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Ectoparasites Infestation and its Associated Risk Factors in Village Chickens (Gallus gallus domesticus) in and Around Potiskum, Yobe State, Nigeria

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ABSTRACT

A cross sectional study on the prevalence of ectoparasites and associated risk factors in village chickens was conducted in Potiskum Area of Yobe State between February, 2016 to November, 2016. Out of 400 village chickens of both sexes and ages that were examined, 338 (84.50%) were infested with ectoparasites. Four fauna of ectoparasites namely lice, flea, ticks and mites were found infesting village chickens at different predilection sites on the bodies of the infested chickens in this study. The most prevalent species of ectoparasites identified was Lipeurus caponis (40.25%) followed by Menacanthus stramineus (14.0%), Echidnophaga gallinacean (8.75%), Cnemidocoptes mutans (7.0%), Cnemidocoptes gallinae (5.0%), Argas persicus (4.50%), Menopon gallinae (2.75%) and Dermanyssus gallinae (2.25%) in a descending order. Results also revealed that 9.0% and 75.50% of the affected village chickens were infested with single and mixed species of ectoparasites. The difference in prevalence rate of ectoparasites in adult chicken (61.75%) was higher than in younger (22.75%) ones. The finding in age group showed that there was a statistical significant differences (P<0.05) in prevalence rate of ectoparasites infestation between adult and young chickens. The prevalence of ectoparasites was higher in female (46.25%) than in the male (38.25%); higher in village chickens reared under extensive management (64.75%) system than those reared under semi-intensive (19.75%) system. Ectoparasites infestation was found to be higher in village chickens sampled from the rural (56.25%) settlements than those sampled from the semi-urban (28.25%) settlements of the study area. There was no statistical significant difference (P>0.05) between male and female chicken, extensive management and semi-intensive managements systems as well as between rural and semi-urban settlements. Results of this study revealed that ectoparasites prevalence rate was higher during the rainy (49.0%) season than in the dry (35.50%) season of the sampling period. The finding in season showed that there was a statistical significant differences (P<0.05) in prevalence of ectoparasites between rainy and dry season. In conclusion, there is a high prevalence of ectoparasites in free range village chickens in Potiskum Area of Yobe State, therefore, adequate control and preventive measures should be put in place to curb the effect of the parasites on the productivity of village chickens.

Keywords: *Ectoparasites, Village chickens, infestation, Potiskum, Yobe State;*

INTRODUCTION

Poultry production plays significant socio economic roles in developing countries and it is one area of livestock production with significant contribution to human nutritional statue in many developing countries in Africa (Assefa *et al.*, 2017). The poultry production system also play

an important role in poverty alleviation and job creation for the most vulnerable women and young people especially in the rural areas (Aklilu *et al*., 2007; Wilson, 2010; ILRI, 2014).Poultry edible products (meat and eggs) has indeed become one of the most important protein sources for man throughout the world due to limited social and religious taboos related to their production, marketing and consumption compared to products from other livestock species such as beef and pork (Beyene *et al*., 2014; Mohammed and Sunday, 2015). Poultry production is being subjected to great pressure to satisfy the demand for animal protein required by the continued increase in human population and also to have surplus for international trade (FAO, 2008; Firaol *et al*., 2014; Sambo *et al*., 2015). The poultry production system can broadly be classified into two which consist of the exotic/commercial poultry and the rural/village poultry production systems (Odenu *et al*., 2016). These two poultry production systems involved the rearing of various species of domesticated and semi domesticated birds species meant for diverse importance of human livelihoods. Various domesticated poultry species such as ducks, turkeys, guinea fowl, quail, pigeons and chickens are important in village poultry production system. However, the chickens are the most dominance in terms of population and popularity (Acamovic *et al*., 2005; Nyoni and Masika, 2012). They are considered as one of the most widely distributed poultry species and forms an important agricultural activity available to most rural dwellers in most developing countries including Nigeria (Akintunde *et al*., 2015; Lawal *et al*., 2015; Mohammed and Sunday, 2015).

Village chickens have also been reported to be used for traditional sacrifices, ceremonies, festivals in some cultures and have played an active role in pest control (Alders *et al*., 2007), hence, they contribute significantly to the livelihoods of the most vulnerable rural households (Nyoni and Masika, 2012). The village chickens constitute the majority of the chicken population in Northern Nigeria and are mainly kept under extensive management system where they roam freely and scavenge for food (Musa *et al*., 2008). Their movement is uncontrolled and they hardly receive any prophylactic treatment or vaccination against common poultry disease (Duru *et al*., 2008; Musa *et al*., 2008).Unfortunately, wide arrays of constraints affects the benefits derived from village chickens and its products in rural Nigeria of which suboptimal management, low genetic potential, poor housings, minimal veterinary care, inadequate supplementary feeding problem both in quality and quantitative terms, predation, accidents, theft and high morbidity and mortality rate due to the menace of various disease are to be considered (El-Yuguda *et al*., 2005; Nwanta *et al*., 2008; Bettridgea *et al*., 2014). High losses of village chickens due to diseases pose a serious threat to food security and livelihood of many rural families in Northern Nigeria (Musa *et al*., 2008), especially those states afflicted by rapid population growth due to unconditioned influx of insurgency displaced people. The prevalence of various diseases are considered the most important factor limiting the maximum productivity of the village chicken in Nigeria (Akintunde and Adeoti, 2014; Mohammed and Sunday, 2015). Among the diseases affecting adequate and maximum productivity of village chickens, the effects of parasitic infection plays an important role (Yeshitila *et al*., 2011; Nafyad *et al*., 2015). However, ectoparasites have been identified as the major impediment to chicken health worldwide owing to the direct and indirect losses they cause (Permin *et al*., 2002; Swai *et al*., 2007). Ectoparasites infestation can affect chicken health directly by causing irritation, discomfort, tissue damage, blood loss leading to anaemia, toxicosis, allergies and dermatitis, which in turn alleviate quality and quantities of meat and egg production (Bala *et al*., 2011; Hobbenaghi *et al*., 2012; Desoky *et al*., 2015; Zeryehun and Yohannes, 2015). In addition, they act as mechanical or biological vectors transmitting number of pathogens such as Rickettsial, bacterial and viral diseases which may result to serious health derailment in chickens and even human population (Bala *et al*., 2011; Asresie and Eshetu, 2015; George *et al*., 2015). Several species of ectoparasites such as the flies, lice, mites, and ticks can infest and live on domestic chickens (Yacob *et al*., 2009; Firaol *et al*., 2014; Angyiereyiri *et al*., 2015). Several studies have analyzed the prevalence of ectoparasites infestation in village chickens in different parts of the Northern Nigeria (Bala *et al*., 2011; Usman *et al*., 2012; Agbede, 2013; Audi and Asmau, 2014) including the Northeastern Nigeria States (Biu *et al*., 2012; Lawal *et al*., 2016).However, despite these various surveys on the prevalent of ectoparasites in village chickens in the northeastern, Nigeria, there is dearth of information on the prevalence of

ectoparasites of village chickens in Yobe State, Northeastern Nigeria. The present study therefore was designed to determine the prevalence of ectoparasites of village chickens and their associated risk factors in and around Potiskum, Yobe State, North eastern Nigeria. It is hoped that the results of this study could be used in making objective decisions in the control strategies of ectoparasites infestation in the study area.

