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Research Article

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Prevalence and associated risk factors of Ectoparasites in chickens in extensive and intensive farms in Wolaita zone, Ethiopia

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Keywords

Prevalence, Ectoparasites, Intensive and Chicken

Abstract

The study was conducted with the objective of identifying the prevalence and species composition of ectoparasites of chikens and associated risk factors in Wolaita Zone Sodo Town and Sodo Zuria distinct from December 2019 to June 2020. A total of 768 chickens were selected using random sampling technique. Samples of ectoparasites were collected from different parts of the body and identified to species level under stereomicroscope. Concomitantly ages, sexes as well as other risk factors were recorded. The most frequent encountered chicken ectoparasite was lice followed by flea, mite and tick in both the intensive and back yard production systems. Species of ectoparasite identified were lice; Lipeurus caponis, Menopon gallinae, Menacanthus stramineus and Goniocoptes gallinae, mite: Knemidocoptes mutans, flea: Echidnophaga gallinacea and tick: Argas persicus. In the current study, overall prevalence of lice (25%), flea (10.94%) mite (4.3%) and ticks (2.08%) irrespective of management differences was recorded. However, the prevalence in extensive (backyard) production system was found to be: 46.35% (lice), 21.91% (flea), 8.71% (mite) and 4.21% (tick) whereas in intensive production system it was: 6.35% (lice), 1.45% (flea), 0.49% (mite) and 0.24% (tick). The prevalence rate of ectoparasites in adult chicken (50.49%) was higher than in young grower (39.34%); higher in female (48.35%) than that of the male (40.57%); higher in local breed (71%) than exotic breed (29%) and higher in extensive management system (86.8%) than in intensive managements(9.22%). The finding in management system showed that there was a statistically significant difference in prevalence of ectoparasites between intensive and extensive management of chicken ($P<0.05$).This might be associated with lack of due attention with respect to hygienic and control system. Generally, the study indicated that ectoparasites are highly prevalent in backyard production systems than in intensive farming system and in local chickens than exotic ones.Therefore, the control of poultry ectoparasites and creating awareness to the community on the overall effect of disease on poultry productivity through training is extremely indispensable.

1. Introduction

1.1 Background

Ethiopia has about 60% of the total chicken population of East Africa, which includes local, exotic, and hybrid chicken breeds. Report on population of Ethiopian chickens estimated to be about 56.53 Million and with regard to breed, 94.3%, 3.21% and 2.49% of the total poultry population to be indigenous, hybrid and exotic, respectively (CSA, 2017). Indigenous chickens reared under traditional scavenging system play significant role through their contribution to the cultural and social life of rural people (Mekonnen, 2007). Nonetheless, production of indigenous chicken in rural Ethiopia has been challenged with several constraints, among others, disease, predation, lack of feed, housing and poor management (Dessie and Ogle, 2001). Parasitism due to gastrointestinal helminthes and ectoparasite constitutes among the major causes that decrease productivity of chickens, but neglected as they are rarely lethal (Ashenafi and Yimer, 2004; Hunduma *et al.*, 2010).

The prevalence of most parasitic diseases in poultry seems to have been reduced in commercial poultry production, due to improvement in management system (Zeryehun *et al.*, 2012), although in rural scavenging poultry a number of parasites are widely distributed (Bagust, 1999; Ashenafi and Yimer, 2004; Hunduma *et al.*, 2010). In addition, Weswne*et al*., (1997) reported different ecto-parasite prevalence in different management systems. The highest prevalence was reported in the free-range chickens. In the cage system, the only ectoparasite found was the mite *D. gallinae*, where as in semi-intensive system lice species of G. gigas had prevalence of 44.1%, *M. gallinae* 23.5%, *M. straminous* 10.7%, *G. gallinae* 2.1% and *D. gallinae* 0.92%. In the free-ranging chickens, G.gigas 78.9%, *M.gallinae* 60.5%, *M.stramineus* 26.6%, *G. gallinae* 10% and *C. heterographus* 14.7% were prevalent. On the otherhand, Ashenafi and Yimer (2005) reported ectoparsites of poultry from central Ethiopia had the prevalence of93.7 %(n=190) diverse species of ect-oparasites were recorded. Among these *M.gallinae* 87.9%, *M .stramineus* (71.6%), *Knemidocoptes mutans* (19.5%) and others were recorded.

Ectoparasites can affect the health of chickens by causing tissue damage and blood loss (Vegad, 2004), toxicosis (Aleya and Sabrina, 2011), dermatitis and allergies (Taylor *et al.*,2007). Furthermore, some ecto-parasites act as vectors of a number of pathogens (Swai *et al*., 2010) and during periods of heavy infestation, may weaken them, and lower their resistance and may lead to death (Soulsby, 1982). Ecto-parasites impose serious threat to the physiology and feed efficiency due to continuous irritation and blood sucking effect thus they are associated with emaciation, anemia and eventually loss of production of egg and meat (Permin *et al*., 2002).

Although ectoparasites constitutes among the most prevalent and the major causes that decrease productivity of chickens in the traditional managed system, they are mostly neglected (Weswne*et al*., 1997; Hunduma *et al*., 2010). Northern fowl mite (*Ornithonyssus sylviarum*) is the commonest and most important permanent parasites of poultry in all major poultry production areas of the United States. It is also recognized as a serious pest throughout the temperate zone of other countries. It is extremely common in almost all types of production facilities. Unlike the chicken mite, the northern fowl mite can easily be found on birds in the day as well as night, since breeds continuously (Calneck,*et al*., 1997).Tropical fowl mite (*Ornithonyssus bursa*) is distributed throughout the warmer region of the world and possibly replaces the northern fowl mite in these regions. It is a much less important pest in the United States. Hosts include poultry, pigeons, sparrows and humans. The tropical fowl mite closely resembles the northern fowl mite but can be distinguished by the shape of the dorsal plate and pattern of setae. This mite can pass entire life cycle on chickens (Calneck, *et al*., 1997).

The incidence of mortality and morbidity due to different ecto-parasitic diseases in chicken demands serious efforts to curtail the diseases. However, despite their devastating effects, ecto-parasites receive less attention than endo-parasites in almost all the production systems, even though, it has been attempted by few researchers (Belihu *et al.,* 2010; Mekuria and Gezahegn, 2010; Amede *et al*., 2011; Tolossa and Tafesse, 2013; Dabasa *et al*., 2017a, b) there is no enough information concerning the species composition, distribution, burden, and economic impact of ecto-parasite in different parts of Ethiopia (Dabasa et al., 2017b) This contributes to a problem in poultry disease control, planning, monitoring and evaluation strategy of the country for rural poultry programs (Arends, 2003).

1.2 Problem of Statement

Although ectoparasites constitutes among the most prevalent and the major causes that decrease productivity of chickens in the traditional managed system, they are mostly neglected (Abebe Wossene *et al.,* 1997; Hunduma Dinka *et al*., 2010). The enormous economic impact of ectoparasitic diseases in poultry due to mortality and morbidity in traditional backyard and intensive productive system can be minimized through stringent disease combating measures. Nevertheless, a little emphasis has been given for poultry ectoparasites in both system of rearing chickens in the country.(Wario *et al*., 2018).

Moreover, information on prevalence of ectoparasites and associated risk factors generated through organized research approach is indispensable in order to understand the epidemiology of the diseases and devise appropriate control and prevention measures. However, in present study area, information on the prevalence of ectoparasites of poultry and their determining factors are generally lacking. Therefore, the following objectives were designed in order to carry out this study.

