



Research Article

Epidemiological Study of Animal Trypanosomosis among Trade Cattle in Adamawa Northern Senatorial Zone, Nigeria

*MUSA, Faisal Kowagol, QADEER, Muhammad Abdul and CHESSED, Godly

Department of Zoology, Faculty of Life Science, Modibbo Adama University, Yola, Nigeria

*Corresponding Author's email: faisalkowagol@gmail.com; Phone: +2348133334964

ABSTRACT

African Animal Trypanosomosis is an important parasitic disease of cattle that causes significant economic losses and constrains cattle production. This study determined the prevalence of trypanosomosis among trade cattle in Adamawa Northern Senatorial Zone. A total of 1,031 cattle blood samples were collected and examined using hematocrit centrifugation, thick stained smear, and thin stained smear techniques. Data were analyzed using IBM SPSS version 26.0, descriptive statistics, and chi-square test at a 5% significance level. The highest prevalence was recorded among cattle from Cameroon (8.54%), while the lowest was observed in Mubi South (2.07%). No statistically significant association was observed between trypanosomosis prevalence and location, sex, age, or breed. Females had a slightly higher prevalence (5.71%) than males (5.56%), while cattle aged 1–3 years recorded the highest prevalence (6.32%). Sokoto Gudali had the highest breed-specific prevalence (7.69%), whereas no infection was detected in Muturu cattle. Body condition score was significantly associated with trypanosomosis prevalence ($\chi^2 = 10.76$, $p = 0.0046$), with poorly conditioned cattle having the highest prevalence (12.15%). Infected cattle had significantly lower mean PCV ($23.8 \pm 3.5\%$) than non-infected cattle ($31.4 \pm 4.2\%$; $p = 0.0024$). Trypanosomosis is present among trade cattle in Adamawa Northern Senatorial Zone, with infected cattle largely originating from neighboring countries Cameroon and Chad. Regular surveillance and screening of trade cattle should be strengthened. Diagnostic practices, vector control, treatment, and veterinary services should be improved, while awareness among cattle traders and herders, conservation of trypanotolerant breeds, and further epidemiological investigations should be recommended.

Keywords: Adamawa; Cattle, Mubi; Muturu; Prevalence; Trade; Trypanosomosis

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INTRODUCTION

African Animal trypanosomosis (AAT) is parasitic diseases of public health importance that limits agricultural productivity in many developing countries of Sub-Saharan Africa. The disease is caused by blood parasites, belonging to the genus *Trypanosoma* and widely transmitted in Africa by tsetse flies (Chinwe *et al.*, 2025). More than 30 species and sub species of tsetse flies (*Glossina* species) occur across approximately 33% of Africa's landmass, where they transmit trypanosomes to humans and livestock in at least 36 sub-Saharan

African countries (Erik *et al.*, 2021). It is generally classified as Neglected Tropical Disease (NTD), either as African Animal trypanosomosis (AAT) or Human African trypanosomosis (HAT). In Africa, the disease affects around 100 million heads of cattle and in Nigeria, six million are estimated to be at risk out of a cattle population that is presently estimated to twenty 20 million (Haruna and Anas, 2022). The World Health Organization (WHO) in the year 2000 gave an estimate of between fifty to seventy million individuals were at the risk of tsetse flies bites in Africa, which causes sleeping sickness. The disease

advances rapidly from less virulent to a chronic animal disease. The actual number of cases on yearly estimate ranges from between 300,000 and 500,000 people and with a direct economic loss of between \$4–5 billion in term of Gross Domestic Product (Ravel *et al* 2015).

Bovine trypanosomosis poses a serious threat to livestock development and agricultural production in many tsetse flies infested areas, where the disease causes significant economic losses through reduced productivity, weight losses, poor reproductive performance and mortality (Mamoudou *et al.*, 2016). Trypanosomosis is a fatal and debilitating disease of various domestic livestock and wild animals. The disease is one of the major constrain of the livestock industry in many tropical countries in Africa and Asia (Fru *et al.*, 2023). There are principally three major causative agents of the disease transmitted by different species of tsetse flies which includes; *Trypanosoma congolense*, *T. vivax*, *T. brucei* and occasionally *T. evansi* (Issa *et al.*, 2021). The impact of bovine trypanosomosis is not restricted to livestock production alone, but extends to changes in land use and exploitation of natural resources use, access to available and cultivable land, restriction of opportunities for diversification of agricultural production (Ebanga *et al.*, 2022). Furthermore, the disease reduces the efficiency of bulls and discourages the use of drought animals in crop production (Haruna *et al.*, 2021).

