

## PREVALENCE OF CAMEL *TRYPANOSOMOSIS* AND ITS ASSOCIATED RISK FACTORS IN MOYALE DISTRICT, BORENA ZONE, SOUTHERN ETHIOPIA

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### Abstract

A cross-sectional study coupled with questionnaire survey was conducted to determine the prevalence of camel *trypanosomosis* and assess associated risk factors in Moyale district, Borena Zone, Oromia region, southern Ethiopia from November 2014 to April 2015. Blood samples were collected from randomly selected 384 camels. Giemsa-stained blood smears were used for the detection of Trypanosomes infection. Out of 384 examined camels, 39 (10.2%) were positive for *Trypanosoma evansi*. There was statistically significant difference between age groups and trypanosome infection ( $P < 0.05$ ). Higher prevalence of the infection was recorded in Age group of  $>4$  years (15.5%) followed by 3-4 years (5.6%) and  $< 3$  years old camels (2.6%), respectively. A higher infection was found in males (15.6%) as compared to females (9.1%). However, there was no statistically significant difference in prevalence between sex categories ( $P > 0.05$ ). The prevalence was varied among study localities within the district revealing the highest prevalence in Bokola (14.3%) and the lowest (7.1%) in Lagasure. A questionnaire survey was administered to 45 respondents comprised of 80% of the interviewed camel herders were pastoralists while the rest were agro-pastoralists to assess knowledge, attitude and practices of the community about camel *trypanosomosis*. All respondents (100%) were familiar with the disease and knew the typical clinical signs of the disease. According to the respondents the cause and means of the transmission of the disease was by biting flies at congregation of camel herds around water and in pasture. About 88.9% of householders stated that the disease occurs at onset of major rainy season. All of them mentioned that the disease causes abortion. The present study revealed that camel *trypanosomosis* is prevalent in Moyale district at relatively low levels. Thus, there is need of further study with the use of more sensitive diagnostic tests in order to establish effective control measures.

**Key words:** Blood, Camel *trypanosomosis*, Moyale, Prevalence, Smear, Survey

## LA PREVALENCE DE LA TRYPANOSOMIASE CHEZ LE CHAMEAU ET SES FACTEURS DE RISQUE DANS LE DISTRICT DE MOYALE, LA ZONE DE BORENA ET LE SUD DE L'ETHIOPIE

### Résumé

Une étude transversale couplée d'une enquête par questionnaire a été menée de novembre 2014 à avril 2015, afin de déterminer la prévalence de la trypanosomiase chez le chameau et évaluer les facteurs de risque associés dans le district de Moyale, la zone de Borena, la région d'Oromia et le Sud de l'Ethiopie. Les échantillons de sang ont été prélevés au hasard sur 384 chameaux. Des frottis sanguins colorés au Giemsa ont été utilisés pour la détection de l'infection par les trypanosomes. Sur 384 chameaux examinés, 39 (10,2%) étaient infectés du *Trypanosome Evansi*. Il y avait une différence statistiquement significative entre les groupes d'âge et l'infection trypanosome ( $P < 0,05$ ). La prévalence la plus élevée de l'infection a été enregistrée chez le groupe de chameaux donc l'âge respectivement est supérieur à 4 ans (15,5%), suivie de 3 à 4 ans (5,6%) et inférieur à 3 ans (2,6%). On a constaté une infection élevée chez les males (15,6%) comparé aux femelles (9,1%). Cependant, il n'y avait pas de différence statistiquement significative de la prévalence entre les catégories de sexe ( $P > 0,05$ ). La prévalence variait entre les localités d'étude au sein du district révélant la plus forte prévalence à Bokola (14,3%) et la plus faible (7,1%) à Lagasure. Pour évaluer les connaissances, les attitudes et les pratiques de la communauté à propos de la trypanosomiase chez le chameau, une enquête par questionnaire a été administré à 45 répondants donc 80% des éleveurs de chameaux interrogés étaient des pasteurs tandis que le reste était des agropasteurs. Toutes les personnes

interrogées (100%) étaient au courant de la maladie et connaissaient les signes cliniques typiques de la maladie. D'après les personnes interrogées, la cause et les voies de transmission de la maladie se faisaient par morsure d'insectes sur le troupeau de chameaux rassemblés autour de l'eau et en pâture. Environ 88,9% des ménages ont déclaré que la maladie se produit au début de la grande saison des pluies. Tous ont mentionné que la maladie provoque l'avortement. La présente étude a révélé que la trypanosomiase chez le chameau est très répandue dans le district de Moyale à des niveaux relativement bas. De ce fait, une étude plus approfondie avec l'utilisation de tests de diagnostic plus sensibles est nécessaire afin d'établir des mesures de contrôle efficaces.

**Mots clés :** le sang, la trypanosomiase chez le chameau, le district de Moyale, la prévalence, le prélèvement et l'enquête.