Materials and Methods

Study Area

Potiskum is a Local Government Area in Yobe State, Nigeria on the A3 highway at 11°43′N11°04′EIt has an area of 559 square kilometers (216 sq mi) and a population of 205,876 at the 2006 census.

Study Population

The apparently healthy village chickens of both sexes and various age groups reared under different management systems that are owned by individual farmers were considered as a study population. Farmers consent to scrap/brush skin samples from their chickens were sought, as farmers were formally enlightened so as they understand the significance of the study. The chickens were examined for the absence or presence of ectoparasites infestation. Aging was considered on the bases of young and adult chickens for convenience of sampling.

Study Design

A cross sectional study was conducted to determine the prevalence of ectoparasites infestation in village chickens in the study area. Households that reared village chickens and are willing to participate in the research were randomly selected to be inclusive. Households were also selected based on the history of no previous use of any form of insecticides on birds. Selected households were visited at least twice during the stipulated study period.

Study Period

This study was conducted from the month of February, 2016 to November, 2016.

Sample Size Determination

The sample size of the village chickens of both sexes and ages required for this study was calculated using the equation given by Thrusfield (2005) for simple random sampling in research. Sample size was determined using 95% level of confidence; since there was no previous work in this study area 50% expected prevalence and 0.05% desired absolute precision were considered. From this calculation, 384 samples were arrived at, but to be on the safest sides of sampling a total of 400 village chickens were examined.

Physical Examination and Sample Collection

Selected village chickens were gently grabbed by the shanks and manually restrained with caution not to allow the chicken go through neither unnecessary struggle nor stress. Physical examination for ectoparasites infestations was carried out by quickly but gently flubbing the feathers of any selected chickens towards the opposite direction of its alignment. The whole body of each chicken was thoroughly examined to assess the presence of ectoparasites by using close visual inspection and magnifying hand lens. During sample collection, ectoparasites that stocked to the body of affected chicken were collected by hand picking and while others were collected by gentle brushing of the skin onto a white cardboard paper. Each collected samples from individual chickens were preserved separately in a sample bottle containing 70% of alcohol and then labeled appropriately for onward transportation to the Department of Veterinary Parasitology and Entomology Research laboratory, University of Maiduguri where further identification will be carried out.

Microscopy Examination

Samples were conveyed to the University of Maiduguri, Department of Veterinary Parasitology and Entomology Research laboratory for identification of the ectoparasites by stereomicroscopic examination. Parasites were further examined, identified and confirmed under the microscope by a more experienced entomologist after comparing their morphology with identification keys.

Data Analysis

The data generated from the study was coded and then entered into Microsoft excel spread sheet and was analyzed using STATA version 11.0. The prevalence of ectoparasites in relation to the risk factors such as age, sex, management, settlement and season were analyzed using chi

square. In all cases $P<0.005$ was considered as statistically significant.

RESULTS

Out of the 400 village chickens of both sexes and different age groups examined for ectoparasites infestation in the study area, 338 with an overall prevalent rate of 84.50% where found to be infested with lice (order: *Mallophaga*), fleas (order: *Siphonaptera*), mites and tick. Among the ectoparasites encountered, Lice were the most predominant with prevalent rate of 57% followed by mites (14.25%), flea (8.75%) and the ticks is the least predominant with prevalent rate of 4.50% (Table 1).

A total of 8 different species of ectoparasites were encountered at various predilection sites of the affected village chickens. These include three species of lice, three species of mites, one species of flea and one species of ticks. The three species of lice identified were *Lipeurus caponis* (40.25%) which were predominantly found on the feathers, *Menacanthus stramineus* (14.0%) found on the thigh and breast region and *Menopon gallinae* (2.75%) found on the fluff/shafts of the feathers of the neck, back, abdomen, wings and areas near cloaca. *Echidnophaga gallinacean* (8.75%) was the only species of flea identified and was found on the Comb, wattles, eye lids and around ears. *Argaspersicus* (4.50%) was also the only species identified and was found on the abdominal area and below wings. The three species of mite identified were *Cnemidocoptes mutans* (7.0%) and *Cnemidocoptes gallinae* (5.0%) which were both found on shank and toes of legs, and *Dermanyssus gallinae* (2.25%) found around the wings and breast of the affected birds. Of all the ectoparasites encountered, *Menopon gallinae* was the most predominant species with a prevalent rate of 40.25% while *Dermanyssus gallinae* was the least prominent species with a prevalent rate of 2.25% (Table 2).

Affected village chickens were found to harbor single, double or multiple ectoparasites infestation. Out of the 338 (84.5%) village chickens affected, 36 (9.0%) were found to harbored single species of ectoparasites, 210 (52.5%) harbored double species of ectoparasites while 92 (23.0%) were found to harbor more than two species of ectoparasites (Table 3).

Prevalence of the ectoparasites infestation was found to be statistical significantly higher in adult (61.75%) than in young (22.75%) chickens (P= 0.0198). The prevalence of ectoparasites infestation was relatively higher in females (46.25%) chickens than in the males (38.25%), although there was no statistically significant (P = 0.3481) difference observed in the rate of infestation among the sexes. The results of ectoparasites infestation in village chickens reared under different management system revealed that infestation was high in chickens reared under absolute free range extensive management system (64.75%) than in chickens reared semi-intensively (P = 0.1003), there was also no statistically significant (P = 0.3481) difference observed in the rate of infestation among the two management systems. The prevalence of ectoparasites infestation was higher in village chickens examined in the rural areas (56.25%) when compared to infestation rate of chickens examined in the semi-urban (28.25%) settlement of the study area, although there was no statistically significant (P = 0.1768) difference observed in the rate of infestation among the village chickens examined in the different settlements. The prevalence of ectoparasites infestation was relatively higher in rainy season (49.0%) compared to in dry season (35.50). Statistically, there was significance (P = 0.0362) difference between the two seasons (Table 4).

