Ethnobotanical Study of South Eastern Foothills of Bhutan

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

ABSTRACT

Ninety three plant species from 82 genera and 44 families with their ethnomedicinal uses were enumerated along with 3 genera of different families of Pteridophytes. Preference ranking of the medicinal plants used for treating 7 different diseases indicated 1st as the most effective treatment. Direct matrix ranking of 12 medicinal plants suggest that people have preference over the highest ranked species for their multipurpose uses besides medicinal use. Use value (UV) of Tinospora cordifolia (Willd.) Miers, Saccharum officinarum with honey and Gmelina arborea Roxb. is 2, 1.5 and 1.7 respectively.

Keywords: Ethnomedicines; preference ranking; direct matrix ranking; use value; traditional knowledge.

1. INTRODUCTION

More than 600 medicinal plants have been identified in Bhutan, mostly from higher elevations [1,2,3,4,5,6,7,8,9,10,11,12] and not much ethnobotanical works have been reported from the southern foothills where diseases like malaria, jaundice, typhoid and witch craft related illnesses are common. Ethnobotany defined [13], and its study is timelessly important to identify

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plants with therapeutic potential [14]. Therefore to document ethnomedical data and traditional knowledge (TK) of local healers related to use medicinal plants from Pemathang and Phuntshothen gewogs (village blocks) of Samdrup Jonkhar, Bhutan, to treat different types of diseases, to add on to the list of medicinal plants from lower altitude to be used in Bhutanese Traditional Medicines and record most popular medicinal plants repeatedly used to cure commonly occurring diseases in the locality of the study area was imperative. As many as 300 species of medicinal plants, which grow in diverse ecological zones of the country, have been identified so far and more than 200 of them are currently used by the Institute of Traditional Medicine Services (ITMS) in g.so-ba-rig-pa (traditional medical system) are effective [15]. The collection, conservation and sustainable utilization of medicinal and aromatic plants (MAPs) in Bhutan are guided by sound legal frameworks and acts: Forest Act 1969, Plant Quarantine Act of Bhutan 1993, Forest and Nature Conservation Act of Bhutan 1995, Environmental Assessment Act 2000 and Biodiversity Act and Framework of Bhutan 2003 and 2006 [16,17,18]; 108 medicinal plants have been reported from the low altitude areas of Bhutan [19] and 116 from high altitude [20]. Total of 81 medicinal plants have been reported from Trashigang Dzonkhag [5]. Recently 113 medicinal plants belonging to 68 families and 103 genera were reported from lower elevations of Bhutan [10]. The remoteness of a few rural places always has resulted in continued use of plants as their medicines by local people along with modern health care and therefore widening scope of ethnobotanical study in the region [4]. Therefore this study was carried to document such information related to medicinal plants from the study area where ethnomedical practices are still popular amongst local healers and elders.

2. MATERIALS AND METHODS

A prior permission from the Dungkhag (sub district) administration was sought and accordingly the most popular local practitioners and informants through gewog office were selected for documenting TK on plants. The Free listing (FL) by informants in their local dialect, Preference Ranking (PR), Direct Matrix Ranking (DMR) and Use Value (UV) of medicinal plants were carried out and interpreted [21]. This has helped the researchers to identify specific and the most commonly used plants against cure for different locally known diseases. Simple approach was used for data collection and compilation.

2.1 Methodology

The gup (gewog head) and mangmis (gup assistant) were approached. Key informants, shaman and women healers were identified. Prior consent was sought from each key informant before interview and they are properly acknowledged. The techniques [22,23] used allowed informants and researchers to see the plants in their natural state, which minimized the risk of misidentification during the interview. Most of the time informal talks were preferred to collect information about the plants with regards to their local names, plant part(s) used, process of preparation of medicine (either individually or in combination with other plant parts) and mode of application and doses for the treatment of a particular disease(s) [21]. The collected specimens were identified using flora of Bhutan [24-32] and internet sources. The herbarium and voucher specimens processed as per [33] and deposited at herbarium, Sherubtse College, Kanglung.

2.2 Study Area

Pemathang gewog (Fig. 1) has a total area of 76.54 square kilometers [34] is located in the altitude of 600 to 1200 meters above sea level. It is hanging plateaus of southern foothills which drops down and extend up to Assam Plain. The gewog lies in the south eastern part of Bhutan between latitude of 26°50′N to 26°57′N and longitude of 91°42′E to 91°48′E bordering the Indian state to the south and is bordered by Phuntshothen gewog in the West, Samrang gewog in the East, Marthalla gewog in the North and Indian State of Assam in the South.