## Introduction

The dromedary camel (*Camelus dromedarius*) is well adapted to hot and arid environments prominent to its unique anatomical, physiological and behavioral characteristics. Dromedaries offer the only means of utilizing large areas of arid lands in many countries around the globe (Bornstein and Younan, 2013). The camels are of great importance socially and culturally as well as economically and thus cornerstone in the social organization of many of the camel-keeping societies (Wako *et al.*, 2012). As the world expects increased global warming, the camel would perhaps be the most favored animal to develop (Ahmed *et al.*, 2010).

World Camel population is estimated to be around 25.89 million spread across 47 countries. About 85% of the camel population inhabits mainly Eastern and Northern Africa and rest in Indian subcontinent and Middle East countries. Somalia has the highest population of 7 million followed by Sudan 4.25 million and Ethiopia 2.4 million camels (FAO STAT, 2011). In the Ethiopia camels are kept in arid and semi-arid lowlands of Borana, Somali and Afar region (Teshome *et al.*, 2003).

According to Hukka (1998) the Borana pastoralist probably started camel production in early 1560 in the gedda period of Abbay Orro. It has been also speculated the Muslim Gebra communities were said to be instrumental in introducing camels to the Borana plateau (Coppok, 1994). Camel husbandry is the main source of living for millions of pastoralists in the semi-arid zones of Ethiopia, including the Borana lowland. Undoubtedly, camels represent a vital contribution to food security and human

welfare in vulnerable households of the dry areas. They are important for milk and meat productions, transportation, draft power, and household income generations. They possess several attributes as; minimum contribution to environmental degradation, utilization of scarce natural resources (feed and water), minimum competition with other ruminants and good adaptation to harsh environment (Megarssa, 2010).

However, infectious and parasitic diseases appear to be the major constraints for the realization of the full potential of these animals. *Trypanosomosis*, camel pox, pneumonia, contagious skin necrosis, mange mite infections and internal parasite are among the major health problems previously reported in camel Borana areas (Getahun, 1998).

There are many parasites that affect the productivity of camel of which the *Trypanosoma evansi*, the protozoan parasitic cause of camel *trypanosomosis* (Surra), constitutes one of the major veterinary problems worldwide (Omer *et al.*, 2004). *T. evansi* is transmitted mechanically, non-cyclically, by haematophagous flies such as horseflies (*Tabanus*) and stable flies (*Stomoxys*) which are endemic in Africa, Asia and South America; although in America the vampire bat also acts as a vector as well as reservoir hosts (Urquhart *et al.*, 1996).

The disease is an important single cause of economic losses, causing morbidity of up to 30.0% and mortality of around 3.0% camels in Ethiopia (Njiru *et al.*, 2001; Tekle and Abebe, 2001). The cost of treatment is also another economic loss to the camel breeders in particular and to the nation's economy in general (Tekle and Abebe, 2001). In Ethiopia, the occurrence of Surra reported

as it has been associated with camel rearing areas (Tekle and Abebe, 2001; Getachew, 2005; Bogale *et al.*, 2012). However, there is no documented information about the prevalence of camel *trypanosomosis* in the study area. And therefore, the objectives of the present study were to determine the prevalence of camel *trypanosomosis* and to identify the associated risk factors with disease occurrence in the study area.

## Materials and Methods

### Description of the Study Area

The district of Moyale is geographically located 3° 34' 9N and 39° 4' 60E at a distance of 777km south of Addis Ababa. The area is bordered on the south by Kenya, on the west by Dire, on the northwest by Arero, on the north by the Dawa River which separates it from Liben, and on the east by the Somali region. The agro-ecology is lowland or kola with topography consisting predominantly of plains. The vegetation coverage consists of thorny bush scrub, acacia species and bush

encroachment. The altitude ranges from 1150 to 1350 m.a.s.l. Moyale district comprised of 9 pastoral and 8 agro-pastoral associations (kebeles). Approximately, there are about more than 700,896 human populations (CSA, 2008) living in it with an estimated area of 15,575.47 square kilometers. Livestock population of the district were Cattle (55134), Goats (64995), Sheep (14725), Poultry (27252), Camels (16998), Donkey (4912), Mule (27) and Horse (10) (MPCDO, 2014). Numerically camels are the most abundant domestic animals in these areas next to cattle and small ruminant and thus they have crucial contribution in social and economic aspect of agro-pastorals and pastoral livelihood of this area (MCPDO, 2014). The climate of Moyale is generally tropical climate, with little rainfall throughout the year with the annual rain fall is estimated at 500 – 600mm. The temperature is very hot with an average of 37°C and reaching as high as 41°C. The driest month is August with 13 mm and with an average of 189 mm most precipitation falls in April. July has the lowest average temperature of the year with only 19.9 °C.