Table1. *Prevalence of ectoparasites infestation of village chickens (Gallus gallus domesticus) in and around Potiskum, Yobe State, Nigeria*

Ectoparasites	Number of chickens infested(N=400)	Prevalence rate (%)
Lice	228	57.0
Flea	35	8.75
Tick	18	4.50
Mites	57	14.25
Total	**338**	**84.50**

Key: *N = Total number of village chickens examined during the study period*

Table2. *Prevalence and predilection sites of ectoparasites infestation in village chickens (Gallus gallus domesticus) in Potiskum, Yobe State, Nigeria.*

Ectoparasites encountered	Species	Predilection sites	No. of chickens infested(N = 400)	Prevalence rate (%)
Lice	*Menopon gallinae*	Fluff/shafts of the feathers of the neck, back, abdomen, wings and areas near cloaca	11	2.75
	Menacanthus stramineus	thigh and breast region	56	14.0
	Lipeurus caponis	Feathers	161	40.25
Flea	*Echidnophaga gallinacea*	Comb, wattles, eyelids and around ears	35	8.75
Ticks	*Argaspersicus*	abdominal area and below wings	18	4.50
Mites	*Cnemidocoptes mutans*	Shank and toes of legs	28	7.0
	Dermanyssus gallinae	wings and Breast	9	2.25
	Cnemidocoptes gallinae	Shank and toes of legs	20	5.0

Table3. *Type of Ectoparasites infestation in village chickens (Gallus gallus domesticus) in Potiskum, Yobe State, Nigeria*

Type of infestation	No. of chickens infested(N= 400)	Prevalence rate (%)
Single	36	9.0
Double	210	52.50
Multiple	92	23.0
Total	**338**	**84.50**

Note: *single infestation = 36/400 (9.0%) while mixed infestation = 302/400 (75.50%)*

Table4. *Risk factors associated with ectoparasites infestation in village chickens (Gallus gallus domesticus) in Potiskum, Yobe State, Nigeria*

Parameters	Risk factors	No. of chickens examined	No. of chickens infested	Prevalence (%)	95% CI LL – UL	*p*-value	RR
Age	Young	142	92	22.75	0.5415 – 0.6704		
	Adult	258	246	61.75	0.4672 – 0.5564	0.0198*	1.185
Sex	Females	204	185	46.25	0.4726 – 0.5753		1.071
	Males	196	153	38.25	0.5084 – 0.6146	0.3481	
Management	Semi-intensive	116	79	19.75	0.5227 – 0.6649	0.1003	1.137
	Extensive	284	259	64.75	0.4799 – 0.5657		
Settlement	Rural	246	225	56.25	0.4758 – 0.5683		
	Sub-urban	154	113	28.25	0.5155 – 0.6366	0.1768	0.9055
Season	Dry	200	142	35.50	0.5304 – 0.6382		
	Rainy	200	196	49.0	0.4552 – 0.5547	0.0362*	1.158

Key: *CI= confidence interval; LL= Lower limit; UL= Upper limit; RR= Relative risk*Statistical significance*

DISCUSSION

The present study revealed that village chickens in the study area were infested with one or more species of ectoparasites with an overall prevalence rate of 84.5%. This high prevalent rate buttress 95.8% recorded in Kenya (Sabuni *et al*., 2010), 84.0% in Ghana (Angyiereyiri *et al*., 2015), 90.77 % in Iraq (Abdullah and Mohammed, 2013), 96.0% in South Africa (Moyo *et al*., 2015), 84.0% in Tanzania (Swai *et al*., 2010), 86.67% in Bangladesh (Shanta *et al*., 2006), 83.85% from Ethiopia (Mulugeta *et al*., 2013) and 88.4% from China (Wang *et al*., 2010).Moreover, in some parts of Nigeria, several similar studies have recorded varying prevalence rate of 70.5% (Muhammad and Malate, 2014), 69.70% (Oche *et al*., 2016), 75.85% (Odenu *et al*., 2016) in Gombe, Benue State and Abuja respectively. Moreover, higher prevalence rate of 100% were recorded in Sokoto (Bala *et al*., 2011) and Ogun (Ekpo *et al*., 2010) States of Nigeria. The high prevalence recorded in this present study may be associated with poor sanitation and hygienic practice which creates favorable environment for the propagation and life cycle progression of the diverse

parasitic species, inadequate housing facilities which can create hiding places for the parasite as well as the free ranging management system of village chickens which may expose the chickens to arthropods of several genera. Scavenging nature of the village chickens may possibly expose them to ectoparasites infestations that are origin of other poultry species or wild birds (Adelusi *et al*., 2014). The difference in the prevalence rates recorded in the present study and other previous similar studies elsewhere might be attributed several significant factors such as the variation in method of study, sample size, sampling period, village chicken husbandry and management system, breed or ecotypes of chickens, climatic and seasonal variation, agro ecological, the study location with respect to urban, peri-urban or rural settlements and implemented methods of the ectoparasitic diseases control and prevention (Banda, 2011) in the various study areas.

The present study revealed that lice (57.0%) followed by mites (14.25), flea (8.75%) and tick (4.50%) as the common types of ectoparasites that infest village chickens in the study area. The result of this study is in accordance with those of Oche *et al*. (2016), Lawal *et al*. (2016) and Kebede *et al*. (2017) who have reported similar findings from Benue, Gombe States and Ethiopia respectively. However, our finding are in contrast with results of Mungube *et al*. (2008) and Moyo *et al*. (2015) who have reported fleas to be most common ectoparasites of free range village chickens in Kenya and South Africa respectively as well as Zeryehun and Yohannes (2015) who have reported mites as the dominant ectoparasites in scavenging village chickens in Ethiopia. The highest prevalent ectoparasites identified in the present study were lice (57.0%) while the least prevalent was tick (4.50%). This finding from this study corroborate those of Agbede (2013), Odenu *et al*. (2016), Lawal *et al*. (2016) and Kebede *et al*. (2017) who have also reported lice to be the most prevalent ectoparasites of free range chickens. However, the lice prevalence rate recorded in the present study was higher than 42.71% reported by Kebede *et al*. (2017) but lower than 72.72% and 84.30% reported by Sadiq *et al*. (2003) and Belihu *et al*. (2010) respectively. The difference in the prevalence rate of lice from the various studies might be attributed to variation in the husbandry and management system, poor hygiene and sanitation, sample size, climatic conditions, humidity, season of study and other agro ecology influencing the distribution and proliferation of lice.