2.3 Justification for the Work

Bhutanese people from south, still practices home remedies and local healing for treating different diseases. No study of this kind was carried out earlier in these gewogs as far as literature review is concerned. As rural-urban migration trend being comparatively high in recent years and young generation undervaluing the TK transmitted orally from their village elders, it was crucial to document the TK on medicinal plants from this study area.
Fig. 1. Map showing two gewogs (study area) of Samdrupjongkhar Dzongkhag

3. RESULTS AND DISCUSSION

Ninety three plant species from 82 genera and 44 families are recorded with their ethnomedicinal uses by the local healers against various diseases besides the 3 genera under 3 different families of Pteridophytes (Table 1, Plates 1, 2 and 3). This study reports comparatively higher traditional uses of plants to 62 enumerated medicinal plants [4] and 81 reported species from Trashigang region [5]. Similarly 42 plant species with ethnobotanical uses reported [2] and 67 species in 37 families from Bumdeling [11]. 153 MAPs species reported from different parts of Bhutan without including the local healers [10,19,20]. The specimens collected were either domesticated by the people for their day-to-day use found in their field or from the nearby forest. Most of the specimens were found abundantly in their locality, which is a testimony of the area with good plant diversity that supports the local community’s health welfare and preservation of local knowledge [23,35]. It has been observed that either single plant or its parts are used to treat single ailment and sometimes combinations of more than one plant or part(s) are used for single or multiple treatments.
Table 1a. List of medicinal plants used by local people with their ethnomedicinal preparation and uses

