveys have been conducted in different areas of the Uttarakhand state of India mainly in tribal areas (Joshi & Pant 2012; Sharma *et al.* 2013; Khajuria & Bisht 2017; Singh *et al.* 2019). However, the present study area is least explored for its folk medicine. The present study reports precise information about the doses, duration of the treatment and mode of administration of medicinal plants used in the folk medicine by the inhabitants of Jaunsar and Bawar areas of Uttarakhand for the first time.

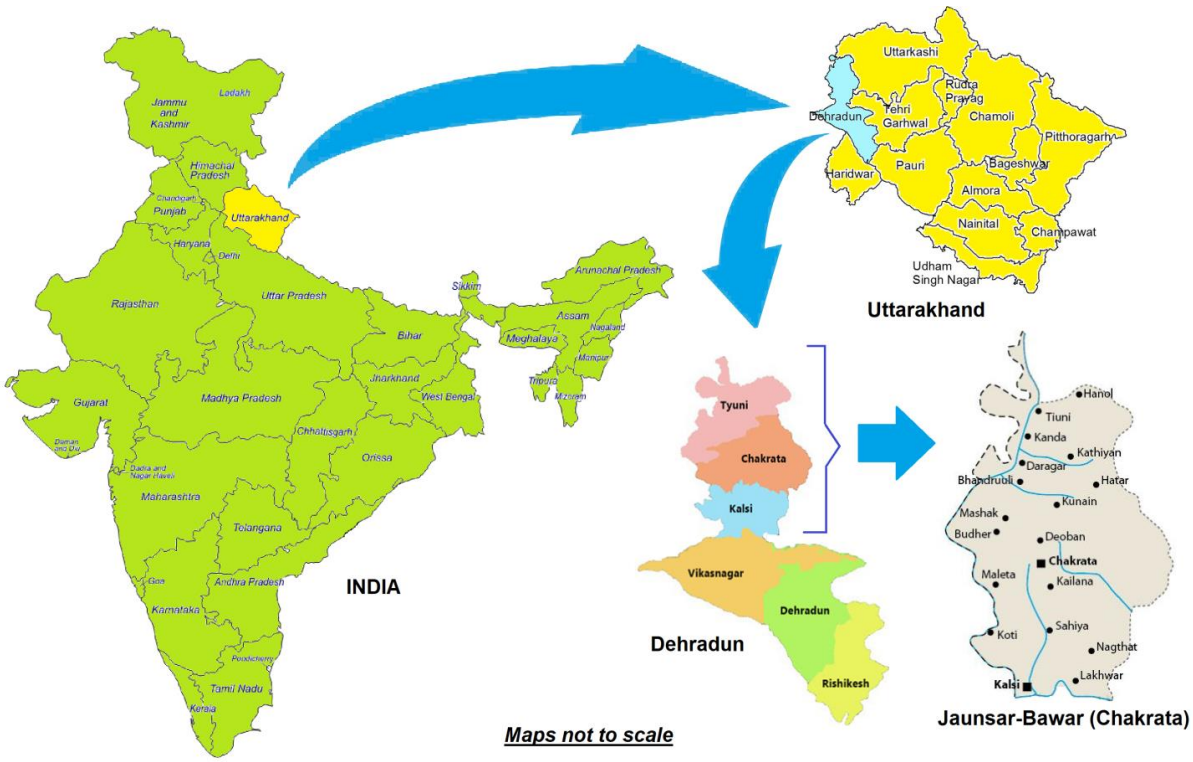

Fig. 1. Geographical location of Jaunsar-Bawar

Materials and methods

Field survey was conducted during the year between 2017 and 2020. A total of 8 visits of 3-5 days were conducted in the study area covering almost all the areas in different seasons included in our previous survey (Kumar et al. 2019). The information about the local uses of these medicinal plants was collected from the local folk practitioners, cattle feeders and elder villagers. In this study, a total of 22 folk healers (17 male and 5 female) of 45-85 years of age were interviewed. The participants were identified by enquiring local people. A few healers having expertise in a specific disease, such as kidney stone, diabetes, hypertension and snakebite, were also interviewed. Practitioners who did not share the proper information about the medicinal use of the herbs were excluded from the study. Before the individual interview, verbal consent was taken from each participant and already informed them to publicise their experience-based knowledge globally for humankind. During the interview, photographs with all the participants were taken; selected pictures are given in Fig. 2.

Information was recorded in the standard questionnaire which included the local name of the medicinal plant, parts used, method of preparation, mode of administration, probable dosage and duration of treatment. As per the information, the plant samples were also collected from the study area to deposit their specimens to Uttarakhand Ayurved University (UAU) herbarium. The voucher specimen number of each plant is given in Table 1. The plant samples were identified with the help of local names given in the local floras published in previous years (Gaur 1999; Kanjilal 2011). Scientific authentication of the plants was done at the Research and Development Centre of UAU. The information about the medicinal plants during the field visit was cross-checked from the ancient Ayurvedic literature and scientific papers available online. A flow chart showing step-wise study design is given in Fig. 3.