1.3 Objectives

1.3.1 General Objective

General objective of this study was to investigate the overall prevalence of ectoparasites of poultry and identify their associated risk factors in extensive and intensive farms in study area

1.3.2 Specific Objective

- ✓ To determine the prevalence of ectoparasites in extensive and intensive poultry farms in the study area.
- ✓ To investigate potential risk factors that co ntributes to the occurrence of poultry ecto-parasites in study areas.
- ✓ To identify the major species of ectoparasites of poultry in study area

2. Materials and Methods

2.1 Description of the Study Area

The study was conducted in extensive and intensive poultry farms of Sodo Zuriya woreda and Soddo town, Wolaita Zone (Fig.1). The study sites are located 380 km south of Addis Ababa, 8° 50°N latitude and 37°45°E longitude, and with an e levation of 1501 to 2958 meters above sea leve l. Its mean annual temperatures range from 12.6 ^{0}C to 27.5^{0}C and the relative humidity is 67% (CSA, 2018). The study area was classified as mid-altitude or Woina dega and temperate highland or "Dega and area receives an annual rain fall of 1201-1600 mm per annum within a bimodal distribution of the season's pattern peaking in mid- April and mid-August of the year. Sodo Zuriya wereda comprises 234,120 cattle, 6135 goat, 35,422 sheep, 6089 donkey, 32 mule, 58 horse and 79,274 poultry (CSA, 2018). According to CSA (2018) 35,800 cattle, 1356 goats, 9031 sheep, 6089 donkeys, 25 mules, 19 horses and 118,378 poultry exist in Sodo town.

Generally, 36,708 local and 42,366 exotic and 36,610 local and 81,768 exotic breeds of poultry are found in Sodo Zuria werada and Sodo town, respectively (CSA, 2018). Sodo Zuriya werada has a total population of 127,711, of whom 62,923 are men and 64,788 women whereas the Sodo town comprises an overall population of 168,369, of whom 86,923 are men and 81,441 women (CSA, 2018). The occupation of most of the inhabitants in Sodo town is animal husbandry which includes village poultry, cattle, sheep and goat rearing under the extensive and semi-intensive animal husbandry management systems. The predominant farming system is mixed crop-livestock production system and cattle are the most important livestock species reared in Sodo Zuriya werada (Wolaita Zone Livestock and Fishery Department, 2019).

2.2 Study Design

A cross sectional study was carried out on 768 loc al and exotic breeds of both sexes of chicken from December 2019 to June 2020 to determine the pr evalence of ectoparasite infestation and species composition of parasites.

2.3 Study population

The study animals were apparently healthy chickens that were managed in extensive and intensive production system and they were categorized based on age,sex, breed and management system. Chickens of both sexes were included in the study and they were grouped into two groups as local and exotic (Sasso Breed and Bovan Breed) breeds. Ages of chicken were determined subjectively based on the size of crown, length of spur and flexibility of the xiphoid cartilage together with observing colour of the shank and growth of the spur and categorized as young grower (Less than 12 weeks of age) and adult (Greater than 12 weeks of age) (Fraol *et al*., 2014).

2.4 Sampling techniques and sample size

The study districts were selected purposely based on transport access, potentiality farms and stock availability, where two districts from Wolaita zone included in sampling chickens. These districts have similar agro-ecology and management practices. The farms and villages were purposively selected based on the availability of chickens within the farm, the potential production activities. In study area, 123,734 and 73,314 chickens has been existing in intensive and backyard production system, respectively. Then, by taking production system as strata, 412 and 356 chickens were allocated proportionally from each production system, namely intensive and backyard, respectively. Systematic random sampling was applied to each production system after sampling interval was determined using the formula K=N/n. Where: N = represents estimated total chickens for backyard farm and intensive farm in sampling frames; n = represents allocated sample size for respective management system and K = interval of chicken to be sampled in intensive and backyard farm, respectively. Accordingly, at every 88 chickens and 87 apparently healthy chickens were caught and examined.

The sample size of chickens required for this study was calculated using the equation given by Thrusfield (2005) for random sampling method. Sample size was determined using 95% level of confidence. Since there was no enough information of previous study on the prevalence of ectoparasites in study area, an expected prevalence of 50% is used to determine the sample size.

$$N = \frac{1.96^2 \times P\,exp\,(1-Pexp)}{d^2}$$

Where N = the total sample size
Pexp = expected prevalence
d = absolute precision.

According to this formula the required sample sizes were 384 for both farming system and to increase precision the sample size was doubled. Therefore, a total of 768 chickens were selected from both intensive and backyard farm poultry production system.

2.5 Data Collection

2.5.1 Questionnaire Survey

Using purposive sampling techniques, the study sites were selected based on the poultry production potential. Consequently, two study sites namely Sodo Zuriya district and Sodo town from Wolaita Zone were carefully chosen by considering the potential of the areas in poultry farming. Then, to collect relevant information pre-tested semi-structured questionnaire were introduced to animal owners. The total sample size for household interview was determined using probability proportionate to sampling technique (Cochran, 1977):

$$n = \frac{z^2 * p\,(q)}{d^2}$$

Where, n is desired sample size according to Cochran (1977) when population household is > 10,000; z is the standard normal deviation (1.96 for 95% confidence interval); p is 0.1 (proportion of population to be included in sample i.e. 10%); q is 1 - p that is 0.9 (90%); d is the degree of accuracy desired (0.05) .

A list of households in each questionnaire survey site was identified with the help of district's and town's kebeles animal health technicians. The targeted households that were involved in the study from Sodo Zuriya district and Sodo town were 34 and 104, respectively. Consequently, a total of 138 households/poultry owner were employed.

2.6 Study Methodology

2.6.1 Clinical Examination procedures and Sample Collection

During examination of each bird, bird's legs were tied with the help of assistant and feathers were manually deflected to observe the presence of parasite. After restraining, the whole body of each chicken was carefully examined to assess the presence of ectoparasites by using close visual inspection and magnifying hand lens. Then, samples were taken randomly from vent, head, neck, leg, back, wattle, comb and wing by naked eyes and using hand lenses. A systematic approach was followed to detect and count ectoparasites. Accordingly, the head was examined first and followed by the neck, body sides, back, ventral part of the abdomen; wings, vent area and legs. Ectoparasites were collected from the birds by displaying the feathers horizontally against their anatomical direction of alignment so as to expose them. Lice and fleas were collected from hosts by parting the hairs or feathers, gently brushing the base of the feathers with a fine soft brush on top of a white cardboard paper while some of them were collected by hand picking and non-toothed thumb forceps. Mites were collected by scraping the skin surface with scalpel blade (Yacob *et al*., 2009).

A thorough examination of cracks and crevices in chicken houses were checked early in the morning and during the night time to ensure the presence of parasites with nocturnal activities. Shank scraps were collected on clean petri-dish. Each chicken examined was assigned with serial number and labeled with the necessary information on the sampling bottle for easy identification. The bio data of each chicken like sex, breed, age and predilection sites and managements systems were recorded in separate sheet. Representative of ectoparasites found in body of the chicken were collected in universal bottle (Film holders, vial) containing 70% ethyl alcohol and transported to Soddo Regional

Veterinary laboratory (SRVL) at Wolaita Zone for further identification. The collected parasites were further be examined by stereomicroscope and identified according to guidelines described by Soulsby, (1982).A chicken with any of with ectoparasite was considered as positive and those with no any ectoparasite was considered as negative.

2.6.2 Ectoparasite identification

A standard methods and procedures were employed in order to identify ectoparasites of poultry. Lice, fleas and mites were heated in 5% KOH for 20 min, washed and dehydrated by treating them with ethanol, then cleared in xylene for 20 min and mounted on the light microscope. Ticks were examined under the light microscope and each morphological character was measured and recorded for identification (William, F., 2001). All ectoparasites were identified based on their morphological characteristics, using the entomological diagnostic guidelines by Soulsby, (1982), Arends (2003), Walker *et al*., (2003), and Ruedisueli and Manship (2006).

