Ethno-veterinary practices by the people Lepcha Primitive Tribe living in the Dzongu Tribal Reserve Area (DTRA) in North-Sikkim, India

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Abstract

People of Lepcha primitive tribe mostly live in Dzongu Tribal Reserve Area (DTRA) situated in the North district of North-east Indian state of Sikkim. DTRA was officially demarcated as Lepcha Reserve area by the former Maharaja of Sikkim and as per article 30.69 (Sikkim's old laws). The practice of age-old traditional methods for the treatment of livestock is still prevalent in far-flung villages within the Reserve. Traditional folk healers, *Bongthing* or *Moandbok* (priest or herbalist) has created and inherited such heritage-knowledge through innumerable generations since the time immemorial. The present exploration of potential local traditional ethno-veterinary medicines (EVM), ingredients and basic formulations in 09 prominent villages in the fringes of DTRA during 2011 to 2017 and consulted 120 folk-practitioners of veterinary medicines. The survey recognized 13 main livestock diseases prevalent inside the study-area, *viz.* diarrhoea, dysentery, cough, foot-mouth diseases, skin disease, delayed expulsion of the placenta etc. The survey also recorded the uses of 27 species of plants from 24 families and few non-biological materials for the preparation of ethno-medicines by the folk-veterinary practitioners in DTRA area.

Key words: Ethno-veterinary, EVM, Livestock, Traditional Knowledge, Heritage, Dzongu, Lepchas

INTRODUCTION

Documentation of traditional usages of plants is an emerging field of interest for the researchers in discoveries of new drugs (Pushpangadan & Dan 2011; Pushpangadan *et al.* 2018). The use of plants by different communities as ethno-medicines in their primary health care is overwhelming. The tribal people are the primary inhabitants of natural habitats, hold tremendous amount of traditional knowledge on the uses of various biotic resources. Indian subcontinent is inhabited by 53.8 million tribal people belonging to 550 tribal communities that constitutes 7.5 % of population. They inhabit in around 5000 forest villages in the country located in varied geographical and climatic zones (Das & Pandey 2007). The plethora of knowledge on plants used in medicine is maximum in the Indian Himalayan region (Samant & Dhar 1997; Samant *et al.* 1998). The East Himalayan Indian state Sikkim is widely known as a center of biodiversity and bio-resources and has been reported to house over 550 species of medicinally important plants (Tamang & Lepcha 2001; Sharma & Sharma 2010).

Pradhan and Badola in 2008 mentioned that exploratory researches on ethno-medicinal use of plants are not sufficiently taken up targeting the remotely located tribal areas of Sikkim. Only few sporadic scientific reports on ethno-medicines in Sikkim have been published so far, including, Biswas (1956), Bennet (1983), Krishna & Singh (1987), Shrivastava & Kapaki (1990), Pandey (1991), Kumar *et al.* (1994), Rai & Sharma (1994), Sinha & Chauhan (1997), Tamang & Lepcha (2002), Gurung (2003), Maity *et al.* (2003a, b), Maity & Rai (2003), Jha *et al.* (2006),

Sharma & Sharma (2010), Pradhan & Badhola (2008), Lepcha & Das 2011, and Yonzon *et al.* (2012).

Dzongu Tribal Reserved Area (DTRA) located in north Sikkim is mostly inhabited by Lepcha primitive tribe. Dzongu was once under the possession of Laso kaji during the regime of Phuntsog Namgyal, and was the 9th district of greater Sikkim (Morris 1938). The DTRA was officially demarcated as Lepcha Reserved Area by the Maharaja of Sikkim (as per the article 30.69 of Sikkim's old laws). These reserves are set up particularly for safeguarding the tribe's culture and preventing it from economic exploitation and such other disabilities those can result from the intrusion of non-lepcha people from outside and can affect the tribe's identity of aboriginality (Fonning 1987). Farming of large cardamom is one of the main stays of the local people for over the last 100 years. In fact, when cardamom introduced in Dzongu is not known. Jhon Morris in his book, *Living with Lepchas* (1938) mentioned that "I have never seen it in such parts of eastern Nepal as I have visited". The book mentioned, "It is believed in Jongu that cardamoms were introduced from Nepal, though I understand that the plant is not cultivated in that country." The keenest observer-traveler cum botanist Sir J.D Hooker makes no mention of it in his Himalayan Journal. Recently, cardamom production is being seriously affected by diseases that put lot of pressure on the Lepcha people (Bhasin 2011). The fragmentation of the forest covers in DTRA was on increase during 1977 to 2000, and the reverse has been noticed during 2000 to 2009 and that is due to loss of cardamom fields. it has been decreased, due to the changes in area covered by large cardamom at the fields by diseases (Agura 2014).

