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Ethno-veterinary practices for camel diseases: A participatory assessment by the *Raika* pastoralist of Rajasthan

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ABSTRACT

The camel is practically symbolic for western arid region of Rajasthan. This animal has the immense contribution to livelihood of the *Raika* pastoral community who has a long relationship with this animal. *Raikas* followed their own traditional practices in all aspects of camel rearing including healthcare practices since time immemorial. Therefore, the present study was designed to document and appraise ethno-veterinary practices followed by the *Raika* pastoral community to cure important camel diseases like trypanosomiasis, camel pox and mange. A total 120 *Raika* pastoralists were interviewed from the six villages of Pali and Jodhpur district of Rajasthan on an open ended interview schedule to document the ethno-veterinary practices. Quantification of Indigenous Knowledge (QuIK) was applied for participatory assessment of the identified ethno-veterinary practices. The *Raikas* were using total 10 ethno-veterinary practices to cure the three diseases. Use of fruit of *Withania coagulans (stock) Dunal* was found to be most effective among the four identified practices to control camel trypanosomiasis (surra). Accordingly, use of neem leaves and; mixture of turmeric, butter and mustard oil were perceived as highly effective to cure camel pox and mange, respectively.

Keywords: Camel, Ethno-veterinary, *Raika* pastoralist, Rajasthan

Camel (*Camelus dromedarius*), the state animal of Rajasthan, is an important livestock species contributing significantly in rural economy and livelihood of desert dwellers in western Rajasthan (Chand *et al.* 2010). Camels in India are primarily reared for carting/draft, agricultural operation, transportation in addition to the secondary utility of milk and hair production (Saini *et al.* 2006*)*. It still plays a very distinctive role in various agricultural operations and rural transportation in dry land farming (Rajput and Tripathi 2006). Economic contribution of camel in terms of transportation, milk, wool, dung, bones, and leather were well documented by Köhler-Rollefson (1992). The human-camel relationship and camel culture of Rajasthan is unique from a global perspective, since the *Raikas* of Rajasthan are probably the only camel pastoralists in the world who have developed a deeply ingrained prohibition against the use of camels for meat (Köhler-Rollefson and Rathore 2004). The *Raikas*, also known as *Rebari*, are the largest pastoralists or specialized camel breeding community that exists in western Rajasthan (Tripathi and Rajput 2006). *Raikas* take pride in fact that for them camel breeding is not just business but their heritage (Rathore 2001). Due to this intimate association with the camel over the centuries, the *Raikas* also accumulated a large body of indigenous knowledge related to camel management, breeding, disease treatment, and behaviour. For this reason, they were referred to as 'native camel doctors' by colonial veterinarians (Köhler-Rollefson 1992). Therefore, ethno-veterinary practices followed by the *Raikas* for camel are considered as old as domestication of camel. Unfortunately, these practices, which are in vogue throughout the camel rearing tracts of India, are little documented and there is danger of extinction of these practices. Therefore, it is utmost important to document these old age practices as well as to assess their validity. Hence, the present study was designed to document and participatory validation of the documented ethno-veterinary practices used to cure important diseases of camel.

MATERIALS AND METHODS

There are 2.13 lakh camel in Rajasthan which constitutes approximately 85.2% of the India's total camel population (Anonymous 2019). Rajasthan is the home of the 61% of the *Raika* pastoralists of India. Therefore, the present study was carried out in Rajasthan. Out of nine regions in Rajasthan, Marwar region was selected purposively due to the highest population of *Raika* pastoralists. Out of six districts of Marwar region, two districts, i.e. Pali and Jodhpur were selected purposively based on the highest population of the *Raika* pastoralist. From each district,

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one tehsil (Bali from Pali district and Bilara from Jodhpur district) was selected based on the highest *Raika* population. Further, three villages from each tehsil were be selected, randomly. Therefore, the present study was conducted in six villages, from each village, 20 *Raika* pastoralists, who were camel herder and migrating along with their camel, were considered as the respondents for this study. Thus, a total 120 *Raika* pastoralists were interviewed either at their doorstep/migratory route with the help of an open-ended interview schedule for documentation of ethno-veterinary practices with rationale used by them to treat different diseases of camel. Prior informed consent was obtained from the village headsman for sharing and publishing their traditional knowledge and practice as ethno-veterinary practices to acknowledge them. While seeking informed consent, the researchers have explained the purpose of the research, its sponsors, potential benefits and possible problems associated for people and the environment, research methodology and participation of residents of the community. They were given an opportunity to read the summarized facts of research through their village headsman.

