Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 549-554
Received: 07-05-2020
Accepted: 09-06-2020

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Ethnoveterinary study of medicinal plants in a tribal society of Marwar region of Rajasthan, India

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Abstract
The aims of the present study were (i) to document ethnoveterinary plants and their formulation techniques in an unexplored region of India and (ii) to select candidate medicinal plants with high consensus factor and fidelity value for further *in vitro* investigation. A total of 60 informants were interviewed using semi-structured questionnaire. A total of 41 plants belonging to 30 families were used to treat livestock ailments in study area. Mostly leaves (47%) were used in recipes formulation mostly in the form of decoction. Gastrointestinal infections were found more common and majority of the plants were used against cow (31) and buffaloes (24) ailments. Recovery time of majority of the recipes was three to four days. Informant consensus factor (Fic) results have shown a high degree of consensus for gastrointestinal, respiratory, and reproductive (0.95 each) ailments. Fidelity level (FL) results showed that *Asparagus gracilis* ranked first with FL value 93% followed by *Rumex hastatus* ranked second (91%) and *Tinospora cordifolia* ranked third (90%). Aged farmers and nomads had more traditional knowledge as compared to younger ones. Plants with high Fic and FL values could be further investigated *in vitro* for the search of some novel bioactive compounds and young generation should be educated regarding ethnoveterinary practices.

Keywords: Cow, ethnoveterinary, herbal plants, medicinal, traditional, fidelity level and informants

Introduction
Traditional veterinary medicine was experienced as early as 1800 B.C. at the time of King Hammurabi of Babylon who devised laws on veterinary fees and charged for treating animals (Veena 1996) [33]. Many ethnoveterinary medicines were neglected due to the development of initial western drugs. Ethnoveterinary practices have gained tremendous importance for the last decade due to the discovery of some effective ethnoveterinary products (Lans *et al.* 2007) [23]. Traditional veterinary medicines provide a cheap therapy and easy accessibility in comparison with western drugs (Ganesan *et al.* 2008) [12]. Ethnoveterinary practices are more common in developing countries due to different socioeconomic factors (Rahman *et al.* 2009) [29]. India is an agriculture country and almost 65% of its population is dependent on agriculture and livestock. India is the world's first largest milk producing country due to its high dependency on agriculture and livestock (Hassan *et al.* 2014) [14]. Resource-poor farmers of India greatly rely on traditional medicine due to their limited access to modern prevention health practices and particularly lack of modern health facilities in their areas (Abbasi *et al.* 2013) [1]. Despite the fact that traditional knowledge is very much important for the livestock health and productivity, the documentation of this knowledge is very much neglected in majority of the remote areas of India. Livestock farmers all over India can draw on over 4000 years of knowledge and experience (Farroq *et al.* 2008). This traditional knowledge has been passed orally from generation to generation but it may be extinct or may be endangered due to the current rapid socioeconomic, environmental, and technological changes [Hussain *et al.* 2008] [17]. Therefore, the documentation of such knowledge is very crucial before its extinction for future developments.

The present research study was therefore designed to document detailed ethnoveterinary knowledge of an unexplored region of India. The present study was designed with the objectives (i) To document ethnoveterinary plants of the Marwar region, (ii) to document the detailed formulation techniques of the reported ethnoveterinary plants, and (iii) to select candidate medicinal plants with high consensus factor and fidelity value for further *in vitro* investigation. The present study would provide baseline information to phytochemists, pharmacologists, and conservationists for further future research studies. This work would also make a great contribution to the conservation of this valuable knowledge.

Materials and Methods

Study Area

Present study was conducted in Pali district of Rajasthan, India. It is located at 24^0-26^0 N, 74^0-$26^0$29 E, with an altitude of 489 m, and is the capital of the Pali district (Fig. 1). Summer temperatures usually shoot above 45 ^{0}C and winters are mild (Shinwari *et al.* 2011) [30]. The dominant vegetation of the study area is *Zizyphus* species, *Acacia species*, Khejri, ker and other xerophytes plants. The area is rural in nature and inhabitants are very much dependent on livestock for agricultural, economic, and food purposes. Locals of the Marwar region use a variety of medicinal plants for the treatment of livestock ailments due to expensive veterinary drugs.

