

A Report on Medicinal Plants Used in Ethno Veterinary Practices of Toda Tribe in the Nilgiri Hills

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Abstract

This study reports the surveyed list of medicinal plants used by Toda tribes of Nilgiri hills in ethnoveterinary practices. During the study, information about ethnoveterinary plants was obtained from Toda tribes by questionnaire method. The ethnoveterinary plants traditionally used by Toda tribes were collected and preserved as herbarium specimens by following the standard methods. The identification of plants was further authenticated with Botanical survey of India, Coimbatore, Tamil Nadu, India. During the survey, it was noted that ten plants were traditionally used by Toda tribes to treat various human and veterinary diseases such as basic first aid for food poison, snake bite, indigestion, physio-therapeutic treatment for bone fracture, antibacterial, antifungal activity over cuts and wounds, insect repellent, deworming in cattle, diarrhea, and increases cattle lactation. The information provided in this study would bring new insights on the development of environmental friendly, effective medicines and vaccines to control veterinary diseases in the future. In addition, this study may be highly useful to protect and conserve the endemic flora species of Nilgiri hills of Tamil Nadu.

Keywords: Ethnoveterinary; Medicinal plants; Conservation; Toda tribe; Nilgiri hills

Introduction

Nature is provided with a lot of herbal medicinal plants which play a major part in the treatment of diseases. Plants are considered as the significant and elemental sources of medicinal traits. Medicinal plants form the richest entity in medicines, food supplements, nutraceutical, pharmaceutical and chemical industries for manufacturing drugs [1]. Application of these medicinal plants as a source of drugs in treating human and animal diseases has been a traditional practice.

Many studies have been carried out on treating specific ailments in livestock with the help of herbal medicines and its derivatives. The traditional use of medicinal plants in treating veterinary diseases is of paramount significance in developing countries; where in, typical therapies for animal health care becomes financially difficult for resource poor farmers [2]. United Nations Food and Agricultural Organization (FAO) stated that the loss in the breeding sector of many developing countries was due to insufficient drugs to treat diseases and infections, which hindered the increased production [3]. Ethnoveterinary medicine has become well known worldwide as an elemental factor of primary health care, as it has been the blessing for marginalized and poor communities. The best reasons for using traditional methods of treating veterinary diseases are: (a) cost effectiveness of the developed technology (b) no side effects noted (c) lack of accessibility to modern veterinary facilities and treatments [4]. These reasons offer an inclined response over the field of ethnoveterinary research and development [5]. So far, the information available on ethnoveterinary medicine is not only scanty but failed to reach to rural farmers in India [6] and Tamil Nadu in particular [7].

An extensive understanding of this concept involves an indirect interaction between plants and people. This course is known as

Ethnobotany which deals with complete health care and diagnosing diseases of animals. Many studies concerning the ethnoveterinary medicinal plants of the Toda tribe in the Nilgiri hills have been attempted in the past [8] but still the detailed information remains deficient. Hence, the current study forms the first report to elucidate the ethnoveterinary medicinal plants used by Toda tribes to treat and control veterinary diseases in the Nilgiri hills of Tamil Nadu.

Material and Methods

Study area profile

The Nilgiri Biosphere Reserve (NBR) was the first Biosphere Reserve in India and is under consideration by the UNESCO for selection as a World Heritage Site. It is located in the Western Ghats between the co-ordinates of 11°15' to 12°15'N and 76°0' to 77°15'E lying at the trijunction to the three States of Kerala (1455.4Km²), Karnataka (1527.4 Km²) and Tamil Nadu (2537.6 Km²) covering an area about 5520 Km². The Nilgiris is situated at an elevation of 900 to 2636 meters above MSL. The NBR is known for its rich biodiversity [9], and is recognized as one of the 14 hotspots of the world because of its unique bio-diversity [10]. About 3300 species of flowering plants can be seen here. Of the 3300 species, 132 are endemic to the Nilgiri Biosphere Reserve [11]. During summer, the climate remains in the maximum of 21°C to 25°C and the minimum of 10°C to 12°C. During winter, the temperature remains a maximum of 16° C to 21°C and minimum of 2°C. Its latitudinal and longitudinal dimensions being 130 KM (Latitude: 10-38 WP 11-49N) by 185 KM (Longitude: 76.0 E to 77.15 E). The Nilgiris is bounded on North, south, east and west of Karnataka State, Coimbatore District, Kerala state and Erode District respectively (Figure 1).

