Haemoparasites and Polyparasitism of Intestinal Helminths of Cattle Slaughtered in Abeokuta, Nigeria and Their Implications for One Health.

Oluwadamilare Dauda (✉ daredauda92@gmail.com)

Osun State University <https://orcid.org/0000-0003-3846-4401>

Olabanji Surakat

Osun State University

Muhammed Rufai

Osun State University

Foluke Akande

Federal University of Agriculture Abeokuta

Monsuru Adeleke

Osun State University

Sunday Akinde

Osun State University

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1 TITLE PAGE

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4 CATTLE SLAUGHTERED IN ABEOKUTA, NIGERIA AND THEIR IMPLICATIONS FOR
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6 AUTHORS AND AFFILIATIONS

7 1. Author 1 - Oluwadamilare Ganiu Dauda

8 Affiliation: Osun State University, Osogbo, Osun State, Nigeria.

9 2. Author 2 - Olabanji Surakat

10 Affiliation: Osun State University, Osogbo, Osun State, Nigeria.

11 3. Author 3 - Mohammed Rufai

12 Affiliation: Osun State University, Osogbo, Osun State, Nigeria.

13 4. Author 4 - Foluke Akande

14 Affiliation: Federal University of Agriculture, Abeokuta, Ogun State, Nigeria

15 5. Author 5 - Sunday Akinde

16 Affiliation: Osun State University, Osogbo, Osun State, Nigeria.

17 6. Author 6 - Monsuru Adeleke

18 Affiliation: Osun State University, Osogbo, Osun State, Nigeria.

19 @Corresponding author

20 E-mail: dare_dauda@yahoo.com

21

ABSTRACT

Background: Haemoparasites and intestinal helminths are major constraints to livestock production resulting in huge economic loss and some helminth parasites of cattle are of serious public health concern. This study investigated the prevalence of haemoparasites and polyparasitism of intestinal helminths amongst cattle slaughtered in two major abattoirs of Abeokuta metropolis and their implications for One Health.

Results: Results showed prevalence for *Trypanosoma* spp., *Babesia* spp., *Anaplasma* spp. and *Theileria* spp. to be 8.3%, 27.34%, 20.7% and 0.39% respectively. For intestinal parasites, prevalence for *Strongyle* eggs was found to be 73.82%, *Neoascaris vitulorum* 0.8%, *Fasciola* spp. 10.15%, *Moniezia* spp. 4.3%, *Eimeria* oocyst 35.94% and *Cryptosporidium* oocyst was 1.17%. Total prevalence for coinfection of haemoparasite and intestinal helminths was 42.6%. Breed-specific prevalence for co-infection of haemoparasites and intestinal parasites showed 55.96%, 37.6% and 6.4% for White Fulani, Red Bororo and Sokoto Gudali respectively, which was statistically insignificant ($P > 0.05$). With respect to sex, females had higher prevalence 92 (84.4%) of coinfection of haemoparasites and intestinal helminths than males 17 (15.6%), which was statistically significant ($P < 0.05$).

Conclusions: This study revealed a high prevalence of haemoparasites and intestinal parasites in cattle slaughtered in Abeokuta, Nigeria. This study therefore recommends strict compliance of meat inspection at abattoirs and the need for immediate operationalization and implementation of a sustainable Preventive One Health intervention in order to mitigate against outbreak of zoonoses in Abeokuta.

Keywords: Prevalence, Haemoparasites, Intestinal helminths, Cattle, Abeokuta, One Health

1. BACKGROUND

In Nigeria, ruminants such as the sheep, goats and cattle constitute the livestock largely reared by farmers in the agricultural sector of the country with sheep having a population of 38.5million, 57.4million goats and 19.2 million cattle (Adebowale et al. 2020) with larger population of these animals largely concentrated in the northern region of the country than the south (Lawal-Adebowale, 2012). Among the ruminants, cattle are regarded as the main source of animal protein in most household and their products such as milk, hoof, bones, blood, hides and skin have great economic benefits (Sam-wobo et al. 2016). 90% of the cattle population in Nigeria are raised under the pastoral husbandry system of Fulani herders (Musa et al. 2014). Under the pastoral husbandry system where cattle are extensively grazed on pastures and forests, cattle may be exposed to various arthropod vectors of haemoparasites (Kamani et al. 2010). Livestock rearing is faced with a number of constraints which limits productivity and profitability (Bakre et al. 2020). A leading constraint to livestock production is animal diseases which constitute a major obstacle to economic development and of importance is parasitism, a leading cause of production losses due to mortality, reduction in weight gain, low fertility in most countries of the world (Musa et al. 2014).

Haemoparasites are found in the blood stream and tissues of vertebrates throughout the world (Pam et al. 2013). Haemoprotozoan diseases especially Babesiosis, Anaplasmosis, Trypanosomiasis and Theileriosis are major diseases causing major constraints to the health and productivity of cattle (Ochai & Kolhatkar, 2007). Even though there is a global distribution of haemoparasites, the distribution of these infections changes continuously due to the migration and transportation of vectors and animals and an increased globalization of both live animals and their products (Stuen, 2020).