2.7 Data Management and Analysis

The data collected from each bird entered into Microsoft-Excel spread sheet and analyzed by using STATA version 13.0 (STATA, 2009). Types of external parasites recovered and different management system were analyzed. Prevalence was calculated as percent of infected animals from total number of animals examined. Risk variables were recruited and analysis was made using regression for association with prevalence of ectoparasite infestation. Chi-square(X^2) test was also employed to evaluate statistical significance difference between risk factor groups in prevalence of ectoparasite infestation. In statistical analysis, a 95% of confidence intervals (CI), and P-value less than 0.05 ($P<0.05$) was considered as statistical significance difference.

3. Results and Discussion

3.1 House hold characteristics of respondents

Among total poultry producers (138) interviewed in Wolaita Sodo town and Sodo zuria wereda, 24 (17.4%) were from intensive farming system and 114 (82.6%) were from extensive farming system. Among interviewed poultry owners, 64.5% and 35.5% were male headed and female headed households, respectively. Concerning respondent's age, most (63.77%) was under the age group of 36-50 years which is a mature age group. In the present study, majority (48.6%) of respondents involved in poultry production were illiterate, while (7.2 %) of respondents were qualified with degree and above. About 35.7%of respondents have engaged in poultry farming with work experiences of 6-7 years (Table 1).

Table 1 Household characteristics

Variables	Category	No of Respondents	Proportion (%)
Sex of the interviewer	Female	49	35.5
	Male	89	64.5
Age of the interviewer (in years)	18-25	2	1.4
	26-35	22	15.9
	36-50	88	63.8
	Above 50	26	18.8
Education status of the interviewer	Illiterate	67	48.6
	Primary education	33	23.9
	Secondary education	16	11.6
	Certificate	8	5.8
	Diploma	10	7.2
	Degree and above	4	2.9
Working Experience in poultry farm (in years)	Below 5 years	48	24.8
	6-10 years	63	45.7
	Above 10 years	27	19.6

3.2 Farm management characteristics and External parasitic infestation in poultry

Chicken of extensive management system due to their scavenging manner prove to more ectoparasite than of intensive management system were suitable environment for disease and these responses agreed with finding (Mungube *et al.*, 2008). This questionnaire survey was aimed to assess general information about ectoparasite of poultry in extensive and intensive farms in Sodo town and Sodo Zuriya district, Wolaita Zone. About 26.1% of respondents were working in poultry farms for their fulltime activity but the remaining 73.9% of respondents explained that they did not have working fulltime activity. Only 21.7% of poultry farm owners use disinfectants at the entrance and exit while others (78.3%) did not use any disinfectant, hence the farm is exposed easy spread of ectoparasites. Only 31.2% of poultry farm owners follow to the feeding process in relation to hygienic practice while others (68.8%) did not follow the feeding process in relation to hygienic practice.

Great number of respondent's forwarded 69.6% own adults and 30.4% Young age group of chickens; 76.8% local and 23.2% exotic breed of chicken; 71% female and 29% male chicken and almost all (100%) extensive management system of chicken most susceptible to ectoparasite, respectively. Only 24.6% of poultry farm owners provide feed to poultry with feeder while others (75.6%) feed poultry on floor; only 32.6% of poultry farm owners had access to veterinary service while others (67.7%) do not have access to veterinary service, these may prove more ectoparasite to poultry production.

About 31.2% of respondents used water source for poultry farm from tap water and the remaining 38.4% use from river and 30.4% from well. Only 26.1% of poultry farm owners wash feed equipment's before feeding while others (67.7%) do not wash feeding equipment's. Only 31.2% of poultry farm owners wash watering equipment's before watering while others (68.8%) use watering equipment's to poultry without washing. Only 20.3% of poultry farm house with washable floor while others (79.7%) of poultry farm house floor were not washable, these leading to more ectoparasite spreading to poultry farms. (Table 2)

Table 2Percentage of response on questionnaire survey (N=138)

Variables	Category	Frequency	Proportion (%)
Fulltime activity of poultry work	Yes	36	26.1
	No	102	73.9
Disinfectant at the Entrance and Exit	Yes	30	21.7
	No	108	78.3
Age group of chickens is most susceptible to ectoparasite	Adult	96	69.6
	Young	42	30.4
Management system ectoparasite most common	Intensive	0	0
	Extensive	138	100
In which types of breed ectoparasite most common	Exotic	32	23.2
	Local	106	76.8
Ectoparasite infestation in terms of sex	Female	98	71
	Male	40	29
Access to veterinary service	Yes	45	32.6
	No	93	67.7
Feeding equipment's wash before feeding	Yes	46	26.1
	No	102	73.9
Watering equipment's wash before watering	Yes	43	31.2
	No	95	68.8
Water access to wash poultry house floor	Yes	60	43.5
	No	78	56.5

According to current study the great number of respondents (75.4%) use extensive management system of rearing that shows the spreading of disease more prevalent in extensive management system than intensive one. Regarding poultry owners literacy rate, 48.6% were illiterate that indicate some of them due to lack of awareness on ectoparasites in poultry production community to prevent the sign and spread of disease. In addition to lack of awareness in poultry farm production the great numbers of respondents (78.3%) were did not use any disinfectant this leading to highly spread of ectoparasite into the farm (Mekuria and Gezahegn, 2010).

Regarding water source for poultry farm the abundant sources were river (38.4%) and well (30.4%), most of the equipment's of watering and feeding (67.7%) were not washed, for poultry fee ding practice, most respondents (75.6%) provide feed for poultry on floor. This shows that such poor hygienic practices have great role in spreading ectoparasites within the chickens. Regarding to veterinary service access the great number of respondents have no accesses to vet service to prevent chicken from ectoparasite. All these show that there has been difficulty in disease control strategy, resulting in high prevalence of ectoparasite in poultry (Mekuria and Gezahegn, 2010).

Regarding risk factors of diseases of ectoparasites in the study area 69.6% of respondents stated that adult age groups were more susceptible to ectoparasite than young chicken. This might be due to young chicken more confined in the house than scavenging outdoor like adult chicken (Asefa *et al.,* 2017).On the other hand, this study revealed also 71% of respondents replied that female chickens were more susceptible to ectoparasite than male chickens. This result is in line with finding of Wario *et al*., (2018).

According to this study most respondents (76.8%) suggested that local breed of chickens were more susceptible to ectoparasite than exotic chicken. This might be related to confinement of exotic breeds of chicken in the housewhile outdoor scavenging behavior of local breeds may expose them for external parasite (Bala *et al.*, 2011).

3.3 Prevalence of ectoparasites infestation

Total of 768 chickens kept under different management systems were considered for the present study. Out of these, 347 heads of chicken were infected with one or more species of ectoparasites with an overall infestation rate of 45.18%. According to the present study, the prevalence of different species of ectoparasites wa s found to be: *Goniocotes gallinae* (1.3%), *Menac anthus stramineus* (12.6%), *Lipeurus caponis* (9.9 %), *Menopon gallinae* (1.69%), *Knemidocoptes m utans* (4.3%), *Echidenophaga* gallinacean (10.94 %) and *Argas persicus*(2.08%).

Table 3 Overall prevalence of ectoparasites in study area

Study area	No Examined	No infected	Prevalence rate (%)
Sodo Town	384	63	16.45
Sodo Zuria	384	284	73.96
Total	768	347	45.18

The overall prevalence of chicken ectoparasites (45.18%) in the current study was comparable with 40% reported by Tesfaheywet and Yonas (2015). However, it was relatively lower than the findings of Wario *et al.* (2018) in Southern Ethiopia, Asefa *et al.* (2017) in and around Jimma town and Hagos and Eshetum (2005) in Central Ethiopia, who reported 65.5%, 67.71% and 93.68%, respectively. The difference of prevalence between the current and previous findings may be due to breed, season, management, agro ecology, different climatic conditions (Temperature and humidity) which may alter the population dynamics of the parasites and implemented methods of the disease control and prevention practiced in the study area, which exposes the chicken to poor hygiene on the farm and chicken houses thus, enabling them to contract a wide range of harmful ectoparasites.