Sampling and Data Collection

Field work was done from January to May 2019. Initially, local administrative officers and representative (*Sarpanch*) of the study area were visited, who provided information on key resource persons in the field of ethnoveterinary medicinal plants. They suggested 60 informants having strong traditional knowledge regarding livestock treatment. Out of 60 informants 45 were farmers and 15 were nomadic people. A brief group discussion was held with the informants prior to data collection for explaining to them the main theme of the present study and to get their consent for the publication of their traditional knowledge. This was done in order to acknowledge informants' cooperation in preserving the traditional knowledge of the study area and build their confidence for providing reliable information. Each informant was separately interviewed in their local languages. Semi-structured questionnaires were designed addressing detailed ethnoveterinary information (*Hindko*). Informants were asked about the number of plants they use to treat their livestock, which part of plant used, recipe formulation, recovery, and other essential questions.

Data Organization

Data collected from informants was organized using Microsoft Excel 2007 and Microsoft Word 2007. Plant habit was categorized into four classes, that is, herb, shrub, tree, and climbers. Plant parts were classified into leaves, stem, root, bark, whole plant, seeds, and fruit. Medicinal plants uses were categorized into 8 major categories, that is, gastrointestinal, dermatological, respiratory, reproductive, wound healing, antipyretic, parasitic, and general body tonic. Recipes were classified into different groups, that is, decoction, powder, crushed, juice, paste, poultice, infusion, and concoction. Route of administration was divided into 3 categories, that is, oral, dermal, and nasal.

Data Analysis

Informant consensus and fidelity level were used to verify the importance of medicinal plants.

Informant Consensus (Fic)

Fic on the reported cures of a given group of ailments was calculated as an informant consensus factor. Fic within a community designates the widely used plants and thus helps in the selection of plants for phyto-chemical and pharmacological studies (Giday *et al.* 2009) [13]. Reported veterinary problems were grouped into 8 major ailments. Fic values are high when one or few plants are reported by the large number of respondents to treat a specific ailment, while low Fic values give an indication that informants do not agree over which plant to use (Heinrich *et al.* 1998 and Canales *et al.* 1998) [15].

The Fic can be calculated using the formula as follows:

$$Fic=\frac{nur-nt}{nur-1}$$

Where Fic = Informants consensus factor, nur = number of used citations in each category, and nt= number of species used

Fidelity Level (FL).

FL is useful for recognizing the most preferred plants used for curing certain ailments by the respondents. Highly preferred plants have always greater FL values than those that are less preferred. FL is always calculated in terms of percentage of informants claiming the use of a certain plant species for the same major purpose. The main purpose of FL is to calculate the importance of plant species for a specific purpose. Prior to the calculation of FL values all of the ailments that were reported are grouped into major classes (Giday *et al.* 2009) [13]. FL value was estimated using the formula:

$$FL = Ip/Iu \times 100,$$

Where Ip is the number of respondents who reported the utilization of medicinal plants for a specific main ailment and Iu is the total number of respondents who mentioned the same plant for any ailment [Friedman *et al.* 1986] [11]. It is assumed that those medicinal plants which are plants used in some recurring manner for the same disease category are more likely to be biologically active (Trotter *et al.* 1986) [32].

Collection and preservation of the reported medicinal plants

Field trips were made with local informants for the collection of the reported medicinal plants. Collected medicinal plants were brought to the laboratory of Arid Forest Research Institute (AFRI), Jodhpur for further processing. Specimen identification and confirmation were undertaken by using flora of India and taxonomic experts. Plants were dried and pressed on herbarium sheets and deposited at the herbarium of department of botany, AFRI, Jodhpur.

