RESEARCH ARTICLE

Sokoto Journal of Veterinary Sciences

(P-ISSN 1595-093X: E-ISSN 2315-6201)

http://dx.doi.org/10.4314/sokjvs.v20i4.2

Luka *et al.*/*Sokoto Journal of Veterinary Sciences*, **20**(4): 232-239.

Ectoparasitic fauna of poultry species in Maiduguri, Borno State, Nigeria

J Luka[1]*, AM Peter[1], MK Zango[1], J Musa[1], EA Malgwi[1], HM Pindar[1], CM Alfred[1] & YD Medugu[2]

1. *Department of Veterinary Parasitology and Entomology, University of Maiduguri, Nigeria*
2. *Department of Animal Health and Production, Adamawa State College of Agriculture, Ganye, Adamawa State, Nigeria*

*Correspondence: Tel.: + 2348030407578; E-mail: joshuadiriki@yahoo.com

Abstract

Ectoparasitic fauna of 397 conveniently sampled domestic birds consisting of 213 chickens, 128 turkeys, 21 ducks, 19 guinea fowls, 8 pigeons and 8 geese were investigated in Maiduguri, Borno State. A total of one hundred and fifty-two 152 (38.29%) birds were infested with one ectoparasitic species or the other comprising of 115 (54.00%) chickens, 33 (25.78%) turkeys, 1 (5.26%) guinea fowl and 3 (37.50%) pigeons. No infestation was encountered among geese and ducks examined. The infestation rate differed significantly based on sex and age ($p<0.05$), but not the management system. Similarly, the occurrence varied significantly ($p<0.05$) based on locations of sampling ($p<0.00001$) and species of poultry examined ($p<0.000049$). Furthermore, 116 (29.21%) of the total birds examined had a single infestation with either louse, tick or mite species, while 36(9.06%) birds had mixed infestation with species from two or more of these ectoparasitic groups. Among the parasites encountered, lice present on 146 (36.77%) birds were the most prevalent, followed by mites 28(7.05%) and ticks 15(3.78%). Nine different species of ectoparasites belonging to the orders Mallophaga and Acarina were identified in the study. *Menopon gallinae, Lipeurus caponis, Menacanthus stramineus, Goniodes gigas, Goniocotes gallinae* and *Columbicola columbae* were the lice identified, while *Cnemidocoptes mutans* and *Ornithonyssus bursa* were the only species of mite identified. The poultry tick, *Argas persicus* was the only tick species found. Conclusively, the study revealed a high but variable burden of ectoparasitic infestation among poultry species examined, and that ectoparasites are common in minor poultry species as they do occur in chickens under different management systems in the study area. The need to investigate the diverse effects of ectoparasitism on the different poultry species is suggested here.

Publication History:
Received: 13-05-2022
Revised: 23-08-2022
Accepted: 25-08-2022

Keywords: Ectoparasitism, Maiduguri, Management, Poultry, Production

Introduction

Poultry refers to any bird reared or hunted for eggs, meat and/or fertiliser production (Oluyemi & Robert, 2002; USDA, 2019). It includes chicken, turkey, goose, duck, pheasant, Guinea fowl and ratites such as ostrich, emu and rhea (USDA, 2019). As a result of over-reliance by man on chickens for poultry products, other species of poultry have been collectively termed as underutilised or minor (Macharia *et al*., 2017) due to their relatively little contribution to the requirements of humans.

Nigeria's poultry population was estimated at 180 million birds, contributing 454 billion tons of meat and 3.8 million eggs annually as animal protein sources, with chickens contributing most of these products (ASL, 2050, ASL, 2018). While the village poultry production system in Nigeria is maintained as part of traditional stock keeping, the commercialised system is big, with the potential of generating thousands of jobs and contributing immensely to the nation's gross domestic product (GDP) (Masaki *et al*., 2020).

Among other factors that may militate against optimal production of poultry is the presence in the flock of disease-causing agents such as bacteria, viruses and parasites responsible for a wide variety of diseases. These agents, long associated with poultry farming (Bassey & Marroh, 2018), are notable for causing huge production losses. For example, ectoparasites consisting of lice, fleas, ticks and mites can be found practically on all avian species (Mirzaei *et al*., 2016), where they hamper production and impact health negatively, mainly by their feeding habits and ability to transmit disease-causing agents. The feeding behaviours of larvae, nymphs and adults of these ectoparasites cause irritation, restlessness and debility and, in heavy infestation, may result in fatal anaemia (Mirzaei *et al*., 2016).

