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GASTROINTESTINAL PARASITES AND ASSOCIATED GUT PATHOLOGY IN CHICKENS SOLD AT LIVE-BIRD MARKETS IN LAGOS STATE, SOUTHWESTERN NIGERIA

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Abstract

Gastrointestinal (GI) parasites compromise intestinal health in poultry, causing impaired nutrient uptake, poor growth rate and reduced productivity. The effectiveness of control programs relies on an accurate understanding of parasite occurrence and distribution. This survey aimed to determine the diversity and pathological effects of GI parasites of chickens in Lagos State, Nigeria. Three hundred and sixty-four (364) chickens were randomly sampled from selected live-bird markets. Standard parasitological methods were employed to process and examine gastrointestinal content and mucosal scrapings for parasite identification. Live helminths were preserved in 70% ethanol, cleared in lactic acid and identified at the species level. Sections of the gut were also assessed for microscopic lesions following standard histopathological procedures. Findings revealed that 251 (69%) of the 364 sampled chickens were infected with GI parasites. Eleven nematodes, 5 cestodes and coccidia of the genus *Eimeria* were detected. *Ascaridia galli* (140, 38.5%), *Eimeria* spp. (98, 26.9%) and *Heterakis gallinarium* (82, 22.5%) were the most common parasites found. Helminths were generally more prevalent in local and male chickens ($P<0.05$) whereas exotic breeds had higher infection rates for *Eimeria* spp. ($P>0.05$). Histopathological analyses revealed mild to severe inflammation, oedema, mucosal erosion, and hyperplasia in infected chickens. This study showed that GI parasites

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are prevalent in chickens and are associated with intestinal damage that can undermine poultry growth and productivity in the study area. Efforts to control must be strengthened to secure chicken production, maintain food security, and prevent economic losses.

Key words: Gastrointestinal parasites, Helminths, Coccidia, Chickens, Nigeria

GASTROINTESTINALNI PARAZITI I PATOLOŠKE PROMENE NA CREVIMA KOD KOKOŠAKA KOJE SE PRODAJU NA PIJACAMA ŽIVIH PTICA U SAVEZNOJ DRŽAVI LAGOS, JUGOZAPADNA NIGERIJA

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Kratak sadržaj

Gastrointestinalni (GI) paraziti predstavljaju ozbiljan rizik po zdravlje creva kod živine, izazivajući smanjenu apsorpciju hranljivih materija, usporeni rast i smanjenu produktivnost. Efikasnost programa kontrole zavisi od razumevanja pojave i distribucije parazita. Cilj ovog istraživanja bio je da se utvrde raznolikost i patološki efekti GI parazita kod kokošaka u državi Lagos, Nigerija. Ukupno 364 kokošaka je nasumično uzorkovano na odabranim pijacama živih ptica. Za obradu i ispitivanje gasrointestinalnog sadržaja i uzimanja uzoraka sluzokože korišćene su standardne parazitološke metode kako bi se identifikovali paraziti. Živi helminti su sačuvani u 70% etanolu, očišćeni u mlečnoj kiselini i identifikovani do nivoa vrste. Isečci creva su podvrgnuti mikroskopskom ispitivanju radi utvrđivanja lezija, uz primenu standardnih histopatoloških procedura. Nalazi su pokazali da je 251 (69%) od 364 uzorkovanih jedinki bilo zaraženo gastrointestinalnim parazitima. Identifikovano je 11 vrsta nematoda, 5 vrs-

ta cestoda i kokcidija iz roda *Eimeria*. Najčešće pronađeni paraziti bili su *Ascaridia galli* (140, 38,5%), *Eimeria spp.* (98, 26,9%) i *Heterakis gallinarium* (82, 22,5%). Učestalost nalaženja helminta bila je češća kod lokalnih ptica i to muškog pola (P<0,05), dok su egzotične vrste ptica češće bile inficirane sa *Eimeria spp.* (P>0,05). Histopatološke analize su utvrdile blagu do tešku inflamaciju, edem, eroziju sluzokože i hiperplaziju kod inficiranih jedinki. Ova istraživanja su pokazala da gastrointestinalni paraziti preovlađuju kod kokošaka i da su povezani sa oštećenjem creva, što može negativno utiče na rast i produktivnost živine. Potrebno je uvođenje bolje kontrole parazita kako bi se obezbedila neometana proizvodnja pilića, obezbedila bezbedna hrana i sprečili ekonomski gubici.