Table 4 Prevalence of ectoparasites by predilection sites

Ectoparasite	Predilection sites	No Examined	No positive	Prevalence (%)
Lice	Fluff/Shafts of the feathers of the neck, Back, Abdomen, wings , Cloacae, Vent, Thigh and Breast region	768	192	25
Mite	Shank , Toes of legs, Wings and Breast	768	33	4.3
Flea	Comb, wattles, Eyelids and around Ears	768	84	10.94
Tick	Abdominal area and below Wings	768	16	2.08
Mixed	Fluff/Shafts of the feathers of the neck, Back, Abdomen, wings , Cloacae, Vent, Thigh and Breast Comb, wattles, Eyelids and around Ears	768	22	2.86

According to the present study, the highest prevalence of external parasites was lice (25%); four species of poultry lice were identified, namely: *Menacanthus stramineus,Lipeurus caponis*, *Menopon gallinae,* and *Goniocoptes gallinae*. These parasites affect chickens and the Predilection sites were back, abdomen, wings, cloacae, almost all part of the body. *Knemidocoptes mutans* (Scaly leg) mites (4.30%) was the only mite found in the current study and may found on the host during night time, due to a nocturnal behavior, and may be found anywhere on the skin. Chickens and turkeys in most parts of the world may harbour this parasite.The parasites are found under the scales of the legs, thus the name Scaly leg, but can occasionally be seen on the comb, wattles and neck. The chicken gets infected from the ground and the infection spreads from the toes upwards. This finding is conceded with results of Lawal1 *et al.,* (2016) from Northern Nigeria.

According to the present study *Argas persicus* (2.08%) was the only tick which infects chickens, turkeys, pigeons, ducks, geese and many wild birds or chicken in tropical and sub-tropical countries. This tick belongs to the soft-bodied ticks, the family *argasidae*. The predilection site of this parasite was on the skin, but most of the time the ticks hide in cracks or under tree bark, away from the host. Also *Echidnophaga gallinacea(*sticktight flea) (10.94%) was the only flea found in current study which is common on chickens and other birds in tropical and subtropical areas throughout the world. The predilection site for the adult flea to attach is the skin of the head, often around the eyes in clusters in hundreds. This finding is similar with results of Lawal1 *et al.,* (2016) from Northern Nigeria.

Table 5 Prevalence of ectoparasite by species and their respective site

Ectoparasites encountered	Common Name	Species identified	Number of examined chicken	Number of infested chicken	Prevalence (%)
Lice	Body louse	*Menacanthus stramineus*	768	122	12.6
	Wing louse	*Lipeurus caponis*	768	76	9.9
	Shaft louse	*Goniocoptes gallinae*	768	10	1.3
	Fluff louse	*Menopon gallinae*	768	13	1.69
Mite	Scaly leg mite	*Knemidocoptes mutans*	768	33	4.3
Flea	Stick tight flea	*Echidenophaga gallinacean*	768	84	10.94
Ticks	Fowl tick	*Argas persicus*	768	22	2.08

According to the present study, the highest prevalence of external parasite was lice (25%); followed by stick tight fleas (10.94%), mites (4.30%) and ticks (2.08%) respectively. The lice prevalence conceded with results of 28% and 22.2% from Nigeria-West Africa and Southwestern Ethiopia in Jimma by (Odenu *et al* 2016) and (Wario *et al*., 2018) respectively. However, the result of current study on lice infestation was lower than the findings of Sabuni *et al*., (2010), Sadiq *et al*.,(2003), Belihu *et al*.,(2010) and Mekuria and Gezahegn,(2010) who reported 90%, 72.72%, 84.3% and 88%, respectively. The prevalence of lice in current study was low and this might be due to management system, season of study and other agro ecology influencing the distribution of lice.

3.4 Type of ectoparasite infestation in study area in association with risk factors

Lice Infestation in Chicken: In the present study, 25% of chicken were infested by lice on one or more of their body surface. In current study, four species of poultry lice were identified, namely: *Menacanthus stramineus* (12.6%), *Lipeurus caponis* (9.9%), *Menopon gallinae* (1.69%) and *Goniocoptes gallinae*(1.3%). The difference was statistically significant ($p<0.05$). Overall prevalence of lice was higher among adult chicken (25.87%) than in young grower (24.07%). This study revealed that, female birds (27.03%) were slightly prone to lice infestation than males (22.04%). The infestation of lice was higher in local breed (29%) than exotic breed (22.9%), higher in extensively managed chicken (46.35%) than intensively managed chicken (6.55%). There was statistically significant difference ($p<0.05$) in the prevalence of the different lice species between different risk factors. (Table 6)

Table 6 Association between prevalence of lice infestation and risk factors

Variables	Parameters (Category)	No Examined	No positive	Prevalence (%)	Chi square (X^2)	P-value
Breed	Local	100	39	39	30.941	0.000
	Exotic	668	153	22.9		
Age	Adult	402	104	25.87	9.622	0.002
	Young	366	88	24.04		
Sex	Female	455	123	27.03	4.528	0.033
	Male	313	69	22.04		
Management	Extensive	356	165	46.35	464.017	0.000
	Intensive	412	27	6.55		

Among the identified lice species, *M. stramineus* (12.6%) was most frequently identified species while *G. gallinae (*1.30%) was the least one. The difference was statistically significant ($p<0.05$).The prevalence of *M. stramineus* (12.6%) the most frequently among the identified lice species which conceded with results of 14% and 22.2% from Nigeria and in Mareka Woreda of Dawuro Zone by Jallailudeen *et al*. (2017) and Tessema (2019) respectively, however the current study revealed that the prevalence of *M. stramineus* (12.6%) was higher than the prevalence of 1.5%, 4.95% and 3.3% reported by Wario *et al*.(2018), Asefa *et al.* (2017) and (Tesfaheywet and Yonas, (2015), respectively. These differences in prevalence may be attributed to differences in geographical areas, sample size and period of study. Different geographical areas and period of study have different climatic conditions (Temperature and humidity) which may alter the population dynamics of the parasites Magwisha *et al.*,(2017).

The higher prevalence 70%, 71.6%, 33.57% and 52.8% of *M. stramineus* was reported from Bangladesh by Shanta *et al.* (2006), from Ethiopia by Hagos and Eshetu (2005) and Nafyad *et al.* (2006) and from Nigeria-West Africa by (Odenu *et al.,* 2006), respectively. This might be due to different host factors, management system. Other factors related with size of sample taken. *L. caponis* 9.9% the second prevalence among lice species which was conceded with results of 15.59% from Mareka Woreda of Dawuro Zone by Tessema W.(2019) and 14% from Southwestern Ethiopia in Jimma Wario *et al*. (2018) higher than the finding of Belihu *et al*.(2018) who reported 0.67% and lower than finding of Hagos and Eshetu (2005) and Jallailudeen *et al*. (2017) who reported 25.3% and 40.25%, respectively. This might be related to favorable climatic condition in tropics for their development.

M. gallinae encountered in the chickens with the prevalence of 1.69% among lice species during the current study. The finding was in agreement with results of 2.75% reported by Jallailudeen *et al*. (2017) from Nigeria. Likewise a 3.6% of infection rate was recorded by Tesfaheywet and Yonas (2015) from Wolayita Zone. However, infestation by *M. gallinae* encountered in current study is lower than the finding of Hagos and Eshetu (2005), Mekuria and Gezahegn, (2010) and Tessema W. (2019) who reported 89.7%, 49%, and 44.95%, respectively.