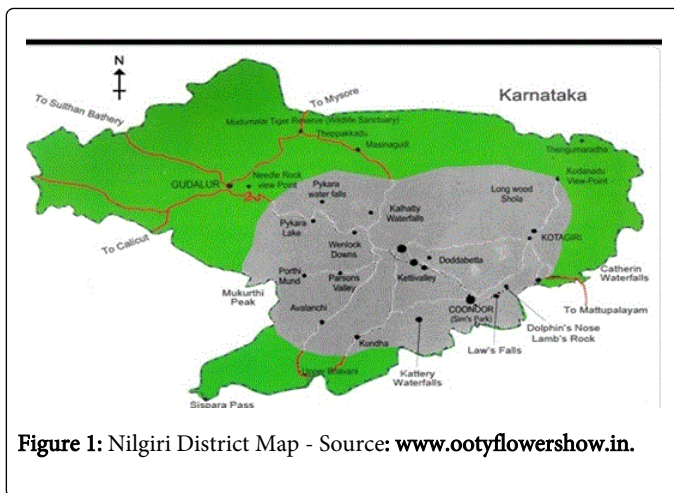


Figure 1: Nilgiri District Map - Source: www.ootyflowershow.in.

Ethnic communities in Nilgiri Biosphere Reserve

The Government of India has recognized 75 primitive tribal groups covered over 15 States and Union Territories at the pre-requisite margin of a pre-agriculture level of technology, a stagnant or declining population, extremely low literacy and a subsistence level of the economy. Among these tribal communities, six tribal communities live in the Nilgiri District. These six primitive tribes are Todas, Kotas, Irulas, Kattunayakas, Paniyas and Kurumbas.

Toda

The pastoral Todas immigrated into the Nilgiris during the 2nd century Before Christ [12]. They were the first to introduce their native domestic cattle and buffaloes. It is also believed that some of the free ranging feral buffaloes in the upper Nilgiris are left by the Todas.

Todas tend to be the most unique tribes for not only existing with their traditional occupation, but also for being very privileged (Figure 2A).

The total tribal population of the district was 25,048 [13] of which Toda population will constitute 1600 individuals. Their houses are built in a special and peculiar way and are called as “Munds” (Figure 2B). Approximately, 72 munds are located in the Nilgiri District and the details are provided in the supplementary Table 1. Todas have the peculiar appearance with curly hair, and they strictly follow vegetarian diet. Todas are well blessed with the indepth knowledge of medicinal herbs and flowers [14] that can be used for various purposes.