Ključne reči: gastrointestinalni paraziti, helminti, kokcidije, kokoške, Nigerija

INTRODUCTION

Poultry is an important source of quality animal protein, income, and employment. It plays a vital role in global socio-economic development. The Nigerian poultry industry contributes approximately 8% to the gross domestic product (GDP) and supplies affordable meat and eggs, enhancing the health and livelihoods of people in both rural and urban areas (Netherlands Africa Business Council [NABC], 2019). The domestic chicken, *Gallus gallus domesticus*, is the most economically significant poultry species raised in Nigeria (Adene and Oguntade, 2006; Ajayi, 2010). It accounts for more than 50% of the estimated poultry population (140-180 million) in the country (Federal Ministry of Agriculture and Rural Development, [FMARD], 2006).

Parasitic infections are a key factor impacting poultry health, welfare, and performance in tropical regions, hindering the poultry industry's ability to keep up with the rising demand for animal protein (NABC, 2019). The most prominent are gastrointestinal (GI) parasites, which damage the gut integrity of bird hosts, impairing nutrient absorption, feed conversion efficiency, growth rate, and overall productivity (Yegani and Korver, 2008). These parasites infect their hosts through the faeco-oral route, either directly (e.g., coccidia and most nematodes) or indirectly via intermediate hosts (e.g. cestodes and trematodes) (Permin and Hansen, 1998). The survival and transmission dynamics of these parasites vary depending on the poultry management practices. Parasites with one-host cycles are more prevalent under intensive farming conditions com-

pared to the heteroxenous forms which prevail in free-range systems where intermediate hosts are readily available (McDougald, 2008a).

While many intestinal parasites are non-pathogenic in chickens, some cause diseases with significant economic consequences (McDougald, 2008a). For example, coccidiosis, caused by intestinal coccidia of the genus *Eimeria*, costs the global poultry industry approximately UK£ 10.4 billion annually (Blake et al., 2020). This estimated loss has been associated with reduced poultry productivity, morbidity and mortality, making disease control highly essential.

Gastrointestinal parasite control primarily relies on good biosecurity and the prophylactic use of antiprotozoal and anthelminthic drugs (Pagani et al., 2008). In order to achieve effective and sustainable control, epidemiological data are required. Previous studies have reported the presence of GI parasites in Nigerian chickens, with prevalence rates varying from 20% to 100% in both exotic and local breeds raised under different farming systems across all geoclimatic regions (Ohaeri and Okwum et al., 2013; Jegede et al., 2015; Afolabi et al., 2016). These studies have shown that *Eimeria* spp. are the most common protozoan parasites while *Ascaridia galli* and *Raillietina* spp. are notable nematodes and cestodes respectively. Despite this plethora of surveys, there is limited and incomprehensive data for GI parasite occurrence among chickens in Lagos State, Nigeria (Adeyemi et al., 2019; Idowu et al., 2019). Such data are essential for developing effective control measures that can support the continued growth of the poultry sector. Therefore, this study aimed to determine the diversity and prevalence of GI parasites and evaluate their pathological impacts in chickens sold at selected live-bird markets in Lagos State, Southwest Nigeria.

MATERIAL AND METHODS

Ethics approval and consent to participate

Ethical approval was granted by the Health Research Ethics Committee of the College of Medicine, University of Lagos, reference number CMUL/ACUREC/01/23/1141. Consent to take part in the study was also obtained from all study participants.

Study area

This study was conducted in Lagos State, one of the six southwestern states in Nigeria. It is situated along the narrow plains of the Blight of Benin, approxi-

mately between latitudes $6^0$35'N and 6.58^{0}N, and longitudes $3^0$45'E and 3.75^{0}E, and covers a land area of 3577sq.km which is 0.4% of Nigeria's total land mass. It is a wetland dominated by freshwater and mangrove swamps. About 25% of the land area is occupied by lagoons, creeks, and rivers. Lagos State has a humid tropical climate with distinct wet and dry seasons. The wet period spans from April through October with a break in August while the shorter, dry season begins in November and ends in March. The region experiences an average annual rainfall of 1783mm, with a mean relative humidity of 83% and ambient temperatures ranging from 28°C to 33°C (Lagos State Government [LASG], 2023). Poultry production is a lucrative business in Lagos State, which hosts a variety of small to large-scale poultry farms. The state's poultry industry has an estimated population of 2.3 million meat-producing birds, an annual egg production of 133 million, and approximately 30 live bird markets (LBMs) (Olorunwa, 2018; Aminu and Hermanns, 2021).

