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A study of wild medicinal plants used in Nargu Wildlife Sanctuary of district Mandi in Himachal Pradesh, India

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ABSTRACT

The current study was carried out from 2019 to 2020 to collect data on the use of wild ethnomedicinal plants in Nargu Wildlife Sanctuary of district Mandi in Himachal Pradesh, India. Information on wild medicinal plants for this survey was collected through personal field visits, interviews, discussion, and a pre-tested questionnaire. A total of 45 plant species, belonging to 28 different families were identified, along with their botanical name, vernacular name, family, and habitat. Of the identified species, most were herbs and shrubs (16), followed by trees (6), climbers (5), and ferns (2). The leaves were the most common part used in the medicinal preparations. The largest number of plant species were from Rosaceae. Different parts of the plants were used by local people to cure several diseases including snakebites, cough, cold, and some other infectious diseases. It was observed that local people of Nargu Wildlife Sanctuary are still dependent on wild medicinal plants for the treatment of various diseases, and proper conservation planning is therefore needed to conserve these useful plant species in this region.

INTRODUCTION

The Indian Himalayan Region is known as a mega-biodiversity hotspot that covers over 18% of the Indian sub-continent (Myers, 2006; Radha et al., 2019a, 2020). Since ancient times, the area has been well known for its rich ethnomedicinal flora (Vidyarthi *et al*., 2013). The abundance of plant diversity in the region is due to the presence of different biogeographic regions (Samant and Dhar, 1997; Radha *et al*., 2019b). The main reasons for the decline in the population of medicinal plant availability in the Himalayan region were excessively caused by the pressures of human activity. With growing demand and renewed global interest in traditional ethnopharmacy, combined with the increasing preference in the healthcare system for natural substances, the natural stock of medicinal plant species in Himachal Pradesh is under great pressure (Chauhan, 2003; Radha *et al*., 2019a).

Since ancient times, indigenous communities have depended primarily on indigenous plants for their daily needs, such as fuel, food, food, and medicines. Documentation of traditional knowledge has provided a variety of essential medicines for the modern world and this information also can be used for the conservation and sustainable use of medicinal plants (Fabricant and Farnsworth, 2001; Rahman *et al*., 2004). Traditional knowledge of medicinal plants is in decline in many areas, as the new generation is having little interest in learning traditional knowledge (Kargioglu *et al*., 2008; Radha and Puri, 2019a, 2019b, 2019c). For the conservation and utilization of biological wealth, proper documentation of traditional knowledge is, therefore, necessary (Muthu *et al*., 2006).

The study area, Nargu Wildlife Sanctuary located in the Mandi district of Himachal Pradesh, harbors a rich assortment of medicinal plants in its sanctuary area (Sharma *et al*., 2015). In earlier studies, it was reported that the Mandi district is well recognized for its ethnobotanical plant diversity in the Western Himalayan region (Sharma *et al*., 2013). This present study aims to document the traditional knowledge of medicinal plants used by the local people of the Nargu Wildlife Sanctuary and encourages

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the preservation of this previously undocumented information for future generations.

MATERIALS AND METHODS

Study area

The study was undertaken in the Nargu Wildlife Sanctuary of district Mandi in Himachal Pradesh, India (Fig. 1). Mandi district of Himachal Pradesh supports three Wildlife Sanctuaries (viz. Bandli, Nargu, and Shikari Devi) (Sharma *et al*., 2013). The Nargu Wildlife Sanctuary (31°046′N to 32°05′N latitudes and 76°50′–77°04′ E longitudes) is situated in Mandi district of Himachal Pradesh, India (Fig. 1). The temperature varies from −10° to 35°C and the average annual precipitation is 1,400 mm. It was stated in earlier studies that the sanctuary region is rich in biodiversity (Sharma *et al*., 2017). The whole region is primarily mountainous with low hills undulating in the west and steep in the northeast to precipitous mountains. There are many elevated ridges, deep cliffs and gorges, and small valleys. The weather is temperate, subtropical, alpine, and sub-alpine in the study section. Around 80% of the rainfall is normally caused by the southwestern monsoon and the remainder by western storms (Sharma *et al*., 2017).