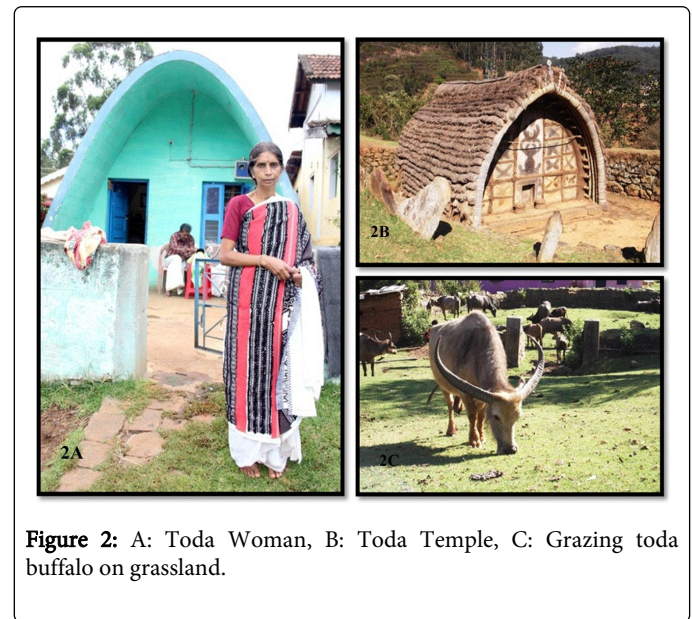


Figure 2: A: Toda Woman, B: Toda Temple, C: Grazing toda buffalo on grassland.

Botanical name	Toda name	Local name	Family	Habit	Parts used	Name of the diseases	Mode of uses and route administration of
<i>Acorus calamus</i> Linn.	Poli	Sweet flag/ Vasambu	Acoraceae	Herb	Rhizome	Food poison and snake bite	Grind rhizome is given to the cattle internally
<i>Berberis tinctoria</i> Lesch.	thokk	Oosikala	Berberidaceae	Shrub	Leaf bunch	Snake bite & indigestion	Bunch of leaves rubbed the cattle from neck to tail
<i>Dodonaea viscosa</i> (L.) Jacq.	Parshoor	Velari	Sapindaceae	Shrub	Shrub	Bone fracture	Leaf is exposed to heat directly and mixed with red soil then tied along the fracture area
<i>Eupatorium adenophorum</i> Spreng.	Sarman	Crofton weed/ Peenar	Asteraceae	Herabaceou s shrub	leaf	Cuts and wounds	Crushed leaf is tied along the wounded area
<i>Euphorbia rothiana</i> spren	kabodi	Common hill	euphorbiaceae	Herb	leaf	Insect repellent	Leaf mixed with salt water then sprayed on the skin of cattle
<i>Lobelia leschenaultiana</i> (C. Presl) Skottsb	Thullksh	Wild tobacco	Campanulaceae	Herb	leaf	Insects presence on the wounded area (Maggot wound)	Leaf paste is applied on insects presence on the wounded area

<i>Parmelia</i> sp. (Lichen)	Kalpodhi	Shield lichen/ Kalpaasi	Parmeliaceae	Lichenous	Whole plant	Blood clotting	Leaf paste is applied on the area of blood clotting
<i>Pteridium aquilinum</i> L Kuhn	Thaff	Bracken fern/ Perani	Dennstaedtiaceae	Herb	Leaf	Bed for cattle	Leaf is directly used for making bed for the cattle
<i>Solanum Sisymbirifolium</i> lam	Pothan	Wild tomato/ Sticky/ Nightshade	Solanaceae	Shrub	Leaf	Deworming &diarrhea	Leaf paste, garlic & salt mixed then given to the cattle internally (Calf)
<i>Anders Foliosus</i> (wight)	cutt	kurinjii	Acanthaceae	Shrub	Leaf	Increase lactation	cattle Leaf is fed directly

Table 1: Ethnoveterinary advantages of plants used by Toda tribe in the Nilgiri district.

Toda buffalo

The only and primary source of occupation of Toda tribe is cattle-herding and dairy-work. They mainly depend upon their buffaloes. Toda breed of buffaloes was named after an ancient tribe (Toda) of southern India. The toda buffaloes are quite categorical from other breeds and are primitive to Nilgiri hills of Western Ghats. They are distinguished with pale brown color, long body, deep and broad chest, and short & strong legs. The head is heavy with horns set wide apart and curving inwards (Figure 2C). The body is insulated with a layer of thick coat of fur. The animals are affable or sociable in nature. Toda buffaloes are good milk makers, yielding about 4.4 to 8.8 litres of rich milk per day.