Trypanosomosis is a chronic hemoprotozoan disease of humans and domestic animals caused by various species of the unicellular eukaryotic protozoan parasite *Trypanosoma* (Constable *et al.*, 2017). With an exception of *Trypanosoma equiperdum* of equines, which causes a venereal disease, all have arthropod vectors in which the transmission is either cyclically by tsetse flies of the *Glossina* species or non-cyclical by many other insects. Cattle infected with trypanosomosis can show major clinical manifestations of a disease, such as intermittent fever, anemia, anorexia, dullness, apathy, watery ocular discharge, reproductive disorder, and superficial lymph node enlargement blinking somnolence and apparent confusion. Also, intention tremor in all limbs and myoclonic jerks are often seen. The animals progressively become emaciated and cachectic, and finally die if untreated (Gebisa *et al.*, 2020).

Trypanosomes are transmitted via bites by various species of *Glossina* and mechanically by biting flies; Transmission takes place mostly in rural areas where agricultural activities expose people to the bite of T

setse fly (Mamodou, 2022). The tsetse fly-transmitted trypanosomes, *T. brucei*, *T. congolense* and *T. vivax* are limited to Africa where they have been responsible for the barring of livestock from large areas of land which are possibly capable of supporting cattle and other ruminants (Ngwu *et al.*, 2023). Infection by one or more of these trypanosome species results in acute or chronic disease which is characterized by intermittent fever, emaciation, anaemia, loss of appetite, weakness, corneal opacity, occasional diarrhoea, parasitaemia, coma and death if not treated (Muturi *et al.*, 2011). This disease usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer's overall profit (Ozovehe *et al.*, 2024).

The distribution of the causative organism is mostly restricted to the African continent and Asia. However, *T. vivax* has been observed to cross the Atlantic moving upwards towards South America through mechanical transmission by biting flies (wama *et al.*, 2025). In addition *T. evansi* have also been observed to have a wide host range causing infection in livestock such as buffalo and camel in some parts of Asia. A major clinical feature consistent with trypanosomosis in livestock is Fever and anaemia. However, there is a generalized leukopenia, weight loss, hypertrophy of the liver and spleen. In chronic cases the infected animals becomes lethargic, emaciated due to in appetite and finally die due to congestive heart failure (Uzoka *et al.*, 2022). This case describes the management of a clinical case of trypanosomosis in an endemic cattle farm.

Bovine trypanosomosis remains an important constraint to cattle production and trade because of its effects on animal health, productivity and economic returns. Trade cattle are particularly important in the epidemiology of the disease because movement of infected animals between different locations may facilitate the maintenance and spread of trypanosome infections. Despite the importance of cattle trade in Adamawa Northern Senatorial Zone, there is limited recent information on the prevalence and distribution of trypanosomosis among trade cattle in the area. The study also compares the packed cell volume (PCV) of infected and non-infected cattle, providing information on the possible haematological effects of infection. The findings are intended to provide current epidemiological evidence that can support surveillance, screening and control of trypanosomosis among trade cattle in the study area.

MATERIAL AND METHODS

The region is located between latitude 9°30' and 11° North of the equator and longitude 13° and 13°45' East of the Greenwich meridian. It has a land area of 4728.77 km² and population of 759,045 in 2003 (Adebayo, 2020). The region consists of five local government areas namely: Madagali, Maiha, Michika, Mubi North and Mubi South which was delineated on the basis of socio-political factor. The region used in this study refers to the Adamawa north senatorial district (Figure 1).

Mubi region belong to the highland relief region of Adamawa state (Adebayo, 2020). The region has a distinct relief con- figuration with series of mountain ranges lying along its eastern border with Cameroon. The elevation of the region ranges between 400 m to 1500 m above sea level. Its relief can be broadly divided into three zones: the highlands ranges, the highland plains and the low lands.

The region has a tropical wet and dry type of climate, coded as Aw in Koppen's classification. The temperature regime is warm to hot throughout the year, due to high radiation income. However, there are periods of low temperatures during the hamattan season (November-February). The months of May to September constitute the wet season in the region. It

has mean annual rainfall of between 900 mm to 1050 mm. Geographic factor contributes a lot in influencing the pattern of rainfall in the region.

The region is located in the Sudan savannah vegetation zone. The herbaceous community makes up the dominant vegetation in the region, even though it withered out during the dry season. The woody species, there- fore, has an important role to play in the environment as it can survive during the dry season when the herbaceous vegetation is not available. However, the natural vegetation has been adversely affected by human use of land in the area. Some of the common indigenous woody vegetation that are found in the region includes; *Aca- cia spp.*, *Adansonia digitata*, *Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Combretum spp.*, *Ficus spp.*, *Tama- rindus indica*, *Terminalia spp.* etc.

The dominant drainage system is the Yedzeram River which takes it source from Gella hills flows through the region in a south north direction (Adebayo, 2020). It is the major tributary of the Ngada River in Borno state which drains into the Lake Chad. Apart from the Yedzeram River there are other subsystems in the region. The River Mangar which takes its source from Mildu hills, River Pakka and Nguli from Pakka hills and River Tsikari from Zumo hills.