| Sl. # | Botanical name | Family | Ethnomedicinal preparation | Treatment [s] |
|-------|----------------|--------|----------------------------|---------------|
| 1     | Caulokaempferia sikkimensis (King ex Baker) K. Larsen | Acanthaceae | Extract of leaves is applied topically on affected part | Body/Lymph inflammation |
| 2     | Justicia adhatoda L. | | Crushed roots are applied as poultice after every 3 days for a month | Fracture and broken bones |
| 3     | Phlogacanthus thyrsiformis (Roxb. ex Hardw.) Mabb. | | A glass of decoction from flower is orally consumed once a week | Lowers blood pressure |
| 4     | Achyranthes aspera L. | Amaranthaceae | Leaves and root are crushed and extract is taken orally mixing with a glass of water | Pneumonia |
| 5     | Centella asiatica (L.) Urb. | Apiaceae | The whole plant is chewed or eaten as vegetable as one likes | Appetizer |
| 6     | Eryngium foetidum L. | | Leaves are boiled and drank as soup | Stomach ache |
| 7     | Foeniculum vulgare Mill. | | Seeds are boiled in water and drink frequently as soup for a week. | Body ache and common cold |
| 8     | Calotropis gigantea (L.) Dryand. | Apocynaceae | Baked and warmed leaves are directly applied to swollen part morning and evening | Fracture and Sprain |
| 9     | Rauvolfia serpentina (L.) Benth. ex Kurz | | Crushed root mixed with water and decoction is orally taken as frequently as possible for a week | Malarial fever |
| 10    | Rhaphidophora decursiva (Roxb.) Schott | Araceae | Infusion from crushed stem drank; also a cattle fodder | Piles/Harsa |
| 11    | Aloe vera (L.) Burm.f. | Asparagaceae | Shoot crushed and directly applied to affected part | Sunburn, burn |
| 12    | Sansevieria trifasciata Prain | | Juice prepared from leaves also applied on body | Inflammation of lymph/body |
| 13    | Chromolaena odorata (L.) R. M. King & H. Rob. | Asteraceae | Leaves are crushed and applied externally as poultice | Haemostasis/Fresh cut bleeding |
| 14    | Ageratina adenophora (Spreng.) R. M. King & H. Rob. | | Leaves and stem are crushed and applied topically on the body | Fresh cut bleeding and antimicrobial |
| 15    | Ageratum conyzoides (L.) L | | Leaves are crushed and applied directly on cuts to stop bleeding | Fresh cut bleeding and pneumonia |
| 16    | Artemisia sp. | | Whole leafy part is used under mattresses and also rubbed externally on the body | Insects repellent. Skin diseases. |
| 17    | Galinsoga parviflora Cav. | | Leaves and stem are crushed and applied externally to the body | Skin diseases |
| Sl.# | Botanical name       | Family               | Ethnomedicinal preparation | Treatment [s]                      |
|------|----------------------|----------------------|----------------------------|-----------------------------------|
| 18   | *Tagetes erecta* L.  | A. Bignonaceae        | A tablespoon of decoction from young flower is drunk | Pneumonia                        |
| 19   | *Oroxylum indicum* (L.) Kurz | Bignoniaceae | Fruit and ash derived from fruit is used to heal deep cuts | Deep cuts and wounds             |
| 20   | *Lobelia*            | Campanulaceae         | Extract of roots applied externally | Wounds                           |
| 21   | *Drymaria cordata* (L.) Wild. ex Schult. | Caryophyllaceae | Baked leaves are sniffed by wrapping in piece of cloth | Sinusitis and nasal congestion   |
| 22   | *Cuscuta reflexa* Roxb. | Convolvulaceae       | Directly fed to cattle | Flukes (namely) in cattle         |
| 23   | *Poranopsis paniculata* (Roxb.) Roberty | | Roots used as poultice | Join the fractured and broken bones |
| 24   | *Costus speciosus*   | Costaceae             | Infusion; stem juice drank directly. | Cools stomach/ Cooling effect     |
| 25   | *Kalanchoe Integra* (Medik.) Kuntze | Crassulaceae | Leaves extract applied externally | Wounds                           |
| 26   | *Luffa cylindrica* (L.) M.Roem. | Cucurbitaceae | Root extracts given at appropriate dose; poisonous if consumed more than recommended dose by the healer | Detoxification                    |
| 27   | *Dillenia indica* L | Dilleniaceae          | Juice extract from the fruits | Anti-dandruff                     |
| 28   | *Dioscorea deltoidea* Wall. ex Griseb. | Dioscoreaceae | Tuber is used as poultice | Join the broken/ fractured body parts |
| 29   | *Rhododendron arboeum* | Ericaceae            | Flowers are crushed and eaten | Dysentery                        |
| 30   | *Euphorbia hirta* L  | Euphorbiaceae         | Tender stems are chewed | Appetizer                         |
| 31   | *E. royleana* Boiss. |                      | Latex of leaves | Eye infection in cattle (Phulo)    |
| 32   | *E. tithylaloides* L |                      | Delicate bark roasted and eaten in small dose | Appetizer                         |
| 33   | *Jatropha curcas* L. |                      | Stem or branch is used to brush teeth | Cure gum and mouth infection      |
| 34   | *Mallopus philippensis* (Lam.) Müll.Arg. |                      | A glass of decoction is drank | Gastric                           |
| 35   | *Ricinus communis* L. |                      | Seeds are crushed into paste and applied externally on affected part | Chicken pox, foot infection/Broken parts |
| 36   | *Sapium laurilfolium* (A.Rich.) Griseb. | | Latex/Khira ko chop | Deworming in cattle and applied in wound |
| 37   | *Cynodon dactylon* (L.) Pers | Gramineae          | Crushed leaves extract is applied externally to affected skin | Skin diseases/ white patch skin   |
| 38   | *Imperata cylindrica* (L.) Raesusch. | | A tablespoon of root extract is taken orally | De-worming in children            |
| 39   | *Saccharum officinarum* L. | | Stem Juice taken orally | UTI and cooling stomach           |
| Sl.# | Botanical name | Family | Ethnomedicinal preparation | Treatment [s] |
|-----|----------------|--------|----------------------------|---------------|
| 40  | *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda |  | Crushed root applied as paste | Cure boils |
| 41  | *Mentha spicata* L. | Lamiaceae | Leaves are rubbed on skin rashes | Anti-allergy/ antirashes |
| 42  | *Clerodendrum infortunatum* L. |  | Leaves are crushed and fed | Lantana poisoning *Bokrey* in cattle |
| 43  | *Ocimum gratissimum* L. |  | A glass of decoction of leaves | Pneumonia |
| 44  | *Ocimum sanctum* L. |  | Leaves and tender twigs are boiled with water and taken as tea | Common cold, sore throat and headache |
| 45  | *Plectranthus scutellarioides* (L.) R.Br. |  | Crushed leaves are rubbed on affected skin; juice prepared from leaves also apply on body | To subsidize swollen lymph/ body parts |
| 46  | *Vitex negundo* L. |  | Crushed leaves rubbed on affected area | Ringworms |
| 47  | *Cinnamomum tamala* (Buch.-Ham.) T.Nees & Eberm. | Lauraceae | A tablespoon of decoction of leaves and bark | Urinary tract infection (UTI) |
| 48  | *Litsea cubeba* (Lour.) Pers. |  | Leaves extract or juice is drank | Jaundice |
| 49  | *Acacia catechu* (L.f.) Wild. | Leguminosae | Bark is crushed and infusion is drank | Pneumonia |
| 50  | *Entada rheedii* Spreng. |  | Boiled fruit is crushed and its endosperm is applied to head | Antidandruff, scabies |
| 51  | *Mimosa pudica* L. |  | Roots are crushed and infusion is given to patient | Pneumonia |
| 52  | *Senna alata* (L.) Roxb. |  | Leaves are crushed and applied externally | Ringworm, insect and snake bite |
| 53  | *Punica granatum* L | Lythraceae | Roasted bark is powdered and paste is applied | Foot infection |
| 54  | *Bombax ceiba* L. | Malvaceae | Concoction mixed with sugar is drank | Menstrual irregularity |
| 55  | *Hibiscus sabdariffa* L. |  | Infusion of crushed leaves and fruits | Dysentery |
| 56  | *Sida acuta* Burm.f. |  | Infusion from crushed roots | Cures constipation |