The encountered lice species with the least prevalence of 1.3% was *G. gallinae*. The finding was conceded with results of 3.3% from Wolayita Zone by Tesfaheywet and Yonas, (2015) and 6.42% from Mareka Woreda of Dawuro Zone by Tessema W.(2019). Nevertheless, the occurrence of infestation by *G. gallinae* with rate of 1.3% lower than work of Hagos and Eshetu, (2005) and Mekuria and Gezahegn(2010) who reported 42.6% and 44.95% respectively. This may be related to favorable climatic condition in tropics for their development. These variations could be attributed to the season, time of the day, and the study location with respect to urban, peri-urban or pure village setting and these environmental factors favor their propagation and life cycle progression of the diverse ectoparasites species.

Generally differences in type and prevalence of the most commonly encountered lice may be due to a variation in agro-climatic and topographic conditions and species adaptability. Besides climatic conditions, these investigators did their work in different ecological locations where differences in breed and general husbandry practices would account for the difference in finding. In addition, a longer period of study might show the seasonal prevalence pattern of the parasites compared to the shorter one. Larger sample sizes depict the true reflection of what is on the ground compared to smaller sample sizes, hence the variation encountered. Collecting ectoparasites within a relatively short period minimizes errors since parasites have their own biology and populations that can vary rapidly in both space and time (Clayton and Moore, 1997).

Mite Infestation: In this study, (4.3%) of chickens were found to have mites on their body surface, Shank, toes of legs, wings and breast and subcutaneous tissue. One species of mites or scally leg mite (*Knemidocoptes mutans*) was found to be the post prevalent parasites in Sodo town and Sodo Zuriya distinct. The occurrence of mites was high in adult chicken (5.22%) compared to young grower chicken, (3.28%). These parasites had a higher frequency of occurrence in females (5.05%) than males (3.19%). There was no statistical difference ($p>0.05$) between different age groups and sexes of chicken. It was higher in local chicken (9%) than exotic chicken (3.59%) as well as higher in extensively managed chicken (8.71%) than intensively managed chicken (0.49%). The difference was statistically significant ($p<0.05$) between breed and management system. (Table 7)

Table 7 Association between prevalence of mite infestation and risk factors

Variables	Parameters (Category)	No Examined	No positive	Prevalence (%)	Chi square (X^2)	P-value
Breed	Local	100	9	9	6.184	0.013
	Exotic	668	24	3.59		
Age	Adult	402	21	5.22	1.763	0.184
	Young	366	12	3.28		
Sex	Female	455	23	5.05	1.560	0.212
	Male	313	10	3.19		
Management	Extensive	356	31	8.71	31.398	0.000
	Intensive	412	2	0.49		

Mites were the third identified ectoparasite in this study area and one mite species (*Knemidocoptes mutans*) was found during the present study, at a rate of 4.3%. These findings was conceded with result of 7% from Nigeria by Jallailudeen *et al*.(2017) and 2.2 % from Eastern Hararghe Zone of Oromia Region by Biressaw and Michael(2018), and *K. mutans* 4.3% higher than the result of 1.82% from Central Ethiopia by Asefa *et al.*,(2017). In the contrary, these findings were lower than 39.6% prevalence reported in Nigeria by Odenu *et al.*, (2006), 33.9% prevalence in Gombe of Northeastern Nigeria by Lawal *et al.* (2014) and 19.5% prevalence from Central Ethiopia by Hagos and Eshetu (2005). The variation in prevalence of *K. mutans* is likely to be due to agro climatic differences between the study areas, season of study, geographic difference and control measure against *K. mutans* in these chickens.

Flea Infestation: The common chicken fleas in the study area were the stick tight flea (*Echidenophaga* gallinacea). The overall prevalence of fleas was 10.94% (Table 3). The prevalence was higher in adult chicken (13.18%) in compared to young growers (8.47%). The difference was statistically significant ($p<0.05$) between different age groups. The parasite was slightly higher in females (10.99%) than in males (10.86%). There was no statistical difference ($p>0.05$) between different sexes of chicken. Also higher in local chicken (13%) than exotic chicken (10.63%) with no statistical difference ($p>0.05$) as well as higher in extensively managed chicken (21.91) than intensively managed chicken (1.47%) The difference was statistically significant ($p<0.05$) between different management system. (Table 8)

Table 8Association between prevalence of flea infestation and risk factors.

Variables	Category	No Examined	No positive	Prevalence	Chi square (X^2)	P-value
Breed	Local	100	13	13	0.502	0.479
	Exotic	668	71	10.63		
Age	Adult	402	53	13.18	4.371	0.037
	Young	366	31	8.47		
Sex	Female	455	50	10.99	0.003	0.956
	Male	313	34	10.86		
Management	Extensive	356	78	21.91	82.020	0.000
	Intensive	412	6	1.47		

The flea was the second most prevalent identified in the study area and one species of chicken flea (*E .gallinacean*, stick tight flea) was found in the present study at a rate of 10.94%. This finding was buttressed by the result of 16.15% from Nigeria by Jallailudeen *et al*. (2017) and 8.75 % from Central Ethiopia by Asefa *et al.*(2017), and *E .gallinacean* 10.94% higher than with result 6.8% from Central Ethiopia by Hagos and Eshetu, (2005).However, this finding was lower than the prevalence of 32.86%, 44.36% and 83.5 % reported by Nafyad *et al.* (2006), Firaol *et al.* (2014) and Tessema W. (2019), respectively. The variation in prevalence is likely to be due to agro climatic differences between the study areas, season of study and control measure (Local) instigated against *E. gallinacean* in these chicken. *E. gallinacean* has been reported in a number of hosts including chicken, turkeys, wild birds, humans, mice, cats and dogs (Mungube *et al.*, 2008) The infestation of stick tight flea is widespread in tropical and subtropical regions (Permin *et al.*, 2002). The difference in agro-ecological conditions could probably be the reason for the differences observed between the present study and the previous studies.

The stick tight flea is a unique among poultry fleas in that the adults become sessile parasites and usually remain attached to the skin of head for days or weeks. It causes irritation and blood loss leading to anemia and death particularly in young chicken (Arends *et al.*, 2003).

A higher prevalence (10.99%) of *E .gallinacean* was recorded in female group than male (10.86%) ones. The difference was statistically significant ($p<0.05$) between sexes of chicken.This finding is inconsistent with the finding of Firaol *et al*. (2014) who reported a higher prevalence (15.09%) of *E .gallinacean* in male group than female chickens (13.99%).Social behavior increases opportunities for vertical (within species) transmission of ectoparasites from one individual to the other as most of the time female's huddle together. The male chicken may introduce more parasites on to the female during mating, since the male is forced upon the female for every mating.

Tick Infestation: The common chicken tick in the study area was soft tick (*Argas persicus*). The overall prevalence of ticks was 2.08% (Table 2). The prevalence was higher in adult chicken (2.47%) in compared to young growers (1.64%). The parasite was relatively higher in males (2.24%) than in females (1.99%) and also higher in local chicken (3%) than exotic chicken (1.95%) as well as higher in extensively managed chicken (4.21%) than intensively managed chicken (0.24%) There was no statistical difference ($p<0.05$) in the prevalence of tick species between different risk factors with exception different management system in which statistically significant ($p<0.05$). (Table 9)

Table 9 Association between prevalence of tick infestation and risk factors

Variables	Category	No Examined	No positive	Prevalence	Chi square (X^2)	P-value
Breed	Local	100	3	3	0.474	0.491
	Exotic	668	13	1.95		
Age	Adult	402	10	2.47	0.676	0.411
	Young	366	6	1.64		
Sex	Female	455	9	1.99	0.061	0.805
	Male	313	7	2.24		
Management	Extensive	356	15	4.21	14.761	0.000
	Intensive	412	1	0.24		

Ticks were the least identified ectoparasite in this study area and one tick species (*Argas persicus*) was found during the present study, at a rate of 2.08%. This finding was comparable with result of 4.2% from Central Ethiopia by Hagos and Eshetu, (2005) and 4.5% from Nigeria by Jallailudeen *et al*. (2017), and an infestation of chickens by *A. persicus* with a prevalence of 2.08% is higher than with infestation rate of 1.3% in Wolayita Zone by Tesfaheywet and Yonas, (2015). Nevertheless, the current study revealed that the lower prevalence (2.08%) of *Argas persicus* was inconsistent with 6.2% and 4.97% prevalence reported in Nigeria by Lawal*etal.*, (2014) and in Ethiopia by Tessema (2019), respectively. The variation in prevalence of *A. persicus* is likely to be due to agro climatic differences between the study areas, season of study, geographic (Altitudinal) difference and control (Management) measure against *A. persicus*in these chickens.