Results

The present study revealed that local farmers of Marwar region utilize 41 medicinal plants belonging to 30 families for the treatment of different types of livestock ailments (Table 1). Among all the families, *Asteraceae* was found to be dominant (4 species) in the study area being in use in ethnoveterinary practices in the region. Traditional farmers mostly used herbs (55%) for the preparation of ethnomedicines (Table 2) followed by shrubs (27%). Almost all plant parts were being used for medicinal purposes but leaves (47%) were found to be the most frequently used plant part followed by whole plant (32%) and roots (17%) (Table 2). Local farmers used these ethnomedicines to treat different types of domestic animals like buffaloes, cows, goats, sheep, and donkeys. A total of 31 plants were found to be used for treatment of cow ailments followed by 24 plants against buffalo's ailments and 17 for goats (Figure 2). Different types of ailments were treated which were categorized into 8 major categories. Gastrointestinal infections were found to be most common in domestic animals and a total of 13 plants were used against them followed by 7 plants which are used as

antipyretic while 6 are used for wounds treatment (Table 3). Local farmers prepare different types of ethnomedicines but the most preferred techniques were decoction and powder (10 plants each) followed by crushing (7 plants) in the studied region (Fig. 3). Monotherapy was most common in the study area; only few plants were found to be used in concoction form (Table 1). For example, stem of *Allium sativum* is mixed with flower of *Punica granatum* and milk and used against gastrointestinal infection; roots of *Asparagus gracilis* are mixed with leaves of *Coriandrum sativum* to make fine concoction and given with water to cattle for delivery purposes. Different types of vehicles were found to be used for preparation and administration of plant recipes like sugar, flour, water, and milk (Table 1). The most common route of administration was oral (75%) followed by dermal (24%) and only single species is administered through nasal pathway (Table 1).

Recovery time of majority of the recipes was three to four days. Informant consensus (Fic) results have shown a high degree of consensus for gastrointestinal, respiratory, and reproductive (0.95 each) ailments, which were followed by parasitic infections and wound healing (0.90 each) (Table 3). The highest plant use citation was for gastrointestinal (260) followed by wound healing (53) and reproductive (47) ailments. The present study revealed 10 medicinal plants having high FL value (Table 4). FL values in this study varied from1.0%to 100%.*Asparagus gracilis* ranked first with the highest FL value (93%) followed by *Rumex hastatus* ranked second (91%), *Tinospora cordifolia* ranked third (90%), and *Aloe barbadensis* ranked fourth (85%). The entire informants interviewed were aged people ranging between 40 and 70 years old. No use of ethnoveterinary medicine by women or young generation was recorded.

Discussion

Livestock keeping is one of the most important economic sources of rural community of study area. The farmers and nomadic people of the area not only depend on plants to get fodder for their animals but also use different medicinal plants to treat various animal diseases. The majority of the people interviewed using ethnoveterinary plants have got this knowledge from their forefathers while some have learned from the other people. The majority of the farmers and nomadic pastoralists were not very well off and heavily dependent on medicinal plants due to their unaffordable potential of using modern veterinary drugs for their animals treatment. The present study revealed that people of the region use 41 medicinal plants for their livestock health care. Similar studies have also been documented in other parts of India (Hassan *et al.* 2014) [14]. Traditional healers of the region mostly use herbs for the treatment of their animals that might be due to the fact that herbs are available everywhere and easy to collect as compared with other growth forms.

The results indicate the abundance of herbs in the study area and their high usage might also be due to the strong efficacy of herbaceous plants against livestock ailments. The same findings were also reported from other studies conducted at different parts of the world Benitez *et al.* (2014). The wider utilization of this *Asteraceae* family might be due to its higher abundance in the study area or might be due to high bioactivity. Similar studies have also been reported from other parts of world (Yineger *et al.* 2007) [35] and from Pakistan (Khan *et al.* 2014; Akhtar *et al.* 2013) [21, 3] where traditional healers mostly use the member of *Asteraceae* family for the preparation of traditional medicines for the treatment of different livestock and human ailments. This observation is however different from that of Appidi *et al.* (2008) [4] and Offiah *et al.* (Kala *et al.* 2005) [20] Offiah *et al.* (2011) [28] who in an ethnoveterinary survey reported *Fabaceae* family as the highest. The difference among studies might be related to the different dominant vegetation of the areas or might be associated with traditional beliefs of different cultures in using specific plants traditionally. Most of the ethnoveterinary recipes in the study region are prepared using leaves of plants. The highest use of leaves in large number of ethnomedicinal and ethnoveterinary studies has also been documented from different parts of the world (Kala 2005; Bhat *et al.* 2013) [20, 19]. Preferred use of leaves might be associated with ease of collection as compared to other plant parts. Leaves are the main site of photosynthetic apparatus and are involved in a variety of physiological processes of plants and produce numerous secondary metabolites that could be a possible reason for their effectiveness and efficacy against different livestock diseases. Local people also use whole plants after leaves for herbal formulation that could be a very destructive type of harvesting for rare and slowly growing plants from conservation point of view. Harvesting of leaves does not pose any serious impact on the life cycle of plants and is considered a sustainable type of harvesting.