Where as, apart from the domestication of crops such as large cardamom, maize, barleys, buckwheat, maize etc., livestock rearing is an important main stay for the people of DTRA since time immemorial. According to Gorer (1938) and Morris (1938), the animals were reared more for socio-cultural reasons than for the economic benefit as all their rituals and ceremonies were accompanied by the animal sacrifice. However, at the present juncture, apart from that, animal and animal-products constitute a significant source of secondary income for local Lepchas; major domestic animals are cows, bulls, goats, pigs, fowl, dogs, cats and few Yaks in Upper Dzongu. (Sharma 2013). Prior to the enforcement of state government's initiative in banning on grazing in the state in 1998, the farmers / families of DTRA do have many herds of livestock spreading from *Lum Lungtyang* to *Rimpi* river in extreme north, resulting a large numbers of cattle have been reduced in past two decades. Forest department (2010). As the rearing of livestock plays an important role in social, religious and economic sustenance of the people in DTRA, the cattle owners and local *Moandoké* still uphold the culture of traditional healing system against the cattle's ailments. The Lepchas of DTRA annually performs ceremonies to mollify the supernatural spirit of "Zampala / Zomola Ruum (God of animals)" to seek fertility enhancement, in taming spread of the diseases in animals (Sharma 2013).

Traditional folk veterinary medicine or ethno-veterinary medicine involves the use of domestic knowledge, belief, practices and skills pertaining to healthcare and management of human, animals and birds (McCorkle 1986). In our country, modern veterinary care reaches only 20% of livestock owners resulting in a loss of approximately Rs.50 billion annually due to diseases in livestock. (Nair *et al.* 2011). Therefore, EVM is an integration of the local knowledge and a procedures created by local people for purpose of preserving health and welfare of the productive animals (Köhler-Rollefson & Bräunig 1998; Punniyamurthy 2010; Das & Triparthy 2009). Rearing of livestock and poultry plays an important role not only in the economy of these people but also associated with their social and religious life (Sharma & Sharma 2010). The potential plants which his being used in EVM needs to be studied carefully and with

Figure 1: Location of map of DTRA: A. Location of Dzongu in Sikkim; B. Forest cover and drainage in the area (not to the scale) [Source: Agura 2014]

systematic approach (Lepcha 2011). In animal health care, the use of plants as supporting therapy in preventive purposes or as a complete therapy has a huge potential regardless whether it is the question of individual or combined plant medicinal preparations which act synergistically (Davidovic *et al.* 2011). Whereas, rapid changes of communities across the world, coupled with poor storage format of ethno—veterinary knowledge inherited from generation to generation by word of mouth, has greatly endangered its survival and sustainability into the future (Ahmed *et al.* 2016; Balaji & Chakravarthi 2010).

There is no records of any extensive exploration on ethno-veterinary traditions including the formulations in Sikkim in general and DTRA in particular apart from few studies made by Bharati & Sharma (2010). However, Sharma (2012) recorded 37 species of herbal plants being used against 15 livestock ailments.

The Lepchas of DTRA consider ethno-veterinary as *thamchang'g Nyeat moan* and they have been practicing it since the time immemorial. This age old methods of treatment of EVM is still in practice in the far-flung villages of DTRA but are yet to record till date. Such knowledge was generated and maintained by practice only through numerous generations by the local folk healers, *Bongthing* (local priest) and *Moandoak* (the knowledge owners of herbals plants). The folk healers are recognized as equivalent to the doctor in their settlements. They proved their efficiency through several cases of successful treatment of using one or more plants. However, doses and the mode of administration may vary from place to place and community wise (Lepcha *et al.* 2013). So, the livestock owners in DTRA mostly depend on such alternative medicines for the treatment of their cattle as medicines are locally available, easily accessible and are much cheaper than that of modern drugs.

Hence, understanding the gap in our recorded knowledge, a study was conducted to explore the potential ethno-veterinary knowledge stored in traditional ways in different far-flung but important fringe areas of DTRA during 2011 to 2016.