Data collection

The study on the ethnobotanical evaluation of indigenous plants of the Nargu Wildlife Sanctuary of district Mandi was carried out from 2019 to 2020. Extensive field visits were carried out in the Nargu Wildlife Sanctuary. Ethnobotanical data were collected through common discussions with the local informers aged between 20 and 70 years (Table 2). Most of the respondents were aged over 60 years (34%) It was found that males were more affable to participate in conversations than females. A total of 73 males were questioned to collect ethnomedicinal data which were selected using purposive sampling technique based on the recommendations of knowledgeable elders and their reputation in the area for their knowledge about herbal medicines and the traditional healthcare system. A questionnaire was developed and pre-tested prior to the survey with informants in order to assess its suitability for the current study and updated according to the informant's response. The revised questionnaire was used for the collection of data about medicinal plants from the local people of Nargu Wildlife Sanctuary. The field survey was carried out with local people as guides and voucher specimens of the medicinal plants were collected and their local identity was verified by other informants. The information obtained was cross-checked with the other informants from this area. The information about local names, habits, parts used, routes of administration, traditional medicinal uses of plants were carefully recorded. The collected plant specimens were identified from Botanical Survey of India Dehradun Uttarakhand and identified plant specimens with voucher numbers were submitted in the herbarium of Shoolini University, Solan, Himachal Pradesh, India.

RESULTS AND DISCUSSION

The present study's results showed that local people of this area have strong traditional knowledge of valuable wild medicinal plants. During interactions with local people of the sanctuary area, it was observed that the traditional knowledge of wild medicinal plants was acquired by them through experience and from their elders. A total of 45 wild ethnomedicinal plants, belonging to 28 different families were identified (Fig. 4). Of the identified species, most were herbs and shrubs (36%); followed by trees (13%), climbers (11%), and ferns (4%) (Fig. 2). Detailed information regarding their botanical name, vernacular name, name of the family, part used for the ailment, etc. are presented in Table 1.

The plants documented for the ethnomedicinal values belong to families Acanthaceae, Amaranthaceae, Asparagaceae, Aspleniaceae, Asteraceae, Berberidaceae, Buxaceae, Dryopteridaceae, Ericaceae, Fabaceae, Lamiaceae, Oxalidaceae, Poaceae, Pinaceae, Polygonaceae, Primulaceae, Rosaceae, Ranunculaceae, Rubiaceae, Salicaceae, Sapindaceae, Saxifragaceae, Scrophulariaceae, Thymelaceae, Urticaceae,

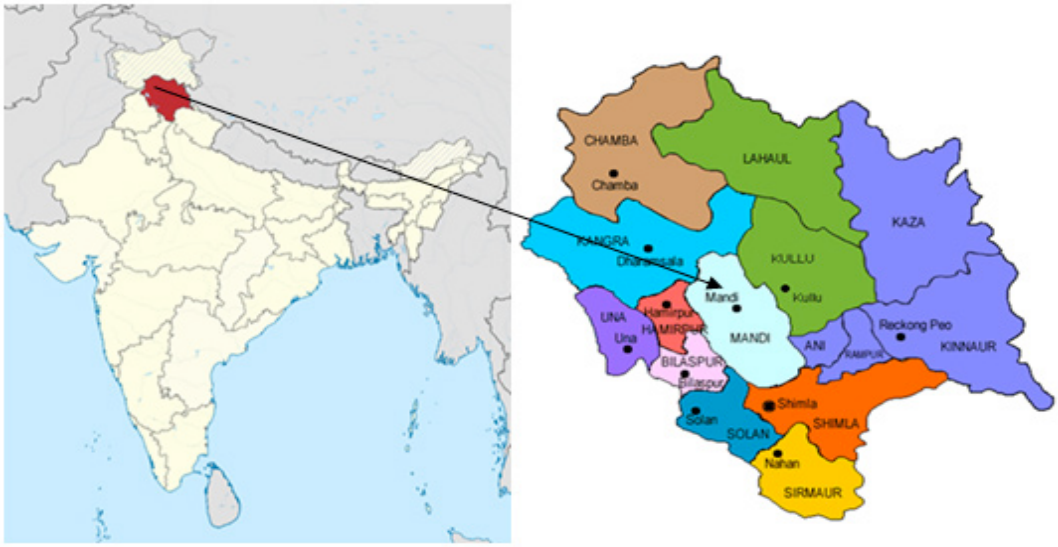


Figure 1. Location of the study area.

Table 1. Wild ethnomedicinal plants used in Nargu Wildlife Sanctuary of Himachal Pradesh, India.