The present results are in contradiction with other studies where roots are the most widely used plant part in ethnoveterinary practices Tabuti *et al.* (2003) [31]. Cows and buffaloes were the most commonly treated animals followed by goats and sheep in the studied region. Similar results have also been conducted by Van Der Merwe *et al.* (2001) [26] and Benitez *et al.* (2012) [6]. There was almost no mention of treating dogs, cats, or donkeys. This is probably because rural people do not generally keep animals as pets and because nonproduction animals are perceived as being more resistant than humans to different kinds of ailments. Production animals are also more important because of their socioeconomic importance in the local inhabitant life. The majority of the plants in the region are used to treat different types of gastrointestinal problems of the livestock like diarrhea, expulsion of worms, constipation, and so forth. It has already been found that stomach infections are more common in lactating animals which might be due to poor quality of fodder and drinking water Luseba *et al.* (2006) [25]. Informant consensus results also showed the highest informant citation for gastrointestinal, respiratory, and gynecological problems. The highest informant citation against these infections gives an indication of high prevalence of these diseases in the region. According to Heinrich *et al.* (1998) [15], high Fic values are very useful in the selection of specific plants for further search of bioactive compounds. Widely used medicinal plants for species ailments always score the highest fidelity level. The present study determined different plants like *Asparagus gracilis*, *Rumex hastatus*, *Tinospora cordifolia*, *Aloe barbadensis*, and so forth, scored highest fidelity values and should be further subjected to phytochemical and pharmacological investigation to prove their medicinal efficacy. The method of drug preparation in many cases varied from individual to individual. The same plant material for the same ailment was prepared in different ways by different traditional veterinary healers. Traditional healers prepare ethnoveterinary recipes mostly in the form of powder and decoction in the study area. Deeba (2009) powdering or boiling is the most common method of drugs extraction. These findings are in line with a study conducted in the Malakand valley of Pakistan [Hassan *et al.* (2014) [14]

while they are contradictory with the studies conducted in other parts of the world (Dold and Cocks 2001) [9].

Most of the recipes are prepared using single plant mixture while some of the recipes are also prepared in the form of concoction and it is generally believed that potency of the drugs can be enhanced when used in concoction form Abede, *et al.* (1993). These recipes are mostly taken orally in the study area due to the high prevalence of the internal diseases. These recipes are given to the livestock with their feed along with different types of ingredients like sugar, flour, milk, and so forth, in the region. Similar findings are also reported from other regions of the world Yineger (2007) [35] and Jabar *et al.* (2006), Wani and Pant *et al.* (2020) [34], Baidya *et al.* (2020) [5] and Nimblakar *et al.* (2020). The use of these vehicles might be due to their enhancing potential of taste and medicinal properties of certain plant remedies. Uniformity was lacking regarding amount of medicines to be used among informants during the interview. It was determined that a contradiction in ethnoveterinary dosage is a serious drawback of traditional medicinal plants. Informants only provided the knowledge of observed time of recovery of animals in response to given recipes. Full recovery is confirmed when the animals restart proper feeding and activities. Similar findings are also reported by other ethnoveterinary studies conducted elsewhere (Gassan *et al*. 2014; Offiah *et al.* 2011) [28]. It was confirmed from the present study that men had better knowledge regarding ethnoveterinary practices as compared to women. The reason might be due to the fact that men are mostly favored in shift of knowledge while women in the majority of the cultures are considered for family's care. This noticeable gender bias reflects the limited involvement of women in cattle production and herd health in Marwar region of India. Aged males had much more indigenous knowledge as compared to young generation which might be due to the lack of interest in such practices. Therefore, documentation of ethnoveterinary practices is an essential step toward the conservation of such knowledge before its extinction.