Several studies have been conducted on haemoparasites in Nigeria. Imalele et al. (2019), in their study on the prevalence of haemoparasites in cattle slaughtered for sale in Calabar reported a prevalence of 11.66%. Akande et al. (2010) in their study on the prevalence of haemoparasites in Abeokuta reported overall infection of 51%. In another study by Okwelum et al. (2021) in Abeokuta, a prevalence of haemoparasites in slaughtered cattle was reported to be 22%.

Helminthic infection, according to Faye et al. (2003), is a cosmopolitan disease that affects ruminants, most particularly in places with poor hygiene and feeding. The gastrointestinal parasites, mainly helminths are responsible for the clinical and subclinical manifestation of

diseases of livestock and this has been a major impedance to livestock production in Nigeria (Biu & Adindu, 2004). Gastrointestinal parasites of cattle have caused production loss to livestock by retarding the growth, lowering productivity and increasing susceptibility of animals to other infections (Yadav et al. 2006). Lowered fertility, reduced work capacity, involuntary culling and treatment cost are other indirect economic losses due to gastrointestinal parasites (Zahid et al., 2005). According to Zahid *et al.* (2005), intestinal helminths of ruminants are mostly nematodes such as *Trichuris* species, *Strongyliodes* species, *Capillaria* species, *Ostertagia* species; cestodes such as *Moniezia* species, *Taenia* species; and trematodes such as *Fasciola gigantica*, *Dicrocoelium* species.

Weakness of the body, abdominal pains, anorexia, diarrhea, enteritis, constipation, loss of weight, jaundice, rough hair coat, anaemia, alopecia, coughing, labour breathing, fever, haemoglobinuria, infertility, abortion and sudden death are clinical manifestations of haemoparasites and gastrointestinal parasites of cattle noted by Otto et al. (2000), Love & Hutchinson (2003) and Otto (2005).

In Ogun state, seperate studies on haemoparasites and intestinal helminths have been previously conducted, however, there is a need to continually have updated information on the prevalence of haemoparasites and intestinal helminths especially in cattle slaughtered in Abeokuta metropolis. Also, this study became imperative considering the emphasis on food safety by the Food and Agriculture Organization (FAO). The data from this study will therefore provide substantial and updated information on the prevalence of haemoparasites and intestinal helminths in cattle slaughtered in Abeokuta, their implications for public health and also provide epidemiological data for effective surveillance and control of zoonotic diseases in Abeokuta metropolis.

2. METHOD

2.1 The Study Area

The study was conducted in two major abattoirs in Abeokuta metropolis, the Ogun state capital. The Lafenwa abattoir (7°09'46" N and 3°19'40" E) located in Abeokuta North local government area of Ogun state, Nigeria. Aladesanmi (Asejere) abattoir, is in Abeokuta South Local Government (7°09'45" N and 3°22'33" E). These two abattoirs are the major abattoir in Abeokuta metropolis with the Lafenwa abattoir slaughtering an average of 100 cattle a day.

2.2 Study Design and Selection of Cattle

The survey of haemoparasites and polyparasitism of intestinal parasites in cattle slaughtered in the two abattoirs was carried out between February 2021 and June 2021. A total of 256 cattle were selected and tagged from the lots prepared for daily slaughter. The samples cut across both sexes and different breeds of cattle that include White Fulani, Sokoto Gudali, Red Fulani, Crossbreed and N'Dama. The cattle were grouped into < 2years and > 2years using their dentition.

2.3 Ethics Approval

Approval and permission for the study was given by the ethics committee of Veterinary Services Unit of the Ogun State Ministry of Agriculture, Abeokuta, Ogun State.

2.4 Blood Sample Collection

5ml of blood samples were collected from the jugular vein of the animal at the point of slaughtering in a sterile ethylene diamine tetra acetic acid (EDTA) tube which was labelled immediately with the location, breed, sex and age of the cattle and placed in ice pack. The samples were then transported to the laboratory of the Department of Veterinary Microbiology and Parasitology, Federal University of Agriculture, Abeokuta for laboratory analysis.

2.5 Faecal Sample Collection

100g of faecal samples were obtained directly from the rectum of each animal with the use of a hand glove. The samples were immediately labelled with the location, breed, sex and age of cattle before been transferred into a clean disposable polythene bag and transported in ice pack to the

laboratory of the Department of Veterinary Microbiology and Parasitology, Federal University of Agriculture, Abeokuta for laboratory analysis.

2.6 Blood Sample Analysis

The Packed Cell Volume (PCV) of the blood samples was done to check for anaemia using the technique of Schalm et al. (1975). The haemoparasites were detected using three techniques. The techniques are wet mount, stained thin blood smear and the buffy coat as prescribed by Cheesbrough (1998). The wet mount specimens and buffy coat were examined using the X10 and X40 objective lens while the thin blood smears were examined using the X100 objective lens.