Study design and population

This study was conducted between March 2019 and June 2022, with a break that lasted five (5) months from March to July 2020 due to the imposed COVID-19 lockdown. A cross-sectional survey was conducted on domestic chickens sold and slaughtered in the daily live bird markets (LBMs) in the study area. Three LBMs located in Lagos Mainland (Oyingbo LBM), Ikorodu (Ejina LBM), and Shomolu (Onipanu LBM) Local Government Areas (LGAs) of Lagos State were selected on purpose due to their large size and high turnover rates. The poultry sold in these markets is sourced from various areas within and around Lagos State.

Data and sample collection

A total of 364 chickens designated for slaughter in the LBMs were randomly selected and included in this study. A minimum sample size was determined using Thurfield's formula: $n = z^2 \times pexp\ (pexp - 1)/d^2$, where n = required sample size; z = confidence interval at 95%; pexp = expected prevalence of 72% based on a previous study (Rufai and Jato, 2017); and d^2 = desired absolute precision of 5%. The breed (exotic or local) and sex (male or female) of each selected chicken were identified at the point of slaughter. Clinical signs of GI infections observed for selected chickens were also noted. Immediately upon slaughtering of the birds, their guts were collected in order to recover the crop, oesophagus, proventriculus, small intestine, large intestine and caeca.

Any lesions observed on the mucosal and serosal surfaces of the tissues were documented. Random tissue sections were taken and kept in 10% formalin for histopathological analysis. Live worms retrieved from the gastrointestinal lumen were collected using forceps and kept in 70% ethanol. Intestinal contents, along with mucosal scrapings, were collected and preserved with a few drops of physiological saline in sterile sample bottles. All samples were properly labeled and transported in cool boxes to the Parasitology laboratory of the Department of Zoology, University of Lagos.

Parasitological analyses

The preserved worms were sorted and counted under a stereo microscope. The worms were then cleared in lactic acid and identified to genus and/or species level under low- and high- power objectives of a compound microscope according to keys provided by Benbrook and Sloss (1961) and Soulsby (1982). Wet preparations of the gastrointestinal contents and mucosal scrapings were made and examined under both low- and high-power objectives of a compound microscope to identify parasites. The samples were also concentrated by sugar-salt floatation method to recover parasite cysts, oocysts, and/or eggs that may be present (Permin and Hansen, 1998). Briefly, the samples were homogenized with additional saline solution and filtered through sterile tea sieves. Fourteen milliliters of the filtrate from each sample were transferred into 15ml Falcon tubes and centrifuged at 1500 rpm for 10 minutes. Exactly 5 ml of saturated sugar-salt solution was then added to the resulting residue in the Falcon tubes. The tubes were then filled with sugar-salt solution until a convex meniscus was formed. Clean, sterile coverslips were placed on top of the tubes, which were then left to stand for 10 minutes. The coverslips were subsequently transferred to clean microscope glass slides and examined under a compound light microscope. Parasite cysts, oocysts, and ova were identified using diagnostic keys from Benbrook and Sloss (1961) and Soulsby (1982).

Histopathological analysis

Formalin-fixed tissues from samples positive for at least one type of GI parasite were processed for routine histopathological examination and stained with haematoxylin and eosin (H & E) as described by Gridley (1960). Fixed tissues that tested negative for parasitic infections were kept as negative controls. The stained tissue sections were then examined under a compound light microscope using 10X and 40X objectives.

Data analyses

Data was entered into Microsoft Excel spreadsheet. Summary statistics of categorical and continuous variables were done on Statistical Package for Social Sciences (SPSS) (IBM SPSS Statistics 20). Pearson's chi-square test was also performed on SPSS in order to determine the relationship between host variables and presence/absence of parasitic infections. All statistical tests were considered significant at $p < 0.05$ with a confidence interval of 5%.

RESULTS

The study found that 251 (69%) of the 364 chickens sampled at the selected LBMs had parasites in their gut, with 11 species of nematodes, 5 species of cestodes, and *Eimeria* spp. identified. Among the nematodes found, *Ascaridia galli* (n = 140, 38.5%), *Heterakis gallinarium* (n = 82, 22.5%) and *Capillaria obsignata* (n = 64, 17.6%) were the most common, while *Gongylonema inguivicola*, *Tetrameres americana* and *Hartertia gallinarium* had the lowest prevalence rates of 0.3%, infecting only 1 chicken each. The most prevalent cestodes included *Raillietina echinobothrida* and *R. tetragona*, infecting 47 (12.9%) and 21 (5.8%) chickens respectively. Oocysts of *Eimeria*, the only protozoan genus found were detected in 98 (26.9%) chickens (Table 1).

