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Full Length Research Article

PREVALENCE AND ASSOCIATED RISK FACTORS OF ECTO- AND ENDOPARASITES IN *GALLUS GALLUS DOMESTICUS* FROM SELECTED MARKETS IN KADUNA METROPOLIS

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ABSTRACT
Parasitic infections significantly impact poultry health and productivity, especially in regions with limited biosecurity where poultry is a key nutritional resource. This study assessed the prevalence and risk factors associated with ectoparasites and endoparasites of local chickens (*Gallus domesticus*) in six major markets in Kaduna Metropolis, Nigeria. A total of 250 chickens were sampled to identify parasitic burden, assess prevalence rates, and determine associated risk factors, including sex and weight. Ectoparasites were examined directly under the microscope by their morphological characteristics, and faecal samples were examined using standard parasitological techniques (Simple flotation and Centrifugal sedimentation) for endoparasites. Ectoparasites identified included *Menacanthus stramineus* (18.4%), *Dermanyssus gallinae* (10.8%), and *Argas persicus* (6.0%), among others, with an overall prevalence of 54.0%. Endoparasites such as *Ascaridia galli* (22.0%) and *Strongyloides avium* (14.0%) were also detected, with a cumulative prevalence of 64.8%. Risk analysis at significant level of 0.05 revealed that lower-weight chickens exhibited significantly higher infestation rates ($p < 0.01$), whereas sex was not a significant determinant of parasitic infections ($p > 0.05$). This study highlights the critical need for improved biosecurity measures, better management practices, and targeted interventions to mitigate parasitic infections and improve poultry productivity and public health in the region.

Keywords: Prevalence, Ectoparasites**,** Endoparasites, Poultry health, Kaduna Metropolis.

INTRODUCTION

Poultry refers to domesticated birds, including chickens, ducks, geese, and turkeys, that are raised by humans for various purposes such as obtaining meat, eggs, and sometimes feathers. Poultry farming serves as major source of livelihood for many people around the world who keep poultry for commercial purposes, either on small or large scales. It holds great significance as one of the primary sources of protein and farm manure, making it a rather indispensable resource (Khanum *et al.,* 2021). Global human population has grown significantly over the last decades from an estimated 2.5 billion people in 1950 to about 8 billion by November 2022 (United Nations, 2022). This in turn has led to an increasing demand for poultry products. For instance, as at 2020, the global chicken population was estimated to be about 33 billion birds by the Food and Agricultural Organization (FAO, 2023), up from about 13.9 billion in 2000 (Statista, 2023).

Generally, poultry chickens make up the largest category of domesticated animals globally (Peters *et al.,* 2022). This is evident from the substantial growth in egg production which has doubled, and poultry meat production has tripled, over the past three decades. In contrast, there has been relatively minimal increase in livestock production, mainly due to the higher demand for poultry products (Asumang *et al.,* 2019). In addition, the local chicken (*Gallus domesticus*) is the predominant type of poultry that is commonly raised across the world.

In Nigeria, domestically reared chickens are mostly raised under little supervision in backyard settings under free-range poultry production systems. These local chickens consume maggots and insects in the cow dung, kitchen waste, viscera of other animals, and faeces, which can act as carriers of parasites (Jaiswal *et al.,* 2020). The little restriction on movement and wide-ranging feeding patterns of free-range chickens results in a heightened chance of contact with potential disease-causing organisms (Adang *et al.,* 2008). Consequently, parasitic infections are common in these chickens and can adversely affect their health and productivity.
Ectoparasites such as lice, mites, ticks, and fleas infest the skin or feathers, while endoparasites (helminths and protozoa) infect internal organs. In regions with limited biosecurity and husbandry practices, these parasites can thrive and spread easily among backyard poultry flocks. Parasitic infestations and infections in poultry can lead to poor growth, anemia, decreased egg production, and even mortality, thereby impacting both poultry production and public health. This study was therefore designed to investigate the prevalence of ecto- and endoparasites in local chickens slaughtered in selected markets in Kaduna metropolis, and to evaluate the influence of factors such as sex and weight on infection rates. The findings aimed to inform control strategies to improve poultry health and productivity in the region.

