Prevalence of Bovine Trypanosomosis in selected kebeles of Guangua, woreda, Amhara region, north west part of Ethiopia.

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Abstract: Trypanosomosis is wasting disease of tropical countries that contribute negatively to benefit human and productivity of animal. The Cross sectional study was conducted in selected Kebeles of Guangua Woreda, Amhara Region, North West Part of Ethiopia from November 2017 to April 2018 to determine the prevalence of bovine trypanosomosis on randomly selected animal using parasitological study**.** Total of 384 blood samples were collected from four kebele and examined. The result of parasitological finding indicates 1.82% of total prevalence in the study area. In the present study two species of Trypanosoma identified, from total (7) positive sample 4(1.04%) was showed *Trypanosoma vivax* and 3(0.78%) of them indicate *Trypanosoma congolense*. The present study indicate there were no statistically significant difference ($p>0.05$) observed between kebele, sex and age group of animal whereas statistically significant difference ($p<0.05$) was observed in body condition. In this study the anemia prevalence was higher in trypanosome infected cattle (71.4%) than in non-infected cattle (28.6%) and the difference was statistically significant ($p<0.05$). The present study showed that there was slightly higher prevalence than previous study which was conducted in Woreda. In general the prevalence of bovine trypanosomosis in the study area was minimum, this may be due to seasonality of fly population Therefore, further study should be conduct in this area especially in wet season to understand the prevalence of the disease and its effect on bovine.
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1. Introduction

Ethiopia is one of the countries with the largest number of livestock in Africa and livestock production plays a major role in the development of Ethiopia's agriculture. Ethiopian livestock population is estimated to be 59.49 million cattle, 30.697 million sheep, 30.200 million goats, 8 million donkey, 2.16 million horse, 1.20 million camels, 0.4 million mules and 59.495 million poultry (CSA, 2017)

Trypanosomosis is a complex and devastating disease caused by protozoa parasite found in blood and other tissue of vertebrate include livestock, wild life and human (Asmamaw *et al.*, 2016). The major veterinary species are *Trypanosoma congolense*, *Trypanosoma vivax, Trypanosoma brucei brucei,* and *Trypanosoma simiae. Trypanosoma brucei rhodesiense* and *Trypanosoma brucei gambiense* are zoonotic (Oyda and Hailu, 2018).

Trypanosomosis is a protozoan disease caused by the genus Trypanosoma affecting animals and human mainly in sub-Saharan Africa and also in Latin America (Abrham *et al.,* 2017). Trypanosomosis in domestic livestock causes a significant negative impact in food production and economic growth in many parts of the Africa, particularly in Sub-Saharan Africa (Shiferaw, *et al.,* 2015). But *T. vivax* also has effect in South and Central America and the Caribbean (Dávila and Silva, 2000). It has greatly hampered people and animals settlement in a considerable part of the Africa. Trypanosomosis that occurs in Africa cover one third of the continent is arguably the most significant disease. Therefore, it remains the major important constraint to livestock production on the continent. The wide occurrence of this disease in people and their livestock retards agricultural and economic development in Africa, and 160 million estimated cattle population are at risk from trypanosomosis (Shiferaw *et al.,* 2015).

Trypanosomosis is a disease which is transmitted cyclically by different species of tsetse flies and mechanically by other flies. The course of the disease may run from a chronic long lasting to an acute and rapidly fatal one depending on the vector-parasite-host interactions, characterized mainly by intermittent fever, progressive anaemia and loss of condition of susceptible hosts which if untreated leads to heavy mortalities (Tilahun, *et al.*, 2012).

Besides clinical diagnosis, parasitological serological and molecular methods with varying degrees of sensitivity and specificity are available for the diagnosis trypanosomo-sis (Dagnachew, 2004). Therapeutic drugs for treatment includes: diminazen aceturate quinapyramine sulphate, homidium bromide and homidium chloride. Prophylactic drugs for cattle include homidium bromide, homidium chloride and isometamidium (Achenef and Bekle, 2013).