A participatory validation of the identified ethno-veterinary practices was done through QuIK (Quantification of Indigenous Knowledge) method developed by De Villiers (1996). The basic premise of this method is that farmers know and understand the environment in which they farm and that answers many questions which can be found in the collective experience of the farming community and doing informal experiments over years. It can be used to unpack the practices of successful farmers, so that information can be disseminated to a wider group of farmers. QuIK methodology represents a rapid and relatively cheap way to elicit ethno-veterinary practices. In QuIK, PRA tool, i.e. matrix ranking was combined with an interview schedule to elicit numerical data from key informants. *Raikas* were, mainly, using ethno-veterinary practices to cure three important diseases of camel, i.e. camel trypanosomiasis (*Surra*), camel pox and mange. Therefore, these three diseases were selected for the participatory assessment of the ethno-veterinary practices which were used to cure these diseases. Among the identified ethno-veterinary practices, important practices as identified by the pastoralists were considered for QuIK. Thus, four practices were selected to evaluate their comparative effectiveness to cure camel trypanosomiasis. Accordingly, three practices were selected to appraise their effectiveness against camel pox and mange. To conduct participatory validation, key informants were identified by Sociometric method (Moreno 1951) among the selected *Raika* pastoralists, those were having detailed understanding regarding selected ethno-veterinary practices. Thus, 21 key informants were identified for participatory validation of camel trypanosomiasis. Accordingly, 19 and 20 key informants were identified for the participatory validation of camel pox and mange, respectively. Four criteria or parameters, viz. availability, ease in preparation, quickness in recovery and lower side effect, were selected to appraise comparative and relative effectiveness of the identified ethno-veterinary practices. Key informants were asked to put required number of pieces of stone out of in each block of matrix as per their perception on each criteria/parameter of the identified ethno-veterinary practices. Data from each key informant were treated as an independent result. Data collected from the key informants on several criteria were subjected to Kruskal Wallis H test due to its non-parametric nature followed by post-hoc test using all pair-wise comparison to identify the most effective practices among the identified practices.

RESULTS AND DISCUSSION

Ethno-veterinary practices against camel trypanosomiasis (Surra) used by the Raika pastoralists of Rajasthan: Surra, mange and worm infestation are common health problems encountered in camels in Rajasthan. These diseases are responsible for the poor health of camels, and if not treated in a timely way, may lead to death. Camel trypanosomiasis (Surra) is one of the most important diseases causing the economic losses particularly in the camel rearing areas. Therefore, camel rearers adopt several indigenous measures during their migratory routes to protect their animals from this costly disease. The first symptom is weakness at the time of getting up with a rider or with a load on the back of the camel. The eyes appear dull and the animal becomes lethargic. The symptoms are usually seen when there are lots of flies around the animals and it is seen during the rainy season from July to October. The body temperature increases up to 39°C in the morning and 41°C in the evening.

Raika pastoralists generally used four ethno-veterinary practices against camel tryoanosomiasis (Table 1). They boiled bark of *khejri* (*Prosopis cineraria)* and kept this mixture whole night and provide to the animal in the early morning. The plant is known as 'Golden tree or Wonder tree' of the desert and known for anti-inflammatory, anticonvulsant, antifungal, antimicrobial and wound healing properties (Rai *et al.* 2017). In case of second practice, they prepare paste of *tumba* (*Citrullus colocunthis*) leaves. They add some salt to the paste and keep in water. Finally, this solution was applied on the body of the camel. Previous studies also reported use of *Citrullus colocunthis* to keep fly away from the infected camel (Gupta *et al.* 2015). This practice helps in neutralizing the poison in the blood, awakening the camel sleeping body and keeping the affected camel strong and fit (Raziq *et al.* 2010). *Raika* pastoralists prepared a powder of *nirgundi* (*Vitex negundo*) leaves, *sahjan* (*Moringa oleifera*) root, desi *ajwain* (*Fumaria indica*) and little salt. Finally this powder was mixed with ghee and offered to the camel for 4-5 days both in morning and evening. In case of last practice to control trypanosomiasis**,** fruits *Whiania coagulans (stock) Dunal* were mixed in water and given to animals in morning for 5-6 days. *Withania coagulans* fruit is known for its ethano-pharmacological significance in healthcare system of India