Table 1: Prevalence and distribution of gastro-intestinal tract parasites by breed and sex of chickens slaughtered at selected LBMs in Lagos State

Parasite	All chicken	Breed		*p*-value	Sex		*p*-value
	N = 364 n (%)	*Exotic* (N= 189) n (%)	*Local* (N= 175) n (%)		*Female* (N= 223) n (%)	*Male* (N= 141) n (%)	
Protozoa							
Eimeria spp.	98 (26.9)	61 (32.3)	37 (21.1)	0.017	68 (30.5)	30 (21.3)	0.053
Cestodes							
Rallietina echinobothridia	47 (12.9)	10 (5.3)	37 (21.1)	0.000	18 (8.1)	29 (20.6)	0.001
Rallietina tetragona	21 (5.8)	0 (0.0)	21 (12.0)	0.000	5 (2.2)	16 (11.3)	0.000
Amoebotaenia sphenoides	8 (2.2)	1 (0.5)	7 (4.0)	0.024	2 (0.9)	6 (4.3)	0.033

Parasite	All chicken	Breed		*p*-value	Sex		*p*-value
	N = 364 n (%)	*Exotic* (N= 189) n (%)	*Local* (N= 175) n (%)		*Female* (N= 223) n (%)	*Male* (N= 141) n (%)	
Davainea proglottina	7 (1.7)	4 (2.1)	3 (1.7)	0.780	4 (1.8)	3 (2.1)	0.831
Choanotaenia infundibulum	5 (1.4)	3 (1.6)	2 (1.1)	0.716	3 (1.3)	2 (1.4)	0.953
Nematodes							
Ascaridia galli	140 (38.5)	23 (12.2)	117 (66.9)	0.000	50 (22.4)	90 (63.8)	0.000
Heterakis gallinarum	82 (22.5)	6 (3.2)	76 (43.4)	0.000	22 (9.9)	60 (42.6)	0.000
Capillaria obsignata	64 (17.6)	3 (1.6)	61 (34.9)	0.000	18 (8.1)	46 (32.6)	0.000
Trichostrongylus tenuis	52 (14.3)	0 (0.0)	52 (29.7)	0.000	7 (3.1)	45 (31.9)	0.000
Capillaria contorta	25 (6.9)	0 (0.0)	25 (14.3)	0.000	3 (1.3)	22 (15.6)	0.000
Capillaria anatis	21 (5.8)	0 (0.0)	21 (12.0)	0.000	3 (1.3)	18 (12.7)	0.000
Ascaridia columbae	3 (0.8)	0 (0.0)	3 (1.7)	0.071	0 (0.0)	3 (2.1)	0.029
Syngamus trachea	3 (0.8)	1 (0.5)	2 (1.1)	0.518	1 (0.4)	2 (1.4)	0.319
Gongylonema inguivicola	1 (0.3)	0 (0.0)	1 (0.6)	0.298	0 (0.0)	1 (0.7)	0.208
Tetrameres Americana	1 (0.3)	0 (0.0)	1 (0.6)	0.298	1 (0.4)	0 (0.0)	0.426
Hartertia gallinarium	1 (0.3)	0 (0.0)	1 (0.6)	0.298	0 (0.0)	1 (0.7)	0.208

Based on the breeds of the sampled chickens, local chickens exhibited significantly higher prevalence rates of infection for most cestode and nematode parasites ($p < 0.05$). Conversely, *Eimeria* parasites were more prevalent in exotic chickens than in local chickens ($p < 0.05$), although no significant difference was observed at the species level ($p > 0.05$) (Table 1). Based on the sex of the chickens, the prevalence of most nematodes and *R. echinobothrida* was significantly higher in male chickens compared to females ($p < 0.05$). However, there was no significant difference in the infection rates of *Eimeria* between the sexes ($p > 0.05$) (Table 1).

Co-infections involving multiple parasite species (n = 169, 46.4%) were more common than single-species infections (n = 76, 20.9%) (Table 2: Single

and mixed parasitic infections of the gastrointestinal tract of chickens slaughtered at selected live-bird markets in Lagos State). The prevalence of co-infection was higher in males (n = 109, 77.3%) than in females (n = 60, 26.9%), and in local (n = 144, 82.3%) than in exotic chickens (n = 25, 13.2%). Most birds were positive for one to three parasite species; only a few had up to five (n = 7, 1.9%) or six (n = 1, 0.3%). Infection with more than one species was common in local (n = 144, 82.3%) and in male (n = 109, 77.3%) chickens (Table 2: Single and mixed parasitic infections of the gastrointestinal tract of chickens slaughtered at selected live-bird markets in Lagos State).