2.6.1 Packed Cell Volume

The EDTA tube containing blood sample was held at an angle to mix the blood sample and the index finger placed on top of the capillary tube in order to track blood into the capillary tube until it was about $\frac{3}{4}$ full. The outside of the capillary tube was wiped with clean tissue and the capillary tube was placed on the plasticine (sealant) and gently pressed into the plasticine. The capillary tubes were placed in the Hawksley haematocrit centrifuge with the plasticine end of the capillary tubes placed against the rubber (outer) edge to stop the blood from spilling out when spun. It was centrifuged at 12000rpm for 5mins. Once the centrifuge came to a complete stop, the lid was opened and the tubes checked to ensure there were no leakages. Each of the capillary tubes was then removed and placed on the haematocrit reader. The tube was adjusted on the slider so that the top of the plasticine was level with the bottom line (0%). The slider was also moved so the top of the plasma fraction levels with the top line. The adjuster on the left was used to align the middle line with the top of the red cells. The PCV was read from the right-hand side scale.

2.6.2 Wet Mount

A drop of blood was dropped on a clean objective glass slide using a plastic pipette. This was then covered with coverslip and immediately examined under the microscope using the x10 and x40 objective lens.

2.6.2 Buffy Coat Technique

After centrifuging, the blood in the capillary was separated into three distinct layers; plasma at the top, the buffy coat at the middle and the red cells at the bottom. The capillary tube was broken at the site red blood cell layer just about 1mm below the buffy coat. This was carefully done by pressing and running the sharp edge of an objective glass slide over the capillary tube. The buffy coat with the adjacent plasma was transferred into an objective glass slide, mixed and covered with a coverslip (18 x 18mm) and was examined for motile trypanosomes under microscope using x10 and x40 objective lens.

2.6.3 Thin Blood Smear

A capillary tube was used to place a drop of blood on one end of a clean objective glass slide. Using a clean smooth-edged glass objective slide as spreader, the spreader was drawn back to touch the drop of blood and the blood was allowed to extend along the edge of the spreader. Holding the spreader at about angle 30°, the drop of blood was spread to make a film about 40–50 mm in length (two thirds of the slide). The film was left for a few minutes to air dry and the specimen number was written on the film for easy identification. The film was placed on a staining rack and fixed in absolute methanol and allowed to dry. After drying, a reverse staining with Field Stain A and B was done and left to dry after which it was viewed under the X100 objective lens.

2.7 Faecal Sample Analysis

Collected fecal materials were subjected to centrifugal sedimentation technique and centrifugal fecal flotation technique according to Zajac & Conboy, 2012.

2.7.1 Centrifugal Sedimentation Technique

10g of faeces was put in a dish container and emulsified with 100mL of water. The faecal sample was sieved through a tea strainer into a beaker. It was then poured into a 15mL centrifuge tube until it was three-quarter full. It was centrifuged for 5 minutes at 1500rpm. After centrifugation, the supernatant was discarded leaving the sediments. Using the Pasteur pipette, a few drops of the sediment were placed on a glass objective slide, covered with a coverslip and viewed under the x10 and x40 objective lens.

2.7.2 Centrifugation Flotation Technique

Salt/sugar solution was used as flotation solution. It has a specific gravity of 1.28. This was prepared by dissolving 400g of Sodium Chloride in 1000mL of distilled water to make a saturated solution. 500g of sugar was then added to the saturated salt solution and was stirred until the sugar was fully dissolved.

Flotation solution was poured into the sediment inside the 15mL centrifuge tube until it was almost full and was centrifuged for 5 minutes at 1500rpm. After centrifugation, the tube was removed from the centrifuge and placed in a test tube rack. Additional flotation solution was added until it formed a reverse meniscus at the top of the tube. Coverslip was immediately placed on the tube and allowed to sit for 5 to 10 minutes before removing the coverslip and placed on a glass objective slide for viewing under the microscope using the x10 and x40 objective lens.

2.8 Data Analysis

The data obtained from the study were analysed descriptively with the use of IBM SPSS 21 software package. Descriptive statistics was deployed in determining the prevalence estimates and chi-square analysis were made in comparing the demographic variables with prevalence estimates. The mean Packed Cell Volume (PCV) was ascertained using t-test. Confidence interval was set at $P \leq 0.05$.

3 RESULTS

3.1 The demographic information of cattle in the study area

A total of 256 cattle were examined for haemoparasites and intestinal helminths. According to sample distribution, 217 (84.8%) blood and stool samples were collected in Lafenwa while 39 (15.2%) were collected in Aladesanmi abattoirs respectively. In the sex category, 57 (22.3%) were male while 199 (77.7%) were female. By age category, 246 (96.1%) were above 2 years while 10 (3.9%) were below 2 years. Distribution by breed reflected that 149 (58.2%), 87 (34.0%), 17 (6.6%), 2 (0.8%) and 1 (0.4%) of cattle were white fulani, red bororo, sokoto gudali, N'dama and crossbreed respectively. (Table 1)

