Ethnobotanical Practices among the People of Dagana District, Bhutan

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Authors’ contributions

This work was done in collaboration among all the seven authors. Author KS designed the study, performed the analysis and wrote the manuscript. The writing of manuscript was assisted by author BS along with proof reading. Authors PPC, P, KJ, KW and MKN assisted in field data collection, data sorting and cleaning. All authors read and approved the final manuscript.

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ABSTRACT

Medicinal plants are one of the most affordable and accessible method available for the treatment of various ailments and diseases by the local people. In this regards, the study aimed to document the ethno-medicinal knowledge of plants used by the local people of Dagana district of Bhutan. Data were collected between June and November of 2020 using semi-structured interviews from the local people, following snowball sampling. The study documented 74 medicinal plant species, used for treating 30 different body ailments and diseases. Maximum number of species (14) was used in treating cut/body wounds and commonly used plant parts was leaves (30 species). Current study area was found to be rich in ethno-medicinal knowledge, but equally threatened with declining practices and management of resources. Thus, appropriate conservation of resources and preservation of traditional knowledge is required.

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1. INTRODUCTION

Traditional knowledge on medicine plays an important role in rural areas and is the most affordable and accessible method available for the treatment of various diseases [1]. It has been estimated that as many as 60-85% of the world’s population rely primarily on plant-based medicines [2,3]. Traditional medicine can be defined as indigenous medicine that is used to maintain health and to prevent diseases based on theories, beliefs, and experiences [4]. It has been used for thousands of years with great contributions made by practitioners to human health, and maintaining its popularity worldwide [5]. Thus, traditional medicine is strongly bonded to nature and dependent on natural resources and culture [6-8].

Most of the inhabitants of Bhutan still utilize the forest resources in various forms such as medicine, food, fuel, fodder and timber. Over the years, it has been observed that the traditional knowledge on ethnobotanical practices is being gradually disappearing in Bhutan (k.S pers. com., 2019) [9] and similar is being reported by [10,11]. Anyinum stated that the loss of traditional knowledge has impacted on the development of modern medicine [11]. Moreover, medicinal plants are at increasing risk from destruction of their habitats (agricultural expansion, fire, construction, overgrazing, and urbanization) and over harvesting of known medicinal species [12-14]. This indicates that due consideration should be given for conservation of these plants since they are being widely exploited for various purposes other than their medicinal value.

Previous studies on ethnobotanical practices have been carried out in most of the areas in Bhutan [15-17,13] apart from Dagana district. In view of this, it is evident the need to document the traditional knowledge of every human communities, to preserve the cultural characteristics as stated by Alves and Rosa [2]. Especially the old age and local healers have information and understanding on a wide range of medicinal values of natural resources that are useful in curing the common ailments [1]. Historically, plant derived products were the only source of nearly all medicinal preparations [18]. At present, these informations are gradually fading with people relying on modern medicines and younger generation not taking up interest in learning such things. Therefore, preservation of indigenous knowledge has become an urgent need for the society.

2. MATERIALS AND METHODS

2.1 Study Area

Dagana district has a total area of 1723 square kilometers, located in the altitude of 185-3800 meters above sea level. The district lies in the South western part of Bhutan between latitude of 28°50’9.90”N to 27°15’9.41”N and longitude of 89°46’50.42”E to 89°49’1.15”E (Fig. 1). The district was initially selected based on the concern raised by the old age group of local people on the declining ethnobotanical practices in the district.

Dagana district has more than 80% of its area under forest cover. Hardy trees like Champ (Magnolia champaca), Chirpine (Pinus roxburghii) and Sal (Shorea robusta) grow throughout the region [19]. Dagana being in a strategic location plays an important role in terms of conservation of key flora and fauna species. It is home to some critically endangered species such as White-bellied heron (Ardea insignis), Crown wand orchid (Paphiopedilum fairrieanum) and Chinese pangolin (Manis pentadactyla). It also harbors important fauna species such as tiger (Panthera tigris), Asian elephant (Elephas maximus), Himalayan mahseer (Tor putitora), Leopard (Panthera pardus), Gaur (Bos gaurus), Dhole (Cuon alpinus) and flora that includes Himalayan yew (Taxus wallichiana) and Shoe shaped belly lip orchid (Gastrochilus calceolaris) [20].