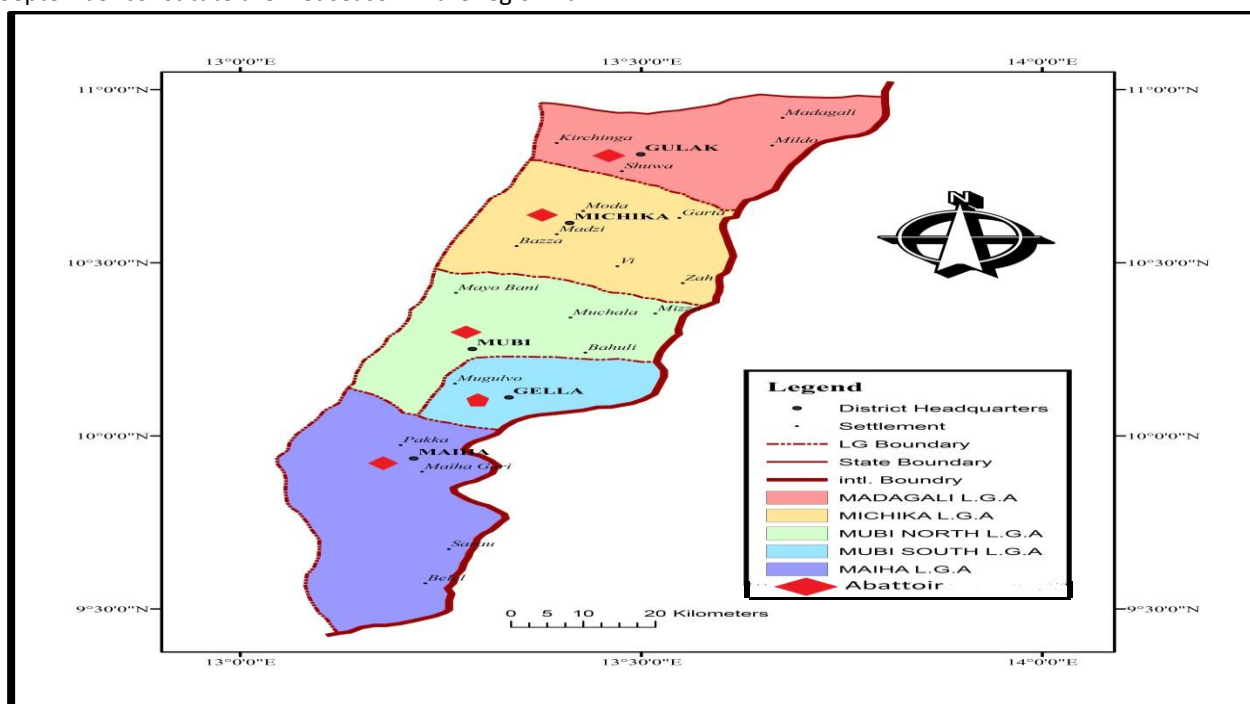


Fig. 1: Map of Adamawa Northern Senatorial Zone Showing Study Area (Source Geography Department ADSU Mubi)

Ethical considerations

An approval of the protocol was made by the Faculty of life Sciences of the Modibbo Adama University, Yola, via the Department of Zoology. A verbal consent was sought from cattle traders and herders before physical examination and blood collection.

Study population and sample size determination

$$N = \frac{z^2 pq}{d^2} \text{ (Thrusfield, 2007)}$$

$$N = \frac{(1.96)^2 (0.25)(0.75)}{(0.05)^2}$$

=458 samples (minimum)

n = the desired sample size (when N is greater than 10,000)

z = the standard normal deviate, set at 1.96, which corresponds to the level of the 95% confidence level

P = the population in the target population estimated to have a particular characteristic, 0.056.

q = 1–P

d = the degree of accuracy desired usually set at 0.05.

An estimated prevalence of 50% was used with a precision level of 5% resulting in a minimum sample size of 458 cattle. The sample size was increased to 1031 cattle far above the estimated value to avoid sampling errors.

Blood samples collection from cattle

The animals were randomly selected based on their availability and the consent of the owners. After restraining the animals, approximately 4 to 5ml of blood was collected with 10ml syringe through the jugular vein and transferred into a tube containing Ethylene Diamine Tetra Acetic Acid (EDTA) anticoagulant. The tubes were labelled with the animal number, breed, sex, age, location, and body condition score.

Determination of breed, age and body condition score of animals

The cattle breed was determined using phenotypic characteristics. Age was determined by examining the dentition and horn rings with help of veterinarian Doctor. The animals were grouped into 3 age groups including young 1-3years, 4-6years and >7years. The body condition score was established on a scale of 1-3, after examining the animal by palpation of the lumbar region as well as by assessing its general appearance following the method proposed by (Mamoudou *et al.*, 2022). The animals were divided into 3 groups according to their body condition score: Good (1), Medium (2) and Poor (3). The origin of the animals was informed by cattle traders/cattle rearers either Nigeria origin or neighboring countries where they purchased the animal.