Table 2: Single and mixed parasitic infections of the gastrointestinal tract of chickens slaughtered at selected live-bird markets in Lagos State

Infection status	Overall = 364 n (%)	Breed		Sex	
		Exotic = 189 n (%)	Local = 175 n (%)	Male = 141 n (%)	Female = 223 n (%)
Single	76 (20.9)	53 (28.0)	23 (13.1)	22 (15.6)	54 (24.2)
Mixed	169 (46.4)	25 (13.2)	144 (82.3)	109 (77.3)	60 (26.9)
Two	66 (18.1)	18 (9.5)	48 (27.4)	28 (19.9)	38 (17.0)
Three	69 (19.0)	5 (2.6)	64 (36.6)	51 (36.2)	18 (8.1)
Four	26 (7.1)	2 (1.1)	24 (13.7)	23 (16.3)	3 (1.3)
Five	7 (1.9)	0 (0.0)	7 (4.0)	6 (4.3)	1 (0.4)
Six	1 (0.3)	0 (0.0)	1 (0.6)	1 (0.7)	0 (0.0)

The distribution of parasite ova and oocysts along the GI of the sampled chickens is shown in Figures 1 - 3. *Ascaridia galli* eggs were frequently detected in the small and large intestines while *H. gallinarium* was restricted to the caeca. Ova of *Capillaria* species were found throughout the gut, except in the gizzard. *Syngamus trachae* eggs were only found in the oesophagus and proventriculus (Figure 1). Most cestode ova were identified in the small intestines, although those of *C. infundibulum* and *D. proglotinna* were also detected in the caeca (Figure 2).

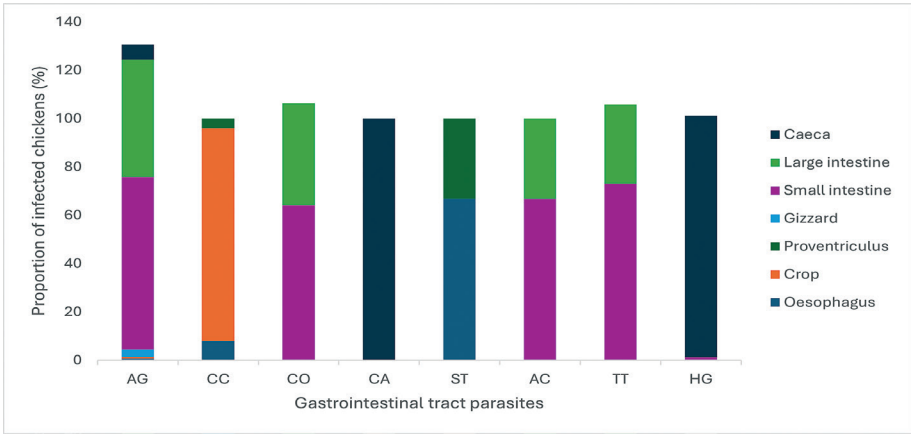

Figure 1: Distribution of nematode ova along the gut of infected chickens slaughtered at selected live-bird markets in Lagos State

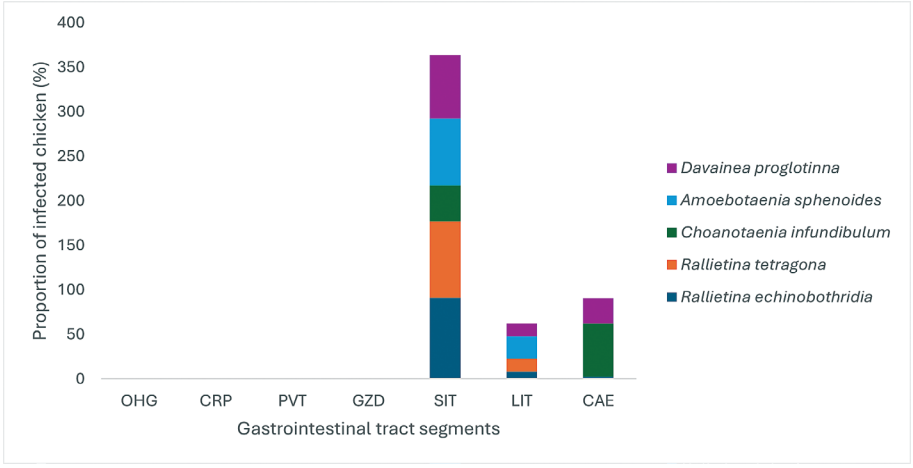

Figure 2: Single and mixed parasitic infections of the gastrointestinal tract of chickens slaughtered at selected live-bird markets in Lagos State

Oocysts of *Eimeria* were mostly detected in the caeca, followed by the large and small intestines; none were found in other parts of the gut (Figure 3).