2.2 Data Collection and Plants Identification

The rapid field survey was carried out between June and November 2020 to document existing ethnobotanical practices by the local people. Data was collected using semi-structure interviews and only the knowledgeable persons were selected based on the snowball sampling. The study gathered data from 32 individuals, of which thirty were male and two female, with age ranging from 39 to 73. All the respondents practice the ethno-medicine occasionally. Respondents were also asked to demonstrate
the procedure of medicinal uses, and same is being recorded and described here. Plants specimen were also collected and later identified referring the Flora of Bhutan [21-25].

3. RESULTS AND DISCUSSION

The study recorded a total of 74 medicinal plants belonging to 50 families (Table 1). Within the plant families recorded, Asteraceae was the largest medicinal plant family having nine species. The remaining 49 families possessed equal to or less than four species each. The most common plant part used for medicinal purposes was leaves (30 species) followed by stem and bark (12 species each), fruits (9 species), root (8 species), seed and whole plant (6 species each), flower (4 species), rhizome (3 species), and berries, bulb, tuber and shoot (1 species each) (Fig. 2).

Local people use the recorded medicinal plants to treat 30 different types of body ailments and diseases. Maximum number of species (14) was used in treating cut/body wounds followed by 11 species in cough and cold and 9 species in diarrhea and dysentery (Fig. 3). Total of 9 ethnomedicinal preparation methods were identified and found that preparation of paste after crushing was mostly used (27.03%) followed by extraction of juice after crushing (24.32%), taken raw (21.62%), decoction (14.86%), poultice (5.41%), extraction of latex/gel (2.70%), burning to coal (1.35%), extraction of oil (1.35%) and preparation of powder (1.35%), which are either applied to the affected parts or taken orally.

The informants also stated the use of animal parts by their ancestors in earlier time such as animal bile, stomach, antler, honey comb, meat and egg yolk for treating various diseases and ailments such as asthma, kidney problem, jaundice, cough and cold, tuberculosis, malaria and heart diseases. Some were also used for removing the splinter and scars from the body, treatment of snake poison and curing high mountain sickness. However, due to strict monitoring by the Department of Forest and park Services (DoFPS) of Bhutan, it’s been told that these things are not being practiced. Similarly, the rock mineral known as Asphaltum (shilajit) is also being used. It is being extracted from the cliff and melted to remove impurities such as sand and stones contains. Then it is mixed with water and drink once before breakfast and the evening dinner. As per informants, the shilajit is known to be best for curing illness as well as to build body immune system against diseases. It is also being applied on the cuts, wounds and burns to heal quicker.
It was found that the people of Dagana district are rich in ethno-medicinal knowledge, and only the elderly people practice it, but occasionally. Some of them were less conscious to share their knowledge, but equally concern with the possible extinction of their indigenous knowledge. Some of the important factors affecting the traditional knowledge on ethno-medicine are declining interest of youngsters towards value of traditional medicine, preferring modern medicine and seeking jobs in cities for better future. Similar was reported by [7] and [26] from Nepal. All the informants were equally concern with the declining of medicinal plants. One of the most important factor affecting this decline was neglecting the existence of such important species by the human community in current study area. When such species do not get management attention, they gets depleted due to various reasons such as habitat loss, overgrazing, unsustainable harvesting, illegitimate trade, soil erosion and drought [12,13,24,27,28].
Table 1. List of ethno-medicinal plants used by local people of Dagana district in Bhutan