Field survey

The study of ethnoveterinary medicinal plants of Toda tribes was conducted during the year 2013-2014. A field survey was conducted among the Toda tribes at Pudu mund, Thalappatheri mund, Pagalkodu mund, Artholl mund, Kopumin mund, Thuvalkodu Mund, Taranad mund, Pillkodu mund, Garden mund, Tamilaga mund, Kunthithol mund of Nilgiri hills. During the study period, information about the traditional ethnoveterinary medicinal plants used by Toda tribes was obtained through questionnaire survey method (Supplementary Data 1). The common names and the medicinal values of the flora that were used by the Toda tribes in ethno veterinary practices were further authenticated with other members of the Toda community during the survey. The collection of plant materials and preparation of herbarium specimens was carried out by following standard methods [15]. The taxonomic identification of plants was authenticated by the Botanical Survey of India, Coimbatore and also with standard books that are predominantly referred [16-19].

Results and Discussion

The Nilgiri Biosphere Reserve is an international biosphere reserve in the Western Ghats and it is very rich in floral and faunal diversity. Many ethnobotany studies have been carried out in the Nilgiri hills, but the outcomes of the study have not reached the local and scientific communities to explore further. The results of the present study revealed that the different types of plants like lichen (10%), shrubs (50%), and herbs (40%) (Figure 3) named as *Acorus calamus* Linn., *Berberis tinctoria* Lesch., *Dodonaea viscosa* (L.) Jacq., *Ageratina adenophora* (Spreng.) King & Rob., *Euphorbia rothiana* Spreng.,

Lobelia leschenaultiana (C. Presl) Skottsb., *Parmelia* sp., *Pteridium aquilinum* L. Kuhn., *Solanum sisymbirifolium* Lam., *Strobilanthes foliosus* (wight.) Anders., which belongs to nine orders (Acorales, Ranunculales, Sapindales, Asterales, Malpighiales, Lecanorales, Dennstaedtiaceae, Solanales, Lamiales) and ten families (Acoraceae, Berberidaceae, Sapindaceae, Asteraceae, Euphorbiaceae, Campanulaceae, Parmeliaceae, Dennstaedtiaceae Solanaceae, Acanthaceae) were surveyed and reported to be traditionally used by Toda tribe for treatment of veterinary diseases.

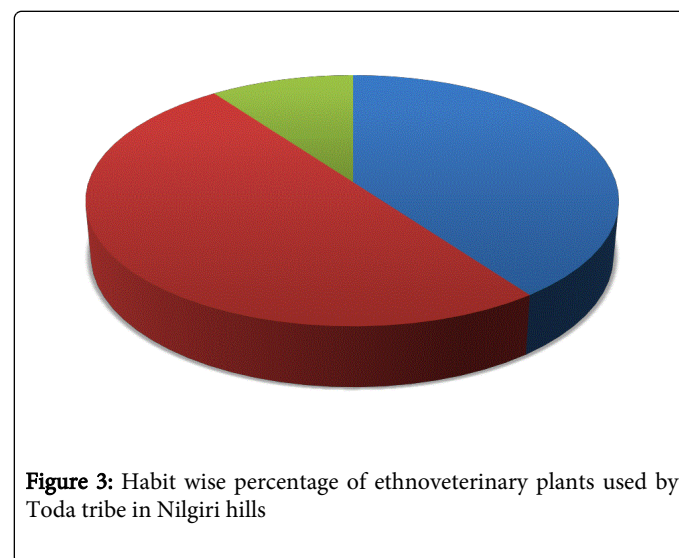


Figure 3: Habit wise percentage of ethnoveterinary plants used by Toda tribe in Nilgiri hills