Mixed Infestation: In this study, (2.86%) chickens were infested by mixed infection of lice, flea and mite found on their body surface, Shank, toes of legs, wings and breast and subcutaneous tissue. The prevalence of mixed infestation with two or more parasite in one host was higher in adult chicken (3.73%) compared to young growers (1.91%). The parasite was relatively higher in females (3.3%) than in males (2.24%). There was no statistical difference ($p>0.05$) between different age groups and sexes of chicken. It was higher in local chicken (7.0%) than exotic chicken (2.25%) as well as higher in extensively managed chicken (5.62) than intensively managed chicken (0.49%). The difference was statistically significant ($p<0.05$) between breed and management system. (Table 10)

Table 10 Association between prevalence of mixed infection and risk factors

Variables	Category	No Examined	No Positive	Prevalence	Chi square (X^2)	P-value
Breed	Local	100	7	7	7.066	0.008
	Exotic	668	15	2.25		
Age	Adult	402	15	3.73	2.278	0.131
	Young	366	7	1.91		
Sex	Female	455	15	3.3	0.749	0.387
	Male	313	7	2.24		
Management	Extensive	356	20	5.62	18.081	0.000
	Intensive	412	2	0.49		

The infestation with one or more types and species of ectoparasites observed in this study was in accord with series of studies done by many researchers such as Abebe *et al.,* (1997), Belihu *et al*.,(2009) in Ethiopia, Swai *et al*., (2010) in Tanzania, Sabuni *et al*., (2010) in Kenya and Nnadi and George, (2010) in Nigeria. Another study demonstrated the infestation of rats with lice and flea which might imply the plausible contribution of rats as a reservoir of ectoparasites in the areas where appropriate pest management is not regularly implemented (Sohrab, R., *et al* 2011). The different species of ectoparasites identified in this study indicate the existence of diverse ectoparasite fauna in the study sites. Taking their life cycle and their direct and indirect effects on the chicken, the mixed infection obviously affects the performance of the sector.

3.5 Risk Factors associated with poultry ectoparasitism.

Management wise prevalence of ectoparasites

In this study the overall prevalence of ectoparasites in extensive and intensive management systems are 86.80% and 9.22% respectively. The difference was statistically significant ($p<0.05$) in the prevalence of the different species of ectoparasites between the various management system with all species of ectoparasites, with the highest prevalence of *M. stramineus* in the extensive (29.49%), followed by *E. gallinacean* (21.91%) and *L. caponis* (18.26%). The difference was statistically significant ($p<0.05$) (Table 11)

Table 11 Prevalence of different species of ectoparasites by management system

Ectoparasite Species	Management System						Chi Squere (X^2)	P - value
	Intensive			Extensive				
	No Examined	No Infected	Prevalence (%)	No Examined	No Infected	Prevalence (%)		
Menacanthus stramineus	412	17	4.13	356	105	29.49	82.020	0.000
Lipeurus caponis	412	11	2.67	356	65	18.26	52.047	0.000
Goniocoptes gallinae	412	1	0.23	356	9	2.53	7.762	0.005
Menopon gallinae	412	2	0.49	356	11	3.09	7.785	0.005
Knemidocoptes mutans	412	2	0.49	356	31	8.71	31.398	0.000
***Echidenophaga* gallinacean**	412	6	1.47	356	78	21.91	82.020	0.000
Argas persicus	412	1	0.24	356	15	4.21	14.761	0.000

The management with overall prevalence was low in intensive management system (9.22%) while high in extensive management system (86.80%). The result is agreed with finding of 2.35% was reported from Debrezeit semi-intensive farm (Biu *et al*. 2007) and 100% in free ranging chicken (Bala *et al.*, 2011). The result is in contrast with finding of (Mekuria and Gezahegn, 2010) who report high prevalence in back yard system and none in intensive system. This variation is due better measures and practices related to good housing, feeding and husbandry system applied intensive farms where exotic breeds are kept. Such high prevalence in extensive management could be due to the free-range system practiced in the study areas, which exposes the chicken to poor hygiene on the farm and chicken houses thus, enabling them to contract a wide range of harmful ectoparasites. The free-range system provides a more sustainable environment for the parasites (Mungube *et al.*, 2008) reported that lack of control measures towards these parasites was a possible factor contributing to the high prevalence of the parasites, becoming vulnerable to ectoparasitism. In study area the backyard farming system, chicken were sharing the same house with their owner's as well as with other livestock. The cleaning litter of poultry is not frequent. The design of houses also matter the introduction of parasite to poultry house and subsequent infestation resulted.

In intensive farming system, chicken were managed under the intensive management system which covers the range of measures and practices relating to good housing, feeding and husbandry standards, including all-in- all-out systems to protect stock from disease predisposing factors.

Prevalence of ectoparasites by breed

In this study the overall prevalence of ectoparasites was higher in local breed than exotic breed 71% and 41.32% respectively. The difference was statistically significant ($p<0.05$). There was no statistical difference ($p>0.05$) in the prevalence of the different species of ectoparasites between the various type of breed with exception *M. stramineus* and *K. mutans*, where the highest prevalence of *M. stramineus* in local breed (26.0%), followed by *L. caponis* (15%) and *E. gallinacean* (13%) (Table 12).

Table 12 Prevalence of different species of ectoparasites by breed

Ectoparasite Species	Breed						Chi Squere (X^2)	P - value
	Exotic			Local				
	No Examined	No Infected	Prevalence (%)	No Examined	No Infected	Prevalence (%)		
Menacanthus stramineus	668	96	14.37	100	26	26	8.803	0.003
Lipeurus caponis	668	61	9.13	100	15	15	3.360	0.067
Goniocoptes gallinae	668	8	1.20	100	2	2	0.436	0.509
Menopon gallinae	668	10	1.50	100	3	3	1.181	0.277
Knemidocoptes mutans	668	24	3.59	100	9	9	6.184	0.013
Echidenophaga gallinacean	668	71	10.63	100	13	13	0.502	0.479
Argas persicus	668	13	1.95	100	3	3	0.474	0.491

Local breed chicken (71.0%) was more infested than exotic breed chicken (41.32%). The finding was lower than report of (Firaol *et a*l. 2014) who reported that 87.55% local breed was more infested than exotic breed chicken 26.4% and higher than report of (Asefa *et al.,* 2017) who reported (41.4%) in local breed and (28.64%) in exotic breed. Local breeds are allowed to free-range, thus becoming more vulnerable to ectoparasite than exotic breed, which are almost kept in door. The management system is also varying from place to place and in different husbandry system.