Trypanosomiasis is controlled either by controlling the vector (Glossina) or by controlling the parasite, or a combination of both (Shiferaw *et al.*, 2015). Trypanosomosis directly affects the milk and meat productivity of animals, reduces birth rates, increases abortion as well as mortality rates; all of these reduce the herd size and herd composition. The indirect impact of the disease mostly lies on crop production through the availability and cost of animals that provide traction power (Samson *et al.,* 2016).

In Ethiopia trypanosomosis is serious constrain for livestock production and agricultural development. Due to the prevalence of tsetse fly which estimated about 22000km2 and the present of other fly that transmits trypanosomosis (Hunde *et al.*, 2012). Out of the nine region of Ethiopia, five (Amhara area, Benshangul-Gumuzs, Gambella, Oromia and Southern Nations Nationalities and Peoples‟ Regional State) are infected with more than one species of tsetse flies (Bitew *et al*., 2011).

The most important trypanosome species affecting livestock in Ethiopia are *Trypanosoma congolense, Trypanosoma vivax* and *Trypanosoma brucei* in cattle, goat, sheep, *Trypanosoma evansi* in camel and *Trypanosomosis equiperdium* in horse (Kumela *et al.*, 2015). Although the disease is one of the obstacles of livestock production and productivity in our country there was no study conducted in the selected kebeles of district about bovine trypanosomosis to show the situation of the disease. Therefore, the study was designed.

- To determine the prevalence of bovine trypanosomosis in Selected Kebeles of guangua woreda
- To identifay the species of trypanosomes in the study area
- To determine the degree of anemia between infected non infected cattle

2. Materials And Methods

2.1. Study Area

The study was conducted in selected kebeles of Guangua Woreda, Amhara regional state north western part of Ethiopia namely Mota, Menta Wuha, Goncha and Addis Alem from November to April 2017/2018. Guangua is one of the woredas in Awi Zone Amhara Region of Ethiopia. Guangua Woreda has a longitude and latitude of 10.950°N 36.500°E with an elevation of ranging from 1583 to 1710 meters above sea level and its temperature ranges from 22 to 31^0c with annual rainfall of 1300-1800mm and it is 505km away from Addis Ababa. Guangua is bordered on the south and west by the Benishangul-Gumuz Region, on the north by Dangila, on the northwest by Faggeta Lekoma and Banja Shekudad, and on the east by Ankasha Guagusa; the Dura River, a tributary of the Abay River, defines part of its western border. Chagni is the administrative center of guangua wereda (Ayenalem and Mossie, 2017).

2.2. Study Design and Study Animals

Cross sectional study design was used. A local zebu cattle (Bos indicus), which are mainly kept under an extensive husbandry system grazing the communally owned pasture land throughout the year were sampled. They grazed together during the day time and returned to their individual owner's farmstead each evening. The body condition of each of the study cattle was scored as good, medium and poor (Nicholson and Butterworth, 1986). Similarly, their age was determined based on (R.F. Johnson, 1998) principles as young (<3 years old), and adult (> 3 years old).

2.3. Sampling Techniques and Sample Size Determination

The study sites (kebeles) were selected purposively based on accessibility and history of trypanosomosis. All ^{villages} were selected from each Kebele. The farmers were informed to bring their cattle to convenient shady place of examination sites a day before start of sampling. The cattle were chosen randomly that involving sex, all age groups, and all types of body conditions. The desired sampling size was calculated according to the formula given by Thrusfield (2007). The sample size was determined based on the expected prevalence of 50%, confidence level of 95% and 5% desired absolute precision.

$N= 1.96^2[Pexp-(1-Pexp)]/d^2$, where N is the required sample size, Pexp was the expected prevalence and d is the desired absolute precision. As result a total of 384 cattle were sampled.