S. No.	Botanical name	Family	Common name	Habit	Voucher Name	Parts used	Routes	Aliments treated
1	*A. indica* (Wall. ex Cambess.) Hook.	Sapindaceae	Kanor	Tree	SUBMS/BOT-3347	Seeds	Topical	Seed paste is applied externally in skin disease and headaches.
2	*A. parviflora* Benth.	Lamiaceae	Neel-kanthi	Herb	SUBMS/BOT-3348	Leaves	Oral	Leaves are chewed and eaten whole in diabetes.
3	*A. viridis* L.	Amaranthaceae	Jangli chauli	Herb	SUBMS/BOT-3349	Whole plant	Oral	The whole plant is used to treat dysentery, inflammation during urination, asthma, and eye infection.
4	*A. racemosus* willd.	Asparagaceae	Sansarpali	Climber	SUBMS/BOT-3350	Roots	Oral	Roots are used in the treatment of gastric pain and indigestion problems.
5	*A. dalhousiae* Hook.	Aspleniaceae	Alafjari	Fern	SUBMS/BOT-3351	Whole plant	Oral	The whole plant is used in cold.
6	*B. asiatica* Roxb. exDC.	Berberidaceae	Kashmal	Shrub	SUBMS/BOT-3352	Whole plant	Topical	The whole plant is used to treat inflammation and wounds.
7	*B. ciliata* (Haw.) sternb.	Saxifragaceae	Pathar chat	Herb	SUBMS/BOT-3353	Whole plant	Oral	Whole plant powder is used to treat kidney stones, ear pain, cough, and cold.
8	*B. pilosa* L.	Asteraceae	Gumber	Herb	SUBMS/BOT-3354	Whole plant	Oral, Topical	Whole plant juice or powder is used to treat a cut, skin disease, snakebite, sores, and wounds.
9	*B. crispa* Benth.	Scrophulariaceae	Budheta	Shrub	SUBMS/BOT-3355	Leaves	Oral	Leaves are used to treat diarrhea, dysentery, and fever.
10	*C. deodara* (Roxb. Ex D.Don) G. Don	Pinaceae	Deodar	Tree	SUBMS/BOT-3356	Leaves, Bark	Topical, Oral	Leaves are used for curing gastric problems, diabetes, and fever. The bark is used for skin diseases and headache.
11	*C. wallichii* DC.	Asteraceae	Bhursa	Shrub	SUBMS/BOT-3357	Whole plant	Topical	The whole plant is used in the treatment of toothache and ulcers.
12	*C. connata* DC.	Ranunculaceae	Bhatani	Climber	SUBMS/BOT-3358	Whole plant	Topical	The juice of the whole plant is inhaled to relieve nose bleeding.
13	*C. tomentosa* (Roth) Moq.	Amaranthaceae	Thula	Shrub	SUBMS/BOT-3359	Leaves	Oral	Leaves juice is applied to skin cuts.
14	*D. papyracea* Wall. ex G.Don	Thymelaeaceae	Setburwa	Shrub	SUBMS/BOT-3360	Whole plant	Oral, Topical	The whole plant is used to treat wound healing and diarrhea.
15	*D. longifolia* (Burm.f.) Wedd.	Urticaceae	Seharu	Shrub	SUBMS/BOT-3361	Leaves	Topical	The fresh juice of leaves is used in skin disease.
16	*D. strictus* (Roxb.) Nees	Poaceae	Bans ghass	Shrub	SUBMS/BOT-3362	Stem	Oral	The stem is used in diabetes and inflammation.
17	*D. bupleuroides* Nees	Acanthaceae	Saundhi	Herb	SUBMS/BOT-3363	Leaves	Oral	The decoction of leaves used in skin infection
18	*D. juxtaposita* Christ	Dryopteridaceae	Nachan	Fern	SUBMS/BOT-3364	Rhizoids	Oral	Rhizoids are used in digestive problems.
19	*D. indica* (Jacks.) focke	Rosaceae	Kiphaliya	Herb	SUBMS/BOT-3365	Roots	Topical	The root paste is applied for snake bites and insect bites.
20	*E. annuus* (L.) Pers.	Asteraceae	-	Herb	SUBMS/BOT-3366	Leaves	Oral	Leaves juice is used to treat diarrhea and diabetes.
21	*F. esculentum* Moench	Polygonaceae	Phaphra	Herb	SUBMS/BOT-3367	Leaves, Shoot	Oral	Dried leaves and shoot is used in the treatment of skin disease and liver infection.
22	*I. heterantha* Brandis	Fabaceae	Kali-kathi	Shrubs	SUBMS/BOT-3368	Flowers	Oral	Flowers are used in the treatment of abdominal pain and various skin infections.
23	*M. africana* L.	Primulaceae	Chhota mehndru	Shrub	SUBMS/BOT-3369	Leaf	Oral	A decoction of the leaf is used in skin allergy.
24	*O. corniculata* L.	Oxalidaceae	Malori	Herb	SUBMS/BOT-3370	Whole plant	Oral	The whole plant is used to treat cold, cough, and jaundice.
25	*P. semicordata* (Wall.) Planch.	Vitaceae	Parenu	Climber	SUBMS/BOT-3371	Bark, Shoot	Oral	Bark and shoots are used in the treatment of Jaundice.
26	*P. capitata* (Buch.-Ham. exD.Don) H. Gross	Polygonaceae	Ratnyaule jhar	Herb	SUBMS/BOT-3372	Shoot, Leaves	Oral, Topical	Leaves paste is used in Skin problems. Shoot powder is used for urinary tract infection and gastric problems.
27	*P. roxburghii* Sarg.	Pinaceae	Chir	Tree	SUBMS/BOT-3373	Leaves, Seeds, Roots	Oral	Leaves are used to treat fever, root extract is used to treat eye infections, and seeds are used to treat skin diseases.
28	*P. utilis* Royle	Rosaceae	Bhekel	Shrub	SUBMS/BOT-3374	Fruits	Topical	Fruits are used to treat throat sore.
29	*P. pashia* Buch.-Ham. ex D. Don	Rosaceae	Kianth	Tree	SUBMS/BOT-3375	Leave, Fruits	Oral	Fruits and leaves are used to treat fever, headaches, and sweating of the body.