3.2 Cumulative Prevalence of Haemoparasites across breed, sex, age and geo-location in the study area

In relation to sex, females had the highest prevalence of *Babesia* 59 (29.6%), *Trypanosoma* 17 (8.5%), *Anaplasma* 44 (22.1%) and *Theileria* 2 (1.0%). With regards to breed, Sokoto gudali had the highest prevalence 8 (47.1%) of *Babesia* spp., followed by the white fulani 41 (27.5%), while the red bororo 8 (9.2%) had the highest prevalence of *Trypanosoma* spp. followed by white fulani 12 (8.1%). However, the differences in prevalence across breed, sex, age, and location for all the haemoparasites was found to be insignificant ($P > 0.05$). (Table 2)

3.3 Prevalence of coinfection of haemoparasites

In relation to breed, white Fulani had the highest prevalence 5 (2.0%) of coinfection followed by the red Bororo 3 (1.2%), however, using statistical analysis, the difference was found to be insignificant ($P > 0.05$). With respect to sex, females had a higher prevalence 7 (2.7%) of coinfection than male 2 (0.8%) and this difference was found to be significant ($P < 0.05$). With respect to location, cattle at the Lafenwa abattoir had a higher prevalence 9 (3.5%) of coinfection of haemoparasites than the Aladesanmi abattoir which recorded 1 (0.4%) prevalence. The difference in prevalence was found to be significant ($P < 0.05$) (Table 3)

3.4 Relationship between haemoparasite infection and the PCV

The mean PCV of infected was 26.46 while for non-infected was 29.28. The mean PCV of those infected was found to be significantly lower than those uninfected ($P < 0.05$). This means that low PCV could be an indication of the presence of haemoparasites in cattle. (Fig. 1)

3.5 Prevalence of intestinal helminths in study area

Helminths detected include Strongyle eggs, *Eimeria* oocyst, *Moniezia benedini*, *Fasciola* spp., *Neoscaris vitulorum* and *Cryptosporidium* oocyst. Of the 256 samples analysed, Strongyle eggs had the highest prevalence 191 (74.6%) and *Neoscaris vitulorum* had the lowest prevalence 2 (0.8%). *Moniezia benedini*, *Eimeria* oocyst, *Fasciola* spp. and *Cryptosporidium* oocyst had prevalence of 10 (3.9%), 93 (36.3%), 26 (10.2%) and 3 (1.2%) respectively (Fig. 2)

3.6 Distribution of Intestinal Helminth infection in Study Area

Total prevalence of intestinal helminths was 209 (81.64%). A total of 112 (43.8%) had single infection of intestinal parasite. 84 (32.81%) had double infection of intestinal parasite while 13 (5.07%) had multiple infections of intestinal helminths (more than 2 infections of helminth) (Fig. 3)

3.7 Polyparasitism of Intestinal Helminths across breed, sex, age and location

Total prevalence of intestinal helminths was found to be 209 (81.64%). In respect to breed, White Fulani had the highest prevalence of double infection 45 (30.2%), followed by the red bororo with prevalence of double infection 33 (37.9%) but the difference wasn't significant ($P > 0.05$). With respect to age, cattle above 2 years had higher prevalence of double infection 80 (32.9%) and multiple infection 14 (5.8%) than cattle below 2 years with a prevalence of double infection 3 (23.1%) and 0 (0%) multiple infection which were also found to be insignificant ($P > 0.05$) (Table 4)

3.8 Prevalence of *Fasciola* spp. in study area

The prevalence of *Fasciola* spp. was found to be 26 (10.2%) and all was found at the Lafenwa abattoir. White fulani had the highest prevalence 14 (5.5%), followed by red bororo 11 (4.3%) and Sokoto gudali 1 (0.4), this difference was insignificant ($P > 0.05$). In respect to sex, females had higher prevalence 25 (9.8%) than males 1 (0.4%) and the difference was found to be significant ($P < 0.05$). Age-specific prevalence, cattle above 2years had a higher prevalence 26 (10.2%) than those below 2 years, however, the difference was insignificant ($P > 0.05$) (Table 5)

3.9 Prevalence of Coinfection of Haemoparasites and Intestinal Helminths in Study Area

The total prevalence of coinfection of both haemoparasites and intestinal helminth was found to be 109 (42.6%). White Fulani had the highest prevalence of coinfection 61 (23.8%) for both haemoparasite and intestinal helminth followed by Red Bororo 41 (16.0%), although the difference was found to be insignificant ($P > 0.05$). in respect to age, prevalence was higher in cattle above 2 years 103 (40.2%) than those below 2 years 6 (2.3%) and difference was also found to be insignificant ($P > 0.05$). However, with respect to sex, females had higher prevalence 92 (35.9%) for coinfection of both haemoparasites and intestinal helminths than males 17 (6.6%), this difference in prevalence was found to be significant ($P < 0.05$) (Table 6)

GIS DISTRIBUTION OF HAEMOPARASITES AND INTESTINAL HELMINTHS IN STUDY AREAS

The GIS distribution of haemoparasites and intestinal helminths in the study areas are shown in fig. 4 and fig. 5 respectively.