2.4. Sample Collection and Transportation

The cattle were chosen randomly and restrained by farmers for sampling. Blood samples were collected from ear vein by puncture using sterile lancet in to heparin-zed capillary tubes filled ¾ of its length from each of randomly selected cattle. Each tube was sealed with crystal seal on one end. Each sample was identified with code number, owner name, name of the animal, sex and age, date of collection, body condition and address on note book and the samples was arranged based on its code number and the sample were transported in ice box.

2.5. Study Methodology

2.5.1. Packed cell volume (PCV) determination

Blood samples were obtained by puncturing the marginal ear vein with lancet and collected directly into heparinised capillary tube. The tube was then sealed at one end with crystal seal. The capillary tube was placed in microhaematocrit centrifuge with sealed end outermost. Then the tube was loaded symmetrically to ensure good balance. After screwing the rotary cover and closing the centrifuge lid, the

samples were allowed to centrifuge at 12,000 rpm for 5 minutes. After centrifugation, the capillary tubes were placed in a haematocrit reader. The length of the packed red blood cells column is expressed as a percentage of the total volume of blood. Animals with PCV less than 24% were considered to be anemic (OIE, 2008).

2.5.2. Buffy coat technique

Heparinized microhaematocrit capillary tubes, containing blood samples were centrifuged for 5 minutes at 12,000 rpm. After the centrifugation, trypanosomes were usually found in or just above the buffy coat layer. The capillary tube was cut using a slide 1 mm below the buffy coat to include the upper most layers of the red blood cells. The content of the capillary tube was expressed onto a glass slide, and covered with cover slip. The slide was examined under x40 objective and x10 eye piece for movement of parasite (Murray, 1988).

2.6. Data Analysis

During the study period, data was collected using the sample collection format and entered into Microsoft Excel. Hematological and parasitological data were managed very carefully. Then, the data from the Microsoft excel sheet were processed and analyzed by using SPSS version 20 statistical software program. Chi square was used to compare the prevalence of trypanosomosis in different variables and to determine the relationship between variables and the result. In all cases the difference between parameters were tested for significance at probability level of 0.05 or less. The prevalence of cattle trypanosomosis was calculated as the number of parasitologically positive animals examined by buffy coat method to the total animals examined (Thrusfield, 2007).

3. Results

3.1. Parasitological Findings

3.1.1. Prevalence of trypanosomosis

Out of total 384 examined cattle 7 were found infected with trypanosomes with over all prevalence of 1.82%. The prevalence of the disease with respect to kebeles were 0, 2.08, 2.08 and 3.12 in Mota, Menta Wuha, Goncha and Addis Alem respectively but its variation was statistically insignificant ($p>0.05$) (table 2). The result was assessed for the type of trypanosome species observed and revealed that from the 7 (1.82%) positive animals examined, 3 (0.78%) was for *T. congolense* and 4 (1.04%) for *T. vivax* (Table 2). The proportion of trypanosome species was 3/7 (42.9%) for *T. congolense* and 4/7 (57.1) for *T. vivax*. The proportion of *T. congolense* was higher in Addis Alem than other kebele whereas *T.vivax* was higher in Menta Wuha.

Table 1: The prevalence of trypanosomosis with respect of kebeles and the species of Trypanosoma identified.

Kebeles	Sample size	species of Trypanosoma identified			%	χ^2	p-value
		T.congolense	*T.vivax*	Total			
Mota	96	0	0	0	0	2.765	0.429
Menta Wuha	96	0	2	2	2.08		
Goncha	96	1	1	2	2.08		
Addis Alem	96	2	1	3	3.12		
Total	384	3	4	7	1.82		
%		0.78	1.04	1.82			

T.congolense =trypanosome congolense T.vivax =trypanosome vivax

Table 2: Prevalence of bovine trypanosomosis and associated risk factors in selected Kebeles of Guangua district