(Continued)

S. No.	Botanical name	Family	Common name	Habit	Voucher Name	Parts used	Routes	Aliments treated
30	*Q. oblongata* D.Don	Fagaceae	Ban	Tree	SUBMS/BOT-3376	Bark, Leave, Fruits	Oral, Topical	The bark is used to treat asthma. Leaf extract is used to treat dysentery. Fruits are used to treat stomach pain and urinary infection.
31	*R. sceleratus* L.	Ranunculaceae	Jaldhaniya	Herb	SUBMS/BOT-3377	Whole plant	Topical	The whole plant is used in treating wounds and skin diseases.
32	*R. arboreum* Smith.	Ericaceae	Burans	Shrub	SUBMS/BOT-3378	Bark, Flowers	Oral	The fresh juice of bark and flowers is used in the treatment of cough, nose bleeding, diarrhea, and dysentery.
33	*R. brunonii* Lindl.	Rosaceae	Jangligulab	Shrub	SUBMS/BOT-3379	Whole plant	Oral, Topical	The whole plant is used to treat digestive problems, skin diseases, and constipation.
34	*R. cardifolia* L.	Rubiaceae	Manjith	Climber	SUBMS/BOT-3380	Roots	Oral	Roots extract is used to treat arthritis.
35	*R. ellipticus* Smith	Rosaceae	Aakhae	Shrub	SUBMS/BOT-3381	Fruits, Roots	Oral	Fruit juice is used to cure cough, fever, and dysentery. Roots extract is used to cure headaches and stomach pain.
36	*R. niveus* Thunb.	Rosaceae	Kala aakhe	Climber	SUBMS/BOT-3382	Fruits Leaves	Oral	Fresh fruits and leaf juice are used to cure dysentery.
37	*R. dentatus* L.	Polygonaceae	Albar	Herb	SUBMS/BOT-3383	Roots	Oral	Roots are used in the treatment of diarrhea and constipation.
38	*R. hastatus* D.Don	Polygonaceae	Khatti- buti	Shrub	SUBMS/BOT-3384	Whole plant	Oral	The whole plant is used to treat blood dysentery, skin diseases, ear pain, and asthma.
39	*S. tetrasperma* Roxb.	Salicaceae	Bains	Tree	SUBMS/BOT-3385	Leaves	Oral, Topical	Dried leaves are used to treat diabetes, fever, piles, wound healing, ear pain, cough, and cold.
40	*S. saligna* Mull. Arg.	Buxaceae	Geru	Shrub	SUBMS/BOT-3386	Leaves	Topical	Leaves extract is directly applied to treat skin diseases and rashes.
41	*S. virgaaurea* L.	Asteraceae	Pinja phool	Herb	SUBMS/BOT-3387	Flower, Stem	Oral	Flowers are used to treat asthma and stem is used to treat diabetes.
42	*S. tomentosa* (Lindl.) Rehder	Rosaceae	Kusthi	Shrub	SUBMS/BOT-3388	Fruits, Stem	Oral	Fruits are used to treat respiratory disorders and stem is used to treat lung infections.
43	*U. dioica* L.	Urticaceae	Kuksh	Herb	SUBMS/BOT-3389	Whole plant	Oral	The whole plant is used to treat kidney stones and skin diseases.
44	*V. thapsus* L.	Scrophulariaceae	Tamakhu	Herb	SUBMS/BOT-3390	Leaves, Flowers	Oral	Leaves are used to treat typhoid and flowers are used to treat cough.
45	*V. canescens* wall.	Violaceae	Banafsha	Herb	SUBMS/BOT-3391	Whole plant	Oral	The whole plant is used for cough, asthma, and cold.

