Prevalence of Bovine Trypanosomiasis in and around Bahirdar, North west Ethiopia.

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Abstract: A cross sectional study was conducted from November 2013 to April 2014 with the aim of determining the prevalence of bovine trypanosomiasis and assessing possible host-related risk factors in and around Bahirdar town, the capital of Amhara Regional State, North western Ethiopia. Blood samples collected from 394 randomly selected cattle of different breed, age and sexes were screened for trypanosomiasis using thin smear method. The overall prevalence of Trypanosomiasis was found to be 3.3% and *Trypanosoma vivax*, which is a mechanically transmissible parasite, was the only species identified. The dominant prevalence was observed in Sebatamit (5.2%) followed by Addisalem (4.7%), Bahir Dar (4.2%), Besawit (3.8%) and Zenzelima (1.8%). However; there are no positive cases detected in Robbit and Yibab Kebeles. Even though statistical significant association was not found between local and cross breed animals; high prevalence of infection was observed in local breeds (4.1%) than cross breeds (1.6%). Prevalence was slightly higher in females (3.7%) than males (2.8%). Both age groups were infected with trypanosomes butthe prevalence rate was higher in adult (3.8%) than young (1.9%). Cattle in poor body condition were highly infected (7.1%) than medium body conditioned animals (1.2%) with $P<0.05$ indicating a statistically significant association. The infection rate varies in months with high rate of infection recorded in November (4.9%) and December (2.3%) and no infection was found in dry months of the year. Although the presents study revealed a low prevalence in the study area, vigorous disease mitigation strategies are warranted owing to the economic implication of the disease.
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1. Introduction

Ethiopia is one of the most populous with largest livestock population in Africa having estimated livestock population of 53.99 million cattle, 25.5 million sheep, 24.06 million goats, 1.91 million horse, 6.75 million donkey, 0.35 million mule, 0.92 million camel and 50.8 million poultry [1]. The agricultural sector plays a vital role in the national economy, livelihood and socio cultural systems. The agricultural sector supports 80% of the population, accounting for about 45% of the national gross domestic product (GDP). The livestock sub sector contributes 16% of the total GDP and over30% of agricultural GDP [2]. However the contribution from this huge livestock resource to national income is disproportionately small due to several factors. Disease of various etiological origins is among numerous factors responsible for poor production and productivity [3, 4]. Among various diseases African animal trypanosomiasis is one of the major constraints to animal production in areas of Africa; which have the greatest potential impact on domestic livestock productivity [5, 6].

Trypanosomiasis is one of the world's most important diseases of livestock and man. It is a parasitic disease caused by species of flagellated protozoa belonging to the genus trypanosome, which inhabit the blood plasma, various body tissues and fluids of vertebrate hosts [7,8]. Animal trypanosomiasis, or 'nagana', is an infectious disease of livestock caused by *Trypanosoma vivax*, *Trypanosoma congolense* and *Trypansoma brucei*, which are the three most important species of trypanosomes responsible for considerable production loss and livestock morbidity where they occur [8]. All three species are transmitted by tsetse flies in the genus Glossina, in which they have obligate life cycle stages and mechanically by the bite of flies [9].

For determination of trypanosome infection status in rural African settings, microscopy-based techniques using direct observation of wet blood films, microscopic examination of Giemsa stained blood

smears, or concentration techniques such as the Buffy Coat Technique (BCT) and the Haematocrit Centrifugation Technique (HCT) are the most common methods of parasite detection, and have been long considered the best diagnostic methods available [10, 11].

Bovine trypanosomiasis is main impediments to livestock development and agricultural production in Ethiopia contributing negatively to the overall development in general and to food self- reliance efforts of the nation in particular [6,12]. The economic losses due to animal trypanosomiasis are production loss, mortality of animal treatment and prevention cost. Vector control, use of trypanotolerant breeds and therapeutic measure helps to prevent and control the trypanosomiasis infection [12, 13]. Many studies have been conducted to know the prevalence of tsetse and mechanically transmitted animal trypanosomiasis in Ethiopia, however, there is no sufficient study carried out on the prevalence of trypanosomiasis in and around Bahir Dar. Therefore the objectives of the study are:

- To estimate the prevalence of trypanosomiasis in and around Bahirdar town.
- To investigate the risk factors that are related with trypanosomiasis infection.