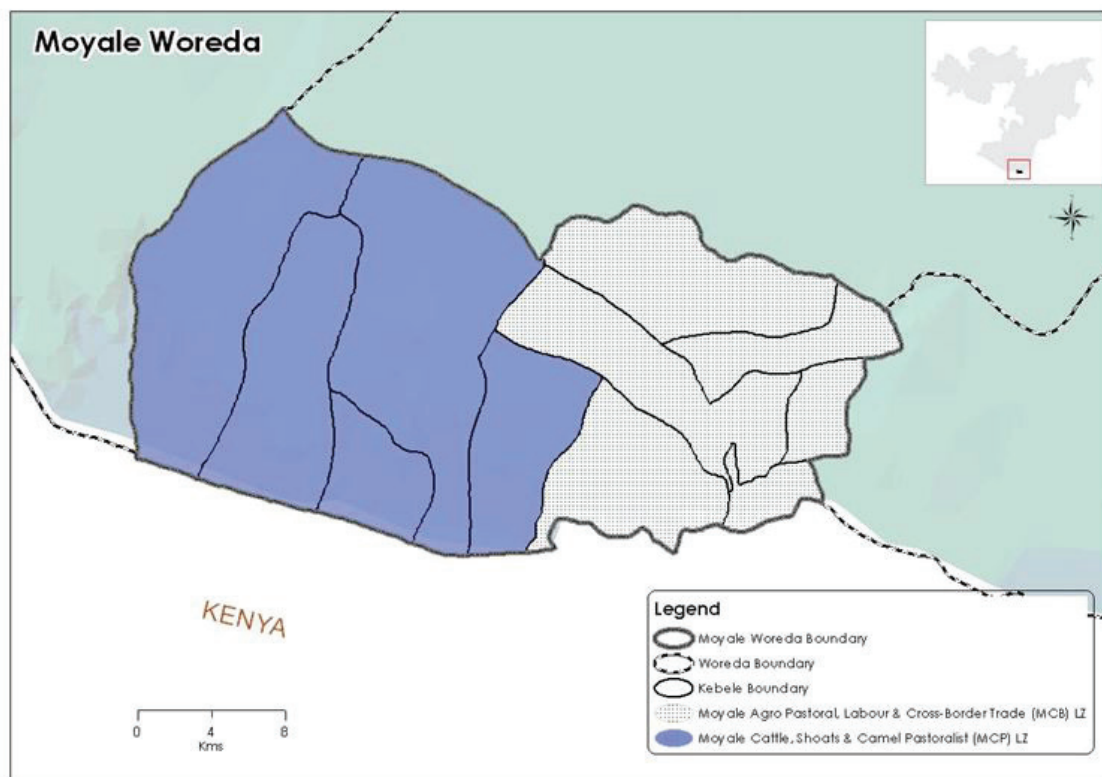


Figure 1: Maps showing study area

The area is characterized by arid and semi-arid lowlands with some mid-altitude areas. The semi-arid lowlands are predominantly occupied by pastoral and agro-pastoral population whose livelihood is mainly dependent on range livestock production. The area receives bimodal rainfall distribution. The main rainy season (Ganna) extends from March to May whereas the short rainy season (Hagaya) lasts from October to November followed by the long dry season (Bonaa). However, the actual length of the rainy season is getting shorter and shorter through time and the area is prone to more frequent drought.

#### *Study Population*

The study population consisted of camels of all age groups and both sex residing in Moyale district that are reared under extensive husbandry system. All study animals were randomly selected from the population at livestock camps ("Fora"), at grazing and watering points. The age of the animals was recorded based on information from the owners during sampling. Camels below 3 years of age were considered as calves, those between 3-4 years as young animals, while those above 4 years of age were considered as adults according to the owners of camels.

#### *Study Design*

A cross-sectional study design was carried out to determine the prevalence of camel *trypanosomosis* and assess associated risk factors in the study area. CAHWS were used as channel to reach camel owners and camel population in the villages. Herds were visited and sampled early in the morning before released to the field, and the samples were processed there immediately to make smear. Simple random sampling was used to select each sampled camel. Pre-tested semi-structured questionnaires were used to assess the knowledge, attitudes and practices of camel owners with regards to camel *trypanosomosis* by considering average population and giving equal chance of both agro-pastoral and pastoral communities in districts. A total of 10 villages were selected from 5 pastoral and agro-pastoral associations (communities), mainly Dambi, Bokola, Maddo, Laga-sure and Malab

were included in the study. The villages were selected randomly, but with some restrictions on the selection imposed based on accessibility to villages by vehicle or proximity to road and camel population.

#### *Sample Size Determination*

The number of animals to sample was calculated considering a minimum expected prevalence of 50%, an accepted error of 5% and a confidence level of 95%, since there was no previous survey conducted in the study area. Therefore, the sample size for this study was determined using the following formula by Thrusfield (2005):

$N = 1.962 P_{exp} (1 - P_{exp}) / d^2$  which is equal to 384 where,

N=Sample size,

$P_{exp}$  = expected prevalence.