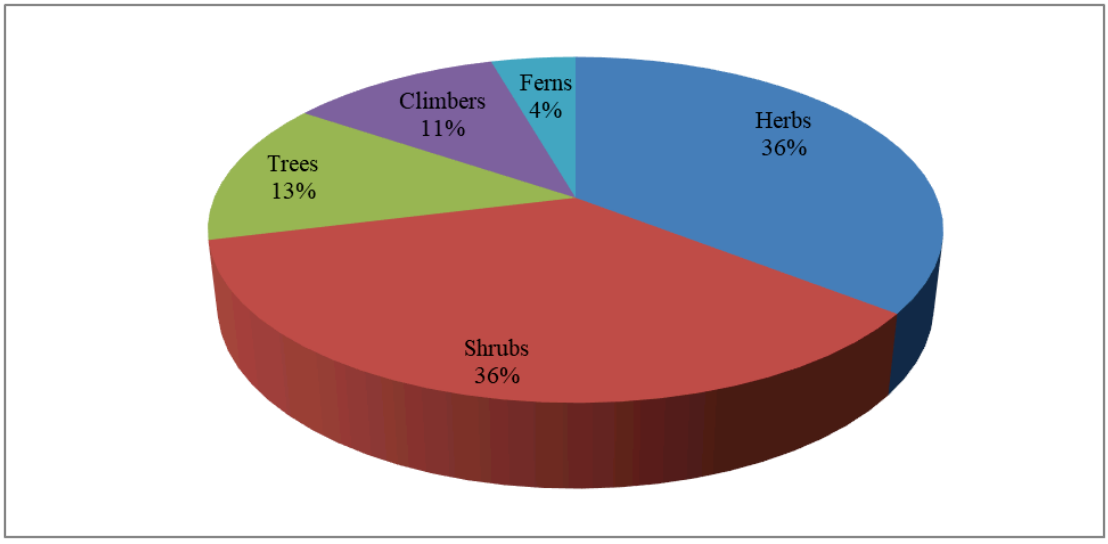


Figure 2. Category of ethnomedicinal plants used in study area.

Table 2. Ethnomedicinal data collected from different groups.

Sr. No.	Age	No. of male informants
1	20–30	3
2	31–40	10
3	41–50	15
4	51–60	20
5	61–70	25

Violaceae, and Vitaceae. The Rosaceae family contributed the highest number of medicinal plants (7) used by local people, followed by Polygonaceae and Asteraceae (4).

In the Nargu Wildlife Sanctuary the most commonly reported diseases were skin infection, dysentery, cough, fever, wound healing, diabetes, and cold. All the plants belonging to the Rosaceae family were used for skin diseases, fever, and dysentery. The plant species *Ajuga parviflora*, *Asparagus racemosus*, *Berberis asiatica*, *Bergenia ciliata*, *Bidens pilosa*, *Cedrus deodara*, *Cirsium wallichii*, *Fagopyrum esculentum*, *Oxalis corniculata*, *Pinus roxburghii*, *Pyrus pashia*, *Quercus oblongata*, *Rhododendron arboreum*, *Rubus ellipticus, Rubus niveus*, *Rumex dentatus*, and *Urtica dioica* were commonly used in the sanctuary area. The plant species reported by local people for the treatment of skin infection were *Aesculus indica*, *Debregeasia longifolia*, *Dicliptera bupleuroides*, *F. esculentum*, *Indigofera heterantha*, *Persicaria capitata*, *P. roxburghii*, *Ranunculus sceleratus*, *Rosa brunonii*, *Rumex hastatus*, *Sarcococca saligna*, *and U. dioica*; for dysentery: *Amaranthus viridis*, *Q. oblongata*, *R. arboreum*, *R. ellipticus*, and *R. hastatus*; for cough: *B. ciliata*, *O. corniculata*, *R. arboreum*, *R. ellipticus*, *Salix tetrasperma*, *Verbascum thapsus*, and *Viola canescens*; for fever: *C. deodara*, *Daphne papyraceae*, *P. roxburghii*, *R. ellipticus*, *R. ellipticus*, and *P. pashia*; for wound healing: *B. asiatica*, *B. pilosa*, *Cyathula tomentosa*, *D. papyracea*, *R. sceleratus*, and *S. tetrasperma*; for diabetes: *A. parviflora*, *C. deodara*, *Dendrocalamus strictus*, *Erigeron annuus*, *S. tetrasperma*, and *Solidago virgaaurea*; for cold: *Asplenium dalhousiae*, *B. ciliata*, *O. corniculata*, *S. tetrasperma*, and *V. canescens*.