Study area:

DTRA is “T” shaped strip of hilly terrains, valleys and steep mountains with the total geographical area of 78 sq km, located at coordinates ranging in between 27°28' – 27°38' N latitudes and 88°23' – 88°38' E longitudes with altitude ranges in between 700 to 6000 m amsl. The area is bounded to the South by river *Ung- Rungfap* (*adjoining to Lum village*), North by Kishong lake, East by River Teesta and west is bounded by Kanchenjunga Biophere Reserved (KBR) (Figure 1). The DTRA is a home of the *Lepchas* or *Rongs*, an indigenous tribe of Sikkim Himalaya. With the approximate population of c.10,000. The DTRA is administratively divided into 7 blocks and 35 wards. The entire area is again divided into upper Dzongu and lower Dzongu with 7 Gram Panchayat Units. DTRA is under the administrative control of Sub-Divisional Administration and Block Development Administration offices located at Passindang, Upper Dzongu. *Rungyong* and *Rungnyu* are two major rivers and their tributaries forms the drainage network. The area receives about 3000 - 3500 mm of precipitation annually.

METHODOLOGY

Based on appropriate format, an extensive survey for EVM were conducted at DTRA area in North Sikkim during the years 2011 – 2016. Most of the remote and interior villages and the administrative blocks including *Lum*, *Luntyang*, *Gor*, *Taryang*, *Sangdong*, *Hee Gyathang*, *Lingdong*, *Barfok*, *Passingdang*, *Lingthem*, *Lingdem*, *Tingvong*, *Ship-Gyer* and at *Naga Namgor*, under DTRA were thoroughly explored and investigated. The name of the places were identified with due consultation of Gram Panchayats, local folk healers, Block Development Officer and other heard man of the projected area. A total of 150 livestock owners were consulted, interviewed based on a structured questionnaire. Few other local non-tribal groups, herdsmen from age group of 25 to 90 were also consulted. The key informants, however, were traditional folk healers (*Moandbok*, *Pawo*, *Mun*, *Bongthing*), herdsmen, livestock owners, farmers and other elderly persons.

The first author being a Lepcha and a resident of DTRA, it was very much easier to interact with informant in their own Lepcha-language. Interviews and discussions were documented through tape-recorder and video camera in addition to writing notes. Interviews were conducted mainly in the field and the useful plants were recognized by the informants themselves. Voucher specimens of all such plants were collected and recorded in the field-note-book. Cross-checking was liberally done among different unrelated informants.

The collected voucher specimens were later processed into mounted herbarium-sheets following Jain and Rao (1977) and were identified using available published literature such including Hooker (1872 - 1897), Grierson and Long (1983 - 2001), and Noltie (1994, 2000), and were matched at the BSHC Herbarium. For updated nomenclature and family delimitation www.plantsoftheworldonline.org has been consulted. A set of voucher specimens has been deposited at Sikkim State Council of Science & Technology under Department of Science & Technology, Deorali, Gangtok, Sikkim.

RESULT

During the survey, a total of 159 ethno-medicinal plant practitioners have been consulted who looks after the health care of domesticated animals in Dzongu. The result of the studies on ethno-veterinary medicines used by the people of Lepcha tribal community living in DTRA has been presented below in tabular form (Table 1).

Table 1: Ethno-veterinary medicinal formulations of Dzongu Tribal Reserve Area (DTRA)
[Abbreviations used: L / * = Lepcha; N = Nepali]