Fig. 2. Photographs of interview with traditional healers

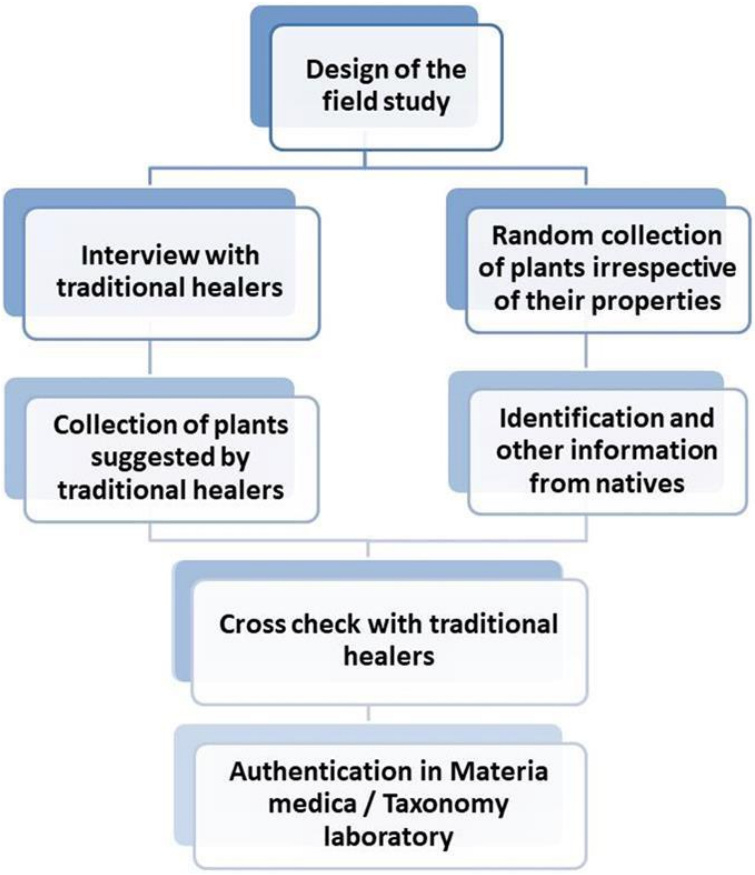

Fig. 3. Step-wise study design of the fieldwork

Results

The research revealed Jaunsar-Bawar region of Uttarakhand has a difficult geographical terrain and also lacks advanced medical facilities. Most of the people in this region are dependent on herbal medicines for their primary healthcare as they prefer higher medical centres only in serious conditions. The farmers, hunters, shepherds and grass cutters of this area are well-acquainted with the herbal remedies for primary healthcare and folk healers/ vaidyas are also consulted in cases of serious problems. The cattle feeders shared valuable information during the interview as their life is closely connected with the forested areas and plant wealth. They are mostly dependent on natural medicine when living in the forest region with their cattle. More than 200 plant species were recorded during the field survey, and based on information collected from the natives, 41 species were found to have therapeutical importance in the traditional medical system of this region. Based on the interview with local traditional healers and other elders, the information about herbal remedies is shown in Table 1. As the activity of a herb depends on its active constituents, selected bioactives found in these herbs are also given in Table 2.

Data analysis

Analysis of collected data on ethnomedicinal plants revealed that Leguminosae was the largest represented family with a total of five members whereas three members each were recorded for Apiaceae, Compositae, Lamiaceae and Ranunculaceae families (Fig. 4). Among them, a majority of plants (7) were found effective in fever, followed by bone-fracture/ joint pain (6) and cuts/ wounds (5) in which two plant species were found effective in more than one health conditions. The distribution of plants based on their uses against different medical conditions is shown in Fig. 5. Similarly, most of the plants used by traditional healers belong to herbs (23) that cover 56% of total plants, whereas the shrubs (9) cover only 22% (Fig. 6). Leaves (18) were the most used part in ethnomedicine followed by roots or underground parts (15). Moreover, topical route was recorded as the most accepted route for drug administration followed by the oral route. The pictures of selected medicinal plants are given in Fig. 7.

