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Haematological Implications of Haemoparasitism among Slaughtered White Fulani Cattle at Bodija Abattoir, Ibadan, Oyo State, Nigeria

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Abstract
Eleven-month study between December 2017 and October 2018 was carried out to assess the prevalence and haematological implication of haemoparasitaemia in adult White Fulani cattle slaughtered at Bodija Abattoir, Ibadan, Oyo State, Nigeria. Twenty blood samples per month (N = 220) were aseptically collected from the jugular vein, deposited in EDTA sample bottles, and transported on ice packs to the laboratory for blood count and parasitological screening. Data obtained on parasitology were subjected to descriptive/inferential statistics, whereas, the haematological values were analyzed using GenStat package to determine statistical difference. The results showed that *Babesia bigemina* (5.45 %), *Babesia bovis* (27.27 %), *Trypanosoma brucei* (5.91 %) and *Trypanosoma vivax* (29.55 %) were present. The result equally showed that haemoparasitaemia was higher during rainy season. The PCV, Hb and RBC were higher in the uninfected, whereas, total WBC and the differentials were higher in the infected ones. The neutrophil, eosinophil, and basophil were significantly higher ($p<0.05$) in infected cattle. It can be concluded that there was a high rate of haemoparasitism among slaughtered White Fulani cattle in the study area. It is therefore pertinent to adopt a strategy that will eliminate or reduce vector populations in the country.

Keywords: Bodija abattoir, haematology, haemoparasites, White Fulani cattle

Introduction

Ticks and tick-borne diseases (TBDs) affect the productivity of bovine in tropical and subtropical regions of the world, leading to a significant adverse impact on the livelihood of resource-poor farming communities (Jabbar *et al*., 2015). Depending on the form of babesiosis, species of *Rhipicephalus,* and *Ixodes* tick are involved in the transmission to bovine (Figueroa *et al*., 2010). Transmission and persistence of vector-borne diseases depend on the overlapping distributions of hosts and vectors combined with the correct set of environmental conditions for a given pathogen (Pfäffle *et al*., 2013; Cunningham *et al*., 2017). Climatic variability is known to influence the tick habitat and the prevalence and incidence of haemoparasites (Leta *et al*., 2013). Seasonality also impacts tick infestation of livestock. Tick infestation in cattle is higher during the rainy season than the dry season since ticks have more successful reproduction cycles in wet and warm seasons than in dry cold periods (Geeta *et al*., 2013). Bovine babesiosis can be caused by a number of *Babesia* species, but *B. bovis*, *B. bigemina* and *B. divergens* are the most important species, both economically, and clinically, in both water buffaloes and cattle (Jabbar *et al*., 2015). The main tick-borne diseases of veterinary importance in the tropical countries are theileriosis, babesiosis, cowdriosis and anaplasmosis (Perveen *et al*., 2021). *B. bovis* is the most pathogenic species, followed by *B. bigemina,* and *B. divergens* (Figueroa *et al*., 2010). Although the disease is usually transmitted by ticks, it can also be transmitted mechanically by biting flies or contaminated surgical instruments and/or needles (Camus and Uilenberg, 2010).

Tsetse flies are known to be widely distributed across Nigeria (Isaac *et al*., 2017). African animal trypanosomiasis (AAT) is a protozoan parasitic disease that causes devastating and serious economic losses to livestock production (Idehen *et al*., 2018). The disease is also among the neglected tropical diseases affecting human across 36 sub-Saharan African countries including Nigeria (Ruberto *et al.,* 2013). *Trypanosoma*