MATERIALS AND METHODS

Description of Study Area

This study was conducted within Kaduna metropolis of Kaduna state in the North-western part of Nigeria. Kaduna metropolis lies between Latitudes 10º 20' 53" N and 10º 39' 06" N of the equator and Longitudes 7º 15' 18" E and 7º 37' 15" E of the Prime Meridien. It is made up of four LGAs namely, Kaduna North, Kaduna South, Igabi, and Chikun Local Government Area (LGA). It has a tropical climate with an average temperature of 28 °C and average annual rainfall of 1200 mm. It lies mainly within the Sudan Savannah Vegetation Zone of Nigeria with distinct wet (April-October) and dry (November-March) Seasons. Shrubs and grasslands are the most common vegetation across the area, but a significant part of the vegetation has given way to infrastructure driven by urbanization. Kaduna metropolis is home to about 3 million people which is

indicative of a very large market for poultry products. Kaduna metropolis is cosmopolitan in nature having diverse ethnic groups including Hausa, Fulani, Gbagyi, Adara, Yoruba, Igbo, Atyap among many other others. Most of the inhabitants are civil servants, and traders. A significant part of the metropolis is considered peri-urban, and most soil is sandy to loamy in composition (Abaje & Oladipo, 2018).

Sample Collection

The study population is composed of 250 locally reared chickens (mixed sexes and ages) across six major markets in Kaduna metropolis - Kawo, Chechenia, Sokoto road, Tudun Wada, Station and Sabon Tasha markets. These markets were purposively selected because of their high volume of poultry trade, ensuring adequate sample size for the study. Each bird was weighed in kilogram (kg) using a weighing scale and then examined externally for ectoparasites. All external parasites seen were collected. A fresh faecal sample was also collected from each examined bird and labelled with the bird's sex and weight. Samples were transported to OLAMS poultry laboratory, Barnawa, Kaduna and kept cool at 4 ^{o}C prior to analysis of endoparasites. The study was conducted between December 2023 to April 2024. The risk factors were assessed from data on sex, weight, management conditions, age, location, and bird owners present at the market were interviewed at the time of sampling.

Examination and Identification of Ectoparasites

Examination for ectoparasites was done by thorough inspection of the entire body of each sampled dusted with Sevin powder (1-napthyl-N-methyl carbarmate), which was placed on a white sheet of paper and vigorously rubbed and ruffled with the use of a fine blunt toothed brush in other to remove the ectoparasites. The parasites collected after losing attachment from the skin and feathers of the birds. The ectoparasites were sorted and preserved in 70% ethanol with 5% glycerin in a bijou bottle. The chickens observed with parasites were noted and the type of parasite was recorded. The sampling was carried out in the morning in the market. The parasites were transported to the laboratory of the department of Biology, Kaduna State University, each parasite was identified directly under the microscope by their morphological characteristics as described by identification keys of Taylor *et al.* (2006).

Examination and Identification of Endoparasites

Fresh faecal sample was collected from each chicken sampled for ecto-parasite. The faecal samples were collected through the chicken cloaca manually with hand covered with disposable gloves or a spatula as the case so permits. Ten grams each of faecal samples collected was placed in a sample bottle and labelled-stored in a fridge at 4 °C until analyses in OLAMS poultry laboratory, Barnawa, Kaduna were done. All the faecal samples collected from each bird were matched with their corresponding records of the ectoparasites. Coccidial oocysts, nematode and cestode and the classification keys developed by Soulsby (1982) was used to identify and document the eggs.

For each bird, the corresponding faecal sample was processed to detect endoparasite ova and oocysts. Two qualitative parasitological techniques were employed: simple flotation and centrifugal sedimentation. In the flotation method, sample was prepared by dissolving 400 g of NaCl in 1000 mL of warm distilled water. The procedure was conducted by adding 10 mL of the floatation medium to 2 g faecal sample in the universal bottle and stirred with a rod. The mixture was then filtered through double layered gauze into a test tube, and more media were added until a meniscus was formed. A coverslip was placed gently on the test tube and allowed to stand on a level surface for at least 10 minutes. The coverslip was carefully removed and placed on a glass slide and examined immediately for parasite eggs under x10 and x40 objective lens. Identification of the eggs was aided by the addition of Lugol's Iodine solution to the sample on the glass slide according to Cervantes *et al. (*2016) and Soulsby (1982). For the sedimentation method, about 5 g of faeces was mixed with 50 mL of normal saline and strained into a centrifuge tube. The suspension was centrifuged at 1500 rpm for 5 minutes. The supernatant was decanted, and the sediment was re-suspended in fresh saline and allowed to sit for 15 minutes before decanting again. A drop of the final sediment was examined under a coverslip at 10x magnification as recommended by Gibbons *et al.* (2005).