In the present study eight species of ectoparasites were identified at difference predilection sites on the infested chickens which included three species of lice namely, *Lipeuruscaponis, Menopon gallinae* and *Menacanthus stramineus*; one species of fleanamely, *Echidnophaga gallinacean*; one species of tick namely, *Argaspersicus* and three species of mite namely, *Cnemidocoptes mutans*, C*nemidocoptes gallinae* and *Dermanyssus gallinae*. The species of ectoparasites recorded in the present study concurs with those reported by Amede *et al*. (2011) and Kebede *et al*. (2017) in a similar study. Moreover, the predilection sites of the various species of ectoparasites recorded in this present study are in accordance with those reported by Souls by (1982).Among these species of ectoparasites encountered, *Lipeurus caponis* (40.25%) was the most prevalence while *Dermanyssus gallinae* (2.25%) was the least. The prevalence rate of *Lipeurus caponis* recorded in the present study is comparable with 41.61% reported by Eneanya *et al*. (2008) form Anambra State, but higher than 18.75% reported by Kebede *et al*. (2017); 9.26% by Oche *et al*. (2016); 5.0% by Bala *et al*. (2011) and 6.20% by Biu *et al*. (2007). The result of the present study also revealed another species of lice *Menacanthus stramineus* (14.0%) as the second most prevalent species of ectoparasites encountered on the infested village chickens. Although, its prevalence rate was lower than 41.70% reported by Belihu *et al*. (2010) from Ethiopia but higher than 5.3% recorded by Moyo *et al*. (2015) from South Africa and 6.9% reported by Bala *et al*. (2011) from Sokoto State, Nigeria. The prevalence rate of *Menopon gallinae* from the present study was 2.75% which were considered lower than 13.28% reported by Kebede *et al*. (2017), 8.1% by Bala *et al*. (2011);12.4%, 97.7% and 40.12% reported by Moyo *et al*. (2015), Sabuni *et al*. (2010) and Sadiq *et al*. (2003)respectively. These variations in the prevalence rates of these species of lice from the reports of the various studies may be connected to differences in geographical areas, host factors, husbandry and management system, poor sanitation, sample size, period of study as well as different favorable climatic conditions such as Temperature and humidity which may influence the population dynamics of the ectoparasites (Arends, 2003; Prelezov and Kolnarski, 2006).

It was observed that most of the village chickens farmers in the study areas keep other livestock, dogs and cats in the same compound with their chickens without maintenance of good sanitations in and around their compound. Although, the prevalence rate 8.75% was recorded in the present study which was considered lower than10.6%, 32.86%, 50.7% and 16.15% recorded by Bala *et al*. (2011); Alemu *et al*. (2015); Moyo *et al*. (2015) and Kebede *et al*. (2017) respectively. The species of flea (*Echidnophaga gallinacean*) reported in this study have been encountered in scavenging village chickens from many parts of the world including Nigeria (Ifeoma *et al*., 2008; Bala *et al*., 2011; Oche *et al*., 2016; Lawal *et al.*, 2016) and some parts of Africa (Permin *et al*., 2002; Maina, 2005; Mungube *et al*., 2008; Kebede *et al*., 2017) at varying prevalence rates. In many cases the occurrences of this species of flea in chickens have been attributed to keeping dogs and cats with chickens under poor housing and hygiene especially where the pets share accommodation with chickens (Moyo *et al*., 2015). *E. gallinacean* has been reported to infest different hosts including different breed of chicken, other species of domestic poultry, wild birds, humans, mice, cats and dogs (Mungube *et al*., 2008). The prevalence rate of this flea species is widespread in tropical and subtropical regions (Permin *et al*., 2002). The variation in prevalence rates may be associated with difference in geographical and climatic factors, inadequate husbandry and management systems. *Argaspersicus* was the only tick species record in this study at a prevalence rate of 4.50%. This finding is comparable to 4.97% and 4.71% reported by Mulugeta *et al.* (2013) and Oche *et al*. (2016) from Ethiopia and Benue State Nigeria respectively, but higher than 3.30% recorded by Zeryehun and Yohannes (2015) from Ethiopia, however lowers than8.80%, 30.0%; 19.0% and 62.72% reported by Bala *et al*. (2011),Dube*et al*. (2010), Mirzaei *et al*. (2016) and Abdullah and Mohammed (2013) from Sokoto, Nigeria, Zimbabwe, Iran and Iraq respectively. The difference may be associated with different agro-ecology, climatic factors in the various study areas, variation in sample size and differences in sampling period, free range nature of village chickens, poor hygiene in and around the chicken house and the lack of parasite control practices.

Three species of mite namely *Cnemidocoptes mutans*, C*nemidocoptes gallinae* and *Dermanyssus gallinae* were reported in this study with *C. mutans* as the most prevalent mite. This finding concurs with the findings of Shanta *et al.* (2006), Taylor *et al*.(2007); Swai *et al*.(2010); Oche *et al*. (2016) who have mentioned this species of mites as the predominant species causing scaly leg on most mite infested village chickens in their various studies. Although, the prevalent rate of *C. mutans* (7.0%) recorded in our study is comparable to 7.26% and 9.40% reported by Odenu *et al*. (2016) and Bala *et al.* (2011) respectively, but higher than 0.57% reported by Moyo *et al*. (2015) and lower than 34.62% and 18.18% recorded by Firaol *et al.* (2014) and Oche *et al*.(2016) respectively. The prevalence of *Cnemidocoptes gallinae* (5.0%) recorded in our study was considered lower than 8.1% reported by Bala *et al.* (2011). The prevalence of *Dermanyssus gallinae* (2.25%) reported in our study is considered lower than 7.03% reported by Kebede *et al.* (2017) from Ethiopia. It was speculated that the variation in the prevalence rates of these mites species as reported from various studies could be attributed to different husbandry and management system of the chickens, climate, geo-ecology of the study areas, varied season of sampling, sample size and the study location with respect to urban or rural settlements.