congolense, *T. brucei brucei*, *T. vivax and T. evansi* are the most important species that infect livestock in Nigeria. These trypanosomes are found where its biological vector (tsetse fly) and other biting flies (*Stomoxys, Tabanids*) exist (Juyal *et al*., 2005; CFSPH, 2009). AAT is caused by extracellular protozoan parasites of the genus *Trypanosoma* and it severely affects the livestock industry in Nigeria causing significant losses which ranges from a decrease in milk production to death (Swallow, 2000). The mature infective form of the parasite, metacyclic trypomastigote, is found in the invertebrate host where several reproductive and developmental stages take place (Peacock *et al*., 2012). Trypanosomes evade the immune system of the host because it possess a variable surface antigen (VSG) which prevents them from lysis by complement alternative pathway (Barry and Carrington, 2004; Vincendeau and Bouteille, 2006). AAT prevalence differed between regions with higher infection in southern Nigeria (Idehen *et al*., 2018, Odeniran and Ademola, 2018, Ngongolo *et al*., 2019, Kazosi *et al*., 2021). The host preferences of each trypanosome species vary but *T. vivax* are known to infect wide host range including cattle, goat, sheep, horse and donkey as they can be transmitted both cyclically by tsetse flies and mechanically by other biting flies (Duffy *et al.,* 2009) resulting in a distribution of infection beyond the "tsetse fly belt". Recently, there were reported cases of human infective trypanosomes (*Trypanosoma brucei gambiense*) isolated from domestic animals (Yanan, 2008; WHO, 2014).

Several studies reported the haematological and biochemical status of water buffaloes and cattle clinically affected by theileriosis, babesiosis, and anaplasmosis (Khan *et al*., 2011; Khattak *et al*., 2012; Atif *et al*., 2012). Adejinmi *et al.* (2004) reported anaemia as a reliable indicator for the severity of haemoparasitism. The ability of trypanosome species alone or in combination with other parasites to cause a significant reduction of PCV of infected animals lends credence to the fact that animal trypanosomiasis is still a serious challenge to profitable production in sub-Saharan Africa (Enwezor *et al.,* 2009). Qayyum *et al.* (2010) studied the haematological profiles in exotic and cross-bred cattle and found a significant decrease in the mean values of PCV, RBC count, Hb and total leukocyte count (TLC) in diseased compared with healthy cattle. Infection by one or more of trypanosome species results in acute or chronic disease which is characterised by intermittent fever, emaciation, anaemia, loss of appetite, weakness, corneal opacity, occasional diarrhoea, parasitaemia, coma and death if not treated (Fasanmi *et al*., 2014). It is therefore exigent to investigate the prevalence of these haemoparasites and the effects on haematological profile in one of the most abundant cattle breeds in Nigeria so as to device a control measure against the haemoparasites.

Materials and Methods

Study area

The study area was Bodija Abattoir, located in Ibadan North Local Government area of Oyo State, Nigeria. Ibadan is the largest city in West Africa and the second largest in Africa, with land size covering an area of 240 km^2. The city is located on geographic grid reference longitude 3º 58′E and latitude 7º 22′N (Filani, 1994). Ibadan has an altitude generally ranging from 185 to 222 m above mean sea level and is drained by three major river basins (Ogunpa, Ona and Ogbere). It is surrounded by secondary rainforest as well as savannah. Spatially, it sprawls over a radius of 12-15 km and experiences a mainly tropical climate with an estimated annual rainfall of about 1250 mm (UNCHS/UNEP, 1997). Bodija Abattoir is in Ibadan North Local Government Area.

Study period and sample collection

The study spanned December 2017 to October 2018. Samples were randomly collected from any twenty ready for slaughter adult White Fulani cattle every month for the duration of the study (11 months). This was because of the abundance of the breed in Nigeria. Three millilitres (3 mL) of blood were aseptically collected from the jugular vein of each targeted cattle. The blood samples were dispensed into Ethylene Diamine Tetra-acetic Acid (EDTA) bottles and taken for analysis at the laboratory of the Department of Veterinary Microbiology and Parasitology, Faculty of Veterinary Medicine, University of Ibadan, Nigeria.

Haematological and parasitological analysis

The various parameters were determined using the blood samples collected: The Packed Cell Volume (PCV), Haemoglobin concentration (Hb), Red Blood Cell Count (RBC), and White Blood Cell Count (WBC) were determined using the method described by Mafuvadze and Erlwanger (2007) and Tripathi *et al.* (2008). The Mean Corpuscular Volume (MCV) and Concentration (MCHC) were calculated mathematically (The Merck Veterinary Manual, 1998). Haemoparasites were detected using the techniques of wet mount, stained thin blood smear and buffy coat as prescribed by FAO (2005) and Maya *et al*. (2007). The wet mount specimens were examined using the ×40 objective lens while the thin blood smears were examined with the ×100 objective lens. The buffy coat was also examined under the ×10 and ×40 objective lenses for motile parasites. A minimum of 50 fields were searched per slide in each of the procedures adopted. Haemoparasites were identified to species level based on structural and morphometric criteria (Purnell, 1981; Norval *et al*., 1991).

