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## Preliminary Findings of Rapid Inventory and Documentation of Traditional Knowledge associated with Biological Resources in Bhutan

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### Abstract

The rapid national inventory and documentation of traditional knowledge associated with biological resources, Education and advocacy programs on the Access and Benefit Sharing (ABS) and Traditional Knowledge (TK) was studied in all 205 gewogs in Bhutan. Semi-structured, open-ended questionnaires and audio-visual devices were used to interview the TK holders and collect information. 19,075 people in all 205 Gewogs were familiarized with ABS and TK. A total of 789 TK holders were recorded, with the greatest number of participants in the age group (51-60). Around 46 different types of diseases were found to be treated by TK holders and 162 species of medicinal plants in 151 genera and 71 families were recorded, with the family Asteraceae having the highest number of species. The highest number of medicinal plant species had a herb life form, and the lowest were ferns. The most widely practiced preparation methods by TK holders were in the form of paste, sap, powder, decoction and infusion, either administered orally or applied topically. Amongst different plant parts used, the whole plant was most often used.

**Key words:** Access and benefit sharing, Bhutan, bioprospecting, dzongkhags, gewogs, prior informed consent, traditional knowledge

### Introduction

Bhutan is home to about 5,600 seed plant species placed in 220 families and 1,415 genera, of which more than 300 species of medicinal plants are used in the Bhutanese traditional medicine system (BANERJEE & BANDOPADHYAY 2016), while many species are used by TK holder in the local healing system. In former times, Bhutan was known by many names such as '*bruk-tsan-dhen-b.kod-pai-rgyal-khab*' (dragon kingdom of bountiful sandalwood) and '*lho-jong sman-jong*' (southern land of medicinal plants) and the living tradition of a rich traditional medical knowledge that is being supported by the country's unique biodiversity validates those names (WANGCHUK & TOBGAY 2015).

The TK has been developed through the experiences of communities over centuries, adapted to local cultures and environments, and passed down from generation to generation (CHETRI et al. 2021) and is an intangible heritage which is rarely recorded in any formal form of documentation. TK has been one of the important sources of modern drug discoveries mainly because their long history of medical uses boosts the hit rate of new drug lead compounds (WANGCHUK & TOBGAY 2015). According to BARRET et al. (1999), as much as one-third to one-half of pharmaceutical drugs are originally derived from plants. For example, the popular cardiac medication 'Digoxin' is derived from foxglove leaves, the painkillers 'Morphine' and 'Codeine' from the opium poppy, and 'Atropine' from the nightshade plant is used for treating nervous system disorders. TK is important not only to those who depend on it but also to modern industries (PFOTENHAUER 2022). Bhutan has huge potential in terms of health care and bioprospecting due to its rich ethnomedical knowledge (WANGCHUK et al. 2011). With the rush for natural product development and bioprospecting from the world's natural resources, it has become crucial to document TK to ensure that the local communities who have practiced such knowledge over the centuries are duly acknowledged in the event their TK is used in bioprospecting. The knowledge about medicinal plants that was once and for many years intact among indigenous and local people, is now rapidly disappearing due to the loss of local cultural diversity (HAMILTON 2004). Local healing systems are still

widely practiced in Bhutan but have not been documented in the country (WANGCHUK 2007).

Thus, recognizing Bhutan's potential in harnessing potential benefits from the unexplored biodiversity and/or associated TK, this initiative of making an inventory and documentation of TK and educating people to create awareness of ABS and TK was initiated. This was a strategic decision because firstly it helps to protect TK from bio-piracy and unlawful utilization and secondly, TK can be utilized in bioprospecting and natural product development guided by ABS principles for the benefit of the custodians of TK as well as biodiversity conservation. This initiative also fulfils the provisions of the Biodiversity Act of Bhutan 2022, Biodiversity Rules and Regulations 2023 and the Access and Benefit Sharing Policy of Bhutan 2015 which entails the preservation and promotion of TK associated with biological resources.