2. Material and Methods

Study Area

A cross sectional study was conducted from November 2013to April 2014 in and around Bahir Dar town which is the capital city of Amhara regional state, north western of Ethiopia. Bahir Dar is found 565km away from Addis Ababa, between $11^0$29'Nlatitude and37^o29'E longitude. The average annual rain fall ranges from 1200-1600mmand the minimum and maximum temperature of 8^0c-30^0c; about 70% of the land is featured by plain plateaus and covered by various bush formation, low woods mainly ever green lands; Some semi-humid highland vegetation with major agricultural products like teff, wheat maize and pulse crops. The altitude of the area ranges b/n1500_2300m above sea level. The type of farming is mixed and the livestock population in and around Bahirdar is estimated 158,564 cattle, 18,827 sheepand goat, 8000 equine and 366,66 poultry [14]. The landscape is marked by the presence of Lake Tana, which drains water shed of Abay River have poor drainage and annual over flooding during the dry months [14]. Nearly 21% of the land in Bahirdar Zuria Woreda is arable/cultivable and about 36% is covered with water. The Woreda has sufficient rainfall and belongs to Woinadega. About 15% of the Woreda's land coverage is natural pasture and grazing natural pasture supplies the major part of feed [14].

Study Design and Sample Size Determination

A cross-sectional study design was used to determine the prevalence of trypanosomiasis of cattle in and around Bahir Dar town. Simple random sampling method is used to select each study animal. Age, sex, breed, body condition, origin of the animal and season of sample collection were considered in relation to prevalence of parasite. The sample size was determined using 50% expected prevalence and 5% desired absolute precision at confidence interval 95% using the formula given by [15].

Where n=the required sample size

$$n = \frac{1.96^2 \times P\,exp\,(1\text{-}P\,exp)}{d^2}$$

Pexp= expected prevalence

d=desired absolute precision

Study Population

The study animals are local and cross breed cattle that are found in and around Bahirdar town. Even though the required sample size is 384; to increase precision a total of 394 cattles were examined for the presence of trypanosoma parasites. Cattle of all age groups and both sex were randomly selected. The age of cattle determined as [4]; young (1-3) and adult (>3).

Study Methodology and Sampling Technique

Parasitological Study

Blood samples collected directly from the ear vein and small drop of blood was put on the slide and covered with cover slip and examined under microscope to appreciate parasite motility or take blood from the ear vein by tip of clean grease free slide and put on another clean slide to make thin and thick smear. Giemsa staining technique is used to stain thin and thick blood smear for examination of parasite morphology and to concentrate hemoparasites, respectively [16].

Associated Risk Factors

The influence of risk factors associated with the animal's age, sex, body condition, breed and origin was recorded during examination of the animal.

Data Entry and Analysis

Data collected from each study animal and laboratory results were coded into appropriate variables and entered into Microsoft excel spread sheet (MESS). All statistical analysis were performed using statistical package for social science (SPSS, Version20) software. The prevalence was calculated for all data as the number of individuals infected divided by the number of individuals sampled multiplied by 100. The variation in trypanosomiasis prevalence between different variables (origin, breed, sex, body condition of the animal and season) is

calculated using Chi-square (χ^2). In all analysis the confidence interval was held at 95%.

3. Result

Prevalence of trypanosomiasis

Out of the total 394 cattle examined for the presence of trypnosomiasis in and around Bahir Dar, 13(3.3%) of animals found positive for *Trypanosoma vivax* infection. A statistical significant difference (P<0.05) was observed with in different body condition of animals. The prevalence of trypanosomiasis in selected kebeles of Bahirdar Zuria Woreda and Bahir Dar town were found statistically non significant (p >0.05), however, high infection was found in Sebatamit, Addisalem and Bahir Dar as compared to other kebeles of Bahirdar zuria worda (Table 2).