Statistical analysis

Parasitological data were subjected to descriptive/inferential statistics (percentage) whereas the haematological values were analysed using GenStat (2005). Statistical means were separated with Duncan's New Multiple Range Test as described by Obi (2002).

Results and Discussion

Results

Monthly distribution of haemoparasites

Table 1 shows the monthly distribution of

haemoparasites in the study area. The results showed that out of 220 White Fulani cattle sampled, 105 of them had haemoparasitaemia of *Babesia* and *Trypanosoma spp*. A total of 12, 60, 13 and 65 cattle had *Babesia bovis, Babesia bigemina, Trypanosoma brucei* and *Trypanosoma vivax* respectively. There were also mixed infections among some of the infected cattle. It is evidenced courtesy of the results that there was greater infection during the peak of the rainy season of May to September accounting for 63 (60 %) out of 105 cases even though it only represented 5 out of the 11 months period of investigation.

Prevalence of Haemoparasites

Table 2 shows the prevalence of haemoparasite species in the study area. Out of 105 animals infected, 12 (5.45 %), 60 (27.27 %), 13 (5.91 %) and 65 (29.55 %) were due to *Babesia bigemina, B. bovis, Trypanosoma brucei* and *T. Vivax* with varying degrees of mixed infection. It was also evidenced that *Babesia spp* accounted for overall prevalence of 32.73 % whereas *Trypanosoma spp* had greater proportion of 35.45 %. Therefore, *B. Bovis* and *T. Vivax* were the most causes of haemoparasitaemia in the study area.

Haematological parameters

Table 3 highlights the haematological parameters of cattle in the study area. Although there was no significant difference ($p>0.05$) among the measured parameters except for the neutrophil, eosinophil and basophil where the infected were significantly higher ($p<0.05$) from the uninfected cattle, there were evidence of lower haematological values for the infected group. The reductions are not far-fetched since the parasites in question attacked and destroyed RBCs in circulation. There were however increased leucocytes count and the differentials which are typical in infected animals that are not immunocompromised since leucocytes help to ward off invading antigens.

Discussion

Distribution and Prevalence of Haemoparasites

Haemoparasitism remains a major threat to livestock industry in tropical and sub-tropical countries especially in cattle and small ruminants (Rajput *et al.,* 2006; Ademola and Onyiche, 2013). The main tick-borne diseases of veterinary importance in the tropical countries are theileriosis, babesiosis, cowdriosis and anaplasma (Perveen *et al*., 2021). Tick infestation in cattle is higher during the rainy season than the dry season since ticks have more successful reproduction cycles in wet and warm seasons than in dry cold periods (Walker *et al*., 2003; Geeta *et al*., 2013). Bovine babesiosis can be caused by a number of *Babesia* species, but *B. bovis*, *B. bigemina,* and *B. divergens* are the most important species, both economically, and clinically, in both water buffaloes and cattle (Jabbar *et al*., 2015). *B. bovis* is the most pathogenic species, followed by *B. bigemina,* and *B. divergens* (Figueroa *et al*., 2010). *Babesia bigemina* was however the main *Babesia* species found in a study in Northern Botswana (Raboloko *et al.,* 2020) similar to the present study. The higher prevalence of *B. bigemina* compared to *B. bovis* may be explained by wider vector range of *B. bigemina* (Walker *et al*., 2013; Raboloko *et al.,* 2020), a higher concentration of *B. bigemina* parasite in the capillary and veins than the *B. bovis* parasite which is evenly distributed in the whole blood vasculature (Rahman *et al*., 2010; Lemma *et al*., 2016) and tick infection rates are usually higher for *B. bigemina* (0.23 %) than *B. bovis* (0.04 %) (Mahoney and Mirre, 1971), with a consequent slower rate of transmission of the latter to cattle. Taken together, this would also suggest that, in an area where both species are present, endemic stability would be more likely to establish for *B. bigemina* compared to *B. bovis* (Bock *et al*., 2004). Similar to the present study, *B. bigemina* had a higher prevalence (29.5 %) compared to *B. bovis* (9.2 %) in Northern Botswana (Raboloko *et al.,* 2020) as well as in Rugombo and Giharo communes (90 %) of Burundi where the mean seroprevalence of *B. bigemina* in cattle sampled across all communes was 63.5 % (253/398) (Nyabongo *et al*., 2021). Of the 168 cattle sampled at Zaria abattoir, 16 were found to be infected with *B. bigemina*, representing 9.5 % (Onoja *et al*., 2013) whereas in the present study it was 5.45%.