### Materials and Methods

The study covered all 20 Dzongkhags (Districts) covering all 205 Gewogs from 2012-2018 (Figure 1) in Bhutan. Bhutan is a small Eastern Himalayan nation with China to the North and India to the South with an area of 38,394 sq. km. The elevation of the country extends from 160 metres in the south to more than 7,000 metres above sea level in the north (NSB 2020).

The process outlined by ABBOTT (2014) about documenting traditional medical knowledge was adapted to guide the documentation of TK in a Bhutanese context. Written approval was sought from the relevant Dzongkhag/Gewog administration prior to the inventory and documentation of TK in their respective Dzongkhags/Gewogs. Sensitization workshops were conducted in all the Gewogs for the public, TK holders and local government officials to familiarize themselves with the importance of TK documentation in the context of ABS and to identify local TK holders (Photo 2). The documentation of TK was conducted based on the Prior Informed Consent (PIC) of the TK holders. Semi-structured questionnaires, open-ended

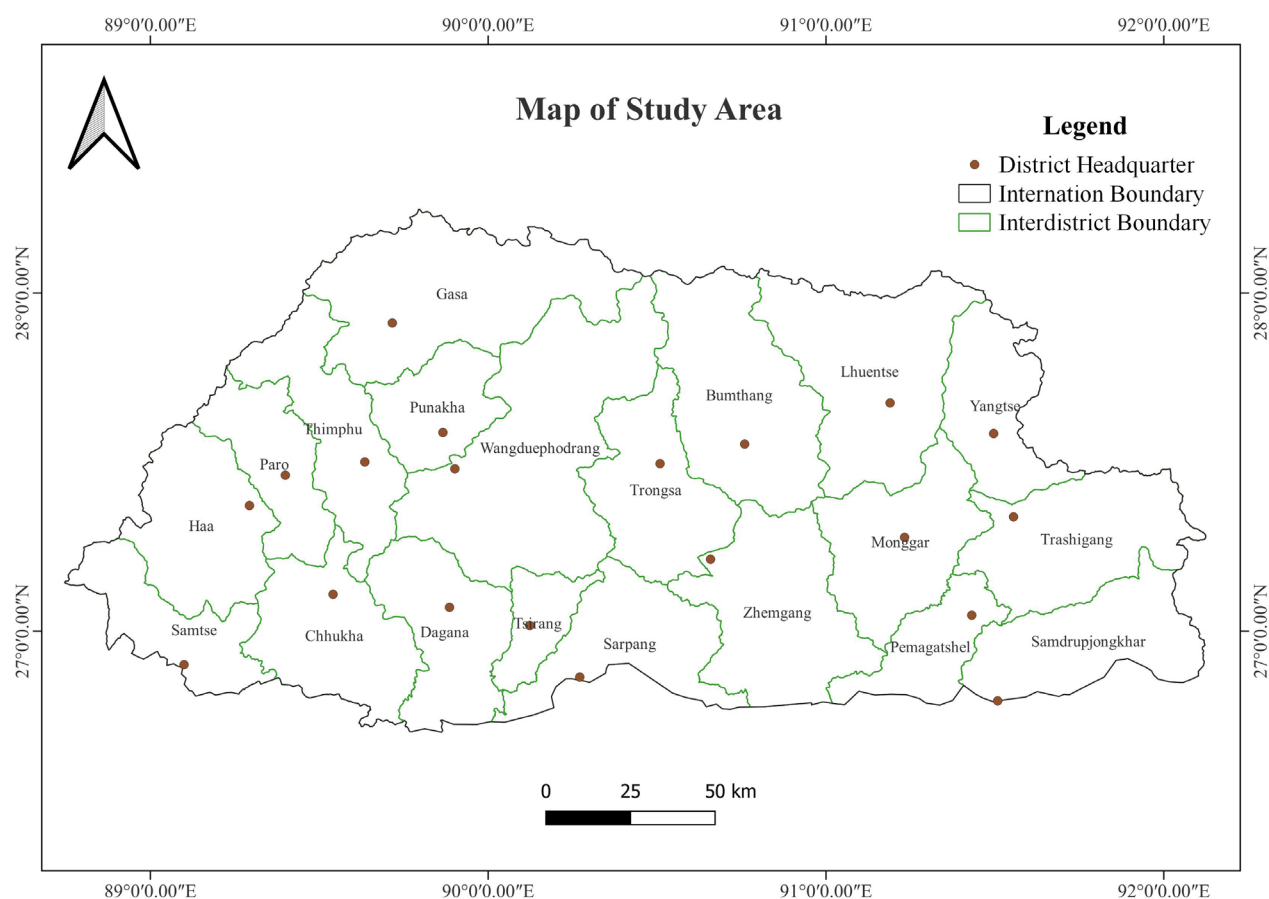


Fig. 1. Map Showing Study Area

questions, and audio-visual devices were used to interview the TK holders and gather information (Photo 3). The information about the plant species used, diseases treated, method of administration and plant habits were recorded. Each TK holder (Photo 1) was assigned a unique TK holder number for their identity and accession.