Thick smear technique

The thick blood smears prepared as described by (Maya *et al.*, 2007) a drop of blood was placed on a clean glass slide. The blood was spread to form a thick film of approximately 1cm in diameter and allow to air dry completely. The dried smear was fixed in absolute methanol for 3 minutes and with 10% Giemsa stain at pH 7.2 for 30 minutes. The slide was then washed gently with tap water and air dried. Examination was done under the microscope using ×100 oil immersion objectives to identify trypanosome species based on morphology.

Thin smear technique

The thin blood smears prepared as described by (Maya *et al.*, 2007) a small drop of blood was placed on one end of a clean microscope slide. A spreader slide held at an angle of 45° was used to spread the blood to produce a thin film with a feathered edge. The smear was allowed to air dried, fixed in absolute methanol for 3 minutes, and stained with 10% Giemsa stain for 30 minutes. The stained slides were rinsed, air dried, and examined under oil immersion ×100 objectives for the morphological identification of *trypanosoma* species.

Buffy coat technique

The buffy coat method as described by Murry *et al.* (1983) was used for the detection of trypanosomes. Blood was collected into heparinized capillary tubes and sealed at one end with crista-seal. The tubes were then centrifuged at 12000 revolutions per minutes for 5minutes, following centrifugation, the capillary tube was cut through the buffy coat region with a small portion of plasma and red blood cells and red cells was expressed onto a microscope slide, cover with a coverslip and examined under ×40 objectives for the presence and motility of trypanosomes. The packed cell volume (PCV) was also determined from the same tube.

Data Analysis

Data obtained from the study were entered, coded, and analyzed using (IBM SPSS) International Business Machine Statistical Package for the Social Sciences, version 26.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the data, while the chi-square test was used to determine the association between trypanosomosis prevalence and selected epidemiological factors. The level of significance was set at p < 0.05.

RESULTS

The overall prevalence of bovine trypanosomosis among trade cattle in Adamawa northern senatorial zone

Out of 1031 whole blood of cattle sampled and examined during this study, the overall prevalence was 5.63%. Base on location Cameroon republic had the highest prevalence of 8.54% and Mubi South with least prevalence 2.07% (Table 1). The study revealed that the prevalence of bovine trypanosomosis did not differ significantly among the sampled location ($p>0.05$; Table 1).

Sex specific prevalence of bovine trypanosomosis indicate that females had the higher prevalence of 5.71% whereas male cattle 5.56% (table 1). Chi-square analysis showed that no significant association between gender and infection ($p>0.05$; Table 1).

Age specific prevalence of bovine trypanosomosis was 6.32% in cattle age 1-3years, 5.91% in cattle age

4-6years, and 5.14% in cattle 7years above (Table 1). Chi-square analysis showed no significant association between age and infection prevalence ($p>0.05$; Table 1).

Breeds specific prevalence of bovine trypanosomosis showed that there is no statistically significant difference ($p>0.05$) in the prevalence of bovine trypanosomosis among the different cattle breeds examined, although the sokoto gudali/ambala breeds had the highest prevalence 7.69% and the muturu breeds recorded no positive case 0.00% (table 2). Statistical significant ($p>0.05$; Table 2).

Body condition score among cattle study showed that cattle with poor body condition had highest prevalence 12.15%, followed by those with medium body condition 5.29%, while cattle with good body condition had the lowest prevalence 4.43% (Table 2), among the body condition groups was statistically significant ($p<0.05$; Table 2).

Table 1: overall prevalence of bovine trypanosomosis among trade cattle according to location, sex and age in Adamawa northern senatorial zone

Location	No Examined	No Positive	Prevalence %	X ² Cal	X ² Tab	P - Value	Remark
Madagali LGA	122	10	8.20	10.69	12.59	0.0984	NS
Michika LGA	142	8	5.63				
Mubi north LGA	139	4	2.88				
Mubi south LGA	145	3	2.07				
Maiha LGA	153	7	4.58				
Cameroon trade cattle	164	14	8.54	0.01	3.84	0.9203	NS
Chad trade cattle	166	12	7.23				
Total	1031	58	5.63				
Sex							
Male	611	34	5.56				
Female	420	24	5.71	0.35	5.99	0.8395	NS
Age (years)							
1-3	95	6	6.32				
4-6	508	30	5.91				
7-above	428	22	5.14				

NS: Not statistically significant

Table 2: breeds specific of prevalence, body condition scores and comparison of mean PCV of infected and non-infected trade bovine trypanosomosis in Adamawa northern senatorial zone