Trypanosomiasis severely affects the livestock industry in Nigeria causing devastating and serious economic losses to livestock production ranging from a decrease in milk production to death (Swallow, 2000; Idehen *et al*., 2018). *Trypanosoma congolense*, *T. brucei*, *T. vivax and T. evansi* are the most important species that infect livestock in Nigeria. These trypanosomes are found where their biological vector (tsetse fly) and other biting flies (*Stomoxys, Tabanids*) exist (Juyal *et al*., 2005; CFSPH, 2009). The host preferences of each trypanosome species vary but *T. vivax* are known to infect wide host range (Duffy *et al.,* 2009). Trypanosomes evade the immune system of the host because it possesses a variable surface antigen (VSG) which prevents them from lysis by complement alternative pathway (Barry and Carrington, 2004; Vincendeau and Bouteille, 2006). AAT prevalence differed between regions with higher infection in southern Nigeria (Odeniran and Ademola, 2018). Although microscopy is not as sensitive as serology and PCR (Office International des Epizooties, 2013; Takeet *et al*., 2013), it had however, showed a higher prevalence of *T. vivax*, while serology and PCR revealed a higher *T. congolense* (Odeniran and Ademola, 2018). Possibly this might be the reason why there is higher prevalence of *T. vivax* in the present study. Infection by one or more of these trypanosome species results in acute or chronic disease, which is characterised by intermittent fever, emaciation, anaemia, loss of appetite, weakness, corneal opacity, occasional diarrhoea, parasitaemia, coma and death if not treated (Fasanmi *et al*., 2014). Outbreak of diseases especially trypanosomiasis in cattle herds is one of the major problems militating against the cattle industry in the tropics including Nigeria (Samdi *et al*., 2008). The overall trypanosomiasis prevalence of 35.45 % got in the present study was lower than 53.4 % reported by Kalu (1991) during an outbreak of bovine

trypanosomiasis in Kaura LGA of Kaduna State, similar to 31.62 % obtained in cattle in derived savanna areas of ogun State (Sam-Wobo *et al*., 2010) but higher than 9.1 %, 9.4 %, 8.4 %, 1.2 % and 3.98 % by Samdi *et al*. (2011), Kneeland *et al*. (2012), Hargrove *et al*. (2012) and Machina *et al*. (2017) in Kaduna State respectively. It is equally lower than 3.9 % in grazing cattle in Ogbomoso, Oyo State (Onyia, 1997) and 4.6 % by Fasanmi *et al*. (2014) in cattle from three farms in Iddo local government area, Oyo State. The probable reason for higher prevalence in the present study could be attributed to the length of study duration which cut across dry and rainy seasons, the possibility that the animals via transhumance moved across all tsetse endemic vegetations from Northern to southern Nigeria and were not given any trypanocide chemoprophylaxis since they were slated for slaughter for health and economic reasons. The higher prevalence of *T. vivax* in the present study is in consonance with previous reports in Nigeria (Kalu *et al*., 1996; Agu and Amadi, 2001; Ameen *et al.,* 2008, Fasanmi *et al*., 2014). The higher prevalence of *T. vivax* may be connected with its molecular biology which may have played a role in conferring it with resistance against both drugs and host defence (Fasanmi *et al*., 2014). The climatic variations across different geographical regions, type of husbandry practices adopted and type and time of administration of trypanocides are factors that can influence prevalence rate. This may thus account for the observed variation in the prevalence rate of bovine trypanosomiasis reported by the different workers.