Approximately 500 grams of plant samples with unique accession numbers derived from each TK holder number were collected for biodiscovery research and three specimens were used for species identification (Photo 4). Digital photographs of the plants were also taken. The samples collected for biodiscovery research were processed at the Natural Product Library at the Bioprospecting Lab in National Biodiversity Centre (NBC), Thimphu, for future research and development. The plants were identified using the Flora of Bhutan (GRIERSON & DAVID 1983). The traditional knowledge data are archived at the 'Bhutan Traditional Knowledge Database System' maintained at NBC. The collected data were analysed using a Microsoft Excel worksheet and QGIS version 3.24.1.

## Results

Education and advocacy programs on ABS and TK were completed for 19,075 people in all the 205 Gewogs of which 9,619 were male and 9,456 were female with approximately 50 % female representation. A total of 789 TK holders were identified and documented, of which 602 were male and 187 were female with the highest numbers in the age group (51-60)

followed by the age group (41-50) and the lowest in the age group (91-100). Out of 789 TK holders, 562 were between 41 and 70 years (Figure 2). The highest number of TK holders was reported from the Mongar Dzongkhag in eastern Bhutan (84) followed by Dagana (83) and Sarpang Dzongkhags (80) in the south and the lowest number was reported from Thimphu Dzongkhag (7) (Figure 3).

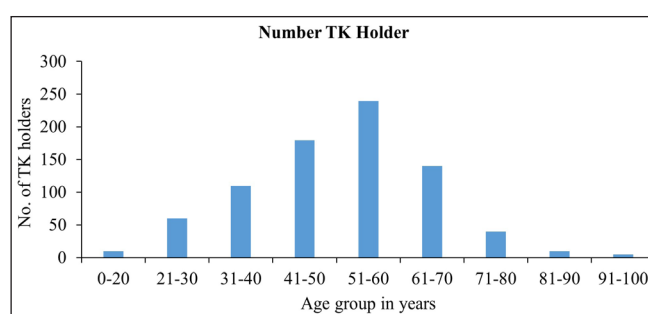


Fig. 2. Illustration of TK Holders in different age groups.