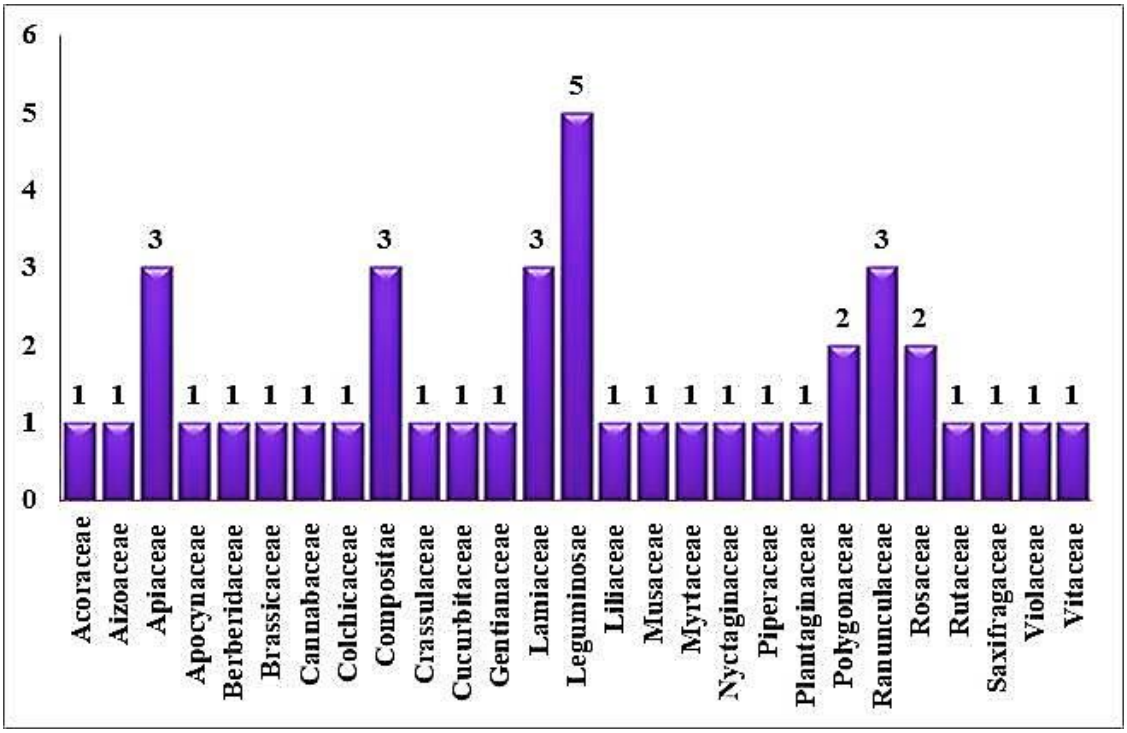

Fig. 4. Family-wise distribution of medicinal plants

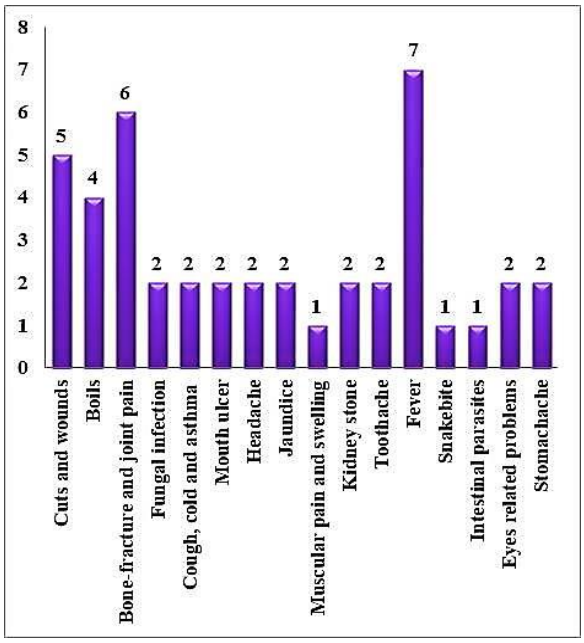

Fig. 5. Application-wise distribution of medicinal plants

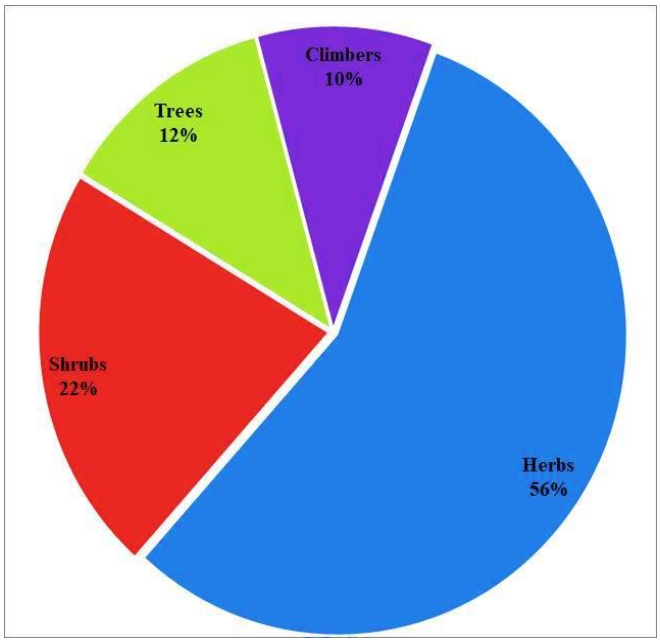

Fig. 6. Category-wise percentage of medicinal plants

Table 1. Medicinal plants and their traditional uses with key identification features