Haematological Parameters

PCV of the infected cattle was within the normal range of 24 to 46 % (Aengwanich *et al*., 2009; Weiss and Wardrop, 2010). Consequently, the slaughtered animals were probably not anaemic thus the meat quality might not have been affected. The present results on PCV are in tandem with Ademola and Onyiche (2013) that reported no difference ($p > 0.05$) in the mean PCV of animals with mixed or single infection but differed from the result of Adua and Idahor (2017) who reported that the non-infected cattle had PCV of 33.14±4.00 which was statistically higher ($p<0.05$) than 30.26±4.65% recorded in the infected ones. Unlike Qayyum *et al.* (2010) that studied the haematological profiles in exotic and cross-bred cattle and found a significant decrease in the mean values of PCV, RBC count, Hb, and total leukocyte count (TLC) in diseased compared to healthy cattle, the present result got decreased PCV, RBC count and Hb concentration while the TLC was increased. The neutrophilia, eosinophilia and basophilia observed in the present study could be due to haemolysis orchestrated by the haemoparasites hence Kraft and Dürr (2005) and Webb and Latimer (2011) reported that neutrophilia is associated with haemorrhage and haemolysis, whereas Kraft and Dürr (2005), Jones and Allison (2007) and Tornquist and Rigas (2010) affirmed that eosinophilia is caused by parasitic infection similar to the claims of Brown *et al*. (1984) and Tornquist and Rigas (2010) that basophilia has been linked with parasitic infection by ticks.

Conclusion

The results showed the presence of *Babesia bigemina*, *B. bovis*, *Trypanosoma brucei* and *T. vivax* in the study area and by extension Nigeria, since these animals are usually brought from Northern Nigeria. A better epidemiological design should be coined to investigate the probable cause and remedy of very high prevalence

Table 1: Monthly distribution of haemoparasites in the study area

Month	Sample No	No -ve	No +ve	*Babesia bovis*	*Babesia bigemina*	*Trypanosoma brucei*	*Trypanosoma vivax*
Dec 2014	20	11	09	-	4	3	4
Jan 2015	20	13	07	-	3	2	4
Feb 2015	20	12	08	2	2	1	5
Mar 2015	20	14	06	-	3	-	4
Apr 2015	20	14	06	1	2	2	4
May 2015	20	08	12	1	5	1	8
Jun 2015	20	05	15	3	8	-	10
Jul 2015	20	04	16	-	11	1	9
Aug 2015	20	09	11	2	9	2	6
Sept 2015	20	11	09	2	9	1	7
Oct 2015	20	14	06	1	4	-	4
Total (%)	220	115	105	12	60	13	65

Table 2: Prevalence of haemoparasite genera in the study area

Parasite	No of sample	No +ve	Prevalence (%)	Overall genera prevalence (%)
Babesia bigemina	220	12	5.45	
Babesia bovis	220	60	27.27	32.73
Trypanosoma brucei	220	13	5.91	
Trypanosoma vivax	220	65	29.55	35.45

Table 3: Haematological parameters of cattle in the study area

Parameter	Uninfected cattle Mean ±SEM	Infected cattle Mean ±SEM
P CV (%)	30.08 ± 3.22	28.02 ±2.25
Hb (g/dl)	10.60± 1.17	9.42 ± 0.75
RBC ($x10^{12}$/L)	10.66± 1.08	9.94 ± 0.15
WBC ($x10^{9}$/L)	12.34 ±1.62	15.15± 1.09
Platelets ($x10^{9}$/L)	8.83±1.15	9.01±0.92
MCV (fL)	28.22 ±4.23	28.19±3.06
MCHC (g/dL)	35.24±2.17	33.62±3.31
Lymphocytes (%)	34.67±0.63	35.51±0.21
Neutrophils (%)	44.13 ± 0.84^{b}	64.57 ± 0.52^{a}
Eosinophils (%)	1 ± 2.05^{b}	5 ± 0.34^{a}
Basophils (%)	1 ± 0.22^{b}	2 ± 0.31^{a}

^{ab} = different means on the same row are statistically different ($p<0.05$)

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