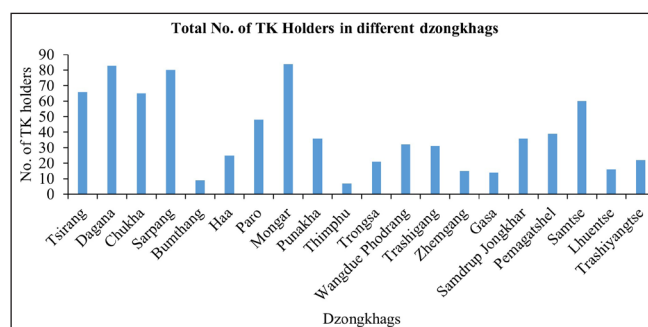


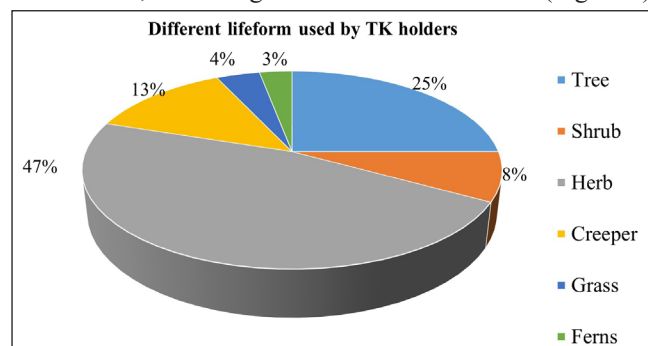
Fig. 3. Number of TK holders in different dzongkhags

During the inventory, it was observed that 46 different types of diseases were treated by the TK holders, of which the most common diseases treated were bone fracture/dislocation, pneumonia, snakebite, sinusitis, food poisoning, fever, headache, jaundice and internal injuries (Table 1). TK holders were also treating frequent diseases in Bhutan such as diabetes, blood pressure, asthma, urinary tract infections, malaria, and others. It was also observed that the administration of medicines was mostly carried out along with chanting of healing mantras and according to TK holders, this is done to ensure that the efficacy of the medicine is enhanced.

**Table 1:** Illustration of the number of times that the disease is reported by the TK Holder, and it corresponds to the total number of plant specimens collected (235). The total number of species in the table does not correspond to the total number of species of plants identified since the same species is used to treat multiple diseases.

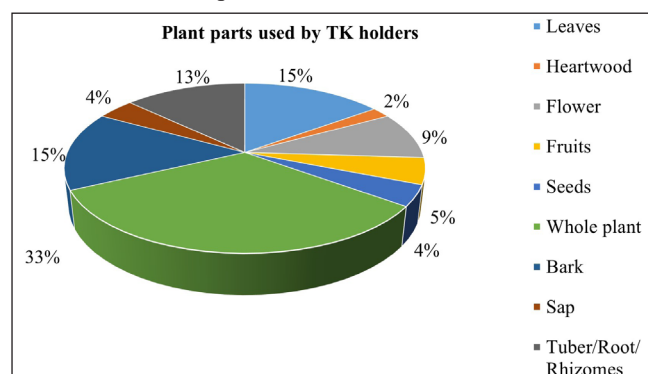
Sl. No	Disease Treated by TK holders	Number of times reported	Number of plant species
1	Bone Fracture & Dislocation	161	20
2	Pneumonia	145	11
3	Snakebite	140	12
4	Sinusitis	140	7
5	Food Poisoning	138	6
6	Fever & Headache	131	5
7	Jaundice	125	13
8	Blood Clotting	125	10
9	Internal Injuries	125	20
10	Stomachache	123	9
11	Diabetes	121	5
12	Arthritis & Joint Pain	113	4
13	Cold & Cough	90	5
14	Tonsillitis	76	11
15	Lymph Node Swelling	66	5
16	Gastritis & Ulcer	61	8
17	Black Spider Bite	55	15
18	Allergy	55	3
19	Blood Pressure	55	10
20	Diarrhea and Dysentery	45	13
21	Malaria	25	4
22	Gum Bleeding & Toothache	25	3
23	Piles	19	3
24	Boil	17	5
25	Constipation	15	2
26	Asthma	14	6
27	Urinary Tract Infection	14	1
28	Ringworm	12	3
29	Dengue Fever	11	4
30	Deworming	11	3
31	Athlete Foot	11	2
32	Black Quarter	10	2
33	Scabies	9	3
34	Bronchitis	9	6
35	Measles	6	2
36	Foot & Mouth Disease	6	2
37	Mumps	5	2
38	Mastitis	4	2
39	Anaemia	4	3
40	Chicken Pox	3	1
41	Multi-Vitamin	3	1
42	Brain Tonic	3	2
43	Anthrax	3	2
44	Haematuria	2	2
45	Aphrodisiac	2	2
46	Altitude Sickness	2	2
<b>Total</b>		<b>2335</b>	<b>262</b>

A total of 2,335 specimens of medicinal plants of 162 species in 71 families and 151 genera were recorded. The family Asteraceae has the highest number of species (12) followed by Fabaceae (9), Lamiaceae (8) and Euphorbiaceae (7). The preference ranking of the plant's families used by the TK holders is presented in Table 2. From the total of 162 plant species recorded, 76 were herbs, 40 were trees, 21 were creepers, 14 were shrubs, six were grasses and five were ferns (Figure 4).