Table 1. Prevalence of trypanosoma infection in the selected kebeles of Bahirdar zuria woreda and Bahir Dar

Origin	No. positive	No. Negative	Examined (total)	Prevalence
Bahir Dar	4	91	95	4.2%
Sebatamit	4	73	77	5.2%
Besawit	2	50	52	3.8%
Addisalem	2	41	43	4.7%
Robbit	0	42	42	0%
Zenzelima	1	54	54	1.8%
Yibab	0	30	30	0%

χ^2=4.244, P=0.644

The prevalence of *Trypanosoma vivax* with Associated Risk Factors

Trypanosoma vivax infection was observed between different body condition, sex category, season and breed of animals.

Out of 394 animals examined, the number of local and cross breed cattle infected with *Trypanosoma vivax* was 11(2.8%) and 2(0.5%), respectively (table 3). The prevalence of infection is relatively high in local breed cattle but the difference was not statistically significant (p>0.05). Prevalence of *T. vivax* infection with in sex was recorded as 3.7 % and 2.8% in female and male, animals respectively but it was not statistically significant (p>0.05). From a total of 394 animals examined for the presence of trypanosoma infection; high prevalence of infection found in adults 11 (3.8%) than young 2 (1.9%) (table 3). But the difference is not statistically significant (P=0.332).

Prevalence of Trypanosomiasis also computed for animals with different body condition is indicated in (table 3). The infection rate in animals with poor body condition was higher (7.1%) than in animals with medium body condition (1.2%). good body conditioned cattle were parasitaemic for bovine Trypanosomiasis. The relation between infection and body condition is statistically significant (P<0.05).

Table 2. Prevalence of trypanosomiasis based on host related factor

Host related factors	No. examined	No. positive	Prevalence	χ^2(P- value)
Breed				
Local	270	11	4.1%	1.613(0.204)
Cross	124	2	1.6%	
Sex				
Male	78	5	2.8%	0.245(0.621)
Female	216	8	3.7%	
Age				
Young	107	2	1.9%	0.942(0.332)
Adult	287	11	3.8%	
Body condition				
Poor	154	11	7.1%	
Medium	173	2	1.2%	11.907(0.003)
God	67	0	0%	

Even though there is no significant association in prevalence of *Trypanosoma vivax* infection among different months of the year, high infection rate recorded 10 (4.9%), in month of November and 3 (2.3%) in December. There was no positive result found in January, February and March (Table 4).

Table 3. The prevalence of trypanosomiais infection in different months of the year

Season	Positive	Negative	Total No. examined	Prevalence
November	10	195	205	4.9%
December	3	128	131	2.3%
January	0	27	27	0%
February	0	19	19	0%
March	0	12	12	0%

χ^2=3.998; P=0.406

4. Discussion

The present study indicated that trypanosomiasis is a concern and represents an obstacle to cattle production in and around Bahir Dar. The study revealed that the prevalence of bovine trypanosomiasis in the area due to *T. vivax* was 3.3% (13/394) which was slightly lower than the previous work reported on epidemiological investigation of mechanically transmitted trypanosomiasis (*Trypanosoma vivax*) of domestic animals in three districts bordering Lake Tana by [17] who reported 4.5% prevalence. Another studies on non-tsetse transmitted bovine trypanosomiasis in Amhara region by [18] and in tsetse controlled areas of Eastern Wollega by [19] indicate prevalence of 6.6% and 7.5%, respectively. Furthermore, the finding is lower than previous reports on bovine trypanosomiasis in tsetse fly infested areas of Amhara [20, 21, 22, 23] Ormia and SNNP [24, 25].

The result found is relatively higher as compared to reports in Addisamba and Amarit District of West Gojjam Zone, Amhara Region [25] and in Mecha Woreda of west Amhara region bordering the Blue Nile River [26] who indicated prevalence of1% and 2%, respectively. The difference may be due to high intervention programs regarding tsetse control and the decrease of fly density population in these sites [27] and low vector control programs conducted in and around Bahir Dar.

T. vivax, which is transmitted mechanically by biting flies, was the only species found in the study site. Flies specifically claimed as a vector includes the horse flies (*Awirazimb, Ewirzimb*), *Stomoxysis* (*Woyinazimb*) and *Hippobosca* (*Litifzimb, Lefatazimb, Charazimb*) that are said to be abundant in the months of September and October. These flies are also reported to be abundant at the end of August and November [28]. [29] and [30] have reported that as the distance from recognized edge of tsetse belt areas increase, the species of trypanosome most commonly encountered and diagnosed is *T. vivax,* because *T. vivax* has the ability to adapt and establish itself in the absence of tsetse flies. The idea can be more strengthened by the result obtained from the Regional laboratory data where Glosina species were not identified in the study area on a survey conducted from 2009 -2011 [26].