Risk factors	No examined	No positive	Prevalence %	χ^2	p-value
Sex					
Male	137	3	2.19	0.160	0.689
Female	247	4	1.61		
Total	384	7	1.82		
Age					
Young	118	2	1.69	0.016	0.901
Adult	266	5	1.87		
Total	384	7	1.82		
Body conditions					
Poor	103	5	4.85	7.516	0.023
Medium	213	1	0.47		
Good	68	1	1.47		
Total	384	7	1.82		

Significant if $p<0.05$

3.1.2. The prevalence of trypanosomosis in relation to risk factor

The prevalence of trypanosomosis was 4.85, 0.47and 1.47 for poor, medium and good body condition category respectively and there was statistically significant difference ($p<0.05$) among animal with different body condition scores (table 3). The proportion of poor body condition in infected cattle (71.4%) was higher than non-infected cattle (25.9) (table 4). The prevalence of Trypanosomosis has little variation in sex; the Trypanosoma infection in male is slightly higher than in the female. The results obtained during examination were 3 (2.19%) and 4 (1.61%) in male and female, respectively and it was statistically insignificant ($p>0.05$) (table 3). Slightly higher trypanosomosis prevalence (1.87%) was recorded in adult animals than 1.69% was in young animals and it was statistically insignificant ($p>0.05$) (table 3).

Table 3: Proportion of body conditions in infected and uninfected Bovine population in selected Kebeles of Guangua district

Status	Body conditions	Frequency	% from total	% from group
Infected	Poor	5	1.30	71.4
	Medium	1	0.26	14.3
	Good	1	0.26	14.3
	Total	7	1.82	100
Non-infected	Poor	98	25.52	25.9
	Medium	212	55.22	56.1
	Good	67	17.44	18
	Total	377	98.18	100

3.2. Hematological finding

The PCV values of sampled animals range from 14-38 and the overall mean value of examined animals was 25.77. The mean PCV value for the infected cattle was 20.43% while the mean PCV value for the uninfected cattle was 25.86% which was statistically significant ($p<0.05$) (table 6). The anemia prevalence was significantly higher in trypanosome infected cattle (71.4%) than in non-infected cattle (28.6%) (table 5).

Table 4: Proportion of anemia in infected and uninfected Bovine population in selected Kebeles of Guangua district

Status	Anemia	Frequency	% from total	% from group
Infected	Anemic	5	1.302	71.4
	Non anemic	2	0.520	28.6
Non-infected	Anemic	108	28.125	28.6
	Non anemic	269	70.052	71.4

Table 5: The mean Packed Cell Volume in infected and non-infected cattle in selected Kebeles of Guangua district

Status	Frequency	Mean PCV%	SD	Over all PCV%	χ^2	p-value
Infected	7	20.43	4.86	143	52.135	0.001
Uninfected	377	25.86	4.82	9751		
Total	384	25.77	4.54	9894		

4. Discussions

The study show an overall prevalence of 7/384 (1.82%) in the study area which is low. This report is close with different reports from different part of Ethiopia, Tadese *et al.,* (2015), Haile *et al.,* (2016), kedir *et al.,* (2018), Tamiru *et al.,* (2014) and Ayana *et al., (*2012) reported 2.86, 3.9, 2.23, 1.38 and 2.10 in percentages respectively.

The prevalence rate in this study was considered to be low when compared with earlier reports from

other parts of Ethiopia. Kumela *et al* (2015) 5.43% in Mandura District, Adugna *et al.,* (2017) 7.29% in Ankesha District of Awi Zone, Bogale *et al.,* (2012) 9.98% in Genji district, western Ethiopia, Nigatu and Abebe (2009), 10.1% in Awi zone and Dawit and Nuraddis (2017) (25.8%) in Assosa district. These were actually due to the difference in geographical area of the study site and the difference in study period. The density of fly population is another determinant factor for occurrence of trypanosomosis, where fly population increases after the short and long rainy seasons, this lies from April to June and September to November. However, this study was conducted from November to April which is in the dry periods, hence lower fly population and consequently lower prevalence of trypanosomosis. In support of this, Sinshaw *et al.,* (2006) revealed that reproduction and development of biting flies is best suited to the climatic conditions prevalent during the heavy rainy seasons and high human activity (an increase in agricultural investment) and deforestation contributed to lower prevalence of bovine trypanosomosis in the current study.