Breeds	No. examined	No. positive	Prevalence (%)	X ² Cal	X ² Tab	P -Value	Remark
Red bororo	442	26	5.88	4.89	9.49	0.2988	NS
White Fulani	270	12	4.44				
Sokoto gudali	91	07	7.69				
Adamawa gudali/ambala	189	13	6.88				
Muturu	39	00	0.00				
Total	1031	58	5.63	9.21	7.96	0.0024	SS
BCS							
Good	451	20	4.43				
Medium	473	25	5.29				
Poor	107	13	12.15				
Condition (PCV)	No. Examined	Mean $\pm$ SD		9.21	7.96	0.0024	SS
Infected	58	23.8 $\pm$ 3.5					
Non-infected	973	31.4 $\pm$ 4.2					

BCS: body condition scores; SS: Statistically significant; NS: Not statistically significant; PCV: Packed cell volume

DISCUSSION

The overall prevalence of trypanosomosis recorded in this study was relatively low compared with findings from some previous studies, the findings of this study is in agreement with the reports of Chibuogwu *et al.* (2023) and Ebanga *et al.* (2020). This difference may be associated with variations in environmental and ecological conditions, including changes in vegetation, climatic conditions, availability and density of tsetse flies and other biting flies, and livestock management practices. In addition, differences in cattle movement, animal husbandry systems, vector-control activities, diagnostic techniques, and the period of sampling may have contributed to the observed variation in prevalence between the present study and previous reports.

Prevalence rates of bovine trypanosomosis among trade cattle according to locations revealed that Cameroon republic had the high prevalence of the disease it could be due to availability of thick forest and swamp areas which they encounter during transboundary trekking of cattle from Cameroon to Nigeria for commercial trade at livestock market. The adults move a lot during the dry season trans-human migration into infected areas in search of dry season fodders and hence the possibility of been bitten by the mechanical vectors (*Tabanus* and *Stomoxys* flies). Similar to the findings of (Mamoudou *et al.*, 2022) who reported from Santa, Bali and Bafut sub-Division of the North West region of Cameroon republic and the least prevalence was observed in Mubi south local government area which could be due to poor vegetation and lack of availability of moist areas which favorable for the breeding of vectors.

Based on sex specific prevalence of cattle trypanosomosis females had the higher prevalence of the disease than male and the difference was not statistically significant. This finding agreed with reports of (Chibuogwu *et al.*, 2023) who reported high prevalence in females 5.5% than males 1.22% and also (Mamoudou *et al.*, 2022) reported from Cameroon that females 13.4% and that of males 5.2% and with the report (Sara *et al.*, 2025) who report from Grazing Hotspots in Jalingo Metropolis, Taraba State, Nigeria, said females had a slightly higher prevalence (65% compared to 35% in males). The higher susceptibility of female cattle does not tend itself to unequivocal interpretation at this point but could be associated with reduced immunity resulting from lactation and stress due to pregnancy. However female cattle under physiological stress may show decreased immunity despite equal chances of

exposure with the males to the vectors on common grazing land. Female animals stay longer in the herd and are given more attention than their male counterparts which in most cases are sold earlier for slaughter as reported by Lawan *et al.* (2020). Nonetheless, the finding of a higher prevalence in female compared with male cattle is consistent with the findings of (Bello *et al.*, 2023) who also reported a higher prevalence of trypanosomosis in females than in male cattle. Perhaps, it might suggest that female cattle are more vulnerable to trypanosomosis in pregnancy, parturition, lactation and those in low plane of nutrition. Moreover, the female cattle are generally herded much longer for the purpose of breeding and milk production, thereby.

Age specific revealed that cattle age 1-3 years had the highest prevalence rate while 7 years and above age had the least prevalence and was not statistically significant ($p > 0.05$). This result agreed with the findings of earlier workers (Dabo *et al.*, 2018). But it disagreed with the report of Godlove *et al.* (2022). From this study, there is a decrease in disease prevalence as animal's age, probably due to age-acquired immunity, which could represent a key positive factor, and bearing in mind that trypanocidal treatments are more frequently used on adults by local farmers/owners. In addition, young animals are more vulnerable to tsetse bites due to their skin fragility. Moreover, they are not agile enough to ward off insects along the grazing route as are the adults.

Breeds specific revealed that Sokoto gudali had the highest prevalence of 7.69% while the least was muturu 0.00% had no infection and they are trypanotolerance and did not statistically significant ($p > 0.05$) the breeds were found to be trypanotolerance because the breeds are able to maintain parasitemia, currently the breeds are found in Michika local government of Adamawa state and are highly susceptible to trypanosomes infection. This result is in concordance with report of (Dabo and Maigari, 2017). But disagrees with the report of (Bello *et al.*, 2023) who said white Fulani are more susceptible. However, this variation in the infection rates among the different breeds of cattle screened was found to be insignificant, justifying the fact that all breeds of cattle are trypanosensitive except muturu. Therefore, the differences could be attributed to the covering of large distance during migration for grazing which will encounter mechanical transmission of the disease.