Table 1. Ethno-veterinary practices used by the *Raika* pastoralists to cure camel tryponosomiasis (Surra)

Practice	Ingredient	Botanical name of used plants	Form of use	Mode of use
First	*Khejri*	*Prosopis cineraria*	Bark	Boiled bark of *khejri* in water and keep whole night and provide to animals in early morning.
Second	*Tumba,* salt	*Citrullus colocunthis*	Leaves Paste	First make paste of *tumba* and mix some salt and put in the water. Finally applied on the body of the camel.
Third	*Nirgundi, Sahjan, Ajwain*, Salt, ghee	*Vitex negundo, Moringa oleifera, Fumaria indica*	Paste	Make powder of *nirgundi* leave, *sahjan* root, desi ajwain and little salt and mix with ghee and offered to animals for 4 – 5 days both in evening and morning.
Fourth	Paneer *dodi* (fruit)	*Withania coagulans (stock) Dunal*	Dodi (fruit)	The fruits of the plant are mixed in water and given to animals in morning for 5-6 days.

and aqueous extract of its fruit has potent antioxidant activities (Shukla *et al.* 2014).

Participatory validation of ethno-veterinary practices to cure camel tryponosomiasis (Surra) by the Raika pastoralists of Rajasthan: For the validation of ethno-veterinary practices, 21 key informants were interviewed. Matrix of decision criteria with respect to the practices for curing of tryponosomiasis (surra) of camel was prepared and administered to key informants individually. Matrix ranking for the relative performance of the options with respect to each criterion, viz. availability, easy in preparation, quickness in recovery and low level of side effect was done with scoring pattern of 1-4. The result, presented in Table 2, depicts discernible difference among different ethno-veterinary practices. Fourth practice, i.e. use of fruit of *Withania coagulans (stock) Dunal* was perceived as most effective in terms of availability and easy in preparation. In terms of availability, there was no significant difference ($P<0.05$) between first, second and third practices. But, these three practices were having significant difference with fourth practice. In case of quickness in recovery, there was no significant difference between first and third practice. These two practices also showed better effectiveness in comparison with the second and fourth practice in quickness of recovery. There was no significant difference ($P<0.05$) between second and third practices in terms of lower level of side effect. But, these two practices were having significant ($P<0.05$) lower level of side effects with first and fourth practices. Overall, use of fourth practice was the most effective to control camel trypanosomiasis (surra). Though this practice was comparatively slow in recovery and were having higher side effect, but, its abundant availability and easy in preparation, made it most effective against camel trypanosomiasis (surra).

Ethno-veterinary practices against camel pox identified by the Raika pastoralists of Rajasthan: Camel pox is a disease caused by a virus of the family *Poxviridae*,

Table 2. Participatory validation of ethno-veterinary practices to cure camel trypanosomiasis (Surra) by the *Raika* pastoralists of Rajasthan

Criteria	First practice	Second practice	Third practice	Fourth practice
Availability	1.95 ± 0.176^{b} (IV)	2.00 ± 0.138^{b} (III)	2.05 ± 0.223^{b} (II)	4.00 ± 0.000^{a} (I)
Ease in preparation	2.57 ± 0.130^{b} (II)	2.00 ± 0.138^{b} (III)	1.62 ± 0.161^{c} (IV)	4.00 ± 0.000^{a} (I)
Quickness in recovery	3.43 ± 0.148^{a} (I)	2.10 ± 0.095^{b} (III)	3.43 ± 0.130^{a} (II)	1.05 ± 0.048^{c} (IV)
Lower level of side effect	3.81 ± 0.088^{a} (I)	2.48 ± 0.131^{b} (II)	2.00 ± 0.258^{bc} (III)	1.71 ± 0.171^{d} (IV)
Overall effect	12.76 ± 0.344^{b} (II)	10.57 ± 0.328^{c} (IV)	12.10 ± 0.457^{b} (III)	14.76 ± 0.181^{a} (I)

^{a,b,c,d}Means bearing different superscripts in row under each criteria differ significantly ($P<0.05$). The multiple comparisons were based on Kruskal–Wallis H test. Values in parenthesis indicate the respective rank under each criterion.