Family and name of plant	Common names	Voucher number	Life form / Part used	Traditional use	Key identification features
Acoraceae					
Acorus calamus L.	Vaca / Sweet flag / Bach	UAU212	Herb / rhizome	Decoction or infusion of rhizome (1 g) is given to children to kill infectious worms of GIT. The garland of its rhizome also kills worms.	A semi-aquatic perennial herb; rhizome creeping, much-branched, cylindrical; leaves bright green, thickened in middle; flowers light brown densely packed in sessile; fruits oblong turbinate with a pyramidal top; seeds free and pendant from the apex.
Aizoaceae					
Trianthema portulacastrum L.	Bishkopra / Black pigweed	UAU213	Herb / aerial parts	Powder of aerial parts (1-3 g) is given with boil water in fever. Decoction of powder can also be used in place of dry powder. The treatment is taken twice a day for three days for better results. The decoction is also useful in rheumatism and alcohol poisoning.	An annual herb with a prostrate mat or clump made by its stems; leaves have round or oval blades borne on petioles; solitary flowers occur in leaf axils with purple and petal-like sepals; fruit curved and cylindrical capsule.
Apiaceae					
Cuminum cyminum L.	Cumin / Jira	UAU214	Herb / seeds	Tea prepared from the seeds (2-3 g) is used in stomachache. Decoction prepared with one teaspoon (3 g) of seeds in 100 mL of water is taken in the complaint of abdominal pain.	An annual herb that grows to 50 cm high; stem cylindrical, glabrous, branched; leaves pinnate or bipinnate with thread-like leaflets; flowers small, white or pink, borne in umbels; fruit lateral fusiform or ovoid achene with two mericarps having single seed.
Seseli diffusum (Roxb. ex Sm.) Santapau & Wagh (Syn. *Seseli indicum* Wight & Arn.)	Van ajwain / Ajgandhika	UAU215	Herb / leaf	Fresh leaves (2-3 g) are chewed in fever. The hot decoction of mature seeds (1-3 g) is consumed twice a day to relieve fever. Leaves are chewed in stomachache and other gastric problems.	An annual herb with Ajwain (*Trachyspermum ammi*)-like fragrance; leaves bipinnate, segments ovate; rays pubescent, involucel comprised of 5-8 linear bractlets; calyx teeth minute; fruit small, hispid.
Trachyspermum ammi (L.) Sprague	Ajwain / Bishop's weed	UAU216	Herb / fruits	A mixture of dried fruits (seeds) and salt (4:1), packed in a cloth, is dipped in hot cow ghee (milk fat) and foment the affected parts during pain and inflammation due to twisted wrists or ankles and joint pains of arthritis. After application,	An annual herb with small, oval-shaped and seed-like fruits; fruits have a bitter and pungent taste with a thyme-like smell.

				the body part is plucked by a strip of cotton cloth for 2-3 hours. The treatment should be repeated twice a day for several days until getting relief. A hot decoction of fruits (3-5 g) is given in high fever. After consumption, the patient is advised to wrapping in a blanket, once the sweating comes out, the patient feels relaxed.	
Apocynaceae					
Holarrhena pubescens Wall. ex G.Don	Kutaja / Coral swirl / Tellicherry bark / Koriya / Kurchi / Kueya / Kuda	UAU217	Shrub / stem or leaf	Milky latex (3-5 drops) of stem or leaf petiole of a mature plant is applied on the boils in a circular form to treat boils. The latex is applied twice a day up to 3-5 days in such a way so that it can cover the whole affected part to stop the growth of boils, relieve pain and heal the boil permanently.	A large shrub up to 3 m tall; bark thick pale brown, rough with a milky latex, which peels off easily; leaves simple, opposite; flowers white, fragrant, terminal corymbose cymes; seeds yellow
Berberidaceae					
Berberis aristata DC.	Daruharidra / Indian Barberry / Kingor	UAU218	Shrub / root	Two to three drops of roots decoction are externally used for eyes infection and burning/ red eyes during summers.	An erect woody shrub; outer bark yellow to brown, inner bark dark yellow; leaves arranged in tufts of 5-8; flowers yellow, developed in a racemose inflorescence; fruits ovoid, succulent, acidic, bright red or bluish-purple.
Brassicaceae					
Brassica nigra (L.) K.Koch	Mustered/ Sarson/ Laiya	UAU219	Herb / seed	Massage of a mixture of mustard oil (seed oil) and water in 1:1 ratio on the forehead is used to get rid of headache.	An annual herb with large stalked leaves; flowers yellow, borne at the top of the stem, petals longer than sepals; pod contains 4-5 tiny black seeds.
Cannabaceae					
Celtis australis L.	Khadik / European nettle tree / Mediterrane an hackberry	UAU220	Tree / stem bark	Paste of fresh bark is used in bone fracture, contusions, sprains and joint pains. A plaster of the bark paste is applied to the damaged portion with the help of a cloth and left for several days to repair the broken bone.	A medium to a large tree of up to 25 m high; bark pale, ashy or grey, smooth; leaves ovate, rounded base, dull green; flowers greenish; fruits small, dark-purple berry-like drupes.
Colchicaceae					
Gloriosa superba L.	Kalihari / Tiger claw / Langly	UAU221	Climber / tuber	Paste of tuber is applied externally in snake bite for 4-5 days.	A beautiful climbing glabrous herb with leafy tendrils and fleshy cylindrical tubers; leaves sessile,