| Sl. no. | Scientific name | Family                | Ethno-medicinal uses                          | Parts used     | Methods of preparation |
|---------|-----------------|-----------------------|-----------------------------------------------|----------------|------------------------|
| 1       | *Adhatoda vasica* L. | Acanthaceae | Relieving pain in joints                       | Stem and root  | Crush and apply as poultice on the affected parts. |
| 2       | *Acorus calamus* L.  | Acoraceae | Treatment of food poison                       | Root           | Root is crushed into paste and taken orally.       |
| 3       | *Sambucus* sp.Wall. ex DC. | Adoxaceae | Building immune system and treatment of constipation | Berries and flower | Raw berries and flowers are chewed. |
| 4       | *Allium sativum* L.  | Amaryllidaceae | Treatment of diabetes and high blood pressure   | Bulb           | Bulb is crush into paste and drank after mixing with hot water. |
| 5       | *Rhus chinensis* Mill. | Anacardiaceae | Treatment of diarrhea, dysentery and cough.     | Fruits         | Raw fruits are eaten or can be made into paste and taken orally. |
| 6       | *Coriandrum sativum* L. | Apiaceae | Treatment of constipation and diarrhea         | Leaves         | Crushed and drink the juice.                       |
| 7       | *Colocasia esculenta* L. Schottt | Araceae | Relieving cough and fever                       | Rhizome        | Rhizome is eaten as raw.                           |
| 8       | *Tupistra aurantica* (Baker) Wall. ex Hook. f. | Asparagaceae | Relieving intense stomach ache                  | Flowers        | Drink the decoction from flowers.                  |
| 9       | *Ageritina adenophora* Spreng. R.M.King & H.Rob. | Asteraceae | Blood coating and healing of cut wound          | Leaves         | Crush and apply the juice gently on the wound.    |
| 10      | *Ageratum conyzoides* L. | Asteraceae | Blood coating and healing of cut wound          | Leaves         | Crush and apply the paste on effected area.       |
| 11      | *Artemisia vulgaris* L. | Asteraceae | Cough relieve and blood coating of cut wound    | Stem and leaves | Crush and drink the liquid or apply on cut wound. |
| 12      | *Bidens pilosa* L.   | Asteraceae | Treatment of external wounds and inflammation   | Whole plant    | Fresh plant is crush and paste is applied.         |
| 13      | *Chromolaena odorata* (L.) R.M.King & H.Rob. | Asteraceae | Relieving wound and skin disease               | Leaves and stem | Crush and apply on affected parts.                  |
| 14      | *Chrysanthemum* sp.  | Asteraceae | Blood coating and healing of cut wound          | Leaves         | Paste of fresh leaves is soaked in the hot water for 1-2 hours and drank. |
| 15      | *Gynura nipalensis* DC. | Asphodelaceae | Treatment of cut wounds and diabetes            | Leaves         | Paste is applied on the wounds; Decoction from leaves is drank. |
| 16      | *Smallanthus sonchifolius* (Poepp.) H.Rob | Asteraceae | Treatment for lowing fat and pressure           | Tuber          | Tuber can be eaten directly.                      |
| 17      | *Xanthium indicum* J. Koenig | Asteraceae | Treatment of wound                             | Seeds          | Poultice of seeds is applied on the wound.        |
| 18      | *Calamus acanthophatus* Griff. | Arecaceae | Healing wound and fever                         | Whole plant    | Smash and apply on wound of forehead.             |
| 19      | *Aloe vera* (L.) Burm.f. | Asphodelaceae | Ulcer                                          | Whole plant    | Gel is squash and apply on body.                  |
| 20      | *Begonia* sp.        | Begoniaceae | Relieving headache                             | Flowers and leaves | Crush flower and leaves is gently rough on.       |
| Sl. no. | Scientific name                   | Family          | Ethno-medicinal uses                                  | Parts used       | Methods of preparation                                      |
|--------|----------------------------------|-----------------|------------------------------------------------------|------------------|------------------------------------------------------------|
| 21     | *Mahonia nipalensis* DC.         | Berberidaceae   | Treatment of dysentery and sore pain                  | Root, stem and   | Decoction of root, stem or fruits (or eaten raw) is being drank. |
|        |                                  |                 |                                                      | fruits           |                                                            |
| 22     | *Alnus nipalensis* D.Don          | Betulaceae      | Healing of burns                                      | Bark             | Crush and juice is applied on affected areas.               |
| 23     | *Brassica juncea* (L.) Czern.    | Brassicaceae    | Relieving headache                                    | Leaves and stem  | Crush and the paste is apply on head.                       |