The result of our study reveal that affected village chickens were found to harbor one or more ectoparasites species; 9.0%, 52.50% and 23.0% of the ectoparasites infestation occur in single (infested by only one species of parasite), double (infested by two species of parasites) and multiple (infested by more than two species of parasite) respectively. The mixed ectoparasites infestation of village chickens found in this study is consistent with previous report by Amede *et al.* (2011), Mulugeta *et al.* (2013) and Firaol *et al.* (2014) in Ethiopia. The prevalence rate of mixed ectoparasites infestation in the present study area may be associated with the poor husbandry and management system, agro-ecology and climatic factors and whether or not strategic ectoparasites control measures were adopted in the study area.

The present study revealed a significant difference in the prevalence of ectoparasites infestation in village chickens when age was considered as one of the hypothesized risk factors. The findings revealed that adult (61.75%) village chickens are significantly more infested by ectoparasites than young (22.75%) chickens. This buttress similar report by Biu *et al* (2007),

Malann *et al*. (2016); Oche *et al*. (2016) and Kebede *et al*. (2017) who have also reported that adult village chickens were more infested by ectoparasites compared with younger ones. The high prevalence rate of ectoparasites in adult chickens compared to the young ones might possibly be associated with the fact that adult chickens scavenge through a wider area mingling with other species of poultry or animals and maybe exposed longer to the infested environment and other source of infestation than the young chickens, hence a higher prevalence rate. However, our finding is inconsistent with those of Mulugeta *et al*. (2013) and Firaol *et al*. (2014) who reported that young chickens were more infested with ectoparasites compared to the adult chickens.

The result of the present study revealed that the female (46.25%) village chickens are more infested than the male (38.25%) ones, although the difference was not significant. This non-significant variation between the sexes signifies that the hens and cockerels of village chickens share equal chance of getting ectoparasites infestation especially where both sexes are reared in the same pen, allowed to mate with each other, when exposed to the same species of ectoparasites fauna and conditions that favors ectoparasites proliferation such as inadequate husbandry system, overcrowding and poor sanitation. Moreover, the high prevalence of ectoparasites in the female village chickens may be associated with the stationary state of the females during incubation of eggs which allows the female chickens to be more susceptible to ectoparasites infestations if the pen is harboring the ectoparasites fauna. This finding is consistent to those of Biu *et al*. (2007); Bala *et al*. (2011); Malann *et al*. (2016); Oche *et al*. (2016) in Nigeria, Mohammad *et al*. (2016) in Iran, Kebede *et al*. (2017) in Ethiopia who reported a higher occurrence of ectoparasites infestation in hens compared to in cockerels and roosters. However, higher infestation rate observed in male than female chickens with presence of statistical significance difference have been reported by Mungube *et al*. (2008); Belihu *et al*. (2010) and Firaol *et al*. (2014).There are conflicting reports on the impact of host sex on prevalence rate of avian ectoparasites.

The result of the present study revealed that the village chickens reared under the extensive management systems (64.75%) are more infested by ectoparasites than those reared under the semi-intensive management system (19.75%). This finding is consistent with similar with work of Mekuria and Gezahegn (2010); Malann *et al*. (2016) and Kebede *et al*. (2017). This finding may be connected to better measures and practices related to good housing, proper sanitation, feeding and husbandry system applied in semi-intensive compared to complete extensive system. Although the difference in our finding was not significance which signifies that infestation by ectoparasites may occur in both management systems where the proper control measures are not put in place. The high prevalence rate of ectoparasites fauna recorded in extensive management system could be associated to the free-range rearing system of village chickens practiced in the study area, which exposes the chicken to poor hygiene thus, enabling them to come in contact with a wide range of ectoparasites. Moreover, Mungube *et al*. (2008) have reported than the free-range scavenging system provides a more sustainable environment for the parasites coupled with lack of inadequate control measures towards these parasites.

The result of the present study also revealed that the village chickens sampled from the rural settlements (56.25%) of the study area are found to be more infested by ectoparasites than those sampled from the semi-urban areas (28.25%) of the study area. This finding may be associated with that fact that most village chickens in the rural areas of the study area are usually reared under traditional extensive management system where the chickens are allowed to scavenge for food and are provided with inadequate husbandry and left without veterinary health care. In most instances it was observed that village chicken farmers in the rural settlements of the study area rear their chickens with other poultry species, livestock and animals within the same compound. These types of practice make the village chickens in these rural areas more vulnerable and get infested easily by ectoparasites. This finding is in agreement with those of Nnadi and George, (2010) and Mulugeta *et al*. (2013) who have also reported that majority of the village chickens reared in the rural areas are usually reared under free range scavenging system which exposes them easily to infections by several pathogens and parasitism including the external parasites infestation.

The result of the present study revealed that the ectoparasites infestation was statistical

significantly higher during the rainy season (49.0%) compared to the dry season (35.50%). This finding is in line with those of Mohammad *et al*. (2016) who also reported high prevalence of ectoparasites in chickens during the rainy season. The rainy season is considered the most favorable weather for the proliferation of parasitic infections including the ectoparasites. Moderated to high ambient temperature and humidity which are one of the characteristics of the rainy season are very essential for the hatching of eggs and larval developmental stages (Soulsby, 1982). This justifies the report that external parasites of poultry are common in the tropics because of the favorable climatic conditions for their development (Nnadi and George, 2010; Firaol *et al*., 2014). Although, the prevalence of ectoparasites have also been reported during the dry season by other researches, but it was justified that prevalence rate are usually high during the rainy seasons compared to the dry season (Alemu *et al*., 2015; Kebede *et al*., 2017).

CONCLUSION

It can be concluded that lice, fleas, tick and mites are the common types of ectoparasites infesting the village chickens population in Potiskum, Yobe State. Among the ectoparasites identified, the lice are the most predominant. The overall prevalence rate of lice infestation (57.0%) was higher than that of mite (14.25%), flea (8.75%) and tick (4.5%) in all the infested chickens. Mixed infestation of ectoparasites was more common than the single infestation. The different species of ectoparasites identified in this study provide evidence of the existence of diverse ectoparasites fauna in the present study locations. Taking into consideration the life cycle of the parasites and their direct and indirect effects on the affected chickens, the mixed infestation will obviously affects the performance and productivity of the chickens. Among the potential risk factors assessed in the present study, ectoparasites infestations was higher among the adult age group of chickens, females, chickens reared under the extensive management systems, chickens reared in rural areas and chickens sampled during the rainy season of the study period. Finally, the observed results of the present study suggest that appropriate ectoparasites control measures should be practiced in village chickens production system to curb the effect of ectoparasites infestations. Village chicken farmers should be enlightened on the economic importance of ectoparasites on the village chicken production and be encouraged to improved husbandry and management system as well as sanitation in and around their poultry houses.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

[1] Abdullah, S. H. and Mohammed, A. A. (2013). Ecto and Endo Parasites Prevalence in Domestic Chickens in Sulaimani Region. The Iraqi Journal of Veterinary Medicine, 37(2):149-155.