					opposite or alternate; flowers axillary, solitary and forming a terminal corymb; capsules oblong and about 4.7 cm long.
Compositae					
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	Catweed / Baseda / Kala Bansa / Kala Padhina	UAU222	Herb / leaf	Juice (5-10 drops) or paste (1-2 g) of fresh leaves is applied on wounds and cuts twice a day for 3-5 days to heal the damaged part. The juice efficiently coagulates the blood of fresh-cut.	An erect bushy, leafy, many-stemmed, perennial shrub, about 100-200 cm long; leaves dark green, slightly hairy, oppositely arranged; flowers white sticky hairy, produce cluster; seeds tiny, light brown to black.
Ageratum conyzoides (L.) L.	Goatweed / Jangali Pudia / Padhina / Visamustih	UAU223	Herb / leaf	Juice (5-10 drops) or paste (1-2 g) of fresh leaves is applied on wounds and cuts twice a day for 3-5 days to heal the damaged part. The juice efficiently coagulates the blood of fresh-cut.	An erect, hairy, tropical annual herb of 30-100 cm high; stems and leaves covered with fine white hairs, possess a weak aromatic unpleasant smell; flowers violet or white, forms cluster at end of the branches; fruits glabrous, about 0.16 cm long; seeds dark with scales.
Anacyclus pyrethrum (L.) Lag.	Spanish Chamomile / Akarkara	UAU224	Herb / leaf or root	A small quantity of fresh leaves or roots is pressed between teeth to relieve toothache. This treatment is also effective in controlling cavity formation and gingivitis by inhibiting bacterial infection.	A perennial herb with numerous stems; flowers born at the branch-end of a stem; leaves alternate, smooth, pinnate; root cylindrical, slightly twisted, crowned with a cluster of grey hair.
Crassulaceae					
Bryophyllum pinnatum (Lam.) Oken	Pashanbheda / Air plant / Pattharchatta / Dard patta	UAU225	Herb / leaf	Fresh leaves (1-2) slightly fried in edible oil are applied on boils twice a day for several days.	A perennial, glabrous and succulent herb grows up to 100 cm high; leaves simple, lobed or compound; flower pendulous, cylindrical; petals united in a campanulate tube.
Cucurbitaceae					
Citrullus colocynthis (L.) Schrad.	Bitter Cucumber / Peetpushpi / Indravaruni	UAU226	Climber / root	Juice (3-5 mL) of fresh roots diluted with water is given to children with stomachache. One teaspoon of crushed fresh roots can also be given followed by some water in the complaint of a stomachache. It is also useful in chest pain due to unknown reasons.	An annual vine with trailing herbaceous stems with rough hairs; leaves alternate, triangular-shaped, hairy; flowers yellow, singly at axils; fruits globose, yellow and smooth; seeds ovate compressed, white or brownish.
Gentianaceae					
Gentiana kurroo Royle	Trayamana/ Himalayan Gentian /	UAU227	Herb / root	Decoction of roots (2-3 g) is used in any type of	A critically endangered Himalayan herb; flowers deep blue,

	India Gentian / Kadu			fever, mainly against typhoid fever.	funnel-shaped; leaves lance-shaped; stems several, unbranched, arising from a stout rootstock.
Lamiaceae					
Mentha × *piperita* L.	Peppermint / Pudina	UAU228	Herb / leaf	Juice or paste of fresh leaves is applied on the forehead in headache and fever.	An erect, aromatic, perennial herb; leaves petioled, opposite, ovate; flowers light pink, borne in thick terminal spikes.
Roylea cinerea (D.Don) Baill.	Ashy roylea / Titpatti / Kadui	UAU229	Shrub / leaf or root	Juice (5-10 mL) of fresh leaves is diluted with water and drank in all types of fever. Decoction/ infusion of fresh leaves is also consumed in place of juice. Roots power (1-2 g) as a whole or in the form of a decoction is also used in fever.	A perennial shrub; leaves ovate, toothed to almost lobed, flat; stem greyish velvety; flower-spikes having 4-12 flowers with separated clusters; flowers white or pink.
Vitex negundo L.	Sinduvara / Chaste tree / Nirgundi / Shimlu	UAU230	Shrub / leaf	The essence of fresh leaves by crushing them between two palms is inhaled in common cold and catarrh.	A deciduous shrub of 1-3 height; leaf foliolate, leaflets lanceolate; stem grey; flowers bluish-purple, borne in lateral cymes; drupe succulent and black when ripe; seeds obovate or oblong.
Leguminosae					
Cajanus cajan (L.) Millsp.	Pigeon pea / Arhar / Tor	UAU231	Shrub / leaf	Five to ten fresh apical immature leaves are chewed for 5-10 minute for mouth ulcer and the leftover pulp in the mouth is spilt out. The treatment can be adopted 2 to 3 days once at any time.	An erect annual shrub of 1-3 m; leaf pointed trifoliate; flower yellow or red; pods green, several pods produced in clusters; seeds 3-5 per pod.
Lablab purpureus (L.) Sweet (Syn. *Dolichos lablab* L.)	Lablab bean / Sem / Chhemi	UAU232	Climber / leaf	Juice prepared from fresh leaves is externally applied for the treatment of fungal infection of the rectum and anus in children. Topical application of fresh leaf paste is used to treat ringworm. The fresh leaf is also rubbed on the infected areas.	An annual vine; leaves have three pointed leaflets, hairy on underneath; inflorescence made up of racemes of many white, purplish or blue flowers; fruit pod bright purple to pale green; seeds 3-4 white, brown, red or black.
Macrotyloma uniflorum (Lam.) Verdc.	Horse gram / Kulath / Gahath	UAU233	Herb / seeds	Decoction (100-200 mL) made up of 5-10 g of seeds is given in kidney stone thrice a day for several days.	A twining annual herb with trifoliate leaves; leaflets ovate, rounded at the base; flowers yellow or greenish-yellow; pods 6-8 cm long with 5-7 seeds.
Pterocarpus santalinus L.f.	Chandan / Sandalwood	UAU234	Tree / stem	Paste of fresh bark prepared by boiling the crushed material with a small amount of water, is applied to the fractured bone in the form of poultice using a cotton cloth. The paste is	A small tree, growing to 5-8 m; leaves alternate, trifoliate with three leaflets; flowers arise in short racemes; fruit 6-9 cm long pod with 1-2 seeds.