|        |                                  |                 |                                                      | Storage root     | Root is eaten raw to remove poison.                         |
|        |                                  |                 |                                                      | Stem and leaves  | Crush and apply the juice on infected parts.                 |
| 24     | *Raphanus raphanistrum* L.       | Brassicaceae    | Snake poison                                          |                  |                                                            |
| 25     | *Cannabis sativa* L.             | Cannabaceae     | Treatment of fungal infection/ringworm               |                  |                                                            |
| 26     | *Terminalia chebula* Retz.       | Combretaceae    | Treatment of cough and cold                          | Fruits           | Fruits is directly eaten.                                   |
| 27     | *Cascuta reflexa* Roxb.          | Convolvulaceae  | Curing of jaundice                                    | Whole plant      | Crush and drink juice.                                      |
| 28     | *Cupressus cashmeriana* Royle ex Carrière | Cupressaceae | Treatment of scabies                                 | Stem             | Portion of stem is burned and coal is applied on the affected area. |
| 29     | *Dioscorea hamiltonii* Hook.f.   | Dioscoreaceae   | Treatment for snake bite                              | Stem             | Bind the stem above the bitten portion (it will not allow blood to pass to other body parts of the body). |
| 30     | *Gaultheria fragrantissima* Wall.| Ericaceae       | Treatment of cough and stomach problems              | Leaves and fruits| Drink the juice prepared from leaves or fruits can be chewed raw |
|        |                                  |                 |                                                      |                  |                                                            |
| 31     | *Rhododendron arboreum* Smith.   | Ericaceae       | Treatment of cough and headache                       | Bark and leaves  | Paste of leaves is applied on forehead and juice from bark is taken orally. |
| 32     | *Euphorbia royleana* Boiss.      | Euphorbiaceae   | Treatment of cough and asthma                         | Stem             | Latex from stem is taken in small quantity orally.          |
| 33     | *Jatropha curcas* L.             | Euphorbiaceae   | Treatment of snake bite                               | Leaves           | Leaves is crushed into paste and apply on the bitten portion. |
| 34     | *Ricinus communis* L.            | Euphorbiaceae   | Treatment of Joint pain and fracture                  | Seeds            | Crush seeds into paste and apply on affected part.         |
|        |                                  |                 |                                                      |                  |                                                            |
| 35     | *Entada rheedi* Spreng.          | Fabaceae        | Curing itching in body                                | Bark and seeds   | Poultice is applied on the itching parts of the body.      |
|        |                                  |                 |                                                      |                  |                                                            |
| 36     | *Erythrina arborescens* Roxb.    | Fabaceae        | Improve loss of appetite and treatment of boil        | Root and bark    | Root part is taken to improve appetite and bark is crush to produce juice, which is applied on the boils. |
|        |                                  |                 |                                                      |                  |                                                            |
| 37     | *Quercus griffithii* Hook.f. & Thomson ex Miq. | Fagaceae | Treatment of diarrhea and dysentery                   | Seed             | Decoction is taken orally.                                  |
|        |                                  |                 |                                                      |                  |                                                            |
| 38     | *Swertia petiolata* Royle.       | Gentianaceae    | Relieving headache                                    | All parts        | All parts of plants is eaten raw.                           |
|        |                                  |                 |                                                      |                  |                                                            |
| 39     | *Dichroa febrifuga* Lour.        | Hydrangeaceae   | Treatment of cough and fever                          | Roots, bark and   | Crush and juice is taken orally.                           |
|        |                                  |                 |                                                      | leaves           |                                                            |