283 4 DISCUSSIONS

284 Findings from this study show that haemoparasites and intestinal helminths are highly prevalent
285 in the study area. The prevalence of 53.9% of haemoparasites observed in this study is higher than
286 the prevalence observed by Nzeako & Okorafor (2014) where a prevalence of 6.67% was reported
287 in their study in Ibadan and also the prevalence of 22% reported by Okwelum et al. (2021) in their
288 report on epidemiological survey of haemoparasitic infection in trade cattle at slaughter in Lafenwa
289 abattoir but similar to the findings of Akande et al. (2010) where a prevalence of 51% was reported
290 in their study on haemoparasites in cattle in Abeokuta. This finding is also similar to the findings
291 reported by Talabi et al. (2009), where a prevalence of 50.2% was reported in the Trans boundary
292 areas of Ogun State, Nigeria and 54% prevalence in sheep at Abeokuta, Ogun State by Takeet et
293 al. (2009). However, the prevalence of 53.9% reported in this study is slightly lower than
294 prevalence of 70% reported by Bakre et al. (2020) in their study in Igboora. The differences in
295 prevalence of haemoparasites values in various locations, according to Velusamy et al. (2014),
296 could be attributed to differences in geographical location and time periods and also differences in
297 distribution of vectors which transmits the parasites (Agbede, 2013).

298 Breed specific prevalence showed the highest prevalence in the white fulani breed (31.3%)
299 followed by the red bororo (18.8%) and then sokoto gudali (3.5%), the difference was however
300 not significant ($P > 0.05$). This is almost similar to the finding of Bitrus *et al.* (2021) in their study
301 of the occurrence of haemoparasites in cattle slaughtered at Jalingo abattoir where the white fulani
302 (13.91%) had the highest prevalence followed by the red bororo (10.94%) and sokoto gudali
303 (10%). This is most likely due to the fact that the white fulani is the dominant breed in the study
304 area. Sex-specific prevalence, the females had a higher prevalence (44.9%) than males (9.0%).
305 The difference in prevalence between sexes was found to be significant ($P < 0.05$). This is similar
306 to what was observed by Enwezor et al. (2009), Pam et al. (2013), Nzeakor & Okorafor (2014),
307 Obed & Imafidor (2018) and Bitrus et al. (2021). This observable difference could be attributed to
308 accumulation of parasites by the females due to the extended breeding practices for economic
309 reasons such as calving and milk production (Nzeakor & Okorafor, 2014).

310 With respect to age, prevalence was higher in cattle above 2years (51.6%) than those below 2years
311 (2.3%) even though this difference was found to be statistically insignificant ($P > 0.05$). The
312 difference is probably due to the higher distribution of cattle above 2years.

The high incidence of haemoparasites recorded in this study, according to Adejinmi et al. (2004) could be as a result of favourable environmental condition that helps in the survival and proliferation of the arthropod vectors responsible for the transmission of these parasites. According to oral findings from butchers and cattle owners at the Lafenwa abattoir, it is noteworthy that most of the cattle were brought in from the Northern part of the country. Several studies on infestation of tick on the cattle population in the Northern part shows high prevalence, this may explain the high prevalence of tick-borne diseases observed in this study. Adejoh et al. (2019) reported a prevalence of 56% tick infestation in their study on survey of ticks and tick-borne parasites in commercial cattle at Lafia, Nasarawa State, Nigeria. Tongjura et al. (2012) and James-Rugu & Jidayi (2004), in separate studies on tick infestation in the Northern part both reported prevalence of 73.3% and 81.8% respectively. This may also be responsible for two tick-borne parasites, *Babesia* (27.7%) and *Anaplasma* (20.7%) having the highest prevalence in this study.

The mean PCV of infected cattle (26.46) was significantly lower ($P < 0.05$) than non-infected cattle (29.28). This is in line with the observation of Akande et al. (2010), Imalele et al. (2019), Zawua et al. (2015), Sam-wobo et al. (2010) and Bakre et al. (2020). Zawua et al. (2015) opined that the low PCV in infected cattle could be as a result of biochemical activity of the parasites which causes a destruction of the red blood cells, invariably leading to anaemia.

The high prevalence of haemoparasites in this study has further shown that proper vector control methods need to be implemented to ensure prevalence of haemoparasites is significantly reduced.

This study also provides the current status on the prevalence of intestinal parasites of cattle slaughtered in Abeokuta, Ogun State and their implications to public health. The overall prevalence of intestinal parasites was 209 (81.6%) including helminth eggs and *Eimeria* oocyst. This prevalence is within the range of the finding of Takeet et al. (2014) where the prevalence of 95.12% was reported in their study on prevalence of gastrointestinal parasites of cattle in Abeokuta and also the finding of Yuguda et al. (2018) where a prevalence of 74.3% was reported in their study on gastrointestinal helminths of slaughtered cattle in Bauchi Central Abattoir. Okike-Osisiogu et al. (2016) also reported prevalence of 87.4% in their study on the prevalence of intestinal parasite in cattle slaughtered in Aba. Gastrointestinal nematode was observed to have the highest prevalence (84.8%), a similar observation to the report of Adedipe et al. (2014) in their study on gastrointestinal helminths in Ibadan where prevalence of 71.7% was reported. According

to Jatau *et al.* (2011), prevailing climatic conditions especially rainfall and temperature favour the development and survival of parasitic nematode eggs to infective stages and this might explain the high prevalence observed as this study was conducted during the early season of rainfall.