				effective in increasing bone density, reducing pain and inflammation. The paste is also used with the bark of *Prunus cerasoides* for better results.	
Uraria picta (Jacq.) DC.	Prishniparni / Dabra / Pitvan / Shankaraja	UAU235	Shrub / leaf	Decoction of dried leaves powder (2-5 g) is given orally twice a day for several days to stop the bleeding of internal wounds, ulcer, dysentery and piles.	An erect perennial, under-shrub, up to 180 cm long; branches velvety; lower leaves 1-3, upper leaves 5-9 foliolate; flower purple, pink or bluish; fruit 5-9 cm long with 3-6 segments.
Liliaceae					
Allium cepa L.	Palandu / Onion / Pyaz	UAU236	Herb / bulb	Crushed bulb after roasted in fire is applied on boils for several hours to stop the growth of boils and relieve pain.	A biennial herb with aromatic fleshy underground bulb; leaves hollow, cylindrical; flowers white, globular umbels; bulb multilayered, peppery and spicy flavoured.
Musaceae					
Musa × *paradisiaca* L.	Banana / Kadli / Kela	UAU237	Herb / stem	Fresh aqueous juice (2-3 drops) of the stem is used externally for eyes problems.	A tropical tree-like evergreen herb; leaves large, overlapping bases; stem cylindrical, multi-layered; flowers developed from the centre of the crown; each plant bears fruit once.
Myrtaceae					
Psidium guajava L.	Guava / Amarud	UAU238	Tree / leaf	The fresh apical immature leaves (1-2 leaves) of *Psidium guajava* (*Psidium guava* Griseb.) are chewed for 5-10 minute for mouth ulcer and spill out after that from the mouth.	A small tree with spreading branches; stem bark smooth and thin with copper-coloured flakes; flowers borne in small clusters; fruit round, ovoid or pear-shaped, sweet when ripe.
Nyctaginaceae					
Boerhavia diffusa L.	Punarnava / Hogweed	UAU239	Herb / root	Fresh root (1-2 g) is chewed twice a day for several days in jaundice. Root powder (1-2 g) is taken with boil water or milk in stomach ache due to lifting heavy objects. The powder is given in muscular and joint pain due to rheumatoid arthritis.	A perennial herb with stout rootstock and many procumbent branches; leaves simple, opposite; flowers pale rose, small, short-stalked; fruits viscid, easily detachable, one-seeded.
Piperaceae					
Piper longum L.	Pipali / Long peeper	UAU240	Shrub / leaf	Paste of freshly crushed leaves is applied to the ringworm. Juice obtained by squeezing fresh leaves is also applied in	A scandent shrub or climber; leaf ovate, acute at apex, cordate and strongly oblique at the base; root perennial woody; stem

				the infected areas including the face.	creeping and jointed; flowers monoecious, male and female flowers borne on different plants; fruit fleshy embedded in spikes; berry glabrous and black or deep red.
Plantaginaceae					
Picrorhiza kurroa Royle ex Benth.	Kutki / Costus / Kuth / Kedarkaru	UAU241	Herb / root	Decoction of crushed fresh root (1 g), boiled with one cup of water until the volume remains half, is consumed as a tea once a day for several days in joints pain, weakness, cough and respiratory problems. Tea of fresh leaves is given in bronchial asthma due to its expectorant property.	A perennial, rhizomatous herb with spoon-shaped leaves; rhizome long and woody; flowers small, pale or purplish-blue with long stamens.
Polygonaceae					
Rheum australe D. Don (Syn. *Rheum emodii* Wall. ex Meisn.)	Indian rhubarb / Himalayan rhubarb / Revatchini / Archu	UAU242	Herb / root	Root paste is externally applied for muscular pain and swelling. Poultice of the fresh roots is applied on the affected parts thrice a day for 1-3 days.	A small herb with stout roots and leafy stem; leaves cordate, long-petioled, orbicular; flowers pale-red; nutlets ovoid-oblong with cordate base and notched apex.
Rumex hastatus D. Don.	Arrowleaf dock / Churki / Almoru / Amildu	UAU243	Shrub / leaf	Leaves paste is applied externally on cuts, blisters and sore. A thick layer of the paste is applied twice a day for 3-5 days for better results.	A small and bushy shrub with many ascending stems; leaves narrow and arrow-shaped; flowers tiny greenish pink; flower-stalk lengthening in fruit.
Ranunculaceae					
Aconitum heterophyllum Wall. ex Royle	Ativisha / Atees	UAU244	Herb / root	Tea of fresh roots (2 g) is given in fever.	A perennial herb up to 120 cm tall; flowers large greenish-purple, darker-veined, having spike-like clusters; leaves ovate-heart-shaped to rounded; seed pods hairy, erect.
Delphinium denudatum Wall. ex Hook.f. & Thomson	Nirvisha / Jadwar	UAU245	Herb / leaf	Paste of fresh leaves with mustard oil is applied on the wounds and cut for 1-3 days. It also stops the bleeding of cuts.	A critically endangered Himalayan herb; leaves 5-15 cm across, rounded in outline; flower small blue or violet, borne in the branched inflorescence with spike-like clusters.
Thalictrum foliolosum DC.	Mamira / Pilijari	UAU246	Herb / root	Fresh roots (1-2 g) are either chewed as a whole or consumed in the form of a decoction in jaundice. The treatment is taken two to three times a day for several days. It is also used as a liver tonic.	An erect, rigid, perennial herb; rootstock fibrous, yellowish-brown, extremely bitter; flowers pale-green, arising in branched terminal panicles; leaves pinnately