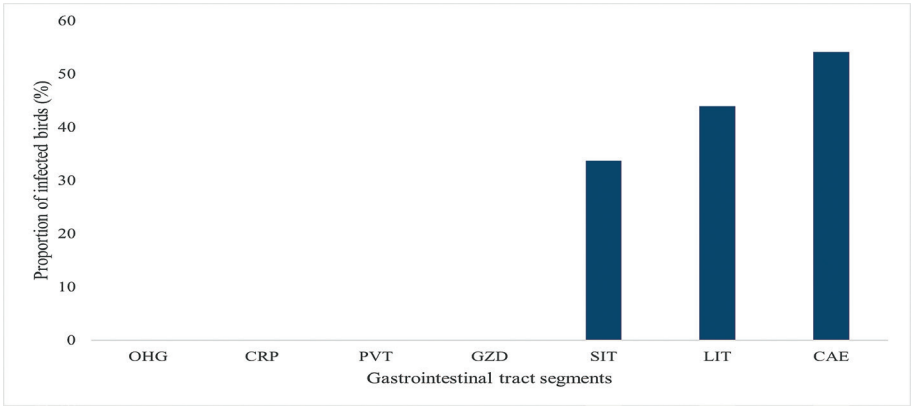

Figure 3: *Eimeria* oocysts distribution in the GI of infected chickens at selected LBMs in Lagos State

Although the sampled birds exhibited no clinical signs of GI infection, approximately 90% of parasitized chickens had gross lesions in at least one part of the gut. These included evidence of necrotic ulcerations on the intestinal mucosa (Figure 4A), severe diffused hemorrhagic enteritis (Figure 4B), severe diffused mucoid enteritis (Figure 4C), severe congestion of the intestinal mucosa (Figure 4D), severe diffused necrotic enteritis (Figure 4E) and presence of numerous tapeworms in the intestinal mucosa (Figure 4F).

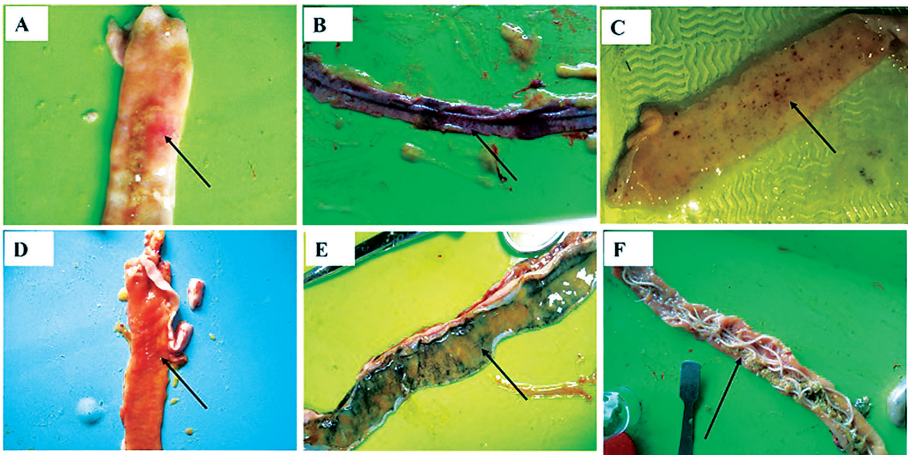

Figure 4: A) focal hemorrhage; B) extensive hemorrhage; C) petechiae; D) whitish coalesced spots on the mucosal surface of intestinal tissue; E) yellow to green mucoid diarrhea in lumen of hemorrhagic small intestine of chickens infected with GI parasites; F) intestinal obstruction with numerous *Ascaridia galli* adults in the lumen of small intestine.

Histopathological analyses revealed the presence of worms in the lumen of the gut, mild to severe infiltration of inflammatory cells, oedema, mucosal erosion, villous atrophy and hyperplasia of the cryptal cells (Figure 5).