Table 3. Ethno-veterinary practices used by the *Raika* pastoralists of Rajasthan to cure camel pox

Practice	Ingredient	Botanical name of used plants	Form of use	Mode of use
First	Hydrogenated vegetable oil and camel milk	-	Paste	Prepare a paste of hydrogenated vegetable oil and camel milk; and applied on the infected body parts of camel.
Second	Neem	*Azadirachta indica*	Leaves	Use paste of leaves of neem and applied on affected body parts of animals.
Third	Poppy seed, turmeric, curry leaves	*Opium poppy, Curcuma longa, Murraya koenigi*	Seeds paste Leaves	Mix all the item and make paste; finally applied on affected parts of animals.

Table 4. Participatory validation of different ethno-veterinary practices for curing of camel pox by the Raika pastoralists of Rajasthan

Criteria	First practice	Second practice	Third practice
Availability	2.47±0.118[a] (I)	2.47±0.118[a] (I)	1.00±0.000[b] (II)
Ease in preparation	2.79±0.096[a] (I)	2.16±0.086[b] (II)	1.00±0.000[c] (III)
Quickness in recovery	1.47±0.193[b] (III)	2.58±0.139[a] (I)	1.95±0.143[b] (II)
Lower level of side effect	1.21±0.096[c] (III)	2.84±0.086[a] (I)	1.95±0.143[b] (II)
Overall effect	7.95±0.223[b] (II)	10.05±0.179[a] (I)	5.89±0.241[c] (III)

[a,b,c]Means bearing different superscripts in row under each criteria differ significantly (P<0.05). The multiple comparisons are based on Kruskal–Wallis H test. Values in parenthesis indicate the respective rank under each criterion.

subfamily Chordopoxvirinae, and the genus *Orthopoxvirus*. It causes skin lesions and a generalized infection. Young camels are more susceptible and mortality rate of the young infected camel is nearly 25% (Fenner *et al.*1993). A total three ethno-veterinary practices were used by *Raika* pastoralists for treatment of camel pox (Table 3). In case of first practice, *Raika* pastoralists prepared a paste of hydrogenated vegetable oil and camel milk; and applied on the infected portion. Both the ingredients, i.e. hydrogenated vegetable oil and camel milk can be applied separately on the infected body parts of the camel (Gupta *et al.* 2015), but**,** *Raika* pastoralists perceived that combinations of these two showed a better and quick recovery. Use of neem (*Azadirachta indica*) leaves was very much popular among the *Raika* pastoralists to cure camel pox. They prepare paste of the neem leaves and apply on the infected body parts for camel pox. As camel pox is highly infectious viral disease, so, application of neem leaves helps in preventing further spreading due to his highly antiviral properties. Studies already revealed the chemopreventive potential of *A. indica* against murine skin carcinogenesis (Arora *et al.* 2011). Third ethno-veterinary practice used by the *Raika* pastoralists was paste prepared using poppy (*Opium poppy*) seed, turmeric (*Curcuma longa*) powder and curry leaves (Leaves of *Murraya koenigi*). They applied prepared paste on the infected body parts of their camel for quick healing of the blisters due to infection. *Raikas* were also using turmeric powder for healing of the wounds as turmeric is known for its healing properties.

Participatory validation of ethno-veterinary practices to cure of camel pox by the Raika pastoralists of Rajasthan: A total 19 key informants were interviewed for the validation of ethno-veterinary practices. Matrix ranking for the relative performance of the options with respect to each criterion, viz. availability, ease in preparation, quickness in recovery and lower level of side effect was done with scoring pattern of 1 to 3. Matrix of decision criteria with respect to the identified ethno-veterinary practices for curing of camel pox is presented in Table 4. The result shows discernible difference among the identified ethno-veterinary practices. Second practice, i.e. use of neem leaves was perceived as highly effective to cure camel pox as it is easily available, very quick in recovery and shows no side effect in comparison to the other two practices. Application of the paste of the hydrogenated vegetable oil and camel milk, i.e. first practice was perceived as second most effective practice due its availability and ease of preparation in comparison to the third practice.