Body condition scores (BCS) among trade cattle associated with bovine trypanosomosis revealed that cattle with poor body condition was observed to be

more infected by trypanosome species (12.15%) than the medium body conditioned ones (5.29%) and good body condition ones (4.3%) it was statistically significant $p < 0.05$ in their trypanosome prevalence. This finding supports previous findings by (Dabo and Maigari, 2018) who reported a similar trend in which animals with poor BCS had significantly higher infection rates than those with good BCS, suggesting that cattle with poor BCS may be more susceptible to the disease due to stress, poor nutrition, workload, other infections, and, hence, compromised immunity. In contrast, quality and plentiful pastures and water sources may contribute in making infected cattle to look healthier and thus possess good BCS as evinced in this study by few infected animal. Similarly, cattle with poor BCS that tested negative might be associated to the drought condition and long trekking distance, where animals move long distances in search of pastures and water sources (Ebanga *et al.*, 2020) which may allow the entry of infected animals and, hence, the onset of the disease.

These findings are in agreement with the observation of (Bello *et al.*, 2025) that good body condition animals with good nutrition have less trypanosome infection rates than the poor conditioned ones. Good body condition animals usually come from feed lots where they are probably treated against various parasites and other diseases, thereby minimizing the chances of detecting trypanosomes among them. By contrast, poor body condition cattle may originate from extensively managed herds with poor nutritional background, which increases risk of trypanosomes among them. Moreover, poor nutrition and management are significant risk factors for acquiring other debilitating diseases by extensively managed cattle under transhumant conditions, and could be responsible for loss of body condition (Godlove *et al.*, 2022).

The mean PCV of infected and uninfected trade cattle examined in this study were within than normal range. However, there was a significant difference ($p < 0.05$) this could be the variety of feed that the animals dwell on. This finding agrees with (Issa *et al.*, 2021; Sonibare *et al.*, 2021) who reported that mean PCV was higher in cattle from Garko and Dambatta of Kano State as compared to other sources. The low PCV value in infected animal agreed with previous findings of (Qadeer *et al.*, 2008b; Arnaud *et al.*, 2020).

CONCLUSION

From the present study, it could be deduced that trypanosomosis is present in trade cattle in Adamawa northern senatorial zone. Though most infected

animals are imported into the zone for the purpose of trading, from neighboring country Cameroon and Chad. The presence or occurrence of trypanosome species in animals in the study area could be an indication of importation of infected animals. This could be of great medical importance as these infected animals predispose other livestock in the area to risk of animal trypanosomosis. The findings demonstrate that cattle trypanosomosis remains an important disease among trade cattle and that differences in prevalence according to origin, age, sex, breed, and body condition should be considered in disease surveillance and control programs.

Based on the findings of this study, the following recommendations are made: Regular surveillance and screening of trade cattle should be conducted to facilitate early detection and control of trypanosomosis. Diagnostic practices, vector control measures, treatment, and veterinary service should be improved to reduce disease transmission and improve cattle health. Awareness and education of cattle traders and herders should be strengthened, while conservation of trypanotolerant breeds and further epidemiological investigation should be encouraged. Regional collaboration among Nigeria, Cameroon, Chad, and neighboring countries should be promoted to enhance cross-border disease surveillance and coordinated control of trypanosomosis.

REFERECES

- Adebayo, A.A., Ed. (2020) Mubi Region: A Geographical Synthesis. Paraclete Publishers, Yola.117-119
- Aliyu, M.B., Aallam, L. and Sarkey, A.K.B. (2021) Clinical manifestation and parasitological study of bovine trypanosomosis naturally occurring in a North Central State Nigeria. *Savannah Veterinary Journal*, **4**: 38-48.
- Arnaud, S., Ignace D., Germain A., Jacques D., Issaka, Y. A. K., Souaïbou F. and Marc, Kpodekon (2020) Prevalence of cattle trypanosomosis in slaughterhouses and farms and impact on hematocrit in cattle. *Journal of advanced veterinary and animal research* **7**(1): 6–15, ISSN 2311-7710.
- Bello, A.M., Abdulsalam, H., Dauda, J., Abdulrahman, H.I., Tukur, S.M., Adamu, L., Bukar, M.M., Mbaya, A.W. and Egwu, G.O. (2023) Trypanosoma evansi: prevalence in naturally infected cattle in Borno and Gombe State, Nigeria. *Savannah Veterinary Journal* **6**(2):31-38.
- Bello, A.M., Hassan A., Halima I. G., Jamila M. D., Lawan, A., Modu, M., Albert W.M., and Godwin, O. E.