Data Analysis

The result obtained was analysed using descriptive statistics such as percentages, means, frequencies and presented in tables and charts. Microsoft excel (2016 version) was utilized to organize data and prepare tables and graphs. Prevalence was calculated as the proportion of examined birds that were parasitized. To analyse risk factors, prevalence was compared between groups (male vs female, weight categories) using chi-square tests. A chi-square test of independence was performed to examine the association between sex and infection rates. The significance was set at alpha = 0.05. All statistical analyses were carried out using SPSS (version 21).

RESULTS

Prevalence of Ectoparasites of Local Chickens

Out of 250 chickens examined, 135 were infested with one or more ectoparasites, yielding an overall ectoparasite prevalence of 54.0%. Thus, roughly one in every two birds harboured an ectoparasitic infestation. The distribution of ectoparasite species identified is presented in Table 1. The most frequently encountered ectoparasites were lice: *Menacanthus stramineus* was found in 18.4% of all chickens, making it the single most prevalent ectoparasite, followed by *Goniodes gigas* (8.4%) and *Goniocotes gallinae* (5.2%). The poultry red mite (*Dermanyssus gallinae*) was observed in 10.8% of chickens, while the tick (*Argas persicus*) and the flea (*Echidnophaga gallinacea*) infested 6.0% and 5.2% of chickens, respectively. Each percentage prevalence is calculated out of the total sample (n = 250). The relative proportion of each ectoparasite among the infested birds (n = 135) is also shown in Table 1.

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Table 1: Prevalence of Ectoparasites Affecting Local Chickens in Kaduna Metropolis

Species of Ectoparasites	Number Infected	Percentage infected (%)	Percentage Prevalence Rate (%)
Menacanthus stremineus	46	34.1	18.4
Gonoides gigas	21	15.6	8.4
Goniocotes gallinae	13	9.6	5.2
Dermanyssus gallinae	27	20.0	10.8
Echidnophaga gallinacean	13	9.6	5.2
Argas persicus	15	11.1	6.0
OVERALL (number examined (n) = 250)	**135**	**100.00**	**54.0**

Menacanthus stremineus (chicken body louse) was the most identified ectoparasite, accounting for about one-third of all ectoparasite infestations (34.1% of infested birds). The combined lice species (*Menacanthus, Goniodes, Goniocotes*) constituted the majority of ectoparasites, followed by mites, ticks, and fleas (Table 1).

Prevalence of Endoparasites of Local Chickens

Among the 250 chickens, 162 had one or more endoparasites detected in their faecal samples, corresponding to an overall endoparasite prevalence of 64.8%. In other words, nearly two-thirds of the chickens were infected with some internal parasite. The endoparasite species identified and their frequencies are shown in Table 2. The most prevalent endoparasites were the nematodes *Ascaridia galli* (22.0%) and *Strongyloides avium* (14.0%), followed by *Heterakis gallinarum* (10.4%). Other helminths observed included *Capillaria spp.* (7.2%) and the cestode *Raillietina tetragona* (7.2%). The least common endoparasite was *Eimeria* (coccidian protozoa), found in 4.0% of the chickens. Cumulatively, the three most prevalent species (*A. galli, S. avium, H. gallinarum*) accounted for about 70% of the endoparasite infections among the infected birds.

Table 2: Prevalence of Endoparasites Affecting Local Chickens in Kaduna Metropolis

Species of Endoparasites	Number Infected	Percentage infected (%)	Percentage Prevalence Rate (%)
Ascaridia galli	55	34.0	22.0
Strongyloides avium	35	21.6	14.0
Heterakis gallinarum	26	16.0	10.4
Capillaria species	18	11.1	7.2
Rallietina tetragona	18	11.1	7.2
Eimeria species	10	6.2	4.0
OVERALL (number examined (n) = 250)	**162**	**100.0**	**64.8**

Risk Factors of Ectoparasite and Endoparasite Among Local Chickens Based on Sex

The prevalence of ectoparasite infestation was slightly higher in male chickens (54.8%) than in females (52.9%), but this difference was not statistically significant ($\chi^2 = 0.089$, $p = 0.765$). Table 3 summarizes ectoparasite infection rates by sex. Out of 146 males examined, 80 had ectoparasites, whereas 55 out of 104 females were infested. Similarly, for endoparasites, 96 males (65.8%) and 66 females (63.5%) were infected (Table 4). The sex of the chickens showed no significant influence on endoparasite prevalence either ($\chi^2 = 0.140$, $p = 0.708$). In summary, neither ectoparasite infestations nor endoparasite infections differed appreciably between male and female chickens in this study.