Disease	Symptom	Ethno-veterinary formulations
Re-biknet (L) Prevalent diseases in high altitude. yaks & sheep; 3600 m and above	Fever, doesn't feed, swelling of skin, gives a sound when rubbed, cattle may die within 10 – 15 days; the disease appear twice a year during Summer	The whole plant of <i>Cissus elongata</i> Roxb. [Vitaceae] (Tundorik*) is crushed into paste and given orally once in a day and applied externally on the body for 2 – 3 days till it gets cured <i>Restrictions:</i> Avoid leafy green fodders.
Somyang-ro (L) Summer cattle fever of cows, buffalos, etc.	Fever, irritation in entire body, can't stand properly and low appetite	Massage with one year old <i>Zea mays</i> L. [Poaceae] (Kutshung*) fruit stick and feeding for two –three dry fruit leaves of <i>Zea mays</i> or dry paddy straw soaking in lukewarm water, 2 – 3 times a day. or The hearth mud and salt is packed inside the leaf of <i>Cucumis sativus</i> L. [Cucurbitaceae] (Tungut*) and given twice a day for 2 – 3 days. <i>Restrictions:</i> Green fodder and cold water not to be given for some days
Sudek-krim (L) Vyagutey (N) Swollen throats of cows and buffalos	Swollen throat , Pain while feeding	Seed paste of <i>Dioscorea deltoidea</i> Wall. ex Griseb. [Dioscoreaceae] (Kusok*) is applied externally on swollen throat and 50 – 60 gm is given orally once in day for 3 - 5 days. Or Paste of <i>Capsicum frutescens</i> L. [Solanaceae] (Rani-Sunkar*) is applied externally on the affected area. Or <i>Flintstone (sudher long*)</i> is rubbed to make a thick paste and is applied externally. <i>Note:</i> If the affected calves are not cured in 2-3 days then the result is death.
Vee-iyit (L) Lomutey (N) Blood in urine of cows, buffalos, etc.	Frequent urination with blood at an interval of 15 – 20 minutes with pain	The decoction of root, bark or twig of <i>Alsophila gigantea</i> Wall. ex Hook. [Cyatheaceae] (Pa'jik*) is given orally for 4 – 5 times once a day. Or Meat of bat to be given three times a day. Or Decoction of 100 gm of Sugar mix with 30 gm of Red /yellow soil with little amount of water is given to the cattle.
Tabok bril (L) Indigestion/ stomach disorder of cows, buffalos, etc.	Loss of appetite and weakness	The mixture or individual fruits of <i>Tetradium fraxinifolium</i> (Hook.) T.G.Hartley [Rutaceae] (Tundorik*), <i>Litsea cubeba</i> (Lour.) Pers. [Lauraceae] (Kuundu*) and <i>Tetrataenium wallichii</i> (DC.) Manden. [Apiaceae] (Syamben*) are given twice a day till cured.
Nyin- hru (L) Thunelo (N) Udder swelling in cows, buffalos, goats, etc.	Swelling of udder due to thickening of milk, fever, reduced lactation	The spine of porcupine (Bokruk*) is made rolled on swelled nipple and pressed inside when other normal nipples are kept tied. The affected nipples are then allowed to let sucked by the calf until thick yellowish, unpleasant odour milk released out completely.
Bik-dulot (L) Loose motion / Diarrhoea. Cows, buffalos, etc.	Watery stool, whole body, loss of weight	The decoction of leaves of castrated female plant of <i>Cannabis sativa</i> L. [Cannabaceae] (Ganjoh*) is given orally twice a day for 1 – 2 days depending on the condition. Or The decoction of matured fruits of <i>Rhus chinensis</i> Mill. [Anacardiaceae] (Tunghril*) is given twice daily for 1 – 2 days. Or The bark of <i>Mangifera indica</i> L. [Anacardiaceae] (Ambi*) and <i>Psidium guajava</i> L. [Myrtaceae] (Sungzampot) 100- 150 gms is crushed to paste with stones and fed to cattle and goats once in a day till recovery.