Table 1: Ethnoveterinary plants used for the treatment of livestock ailments in Marwar region

Plants name/family name	Local names	Habit	Part used	Ailment treated	Animal treated	Recipe	Route
Acacia modesta Wall. (*Fabaceae)*	*Kikar*	Tree	Leaves seeds	Delivery	Buffalo, cow	decoction	Oral
Achyranthes aspera Lin. (*Amaranthaceae)*	*Gishkay*	Herb	Whole plant	Anthelmintic and delivery	Buffalo, cow, goat, sheep	Powder	Oral
Allium cepa L. (*Amaryllidaceae)*	*Pyaz*	Herb	Whole plant	Febrifuge, tonic	Sheep, goat	Decoction	Oral
Allium sativum L. (Liliaceae)	*Matar*	Herb	Stem	Gastrointestinal	Goat	Concoction	Oral
Aloe barbadensis Mill. (*Liliaceae)*	*Guvarpatha*	shrub	Root	Gastrointestinal	Buffalo, cow, goat, sheep	Powder	Oral
Artemisia brevifolia Wall. (*Asteraceae*)	*Jaukay*	Herb	Leaves	Removal of placenta	Cow	Decoction	Oral
Asparagus gracilis Royle. (*Liliaceae*)	*Lachgawa*	Herb	Root	Delivery	Goat	Concoction	Oral
Brassica campestris L. (*Brassicaceae)*	*Sarson*	Herb	Whole plant	Exlenal lice	Cow, buffalos	Paste	Dermal
Calotropis procera (Willd.) R.Br. (*Apocynaceae)*	*Spulmaey*	Shrub	Fruit, leaves	Intestinal worms and skin infections	Buffalo, cow, goat, sheep	Paste, concoction	Oral dermal
Cannabis sativa L. (*Cannabaceae*)	*Bhang*	Shrub	Leaves	External parasites, appetizer	Cow, donkey, buffalo	Poulitice, powder	Dermal, oral
Chenopodium album L. (*Amaranthaceae*)	*Bathua*	Herb	Whole plant	Wound healing	Goat, sheep, cow	Paste	Dermal
Chrysanthemum leucanthemum L. (*Asteraceae*)	*Chitti pulari*	Herb	Whole plant	Increase milk production	Cow, buffalo, goat	Powder	Oral
Citrullus colocynthis (L.) Schrad. (*Cucurbitaceae*)	*Tumba*	Herb	Fruit, root	Abdomen pain, gestations, skin infection	Buffalo, cow, goat, sheep	Juice, powder	Oral
Convolvulaus arvensis L. (*Convolvulaceae)*	*Shankpuspi*	Herb	Whole plant	Constipation	Cow buffalo, sheep	Crushed	Oral
Coriandrum sativum L. (*Apiaceae*)	*Dhania*	Herb	Leaves, root	Antidiurentic	Buffalo, cow	Decoction water	Oral
Curcuma longa L. (*Zingiberaceae*)	*Haldi*	Herb	Leaves, root	Antidiuretic	Buffalo, cow	Decoction water	Oral
Cynodone dactylon L. (*Poaceae*)	*Dubhghas*	Herb	Whole plant	Wound healing, analgesic	Cow, buffalo	Concoction	Oral
Cynoglossum lanceolant Forssk. (Boraginaceae)	*Pachy*	Herb	Root	Common cold	Cow, buffalo	Crushed	Oral
Cyperrus niveus Retz. (*Cyperaceae)*	*Kulio*	Herb	Whole plant	Common cold, stomach worms, joint pains	Cow, goat	Crushed	Oral
Datura inoxia Mill. (Solanaceae)	*Mangaz*	Herb	Whole plant	Antilice	Sheep, cow	Paste	Dermal
Hedera nepalensis K. Koch (*Araliaceae)*	*Zalai*	Shrub	Leaves	To remove leeches	Sheep	Infusion	Nasal
Melia azedarach L. (*Meliaceae*)	*Dhrek*	Tree	Leaves	Stomach flatulence	Cow, buffalo	Powder	Oral
Mentha arvensis Linn. (*Lamiaceae*)	*Pudina*	Herb	Leaves	External parasite	Cow	Paste	Oral