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| Sl. no. | Scientific name | Family          | Ethno-medicinal uses                                      | Parts used | Methods of preparation                                      |
|--------|-----------------|-----------------|------------------------------------------------------------|------------|------------------------------------------------------------|
| 40     | *Juglans regia* L | Juglandaceae    | Treatment of dry skin problems                            | Seed       | Oil is extracted and applied on the affected areas.        |
| 41     | *Elsholtzia blanda* (Benth.) Benth. | Lamiaceae | Reducing high blood pressure                             | Leaves     | Leaves are chewed and eaten raw.                            |
| 42     | *Gmelina arborea* Roxb. ex Sm. | Lamiaceae | Relieving cough and ulcer                                 | Bark       | Chewing of bark or boil and drink the extract.             |
| 43     | *Cinnamomum impressinervium* Meisn. | Lauraceae | Treatment of diabetes                                      | Leaves     | Dried leaves is crushed into powder and taken orally.      |
| 44     | *Cinnamomum tamala* (Buch.-Ham.) Th. G. G. Nees | Lamiaceae | Treatment of ulcer and gastritis                          | Bark       | Bark is peeled and eaten as raw.                            |
| 45     | *Lindera neesiša* (Wall. ex Nees) Kurz | Lamiaceae | Treatment of stomach ache/or food poison                   | Fruits     | Fruits is eaten as raw.                                     |
| 46     | *Gossypium hisutum* L. | Malvaceae | Treatment of rashes on skin                               | Leaves     | Leaves are crush and juice is applied on the affected parts. |
| 47     | *Myrica esculenta* Buch.-Ham. ex D. Don | Myricaceae | Treatment of fever and cut wounds                         | Bark       | Bark is crush and applied on the cuts. Juice is taken orally for the treatment of fever. |
| 48     | *Psidum guajava* L | Myrtaceae | Treatment of diarrhea and dysentery                        | Fruits     | Fruit is eaten fresh.                                      |
| 49     | *Ficus racemosa* L | Moraceae | Treatment of diarrhea and dysentery                        | Bark       | Bark is crushed and juice is taken orally.                 |
| 50     | *Musa sp.*     | Musaceae | Treatment of arrow poison or snake bite                    | Young banana shoots | Squeeze the banana shoots and drink raw liquid.             |
| 51     | *Peperomia tetraphylla* (G. Forst.) Hook. &Arn. | Piperaceae | Treatment of itching of skin                              | Leaves     | Crushed leaves are applied on affected parts.              |
| 52     | *Platago lanceolata* L. | Plantaginaceae | Treatment of diarrhea, asthma and skin diseases           | Leaves     | Leaves are crush and applied on infected parts or juice is taken orally. |
| 53     | *Dimeria sp.(L.) Willd. ex Schult* | Poaceae | Relieving from diarrhea                                    | Whole parts | Crushed and mixed with Maida flour and eaten.              |
| 54     | *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda | Grassaceae | Healing wounds                                             | leaves      | Smash and apply the paste on wounds.                       |
| 55     | *Rumex nipalensis* Spreng. | Polygonaceae | Cough relieve and blood coating of cut wound               | leaves      | Crush and drink juice or apply.                            |
| 56     | *Maesa chisia* Buch. Ham. ex D. Don | Primulaceae | Treatment of scabies and skin diseases                     | Fruits     | Fruits are crush into paste and applied.                   |
| 57     | *Clematis Montana* DC. | Ranunculaceae | Treatment of cough and cold                               | Root       | Paste of roots is soaked into hot water for 1-2 hours and drank. |
| 58     | *Prunus persica* (L.) Stokes | Rosaceae | Treatment of wounds and sore throat                        | Bark and leaf | Decoction is taken orally.                                |
| 59     | *Rubus ellipticus* Smith | Rosaceae | Treatments of diabetes and cut wounds                     | Bark and leaf | Crush and apply on cuts; juice is taken orally.             |