Disease	Symptom	Ethno-veterinary formulations
Kuptyol-hlu (L) Difficulty in expulsion of placenta in cows, buffalos, goats, etc.	Impatient, mooing for longer period, placenta not coming out easily during birth	The leaves of <i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta [Costaceae] (ankhley*/Beth lauri) Or Leaves of sugarcane [<i>Saccharum officinarum</i> L. of Poaceae] Or Leaves of <i>Zea mays</i> L. [Poaceae] is given to eat and it works within two hours.
Sya'k (L) Ticks/ mites infestation in majority of cattle	Loss of weight, wounds in skin, etching	Decoction of 2 – 3 litre in the ratio of 6:3:1 of <i>Nicotiana tobacum</i> L. [Solanaceae] (Tongkun-nyom*), <i>Lyonia ovalifolia</i> (Wall.) Drude [Ericaceae] (Sunglen nyom*) and common salt in 250 – 300 ml of water is applied externally on the whole body.
Bruttzyak (L) Skin diseases in majority of livestock	Irritation on skin, scar formations, loss of body hair	Paste of 4 – 5 fruits of <i>Litsea cubeba</i> (Lour.) Pers. [Lauraceae] (Kuundu*) dissolved in half a cup of lukewarm water and give orally twice a day for early treatment and doses can be increased if it is mature. Application of root paste of <i>Acorus calamus</i> L. [Acoraceae] (Ruklop*) or tender shoots of <i>Lyonia ovalifolia</i> (Wall.) Drude [Ericaceae] (Tuksol-kung*) would be more effective. Or 10 – 20 gm leafy shoot of <i>Tetrastigma serrulatum</i> (Roxb.) Planch. [Vitaceae] (Tundo-rik*) are crushed and mix in 200 ml of water, given orally once in a day, for 3 – 4 days in the treatment of dermatitis in cattle. It can also apply externally on the whole body or on parts of the body. <i>Caution:</i> For pigs, refrain from giving oral dose of <i>Litsea cubeba</i> (Kundu*), it may result to instant death.
Bongkur nyet (L)/ Khuret (N) Foot and mouth disease in cows, buffaloes, pigs, goats	Excessive salivation, fever, vesicular lesions in hoof mouth and tongue	Few leaves of <i>Cucumis sativus</i> L. [Cucurbitaceae] (Suret*), and of <i>Cucurbita pepo</i> L. [Cucurbitaceae] (Tungut*), red mud and 1 to 2 big spoon of salt are mix together and administered orally to the sick cattle. Or 8 – 10 gm of the termites/white ant's (Tukfil*) left castle mud is given by mixing with 200 – 250 gm of maize flour thrice a day for seven days and the mixture of <i>Curcuma longa</i> L. [Zingiberaceae] (Munga*) rhizome (turmeric) powder, edible oil, and charcoal powder are applied externally. Or 10 to 20 gm of paste of <i>Capsicum frutescens</i> L. [Solanaceae] (Runi-sungkar*) is externally applied twice in a day and feeding of 200 – 250 gm <i>Fagopyrum esculentum</i> Moench [Polygonaceae] (Kurrhu*) seeds along with the food till it cures. Or The leaves of <i>Nyctanthes arbor-tristis</i> L. (Oleaceae), whole plant of <i>Swertia chirayita</i> (Roxb.) H.Karst. [Gentianaceae] (Rungen*) leaves of <i>Azadirachta indica</i> A.Juss. [Meliaceae] (Nimpat*) are crushed together in half litre of water and given orally once in a day till recovery <i>Restrictions:</i> Avoid green leafy fodders and salt. Or A spoon full honey of <i>Apis mellifera</i> (EE-thu*) is mixed with fodder and administered to cure mouth & foot disease.
Khimmyung (L) Rabies in cattle, dogs, cows, pigs, goats	Fever, sour throats, vomiting, impatient, unusual mooing and discomfort feelings	The bark of <i>Betula cylindrostachya</i> [Betulaceae] (Sungli-kung*) and seeds of <i>Datura stramonium</i> L. [Solanaceae] are crushed into paste with 500 ml of water and given orally to livestock. The disease is caused by the bites of mad dog. Or The fruits of <i>Datura stramonium</i> , root-stock of <i>Smilax fulgen aspera</i> ferox Wall. ex Kunth [Smilacaceae], whole plant of <i>Equisetum diffusum</i> D.Don [Equisetaceae], <i>Tectaria coadunata</i> (J.Sm.) C.Chr. [Polypodiaceae], rhizome of <i>Curcuma caesia</i>