**Fig. 4.** Lifeforms of plants used by TK holders in the formulation of their medicines.

Most of the preparations used by the TK holders were in the form of paste, sap, powder, decoction and infusion, either administered orally or applied topically. It has been also observed that TK holders use plants in three different ways; a) single plant to treat a single disease, b) single plant to treat many diseases and c) a combination of two or more plants to treat a single disease. It has also been observed that most of the plants used by TK holders were also known to other TK holders, but the parts used, method of preparation and types of diseases treated varies from one TK holder to another. TK holders also use different plant parts in their medical formulation. Among them 'whole plant (33 %)' followed by 'leaves (15 %)' and 'bark (15 %)' were the most frequently used plant parts whereas seeds and sap are the least used plant parts (Figure 5). The reason for preferring the 'whole plant' is because it contains all plant parts and it is believed that if one part doesn't benefit, the others do.,



**Fig. 5.** Illustration of TK holders' preference of plant parts in the formulation of their medicine.

TK holders collect almost all the plants used in their medicinal formulation from the wild, however, there are trends that TK holders cultivate those locally available/cultivable plants either in kitchen gardens or on farmland. Most of the TK holders prepare medicines only when the client(s)/patient(s) approach them for medication. TK holders believe that the best time for the collection of medicinal plants is before or within Blessed Rainy Day (Thruabaab) corresponding to the month of September in the western calendar, because it is believed that efficacy is at its maximum at this time of the year.

**Table 2:** The preference ranking of families of TK plants used by TK holders. The number(s) in brackets represent the number of plant species from each family.

Preference Ranking	Families
1	Asteraceae (12)
2	Fabaceae (9)
3	Lamiaceae (8)
4	Euphorbiaceae (7)
5	Rutaceae (5), Zingiberaceae (5), Poaceae (5), and Rubiaceae (5)
6	Solanaceae (4), Apiaceae (4), Lauraceae (4), and Cucurbitaceae (4)
7	Phyllanthaceae (3), Asparagaceae (3), Apocynaceae (3), Menispermaceae (3), Urticaceae (3), Brassicaceae (3), and Moraceae (3)
8	Malvaceae (2), Amaranthaceae (2), Amaryllidaceae (2), Saxifragaceae (2) Meliaceae (2), Ranunculaceae (2), Rosaceae (2), Juglandaceae (2), Acanthaceae (2), Santalaceae (2), Piperaceae (2), Plantaginaceae (2), Myricaceae (2), Polygonaceae (2), Gentianaceae (2), Anacardaceae (2), and Combretaceae (2)
9	Cannabaceae (1), Sapindaceae (1), Acoraceae (1), Asphodelaceae (1), Araceae (1), Aspleniaceae (1), Begoniaceae (1), Crassulaceae (1), Caricaceae (1), Costaceae (1), Cuscutaceae (1), Cyperaceae (1), Caryophyllaceae (1), Dryopteridaceae (1), Hamamelidaceae (1), Oleaceae (1), Equisetaceae (1), Saururaceae (1), Moringaceae (1), Musaceae (1), Scrophulariaceae (1), Nephrolepidaceae (1), Oxalidaceae (1), Melanthiaceae (1), Orchidaceae (1), Pteridaceae (1), Lythraceae (1), Ericaceae (1), Smilacaceae (1), Araliaceae (1), Aspidiaceae (1), Rhamnaceae (1), Bignoniaceae (1), Elaeagnaceae (1), and Betulaceae (1)