Out of a total of 13 positive cases in different breed of animals, maximum disease prevalence was observed among local breeds than that of the cross breeds 11(4.6%) and 2(1.6%) cases, respectively. The result is not in agreement with [31] in Nepal. They suggest that the degree of resistance to disease exhibited by local animals resulted in decreased clinical trypanosomiasis but they may remain carriers and thus a constant source of re infection to the susceptible exotic animals in enzootic area. The difference may be due to the common practice that peoples in and around Bahir Dar keep cross breed cattle at home and manage local breed cattle in free range management system; thus there is low exposure of crossbreed cattle to fly bite during grazing and watering as compared to local breed cattle.

In the present study, the rate of infection was compared among sex. Higher rate of infection observed in females (3.7%) compared to males (2.8%). However, there was no significant difference in the prevalence *of Trypanosomiasis* in female animals compared to male animals (P=0.245). This might be due to the fact that both sexes have virtually similar exposure to biting flies in grazing areas and watering points. This result is in agreement with what was reported previously in the country [32, 33, 21, 34, 26].

Similarly when the prevalence of trypanosomiasis was computed for the two age categories in this study, the infection rate between

young and adult cattle was different but statistically insignificant (P=0.332). High prevalence of infection observed in adult (3.8%) than young cattle (1.9%). This finding was in line with previous reports [23, 28, 22] who indicated the prevalence of infection in young and adult as 2.0% and 8.6%, 0.9% and 2.5% and 1.2% and 6.9% respectively. Furthermore [26] and [35] justified that suckling calves were not allowed to go out with their dams until they are weaned off. Young animals are also naturally protected to some extent by maternal antibodies [36]. This could result in low prevalence of trypanosome in the young.

The infection rate in animals with poor body condition was significantly higher than in animals with moderate body condition and good body conditioned cattle. Good body conditioned cattle were not even positive for *T. vivax*. This result agreed with the findings of other authors (34,28,22,26,35]. The absence of trypanosome infection in good body condition animals might be due to the fact that well-nourished animals have good level of immunity and are in a better position to resist infection. Moreover, there is a very rare possibility of re-establishment of infection in animals with good body condition [34].

Seasonal difference in prevalence of trypanosomiasis indicated high rate of infection in early dry season (October and November) than in late dry season (December to March). The result was found to be similar to previous report by [19] in Amhara region. A longitudinal survey of African animal trypanosomiasis with *T.vivax* infection in domestic cattle in Nigeria by [37] showed a prevalence of 22.1% and 29.9% in early wet season and let wet season, respectively. Epidemiological investigation of mechanically transmitted trypanosomiasis by [18] also indicated high rate of infection observed in early dry season as well as early wet season when the fly population increases and the host defense mechanism is compromised due to starvation.

5. Conclusion and Recommendations

Although the present study indicated the prevalence rate of trypanosomiasis as fairly low (3.3%), the disease is important which can limit livestock rearing and agricultural activity in and around Bahir dar town; Western Amhara Region. *Trypanosoma vivax* is the only trypanosoma species that is found in and around Bahir Dar. The sole presence of T. vivax indicates that the importance of mechanically transmitted trypanosomiasis in the study site. Low result finding is due to the season of the year that the study has been conducted. Awareness of the people about the disease is low in the area.

Based on the above conclusion the following recommendations are forwarded:

- Epidemiological studies should be conducted in order to determine the impact on productivity as well as its economic impact at large.
- A progressive and integrated control campaign in the in and around Bahirdar quite necessary to minimize the effect of trypanosomiasis and to make sustainable livestock development.
- Effective vector control measures should be applied in order to reduce the density of biting flies.
- Awareness should be given to animal owners about the effect of disease on animal health, way of transmission and method of prevention.