Disease	Symptom	Ethno-veterinary formulations
		Roxb. [Zingiberaceae], root of <i>Calotropis procera</i> (Aiton) W.T.Aiton [Apocynaceae] and bark of <i>Betula cylindrostachya</i> , are crushed into a paste in 200 ml of water and given orally twice a day for 7 – 8 days till recovery.
Moh (L) Non-accidental cuts & wounds in Almost all cattle.	Appearance of unusual spots and formation of pus in the skins and other parts of body	10 – 12 leaves of <i>Ageratina adenophora</i> (Spreng.) R.M.King & H.Rob. [Asteraceae] (Vongnokbu*) is crushed into paste and applied on wounds of cattle and goats once in a day till recovery. Or About 50 gm of ashes (Purusor*) of any wood, rhizome-powder of <i>Curcuma longa</i> (Munga*) and few ml of mustard oil are mixed together and applied on the infected areas till recovery. Or The black powder of dry-battery is mixed with one spoonful of mustard oil and applied on the wounds (<i>gare ghau</i>) once daily till recovery in cattle. It protects from further infections.
Ateth- haal (L) Bone-fracture in cows, goats, buffalos, pigs	Fracture of breaking of bones, unusual mooing, appearance or accumulation of blood at affected area	About 50 gm of bark of <i>Machilus odoratissima</i> Nees [Lauraceae] (Run-kung*), 50 gm of stem of <i>Plumbago indica</i> L. [Plumbaginaceae], 40 gm of raw rhizome of <i>Curcuma longa</i> (Munga*), 50 gm of bark of <i>Acer campbellii</i> Hook.f. & Thomson ex Hiern [Aceraceae] (Yali*), 50 gm of rhizome of <i>Kaempferia galanga</i> L. [Zingiberaceae] (Rebireep*), 5 – 6 leaves of <i>Cissus quadrangularis</i> L. [Vitaceae], 60 – 70 gm of red-soil, 2 spoonful of common salt, and 5 – 10 gm of slake lime are crushed into a paste, mix in 1 litre of water and then applied on the affected areas. The affected areas should be properly tied with the bandage, taking support of bamboo-slips and needs to replace it after 20 days.
Lhheng-kok (L) Cough in goats, dogs, cows, buffalos	Increase rate of respiratory actions, swelling and discomfort in stomach, frequent coughing, purulent nasal discharges	500 gm of powdered rice or wheat, 100 gm of Himalayan black salt and 70 gm of Potash-alum (<i>fitkari</i>) are mixed, made a paste and 1litre of water is added to it and given orally three times a day for 3 – 4 days in cough in cattle.
Tubok-hreng dok (L) stomach problems cows, goats, buffalos	Enlargement of stomach, frequent evacuation of watery faeces; may contain blood and mucus with unpleasant ant odour	50 gm of the Himalayan black salt is heated on the oven and applied on the affected areas (abdomen) for three consecutive days, preferably in the morning or in afternoon in stomachic (or stomach enlargement)

DISCUSSION

In Sikkim, the majority of Lepcha primitive tribe lives in Dzongu Tribal Reserve Area (DTRA), an officially demarcated reserved area by Maharaja of Sikkim for Lepcha tribal community. The practice of age old traditional methods for the treatment of livestock diseases has been evolved and inherited through the generations since time immemorial and was maintained by the folk healers (*Moandbok*). Apart from the basic studies by Sharma & Sharma (2010) and Bharati & Sharma (2010), no extensive study has been carried out in respect to ethno-veterinary and its formulation Sikkim in general and DTRA in particular. Present ethno-veterinary exploration in DTRA during 2013 to 2017 led to consultation of 159 ethno-medicinal plant practitioners. A total of 11 prominent/ prevalent livestock diseases has been identified from the study area. The common livestock ailments in the area are blood with urine, diarrhoea, dysentery, bone fracture, wounds, foot-mouth diseases, udder infections, skin diseases, delayed expulsion of the placenta, fever, etc. (Plate-I. E). Altogether 39 plant species of EVM importance, under 23 families have been recorded from the DTRA. These plants are *Acer campbellii* Hook.f. & Thomson ex Hiern (Aceraceae), *Acorus calamus* L. (Acoraceae) [Plate-I. B], *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. (Asteraceae), *Alsophila gigantea* Wall. ex Hook. (Cyathecaceae), *Azadirachta indica* A.Juss. (Meliaceae), *Betula cylindrostachya* Lindl. ex Wall. (Betulaceae), *Calotropis procera* (Aiton) W.T.Aiton (Apocynaceae), *Capsicum frutescens* L. (Solanaceae), *Cannabis sativa* L.