Prevalence of ectoparasites by sex

The overall prevalence of ectoparasites in male and female sex groups was 40.58% and 48.35%, respectively. The difference in overall prevalence between male and female chickens was no statistically significant ($p<0.05$), nonetheless, the present study revealed no statistical difference ($p>0.05$) in the prevalence of the various species of ectoparasites between the two sexes of chicken, where the highest prevalence of *M. stramineus* in female chicken (18.02%), followed by *E.gallinacean* (10.99%) and *L. caponis* (10.52%).(Table 13)

Table 13 Prevalence of different species of ectoparasites by sex

Ectoparasite Species	Sex						Chi Squere (X^2)	P - value
	Male			Female				
	No Examined	No Infected	Prevalence (%)	No Examined	No Infected	Prevalence (%)		
Menacanthus stramineus	313	40	12.78	455	82	18.02	3.814	0.051
Lipeurus caponis	313	28	8.95	455	48	10.52	0.535	0.465
Goniocoptes gallinae	313	6	1.92	455	4	0.88	1.554	0.213
Menopon gallinae	313	4	1.28	455	9	1.99	0.546	0.460
Knemidocoptes mutans	313	10	3.19	455	23	5.05	1.560	0.212
Echidenophaga gallinacean	313	34	10.86	455	50	10.99	0.003	0.956
Argas persicus	313	7	2.24	455	9	1.99	0.061	0.805

The present study revealed that female birds had higher prevalence (48.35%) than male (40.58%) ones, even though there was no statistical significance difference (P>0.05) between both sexes. This finding was in line with Wario *et al*. (2018), Mekuria and Gezahegn (2010) and Asefa *et al.* (2017) who found that female chickens had a higher prevalence of ectoparasites than male ones with no statistical difference. However, the result of the current study was contrary to the finding of Biressaw and Michael (2018) who recorded that a slight higher prevalence (56.82%) in males than the females (54.8%) ones. Similarly, Belihu *et al.* (2010) observed that males had a slightly higher (94.3%) infestation rate than female (88.3%) ones and the differences were not statistically significant. There are conflicting reports on the impact of host sex on prevalence of avian ectoparasites. However, some have stated that a number of host factors may occasionally cause variation in louse prevalence in some cases (Saxena *etal.,* 1995) but generally there is no significant difference in prevalence with respect to host sex.

These findings suggest that sex is not an influential factor on the prevalence rates of ectoparasites in poultry. Social behavior also increases opportunities for vertical (within species) transmission of ectoparasites from one individual to the other as most of the time female's huddle together. The male chicken may introduce more parasites on to the female during mating, since the male is forced upon the female for every mating (Saxena *etal.*, 1995).

Prevalence of ectoparasites by age

The overall prevalence of ectoparasites in adult and young groups was 50.50% and 39.34%, respectively. The difference in overall prevalence between adult and young chickens was statistically significant (p<0.05). Nonetheless, the present study revealed that no statistical difference (p>0.05) in the prevalence of the various species of ectoparasites between the two age groups with exception *M. stramineus, M. gallinae and E. gallinacean,* where the highest prevalence of *M. stramineus* in young chicken (13.11%), followed by *E.gallinacean* (8.47%) and *L. caponis* (8.47%).(Table 14).

Table 14 Prevalence of different species of ectoparasites by age group

Ectoparasite Species	Age group						Chi Squere (X^2)	P -value
	Adult			Young				
	No Examined	No Infected	Prevalence (%)	No Examined	No Infected	Prevalence (%)		
Menacanthus stramineus	402	74	18.41	366	48	13.11	4.017	0.045
Lipeurus caponis	402	45	11.20	366	31	8.47	1.594	0.207
Goniocoptes gallinae	402	1	0.25	366	9	2.46	7.283	0.007
Menopon gallinae	402	3	0.75	366	10	2.27	4.541	0.033
Knemidocoptes mutans	402	21	5.22	366	12	3.28	1.763	0.184
Echidenophaga gallinacean	402	53	13.18	366	31	8.47	4.371	0.037
Argas persicus	402	10	2.47	366	7	2.24	0.676	0.411

The adult chicken had a 50.5% overall prevalence of ectoparasite, which was slightly higher than that of young chickens (39.34%). These finding are in agreement with those from studies in and around Jimma Town by (Asefa *et al.*, 2017), in Nigeria by (Jallailudeen *et al.*, 2017) and from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which adult chicken were higher prevalence when compared to young chicken. Older chicken may be exposed longer to the infested environment than the young grower, hence a higher prevalence and intensity rates. This result disagrees with the finding of Mekuria and Gezahegn (2010) who reported young chicken had a 95.7% overall prevalence of ectoparasite, which was slightly higher than that of adult (80.8%) and (Biressaw and Michael, 2018) where 60.76% and 54.1% of young and adult chicken were infested, respectively with no statistical significance difference P>0.05. Management difference in different study areas may attribute to such differences.

Risk factors associated with poultry ectoparasitism

In this study, variables like breed (local and exotic), ages (adult and young), sexes (male and female) and management system (extensive and intensive) were considered as risk factors and assessed for the presence of statistically significant association between different categories and the prevalence of poultry ectoparasitism using logistic regression analysis. Likewise, the total of 768 chickens was examined and the overall prevalence 45.18% was recorded showing significant variations among the hypothesized risk factors for infestation of chickens with ectoparasites at current study area.

The prevalence of chicken ectoparasites and its association with the hypothesized risk factors is summarized in Table 15.

Table 15 Prevalence of chicken ectoparasite with associated risk factor

Variables	Category	No of Examined	No of Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	71	71	0.29	0.1818-0.4549	0.000*
	Exotic	668	276	41.32	Ref*	1.5895-3.7709	
Age	Adult	402	203	50.5	0.64	0.4774-0.8470	0.002*
	Young	366	144	39.34	Ref*	1.0294-2.5002	
Sex	Female	455	220	48.35	1.37	1.0249-1.8343	0.034*
	Male	313	127	40.58	Ref*	0.3059-0.8107	
Mgt	Ext	356	309	86.8	64.71	41.121-101.82	0.000*
	Int	412	38	9.22	Ref*	0.0008-0.0033	

Mgt=Management:Ext = Extensive: Int =Intensive: I=Confidence of Interval: Ref = Reference: * = Significant

Generally, local breed of chicken was found more prone to ectoparasites than exotic breed with statistically significant variation (OR=0.29; CI=0.1818-0.4549; p=0.000). Statistically significant variation finding has been observed in prevalence of ectoparasite between different breed (local and exotic) consistent with previous finding reported in and around Ambo Town by (Firaol *et al.*, 2017) in which local breed of chicken were higher (OR=19.6) prevalent when compared to exotic chicken that indicates breed is one of the important risk factors influencing ectoparasites in poultry. This result disagrees with the finding studies in and around Jimma Town by (Asefa *et al.*, 2017) in which exotic breed of chicken were higher(OR=0.8) prevalent when compared to local chicken. Regarding age of examined chickens, statistically significant variation was observed and adults were found more susceptible for ectoparasites than young chickens (OR=0.64; CI=0.4774-0.8470; P=0.002). The current finding has been observed in prevalence of ectoparasite between different age group (adult and young) conceded with previous finding reported in Nigeria by (Jallailudeen *et al*., 2017) in which the prevalence in adult group of chicken were higher(OR=1.185) when compared to young chicken that indicates age is one of the important risk factors influencing ectoparasites in poultry. This result disagrees with the finding studies in and around Ambo Town by (Firaol *et al.*, 2017) where the prevalence in young chicken were higher (OR=1.88) when compared to adult chicken (OR=1.0).