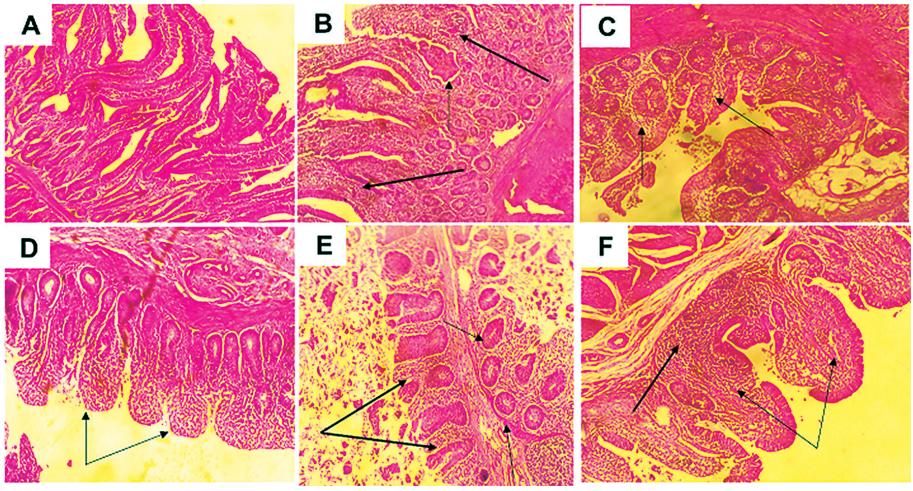

Figure 5: Histopathological lesions observed in the gastrointestinal tract of chickens slaughtered at selected LBMs in Lagos State

DISCUSSION

Poultry meat and eggs are among the most widely consumed and affordable sources of high-quality animal protein for millions of people in low- to middle-income countries (Akintunde and Adeoti, 2014). Gastrointestinal parasites, however, limit poultry health and productivity, undermining the potential of the poultry industry in meeting the growing demand for nutritious food in the developing world (Berhe et al., 2019). Efforts to determine and monitor the occurrence of these infectious agents are essential for planning and implementing effective control programs and policies which in turn ensure food and economic security.

This study revealed a high prevalence of GI parasites in chickens from Lagos State. Previous studies in Nigeria (Ohaeri and Okwum, 2013; Junaidu et al., 2014; Idika et al., 2016; Rufai and Jato, 2017; Elele et al., 2021) have reported similar or even higher prevalence rates, suggesting that gastrointestinal (GI) parasites may contribute to poor poultry productivity, leading to unprofitable poultry production in the country. The high prevalence observed may be a result of the warm, humid climate of the examined area, which supports

the survival of parasites and their intermediate hosts. Inadequate biosecurity practices, hygiene standards and disease control measures may also contribute to parasite survival and dissemination. Furthermore, it is likely that available antiparasitic drugs used for the control of prevalent parasites in the study area have become ineffective.

Nematodes were the most common helminths parasitizing chickens in the study. They have been recognized as the most important helminths of poultry in terms of species diversity, abundance, distribution and pathogenicity (McDougald, 2008a; Ola-Fadunsi et al., 2019). Nematodes are highly resilient organisms that adapt to and thrive in a wide range of ecological settings, including extreme environments (Sapir, 2021). They were found across different parts of the gut of chickens in this study unlike the cestodes which were restricted to the small intestine. These findings are in line with the reports from other parts of Nigeria (Ohaeri and Okwum, 2013; Elele et al., 2021) but differ from those of other authors (Idika et al., 2016; Imam et al., 2017), reflecting the differences that exist between studies in terms of study population, sampling period, sample size, survey design and methods.

Ascaridia galli was the most dominant parasite species found in this study. Similar findings have been reported in other studies conducted in Nigeria (Idika et al., 2016; Rufai and Jato, 2017; Elele et al., 2021; Ozougwu et al., 2021) and might be attributed to the fact that *A. galli* possess a simple and direct life cycle with environmentally resistant eggs. They also feature a wide host range including wild or domestic turkeys, doves, ducks, geese, guinea fowls as well as paratenic hosts such as grasshoppers and earthworms (McDougald, 2008a). The high prevalence of *A. galli* also suggests that chickens might be important reservoir hosts, increasing the risk of exposure to other natural poultry hosts in the study area. Although infection with *A. galli* is usually asymptomatic, high worm burdens, especially in cases of poor management can cause stunted growth, weight loss, intestinal obstruction and death of affected birds which invariably amount to economic losses (Permin and Hansen, 1998).

High prevalence of *Heterakis gallinarium* in this study is noteworthy. The cecal nematode plays an important role in the transmission of *Histomonas meleagridis,* a trichomonad flagellate which can cause a severe disease histomoniasis in gallinaceous birds, and accounts for up to 100% morbidity and mortality in turkeys (Hu et al., 2004; McDougald and Fitz-Coy, 2008). Both *A. galli* and *H. gallinarium* had the highest egg output among the nematodes detected in this study, supporting facts about the high fecundity and robust reproductive capacity of these helminths.