PLATE - I. Cattle and cattle-sheds in DTRA, Sikkim: **A.** Skin infection in cow; **B.** *Acorus calamus*, - commonly used plant in EVM; **C.** A traditional cowshed at Lower Dzongu; **D.** A local man is in the process of constructing cowshed using local rattans at *Breng- Katam* village; **E.** A cow suffering with *blood-urine* disease; **F.** A cowshed constructed with government assistance

Figure 2. Usages of plant parts in preparation of ethno-veterinary formulations

(Cannabaceae), *Cissus elongata* Roxb. (Vitaceae), *Cissus quadrangularis* L. (Vitaceae), *Cucumis sativus* L. (Cucurbitaceae), *Curcuma caesia* Roxb. (Zingiberaceae), *Cucurbita pepo* L. (Cucurbitaceae), *Curcuma longa* L. (Zingiberaceae), *Hellenia speciosa* (J.Koenig) S.R.Dutta (Costaceae), *Datura stramonium* L. (Solanaceae), *Dioscorea deltoidea* Wall. ex Griseb. (Dioscoreaceae), *Equisetum diffusum* D.Don (Equisetaceae), *Fagopyrum esculentum* Moench (Polygonaceae), *Kaempferia galanga* L. (Zingiberaceae), *Litsea cubeba* (Lour.) Pers. (Lauraceae), *Lyonia ovalifolia* (Wall.) Drude (Ericaceae), *Machilus odoratissima* Nees (Lauraceae), *Mangifera indica* L. (Anacardiaceae), *Nicotiana tabacum* L. (Solanaceae), *Nyctanthes arbor-tristis* L. (Oleaceae), *Plumbago indica* L. (Plumbaginaceae), *Psidium guajava* L. (Myrtaceae), *Rhus chinensis* Mill. (Anacardiaceae), *Saccharum officinarum* L. (Poaceae), *Saccharum officinarum* L. (Poaceae), *Smilax ferox* Wall. ex Kunth (Smilacaceae), *Swertia chirayita* (Roxb.) H.Karst. (Gentianaceae), *Tetradium fraxinifolium* (Hook.) T.G.Hartley (Rutaceae), *Tetrataenium wallichii* (DC.) Manden. (Apiaceae), *Tetrastigma serrulatum* (Roxb.) Planch. (Vitaceae), *Tectaria coadunata* (J.Sm.) C.Chr. (Polypodiaceae), and *Zea mays* L. (Poaceae).

The study further revealed that apart from whole plants, the roots, seeds, flowers, barks, and leaves are being used in larger extent for the preparation of ethno-veterinary formulations (Figure 2). Apart from plants some other materials are also used in EVM, like gravels, clay-mud, wild-honey, black-salt, charcoal, slake limes, etc. as part of combinations for increasing the efficacy of their traditional drugs (Table 1). These materials are easily/ readily available within the territory of DTRA.

During the study, it was also realized that in order to improve the health of their livestock, the local people need to take care on the better maintenance of *ghausalas* (= cow-shades) (Plate-I. F).

The study further confirmed that the traditional healing practice is the lone alternative to modern medicines form of improvement in health of the cattle in the region.

The study further emphasized on conservation of ethno-veterinary knowledge which are in verge of vanishing due to several factors including ignorance, road connectivity, major developmental activities, influx of people from outside, etc. The local tribal people of DTRA are directly or indirectly depended on ethno-veterinary forms of livestock healing in many inaccessible areas such as *Sakyong-Pentong*, *Lungthem*, *Lingzya*, *Ruwong*, *Lungtyang*, *Breng katam* and in other fringe areas. (Plate-I. C & D). Therefore, the documentation of EVM practice and its formulations shall ensure the conservation of local traditional knowledge and for better resource management in the region in near future. It would be possible to pinpoint to specific individuals or groups as originators if a remedy turns out to be so valuable that patency issues arise (Sindhu *et al.* 2015; Lepcha 2014; Pradhan & Mishra 2018). The knowledge on herbal formulations being applied on treatment of animals needs further investigation in filing for Intellectual Property Right (IPR) for the benefit of the livestock's holders and other EVM practitioners.

CONCLUSION

Dzongu Tribal Reserve Area (DTRA) is rich in its heritage of folk healers having enormous knowledge on the uses of plant resources in Ethno-veterinary practices. Apart from the basic studies by Sharma & Sharma (2010) and Bharati & Sharma (2010), no other extensive study has been carried out in respect to ethno-veterinary and its formulations in Sikkim in general and DTRA in particular. Livestock is an integral part of people of DTRA and apart from the allopathic medicines, they still rely on ethno-veterinary practices for the treatment of their livestock. But, the number of folk-healers are reducing fast endangering the traditional heritage. It is high time to explore all such traditional knowledge from Sikkim in general and DTRA in particular before all these are lost.

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