[2] Acamovic, T., Sinurat, A., Natarajan, A., Anitha, K., Chandra sekaran, D., Shindey, D., Sparks, N., Oduguwa, O., Mupeta, B. and Kitalyi, A. (2005). Poultry. In: Owen et al. (eds), Livestock and Wealth Creation: Improving the husbandry of animals kept by resource-poor people in developing countries. Editors. Nottingham University Press, Nottingham, pp. 301-322.

[3] Adelusi, S. M., Vajime, C. G., Omudu, E. A., Okpotu, R. O. and Onazi, F. O. (2014). Avian Ectoparasitism in Makurdi, Nigeria: Do Wild Birds Serve as Reservior for Domestic Birds? Nigerian Journal of Pure and Applied Sciences, 6: 11-15.

[4] Agbede, R. I. S. (2013). A survey of Ectoparasites of on Animals in Zaria.J. ofAni. Prod. and Res. (NAPRI), 1(2): 179-180.

[5] Akintunde, O. K. and Adeoti, A. I. (2014). Assessment of factors affecting the level of poultry disease management in southwest, Nigeria. Trends in Agric. Econs, 7(2): 41-56.

[6] Akintunde, O, K.,Adeoti, A. I., Okoruwa, V. O., Omonona, B. T. and Abu, A. O. (2015). Effect of disease management on profitability of chicken egg production in Southwest Nigeria. Asian J. of Poul. Sci., 9(1): 1-18.

[7] Aklilu, H. A., Almekinders, C. J. M. and Van der Zijpp, A. J. (2007). Village poultry consumption and marketing in relation to gender, religious festivals and market access. Trop. Anim. Health Prod. 39, 165–168.

[8] Alders, R., Bagnol, B., Harun, M. and Young, M. (2007).Village poultry, food security and HIV/AIDS mitigation. LEISA Magazine, 3 September 2007, 23, 20-21. http://www.leisa.info/index.php?url=getblob.php&o_id=191135&a_id=211&a_seq=0.

[9] Alemu, N., Muktar, Y., Kassaye, D. and Hiko, A.(2015). Prevalence of Lice and Fleas in Backyard Chickens of Bishoftu Town, Ethiopia. American-Eurasian J. Agric. and Environ. Sci., 15 (11): 2136-2142.

[10] Amede, Y., Tilahun, K. and Bekele, M. (2011). Prevalence of Ectoparasites in Haramaya University Intensive Poultry Farm. Global Veterinaria 7 (3): 264-269.

[11] Angyiereyiri, E. D., Sackey, I and Bonu-Ire, M. S. T. (2015).Survey on Arthropod Ectoparasites on Goats and Domestic Fowls in Vunania, Navrongo, Ghana .Canadian Journal of Pure and Applied Sciences, 9 (2): 3371-3377.

[12] Arends, J. J. (2003). External parasites and poultry pests. In: Diseases of poultry; 11 ed., (Edited by Calnek, W. B., Barnes, J. H., Beard, W. C., Mc Dougald, L. R. and Saif, Y. M.). Iowa State Press, Blackwell Publishing Company, Ames, Iowa, pp: 905-930.

[13] Asresie, A. and Eshetu, M. (2015). Traditional Chicken Production System and Marketing in Ethiopia: A review. J. of Mar. and Cons. Res., 8, 27-34.

[14] Assefa, K., Belay, A. and Tolosa, Z. (2017). Study on Prevalence of Ectoparasites of Poultry in and Around Jimma Town. European Journal of Biological Sciences 9 (1): 18-26.

[15] Audi, A, H. and Asmau, A. M. (2014). Prevalence of bird Louse, Menacanthus Cornutus (Pthiraptera: Amblycera) in Four Selected Poultry Farms in Kano State, Nigeria. Bayero J.Pure App.Sci., 7(1):142 -146.

[16] Bala, A. Y., Anka, S. A., Waziri, A. and Shehu, H. (2011). Preliminary Survey of Ectoparasites Infesting Chickens (*Gallusdomesticus*) in Four Areas of Sokoto Metropolis. Nig. J. Basic and App. Sci. 19: 173-180.

[17] Banda, Z. (2011). Ectoparasites of indigenous Malawi chickens. Australian Journal of Basic and Applied Sciences; 5: 1454-1460.

[18] Belihu K, Mamo A, Lobago F, Ayana D (2010). Prevalence of Ectoparasites in Backyard Local Chickens in Three Agroecologic Zones of East Shoa in Ethiopia. Revue Méd. Vét: 160: 537-541.

[19] Bettridgea, J. M., Lyncha, S. E., Brenaa, M. C., Melesec, K., Dessieb, T., Terfaa, Z. G., Destab, T. T., Rushtone, S., Hanotted, O., Kaiserf, P., Wigleya, P. and Christley, R. M. (2014). Infection-interactions in Ethiopian village chickens. Preventive Veterinary Medicine 117, 358–366.

[20] Beyene, K., Bogale, B. and Chanie, M. (2014). Study on effects and occurrence of nematodes in local and exotic chickens in and around Bahir Dar, Northwest Ethiopia. American-Eurasian J. of Sci. Res., 9(3): 62-66.

[21] Biu, A.A, Agbede, R. I. S. and Peace, P. (2007).Studies on ectoparasites of poultry in Maiduguri, Nigeria. Nig. J. Parasitol., 28:1117-1145.

[22] Biu, A. A., Ahmed, H. A., Konto, M. and Paul, B. T. (2012). Survey of podoknemidokoptiasis in locally domesticated market chickens (*Gallusgallusdomesticus*) in Maiduguri, Nigeria. J. Med. App. Biosci.4: 39-46.

[23] Desoky, A. S. S., Abdel-Gwad, K. H., Maher Ali, A., and Nafady, A. A. (2015). Comparison between spraying and washing method of reduction ratios on animal ectoparasites by using Diazinon 60% EC under field conditions in farm animals. African J. of Agric. Sci. and Tech., 3(6):294-298.