- (2025) Hematology of naturally infected *Trypanosoma evansi* cattle in Borno State, Nigeria: Alterations due to body condition score, breed, age, and sex. *Journal of research in veterinary sciences* **5**(3): 243-249.
- Chibuogwu, F.U., Ajunwa, L.O., Oyo, A.E., Preye, T.M., Ebulue, R.O., Achagwa, S.M., Onyeagu, C.L., Enoch, E., Ofikwu, P.O. and Jonah, A.O. (2023) Studies On Prevalence Of Trypanosome Infection In Abattoirs In Asaba, Delta State, Nigeria. *FUDMA Journal of Sciences* **7**(3) pp 28 – 32.
- Chinwe, C., Elizabeth, O. and Chukwuemeka, I. (2025) Prevalence of Human and Animal African Trypanosomiasis in Nigeria: A Scoping Review. *Parasitologia* **5**, 53 <https://doi.org/10.3390/parasitologia5040053>.
- Constable, P.D., Hinchcliff K.W., Done, S.H. and Grünberg, W. (2017) *Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats*. 11th ed. St. Louis, MO: Elsevier Ltd. p. 2150–6.
- Dabo, N.T. and Maigari A.K. (2017). Soft Options for Effective Diagnosis of African Animal Trypanosomiasis: A Review. *International Journal of Medical Evaluation and Physical Report*, **2**(2):1-9.
- Dabo, N.T. and Maigari, A.K. (2018) prevalence of trypanosomes in trade *bos indicus* (cattle) at kano, Nigeria. *FUDMA Journal of Sciences (FJS)* Vol. **2**(2), pp 184 – 191s
- Ebanga, E.J., Amadoh J.A., Farikou, O., Abba S. and Oumar, M. (2020) Animal Trypanosomiasis in Cattle of Good Body Condition Score in the Adamawa Region of Cameroon: Hematological and Immunological Implications. *International Journal of Tropical Disease*, **3**:2
- Erick, S., Moses M.N., Joel L.B., Osman, A.A., and David, M. (2021) Knowledge, Attitudes, and Practices on African Animal Trypanosomosis and its vectors Among Small-Holder Farmers Neighbouring Arabuko Sokoke Forest Reserve, Kenya: A Cross Sectional Study. *Research square*. **102** (1)
- Fru, M.A., Silas, L.S., Rodrigue, M.N., Samuel, A., Hakan, B. and Jacques, F.M. (2023) an update on tsetse flies and animal trypanosomiasis distribution and control in North Region of Cameroon: A scoping review. : A scoping review. <https://doi.org/10.54905/diss/v24i73/e22s1021>.
- Gebisa, G., Beriso, K., Bogale B., Gizaw O., and Chala, D. (2020). Bovine trypanosomosis and its vectors in three selected districts of buno bedele zone of Oromia Region. *Ethiopia journal of Veterinary Medicine Int.* **1**(8).
- Godlove, M., Prudentia Y.L. and Harriet, N. (2022) Susceptibility of indigenous beef cattle breeds of pastoral farms in the North West Region of Cameroon to natural trypanosome challenge. *International Advanced Research Journal in Science, Engineering and Technology* **9**(2), pp 2394-1588.
- Gumel, M.A., Manu, A.Y. and Qadeer, M.A. (2011) some aspect of the prevalence of bovine trypanosomosis in Muri District, Taraba State, Nigeria. *Biological environmental sciences journal for the tropics* **8**(2), ISSN: 0795-9057, PP 166-169.
- Haruna, A.D., and Anas, M.A. (2022) Prevalence of Trypanasomiasis in Northern Nigeria: A Review *Journal of Science, Management and Technology*. **6**(1) ISSN: 1597-7463.
- Idehen, C.O., Obaloto O.O., Opabunmi R.O., Olaleye O.O., Bongaby L.A. Aluma L.A., Gbadamosi F. and Ikyase C.T. (2019). Dry Season Prevalence of Bovine African Trypanosomosis in parts of Bokokos Local Government Area of Plateau State, Nigeria. *Egypt. Journal Veterinary Science* Vol. **50**, No. 1 pp.75- 80
- Issa, F.H., Gloria, D.C. and Jacob, K.P.K. (2021) Molecular identification and prevalence of trypanosomes in cattle distributed within the Jebba axis of the River Niger, Kwara state, Nigeria. *Parasites Vectors* <https://doi.org/10.1186/s13071-021-05054-0>
- Lawan, P.Y., Musongong, G.A., Ndofo-Foleng, H.M. and Atanga, M.H.N. (2020) Associated causes of low productivity of indigenous beef cattle farming under the pastoral systems of the North West Region of Cameroon, *Journal of Agriculture and Life Sciences* **7** (2).
- Machina, I.B., Suleiman, A., Ladan, H.I., Hassan, A., Abubakar, A.T., Baba, U.M., Abdulrafii, A.D., Tamba, Z., Ubale, C. and Aliyu, Z. (2017) The Prevalence of Trypanosomes Infection in Cattle in Five Local Government Areas of Kaduna State, North-Western Nigeria *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)* ISSN: 2319-2372. Volume **10**, (11), PP 77-81 www.iosrjournals.org
- Mamoudou, A., Mbakou, L.M., Ngwa, V. N., Sevidzem, S.L., Zoli, A.P. and Achukwi, M.D. (2016) Preliminary assessment of bovine trypanosomiasis and its vectors in Santa, Bali and Bafut Sub-Divisions of the, North West Region, Cameroon. *International Journal of Biological and Chememical Sciences* **10**(1): 1-12, ISSN 1991-8631.
- Mamoudou, A., Mohamadou, B. and Lendzele, S.S. (2022) Bovine Trypanosomiasis Prevalence and Associated Risk Factors at the Ngaoundere Municipal Abattoir. *Asian Journal of Animal and Veterinary Advances* **17**(3): 111-117. ISSN 1683-9919.