The most commonly used parts of the plants were leaves, followed by whole plant and roots (Fig. 3). Leaves were reported as the most widely used parts of medicinal plants. It was observed that few plants were used as whole plants for the treatment of various diseases by the local people and these were *A. viridis*, *A. dalhousiae*, *B. asiatica*, *B. ciliata*, *B. pilosa*, *C. wallichii*, *Clematis connata*, *D. papyracea*, *O. corniculata*, *R. sceleratus*, *R. brunonii*, *R. hastatus*, *U. dioica*, and *V. canescens*. Local people of the sanctuary area reported that the paste of fresh leaves *Persicaria capitita* were applied on the skin for curing skin diseases. The rhizomes of *Dryopteris juxtaposita* are used for curing digestive problems. Dried leaves of *F. esculentum* were used to cure skin diseases and liver disorders. The juice of the *C. connata* is used for nose bleeding*; C. tomentosa* leaf juice is applied on skin cuts; *D. longifolia* leaf juice is used for skin diseases; *E. annuus* leaf juice is used in diarrhea and diabetes*; R. ellipticus* fruits juice is used for the treatment of cough, dysentery, and cold; *Rubus nivis* fruit and leaf juice is used to cure dysentery.

Few plant species were used as fodder for livestock, such as *A. indica*, *A. parviflora*, *A. viridis*, *A. racemosus*, *A. dalhousiae*, *B. asiatica*, *B. ciliata*, *B. pilosa*, *Buddleja crispa*, *C. deodara*, *C. wallichii*, *C. connata*, *C. tomentosa*, *D. papyracea*, *D. longifolia*, *D. strictus*, *D. bupleuroides*, *D. juxtaposita*, *Duchesnea indica*, *E. annuus*, *I. heterantha*, *Myrsine africana*, *Q. oblongata*, *R. sceleratus*, *R. arboreum*, *R. brunonii*, *R. ellipticus*, *R. dentatus*, *U. dioica*, *V. thapsus*, and *V. canescens*.

The present study found that few plant species are used as wild edibles plants such as *B. ciliata* leaves and fruits are edible, *Berberis aristata* and *R. ellipticus* fruits are edible; *R. hastatus* leaves are used as sallet; *R. arboreum* fruits are edible and *U. dioica* leaves are cooked as a wild vegetable. In addition to their medicinal importance, certain plant species are of religious and cultural importance for the local people. *A. racemosus* and *O. corniculata* are highly used by the native people of the study area both for medicinal properties and cultural significance. Some of the wild ethnomedicinal plants were also used as timber wood such as *A. indica*, *C. deodara*, *P. roxburghii*, and *Q. oblongata*.