World over, the ectoparasitic fauna of chickens is well exploited, ostensibly due to the availability and rearing ease of chickens in both rural and urban settings. However, the fauna of most of the other minor poultry species remains underexploited. Currently, there are more reports of studies conducted on ectoparasitism of chickens (Bala *et al*., 2011; Iposu *et al*., 2013; Jilo *et al*., 2017; Lawal *et al*., 2017) than on other species of poultry combined. The few available documented reports of the presence of ectoparasites on minor poultry species such as pigeons (Dranzoa *et al*., 1999), turkeys (Fabiyi *et al*., 2017) and captive birds (Njila *et al*., 2018) suggest the modest contributions of these species in meeting protein requirement of humans when compared to chickens.

The present study was designed to determine the occurrence and species of ectoparasites on available domesticated poultry species in Maiduguri, Borno State and to comparatively determine their distribution across the various species.

Materials and Methods

Description of study and study area

This study was conducted on chickens, turkeys, pigeons, guinea fowl, ducks and geese from Maiduguri Metropolis, Borno State, during the cold, dry period of December 2018 to March 2019. Maiduguri, the study location, is the capital and largest city in Borno State. It is situated within latitudes 11.5° N and 11.4° N and longitudes 13.5° E and 13.25° E (Udoh, 1981). It covers an area of 543 km^2 and borders Jere Local Government area to the north, Konduga to the west, south and south-west, while it is bordered in the north-west by Mafa (Haruna, 2010). Maiduguri has a temperature range of between 30 and 40^{O}C and a mean annual maximum temperature of 34.8^{O}C. The city has two seasons consisting of the rainy from June to September and the dry season from October to May, although the rainy season may set in earlier or can last later than the specified months during rainy years (Haruna, 2010). The months of March and April appear to be the hottest months of the year, while November-January is cool, dry and dusty.

Sample Collection and Transportation

The live bird market (LBM) component of the Maiduguri Monday market (Yan Kaji) was used as the sampling point, along with some conveniently selected established and backyard poultry farms in Maiduguri. Willingness to participate in the study, and permission for sample collection after a detailed explanation of the collection procedure to the farmers and the poultry vendors was the only criterion used for selecting participants. A total of 397 birds of different ages consisting of 213 chickens, 128 turkeys, 19 guinea fowls, 8 pigeons, 8 geese and 21 ducks were conveniently selected for the study.

Sample collection was made twice a week. During each visit, birds were examined by the gentle movement of the hand against the direction of the feather in a caudo-cranial fashion aided by a hand lens. The plume and the down feathers were similarly examined and brushed on a white paper to allow visualisation of brushed external parasites, while scrapings of scaly legs were collected (Rezaei *et al.,*

2016). The ectoparasites and the scrapings from each poultry host were collected into universal sample bottles containing 70% ethanol and 5% glycerine and transported to the Veterinary Parasitology and Entomology Research Laboratory of the Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Maiduguri for examination and identification. Information of the sampled birds consisting of the age, sex, species and rearing system, where possible, were recorded.

Sample examination

The ectoparasites collected from each host were divided into two parts and processed as described by Mathison & Pritt (2014). Briefly, one part was transferred as an individual parasite to Petri dishes, cleared in lactophenol solution for 24 hours, and then identified with the aid of a stereomicroscope using established taxonomic keys (Soulsby, 1982; Bhatia *et al*., 2006). The second part of the collected ectoparasites was processed by clearing in 1% potassium hydroxide (KOH) for 24 hours, followed by dehydration of the cleared ectoparasites in ascending grades of alcohol (50%, 70% and 100%) before being mounted on a glass slide using polyvinyl alcohol (PVA). Identification keys such as body morphology, shape and length of mouthpart, number of abdominal segments, and morphology of the setae as earlier described (Soulsby, 1982; Bhatia *et al*., 2006) were used. Leg scrapings were individually transferred to test tubes, after which 2% potassium hydroxide was added and then boiled to dissolve the scaly tissue. The decant containing the mite was examined, and the parasite was identified as earlier described (Bhatia *et al*., 2006).