| 57  | *Azadirachta indica* A. Juss. | Meliaceae | Leaves decoction is drank | Malarial fever and typhoid |
| 58  | *Stephania glabra* (Roxb.) Miers | Menispermaceae | Fed to weak cattle | Provides strength to cattle |
| 59  | *Tinospora cordifolia* (Wild.) Miers |  | A glass of decoction every morning | Blood pressure |
| 60  | *Ficus semicordata* Buch.-Ham. ex Sm. | Moraceae | Root paste applied topically | Suppress boil |
| 61  | *Ficus racemosa* L. |  | Bark is crushed and infusion is drank | Dysentery |
| 62  | *Ficus religiosa* L. |  | Apply latex on the area | Mumps |
| 63  | *Maclura cochinchinensis* (Lour.) Corner |  | Seed rubbed on area affected by venomous hair | Rashes/Skin infection |
| Sl.# | Botanical name                  | Family                | Ethnomedicinal preparation                                                                 | Treatment [s]                                      |
|------|--------------------------------|-----------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 64   | Morus alba L.                  | Concoction with alum ([*fetken*]) is orally administered to patient in a tablespoon | Jaundice                                          |
| 65   | Morus macroura Miq.            | Concoction with alum ([*fetken*]) is orally administered to patient | Jaundice                                          |
| 66   | Moringa oleifera Lam.          | Moringaceae           | Roots extract applied on cattle wounds to kill maggots                                      | Kill maggots of cattle wounds; Deadly poisonous and fatal if consumed. |
| 67   | Musa balbisiana Colla.         | Musaceae              | Latex from inflorescence and stalk                                                           | Stops and diarrhoea and vomiting; Food poisoning   |
| 68   | Psidium guajava L.             | Myrtaceae             | Juice taken in a tablespoon                                                                  | Diarrhea in infants                                |
| 69   | Oxalis corniculata L.          | Oxalidaceae           | Fruits’ extract is applied in drops                                                           | Remove eyes dust                                   |
| 70   | Phyllanthus emblica L.         | Phyllanthaceae        | Fruit juice taken in a tablespoon                                                             | A sore throat                                      |
| 71   | Piper rhytidocarpum Hook. f.   | Piperaceae            | Locket out of these two is put around neck                                                    | Epilepsy (*Chopwa*)                               |
| 72   | Rumex nepalensis spreng.       | Polygonaceae          | Crushed roots with garlic is rubbed and applied                                              | Skin diseases and ringworm                        |
| 73   | Clematis buchananiana DC.      | Ranunculaceae         | Leaves heated and wrapped in cloth piece and sniffed                                          | Sinusitis and nasal congestion                    |
| 74   | Paederia foetida L             | Rubiaceae             | Rub the leaves on skin                                                                        | Lymph swell (**Kalo bagay**)                      |
| 75   | Uncaria acids (Hunter) Roxb.   | Rubiaceae             | Crushed leaves applied as poultice; Used by shaman during ritual                             | Fractures/Broken bones; evil eye (**Dewa**)        |
| 76   | Rubus ellipticus Sm.           | Rosaceae              | Infusion from crushed roots                                                                  | Gastric and diarrhoea                             |
| 77   | Rosa sp.                       | Rosaceae              | Petal extract is dropped in eyes                                                              | Clearing eye dust and infection                   |
| 78   | Aegle marmelos (L.) Corrêa     | Rutaceae              | Juice mixed with coconut                                                                      | Gastritis and dysentery                           |
| 79   | Citrus aurantifolia Swingle    | Rutaceae              | Pickle is used treat diarrhea and dysentery; juice is mixed with water, sugar and salt to bring cool our body and freshness in mind | Dysentery and diarrhoea, cooling the body, antidandruff, pimples and blemishes |
| 80   | Citrus limon (L.) Burm. f.     | A tablespoon of concoction of root extract of *Morus*'s and alum in appropriate dose         | Strong medicine for treating Jaundice            |
| 81   | Citrus medica L.               | A tablespoon of concoction of root extract of *Morus*'s and alum in appropriate dose         | Strong medicine for treating Jaundice            |
| 82   | Zanthoxylum caribaeum Lam.     | Spines from bark is rubbed on affected skin till swollen part till it is subsided            | Body/lymph swelling (**bagay**)                   |
| Sl.# | Botanical name                | Family          | Ethnomedicinal preparation                                                                 | Treatment [s]                        |
|-----|------------------------------|-----------------|-------------------------------------------------------------------------------------------|-------------------------------------|
| 83  | Todalia asiatica (L.) Lam    | Solanaceae      | A glass of decoction of leaf is drank once a week                                           | Treatment of severe gastritis        |
| 84  | Solanum viarum Dunal         | Solanaceae      | Fruits are roasted and smoke from burned seed is inhaled to infected tooth through slim bamboo made pipe | Tooth decay                         |
| 85  | Schima wallichii Choisy      | Theaceae        | Paste from seed is applied to affected area                                                | Scorpion stung and poisoning        |
| 86  | Urtica parviflora Roxb.      | Urticaceae      | Leaves cooked with rice maize or finger millet flour and made to chapati.                  | Lowers or controls BP               |
| 87  | Gmelina arborea Roxb.        | Verbenaceae     | Bark is crushed and fed to cattle along with fodder                                        | Foot and mouth disease (Khorath)    |
| 88  | Tetrastigma serrulatum (Roxb.) Planch. | Vitaceae | Extracted juice orally administered to cattle in a bamboo made container. | Lantana poisoning Bokrey in cattle   |
| 89  | Alpinia nigra(Gaertn.) Burtt  | Zingiberaceae   | Concoction from rhizomes extract and aurchal is taken orally in a tablespoon               | Jaundice                            |
| 90  | Curcuma caesia Roxb.         | Equisetaceae    | Decoction from crushed roots; sliced roots are dried and chewed also whenever appetite is lost | Body ache; Appetizer and stomach disorder |
| 91  | Equisetum arvense L.         | Equisetaceae    | Poultice from the whole plant tied to injured part of the body                             | Fractured bone                      |
| 92  | Drynia quercifolia (L.) J. Sm | Polypodiaceae   | Root paste of a single plant is applied topically on affected part                         | Body ache and joint pains           |
| 93  | Pteris biaurita L.           | Pteridaceae     | Fresh leaves extract and paste applied on cuts                                             | Immediate stops bleeding            |
Table 2 (a-e). PR of the use of medicinal plants for treating diseases by 7 informants (i). (Highest number is most preferred; lowest number is least preferred). Rank was determined based on the total score of each species and species with 1st rank given is indicated as most effective medicinal plant for respective treatment.