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References

1. Central statistical Agency (CSA). Federal Democratic Republic of Ethiopia. Central statistical agency. Agricultural sample survey2012/13 [2005 E.c.] Report on Livestock and livestock characteristics (private peasant holdings) statistical bulletin 2013; 2: 1-178.
2. Asfaw W. Country report: Ethiopian proceeding of seminar on livestock Development policies in eastern and southern Africa,28july1August,1997, Mbabany, organized by CTA, OAU/IBR and the ministry of agriculture and cooperatives.
3. Cherenet T, Sani RA, Speybroeck N, Panandam JM, Nadzr S, Vanden Bossche P. A comparative longitudinal study of bovine trypanosomiasis in tsetse-free and tsetse-infested zones of the Amhara Region, northwest Ethiopia. Veterinary Parasitology 2006; 140: 251–258.
4. Bitew M, Amedie Y, Abebe S, Tolosa T. Prevalence of bovine trypanosomiasis in selected areas of Jabi Tehenan district, West Gojam of Amhara regional state, North western, Ethiopia. African Journal of Agricultural Research 2011; 6(1): 140-144.
5. D'Ietern GDM, Authie E, Wissocq, N, Murray M. Trypanotolerance, an option for sustainable livestock production in areas at risk from trypanosomiasis. Revue Scientific et. Technique 1998; 17(1): 77-92.
6. Abebe G. Trypanosomiasis in Ethiopia. Ethiopian Journal of biomedical Science 2005; 4(1): 75-121.
7. Radostits OM, Gray CC, Hinchciff WK, Constable DP. A text book of disease of cattle,

sheep, goat, pigs and horses. 10th ed. New York, USA, 2007; 1209-1226.
8. Durden M.2002. Medical veterinary Entomology. Academic press USA,2002; 304-315.
9. Cecchi G, Mattioli RC, Slingenbergh J, Delarocque S. Land cover and tsetse fly distributions in sub-Saharan Africa. Medicaland Veterinary Entomology, doi:10.1111/j.1365-2915.2008.00747.
10. Andrew PC, Tosas O, Tilley A, Picozzi K, Coleman P, Hide G, Susan CW. Constraints to estimating the prevalence of trypanosome infections in east African zebu cattle. Journal of parasites & vectors, 2008; 3:82.
11. Moti Y, Fikru R, Büscher P, Van Den Abbeele J, Duchateau L. Detection of African animal trypanosomes: The haematocrit centrifugation technique compared to PCR with samples stored on filter paper or in DNA protecting buffer. Journal of veterinary parasitology 2014; 3(1-2): 1-25.
12. Bowman D, Lynn RC, Eberhard ML, Alcoraz A. 2003. Parasitology for Veterinarian. 8th ed. USA, 2003; 83-84.
13. Charleslefevre P, Blancou J, Chermette R, Uilenberg G. 2010. Infectious disease of livestock. 1st ed. Paris: Lavoizer publisher,2010;. 1867-1967.
14. Moudlin I, Holmes PH, Miles MA. Thetrypanosomiasis. Wallingford, CAB International Publishing, UK, 2004;1-634.
15. Thrusfeild M. Veterinary Epidemiology.3rded. Blackwell publishing, UK, 2005; 433.
16. Chaudhri SS, Gupta SL. Manual of veterinary parasitology.: IBDC publisher, India, 2003; 19-78.
17. Alekaw ST. Epidemiologicalinvestigationofmechanicallytransmittedtrypanosomiasis (trypanosoma vivax) of domestic animals in three districts bordering Lake Tana, Ethiopia. A thesis submitted to the Faculty of Veterinary Medicine, Addis Ababa University in partial fulfillment of the requirements of the Degree of Master of Science in Tropical Veterinary Epidemiology. 2004.
18. Cherenet T, Sani RA, Panandam JM, Nadzr S, Speybroeck N, Van den bossche P. Seasonal prevalence of Bovine trypanosomiasis in a tsetse-infested zone and a tsetse-free zone of the Amhara region, North-west Ethiopia. Journal of veterinary research 2004; 71(4):307-312.
19. Yibrah T, Semeamlak M. Prevalence of bovine trypanosomiasis in tsetse controlled and uncontrolled areas of eastern Wollega, Ethiopia. journal of scientific & innovative research 2013;2(1): 62-75.
20. Shimelis D, Habtamu G, Getachew A. A cross-sectional study on bovine trypanosomiasis in Jawi district of Amhara Region, Northwest Ethiopia. Ethiopian veterinary journal,2011; 15 (1): 69-78.
21. Denbarga Y, Ando O, Abebe R. Trypanosoma species causing bovine trypanosomiasis in south Achefer district, Northern Ethiopia. Journal of veterinary advance 2012; 2(2): 108-113.
22. Yehunie B, Wudu T, Nuria Y, Sefinew A. Prevalence of bovine trypanosomiasis in Wemberma district of West Gojjam zone, North West Ethiopia. Ethiopian veterinary journal 2012; 16 (2):41-48.
23. Bizuayehu A, Basaznew B, Tewodros F, Mersha C. Bovine trypanosomiasis: a threat to cattle production in chena district, southwest Ethiopia. open journal of animal sciences 2012; 2(4): 287-291.
24. Wondewosen T, Dechasa T, Anteneh W. Study of bovine trypanosomiasis Prevalence and tsetse density in selected villages of Arbaminch, Ethiopia. Journal of Veterinary Medicine and Animal Health 2012;4(3): 36-41.
25. Abrahm Z Tesfahewet Z. Prevalence of bovine trypanosomiasis in selected district of Arbaminch, SNNPR, Southern Ethiopia. Journal of global veterinarian 2012; 8(2):168-173.
26. Addisalem HB, Tafere CM, Beshatu FW Asamnew TM. Prevalence of Bovine Trypanosomiasis in Addisamba and Amarit District of West Gojjam Zone, Amhara Regional State. American-Eurasian. Journal of Scientific Research 2012; 7 (3):112-117.
27. Ayana M, Tesfahewet Z, Getnet F. A cross-sectional study on the prevalence of bovine trypanosomiasis in Amhara region, northwest Ethiopia. Livestock research for rural development 2012; 24: 8.
28. Sinshaw A, Abebe G, Desquesnes M, Yoni W. Biting flies and Trypanosoma vivax infection in three highland districts bordering Lake Tana, Ethiopia. Journal of vet parasitology 2016; 142(1-2): 35-46.
29. Jordan AM. Trypanosomiasis control and. African rural development. Longman, London, 1986; 357.
30. ILRAD. The International Laboratory for Research on Animal Disease report Nairobi, Kenya, 1990; 27-36.
31. Mahrjan M, Mishra DR. Trypanosomiasis in domestic animals of Makwanpur district, Nepal. Annals of the New York Academy of Sciences, 2006; 1081, 320–321.