But the result show that slightly higher prevalence (1.82%) when compare to the previous study in same Woreda which was (1.04%) (Ayenalem and Mossie, 2017). These differences occur due to the difference in study year and the technique used in detection of Trypanosomes. the previous study that was conducted by Ayenalem and Mossie was done in 2013/2014 while the present study was conducted in 2017/2018 that has 4 year gap between study period and Ayenalem and Mossie used thin blood smear to study the prevalence of the disease which is very less sensitive when compare with buffy coat technique which was used during my study. Thin blood smear is very less sensitive in low parasitemic cases leading to false negative during the chronic phase the sensitivity is low as, due to the immune response of the host, parasites are scanty and rarely seen in the blood and the sensitivity is almost nil in healthy carriers, where parasites are never seen (OIE, 2013).

This study showed that there is association between the trypanosome infection and body condition of cattle. The majority of the infected animals manifest poor body conditions because of the effect of the disease. However, poor body condition could also be the consequence of other pathogens and nutritional stress (Pereckiene *et al.*, 2007). The finding agrees with the reports of earlier studies in Ethiopia Dinka and Mulugeta, (2016), Bekele and Nasir, (2011) and Mulatu *et al.,* (2016).

In this study, the associations existed between the occurrence of parasitaemia and mean PCV value of the animals. The mean PCV value of uninfected (25.86%) was significantly higher than that of infected animals (20.43%). The lower mean PCV value in parasitaemic animals than that of aparasitaemic ones was also recorded in previous studies in Ethiopia Adugna *et al.,* (2017) and Dinka and Mulugeta, (2016). The difference in prevalence of the disease between the sex and age groups were not statistically significant ($p > 0.05$). That means the sex and age of the animal does not contribute to the occurrence of the trypanosomosis. Which agrees with study conducted by kedir *et al.,* (2018), Dinka and Mulugeta, (2016) and Ali and Bitew, (2011). Like that of age and sex, the difference in prevalence along kebeles were not statistically significant ($p>0.05$). The proportion of *T. congolense* was higher in Addis Alem than other kebele whereas *T.vivax* was higher in Menta Wuha. The difference in proportion trypanosome species between the kebeles is most related with agricultural activities and deforestation.

5. Conclusion And Recommendations

The current study shows that 1.82% prevalence of bovine trypanosomosis in study area. *T.congolense* and *T.vivax* were the two species of trypanosome which identified in the area with slightly higher prevalence of *T.vivax*. The study shows that the percentage of poor body condition and anemia were higher in diseased cattle than non-diseased cattle, During this study sex, age and origin did not have role in the occurrence of bovine trypanosomosis. Even if the disease has lower prevalence and it is not serious issue according to the present study, the effect of trypanosomosis on the health and production of cattle still present. From this conclusion the following recommendations are given:-

- ❖ The effect of trypanosomosis on the health and production of cattle in study area should not be ignored.
- ❖ Adequate veterinary services, vector control and introduction of trypanotolerant breed in the area should be considered to control the disease.
- ❖ Control efforts for trypanosomosis in the study area should target both cyclically and mechanically transmitted trypanosome infections.
- ❖ Further study should be conduct in this area especially in wet season to understand the prevalence of the disease and its effect on bovine.