| List of medicinal plants | i1 | i2 | i3 | i4 | i5 | i6 | i7 | Total | Rank |
|-------------------------|----|----|----|----|----|----|----|-------|------|
| **a. Treatment: Deep cut/cuts** |    |    |    |    |    |    |    |       |      |
| Ageratum conyzoides (L.) | 1  | 4  | 4  | 1  | 2  | 3  | 4  | 19    | 2nd  |
| Pteris biurita L. | 4  | 2  | 2  | 4  | 4  | 3  | 23 |       | 1st  |
| Chromolaena odorata (L.) R.M.King & H.Rob. | 3  | 3  | 3  | 2  | 3  | 2  | 1  | 17    | 3rd  |
| Ageratina adenophora (Spreng.) R.M.King & H.Rob. | 2  | 1  | 1  | 3  | 1  | 1  | 2  | 11    | 4th  |
| **b. Treatment: Body/lymph Inflammation (Bagay)** |    |    |    |    |    |    |    |       |      |
| Paederia foetida L (Biriko Gatho) | 4  | 4  | 5  | 3  | 5  | 4  | 5  | 30    | 1st  |
| Sansevieria trifasciata Prain | 3  | 5  | 3  | 5  | 4  | 4  | 29 |       | 2nd  |
| Aegle marmelos (L.) Corrêa | 2  | 1  | 2  | 2  | 3  | 1  | 2  | 13    | 4th  |
| Zanthoxylum caribaeum L. | 2  | 3  | 4  | 4  | 1  | 3  | 3  | 20    | 3rd  |
| **c. Treatment: Lantana camara L. poisoning (Bokrey) in cattle** |    |    |    |    |    |    |    |       |      |
| Gmelina arborea Roxb. | 5  | 3  | 3  | 5  | 4  | 4  | 26 |       | 1st  |
| Boehmeria penduliflora Wedd. ex D.G.Long | 4  | 5  | 3  | 5  | 2  | 4  | 2  | 27    | 2nd  |
| Bombax ceiba L. | 3  | 4  | 4  | 4  | 3  | 5  | 12 |       | 4th  |
| Clerodendrum infortunatum L. | 2  | 1  | 2  | 2  | 3  | 1  | 1  | 8     | 3rd  |
| **d. Treatment: Appetizer** |    |    |    |    |    |    |    |       |      |
| Vitex negundo L. | 4  | 4  | 1  | 1  | 1  | 1  | 14 |       | 4th  |
| Curcuma caesia Roxb. | 2  | 2  | 5  | 4  | 5  | 4  | 25 |       | 2nd  |
| Euphorbia royleana Boiss. | 1  | 1  | 2  | 2  | 2  | 1  | 11 |       | 4th  |
| Euphorbia tithymaloides L. | 3  | 5  | 3  | 5  | 5  | 5  | 31 |       | 1st  |
| **e. Treatment: Fracture/sprain** |    |    |    |    |    |    |    |       |      |
| Poranopsis paniculata (Roxb.) Roberty | 1  | 1  | 2  | 1  | 2  | 1  | 10 |       | 3rd  |
| Uncaria acida (Hunter) Roxb. (Bhuisey karo) | 3  | 4  | 1  | 2  | 4  | 1  | 3  | 25    | 1st  |
| Caulokaempferia sikkimensis (King ex Baker) K.Larsen | 2  | 3  | 4  | 3  | 1  | 3  | 2  | 18    | 2nd  |
| Calotropis gigantea (L.) Dryand. | 1  | 1  | 1  | 2  | 1  | 1  | 8  |       | 4th  |
Table 3. DMR of multipurpose use of medicinal plants. Total score of 3 popular informants determined by ‘✓’ as used and ‘✗’ as not used respectively; Species with highest tick mark is ranked as A and most preferred species and D as less preferably used.