Of these plants, one monocot plant (10%), seven dicot plants (70%), one lichen species (10%) and one pteridophyte (10%) plants were reported to have medicinal uses (Table 2, Figures 4 and 5). *Eupatorium adenophorum* Spreng. and *Lobelia leschenaultiana* (C. Presl) Skottsb. belong to same order Asterales. Rajan et al. [14] reported that the ethnobotany plants such as *Berberis tinctoria* Lesch. and *Euphorbia rothiana* Spreng. were traditionally used by Toda tribes to treat various diseases in human beings. Kumaravelu [20] reported that the flora *Lobelia* spp. was used by Toda tribes for treating cattle ailment. Sathyavathy and Janardhanan [21] documented the folklore medicinal practices of badaga community in the Nilgiri Biosphere Reserve. They reported that the flora *Acorus calamus* Linn., *Berberis tinctoria* Lesch., *Dodonaea viscosa* (L.) Jacq., *Solanum sisymbirifolium* Lam., and *Lobelia excelsa* Lesch. were used by badaga community to

treat various diseases in human beings. They further stated that *Dodonaea viscosa* (L.) Jacq. and *Strobilanthes kunthianam* was traditionally used by badaga community to treat veterinary diseases. Manikandan [22] reported that the ethnobotany plants, *Berberis tinctoria* Lesch. and *Dodonaea viscosa* (L.) Jacq. was used by badaga community to cure various diseases in human beings. The leaf paste of *Solanum sisymbirifolium* Lam. was used by badaga community in the Nilgiris to repel insect's ticks infecting cattle [22]. Rajan and Sethuraman [23] studied the plants used in the folk medicine by the Kotas of Nilgiri district, Tamil Nadu. They documented that the fruit of *Berberis tinctoria* Lesch are edible and the leaf of *Dodonaea viscosa* (L.) Jacq. is very effective against bone fracture. They further reported that the leaf of *Euphorbia rothiana* Spreng. was used as veterinary medicine to treat cattle disease and they also believed that the plant could separate the new born calves from the mother when it get mixed. Recently, medicinal plants used as an immunostimulants were reviewed for the alternative of chemotherapeutics and antibiotics in

aquaculture practices [24]. The genus *Parmelia* is a large genus of lichenized fungus. Many studies reported the ethnomedicinal value of *Parmelia* Spp. Sharma et al. [25] reported that the lichens were used in folk medicines by Rai and Limbu communities of east Nepal. Rajan et al. [14] reported that the toda tribes in Nilgiri hills used a type of moss paste from *Parmelia caperata* to heal wounds caused by animal bites. They highlighted that the plant, *Dodonaea viscosa* (L.) Jacq. was used to treat bone fractures. Similarly, the leaf paste of *Dodonaea viscosa* (L.) Jacq. was used traditionally by tribes of Nilgiri hills to cure bone fracture when applied over the fractured area [7,26]. The monocot aromatic plant, *Acorus calamus* Linn. was used to treat food poison and snake bite. It was reported that 50 ml of *Acorus calamus* Linn. extract was able to cure enteritis, when administered orally [7]. They also reported that the infusion of *Acalypha indica* L. and *Solanum surattense* Burm. leaves, *Acorus calamus* Linn. rhizome and *Allium cepa* L. bulb is given orally to cattle once a day to cure tympany.