Table 3: Prevalence of Ectoparasite Infection Among Local Chickens by Sex.

		Manancantus stramineus	*Goniodes gigas*	*Goniocotes gallinae*	*Dermanyssus gallinacea*	*Echidnopaga gallinacean*	*Argas persicus*	Total
Male		28	10	9	15	8	10	**80**
	%	20.7	7.4	6.7	11.1	5.9	7.4	
Female		18	8	7	12	5	5	**55**
	%	13.3	5.9	5.2	8.9	3.7	3.7	
Total		**46**	**18**	**16**	**27**	**13**	**15**	**135**
		34.1	**13.3**	**11.9**	**20.0**	**9.6**	**11.1**	**100%**

Chi-square test: (χ^2) = 0.089, p-value = 0.765 (p>0.05) (no significant association between sex and ectoparasite infestation)

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Table 4: Prevalence of Endoparasite Infection among Local Chickens by Sex

		Ascaridia galli	*Strongyloides avium*	*Heterakis gallinarum*	*Capillaria species*	*Rallietina tetragona*	*Eimeria species*	Total
Male		33	22	16	11	10	4	**96**
	%	20.4	13.6	9.9	6.8	6.2	2.5	
Female		22	13	12	6	7	6	**66**
	%	13.6	8.0	7.4	3.7	4.3	3.7	
Total		**55**	**35**	**28**	**17**	**17**	**10**	**162**
		34.0	**21.6**	**17.3**	**10.5**	**10.5**	**6.2**	**100%**

Chi-square test: (χ^2) = 0.140, P-value = 0.708 (p>0.05) (no significant association between sex and endoparasite infestation)

Prevalence of Ecto- and Endoparasite Among Local Chickens Based on Weight

The prevalence of parasitic burden showed a declining trend with increasing body weight of the chickens. Among the 126 birds weighing between 1.00–1.99 kg, 93 (73.8%) were parasitized with either ectoparasites or endoparasites. In the 2.00–2.99 kg weight category, 41 out of 73 birds (56.2%) were affected, while 28 out of 51 birds (54.9%) in the 3.00–3.99 kg range were found to be affected (Table 5). Chi-square statistical analysis ($\chi^2(2, N = 250) = 9.061$, $p = 0.011$), indicated that lower-weight chickens are significantly more likely to be infected compared to their heavier counterparts.

Table 5: Prevalence of Ecto- and Endoparasite Among Local Chickens Based on Weights

Weight of chicken	Number examined	Number infected	Percentage (%)
1-1.99kg	126	93	73.81%
2-2.99kg	73	41	56.16%
3-3.99kg	51	28	54.90%
Total	**250**	**162**	**64.80%**

Chi-square test: (χ^2) = 9.061, p-value = 0.011 (p<0.05) (there is significant association between chicken weight and infection prevalence)

DISCUSSION

This study provides valuable insight into the burden of ecto- and endoparasitic infections in local chickens slaughtered in major markets of Kaduna Metropolis. The overall prevalence of ectoparasites (54.0%) and endoparasites (64.8%) reveals a significant level of infestation among locally reared chickens in the region. These findings highlight the continuing challenge of parasitic infections in backyard and semi-intensive poultry systems common in Nigeria.

The ectoparasite prevalence observed is comparable to reports from other parts of the country. For instance, Odenu *et al.* (2016) recorded an ectoparasite prevalence of 57.3% in Abuja, while Murillo and Mullens (2016) found varying rates in backyard flocks in California. Such moderate prevalence rates suggest that, although parasite infestation is not universally severe, it remains consistently present across different ecological zones and husbandry systems. Environmental factors such as humidity, temperature, and hygiene, as well as poultry management practices, influence ectoparasite survival and transmission. Lice were the most dominant ectoparasites, with *Menacanthus stramineus* being the most prevalent species (18.4%). This agrees with findings by Elele *et al.* (2021) and McCrea *et al.* (2014), who also identified *M. stramineus* as a common and harmful ectoparasite in village chickens. Other lice species such as *Goniodes gigas* and *Goniocotes gallinae* were also identified, reinforcing that lice are the primary ectoparasitic threat in these systems. Mites (*Dermanyssus gallinae*), ticks (*Argas persicus*), and fleas (*Echidnophaga gallinacea*) had lower prevalence (10.8%, 6.0%, and 5.2%, respectively). This could be attributed to the husbandry systems in the study area, where many sellers kept chickens in partially confined or perch-based housing, reducing contact with tick- and flea-infested bedding or ground.