Hence, a total of 384 one humped camels of different ages and both sexes were randomly selected from herds in this study.

#### *Blood sample collection.*

After animals were restrained by owners whole blood samples (5ml) were collected from jugular vein of 384 camels into heparinized vacutainer tube 5 ml Ethylene Diamine Tetra-acetic Acid (EDTA) coated vacutainer tubes, after proper disinfection of the site with 70% alcohol and then samples were labeled on species, identification number, sex, age and village and immediately kept in cooler box and transported immediately to the Yabello Regional Veterinary parasitology laboratory for examination. Parasitological examination of blood samples was conducted using Giemsa stained thin blood smears and examined (Uilenberg, 1998).

#### *Questionnaire survey*

Questionnaire data were collected from camel herders at the wells and dwelling areas of pastoral and agro-pastoral associations and temporary livestock camps ("Fora"). Semi-structured questionnaire was used for 45

camel owners and asked to obtain information on the herd size, year of possession (how long herder experienced with the camel), seasonal occurrence of the disease in the herds and associated risk factors, types of livestock grazed together with camels as well as camel management and husbandry practices, herd movement, feeding and water source, camel diseases of importance, *trypanosomosis* situation and *trypanosomosis* control measures.

#### Data collection and analysis

The data collected during sampling and laboratory results were entered in Microsoft Excel spread sheet. Descriptive statistic was used to estimate the prevalence for camel *trypanosomosis* in the study area. Risk factors such as age, sex and study areas were considered and their difference with infection was analysed by chi-square. In all the analyses, confidence level will be held at 95% and  $P < 0.05$

was set for significance. The statistical software SPSS version 20 was used for data analysis.

## Results

### Results of Laboratory Analysis

Of the total 384 blood samples collected and examined 39 (10.2%) samples were positive for *T. evansi*. Of the total camels examined 10 (15.6%) males and 29 (9.1%) females were positive for camel *trypanosomosis* and with statistically non-significant variation ( $P > 0.05$ ) (Table 1).

There was significant difference in prevalence of parasites with age ( $P < 0.05$ ) of the camels observed. Highest trypanosome infection was recorded in age group of  $> 4$  years (15.5%), followed by 5.6% and 2.6% in 3 to 4 years and  $< 3$  years old camels, respectively (Table 2).

**Table 1:** Prevalence of *T. evansi* based on sex

Sex	No. of examined	No. of positive	Prevalence	X <sup>2</sup>	P-value
Male	64	10	15.6%	2.517	0.113
Female	320	29	9.1%		
Total	384	39	10.2%		

**Table 2:** Age-wise prevalence of *T. evansi* infections in camels

Age	No. of examined	No. of positive	Prevalence	X <sup>2</sup>	P-value
$< 3$ years	76	2	2.6%	13.480	0.001
3-4 years	108	6	5.6%		
$> 4$ years	200	31	15.5%		
Total	384	39	10.2%		

**Table 3:** Prevalence of *T. evansi* among PAs (kebeles) in the study area

Kebeles (PAs)	No. of animals examined	No. of positive	Prevalence%	X <sup>2</sup>	P value
Bokola	105	15	14.3%		
Dambi	83	9	10.8%		
Maddo	73	6	8.2%	3.397	0.494
Laga-sure	70	5	7.1%		
Malab	53	4	7.5%		
Total	384	39	10.2%		

There was statistically non-significant variation ( $P>0.05$ ) in *trypanosomosis* prevalence among the five PAs of Moyale district (Table 3). In this study, *Trypanosoma evansi* infection was found in all the five examined PAs of the district. The prevalence was found to be different among camels from different PAs, the highest being 14.3% in Bokola, 10.8% in Dambi, 8.2% in Maddo, 7.5% in Malab and 7.1% in Lagasure (Table 3).

#### Questionnaire Survey Results

In this study, number of households surveyed was 45 from which 80% of them were from the pastoral communities and the rests were agro-pastoralists area. The householders age ranges from 25-70 years and the majority (75.6 %) of them were illiterate. The survey result indicated that all householders have more than 5 years of camel herding experience and about 46.7% of them have herded camel for more than 25 years, 24.4% of them herded camel for the past 15 to 20 years and 4.4% of them have herded camel for less than 5 years (Table 4). And also, average possession of the camels is 40 with range of 5-80 numbers of camels.

#### Householders awareness on camel *Trypanosomosis*

A 100% of the herders mentioned that

they knew camel *trypanosomosis* which they call “Dhukkaana” in their vernacular name. They described the disease accurately and ranked as a disease of first priority in camel. They thought that biting flies are important vectors for camel *trypanosomosis* to occur. They mentioned that camel contract the disease when moved to other place for long distance and get mixed with camels from neighboring herds (Golbo). The herder added that congregation of camel herds around water and in pasture into close proximity facilitated efficient transmission of the disease by the biting flies.