					decompounded; leaflets sub-orbicular, slightly lobulated.
Rosaceae					
Prunus cerasoides Buch.-Ham. ex D.Don	Padmakastham / Bird cherry / Himalayan Wild Cherry / Padmakasth / Painya / Pajha	UAU247	Tree / stem bark	A thick paste of fresh bark, crushed and cooked with a little amount of water, is applied externally with the help of cloth on the inflammation of joints. A poultice of the paste is applied to the fractured bone area for several days to repair the broken bone. The paste helps reduce muscular pain and other pains including due to old fractures. The paste is also applied in combination with *Santalum album* L. (Indian sandalwood / Chandan) for better results.	A medium-sized tree grows up to 30 m high; stem bark smooth and peels off in thin horizontal stripes; leaves elliptic, long-pointed; flowers pink, long-stalked, paired or few-flowered clusters at the end of branches; fruit yellow, maturing to red.
Prunus persica (L.) Batsch	Aruka / Peach / Aru	UAU248	Tree / seed pericarp or leaf	Paste of seed pericarp is topically applied on infection due to breakage of hairs, folliculitis and boils. Topical application of fresh leaves paste or juice (5-10 drops) is effective for wounds by protecting them from further microbial infections.	A small tree up to 8 m high; stem erect with glabrous branched twigs; leaves alternate, simple, elliptic-lanceolate; flowers cup-shaped with pink petals; fruit fleshy and downy drupe enclosing a hard furrowed one-seeded stone.
Rutaceae					
Zanthoxylum armatum DC.	Tumburu / Tejovati	UAU249	Shrub / stem or seed	The stem is used to clean teeth like a brush and it is effective in toothache. Seeds are used in toothache by crushing the mature seeds between two teeth.	A perennial shrub with dense glabrous foliage, straight pickles on stems; leaves compound, imparipinnate, rachis winged; leaflets lanceolate, dark flossy green; flowers yellow or green; fruits reddish sub-globose glabrous follicles; seeds solitary, shiny black.
Saxifragaceae					
Bergenia ciliata (Haw.) Sternb.	Fringed elephant's ears / Winter begonia / Pashanbhed	UAU250	Herb / root	Fresh or dried mature roots (1-3 g) are chewed in kidney stone twice a day for several days. The decoction of dried roots (1-3 g) is also taken in place of raw roots.	An evergreen herb with fleshy leaves, stout creeping rhizomatous rootstock; leaves glabrous, sparsely hairy in margins, obovate or elliptic; flowers white pink; fruits capsules, rounded with numerous seeds.
Violaceae					
Viola odorata L.	Benfasha / Wood violet	UAU251	Herb / leaf	Fresh leaves (2-3 g) are taken as whole or in the form of a decoction in	A small perennial herb; leaves and flowers all in a basal rosette;

				fever. A tea of fresh roots (3 g in 1 cup of water) is effective in cold and fever.	hooked style and hairy leaf-stalks.
Vitaceae					
Cissus quadrangularis L.	Hatjod / Veld grape	UAU252	Climber / stem or root	Decoction of stems or roots (2 g) is used to heal fractured bones. Paste of stems or roots is applied at the damaged areas to reduce inflammation and pain.	An evergreen climber growing up to 5 m, having quadrangular-sectioned branches with small internodes; leaves toothed trilobed, appeared at the nodes; flowers white, yellowish or greenish in racemes.

Ageratina adenophora

Bergenia ciliata

Berberis aristata

Prunus cerasoides

Anacyclus pyrethrum *Zanthoxylum armatum*

Fig. 7. Images of selected medicinal plants captured from their natural habitats

Table 2. Major bioactives of selected folklore medicinal plants

S.No.	Plant name	Bioactive compounds	Reference
1.	*Picrorhiza kurroa*	kutkoside, picroside-I, picroside-II	Ganeshkumar *et al.* 2017
2.	*Ageratum conyzoides*	lycopsamine, echinatine	Wiedenfeld 2011
3.	*Ageratina adenophora*	eupatorone, neochlorogenic acid, macranthoin F, macranthoin G	Poudel *et al.* 2020
4.	*Delphinium denudatum*	talatizidine, isotalatizidine, condelphine, denudatine	Mohanapriya & Vijaiyansiva 2013
5.	*Holarrhena pubescens*	ursolic acid, lupeol, naringin and its glycosides	Tuntiwachwuttikul *et al.* 2007
6.	*Prunus persica*	quercetin, catechin, cyanidin	Bento *et al.* 2020
7.	*Bryophyllum pinnatum*	bryophillin A, bersaldegenin-3-acetate, bryophillin C	Supratman *et al.* 2001
8.	*Allium cepa*	allicin	Bystrická *et al.* 2013
9.	*Picrorhiza kurroa*	picroside I, II	Debnath *et al.* 2020
10.	*Cissus quadrangularis*	quadrangularin A, ascorbic acid	Chen *et al.* 2009
11.	*Pterocarpus santalinus*	santalin A, santalin B, savinin, calocedrin, pterolinus K, pterolinus L	Bulle *et al.* 2016
12.	*Trachyspermum ammi*	thymol, carvone, limonene, dillapiole	Bairwa *et al.* 2012
13.	*Piper longum*	piperine, piperlongumine, sylvatin, sesamin, diaeudesmin piperlonguminine, pipermonaline, piperundecalidine	Kumar *et al.* 2011
14.	*Vitex negundo*	casticin, isoorientin, chrysophenol D, luteolin	Ambika & Sundrarajan 2015
15.	*Boerhavia diffusa*	boerhaavia G, boerhavia H	Ahmed-Belkacem *et al.* 2007
16.	*Thalictrum foliolosum*	berberine, jatrorrhizine, palmatine	Sharma *et al.* 2020
17.	*Rheum australe*	emodin, chrysophanol	Pandith *et al.* 2018