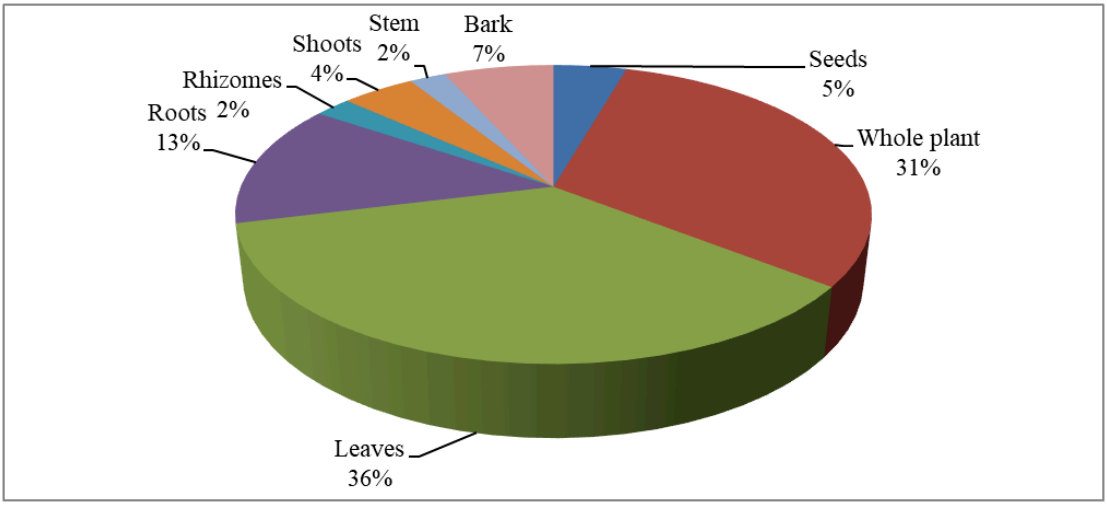
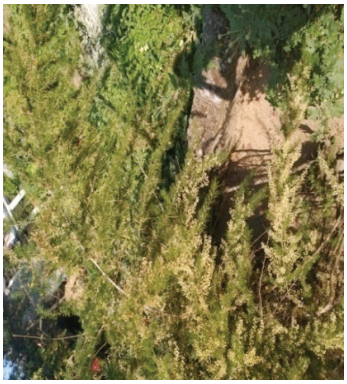


Figure 3. Plant parts used in study area.