## Discussion

With the completion of the education and advocacy programs on ABS and TK in all 205 Gewogs, we expect that around 19,000 people now have a modest understanding of the importance of TK in the context of ABS. TK holders are aware of the requirement of PIC and the Mutually Agreed Terms (MAT) in any engagement-related access to biological resources and associated TK. The study found that most of the TK holders and practitioners were elderly (Aged 41-70 years) and mostly males (602 males and 187 females out of 789 TK holders). The result was supported by SHERUB et al. (2021) who found out that in Dagana, ethnomedicinal knowledge is practiced only by elders. A study in Myagdi District in Nepal reported that knowledge about medicinal plants and practices is now confined only to elderly people of that community (POUDEL 2022). CHETRI et al. (2021) also found out that ethnomedicines were mostly practiced by elderly people in their households however, in their study, it was practiced mostly by elderly women and mothers.

It has been observed that 46 different types of diseases are treated by the TK holders. The TK holders in Bhutan most often treat bone fractures and dislocation, and least often Haematuria, Aphrodisiacs and Altitude sickness. However, another study, on wetland medicinal plants, found that the diseases related to digestion were treated most and problems related to snakebite were treated least by TK holders (TENZIN & TENDAR 2021). TK holders mostly treat those diseases that require immediate attention and refer those diseases that merit treatment through western medicine to a nearby hospital. The administration of medicines is mostly conducted along with the chanting of healing mantras to enhance the efficacy of the medicine according to TK holders. A similar perception was also reported in the study conducted by CHETRI et al. (2018a). We documented 162 species of medicinal plants belonging to 71 families and 151 genera. CHETRI et al. (2018a) recorded 46 plant species from 45 genera and 37 families in Goselling

gewog in Tsirang. While CHETRI (2019) recorded 93 plant species from 82 genera and 44 families with ethnomedicinal uses in Pemathang gewog in Samdrup Jongkhar district. SHERUB et al. (2021) reported 74 medicinal plants belonging to 50 families in the Dagana district. In the present study, the family Asteraceae was found to have the most medicinal plant species that are being used by TK holders in Bhutan. SHERUB et al. (2021) also reported that the family Asteraceae was found to be the family with the most medicinal plants in Dagana District in Bhutan and a similar result was reported by (WANGCHUK et al. 2016) from Dagala gewog in the Thimphu district. However, a study by WANGCHUK et al. (2011) on Ethnobotanical authentication and identification of Khrog-sman (Lower Elevation Medicinal Plants) of Bhutan found that the family Fabaceae had the most medicinal plant species. Moreover, in Dolpa, Humla, Jumla and Mustang districts of Nepal, family Labiatae was found to have the most medicinal plant species (KUNWAR et al. 2006) while in Kedarnath wildlife Sanctuary in India Rosaceae emerged as a major family with medicinal plants (MALIK et al. 2015).

The lifeforms that TK holders mostly utilized in Bhutan were found to be herbs, with 47%. CHETRI et al. (2018b) recorded that 58% of the medicinal plants in Kilikhar in the Mongar district were herbs. WANGCHUK et al. (2016) also reported that 85 out of 100 medicinal plants were herbs in Dagala Gewog. In Kedarnath Wildlife Sanctuary in India it was found that 103 out of 152 species of medicinal plants were herbs (BHAT et al. 2013). In the state of Uttarakhand in India, they also reported 42 herbs, 7 shrubs and 4 trees from a total of 53 medicinal plants (NEGI et al. 2018). It may be due to the TK holders' increased focus on herbal medicines.

The study recorded that most of the preparation methods followed by TK holders were in the form of paste, sap, powder, and decoction which are applied topically or taken orally but their preferences were difficult to rank due to the use of the same