High nematode infection greatly affects livestock production by causing reduction in milk, meat, wool, hide products, and strength of animals (Nwosu *et al.* 2007; Ekong *et al.* 2012), also leads to decreased growth rate, weight loss in young ruminants and late maturity (Swai *et al.* 2006). Nematode infection is followed by trematode (10.2%) and cestode (3.9%). This is consistent with the observation by Adedipe *et al.* (2014). A lot of the animals in this study have multiple gastrointestinal parasitic infection suggesting they could be suffering from parasitic gastroenteritis (PGE) complex which is more prevalent during the rainy season (Jatau *et al.* 2011).

Neoascaris vitulorum (0.8%) and *Fasciola* spp. (10.2%) are two parasites with zoonotic potential observed in this study. The prevalence of *Fasciola* (10.2%) is lower than 29.8% prevalence reported by Karshima *et al.* (2016) and 27.68% reported by Magaji *et al.* (2014) but almost in consonant with the 13.37% prevalence reported by Liba *et al.* (2018) in their study on prevalence of fascioliasis in cattle slaughtered at Maiduguri.

Breed-specific prevalence for *Fasciola* spp., the white fulani had the highest prevalence 14 (5.5%) followed by the red bororo 11 (4.3%) and then sokoto gudali 1 (0.4), however, the difference was not significant. With respect to age, cattle above 2 years had higher prevalence 26 (10.2) than cattle below 2 years, the difference was also found not to be significant. The huge disparity seems to be as a result of the sample size, however, with respect to sex, females had a higher prevalence 25 (9.8%) than males 1 (0.4%) and this difference was found to be significant ($P < 0.05$). This finding deviates from the findings of Magaji *et al.* (2014) and Jegede *et al.* (2015) but correlates with the reports of Biu *et al.* (2006), Aliyu *et al.* (2014) and Karshima *et al.* (2016) where female cattle had higher prevalence than male. The observable higher prevalence by females may be due to stress associated with hormonal imbalances during pregnancy in female animals which increases their susceptibility to infections coupled with the fact that female cattle are normally kept longer in herds for the purpose of breeding (Karshima *et al.* 2016). Fasciolosis is a parasitic worm infection of veterinary and medical importance. It is caused by either *Fasciola gigantica* or *Fasciola hepatica*.

In this study, *Neoscaris vitulorum* was also observed with a prevalence of 2 (0.8%). *Neoscaris vitulorum* (also called *Toxocara vitulorum*) is the most important parasite responsible for calf mortality and morbidity under three months of age in tropical countries and heavy burden of the adult *T. vitulorum* in young calves could result in high mortality rate and economic losses (Srivastava & Sharma, 1981).

Co-infection of haemoparasites and intestinal helminths was also studied. The overall prevalence of co-infection of at least one haemoparasite and at least one intestinal helminth was found to be 109 (42.6%). There was a high prevalence of co-infection of haemoparasite and intestinal helminths in the white fulani 61 (23.8%), followed by the red bororo 41 (16.0%) and then followed by the Sokoto gudali 7 (2.7%) but the difference was not significant ($P > 0.05$). The prevalence observed is as a result of the disparity in sample size. Sex-specific prevalence, females had higher prevalence 92 (35.9%) of co-infection of haemoparasite and intestinal parasite than males 17 (6.6%) and this difference was found to be significant ($P < 0.05$). This was also observed by Pam et al. (2013) in their study on the occurrence of haemoparasite and gastrointestinal parasite of cattle in Jos. The reason for high prevalence in female could be as a result of long-term exposure due to their prolonged stay in herds for production purpose.

According to Pam et al. (2013), the high prevalence of co-infection reported may be as a result of continued contamination of feed and water these animals consume by their faecal matter and even in advance countries where disposal of both animals and human excreta to farm land, and on pasture, may lead to direct infection. Poor farming practices such as poor deworming program, and poor control of ectoparasites may also contribute to the high prevalence of infections.

4.1 Implications for one health

The practice of using hands to remove certain tick species especially *Amblyomma variegatum* by the farmers puts them at risk of tick bites and, consequently to zoonotic pathogens they may transmit (Katswara & Mukaratirwa, 2021). *Amblyomma* tick bites are painful and can transmit diseases including African tick bite fever to humans (Anna, 2009). Cattle can also be reservoir host of trypanosome species that can infect man.

Most intestinal parasites spend a part of their life cycle outside the definitive host when eggs are excreted into the environment. Environmental conditions, biotic (availability of intermediate host and predation of helminth eggs and larva) and abiotic (rainfall, temperature, humidity and soil pH) factors play important roles in the survival and transmission of helminths.