| Species          | Gmelina arborea Roxb. | Oroxylum indicum (L.) Kurz | Bombax ceiba L. | Mallotus philippensis (Lam.) Müll. Arg. (Sidurey) |
|------------------|------------------------|----------------------------|-----------------|-----------------------------------------------|
| Medicines        | ✓                      | ✓                          | ✓               | ✓                                             |
| Timber           | ✓                      | x                          | ✓               | x                                             |
| Articrafts       | ✓                      | ✓                          | ✓               | x                                             |
| Rituals          | ✓                      | ✓                          | x               | x                                             |
| Firewood         | ✓                      | ✓                          | ✓               | ✓                                             |
| Fodder           | ✓                      | ✓                          | ✓               | ✓                                             |
| Total            | 6                      | 5                          | 4               | 3                                             |
| Rank             | A                      | B                          | C               | D                                             |

| Species          | Prunus persica (L.) Stokes | Psidium guajava L. | Sapium laurifolium (A. Rich.) Griseb. | Aegle marmelos (L.) Corrêa |
|------------------|----------------------------|-------------------|--------------------------------------|---------------------------|
| Medicines        | ✓                          | ✓                 | ✓                                    | ✓                         |
| Timber           | x                          | ✓                 | x                                    | x                         |
| Articrafts       | x                          | ✓                 | x                                    | ✓                         |
| Rituals          | x                          | ✓                 | x                                    | x                         |
| Firewood         | ✓                          | ✓                 | x                                    | ✓                         |
| Fodder           | x                          | ✓                 | x                                    | x                         |
| Total            | 2                          | 3                 | 1                                    | 4                         |
| Rank             | C                          | B                 | D                                    | A                         |

| Species          | Ficus racemosa L. Dumri | Tinospora cordifolia (Willd.) Miers | Ricinus communis L. | Boehmeria penduliflora Wedd. ex D. G. Long (Chipley) |
|------------------|-------------------------|-----------------------------------|---------------------|---------------------------------------------|
| Medicines        | ✓                       | ✓                                 | ✓                   | ✓                                           |
| Timber           | x                       | x                                 | x                   | x                                           |
| Articrafts       | x                       | x                                 | x                   | x                                           |
| Rituals          | ✓                       | x                                 | x                   | x                                           |
| Firewood         | ✓                       | ✓                                 | x                   | ✓                                           |
| Fodder           | ✓                       | ✓                                 | x                   | ✓                                           |
| Total            | 4                       | 2                                 | 1                   | 3                                           |
| Rank             | A                       | C                                 | D                   | B                                           |

Different plant species are used for the treatment of different ailments. In such cases, local people show preference towards plant species on the basis of their healing power, against a given disease [36,37]. Medicinal plant species were collected through FL by 7 informants (i) in their local language (Lhotshamkha) for both specific and combined treatment.