S.No	Name of Toda Village	Location	S. No	Name of Toda Village	Location	S.No	Name of Toda Village	Location
1	Garden Mund	Ooty	25	ChinnaKadi Mund	Sandynallah	49	Koppumin Mund	Glenmargan
2	Tamilaga Mund	Ooty	26	Neerkasi Mund	Sandynallah	50	Pikkapathi Mund	Ebbanadu
3	Kandal Mund	Ooty	27	Malavithi Mund	Near Governer Solai	51	Inkaththi Mund	Near Kattabettu
4	Manjakkal Mund	Ooty	28	Attkor Mund	Near Governer Solai	52	Onnaya Mund	Kundha
5	Minik Mund	Ooty	29	Melkavakkadu Mund	Near Governer Solai	53	Theppakodu Mund	Kundha
6	Kunthithol Mund	Lovedale	30	Kelkavakkadu Mund	Near Governer Solai	54	Onnakudi Mund	Avalanchi
7	Kannaya Mund	Ithalar	31	Kallisal Mund	Near Governer Solai	55	Karikadu Mund	Ithalar
8	Pagala Mund	Ullathi	32	Chinnakaria Mund	Near Pykara	56	Pedukal Mund	Kodanadu
9	Neethi Mund	Ullathi (Thalaikundha)	33	Kalmothi Mund	Parsens Valley	57	Ponkadu Mund	Kodanadu
10	Marli Mund	Dhavane	34	Eerkodu Mund	7th Mile	58	Nerveni Mund	Kodanadu
11	Muthanadu Mund	Thalakundha	35	Ankuthkuli Mund	Sandynallah	59	Nedi Mund	Ullikkal
12	Pagalkodu Mund	9th Mile	36	Kallakor Mund	Parsens Valley	60	Pudu Mund	Glenmargan
13	Karimuli Mund	Near KamarajaSagar dam	37	Narikkuli Mund	9th Mile	61	Kakodi Mund	9th Mile
14	Karia Mund	Pykara	38	Thavuttukodu Mund	Sandynallah	62	Kombuthukki Mund	Near Thalaikundha
15	Perattathalai Mund	9th Mile	39	Pathankodu Mund	Dunsandal estate	63	Thenadu Mund	Near Thalaikundha
16	Thalappatheri Mund	9th Mile	40	Kenkodu Mund	Dunsandal estate	64	Thoodakorai Mund	9th Mile
17	Emikkal Mund	8th Mile	41	Malkodu Mund	Dunsandal estate	65	Mekkodu Mund	Parsens Valley
18	Eepkodu Mund	8th Mile	42	Kerada Mund	Dunsandal estate	66	Nerkodu Mund	Kadanadu
19	Aganadu Mund	Parsens Valley	43	Pashthar Mund	Dunsandal estate	67	Thukkar Mund	Parsens Valley
20	Kunthikodu Mund	Parsens Valley	44	Artholi Mund	Glenmargan	68	Erkodu Mund	Solur via
21	Aanakkal Mund	Parsens Valley	45	Kopumin Mund	Glenmargan	69	Pilkodu Mund	Kokkal
22	Pennappal Mund	Sandynallah	46	Thuvalkodu Mund	Glenmargan	70	Nedukodu Mund	Parsens Valley
23	Naththanar Mund	Sandynallah	47	Taranad Mund	Glenmargan	71	Osa Mund	9th Mile

24	Kadi Mund	Sandynallah	48	Pillkodu Mund	Glenmargan	72	Karkaal Mund	Naduvattam
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Table 2: Names of Toda village and their location in the Nilgiri district using Ethnoveterinary medicinal plants.