1. *A. indica*

2. *A. parviflora*

3.*A. viridis*



4. *A. racemosus*

5. *A. dalhousiae*

6. *B. asiatica*

7. *B. ciliata*

8. *B. pilosa*

9. *B. crispa*

10. *C. deodara*

11.*C. wallichii*

12. *Clematis connate*

13.*C. tomentosa*

14. *D. papyracea*

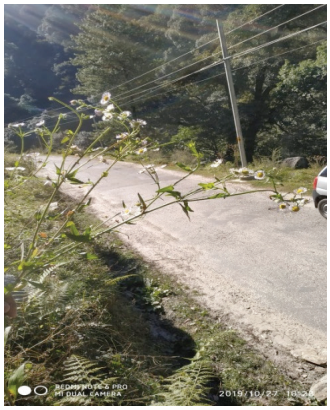
15.*D. longifolia*

16. *D. strictus*

17. *D. bupleuroides*

18. *D. juxtaposita*

19.*D. indica*



20. *E. annuus*

21.*F. esculentum*

22. *I. heterantha*

23.*M. africana*

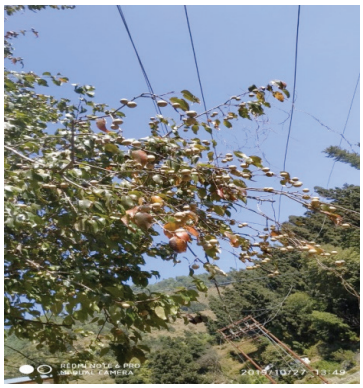
24.*O. corniculata*

25. *Parthenocissus semicordata*

26. *P. capitata*

27. *P. roxburghii*

28. *Prinsepia utilis*



29. *P. pashia*

30. *Q. oblongata*

31.*R. sceleratus*

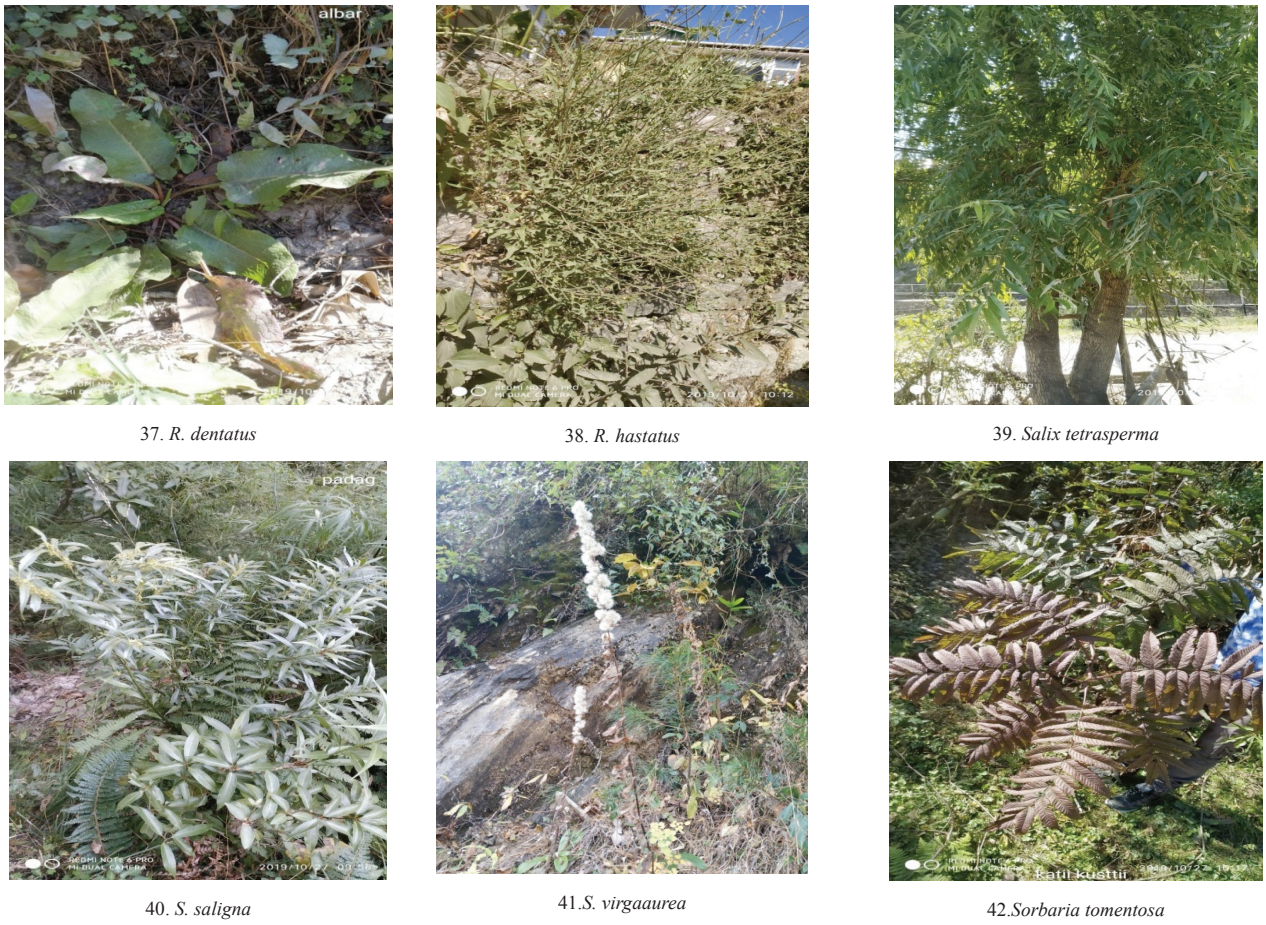
32.*R. arboreum*

33. *R. brunonii*

34. *Rubia cardifolia*

35. *R. ellipticus*

36. *R. niveus*



37. *R. dentatus* 38. *R. hastatus* 39. *Salix tetrasperma*

40. *S. saligna* 41.*S. virgaaurea* 42.*Sorbaria tomentosa*

Figure 4. Ethnomedicinal plants used in Nargu Wildlife Sanctuary of district Mandi in Himachal Pradesh.

The data produced from the study on the medicinal plants used by the native people need comprehensive phytochemical research including with few clinical studies which might help to create awareness programs of the preservation, promotion, traditional knowledge of ethno-medico-botany in the study area. There is also a serious need for the development of conservation repositories like herbal gardens, nurseries, and inspiring farmers to cultivate endangered medicinal plant species of the state.

CONCLUSION

The Himalayas has an amazing assortment of plant species due to its unique location and has been considered as a treasure that is confined to societies living here, but this wealth is diminishing fast because societies residing in this belt hesitate to share their information with others. The ethnobotanical study conducted in Nargu Wildlife Sanctuary of district Mandi revealed that native people of the sanctuary area have faith and respect for traditional medicines. Forty-five medicinal plants belonging to different families were reported from the study area including common name, ailments treated, parts used, and mode of administration. The findings indicated that the natives of Himachal Pradesh, especially those residing in remote and high-altitude areas, are mainly dependent on the surrounding plant resources to meet their daily requirements. The information collected from the local inhabitants of the Nargu Wildlife Sanctuary indicates that study area is rich in wild ethnomedicinal plants, and the results contribute to spreading their uses. The social significance of wild medicinal plants in the community is very important for public health and thus more attention needs to be paid to research on these traditional medicinal plant species in an effort to improve human health that can be applied more effectively in geographical areas that lack access to good healthcare facilities.

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

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CONFLICTS OF INTEREST

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