Data analysis

Data generated from the study were analysed using the statistical package for social sciences (SPSS) version 21 (SPSS, 2011). Significant variation among and between variables was tested using chi-square, while $p<0.05$ was considered significant throughout the study.

Results

Among 397 birds examined for ectoparasitic infestation, 152 (38.29%) were infested with different species of ectoparasite belonging to either of the two orders; Mallophaga and Acarina. The infestation rate was significantly ($p<0.003$) higher in females 92 (46.00%) than in male birds 60 (30.46%) (Table 1), and in adults 118 (42.60%) than in young birds 34 (28.33%), and under semi-intensive 106 (41.41%) than the intensive management system 46 (32.62%), though with no significant ($p>0.05$) variation in both cases (Table 1).

Although collected samples were not distributed evenly among the locations, there was a very significant variation ($p<0.0001$) in prevalence based on the locations of sample collection. Maiduguri Monday market had the highest number of infested birds 72 (60.0%), followed by Pompomari 23 (23.0%), Fori 22 (55.0%) and the least rate was from Lagos street 2 (20.0%) (Table 2). The highest infestation among the species of poultry examined was in chicken 115

Table 1: Occurrence of ectoparasites of poultry in Maiduguri based on sex, age and management system

Parameter	No. Examined	No (%) Infested
Sex		
Male	197	60 (30.46)[a]
Female	200	92 (46.00)[b]
Age		
Young	120	34 (28.33)[a]
Adult	277	118 (42.60)[b]
Management System		
Semi-intensive	256	106 (41.41)[a]
Intensive	141	46(32.62)[a]
Total	397	152(38.29)

Different superscripts in columns differed significantly ($P<0.05$)

Table 2: Prevalence of ectoparasites of poultry in Maiduguri based on location

Location	No. Examined	No (%). Infested
University staff quarters	5	5 (100.00)[a]
Old Airport	23	15 (65.22)[b]
Monday market	120	72 (60.00)[c]
Fori	40	22 (55.00)[d]
Pompomari	100	23 (23.00)[e]
Lagos street	10	2 (20.00)[e]
Mairi Kuwait	99	13 (13.13)[f]

Different superscripts in columns differed significantly ($P<0.05$)

(54.0%), followed by turkeys 33 (25.78%). Guinea fowls had only 1 (5.26%) infested bird, while no infestation was detected in geese and ducks (Table 3). There was a significant variation ($p<0.000049$) in the prevalence based on the species examined.

Between the breeds of chickens examined in the study, the village chickens 71(97.26%) were more significantly ($p<0.00001$) infested with ectoparasites than the exotic birds 44(31.43%) (Table 4). Table 5 details the number of poultry species infested and the various species and numbers of ectoparasites found. Nine different species of ectoparasite belong to two orders; Mallophaga (*Menopon gallinae*; *Menacanthus stramineus; Lipeurus caponis; Goniocotes gallinae; Goniodes gigas and Columbicola columbae)* and Acarina *(Argas persicus) and mite* (*Cnemidocoptes mutans* and *Ornithonyssus bursa)* were identified in the study. *Lipeurus caponis* recovered in 213 (53.65%) birds was the most abundant, followed by *Menopon gallinae* 174 (43.80%) and *Goniocotes gallinae* 161 (40.60%), while *Columbicola columbae* 3 (0.76%) was the least prevalent parasite (Table 5). Furthermore, the ectoparasitic mix of the recovered species indicates that single infestation due to either of mites, lice or ticks was more common than mixed infestation (Table 6).

Table 3: Prevalence of ectoparasites of poultry in Maiduguri, Borno State, Nigeria, based on the species of poultry examined

Poultry Species	No. Examined	No. (%) Infested
Chicken	213	115 (54.00)[a]
Turkey	128	33 (25.78)[b]
Guinea fowl	19	1 (5.26)[c]
Pigeon	8	3 (37.50)[d]
Geese	8	0(0.0)[e]
Duck	21	0(0.0)[e]
Total	397	152(38.29)

Different superscripts in columns differed significantly ($P<0.05$)

Table 4: Prevalence of ectoparasites of chickens in Maiduguri, Borno State, Nigeria based on breed (n=213)

Breed Type	No. Examined	No. (%) Infested
Village Chickens	73	71 (97.26)[a]
Exotic (Layer)	140	44 (31.43)[b]
Total	213	115 (54.00)