[24] Dube, S., Zindi, P., Mbanga, J. and Dube, C. (2010). A Study of Scavenging Poultry Gastrointestinal and Ecto-parasites in Rural Areas of Matebele land Province, Zimbabwe. Inter. J. Poul. Sci., 9(9): 911-915.

[25] Duru, S., Saidu, L., Akpa, G. N., Jokthan, G.E., Kabir, M., Olugbemi, T. S., Abdu, S. B., Yashim, S. M. and Hamman, I. (2008). Prevalent disease in Local Poultry: A case study of Zaria area, Kaduna state. In: Proceedings of the 13th Annual Conference of the Animal Science Association of Nigeria (ASAN), pp. 683 – 686.

[26] Ekpo, U. F., Ogbooye, A. A., Oluwole, A. S. and Takeet, M. (2010). A preliminary survey on the parasites of free range chicken in Abeokuta, Ogun State, Nigeria. J. Nat. Sci. Engr. Tech. 9(2):123-130.

[27] El-Yuguda, A.D., Dokas, U.M. and Baba, S.S. (2005).Effects of Newcastle disease and infectious bursal disease vaccines, climate, and other factors on the village chicken population in North-eastern Nigeria. Scientific Journal of Food, Agriculture and Environment, 3: 55-57.

[28] Eneanya, C. I., Amagba I. C. and Ikpeze, O. O. (2008). Ectoparasitic fauna of poultry farms in Awka, Anambra, Nigeria. International Journal of Zoonoses, 13(2):93-97.

[29] Food and Agriculture Organization (FAO) (2008). Poultry Sector Country Review. Food and Agriculture Organization of the United Nations, Rome http://www.fao-ectad-nairobi.org/IMG/pdf/Ethiopia Poultry Sector Review.

[30] Firaol, T., Dagmawit, A., Askale, G., Solomon, S., Morka, D., and Waktole, T. (2014).Prevalence of Ectoparasite infestation in Chicken in and Around Ambo Town, Ethiopia. J. Vet. Sci. Technol., 5, 189.

[31] George, D. R., Finn, R. D., Graham, K. M., Mul, M. F., Maurer, V., Moro, C. V. and Sparagano, O. A. (2015). Should the poultry red mite Dermanyssusgallinae be of wider concern for veterinary and medical science? Paras .and vect.8 (1), 178.

[32] Hobbenaghi, R., Tavassoli, M., Alimehr, M., Shokrpoor, S. and Ghorbanzadeghan, M. (2012). Histopathological study of the mite biting (*Dermanyssusgallinae*) in poultry skin. Veterinary Research Forum, 3: 205-208.

[33] Ifeoma, C., Chioma, I. and Osegboka, O. (2008). Preliminary survey of ectoparasites of chicken in Awka, south-eastern Nigeria. Animal Research International, 5(2): 26 – 29.

[34] ILRI (2014). Livestock policy analysis. ILRI Training Manual ILRI, Nairobi, Kenya.

[35] Kebede, A., Abebe, B. and Zewdie, T. (2017). Study on Prevalence of Ectoparasites of Poultry in and Around Jimma Town. European Journal of Biological Sciences 9 (1): 18-26

[36] Lawal, J. R., Hambali, I. U., Bello, A. M., Wakil, Y., Ibrahim, A., Salihu, I., Jajere, M. S., Mustapha, F. B., Mustapha, M. and Gulani, I. A. (2015). Causes of Village Chicken (*Gallusgallusdomesticus*) Losses and Level of Awareness of Newcastle Disease Consequence among Village Chicken Farmers in Bauchi State, North Eastern Nigeria. International Journal of Life Sciences Research, 3 (1): 251-260.

[37] Lawal, J. R., Bello, A. M., Balami, S. Y., Wakil, Y., Yusuf, Z. B., Dauda, J., Mshelia, E. S., Mana, H. P., Adam, M. K. and Biu, A. A. (2016). Prevalence and Economic Significance of Ectoparasites Infestation in Village Chickens (*Gallusgallusdomesticus*) in Gombe, Northeastern Nigeria. Direct Research Journal of Agriculture and Food Science, 4 (5): 94 – 103.

[38] Maina, A.N. (2005). Prevalence, intensity and lesion associated with gastrointestinal and ectoparasite of indigenous chicken in Kenya. MSc thesis. University of Nairobi.

[39] Malann, Y. D., Olatunji, B. O. and Usman, A. M. (2016). Ectoparasitic Infestation on Poultry Birds raised in Gwagwalada Area Council, FCT-Abuja. International Journal of Innovative Research and Development, 5 (13): 74 – 77.

[40] Mekuria, S. and Gezahegn, E. (2010). Prevalence of External parasite of poultry in intensive and backyard chicken farm at WolaytaSoddo town, Southern Ethiopia. Vet. World 3: 533-538.

[41] Mohammed, B. R. and Sunday, O. S. (2015).An Overview of the Prevalence of Avian Coccidiosis in Poultry Production and Its Economic Importance in Nigeria. Vet. Res. Int., 3(3): 35-45.

[42] Mohammad, M., Omid, G., Mohammad, Y. (2016).Prevalence of Ectoparasites of indigenous chickens from Dalahu Region Kermanshah Province, Iran. Turkiye Parazitol.Derg, 40: 13-6.

[43] Moyo, S., Masika, P. J. and Moyo, B. (2015).A Diagnostic Survey of External Parasites of Free-Range chickens, in the rural areas of Eastern Cape, South Africa. Int. J. Agric. Sci. Vet. Med. 3(2): 1 – 9.

[44] Muhammad, I. and Malate, G. (2014). Prevalence of Ectoparasites in Local Breed of Chickens in Gombe Local Government Area, Gombe State, Nigeria, International Journal of Entrepreneurial Development, Education and Science Research, 2 (1): 221 – 227.

[45] Mulugeta, A., Mersha, C. and Basaznew, B. (2013).Major Constraints of Village Poultry Production in DembaGofa District of Southern Region, Ethiopia. British Journal of Poultry Sciences 2 (1): 01-06

[46] Mungube, E. O., Baun, S. M., Tenhagen, B. A., Wamae, L. W., Nzioka, S. M., Muhammed, L. andNginyi, J. M. (2008). Prevalence of Parasites of the Local Scavenging Chickens in a Selected Semi-Arid Zone of Eastern Kenya", Trop. An. Health and Prod., 40:101-109.