The endoparasite burden was notably higher than ectoparasites, with a prevalence of 64.8%. This is in line with several studies from Nigeria: Mohammed *et al.* (2019) reported 68.5% in Abuja, while Yoriyo *et al.* (2005) observed 87% in Bauchi. Such infections are often exacerbated by poor sanitation and unrestricted access to contaminated soil or intermediate hosts during scavenging. Unlike intensive systems where biosecurity is enforced, backyard flocks are frequently exposed to infective stages of helminths and protozoa.

Ascaridia galli (22.0%) was the most frequently encountered endoparasite. This nematode is widely regarded as the most common gastrointestinal helminth in local poultry due to its simple direct life cycle. Elele *et al.* (2021) and Soulsby (1982) similarly emphasized its prevalence in indigenous chicken flocks. *Strongyloides avium* (14.0%) and *Heterakis gallinarum* (10.4%) were also detected at considerable levels. The detection of *Capillaria spp.* and *Raillietina tetragona* (each 7.2%) suggests exposure to diverse endoparasitic species, while *Eimeria spp.* (4.0%) indicates some level of protozoal involvement. Analysis of risk factors showed no significant difference in infestation and infection between sexes for both ectoparasites and endoparasites ($p > 0.05$). Male and female chickens exhibited near-identical infection rates, confirming observations from Adang *et al.* (2008) and Gimba *et al.* (2019), where sex was not a significant predictor of parasite load. While minor numerical differences were seen (e.g., males had slightly higher infection rates), these were not statistically meaningful and may reflect random variation or sample size effects.

In contrast, body weight was significantly associated with prevalence of parasitic infestation and infection. Chickens weighing between 1.00–1.99 kg had a much higher prevalence (73.8%) than those in the 2.00–2.99 kg (56.2%) and 3.00–3.99 kg (54.9%) categories. The chi-square test confirmed a statistically significant

association (χ^2 = 9.061, p = 0.011). This finding suggests that lighter-weight chickens—possibly younger or immunologically immature birds—are more vulnerable to parasitic infestation and infection. Alternatively, heavy parasite loads may impair weight gain, resulting in persistently lower body mass in infected individuals. The cross-sectional nature of this study does not allow causation to be confirmed, but it emphasizes the vulnerability of lower-weight chickens and the need for early intervention, especially in chicks and growers.
The findings indicate that parasite prevalence is widespread, yet preventable through regular
Treatment and better husbandry. Importantly, these parasitic burdens not only reduce productivity but also pose public health risks, as some ectoparasites and endoparasites may serve as vectors of zoonotic agents. Therefore, the findings from this study have implications beyond animal health and touch on food safety and community health standards.

Conclusion

In conclusion, the local chickens slaughtered in Kaduna metropolis showed an overall ectoparasite prevalence of 54.0% and an endoparasite prevalence of 64.8%. The most prevalent external parasites were *Menacanthus stramineus*, followed by *Dermanyssus gallinae*, *Argas persicus*, and *Echidnophaga gallinacean*, while the most prevalent internal parasites were nematode worms (particularly *Ascaridia galli and Strongyloides avium*). The sex of the chickens did not have a significant effect on prevalent rates for either ectoparasites or endoparasites in this study. However, lighter-weight (and presumably younger) birds tended to carry heavier parasite burdens than adults. To improve the health and productivity of these indigenous chickens, it is recommended that better biosecurity and parasite control measures be implemented to minimize parasite transmission and sustain healthier flocks that contribute to food security and livelihoods in the region.

REFERENCES

Abaje, I. B. & Oladipo, E. O. (2018). Recent changes in the temperature and rainfall conditions over Kaduna State, Nigeria. *Global Journal of Environmental Science and Management*, *4*(2), 133-144.

Adang, K. L., Oniye, S., Ajanusi, O. J., Ezealor, A. & Abdu, P. (2008). Gastrointestinal helminths of the domestic pigeons (Columba livia domestica Gmelin, 1789 Aves: Columbidae) in Zaria, Northern Nigeria. *Science World Journal, 3*(1), 33-37.

Asumang, P., Delali, J.A., Wiafe, F., Kamil, Z., Balali, G.I. & Gobe, V.A.D. (2019). Prevalence of gastrointestinal parasites in local and exotic breeds of chickens in Pankrono-Kumasi, Ghana. *Journal of Parasitology Research*, 2019: 5746515.