There is an interconnectivity between humans and animals and their shared environment. In order to prevent outbreak of zoonotic diseases, the one health approach is important. The One Health strategic goal, according to Sara et al. (2020) is to prevent, detect and control disease that pose a major public health risk and also involve sustainable practices in agriculture and improving the overall health and well-being of humans, animals, and their shared environment. The one health strategy understands the interconnection between people, animals and their environment. It recognizes the fact that a single sector cannot effectively address issues of such a broad interconnectivity and hence proposes a collaborative and interdisciplinary approach with the goal of achieving optimal health outcomes (CDC, 2018). Both from the veterinary and the human public health point of view, fascioliasis is a serious “One-Health” problem (Rinaldi *et al.* 2012). The one health approach is jointly supported by WHO, FAO, and OIE to tackle zoonotic diseases (Lubroth, 2013; WHO et al. 2019).

Experts in these three sectors need to come up with strategies targeted at investigating some of the knowledge gaps, development of control strategies, vector control, treatment of zoonotic infections and analysis of burdens.

5. CONCLUSIONS

In conclusion, this study reveals a high prevalence of tick-borne diseases and intestinal helminths of veterinary and zoonotic importance in cattle slaughtered in Abeokuta. It also reveals complex cases of polyparasitism of intestinal helminths in cattle slaughtered in Abeokuta. The presence of *Fasciola* spp. at the Lafenwa abattoir which is the major abattoir for beef sourcing in Abeokuta shows that there is a need to ensure strict compliance of meat inspection at abattoirs and also a need for immediate operationalization and implementation of a sustainable Preventive One Health intervention in order to mitigate against outbreak of zoonoses in the study areas.

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4 429 **DECLARATIONS**

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7 430 **ETHICS APPROVAL**

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9 431 Approval and permission for the study was given by the ethics committee of Veterinary Services
10
11 432 Unit of the Ogun State Ministry of Agriculture, Abeokuta, Ogun State.
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14 433 **CONSENT FOR PUBLICATION**

15
16 434 Not applicable.
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19 435 **AVAILABILITY OF DATA AND MATERIALS**

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21 436 The datasets generated during and/or analysed during the current study are available from the
22
23 437 corresponding author on reasonable request.
24

25
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28 439 The authors declare that they have no competing interests.
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37
38 443 OGD, OS and MR contributed to the study design, data collection and preparation of the
39
40 444 manuscript. FA, SA and MA contributed to study design and data analysis. All authors read and
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42 445 approved the final manuscript.
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Fig 5: Distribution of intestinal helminths using GIS

$p = 0.002$

Fig 1: Relationship between haemoparasite infection and PCV

Fig 2: Prevalence of intestinal helminths in study area

Fig 3: Distribution of coinfection of intestinal helminth infection in study area

Fig 4: Distribution of haemoparasites using GIS

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Table 1: Demographic information of cattle in the study area

	No examined (%)
Location	
Lafenwa	217 (84.8)
Aladesanmi	39 (15.2)
Total (%)	256 (100)
Sex	
Male	57 (22.3)
Female	199 (77.7)
Total (%)	256 (100)
Breed	
White Fulani	149 (58.2)
Red Bororo	87 (34.0)
Sokoto Gudali	17 (6.6)
N'dama	2 (0.8)
Crossbreed	1 (0.4)
Total (%)	256 (100)
Age	
> 2	246 (96.1)
< 2	10 (3.9)
Total (%)	256 (100)

Table 2: Cumulative prevalence of haemoparasites across breed, sex, age and location in the study area

	No examined	<i>Babesia</i> spp. (%)	<i>Theileria</i> spp. (%)	<i>Anaplasma</i> spp. (%)	<i>Trypanosoma</i> spp. (%)
SEX					
Male	57	12 (21.1)	0 (0)	9 (15.8)	4 (7.0)
Female	199	59 (29.6)	2 (1.0)	44 (22.1)	17 (8.5)
Total (%)	256	71 (27.7)	2 (0.8)	53 (20.7)	21 (8.2)
<i>P</i> value		<i>P</i> =0.24	<i>P</i> =0.44	<i>P</i> =0.29	<i>P</i> =0.7
AGE					
> 2	246	69 (28.0)	2 (0.8)	51 (20.7)	19 (7.7)
< 2	10	2 (20.0)	0 (0)	2 (20)	2 (20)
Total (%)	256	71 (27.7)	2 (0.8)	53 (20.7)	21 (8.2)
<i>P</i> value		<i>P</i> =0.57	<i>P</i> =0.77	<i>P</i> =0.95	<i>P</i> =0.16
BREED					
White fulani	149	41 (27.5)	2 (1.34)	30 (20.1)	12 (8.1)
Red bororo	87	21 (24.1)	0 (0)	22 (25.3)	8 (9.2)
Sokoto	17	8 (47.1)	0 (0)	1 (5.9)	1 (5.9)
Gudali					
N'dama	2	0 (0)	0 (0)	0 (0)	0 (0)
Cross Breed	1	1 (100)	0 (0)	0 (0)	(0)
Total (%)	256	71 (27.7)	2 (0.8)	53 (20.7)	21 (8.2)
<i>P</i> value		<i>P</i> =0.13	<i>P</i> =0.83	<i>P</i> =0.38	<i>P</i> =0.97
LOCATION					
Aladesanmi	39	7 (17.9)	0 (0)	6 (15.4)	4 (10.3)
Lafenwa	217	64 (29.5)	2 (0.9)	47 (21.7)	17 (7.8)
Total (%)	256	71 (27.7)	2 (0.8)	53 (20.7)	21 (8.2)
<i>P</i> value		<i>P</i> =0.17	<i>P</i> =0.54	<i>P</i> =0.37	<i>P</i> =0.61