[47] Musa, U., Abdu, P. A., Dafwang, I. I., Edache, J. A., Ahmed, M. S., Bawa, G. S., Karsin, P. D. and Emannaa, P. E. (2008). A survey of causes of mortality in some Local chicken flocks in Plateau state: In: Proceedings of the 33rd Annual Conference of the Nigeria Society of Animal Production (NSAP), pp. 551 – 554.

[48] Mirzaei, M., Omid, G., Mohammad, Y. (2016).Prevalence of ectoparasites of indigenous chicken from Dalahu region, Kermanshah Province, Iran. Turkiye Parazitol. Derg, 40: 13-6

[49] Nafyad, A., Yimer, M., Dawit, K. and Adem, H. (2015). Prevalence of Lice and Fleas in Backyard Chickens of Bishoftu Town, Ethiopia. American-Eurasian J. Agric. & Environ. Sci., 15(11): 2136-2142.

[50] Nnadi, P. A. and George, S. O. (2010).A cross-sectional survey on parasites of chickens in selected villages in the subhumid zones of southeastern Nigeria. J. Parasitol. Res. Pp.1–6.

[51] Nwanta, J. A., Abdu, P. A. and Ezema W. S. (2008). Epidemiology, Challenges and Prospects for control of Newcastle disease in village poultry in Nigeria. World's Poultry Science Journal, 64: 119 – 127.

[52] Nyoni, N. M. B. and Masika, P. J. (2012). Village chicken production practices in the Amatola Basin of the Eastern Cape Province, South Africa. African Journal of Agricultural Research Vol. 7(17), pp. 2647-2652.

[53] Oche, D. A., Ogwiji, O., Torhemen, M., Andyar, A. C., Akahaan, R. T., Luga, Z. T., Wayo, N. S., Tiough, S. M. and Kwaghtse, W. R. (2016). Survey of Ecto-parasites in Chickens in Benue State of Nigeria. Scholarly Journal of Agricultural Science , 6(8): 235-238

[54] Odenu, R. A., Mohammed B. R., Simon M. K. and Agbede R. I. S. (2016).Ecto-parasites of Domestic Chickens (*Gallusgallusdomesticus*) in Gwagwalada Area Council, Abuja, Nigeria-West Africa. Alexandria Journal of Veterinary Sciences, 51(1): 140-146.

[55] Permin, A., Esmann, J. B., Hoj, C. H., Hove, T. and Mukatirwa, S. (2002). Ecto-Endo, and Haemoparasites in free range chicken in the Gomoronzi District in Zimbabwe. Preventive Veterinary Medicine, 54: 213-224.

[56] Prelezov, P. N. and Koinarski, K. T. (2006). Species Variety and Population Structure of Mallophaga (Insecta: phthiraptera) on Chickens in the Region of Stara Zagora", Bulgarian Journal of Veterinary Medicine, 9 (3): 193-200.

[57] Sabuni, Z. A., Mbuthia, P. G., Maingi, N., Nyaga, P. N., Njagi, L. W., Bebora, L. C. and Michieka, J. N. (2010). Prevalence of ectoparasites infestation in indigenous free-ranging village chickens in different agro-ecological zones in Kenya. Livestock Research for Rural Development 22 (11): 1-5.

[58] Sadiq, N. A., Adejinmi, J. O., Adedokun, O. A., Fashanu, S. O., Alimi, A. A. and So fun made, Y.T. (2003). Ectoparasites and haemoparasites of indigenous chicken (*Gallusdomesticus*) in Ibadan and environs. Tropical Veterinarian, 21: 187-191.

[59] Sambo, E., Bettridge, J., Dessie, T., Amare, A., Habte, T., Wigley, P. and Christley, R. M. (2015).Participatory evaluation of chicken health and production constraints in Ethiopia. Preventive Veterinary Medicine 118, 117–127.

[60] Shanta, I. S., Begon, N., Anisuzzaman, A. S., Bari, M. and Karim, M. J. (2006).Prevalence and clinic pathological effects of Ecto parasites in backyard poultry. Bangl. J. Vet. Med. 4(1): 19-26.

[61] Souls by, E. J. L. (1982). Helminths, Arthropods and Protozoa of Domestic Animals.7th Edition. London: Bailliere and Tindall, East Sussex, UK.

[62] Swai, E. S., Karimuribo, E. D., Kyakaisho, P.F. and Mtui, P. F. (2007). Free-range village chickens on the humid coastal belt of Tanga, Tanzania: their roles, husbandry and health status. Livestock Research for Rural Development, 19(104).

[63] Swai, E., Kessy, S. M., Sanka, P., Banga, S. and Kaaya, J. E. (2010).A survey on Ectoparasites and haemoparasites of free-range indigenous chickens of Northern Tanzania, Tanzania, 22:9.

[64] Thrusfield, M. (2005).Veterinary epidemiology. 3rd ed. Blackwell Science. Ltd. London, UK. pp: 228-246.

[65] Taylor, M. A., Coop, R. L. and And wall, R. L. (2007).Veterinary Parasitology, 3rd ed., Blackwell Science, Ltd., London, UK.

[66] Usman, M., Fabiyi, J. P., Mohammed, A. A., Mera, U. M., Mahmuda, A., Alayande, M. O., Lawal, M. D. and Danmaigoro, A. (2012). Ectoparasites and haemoparasites of chickens in sokoto, northwestern Nigeria. Sci. J. Zoology (2012) 1(3) 74-78.

[67] Wang, F. F., Wang, M., Xu, F. R., Liang, D. and Pan, B. L. (2010).Survey of prevalence and control of ectoparasites in caged poultry in China. Vet. Rec. 167: 934-937.

[68] Wilson, R. T. (2010). Poultry production and performance in the Federal Democratic Republic of Ethiopia. World Poult. Sci. J. 66, 441–453.

[69] Yacob, H., Ziad, D. and Asoke, K. (2009). Ectoparasites and gastrointestinal helminthes of chickens of three agro climatic zones in Oromia region, Ethiopia. Animal Biology, 59: 497-500.

[70] Yeshitila, A., Kefelegn, T. and Mihreteab, B. (2011). Prevalence of Ectoparasites in Haramaya University Intensive Poultry Farm. Global Veterinaria 7 (3): 264-269.

[71] Zeryehun, T. and Yohannes, Y. (2015). Ectoparasite infestation of free scavenging chickens reared under traditional backyard production system in Wolayita Zone, southern Ethiopia. Ethiopian Veterinary Journal, 19 (2):55-66.