Different superscripts in columns differed significantly ($P<0.05$)

Table 5: Distribution of species of ectoparasite based on poultry species in Maiduguri, Borno State, Nigeria

Species of ectoprasites	Poultry species and number infested					Total
	Chicken	Turkey	Guinea fowl	Peacock	Pigeon	
Argas persicus	62	9	0	0	0	71
Menopon gallinae	173	0	0	1	0	174
Menacanthus stramineus	0	43	0	0	0	43
Lipeurus caponis	101	103	9	0	0	213
Goniodes gigas	90	17	0	0	0	117
Goniocotes gallinae	161	0	0	0	0	161
Columbicola columbae	0	0	0	0	3	3
Cnemidocoptes mutans	150	0	0	0	0	150
Ornithonyssus bursa	90	0	0	0	0	90
Total	827	172	09	01	03	1,022

Table 6: Infestation types of ectoparasites of poultry in Maiduguri, Borno State, Nigeria

Infestation Type	Type of Ectoparasite	No. (%) Infested
Single infestation	Lice	109 (27.50)
	Mite	2 (0.50)
	Tick	5 (1.26)
Subtotal		116(29.20)
Mixed infestation	Lice + mites	25 (6.30)
	Lice + tick	11 (2.77)
Subtotal		36(9.07)
Total		152 (38.29)

Discussion

The overall prevalence (38.3%) of ectoparasites consisting of lice, mites and ticks in this study is comparable to the 41% reported by Nnadi & George (2010) from Enugu (Nigeria) in chickens and lower than the 100% each reported from Sokoto (Bala *et al*., 2011) and Abeokuta (Ekpo *et al*., 2010), Nigeria. Also, the obtained prevalence is greater than the 15.2% reported in chickens by Biu *et al*. (2007) from Maiduguri. The effect of breed, season of the year, management system, agro-ecological, preventive and control methods of diseases have earlier been elucidated to influence prevalence pattern and distribution of ectoparasites on their hosts (Rezaei *et al*., 2016; Kebede *et al*., 2017), and may likely be responsible for the variation observed. The type of management system employed, especially in backyard poultry production, is often fraught with poor hygienic practices which provide a favourable environment for the proliferation and transmission of infective forms of parasites (Rezaei *et al*., 2016).

The findings in this study of a significantly higher occurrence in females than males agree with the earlier findings of Mata *et al*. (2018) among exotic and local chickens from Ethiopia and Onyekachi (2021), who investigated chickens from three poultry farms in Awka, Nigeria. However, it disagreed with Mungube *et al*. (2008), who observed a higher prevalence in males than females. The current finding may be attributed to the longer holding period of the female birds, especially those being reared for egg production, coupled with the sedentary life of local chickens during brooding, which formed the bulk of the examined birds in this study. Furthermore, it was observed that more adult birds (42.6%) were found to be infested compared to the young ones (28.2%), and this is in agreement with previous reports of Mata *et al*. (2018) and Kaboudi *et al*. (2019). This can be explained by the fact that there is an increased possibility of contact with ectoparasites with increasing age. In addition, a longer duration of contact with environmental sources of infestation such as infested housing facilities and birds ensures transmission to non-infested birds.

Although collected samples were not equally distributed across the sampling locations, the distribution of ectoparasitic occurrence showed significant differences ($P<0.05$) across the locations. Since all the sampling locations are situated in the same geographical entity, the differences observed in occurrence are unlikely to be due to the influence of geographical or climatic factors such as temperature, humidity or season, but rather due to variations in hygienic practices, management system, preventive and control measures and general biosecurity approaches adopted across the locations of sampling. Also, the wide differences between the numbers of samples collected from the different locations limit the generalisation of the effects of geographical location in the present study.

Based on the species of poultry examined, obtained results indicate that chickens were the most infested with 54%, followed by turkeys, while no infestation was recorded in ducks and geese. Among other likely factors responsible, the occurrence pattern is indicative of host preference by infesting parasites for some poultry species over others. Lice constituting the majority of the infesting arthropods have been shown to have a preference for some hosts (Permin & Hansen, 1998) compared to others, despite their cosmopolitan distribution. Most of the species of lice recovered in this study have been documented to be the species infesting chickens, which agrees with the host-parasite distribution pattern of these arthropods (Soulsby, 1982). Furthermore, the absence of ectoparasites in ducks and geese, which are birds with high water contact behaviours, agrees with Bhatia *et al*. (2006), where these species were shown to harbour fewer ectoparasites than chickens. The behavioural pattern of these species, where they spend substantial time in water, maybe an explanation for the zero prevalence of ectoparasites.