References

1. Abrham, A., Shemeles, D., Takele, D. and Dessie B. (2017). Review on Characterization of Trypanosoma congolense; A Major Parasite of Cattle in Africa. *Acta Para. Glob.* 8 (1): 39-49.
2. Achenef, M. and Bekle, B. (2013). Drug and Drug Resistance in Africa Animal Trypanomosis, *Eur. J. of App. Sci*. 5(3): 84-91.

3. Adugna, T., Lamessa, A., Hailu, S., Habtamu, T. and Kebede, B. (2017). A Cross-Sectional Study on the Prevalence of Bovine Trypanosomosis in Ankesha District of Awi Zone, Northwest Ethiopia. *Austin J Vet Sci & Anim Husb*: 4(2): 1034.
4. Ali, D. and Bitew, M. (2011). Epidemiological study on bovine trypanosomiasis in Maokomo special district Benishangul-Gumuz regional State, Western Ethiopia. *Glob. Vet.* 6: 402-408.
5. Asmamaw, A., Shimelis, T., Teshome, k., Birhanu, E. and Yesharg, A. (2016). Epidemiology of bovine Trypanosomosis in Kamashi District of Benishangul Gumuz Regional State, Western Ethiopia: Prevalence, Vector density and associated risks. *Biomed. and Nur.* 2:4.
6. Ayana, M., Tesfaheywet, Z. and Getnet, F. (2012). A cross-sectional study on the prevalence of bovine Trypanosomosis in Amhara region, Northwest Ethiopia. *Livest. Res. Rural Dev*, 24(8).
7. Ayenalem, D. and Mossie, T. (2017). Prevalence of Bovine Trypanosomosis and Farmers' Perception of the Disease and Its Management in Guangua and Dangila Districts. *J Bio Agri and Health.* 7:7.
8. Bekele, M. and Nasir, M. (2011). Prevalence and host related risk factors of bovine trypanosomosis in Hawa-gelan district, West Wellega zone, Western Ethiopia. *Afr J Agri Res* 6: 5055-5060.
9. Bitew M, Amedie Y, Abebe A, Tolosa T (2011). Prevalence of bovine Trypanosomosis in selected areas of Jabi Tehenan district, West Gojam of Amhara regional state, Northwestern Ethiopia. *Afr. J. Agric. Res.* 6:140-144.
10. Bogale, B., Wodajo, K. and Chanie, M., (2012). Occurrence and identification of bovine trypanosomosis in Genji district, western Ethiopia. *Acta Para Glob* 3(3), 38-42.
11. Dagnachew, S. (2004). Epidemiology of bovine trypanosomosis in the Abay basin areas of northwest Ethiopia, MSc thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre zeit, Ethiopia, pp: 151-157.
12. Dávila, A.M. and Silva, R.A. (2000). Animal trypanosomiasis in South America. Current status, partnership, and information technology. *Ann N Y Acad Sci.* 916:199-212.
13. Dawit, T. and Nuraddis, I. (2017) Prevalence of Bovine Trypanosomosis in Assosa District of Benishangul Gumuz Regional State, Ethiopia. *Advan. Biol. Res.,* 11 (1): 13-17.
14. Dinka, A. and Mulugeta, Z. (2016). Study on the Prevalence of Bovine Trypanosomosis, Vector Density and Associated Risk Fators in Assosa District of the Benishangulgumuz Region, West Ethiopia. *Europ. J. Appl. Sci*., 8 (5): 319-325.
15. Haile, G., Mekonnen, N., Lelisa, K. and Habtamu, Y. (2016) Vector identification, prevalence and anemia of bovine trypanosomosis in Yayo District, Illubabor Zone of Oromia Regional State, Ethiopia. *Ethiopian Veterinary Journal*. 20: 39- 54.
16. Hunde, A. B., Tafere, C.A., Beshatu, F. W. and Asamnew, T. M (2012). Prevalence of Bovine Trypanosomosis in Addisamba and Amarit District of West Gojjam Zone, Amhara Regional State *Am-Euras. J. Sci. Res*. 7 (3): 112-117.
17. Kedir, M., Desa, G., Chala, D., Shimellis, S. and Lelisa, K. (2018). Trypanosomosis: Prevalence in Cattle in Dibati District, Metekel Zone, North Western Ethiopia. *Austin J Vet Sci & Anim Husb*. 5(1): 1040.
18. Kumela, L., Delesa, D., Mohamed, K. and Teka, F. (2015). Prevalence of Bovine Trypanosomosis and Apparent Density of Tsetse and Other Biting Flies in Mandura District, Northwest Ethiopia, *J Veterinar Sci Technol*. 6: 229.
19. Mulatu, E., Lelisa, K. and Damena, D. (2016). Prevalence of Bovine Trypanosomosis and Apparent Density of Tsetse Flies in Eastern Part of Dangur District, North Western Ethiopia. *J Vet Sci Technol* 7: 347.
20. Murray, M., (1988). Trypanotolerance, its criteria and genetic and environmental influences. Livestock Production in Tsetse Affected Areas of Africa. *Eds ILCA/ILRAD* 8:133-151.
21. Nicholson, M. and Butterworth, M. (1986). A guide to condition scoring of zebu cattle. ICCA, Addis Ababa, Ethiopia.
22. Nigatu, K. and Abebe, A. (2009). Trypanosomosis of cattle in selected districts of Awi zone, northwestern Ethiopia. *Trop. Anim. Hlth. Prod*. 41: 1353-1356.
23. OIE (2008). Manual of standards for diagnostic tests and vaccines for terrestrial animals, 6th ed. Paris. pp: 813.
24. OIE (2013): Trypanosomosis (tsetse-transmitted), Version adopted by the world assembly of delegates of the OIE, Pp, 1-11.
25. Oyda, S. and Hailu, M. (2018). Review on prevalence of bovine trypanosomosis in Ethiopia. *Afr. J. Agric. Res.* 13(1): 1-6 .
26. Pereckiene, A., Kaziūnaite, V., Vysniauskas, A., Petkevicius, S., Malakauskas, A. (2007). A comparison of modifications of the McMaster method for the enumeration of Ascaris suum eggs in pig faecal samples. *Vet Parasitol* 149: 111-116.