plants to treat different diseases, and not always consistently. However, CHETRI (2019) reported that the most widely used ethnobotanical preparation methods were mostly crushing and pounding (34.4%) followed by decoction (10.8%) and then rubbing (9.7%) on the body. Similarly, SHERUB et al. (2021) reported that nine different types of preparation methods, and they also found that crushing was mostly practiced method of preparation in ethnomedicine (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 TK holders mostly used the whole plant (33%) followed by leaves (15%) and bark (15%). Similarly, WANGCHUK et al. (2016) reported that whole plants (51 out of 100 plant species) were used mostly in Dagala gewog. However, SHERUB et al. (2021) found that in Dagana district, leaves were most used (30 species out of 74 species recorded), followed by stem and bark (12 species each) and then the least used were tubers and shoots (one species each). Furthermore, in India, it was found that roots (33%), were mostly used to treat various diseases followed by leaves (27%), and the least used were seeds, fruits and flowers (9%) (MALIK et al. 2015). Similarly, NEGI et al. (2018) found that roots and underground parts were used most (38%), followed by leaves (27%), whole plant (11%), fruits/seeds (16%) and bark (8%). Therefore, the use may differ from region to region due to differences in climate and soil factors. It was found that the most frequently used medicinal plants by TK holders in Bhutan were cultivated and used whenever needed. The finding was supported by CHETRI et al. (2018a) who reported that 60% of the medicinal plant specimens that they collected were domesticated or found in kitchen gardens in Goselling gewog in Tsirang. CHETRI et al. (2018b) also found that in Kilikhar in Mongar the medicinal plants were collected either from home gardens or nearby forests. In Bhutan, TK holders believe that around the month of Blessed Rainy Day (corresponding to September in the western calendar) is the best time for collecting medicinal plants because it is believed that their efficacy is at its maximum at this time of the year. TK prevalent in Bhutan partially follows the principle of the Bhutanese Traditional Medicine System (Sowa Rigpa) mostly in the north, central and eastern Dzongkhags, and follows Ayurveda medicine in the southern Dzongkhags. The reason might be that some of the knowledge may have been adapted from these two complementary medicines because of the easy access to these systems. However, the medicinal plants used by TK holders and the ones used in Sowa Rigpa and Ayurveda medicine are not similar. Even in the event that the plants used by Sowa Rigpa, Ayurveda and TK holders are similar, the way of administration and types of diseases treated are different, indicating some level of uniqueness in the Bhutanese TK. This view was also supported by some of the TK holders that were interviewed. Further, it was also observed that most of the plants used by TK holders were known to other TK holders, but the parts used, method of preparation and types of diseases treated vary from one TK holder to another, although there were only a few incidences where TK only belonged to a particular individual/kin/family, etc.

Out of 162 plants species used in TK, 20 species are prioritized for research and development in the next five years, and

the reason for prioritization of these species is because these plants have been widely and frequently used by TK holders in treating frequent diseases and problems such as diabetes, blood pressure, pneumonia, jaundice, snakebite, etc. These plants merit detailed pharmacological studies to validate the local TK, and because the chances of finding Active Pharmaceutical Ingredient (API) seem to be reasonably high.

## Conclusion

The current study provides preliminary findings of the TK associated with biological resources in Bhutan, but may not have been able to document all the knowledge held by the TK holders as TK is dynamic and complex in nature. To generate a complete finding of the richness of TK, a separate focused group documentation programme with selective TK holders and communities may be convened. To collect plant specimens that could not be collected during the current study period, a separate project must be planned. The rich repository of information on Bhutanese TK could be essential for biodiscovery research and natural product development, since the chances of finding active pharmaceutical ingredients are high. To capitalize on this rich TK, the Bioprospecting and ABS programme at NBC has been validating the TK and venturing into bioprospecting and natural product development based on the principles of ABS engaging TK holders/local communities. A fair share of benefits arising from the utilization of TK is shared with custodians of TK incentivizing and recognizing their role in the preservation of TK and associated biological resources thereby promoting peoples' participation and leadership in conservation.

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Photo 1. A TK Holder from Samtse Dzongkhag with medicinal plant samples.



Photo 2. Participants of the workshop on education and advocacy on Access and Benefit Sharing and Traditional Knowledge.



**Photo 3.** An official from NBC interviewing TK Holder in Bjabcho, Chhukha Dzongkhag.



**Photo 4.** Processing and drying of plant specimens for biodiscovery and herbarium in the field.