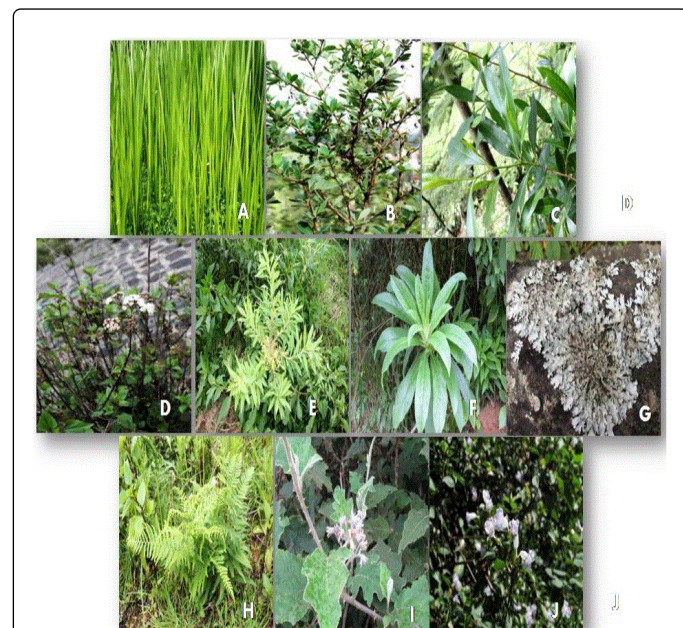
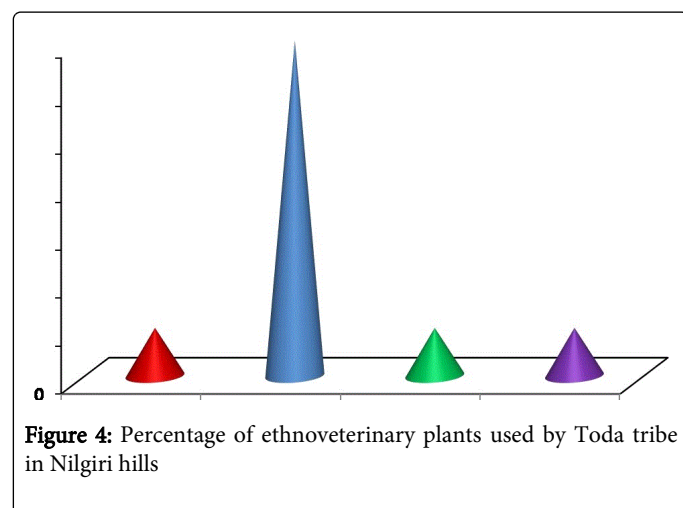


Figure 5: Ethnoveterinary plants used by Toda tribe in Nilgiri hills. A. *Acorus calamus* Linn. F. *Lobelia leschenaultiana* (C. Presl) Skottsb. B. *Berberis tinctoria* Lesch. G. *Parmelia* sp. C. *Dodonaea viscosa* (L.) Jacq. H. *Pteridium aquilinum* L. Kuhn. D. *Eupatorium adenophorum* Spreng. I. *Solanum sisymbirifolium* Lam. E. *Euphorbia rothiana* Spreng. J. *Strobilanthes foliosus* (Wight) Anders

Western Ghats is very rich in floral diversity with high endemism and particularly, *Berberis tinctoria* Lesch. and *Strobilanthes foliosus* (Wight) Anders. were the endemic flora of the Nilgiri hills. Therefore, efforts are needed to conserve these floral species as they have high ethnoveterinary and medicinal value. Furthermore, the use of

chemical drugs is not only ineffective but also causes side effects. Hence, plant based drugs are increasingly important in the field of ethnoveterinary medicine to control various diseases. In this scenario, knowledge about the indigenous and traditional medicines used by tribal people of Nilgiri hills is of great significance to the scientific community to treat human and veterinary diseases. The study concludes that the Nilgiri hills harbors a majority of endemic flora that was used by Toda tribes in ethnoveterinary practices. But still, a large proportion of flora remains unexplored in Nilgiri hills and studies are further needed to reveal the ethnoveterinary medicinal values of these flora.

Conclusion

The tribal people of India play an important role in the conservation of biodiversity as they possess indigenous knowledge on the medicinal value of plants in the hills. In this study, the list of wild plants used by Toda tribes in the Nilgiri hills will provide basic information for future research in the field of ethnoveterinary medicine. Many studies concerning the medico – ethnobotany (when implied to human treatment) of the Toda tribes in the Nilgiri hills have been attempted in the past, but have not properly reached to scientific communities. Now, this survey would be very useful to young researchers to further explore the ethnoveterinary plants of the Toda tribes in the Nilgiri hills. This study may also be helpful to develop ecofriendly effective medicines and vaccines to treat veterinary diseases.