Raillietina species, *R. echinobothrida* and *R. tetragona* were the most common cestodes infecting chickens in this study. This is consistent with the find-

ings of previous studies (Uhuo et al., 2013; Opara et al., 2014; Jegede et al., 2015) and supports the view that these are the most prevalent and widespread tapeworms in poultry (Belete et al., 2016). The use of small ants and beetles as intermediate hosts likely explains their ubiquity (Permin and Hansen, 1998). At high infection intensity, *Raillietina* worms may affect chicken health and productivity. Experimental studies with *R. echinobothrida* have demonstrated nodular granulomas and catarrhal enteritis in the jejunum of the small intestine with infections characterized by reduced growth, emaciation, and weakness (Simon, 2005).

Eimeria species were identified as the sole protozoan parasites infecting chickens in this study. This finding reinforces the recognition of *Eimeria* as one of the most prevalent and widespread poultry parasites, particularly in intensive poultry farming systems where birds are kept in confinement (McDougald, 2008b). They occur everywhere chickens are raised owing to their short and direct life cycle and their highly resistant environmental oocysts which several disinfectants are inactive against (Ola-Fadunsi et al., 2019). Although a study conducted in Akure, Ondo State, reported other gut protozoa, including *Histomonas meleagridis* and *Giardia lamblia* at prevalence rates of 0.6% and 0.3% respectively, *Eimeria* (7.7%) parasites still had the highest prevalence rate of infection (Afolabi et al., 2016).

Most of the helminth parasites were significantly more common in local than exotic chickens. This finding supports the fact that parasitism is prevalent in traditional, free-range systems where local breeds are managed with minimal housing, feeding, and disease control (Permin and Hansen, 1998; McDougald, 2008a). This is supported by Shifaw et al. (2021) who showed that the recent shift from poultry cage systems to extensive free-range or backyard systems is increasing the incidence of helminth infections in developed countries. Indigenous poultry raised in village production systems are free to roam the environment in search of food and water, which exposes them to the infective stages and intermediate hosts of various parasites. This foraging habit also explains why mixed helminth infections were more prevalent in local chickens in this study. Regular deworming, provision of dietary supplements and vitamins will help improve traditional chicken production, increase profitability, and enhance prospects for commercialization. Furthermore, controlling these pathogens in free-range poultry systems will help reduce the risk of transmission to commercial indoor systems.

Eimeria parasites were significantly more prevalent in exotic chickens compared to local breeds. Exotic or improved breeds of chickens are commonly raised in commercial intensive poultry systems characterized by indoor-rearing and high stocking density which favor the accumulation and

rapid spread of monoxenous parasites such as *Eimeria* spp. The risk of exposure to oocysts is increased in these indoor settings, particularly in deep-litter systems where birds have access to feed and water contaminated with feaces. High moisture content resulting from water spillage and warm temperatures in enclosed poultry houses are conditions that also favor the survival, sporulation and abundance of *Eimeria* oocysts (Rao et al., 2015).

Gross lesions characteristic of gastrointestinal tract parasites, including nodules, focal to extensive hemorrhages, petechiae, ballooning, mucus presence, and caecal cores, were observed on the gut mucosa of the infected chickens. These findings provide evidence that parasites are causing varying degrees of damage to the gut integrity of their hosts. Tay et al. (2017) reported similar lesions in the intestinal mucosa of local chickens infected with helminths in Ghana. Previous studies also reported similar findings in backyard and commercial chickens suffering from coccidiosis (Yohannes et al., 2014; Molla and Ali, 2015; Islam et al., 2020).

Histopathological analyses revealed mild to severe inflammation, oedema, loss of crypts, and hyperplasia in the current study. These pathomorphological changes of the intestinal tract have also been reported elsewhere (Shahraki et al., 2018). The observed intestinal pathologies imply that the studied birds are suffering from malabsorption and nutrient deprivation which can lead to reduction in feed conversion efficiency, poor weight gain and lowered productivity.

CONCLUSION

This study determined the prevalence of gastrointestinal parasites in chickens in Lagos State, Nigeria, highlighting their role in causing intestinal tissue damage that can adversely affect poultry performance and productivity. Veterinary health practitioners and poultry extension agents should promote the implementation of strict biosecurity protocols and effective disease control measures among poultry owners and farmers.

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Author's Contribution

OA, EI, BA and IJ conceived and designed this study. OA conducted laboratory analyses, collected and analyzed data, and wrote the original draft of the manuscript. TO interpreted and annotated histopathological data. All authors revised the manuscript critically and together with OA prepared the final draft of the manuscript. All authors read and approved the final manuscript

Competing interest

The authors declare that they have no competing interests.

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