Further, on the assessment of the route of migration, it claimed that it depend on season as the camel prefers the dry ecology instead of wet ecology. So, their movement depend on season that routed to Golbo and Forole Southern ward of district during dry seasons (“Bona and Adolessa”) and Northern ward during wet seasons (“Hagayya and Ganna”). With regard to abortion all of the herders mentioned that camel *trypanosomosis* causes abortion in pregnant animal. About 74.2 % of the herders mentioned that abortion occurs in mid-gestation (130-260days) and 15.6% stated that it occurs in late gestation (261-360 days). Small number (10.2%) of herders believe occurrence of abortion in

**Table 4:** Demographic characteristics of camel owners

Parameter	Frequency	Percentage
<b>Categories of pastoral association (PA's)</b>		
pastoral	36	80%
agropastoral	9	20%
<b>Age of the herders</b>		
25-50	11	24.4%
>50	34	75.6%
<b>Householders education level</b>		
Illiterate	34	75.6%
Primary	11	24.4%
<b>Experience of herding the camels</b>		
<5	2	4.4%
5-10	4	8.9%
10-15	7	15.6%
15-20	11	24.4%
>20	21	46.7%

**Table 5:** Local and scientific name of major clinical signs mentioned by camel herders.

Local name of clinical signs	Scientific names of clinical signs and symptoms
<i>Nyaata dhowwa</i>	Inappetance
<i>Rifeensi irra dhuma</i>	Loss of hair
<i>Ni dadhabsa</i>	Weakness
<i>Ni huuqqata</i>	Emaciation
<i>Aannan diqqeessa</i>	Reduction in milk yield
<i>Ni salleessa</i>	Abortion
<i>Imimmanti ijaa yaa'a</i>	Lacrimation
<i>Morma dheeressa</i>	Stretching of neck
<i>Fincaan fooli qaba</i>	Urine odour
<i>Ni golgolaa'a</i>	Depression
<i>Ogore ajjeesa</i>	Death in calves

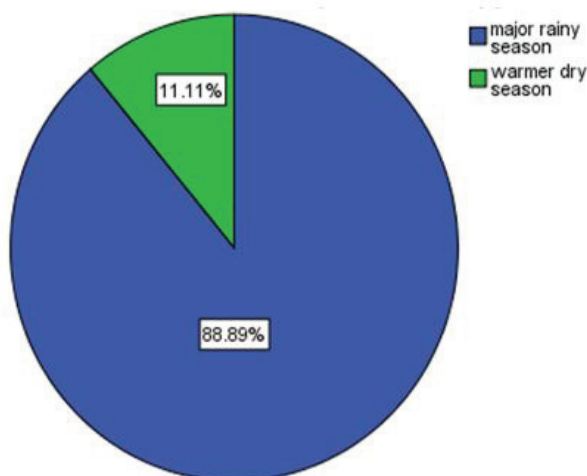
early gestation (<130 days). Moreover, all the interviewed camel herders mentioned that the disease causes dramatically reduction in milk production.

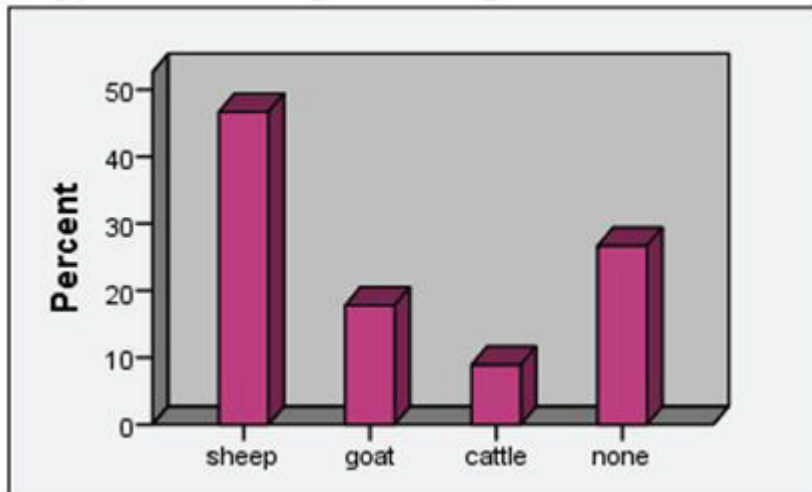
The questionnaire was designed to extract specific information on camel *trypanosomosis*, its occurrence in their herds and also the typical clinical signs of the disease. The camel herders mentioned the clinical signs of the disease (Table 5).

The majority (88.9%) herders stated that the disease occurs at onset of major rainy season ("Ganna") extending from March to May, the herder added that they relate between seasonal outbreaks of camel *trypanosomosis* and

increase in number of insect flies responsible for disease transmission during the rainy season. However, 11.1% argued as the disease happen mostly at the onset of warmer dry season ("Bona") from December to February of the year. These respondents mention the reason for the occurrence of the disease during the dry season, because camels are usually in stress suffer from low plane of nutrition and trek for long distances in search of water and pasture.