Table 3: Prevalence of coinfection of haemoparasites

	No examined	No infected (%)	Single infection (%)	Co-infection (%)
SEX				
Male	57	23 (9.0)	21 (8.2)	2 (0.8)
Female	199	115 (44.9)	108 (42.2)	7 (2.7)
Total (%)	256	138 (53.9)	129 (50.4)	9 (3.5)
<i>P</i> value				<i>P</i> = 0.02
AGE				
> 2	246	132 (51.6)	123 (48.05)	9 (3.5)
< 2	10	6 (2.3)	6 (2.3)	0 (0)
Total (%)	256	138 (53.9)	129 (50.35)	9 (3.5)
<i>P</i> value				<i>p</i> = 0.12
BREED				
White fulani	149	80 (31.3)	75 (29.3)	5 (2.0)
Red bororo	87	48 ((18.8)	45 (17.6)	3 (1.2)
Sokoto Gudali	17	9 (3.5)	8 (3.1)	1 (0.4)
N'dama	2	0 (0)	0 (0)	0 (0)
Cross Breed	1	1 (0.39)	1 (0.39)	0 (0)
Total (%)	256	138 (53.9)	129 (50.39)	9 (3.6)
<i>P</i> value				<i>p</i> = 0.29
LOCATION				
Aladesanmi	39	16 (6.2)	15 (5.9)	1 (0.4)
Lafenwa	217	122 (47.7)	113 (44.1)	9 (3.5)
Total (%)	256	138 (53.9)	128 (50.0)	10 (3.9)
<i>P</i> value				<i>p</i> = 0.08

Table 4: Polyparasitism of Intestinal Helminths across breed, sex, age and location

	No examined	Single Infection (%)	Double infection (%)	Multiple infection > 2 (%)	<i>P</i> value
SEX					
Male	57	25 (43.9)	20 (35.1)	0 (0)	
Female	199	87 (43.7)	63 (31.7)	14 (7.0)	
Total (%)	256	112 (43.8)	83 (32.4)	14 (5.5)	<i>p</i> = 0.55
AGE					
> 2	246	105 (42.7)	80 (32.5)	14 (5.7)	
< 2	10	7 (70.0)	3 (30.0)	0 (0)	
Total (%)	256	112 (43.8)	83 (32.4)	14 (5.5)	<i>p</i> = 0.12
BREED					
White fulani	149	65 (43.6)	45 (30.2)	9 (6.0)	
Red bororo	87	37 (42.5)	33 (37.9)	4 (4.6)	
Sokoto Gudali	17	9 (52.9)	4 (23.5)	1 (5.9)	
N'dama	2	0 (0)	0 (0)	0 (0)	
Cross Breed	1	1 (50.0)	1 (50.0)	0 (0)	
Total (%)	256	112 (43.8)	83 (32.4)	14 (5.5)	<i>p</i> = 0.29
LOCATION					
Aladesanmi	39	19 (48.7)	13 (33.3)	0 (0)	
Lafenwa	217	93 (42.9)	70 (32.3)	14 (6.5)	
Total (%)	256	112 (43.8)	83 (32.4)	14 (5.5)	<i>p</i> = 0.94

Table 5: Prevalence of *Fasciola* spp. in study areas

	No examined	No infected (%)	<i>P</i> value
BREED			
White fulani	149	14 (5.5)	
Red bororo	87	11 (4.3)	
Sokoto gudali	17	1 (0.4)	
N'dama	2	0 (0)	
Crossbreed	1	0 (0)	
Total (%)	256	26 (10.2)	
			$p = 0.73$
SEX			
Male	57	1 (0.4)	
Female	199	25 (9.8)	
Total (%)	256	26 (10.2)	
			$p = 0.017$
AGE			
> 2	246	26 (10.2)	
< 2	10	0 (0)	
Total (%)	256	26 (10.2)	
			$p = 0.278$

Table 6 Prevalence of Co-infection of Haemoparasites and Intestinal Helminths in Study Area

	No examined	Coinfection Haemoparasites + Intestinal helminths	of Prevalence (%)	<i>P value</i>
SEX				
Male	57	17	6.6	
Female	199	92	35.9	
Total	256	109	42.6	
				$p = 0.02$
AGE				
> 2	246	103	40.2	
< 2	10	6	2.3	
Total	256	109	42.6	
				$p = 0.25$
BREED				
White fulani	149	61	23.8	
Red bororo	87	41	16.01	
Sokoto Gudali	17	7	2.7	
N'dama	2	0	0	
Cross Breed	1	0	0	
Total	256	109	42.6	
				$p = 0.47$
LOCATION				
Aladesanmi	39	12	4.7	
Lafenwa	217	97	37.9	
Total	256	109	42.6	
				$p = 0.10$