Ten different species of arthropod belonging to two orders; Acarina (*Argas persicus, Cnemidocoptes mutans* and *Ornithonyssus bursa*) and Mallophaga (*Menopon gallinae, Lipeurus caponis, Menacanthus stramineus, Goniodes gigas, Goniocotes gallinae* and *Columbicola columbae*) were identified. The species of lice encountered in this study are similar to those earlier reported in chickens from Argentina (Nahal *et al*., 2021); Ethiopia (Mata *et al*., 2018), Nigeria (Chidiogo *et al*., 2020), and in chickens, turkeys and pigeons from Iran (Rezaei *et al*., 2016). Conversely, the poultry flea, *Echidnophaga gallinacea,* consistently reported in previous studies was not encountered in the current study. Thus, the reason for this variation remains unclear. *Lipeurus caponis, Menopon gallinae* and *Goniocotes gallinae* were the three most common lice isolated from this study in order of frequency of occurrence, while the pigeon louse, *Columbicola columbae* was the least recovered louse. This is in agreement with the finding of Kebede *et al*. (2017) and Mata *et al*. (2018) in chickens around Jimma town in Ethiopia where these species were also the commonest recovered and in the same order of frequency. However, it disagrees with the report of

Odenu *et al*. (2016), who reported *Menacanthus stramineus* and *Goniodes gigas* as the most prevalent lice of poultry from Gwagwalada, Nigeria. Furthermore, the occurrence rate in this study is higher compared to previous findings from Ethiopia (Kebede *et al*., 2017), Iran (Rezaei *et al*., 2016) and Nigeria (Biu *et al*., 2007).

Lipeurus caponis, commonly called the wing louse of fowl, is found underneath large wing feathers and is described as a sluggish louse (Bhatia *et al*., 2006), probably a reason for the high recovery in this study. The shaft louse of poultry, *Menopon gallinae* and the large yellow body louse of poultry, *Menacanthus stramineus* are two lice of poultry that occurred in very high proportion in this study when compared with the previous report by Rezaei *et al.* (2016).

The fowl tick, *Argas persicus*, the only tick isolated from this study, affects a wide range of poultry species causing depletion of a large quantity of blood, sleep disorders and a drop in production, and in extreme cases, results in the death of birds (Bhatia *et al*., 2006). The recovery in this study of *Argas persicus* from chickens and turkeys agrees with the earlier reports of Rezaei *et al*. (2016) and Fabiyi *et al*. (2017) where the parasite was recovered from layer chickens and turkeys from Iran and Nigeria, respectively. The attribute of *Argas persicus*, as an intermittent feeder and visitor to their hosts limits precise determination of the occurrence rate in flocks and thus could have been responsible for the zero-occurrence recorded in some species in this study, especially when few samples and low infestation rates are involved.

The mites, *Cnemidocoptes mutans* and *Ornithonyssus bursa* are important as burrowing and surface mites respectively. *Cnemidocoptes mutans,* commonly called the scaly leg mite of poultry is important as a cause of inflammation, which can ultimately result in lameness, scale loss, encrustation and hypersensitivity (Hopla *et al*., 1994). Previous recovery of *Cnemidocoptes mutans* from chickens in Nigeria (Odenu *et al*., 2016), Northeast Tunisia (Kaboudi *et al*., 2019) and Ethiopia (Zeryehun & Yohannes, 2015), coupled with the high (70%) occurrence among chickens sampled in this study emphasises the importance of the chicken host to this parasite.

The finding in this study of a higher infestation rate with single than with mixed species of ectoparasites appears similar to the report of Kaboudi *et al*. (2019) on domestic backyard chickens from Tunisia. It, however, disagreed with Lawal *et al*. (2017), who reported more infestation with mixed parasites among chickens in Gombe, Nigeria. Preventive and control measures adopted for diseases, along with the type of management system practised, affect the distribution of parasite species available. Furthermore, the parasite recovered from each study reflects the available parasite species on the host and, by extension, the environment at the time of the investigation.