Most common diseases treated by 7 informants (local healers) in the 2 gewogs were listed against medicinal plants to verify the result of PR (Table 2. a-e) on use of medicinal plants. Species with the highest score (1st rank) is indicated as the most effective medicinal plant for respective treatment/s. This study shows that ethnomedicinal knowledge of the local healers about different plant species is very specific, also reported [35]. Ethnomedicinal preparation methods used by informants is mostly by crushing and pounding (34.4%) followed by decoction (10.8%) and rubbing on the body (9.7%). The most effective treatment against jaundice is concoction made from Morus alba. root, alum powder and Citrus spp. with the knowledge of administering appropriate dose and consuming less oil during the treatment. Plants reported with medicinal value have other uses too. Therefore, DMR (Table 3) was used to assess the various uses of medicinal plants identified [38]. Total score of 3 popular informants determined by placing ‘✓’ & ‘✗’ mark as ‘used’ and ‘not used’ respectively. Species with highest ‘✓’ mark is ranked as ‘A’ and most preferred species and ‘D’ as the least preferred with highest ‘✗’ mark (Table 3). DMR was carried out basically to find out the local people’s preference over use of plants for their multipurpose use, which has otherwise realized...
local people to protect and conserve some of these plants high ranked plants owing to their daily use in preparing more remedies. The UV of different medicinal plants as informed was performed to cross verify the use of medicinal plants to treat disease done by PR and FL [13, 21]. The multipurpose uses of these medicinal plants in different occasions (no of events) were also recorded with their different uses. UV is of *Tinospora cordifolia* (Willd.) Miers, *Saccharum officinarum* with honey from Melipona bees and *Gmelina arborea* Roxb. are 2, 1.5 and 1.7 respectively for treating various diseases (Table 4). Some local practitioners reported collecting medicinal plants/parts from nearby forest collections which to prepare concoctions with locally available medicinal plants for treating their regular patients. Comparative study on use of the most common ethnomedicinal plants (73 species) reported from southern Bhutan [35] with nearby north east states of India was done to validate the use of same species and their uses for treating human and livestock diseases with similar kind of records [39,40]. It is also interesting to observe that some of the species have been recorded with same ethnomedicinal importance and many with different uses and with different part(s) used [39, 40, 41]. This study indicates TK of medicinal uses of plants are either entirely different in their uses or some time similar uses which gives an idea of knowledge transmission amongst the people [35].

**Table 4. UVs stands for use value (UV) for a given species (s) by one informant (i) during number of events (n)**

| Estimating UV based on local perceptions |   |   |
|----------------------------------------|---|---|
| Name of the Informant: Khada Nanda Rizal |   |   |
| Name of the species: *Saccharum officinarum* varieties with melipona honey |   |   |
| Sl.# | Uses: Treatment | UV is = $\sum_{i=1}^{n} U_{is}$ |
| 1 | Jaundice | 1.5 |
| 2 | UTI/Niranjan/Garam |   |
| Total Uses | 2+1 |
| No. of events | 1+1 |

| Estimating UV based on local perceptions |   |   |
|----------------------------------------|---|---|
| Name of the Informant: Narad Muni Dhungana |   |   |
| Name of the species: *Gmelina arborea* Roxb. |   |   |
| Sl.# | Uses: Treatment | UV is = $\sum_{i=1}^{n} U_{is}$ |
| 1 | Pneumonia (Khatira) | 1.7 |
| 2 | Evil eye (*Bokshi*) |   |
| 3 | Appetizer (*Nasko*) |   |
| 4 | UTI/Garam |   |
| 5 | Skin disease in cattle (*Bokrey*) |   |
| Total Uses | 2+1+2 |
| No. of events | 1+1+1 |

| Estimating UV based on local perceptions |   |   |
|----------------------------------------|---|---|
| Name of the Informant: Mitra Lal Dhungyal |   |   |
| Name of the species: *Tinospora cordifolia* (Willd.) Miers |   |   |
| Sl.# | Uses: Treatment | UV is = $\sum_{i=1}^{n} U_{is}$ |
| 1 | Ulcer |   |
| 2 | Hypertension |   |
| 3 | Diabetes | 2 |
| 4 | Gastritis |   |
| Total Uses | 1+1+2 |
| No. of events | 1+1 |
Table 5 (a-g). FL of medicinal plants done by 7 Informants (i) in their local language (Lhotshamkha) for specific treatments. Most common diseases treated by informants in the 2 gewogs were identified and listed the medicinal plants used against each disease.