| Sl. no. | Scientific name             | Family          | Ethno-medicinal uses                          | Parts used | Methods of preparation                                                                 |
|--------|-----------------------------|-----------------|-----------------------------------------------|------------|----------------------------------------------------------------------------------------|
| 60     | Rubia cordifolia L.         | Rubiaceae       | Relieve pain in joints                        | Stem and leaves | Crush and apply or boil and apply the liquid.                                          |
| 61     | Zanthoxylum armatum DC.     | Rutaceae        | Relieving body pain and treatment of cuts or wounds | Stem and leaves | Decocion is applied on the body; leaves is crush and apply on the cuts/wound.          |
| 62     | Viscum nepalense Spreng.   | Santalaceae     | Healing the fracture of joints in legs and hands | Stem       | Chew and swallow the parts of stem.                                                    |
| 63     | Houttuynia cordata Thunb.   | Saururaceae     | Treatment of diarrhea                         | Leaves     | Crush and juice is taken orally.                                                        |
| 64     | Buddleja bhutanica Yam      | Scrophulariaceae | Treatment of skin disease                     | Flower and leaves | Extracts is applied on infected parts.                                                  |
| 65     | Capsicum sp.                | Solanaceae      | Treatment for snake bite                      | Fruit      | Paste of small red peppers is applied on the bite portion to minimize the effect of poison. |
| 66     | Datura stramonium L.        | Solanaceae      | Treatment of burns                            | Leaves     | Leaves is used as poultice. Placed the seed on the rock and inhale the hot air through closed pipe. |
| 67     | Solanum khasianum C.B.Clarke |                | Removing the parasite from the teeth          | Seeds      | Decocion is taken orally. Juice of leaves is applied on infected areas.                |
| 68     | Daphne bholua D. Don        | Thymelaeeaceae  | Treatment of fever                            | Bark       | Juice of leaves is applied on infected areas.                                          |
| 69     | Debregeasia longifolia (Burm. f.) Wedd. | Urticaceae | Treatment of scabies and skin diseases        | Leaves and fruits | Juice of leaves is applied on infected areas.                                          |
| 70     | Urtica parviflora Roxb.     | Urticaceae      | Treatment of diabetes                         | Leaves     | Leaves can be prepared into curry and taken orally.                                   |
| 71     | Amomum subulatum Roxb.      | Zingiberaceae   | Treatment of sore throats                     | Seeds      | Chew the seed and swallow.                                                            |
| 72     | Curcuma longa L.            | Zingiberaceae   | Relieving body and stomach ache               | Roots      | Decocion from crushed roots is drunk.                                                  |
| 73     | Cautleya spicata (Sm.) Baker|                 | Treatment of constipation                     | Rhizome    | Juice is extracted and drank.                                                         |
| 74     | Zingiber officinale Roscoe  |                 | Treatment of stomach problems                 | Rhizome    | Can be chewed or make into paste and eaten as raw.                                   |
4. CONCLUSION

The world is facing massive loss of wildlife due to overexploitation [29] including the collection for medicinal purposes [11]. Equally, it is crucial to protect the traditional knowledge, as it is valuable not only to those directly involved with it, but also to the development of modern medicine [2]. In this regard, holders of traditional knowledge can play an important role as natural resource managers [2] to ensure its long term survival. For this, it is important not only to document the traditional use of species, but also to integrate the cultural and biological aspects of such practices into a broader discourse encompassing conservation, cooperative management, and sustainability.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable to this research.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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