Conclusively, the study has established a high but variable burden of ectoparasitic infestation among the species of poultry examined, and infestation is a common occurrence in minor poultry species as it does occur in chickens. Also, the host-parasite distribution of the ectoparasitic species in this study is closely associated with the behaviour and management system. Therefore, the effects of either single or mixed parasite occurrence need to be investigated among different poultry species.

Funding

No funding was received.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

ASL (African Sustainable Livestock) 2050. (2018). Livestock and livelihoods spotlight Nigeria Cattle and poultry sectors. FAO, 2018, Rome, Italy

Bala Y, Anta A, Waziri A & Shehu H (2011). Preliminary survey of ectoparasites infesting chickens (*Gallus gallus domesticus*) in four areas of Sokoto Metropolis. Niger. *Nigerian Journal of Basic and Applied Sciences*, **35**: 101-126.

Bassey SE & Marroh R (2018). A survey of ectoparasites in the free-range domestic fowl, *Gallus gallus domesticus*, in Amassoma, Bayelsa State, Nigeria. *Journal of Environment and Bio Research*, **2**: 1–3.

Bhatia BB, Pathak KML & Banerjee DP (2006). *Textbook of Veterinary Parasitology,* second revised edition. Kalyani Publishers, India. Pp 61-67.

Biu A, Agbede I & Peace P (2007). Study on ectoparasites of poultry in Maiduguri, Nigeria. *Nigerian Journal of Parasitology*, **28**(2): 69-72.

Chidiogo NC, Ilozumba PCO & James CG (2020). Prevalence of ectoparasitic arthropods on free range domestic fowls (*Gallsu gallus domesticus*) in Amansea and Ifite communities (Awka, Nigeria). *Advances in Zoology and Botany*, **8**(2): 64-68.

Dranzoa C, Ocaido M & Katete P (1999). The ecto-, gastrointestinal and haemoparasites of live pigeons (*Columbia livia*) in Kampala, Uganda. *Avian Pathology*, **28**(2): 119-124.

Ekpo UF, Ogbooye AA, Oluwole AS & Takeet M. (2010). A preliminary survey on the parasites of free-range chicken in Abeokuta, Ogun State, Nigeria. *Journal of Natural Sciences Engineering and Technology,* **9**(2):123-130.

Fabiyi JP, Alayande MO, Akintule AO, Lawal MD, Mahmuda A & Usman M (2017). Prevalence and seasonal fluctuations of ectoparasites infesting backyard turkeys, *Meleagris gallopavo*, in Sokoto, North-Western Nigeria. *Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicau*, **70**(1): 21-24.

Haruna T (2010). Assessment of the Structure of the Unemployed in Maiduguri urban, Borno State. B.Sc Geography Project, Department of Geography, Faculty of Science, Adamawa State University, Mubi. Pp 9.

Hopla CE, Durden LA & Keirans JE (1994). Ectoparasites and classification. *Revue Scientifique et Technique (International Office of Epizootics)*, **13**(4):987-1017.

Iposu SO, Okwelum N, Sanni RO, Sanwo K & Oduguwa BO (2013). Prevalence of mites and fleas as primary turkey ectoparasites in Odeda local government area of Ogun State, Nigeria. *Global Journal of Biology, Agriculture and Health Sciences*, **3**(3): 154 – 157.

Jilo K, Galgalo W & Mata W (2017). Camel mastitis: A review. *MOJ Ecology and EnvironmentalSciences*, **2**(5):00034.

Kaboudi K, Romdhane RB, Salem AB & Bouzouala M. (2019). Occurrence of ectoparasites in backyard domestic chickens (*Gallus gallus domesticus*) in the northeast of Tunisia. *Journal of Animal Health and Production*, **7**(3): 92-98.

Kebede A, Abebe B & Zewdie T (2017). Study on prevalence of ectoparasites of poultry in and around Jimma town. *European Journal of Biological Sciences*, **9**(1): 18-26.

Lawal JR, Yusuf ZB, Dauda J, Gazali, YA & Biu AA (2017). Ectoparasites infestation and its associated risk factors in village chickens *(Gallus gallus domesticus)* in and around Potiskum, Yobe State, Nigeria. *Journal of Aquatic Science and Marine Biology,* **1**(1): 8-19.