Based on evaluation those practicing the isolation of the infected camels from those uninfected camels, only 24.4% herders mentioned that they separate camel suffering from camel *trypanosomosis* from healthy camels.

**Figure 2:** Season of the year for disease occurrence in the study area.



**Figure 3:** Type of animal grazed together with camel.

The rest 75.6% responded that they don't practice isolation of diseased animal from the healthy one due to the requirement of extra penning during night.

Also, 73.3% of camel herders responded that they mix camel with other livestock species particularly with goats and sheep during herding.

A 60% of the herders respond that they keep camel calf together with adult camel in night penning and the rest 40% of the respondent isolate calf camel from adult camel at night penning. 71.1% of the herders responded that they herd camel calf together with adult camel during herding and only 28.9% of the herders isolate camel calf from adult during herding.

All herders mentioned that no veterinary intervention was taken by government and other non-governmental organizations as option to control the occurrence of the disease in their herds and their camel received poor attention from district veterinary services unlike other livestock species in the same area. Additionally, the majority (75%) of herders mentioned that veterinary health post was very far away from their villages and on average it took 3 hours to reach a nearby livestock health clinics and posts. They added that this situation forced them to look for other options and 77.8% of them said that they buy drug from market and administer drug by themselves and 22.2% of

the herders use the traditional remedy. The herders mentioned that the traditional remedy which involved the application of a concoction of herbs, mixed with soup and the branding of oedematous areas on sick animals using hot metal. They believe that this subsides the swelling.

## Discussion

The overall prevalence of 10.2% recorded in the current study interestingly, in agreement with the investigations made by Getahun (1998) and Tekle and Abebe (2001) who recorded 10.2% and 10.9% of prevalence of camel *trypanosomosis* in Liban district, Borena Zone and Southern range land of Borena, respectively. This might be due to the same agro-ecological condition of the study area. The current finding was also in consistent with that reported by Hagos et al. (2009) who obtained 12.1% prevalence of camel *Trypanosomosis* by using parasitological examination in dry and wet areas of Bale Zone. This might be associated with the season of the study period and sensitivity of the diagnostic techniques used. From abroad country of Pakistan and Saudi Arabia the current results are parallel with the investigations made by Bhutto et al. (2010), Shah et al. (2004) and Hussain et al. (1991) who reported 11.25%, 10.9% and 13.2% prevalence of camel *trypanosomosis*, respectively.



The present result was higher compared with the investigations made by Kassa et al. (2011), Tadesse et al. (2012) and Eshetu et al. (2013), who reported 4.4%, 3.5% and 6.5% prevalence in Fentale district South East Shoa Zone, Jijiga Administrative Zone of the Ethiopian Somali Region and Jijiga Administrative Zone of the Ethiopian Somali Region, respectively. This may be due to type of test used, appropriate technique used during sampling and appropriate procedure used. This result is also higher compared with report in the Punjab region of Pakistan in camels (Murtaz et al., 2006) who reported the prevalence of 3.3% and 4% from parasitological and serological examinations, respectively.

However, the present finding was lower than the previous study of Abera et al. (2014) and Bogale et al. (2012) who reported 17.9% and 18.22% prevalence at Sawena district and Delo-Mena District of Bale Zone, Oromia Region, Southwest Ethiopia, respectively. The prevalence in the current study is also lower than the findings by previous workers who reported a prevalence of 21% in eastern Ethiopia, in selected semi-nomadic household (Zelege and Bekele, 2001), 28% in Kenya (Njiru et al., 2001), 29% in Niger (Pacholek et al., 2001) and 33% in Sudan (Elamin et al., 1999). The possible explanation for the lower prevalence rate detected in this study might be related to distribution, challenge and density of parasite vector. The current study was also conducted during the dry season where the distribution of biting flies is very low in this dry season as their reproduction is high in rainy season.

In this study, a significantly ( $P < 0.05$ ) higher prevalence of camel *trypanosomosis* was noted in adult camels (15.5%), followed by young ones (5.5%) and calf less than 3 years old (2.6%). This result agrees with a previous report from Jijiga, Somali Region, Ethiopian, who reported that in adult camels above 4 years old had a significantly higher prevalence of infection as compared to the young ones below 4 years old (Eshetu et al., 2013). The current result is in line with that of Abera et al. (2014) in bale zone in which higher infection rate was recorded in camel above 4 years. Similar suggestion was also given in

the study in Saudi Arabia who reported that the younger were less susceptible to infection than adults (Mohammed and Bernard, 2013). The higher prevalence in old camels might be due to they move long distance in search of water and pasture as a result they are more exposed to biting flies and many stress impose them more susceptible to the infection. This idea is supported by Bogale et al. (2012), who reported the higher prevalence in old camels might be due to heavy stress through their use for transportation of goods from one place to another and poor management.