32. Adane M, Gezahegn M. Bovine Trypanosomiasis in three districts of East Gojjam Zone bordering the Blue Nile River in Ethiopia. Journal of Infection in Developing Countries 2007; 1(3): 321-325.
33. Abebayehu T, Esthete H, Berhanu M, Rahmeto A, Solomon M. Mechanically Transmitted Bovine Trypanosomiasis in Tselemty Woreda, Western Tigray, and Northern Ethiopia. Journal of Agriculture 2011; 6(1): 10-13.
34. Bekele D, Moti Y, Hailu D, Mezene W. Cross sectional study of bovine trypanosomiasis and major clinical signs observed in Diga District, Western Ethiopia. African Journal of Agricultural Research 2013; 8(6): 500-506.
35. Peacock L, Cook S, Vanessa F, Bailey M, Gibso W. 2012. The life cycle of Trypanosoma (Nannomonas) congolense in the tsetse fly. Journal of biomedical research centre, Parasites & Vectors 2012; 5:109.
36. Fimmen HO, Mehlitz D, Horchiner F, Korb E. 1992. Colostral antibodies and Trypanosoma congolense infection in calves. Trypanotolerance research application. GTZ, No. 116, Germany, 1992; 173-187.
37. Majekodunmi AO, Fajinmi A, Dongkum C, Picozzi K, Thrusfield MV, Welburn SC. A longitudinal survey of African animal trypanosomiasis in domestic cattle on the Jos Plateau, Nigeria: prevalence, distribution and risk factors. *Jo*urnal of biomedical research centre; Parasites & Vectors 2013;6:239.

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