- Maya, J.D., Cassels, B.K. and Iturriaga, P. (2007). "Mode of Action of Natural and Synthetic drugs against *Trypanosoma Cruzi* and their interaction with the mammalian host". Comparative Biochemistry and Physiology, a part of molecular and integrating physiology **146**(4): 601-20
- Murray, M., Trail, J.C.M., Turner, D.A. and Wissocq, Y. (1983). Livestock Productivity and Trypanotolerance. Network Training Manual. International Livestock Centre for Africa, Adis Ababa, 198.
- Muturi, C.N., Ouma, J.O., Malele, I.I., Ngue, I.M., Rutto, J. J., Mithorfa M.K., Enyaru, J. and Masika, D.K. (2011). Tracking the feeding patterns of Tsetse flies (*Glossina* Genus) by analysis of blood meals using mitochondrial cytochrome genes. Plos ONE, **6**(2): pp 72-84, DOI10.1371/journal.
- Ngwu, G.I., Nwankwo, N.C., Ngwu, M.I., Onah, I.E., Nnaji, N.F. and Ezeh, I.O. (2023) Prevalence of African animal trypanosomiasis and the Associated Blood Parameters Among Trade Ruminants at Obollo-Afor Market. Animal Research International **20**(2): 4892 – 4898
- Ozovehe, O.L., Olanrewaju, R.A. and Olusola, O. (2024) Tsetse and bovine trypanosomiasis prevalence in Ido local government area of Oyo state, Nigeria. *Journal of Dairy, Veterinary & Animal Research*. **13**(2):61–64.
- Qadeer, M.A., Akogun, O.B., Gundiri, M.A, Dede, P. and Abdulazeez, A.A. (2008a) Prevalence of bovine trypanosomosis at slaughter in Adamawa state, Nigeria. *Biological and environmental sciences journal for the tropics* **5**(3): 59-62, ISSN: 0794-9057.
- Qadeer, M.A., Danbirni, S., Usman, M., Akogun, O.B., Gundiri, M.A. and Bobbo, A.G. (2008b) Prevalence of bovine trypanosomosis in Bassa Local Government Area, Plateau State, Nigeria. *Nigerian journal of parasitology* **29**(2), ISSN: 1117-4145, PP 136-139.
- Ravel, S., Mediannikov, O., Bossard G., Desquesnes, M., Cuny, G., Davoust, B. (2015) A study on African Animal trypanosomosis in four areas of Senegal. *Folia Parasitologica* <https://doi.org/10.14411/fp.2015.044>
- Sarah, B.G., Wama, B.E., Stephen, D.T., Vera, A.Y., David, C.B., Munirah, I.F. and Usman K.Y. (2025) Prevalence of *Trypanosoma* Among Cattle Found in Grazing Hotspots in Jalingo Metropolis, Taraba State, Nigeria. *MIKAILALYS Journal of Multidisciplinary Sciences*. **3** (3) Pp 1228-1244, ISSN: 2987-3924.
- Shiferaw, S., Muktar, Y., and Belina, D.A. (2015) review on trypanocidal drug resistance in Ethiopia. *Journal of Parasitology and Vector Biology*, **7**(4):58-66.
- Sonibare, A.O., Jarra, E., Luka, J., Olurode, S.A., Olaniyi, M.O., Akande, F.A., Takeet, M.I., Akinkuotu, A.O., Mshelbwala, F.M., Otesile, E.B. and Adewuyi, O.(2021) Reliability of Some Clinical Parameters for Field Diagnosis of African Animal Trypanosomosis in Cattle. *Nigerian Veterinary Journal*, **42** (2): 129- 139, ISSN 0331-3026.
- Thrusfield, M. (2007) Veterinary Epidemiology, Veterinary Clinical Studies Royal (Dick) School of Veterinary Studies, University of Edinburg, Third Edition. Blackwell Publishing, pp. 158-161.
- Uzoka, N.B., Monday, C.O., Onwe, D.A., Maduforo, S.A., Nwele, M.O. And Onyebuchi, F. (2022) knowledge, attitude and treatment practices associated with the control of African animal trypanosomiasis among Fulani cattle herders in selected areas of Enugu State, Nigeria. *Animal Research International* **19**(2): 4428 – 4433.