Our result is in close agreement with the report of Atarhouch et al. (2003) who showed that the infection rate of camel *trypanosomosis* increased with age up to maximum in the 7-10 years old age. However, this result is reverse to the observations of Lemecha et al. (2008), who reported a higher prevalence in young compared to adults by using standard parasitological detection techniques. The present study was contradicted with that of Pathak and Khanna (1995), who reported that all camels were equally susceptible to trypanosome infection regardless of breed and age. A greater proportion of the herders (60%) keep camel calf together with adult camel both in penning and during herding. This practice considered as risk for camel *trypanosomosis* spread within and between herds from adult to susceptible young animals. Separately keeping animals with different age structure is useful not only to prevent camel *trypanosomosis* transmission but also for other contagious diseases. In addition, lack of isolation of infected from non-infected camels in herding and penning puts the majority of the herds at risk of developing the disease sooner or later.

In the present study, there was no statistically significant difference observed between sex and the disease ( $P > 0.05$ ). This might be due to all camels were equally susceptible to trypanosome infection regardless of breed and sex (Pathak and Khanna, 1995). However, the highest prevalence of the disease was recorded in male (15.6%) than female (9.1%). This might be due to the fact that male camel were used for work all the time and travel from one place to another place to provide

transportation service more than female camels, so that they have a higher probability of acquiring an infection. Frequent travel could also compromise their immune response to infection due to the stress of fatigue.

The present study is in agreement with the finding of Abera et al. (2014) who recorded higher infection rate in male (20.3%) than female (17.3%). Similarly, Bogale et al. (2012) in Delo-Mena district, Bale zone also reported on sex related differences in prevalence of camel trypanosomes, that a higher infection was found in males (20.25%) as compared to females (17.72%). However, other studies in Asia have reported sex related differences in prevalence in camels (Shah et al., 2004) where females (15.68%) were observed to be more susceptible to the disease than males (11.76%) counterparts. The current study was also contradicted with report from the same continent, Pakistan who reported a higher infection was found in females (15.79%) as compared to males (9.84%). This record might be due to stress during pregnancy and lactation which could decrease resistance in female camel and render them more susceptible to infection (Bhutto et al., 2010).

In the present study, there was no statistically significant difference observed between the prevalence of camel trypanosomes infection among the sites (PAs) of district ( $P>0.05$ ). The prevalence was different among different sites of the district; the highest prevalence of the disease was observed in Bokola 15 (14.3%), followed by Dambi 9 (10.8%) and Maddo 6 (8.2%) whereas the lowest was recorded in Malab 4 (7.5%) and Laga-sure 5 (7.1%) during the study period. This might be due to the difference in management system and vector density.

The majority of Moyale district camel herders have 16-20 years of herding experience indicating that they start camel production relatively recently and they are traditionally cattle keepers and camels are a relatively new introduction. On average, a camel owner possesses 40 camels with range of 5-80 heads of camels. Recent starting of camel production may create gap in the herd and health management. In line with this,

Megarsa et al. (2008) stated that late comers into camel business, such as Borana and Guji have less experience with dromedaries and acquired less adequate traditional knowledge and difference in camel herding strategies that has already been demonstrated to influence some production parameters may also result in variations in disease occurrence.

It was evident from this study that all of the herders are aware of camel *trypanosomosis* which they call 'Dhukkaana' in their vernacular. They described the disease accurately and ranked it as a disease of first priority in camels. This shows the camel *trypanosomosis* is very important disease in the area from the past to nowadays and continues to pose a significant impact on the livelihood of pastoral communities. All of the herders deeply explain the possible further transmission factors of the disease.

All of the interviewed herders knew the role of insects (biting flies) such as stomoxo and tabanid spp as mechanical transmitters of camel *trypanosomosis* which are abundant during rainy seasons. In addition, the informants were able to link increased cases of infection to a build-up of the biting fly population. It is known that biting flies play an important role in the transmission mechanisms of camel *trypanosomosis* (Evans et al., 1995; FAO, 2000). They mentioned that camel contract the disease when travel to other place for long distance and get mixed with camels from neighboring herds of Golbo. This idea is supported by Bossche and Vale (2000), who reported that management factor and movement patterns of animals may lead to increased risk of developing infection. The herders added that congregation of camel herds around water and in pasture into close proximity facilitated efficient transmission of the disease by the biting fly. This idea is supported by Luckins (1988), who reported that local epidemics of infection occur where conditions exist for the spread of infection with *T. evansi*, such as when many animals are stabled together or close herded and particularly when the biting fly population is abundant during the wet season.