Cervantes-Rivera, K., Villagómez-Cortés, J. A., Arroyo-Lara, A. & Landín-Grandvallet, L. A. (2016). A diagnostic survey of gastroenteric helminths in backyard poultry of a rural village in Mexican tropics. *ARPN Journal of Agricultural and Biological Science*, *11*(12), pp.837–843.

Ekpo, U.F., Ogbooye, A.A., Olumoye, A.S., & Takeet, M. (2010). A preliminary survey on the parasites of free-range chickens in Abeokuta, Ogun State, Nigeria. *Journal of Natural Sciences, Engineering and Technology, 2*(1), 123–130.

Elele, K., Amawulu, E. & Eniyekedidei, K.P. (2021). Parasites Status of Village Chickens(*Gallus gallus domesticus*) in Selected Communities in Yenagoa Local Government Area of Bayelsa State, Nigeria. *Open Journal of Applied Sciences*, *11*, 230-238.

Food and Agriculture Organization of the United Nations (FAO). (2023). *Global chicken population data 2020*. FAOSTAT Live Animals (retrieved 2023).

Gibbons, L.M., Jacobs, D.E., Fox, M.T. & Hansen, J. (2005). *The RVC/FAO Guide to Veterinary Diagnostic Parasitology: Faecal Examination of Farm Animals for Helminth Parasites*. Available at: http://www.rvc.ac.uk/review/Parasitology/Index/Index.Htm.

Gimba, F. I., OlaFadunsin, S. D., Abdullah, D. A., Konto, M., Daudu, B. B. & Abubakar, D.(2019). Prevalence of ecto and endoparasites of chickens in some villages in Taraba State, North Eastern Nigeria. *Livestock Research for Rural Development*, *31*(4).

Jaiswal, K., Mishra, S. & Bee, A. (2020). Prevalence of Gastrointestinal Helminth Parasites in *Gallus gallus domesticus* in Lucknow, U. P, India. *Advances in Zoology and Botany*, *8*(5), 422–430. https://doi.org/10.13189/azb.2020.080506

Khanum, H., Musa, S., Islam, M., Akter, R., & Sarker, F. (2021). Occurrence of Endoparasites in Domestic Fowls (*GALLUS GALLUS*) And Ducks (*ANAS PLATYRHYNCHOS*). *Bangladesh Journal of Zoology*, *49*(1), 35–46.

McCrea, B., Jeffrey, J. S., & Ernst, R. A. (2014). *Common Lice and Mites of Poultry: Identification and Treatment.* University of California.

Murillo, A.C., & Mullens, B.A. (2016). Diversity and prevalence of ectoparasites on backyard chicken flocks in California. *Journal of Medical Entomology*, *53*(3), pp.707–711.

Mohammed, B.R., Ojo, A.A., Opara, M.N., & Jegede, O. (2019). Haemo- and endoparasites of indigenous chickens reared in Gwagwalada Area Council, Abuja, Nigeria. *Annals of Parasitology*, *65*(3): 293–296.

Odenu, R.A., Mohammed, B.R., Simon, M.K. & Agbede, R.I.S. (2016). Ecto-parasites of Domestic Chickens (Gallus gallus domesticus) in Gwagwalada Area Council, Abuja, Nigeria-West Africa. *Alexandria Journal of Veterinary Sciences*, *51*(1), 140.

Peters, J., Lebrasseur, O., Irving-Pease, E. K., Paxinos, P. D., Best, J., Smallman, R., Callou, C., Gardeisen, A., Trixl, S., Frantz, L., Sykes, N., Fuller, D. Q., & Larson, G. (2022). The biocultural origins and dispersal of domestic chickens. *Proceedings of the National Academy of Sciences*, *119*(24).

Statista. (2023). Number of chickens worldwide from 2000 to 2023. *Statista*. Available in: https://www.statista.com/statistics/263962/number-of-chickens-worldwide-since-1990/ (18 December 2023).

Soulsby, E.J.L. (1982). *Helminths, Anthropods and Protozoa of Domesticated Animals*. 7th ed. Bailliere Tindall.

Taylor, J. N., Schober, T. J., Bean, S. R. (2006). Novel food and non-food uses for sorghum and millets. *Cereal Science*, *44*: 252 271

United Nations Department of Economic and Social Affairs (UN DESA). (2022). *World Population Prospects 2022: Summary of Results.* United Nations, New York.

Yoriyo, K.P., Fabiyi, J.P., Adamu, S.U., & Panda, S.M. (2005). Intensities of helminth parasites of freeranging chickens in Bauchi and environs, Nigeria. *Yankari Journal*, *2*: 135–137.