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References

1. Ncube NS, Afolayan AJ, Okoh AI (2008) Assessment techniques of antimicrobial properties of natural compounds of plant origin: Current methods and future trends. AFB 7:1797-1806.
2. McGaw LJ, Van der Merwe D, Eloff JN (2007) In vitro anthelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethno-veterinary medicine. Veterinary Journal 173: 366-372.
3. FAO (2002) Genetics and animal health-Spotlight. Rome, FAO pp: 32.
4. Padmakumar V (1998) Farmers' reliance on ethnoveterinary practices to cope with common Cattle ailments. Indigenous Knowledge and Development Monitor. 6: 14-16.
5. Yineger H, Kelbessa E, Bekele T, Lulekal E (2007) Ethnoveterinary medicinal plants at Bale Mountains National Park, Ethiopia. Journal of Ethnopharmacology 112: 55-70.
6. Geetha S, Lakshmi G, Ranjithakani P (1996) Ethnoveterinary medicinal plants of Kolli hills, Tamilnadu. jetbas 12:139-144.
7. Ganesan S, Chandhirasekaran, Selvaraj A (2008) Ethnoveterinary healthcare practices in Southern districts of Tamil Nadu. Ijtk 7: 347-354.

8. Rajan S, Sethuraman M, Suresh Baburaj D (1997) Plants from the traditional medical system of the Nilgiri tribes. *Ancient Science of Life* 16: 360-365.
9. Daniels RJR (1992) The Nilgiri Biosphere Reserve and its role in conserving India's biodiversity. *Current Science* 64: 706-708.
10. Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J (2000) Biodiversity hotspots for conservation priorities. *Nature*. 403: 853-858.
11. Ahmedullah A, Nayar MP (1986) Endemic plants of the Indian Region Peninsular India. *BSI Flora of India Series* 4: 143-153.
12. Prabhakar R, Gadgil M (1994) Nilgiri Biosphere Reserve: Biodiversity and population growth Survey of the Environment (The Hindu) 3 1-37.
13. Anonymous (1981) Census Reports. Government of India, New Delhi.
14. Rajan S, Jayendran M, Sethuraman M (2005) Folk herbal practices among Toda tribe of the Nilgiri Hills in Tamil Nadu, India. *Jnr* 5: 52-58.
15. Jain SK, Rao RR (1977) *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers and Publishers, New Delhi.
16. Beddome RH (1866) *The Ferns of British India*. Oxford and IBH publishing co, 66 Janpath, New Delhi.
17. Fyson PF (1974) *The flora of the Nilgiri and Pulney hill-tops (above 6500 feet) 1*, Dehradun; Periodical experts, Delhi.
18. Mason E Hale (1974) *The biology of Lichens*, Edward Arnold (Publishers) Ltd, London.
19. Mathew KM (1983) *The flora of Tamilnadu, carnatic - Part I-Polypetalae, Part II-Gamptelae and Monochlamydeae, Part III-Monocotyledones*.
20. Kumaravelu (2008) Ethno-Botanical knowledge of the Toda tribes of the Nilgiris. *Eco News*. 14: 17-19.
21. Sathyavathy R, Janardhanan KJ (2011) Folklore medicinal practices of badaga community in Nilgiri Biosphere Reserve, Tamil Nadu, India. *Ijprd* 3: 50-63.
22. Manikandan A (2007) Ethno-medico-botanical studies of Badaga population in the Nilgiri district of Tamilnadu, South India. *Asl* 17: 50-59.
23. Rajan S, Sethuraman M (1991) Plants Used in the folk medicine by the kotas of Nilgiri district, Tamil Nadu. *Asl* 10: 223-230.
24. Vaseeharan B, Thaya R (2014) Medicinal plant derivatives as immunostimulants: an alternative to chemotherapeutics and antibiotics in aquaculture. *Aquacult Int* 22:1079-1091.
25. Sharma AK, Sharma MC, Mahaveer P Dobhal (2013) Phytochemical constituents from different species of *Parmelia* genus: A review. *Der Chemica Sinica* 4:1-11.
26. Narayana VL, Rao N (2013) *Traditional Veterinary Medicinal Practices in Srikakulam*.