During this study, all herders were able to mention two or more of the typical clinical

signs and symptoms of camel *trypanosomosis*. The herders recognized camel *trypanosomosis* through signs of emaciation, stretching of neck, dullness and urine odour, while few of them observed other signs of camel surra in addition to these signs. Furthermore they describe the sign of fever, inappetance, weakness and depression. Similar suggestion was given by Bogale et al. (2012), who reported that camel *trypanosomosis* causes anorexia, weakness and emaciation that lead to low milk and meat yield, poor traction power, increased abortion and death. These results were an indication of an enormous wealth of knowledge herders possess on the diseases. In another study by Catley et al. (2001), loss of tail hair was also mentioned by herders as a sign of camel *trypanosomosis*. Moreover all of the herders mentioned that camel *trypanosomosis* causes abortion in pregnant animal. This is in line to the study in the Middle East and Africa which was reported that Camel *trypanosomosis* is one of the main causes of camel infectious abortion (Tibary et al., 2006). Furthermore, herders added that camel *trypanosomosis* induced abortion at any stage of gestation. In line to this Zelalem et al. (2015) reported camel *trypanosomosis* cause abortion in all stages of pregnancy in camel.

With regard to their routes of movement, they mentioned that the majority of migrations of owners and their animals are seasonally to southern ward and northern ward of the district. They move to Southern ward of district during dry seasons (“Bonna and Adolessa”) and Northern ward during wet seasons (“Haggaya and Ganna”). The reasons for that might be lack of water and grazing and biting insects in certain season and area according to the owners of camels. This movement put their animal on extra risk of contracting the disease from another district and neighboring of the Golbo, Gabra and Garri. This idea is in line with report of Macpherson (1995) who explained the transhumance by seasonal movement of livestock has profound effect on the epidemiology and spread of this disease in Africa. With regard to frequency of occurrence of disease most of the herders mentioned that the disease affects their herds

only once a year and some of them mention that the disease affect their herds twice a year.

With regard to the temporal occurrence of the disease, majority of the herders mentioned that the disease mainly occur in major rainy season (“Ganna”). The herder added that they relate between seasonal outbreaks of infection and increase in number of insect flies responsible for disease transmission during the rainy season. This finding is in line to Surveys in various tropical areas have shown a definite correlation between seasonal outbreaks of *Trypanosoma evansi* infection and increase in number of flies responsible for disease transmission during the rainy season (Mahmoud and Gray, 1980; Njiru et al., 2002). A good number of the herders reported occurrence of disease during dry season (“Bona”) of the area. According to pastoralists, occurrence of the disease during the dry season was due to camels are usually in a low plane of nutrition and trek for long distances in search of water and pasture. This is likely to stress the animals and subsequently trigger clinical signs of trypanosomes in animals. A high prevalence of camel *trypanosomosis* occurring in the dry season has also been reported in semi-arid range lands in Kenya by Evans et al. (1995).

A greater proportion (73.3%) of camel herders responded that they mix camel with other livestock species particularly with goats and sheep during grazing. Animals that grazed together with camel may be a constant threat to camels and the presence of a large population of sheep and goats may have acted as a reservoir, since they have been shown to harbour *T. evansi* inapparently (Evans et al., 1995). This suggestion is in consistent with that reported earlier by Mahmoud and El Malik, (1977), when they stated that as long as biting flies of Tabanids and Stomoxys are abundant, one expects those goats, and sheep’s harboring *T. evansi*; would constitute foci of infection (reservoir). Moreover, Boid et al. (1981) reported that, the existence of antibodies against *T. evansi* in sheep and goats pointed to their role as reservoirs for the disease.

Almost all (95%) of herders mentioned that no veterinary intervention was taken

when their camel become infected by the disease and their camel received poor attention from district veterinary services unlike other livestock species in the same area. A greater proportion (77.8%) of them buy drug from local market and administer drug by themselves. Additionally, the majority (75%) of herders mentioned that veterinary health post was very far away from their villages and on average it took them 3 hours to reach a nearby livestock health clinics and posts. These distance obstacles camel owners not to get necessary animal health intervention for sick camels. As a means to help their camels when they get sick owners employee traditional remedy option like the application of a concoction of herbs, mixed with soup and the branding of oedematous areas on sick animals using hot metal.

### Conclusion

Camel *trypanosomosis* causes a significant impact on the camel production and economic growth of the study area by affecting health and productivity of camels so that it is a disease of major economic importance in the study area. The camel herders have no easy access to veterinary clinic and healthy post; and thus, mostly depend on traditional remedy which has some side effect on the health and welfare of animal. In this study, the occurrence of the disease was found to have seasonal trend mainly associated with rainy season with high population of biting fly during this season. The pastoralists mentioned that seasonal movement of camels in search of water and browse is one of the most important risk factors for the spread of camel *trypanosomosis*. The majority of pastoralist do not separate younger camel from adult once during herding and penning. The greater proportion of the pastoralists also did not practice the isolation of infected camel from healthy herds. The present study revealed that camel *trypanosomosis* is prevalent in Moyale district at relatively low levels during the dry season of the year, using parasitological techniques. There is a need of further study involving different seasons of the year along with the use of more sensitive diagnostic tests

in order to establish effective control measures.

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