Discussion

The results of the present study revealed that cuts, wounds, boils, bone-fracture, joint pain, fungal infection, cough, cold, asthma, mouth ulcer, headache, jaundice, muscular pain, swelling, kidney stone, toothache, fever, snakebite, intestinal parasites, eyes related problems and stomachache are the main health conditions treated by the folk healers with the help of herbal medicine. Most of the above health conditions are associated with acute pain and inflammation and require emergency management (Abdolrazaghnejad *et al.* 2018). Hence, the traditional knowledge of healers of these rural areas is playing a key role in the primary healthcare of a large population using natural remedies. Moreover, herbal remedies are the best choice of treatment due to their high efficacy with no serious side effects.

It has been noticed that most of the ethnomedicinal herbs were used topically mainly for the treatment of cuts, wounds and bone fractures. However, the oral application of selected herbs was recorded for a few health conditions including stomachache and intestinal worms. Although the oral administration of a drug is most accepted, the topical route has many advantages over due to its easy application at a selective site and minimum side effects (Sharadha *et al.* 2020). Hence, it can be considered safe to use an herbal remedy via a topical route even without consulting a practitioner.

The results of the present field survey were found encouraging as many plants species were explored for their traditional uses for the first time. The present work can be considered as an extension of the field surveys conducted earlier by various researchers. Previous studies on the ethnobotanical survey of medicinal plants of other areas of Uttarakhand shows that the Gujjar tribe of Sub-Himalayan tract uses leaf or root of *Vitex negundo, Withania somnifera* and *Senna tora* for boils, leaf or stem bark of *Dalbergia sissoo* for eczema and fruits of *Abrus precatorius* and *Plumbago zeylanica* for leucoderma (Sharma *et al.* 2013). On the other hand, in the Siwalik region, inhabitants use *Adhatoda vasica* for rheumatism, cough and intestinal worms, *Achyranthes aspera* for skin diseases and colic conditions while *Carissa opaca* and *Quirivelia frutescens* were used for fever, skin disease and toothache (Gaur & Sharma 2011). The field studies on the Pauri region revealed that the bark of *Acacia catechu* is used for waist pain, leaves of *Adhatoda vasica* with *Piper nigrum* for bronchitis and tuberculosis, roots of *Boerhaavia diffusa* with ghee for redness of the eyes, the leaf powder of *Adiantum capillus-veneris* for menstruation problems, juice of *Chenopodium album* for urinary problems whereas fruit or seed powder of *Rubus niveus*, leaves of *Ocimum basilicum* and *Cynodon dactylon* are used for calculi by the natives (Dangwal & Sharma 2011; Khajuria & Bisht 2017). Traditional healers of this region also used the seed oil of *Madhuca longifolia* for bodyache, leaf paste of *Delphinium denudatum* for burns and leaf paste of *Cyperus rotundus* for the treatment of skin ailments (Pandey & Pandey 2010). Apart from common ailments, the inhabitants also used various plants for psychomedicinal purposes that include *Stephania glabra*, *Betula utili* and *Prunus cerasoides* (Tiwari *et al.* 2010).

Ethnobotanical field surveys play a key role in the new drug discovery from natural products (Albuquerque *et al.* 2014). Such studies are not limited to a certain region but extensively conducted worldwide *viz.* Asia (Xiong *et al.* 2020), Africa (Van Wyk *et al.* 2008), America (Botsaris 2007), Europe (Pieroni *et al.* 2013) and Australia (Thompson *et al.* 2019). To date, several medicinal products have been developed from natural sources and used extensively across the globe. Still, there are many remote areas having rich plant diversity, that are unexplored, the ethnobotanical survey of such areas may help find a solution to different untreatable chronic diseases including cancers.

Conclusions

The present survey-based study revealed that a major part of Jaunsar-Bawar region of Uttarakhand is remote in location. The rural population of this region still depends on folk medicine due to limited access to advanced medical facilities. Although in the nearby towns hospital facilities are also available, many people cannot afford the costly treatment. Hence, the folk knowledge of herbal remedies is no less than a boon for the inhabitants of this region. Interestingly, these plants are effective in treating various ailments without showing any adverse effect as being practised for centuries. However, their scientific validation with the proper mode of action is necessary to develop them as a medicine for commercial use.

Declarations

List of abbreviations: Not applicable.
Ethics approval and consent to participate: All the participants provided prior informed consent before the interviews.
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Author Contributions: Deepak Kumar Semwal: Conceptualization and designing the study, Supervision, Data collection and formal analysis, Review and editing; **Ankit Kumar:** Data collection and formal analysis, Writing original draft; **Ashutosh Chauhan:** Data collection and formal analysis; **Ruchi Badoni Semwal:** Validation and Visualization; **Ravindra Semwal:** Writing original draft; **Sunil Kumar Joshi:** Review and editing.

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