27. R.F. Johnson, (1998): The Stockman's Handbook by Ensminger, 2nd ed., Pp 539.
28. Samson, L., Gezahegn, A., Zewdu, S., and Melkamu, B. (2016). Prevalence of bovine trypanosomosis in Ethiopia: a meta-analysis. *Para & Vecto*. 9:139.
29. Shiferaw, S., Y. Muktar, and D. Belina (2015): A review on trypanocidal drug resistance in Ethiopia. *J. Parasitol. Vect. Biol*. 7: 58-66.
30. Sinshaw, A., Abebe, G., Desquesnes, M. and Yoni, W. (2006): Biting flies and trypanosome vivax infection in three highland districts bordering Lake Tana, Ethiopia, *Vet. Parasitol*., 141: 35-46.
31. Tadese, E., Getaneh, G. and Assaye, M. (2015). Prevalence of Bovine Trypanosomosis in Bure and Womberma Districts of West Gojjam Zone, North West Ethiopia. *Acta Parasitologica Globalis*. 6: 164-173.
32. Tamiru, F., Mideksa, B., Roy. R.K. and Terfa, W. (2014). Post Control Survey on Prevalence of Bovine Trypanosomosis and Vector Distribution in Ameya District, South West Shewa, Ethiopia. *Glob J Med Res k*. 14(3): 45-52.
33. Thrusfield, M. (2007). Veterinary Epidemiology. 3rd ed., UK, Blackwell Science Ltd. pp: 233-250.
34. Tilahun, A., Yilkal, A. and Yacob, H., (2012). Bovine trypanosomosis in three districts of Southwest Oromia, Ethiopia. *Ethiop Vet. J*., 16(1):23-39.

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