Ethno-veterinary practices against mange of camel identified by Raika pastoralists of Rajasthan: Due to severe mange, infected camels rub with their calves, other animal or trees and spread the disease. Affected camels become restless due to intense pruritus. They bite, scratch and rub the affected areas which may lead to formation of large wound with maggot infestation and secondary bacterial infections. A total three ethno-veterinary practices (Table 5) were used by the *Raika* pastoralists of Rajasthan for treatment of mange of their camel. In case of first practice, *Raikas* used three ingredients, viz. turmeric *(Curcuma longa)* powder, butter made of cow milk and mustard oil. They prepare a mixture of turmeric powder and butter made of cow milk with help of cold water and give to the animal for four days. After providing this mixture, they massage camels' body with mustard oil and tied them under sunlight. *Raikas* also used combination of fitkari (Alum) and human urine to cure

Table 5. Ethno-veterinary practices against mange of camel identified by the *Raika* pastoralists of Rajasthan

Practice	Ingredient	Botanical name of used plants	Form of use	Mode of use
First	Turmeric, Butter, Mustard oil	*Curcuma longa*	Mixture	Turmeric + cold water + butter made of cow milk and given to animals for four days. Body message of animals with help of mustard oil and tied animals in the sunlight.
Second	Alum, Urine	-	Paste	Alum + human urine mix and applied on animals' body.
Third	Ferrous sulphate, gun powder and *gandrabh*	*Gardenia jasminodes*	Powder and paste	Make a paste of all items and mix in the mustard oil and massage body of camel.

Table 6. Participatory validation of different ethno-veterinary practices used for mange of camel by the *Raika* pastoralists of Rajasthan

Criteria	First practice	Second practice	Third practice
Availability	2.30±0.105[a] (II)	2.80±0.092[a] (I)	1.00±0.00[b] (III)
Ease in preparation	2.40±0.112[a] (II)	2.65±0.131[a] (I)	1.15±0.109[b] (III)
Quickness in recovery	2.30±0.128[a] (II)	1.05±0.050[b] (III)	2.65±0.112[a] (I)
Lower level of side effect	2.70±0.128[a] (I)	1.45±0.135[b] (III)	1.85±0.167[b] (II)
Overall effect	9.70±0.242[a] (I)	7.95±0.153[b] (II)	6.60±0.235[c] (III)

[a,b,c]Means bearing different superscripts in row under each criterion differ significantly ($P<0.05$). The multiple comparisons are based on Kruskal–Wallis H test. Values in parenthesis indicate the respective rank under each criterion.

mange of camel body. Alum is known for its antifungal property. Therefore, application of alum on the infected body part helps in decreasing severe mange. In the third practice, *Raikas* used three ingredients, viz. *Neela thotha* (Ferrous sulphate), *Barud* (gun powder), Gandrabh (*Gardenia jasminodes*).They prepare paste of these three items with the help of mustard oil and apply to the infected body parts and massage the whole body of a camel for relief from mange.

Participatory validation of ethno-veterinary practices to cure of mange of camel by the Raika pastoralists of Rajasthan: Matrix of decision criteria with respect to the practices for curing of mange of camel is presented in Table 6. The present study established that first practice, i.e. mixture of turmeric, butter and mustard oil was the most effective practice to cure mange of camel in comparison to the other two studied ethno-veterinary practices at 5% level of significance. The second practice, i.e. paste of alum and urine was highly available and easy in preparation. But, this practice was perceived as second most effective due to delay in quickness of recovery and comparatively higher level of side effect. The third practice, i.e. mixture of ferrous sulphate, gun powder and *gandrabh* showed quickness in relief from mange. But, this practice was considered as least effective by the *Raika* pastoralists as availability of the ingredients was not easy and its difficulty in preparation.

The Camel husbandry is considered as a traditional occupation among *Raika* pastoralists of western Rajasthan. Due to their migratory nature, they mostly depend on old age traditional knowledge for treatment of their animals as modern veterinary healthcare practices are still beyond their reach. They believe that the kind of traditional way of treating camel by employing the knowledge passed on orally from one generation to generation provides a permanent and safe cure for the common ailments of camel. Study concluded that to cure trypanosomiasis (surra), camel pox and mange, *Raika* pastoralists of the Marwar region of Rajasthan mostly depends on ethno-veterinary practices. Participatory validation appraised that use of *Withania coagulans (stock) Dunal,* neem leaves and mixture of turmeric, butter, mustard oil was most effective to cure camel trypanosomiasis, camel pox and mange respectively. Concerns regarding efficacy, quality, safety and dose standardization remain. Hence, it is an urgent need to evaluate the pharma dynamics of these ethno-veterinary practices.

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