Macharia JW, Mberu MN, Wamuyu L, Imboma T, Lichoti JK, Ngeiywa KJ & Ommeh SC (2017). Phenotypic analysis of underutilised poultry species in Kenya. *Livestock Research for Rural Development.* **29**(5): 1-8.

Masaki, MN, Lee IVD, Duns H, Toromade F & Ayo O (2020). Poultry sector study Nigeria. A publication of Netherlands Enterprise Agency, commissioned by Nigeria's Ministry of Foreign Affairs, October, 2020. https://www.rvo.nl/sites/default/files/2020/10/Poultry-Sector-Study-Nigeria.pdf, retrieved 14-07-2022.

Mata W, Galgalo W & Jilo K (2018). Prevalence of the major ectoparasites in poultry in extensive and intensive farms in Jimma, South-western Ethiopia. *Journal of Parasitology and Vector Biology*, **10**(7): 87-96.

Mathison BA & Pritt BS (2014). Laboratory Identification of Arthropod Ectoparasites. *Clinical Microbiology Review*, **27**(1): 48–67.

Mirzaei M, Ghashghaei O & Yakhchali M (2016). Prevalence of ectoparasites of indigenous chickens from Dalahu Region, Kermanshah Province, Iran. *Turkish Journal of Parasitology*, **40**(1): 13-16.

Mungube EO, Bauni SM, Tenhagen BA, Wamae LW, Nzionka SM, Muhammad L & Nginyi JM (2008). Prevalence of parasites of the local scavenging chickens in a selected semi-arid zone of Eastern Kenya. *Tropical Animal Health and Production*, **40**(2): 101-109.

Nahal A, Righi S, Boucheikhchoukh A & Benakhla A (2021). Prevalence of ectoparasites in free range backyard chicken flocks in Northeast Algeria. *Veterinarska Stanica*, **52**(6): 693-702.

Njila HL, Debi-Dore JD, Ombugadu A, Dibal M & Mafuyai MJ (2018). Survey of ectoparasites infesting captive birds in the Jos Museum zoological garden, North-Central Nigeria. *Journal of Natural Sciences Research*, **8**(7):36-40.

Nnadi PA & George SO (2010). A cross-sectional survey on parasites of chickens in selected villages in the sub-humid zones of South-eastern Nigeria. *Journal of Parasitology Research*, doi.10.1155/2010/141824.

Odenu RA, Mohammed BR, Simon MK & Agbede RIS (2006). Ectoparasites of domestic chickens (*Gallus gallus domesticus*) in Gwagwalada Area Council, Abuja, Nigeria-West Africa. *Alexandria Journal of Veterinary Sciences*, **51**(1): 141-146.

Oluyemi JA & Roberts FA (2002). Poultry Production in Warm Wet Climates. Macmillan, London. Pp 26-28.

Onyekachi O (2021). Prevalence of ectoparasites infestation of chickens in three poultry farms in Awka. *Asian Basic and Applied Science Journal*, **3**(2): 1-13.

Permin A & Hansen JW (1998). Epidemiology, diagnosis and control of poultry parasites. Food and Agricultural Organisation (FAO) Manual 4. Italy. Pp 8.

Rezaei F, Hashemnia M, Chalechale A, Seidi S & Gholizadeh M (2016). Prevalence of Ectoparasites in free-range backyard chickens, domestic pigeons (*Columba livia domestica*) and turkeys of Kermanshah province, West of Iran. *Journal of Parasitic Diseases*, **40**(2): 448-453.

Statistical Package for Social Sciences (SPSS) (2012). Statistical package for Social Sciences 2012, version 21.0.IBM Corporation, New York, USA.

Soulsby E (1982). Helminths, Arthropods and Protozoa of Domesticated Animals, seventh edition, Baillere Tindall, London. Pp 492-552.

Udoh RK (1981). Geographical Regions of Nigeria. Heinemann Education Books Ltd, London 1. Pp 45-47.

USDA (2019). What is poultry? https://ask.usda.gov/s/article/What-is-poultry, retrieved 01-05-2020.

Zeryehun T & Yohannes Y (2021). Ectoparasitic infestation of free scavenging chickens reared under traditional backyard production system in Wolayita Zone, Southern Ethiopia. *Ethiopian Veterinary Journal*, **19**(2): 55-66.