| Medicinal plant | Part(s) used | Preparations/dosage |
|-----------------|-------------|---------------------|
| **a. Name of the disease/uses: Cut** |
| Ageratum conyzoides (L.) | Leaves with tender stem | Poultice |
| Pteris biaurita L. (Unew) | Leaves with tender stem | Poultice & juices from green leaves |
| Chromolaena odorata (L.) R.M.King & H.Rob | Leaves with tender stem | Poultice & juices from green leaves |
| Tinospora cordifolia (Willd.) Miers | Leaves with tender stem | Poultice & juices from green leaves |
| **Informant's name: Pundari Timsina** | **Date: 17/01/2013** |
| **b. Name of the disease: Swollen lymph/body (Bagay)** |
| Paederia foetida L | Swollen node | Rubbing extract |
| Sansevieria trifasciata Prain | Leaves | Juice drank and crushed leaves rubbed externally |
| Aegle marmelos (L.) Corrêa | Fruit | Juice from fruit |
| Zanthoxylum caribaeeum Lam. | Spine/thorn | Infusion from thorn extract |
| **Informant's name: Pundari Timsina** | **Date: 17/01/2013** |
| **c. Name of the disease: Lantana poisoning (Bokrey) in cattle** |
| Gmelina arborea Roxb. | Bark | Concoction with leaves |
| Boehmeria penduliflora Wedd. ex D.G.Long | Root | Infusion |
| Bombax ceiba L. | Bark | Rubbed on body |
| Clerodendrum infortunatum L. | Root | Leaves extract fed |
| Citrus reticulata Blanco | Bark | Concoction with leaves |
| **Informant's name: OP Sharma** | **Date: 17/01/2013** |
| **d. Name of the disease: Gastritis (Gano)** |
| Mallotus philippensis (Lam.) Müll.Arg. | Bark | Decoction, boil and drink |
| Tinospora cordifolia (Willd.) Miers | Stem | Soak & drink |
| **Informant's name: Mitra Lal Dhungyal** | **Date: 17/01/2013** |
| **e. Name of the disease: Hypertension (High blood pressure)** |
| Urtica dioica L. | Tender leaves | Broth from mixers of all |
| Zea mays L. | Flour | |
| Eleusine coracana (L.) | Flour | |
| Tinospora cordifolia (Willd.) Miers | Tender Leaves | |
| **Informant's name: Pundari Timsina** | **Date: 17/01/2013** |
| Medicinal plant                        | Part(s) used | Preparations/dosage                                      |
|---------------------------------------|--------------|----------------------------------------------------------|
| Uncaria acida (Hunter) Roxb.          | Root         | Infusion/ apply externally                               |
| Calotropis gigantea (L.) Dryand.      | Leaves       | Baked leaves applied on joints                           |
| Poranopsis paniculata (Roxb.) Roberty | Stem         | Poultice                                                 |
| Lepidium sativum L.                   | Seed         | Soup drank                                               |
|                                        |              | Date: 18/01/2013                                        |

**Informant's name:** Pudari Timsina

| Medicinal plant                        | Part(s) used | Preparations/dosage                                      |
|---------------------------------------|--------------|----------------------------------------------------------|
| Solanum viarum Dunal                  | Fruit        | Smoke from burned seed to tooth through bamboo made pipe |
| Drymaria cordata (L.) Willd. ex Schult.| Whole plant  | apply externally                                         |
| Morus macroura Miq.                   | Roots        | Decoction                                                |
| Citrus medica L.                       | Roots        | Root extract applied to affected teeth                   |
|                                        |              | Date: 18/01/2013                                        |

**Informant's name:** Pundari Timsina
Plate 1. Medicinal plants: (a) Costus speciosus (d) Rauvolfia serpentina (L.) Benth. ex Kurz (b) Daphniphyllum himalayense sub sp. Himalayense (c) Aquilaria malaccensis Lam. (e) Zanthoxylum caribaeum Lam. (f) Tetrastigma serrulatum (Roxb.) Planch.
Plate 2. (g) *Centella asiatica* (L.) Urb.  (h) *Sapium laurifolium* (A.Rich.) Griseb.  (i) *Ficus racemosa* L.  (j) *Cassia alata* (L.) Roxb.  (k) *Tinospora cordifolia* (Willd.) Miers  (l) *Urtica parviflora* Roxb.
Plate 3. (m) *Stephania glabra* (Roxb.) Miers  (n) *Euphorbia sp.*  (o) *Ricinus communis* L.  (p) *Drymaria cordata* (L.) Willd. ex Schult.  (q) *Ocimum gratissimum* L.  (r) *Tinospora cordifolia* (Willd.) Miers
Plate 4. Informants (a) Dilli Ram Khatiwara (b) Dilli Prasad Khatiwara (c) Timsina Jhakri (d) Dharmananda Gautum (e) Narad Muni Dhungana (f) Tika Devi Adhikari (g) Research team collecting specimens with informant
4. CONCLUSION

This study does not give an exhaustive ethnobotanical documentation of the study area because only 2 gewogs out of 11 gewogs of Samdrup Jonkhar District were studied. A comprehensive study from other southern parts of the country could reveal substantial ethnomedicinal and ethno-veterinary information for Bhutan which could be useful for carrying phytochemical studies in future and to add on to list of Bhutanese traditional medicines.

CONSENT

Prior consent was sought from each key informant before interview and they are properly acknowledged.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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