Morus alba L. (Moraceae)	*Sahtoot*	Tree	Leaves, fruit	Laxative	Buffalo, cow	Crushed	Oral
Nerium oleander L. (*Apocynaceae*)	*Ghanderay*	Shrubs	Whole plant	Stomachache	Sheep	Concoction	Oral
Ocimum basilicum L. (*Lamiaceae)*	*Kshmalay*	Shrub	Leaves	Gastrointinal	buufaloes	Decoction	Oral
Punica granatum L. (*Lythraceae)*	*Anar*	Shrub	Fruit, leaves	Anthelmintic	Cow, buffalo, goat	Decoction	Oral
Ricinus communis Linn. (*Euphorbiaceae*)	*Arund*	Shrub	Leaves, stem	Common cold	Buffalo, cow	Powder	Oral
Rumex hastatus D. Don. (*Polygounaceae*)	*Tarooky*	Shrub	Root and leaves	Wound healing	Goat, cow, buffalo	Powder	Oral
Solanum surrattense Burm.f. (*Solanaceae*)	*Kandiari*	Herb whole plant	Whole plant	Fever, cough, intestinal infections	Cow, buffalo, goat, sheep	Crushed	Oral
Sonchus asper (L.) Hill. (*Asteraceae*)	*Spingul*	Herb	Whole plant	Milk production	Goat, buffalo, cow	Decoction	Oral
Sonchus asper (L.) Hill. (Asteraceae))	*Spingul*	Herb	Whole plant	Milk production	Goat, cow, buffalo	Decoction	Oral
Tagetes minuta L. (*Asteravceae*)	*Ban hanjari*	Herb	Leaves	Skin infections	Cow, buffalo	Juice	Oral
Tamarix aphylla (L.) H. Karst.	*Khagal*	Tree	Leaves	Kill worms of wounds	Cow	Paste	Dermal
Tinospora cordiflolia Miers. (*Menispermaceae*)	*Giloe*	Climber	Whole plant	Skin infections	Cow, goat	Poultice	Dermal
Tribulus terrestris Linn. (*Zygophyllaceae*)	*Markondai*	Herb	Whole plant	Chronic cough	Cow, buffalo,	Crushed	Oral
Trifolium repens L. (*Papilionaceae*)	*Shoutal*	Shrub	Root	Tonic, laxative	Goat, cow	Powder	Oral
Triticum aestivum L. (*Poaceae*)	*Gandam*	Herb	Seeds	Common cold, dysentery	Cow	Powder	Oral
Verbena officinalis L. (*Verbenaceae*)	*Shamakay*	Herb	Stem, leaves	Wound healing	Buffalo, cow	Decoction	Oral
Vitex negundo L. (*Verbenaceae*) Marmandi	*Marmandi*	Shrub	Stem	Mange, fever, stomach	Cow, goat	Crushed decoction	Oral
Zizyphus nummularia W. & A. (*Rhamnaceae*) Kurkunda	*Kurkunda*	Tree	Leaves	Wound healing	Cow	Decoction	Oral

Table 2: Habit and parts used of ethnoveterinary plants

General attributes	Total plants	Percentage
Habits		
Herbs	22	55
Shrubs	11	27
Trees	06	15
Climber	01	02
Parts used		
Leaves	19	47
Root	13	17
Stem	07	10
Fruit	04	07
Seed	03	02

Table 3: Habits and plants parts used of ethnoveterinary plants

Diseases categories	Nur	Nr.	Fic
Gastrointestinal	260	13	0.95
Respiratory	22	02	0.95
Reproductive	47	03	0.95
Dermatological	12	04	0.77
Wounds	53	06	0.90
Antipyretic	14	07	0.53
Parasitic	45	05	0.90
General body tonic	09	03	0.75

Conclusions

Local farmers and nomads of the region utilize different medicinal plants for the treatment of livestock due to their low income status and high expenses of western drugs. Traditional healers possess tremendous expertise in preparing herbal formulations of medicinal plants. Gastrointestinal infections were most common in the studied region; therefore attention should be given to provide good quality fodder and water to the livestock. Plants with high informant consensus and fidelity level should be subjected to further *in vitro* investigation for their phytochemical analysis and pharmacological activities. Young generation should be mobilized to take interest in ethnoveterinary practices in order to conserve this knowledge.

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