Similarly, statistically significant variation was encountered between sexes of chickens as females were 1.37 times infested than male chicken in the current study (OR=1.37; CI=1.0249-1.8343; P=0.034). These finding are in agreement with studies from Nigeria by (Jallailudeen *et al*., 2017) in which female chicken were higher(OR=1.071) prevalent when compared to male chicken that indicates sex is one of the important risk factors influencing ectoparasites in poultry. This result disagrees with the finding studies in and around Ambo Town by (Asefa *et al.*, 2017) in which male chicken were higher (OR=0.79) prevalent when
compared to female chicken. In the same way, chi ckens kept under extensive management were sig nificantly prone to ectoparasites by 64.71 times than that kept under intensive management system (OR=64.71; CI=41.121-101.82; P=0.000). Statistically significant variation finding has been observed in prevalence of ectoparasite betw een different management system consistent with previous finding those reported from studies in and around Ambo Town by (Asefa *et al.*, 2017), in Nigeria by (Jallailudeen *et al*., 2017)

and from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive manag ement system chicken were higher by (OR=0.999 7), (OR=1.137) and (OR=8.12) respectively prevalent when compared to intensive management system of chicken that indicates management system is one of the important risk factors influencing ectoparasites in poultry. There is no result previously findings disagrees with the current studies because management system is one of the most common hypothesized risk among all other risk factors.

Total of 768 chickens kept under different management systems were considered for the present study. Out of these, in urban or sodo town (16.45%) and rural or sodo zuria district (73.96%) poultry were infested with ectoparasite respectively. According the present study, the prevalence of ectoparasite infestation was higher rural than urban rearing system. This is due to traditional free range, there is no separate poultry house and the chickens live in family dwelling together with human beings (Solomon, 2007). The bio-security of the backyard poultry production system is very poor, as scavenging birds live together with people and other species of livestock. Poultry movement and droppings are very difficult to control and chickens freely roam in the household compound. There is no practice (or even viable means) of isolating sick birds from the household flocks and dead birds are left for either domestic or wild predators. Unfortunately, however village or backyard poultry production system is largely dependent on local chickens with little or no inputs. It is characterized by poor health care with minimal level of bio-security, high off take rates and high level of mortality. The system does not involve investment beyond the cost of the foundation stock and handfuls of local grains. Mostly, indigenous chickens are kept although some hybrids and exotic breeds may be kept under this system (Dawit *et al*., 2008).There is no purposeful feeding of chickens and scavenging is almost the only source of diet. Different feeding materials are present for scavenging including seeds, plant materials, worms, insects and unidentified materials (Tadelle and Ogle, 2000).Under village(rural) poultry production system, prevalence of diseases, predators, lack of proper health care and poor feeding information were reported to the major constraint of poultry production (Moges *et al*., 2010; Dinka *et al*., 2010 and Mengesha *et al*., 2001).

3.6 Association between species of ectoparasite infestation and hypothesized risk factors

Generally, local breed of chicken was found more prone to ectoparasites than exotic breed with statistically significant variation (OR=0.29; CI=0.1818-0.4549; p=0.000). Regarding age of examined chickens, statistically significant variation was observed and adults were found more susceptible for ectoparasites than young chickens (OR=0.64; CI=0.4774-0.8470; P=0.002). Similarly, statistically significant variation was encountered between sexes of chickens as females were more infested than male chicken in the current study (OR=1.37; CI=1.0249 1.8343; P=0.034).In the same way, chickens kept under ex tensive management were significantly prone to ectoparasites than that kept under intensive management system (OR=64.71; CI=41.121-101.82; P=0.000).(Table 15).

The relative prevalence (ODD ratio) of chicken association between different species ectoparasite infestation to the relative risk factors is summarized as fallow.

Table 16 Univariable Logistic regression of lice infestation by risk factors

Variables	Parameters (Category)	No of lice Examined	No of lice Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	39	39	0.47	0.2991-0.7219	0.001*
	Exotic	668	153	22.9	Ref*	0.4278-0.9555	
Age	Adult	402	104	25.87	0.91	0.6537-1.2586	0.556*
	Young	366	88	24.04	Ref*	0.2792-0.4363	
Sex	Female	455	123	27.03	1.31	0.9344-1.8369	0.117*
	Male	313	69	22.04	Ref*	0.2165-0.2694	
Mgt	Ext	356	165	46.35	12.31	7.9150-19.171	0.000*
	Int	412	27	6.55	Ref*	0.0475-0.1036	

As we can observe from the result of the above Table 16, local breed of chicken was found more prone to lice infestation than exotic breed with statistically significant variation (OR=0.47; CI=0.2991-0.7219; P=0.001). Statistically significant variation finding has been observed in prevalence of lice infestation between different breed (local and exotic) consistent with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which local breed of chicken were higher (OR=12; CI=7.320-19.673; P=0.000) prevalent by lice when compared to exotic chicken that indicates breed is one of the important risk factors influencing lice infestation in poultry. There is no result previously findings disagrees with the current studies because local breed of chicken more susceptible to lice infestation than exotic breed due to manner of chickens scavenging out door. Regarding age of examined chickens, no statistically significant variation was observed and adults were found more susceptible for lice infestation than young chickens (OR= 0.91; CI=0.6537-1.2586; P=0.556). The current finding has been observed in prevalence of lice between different age group (adult and young) conceded with previous finding reported in wolaita sodo by Mekuria and Gezahegn (2010) in which adult group of chicken were higher (OR=0.82; CI= 0.49-1.34; P= 0.42) prevalent when compared to young chicken. This result disagrees with the finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which young of chicken were higher (OR=0.58; CI=0.3666-.9710; P=0.020) significantly prevalent when compared to adult chicken.

Similarly, there is no statistically significant variation was encountered between sexes of chickens as females were more infested with lice than male chicken in the current study (OR=1.31; CI=0.9344-1.8369; P=0.117). These finding are in agreement with studies reported in woloaita sodo by Mekuria and Gezahegn (2010) in which female group of chicken were higher (OR=1.19; CI= 0.73-1.96; P= 0.47) prevalent with lice when compared to male chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.,* 2017) in which male chicken were higher (OR=0.79; CI= 0.508-1.21; P= 0.275) prevalent with lice when compared to female chicken that indicates sex is one of the important risk factors but not significantly influen cing lice infestation in poultry. In the same way, c hickens kept under extensive management were si gnificantly prone to lice than that kept under intensive management system (OR=12 .31;CI=7.9150 19.171; P=0.000).

Statistically significant variation finding has been observed in prevalence of lice infestation between different management system consistent with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in whic h extensive management system chicken were hi gher (OR=8.12; CI=5.012-13.164; P=0.000) prevalent with lice when compared to intensive management system of chicken that indicates management system is one of the important risk factors influencing lice infestation in poultry. There is no result previously findings disagrees with the current studies because management system is one of the most common hypothesized risk among all other risk factors due to scavengingsystem more susceptible to lice infestation.

Table 17 Multivariable Logistic regression of lice infestation by risk factors

Variables	Parameters (Category)	No of lice Examined	No of lice Positive	Prevalenc e (%)	Odd ratio	CI (95%)	P value
Sex	Female	455	123	27.03	1.51	1.0328-2.2069	0.033*
	Male	313	69	22.04	Ref*	Ref*	
Mgt	Ext	356	165	46.35	12.64	8.1037-19.7258	0.000*
	Int	412	27	6.55	Ref*	Ref*	

Generally, in the present study, chickens kept und er extensive management were significantly prone to lice infestation than that kept under intensive management system (OR=12.64; CI=8.1037-19.7258; P=0.000). On the other hand, statistically significant variation was encountered between sexes of chickens as females were more infested with lice species than male chicken in the current study (OR=1.51; CI=1.0328-2.2069; P=0.033). Statistically significant variation
finding has been observed in prevalence of ectopa rasite between different management system and sex consistent with previous finding those reported from studies in and around Ambo Town by (Asefa *et al.*, 2017), in woalita sodo by by Mekuria and Gezahegn (2010) and from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system and female chicken were higher infected by lice infestation respectively. That indicates by multivariable logestic regression from all other risk factors sex and management were hypotheses risk factors for lice infestation in poultry ectoparasite.

Table 18 Univariable Logistic regression of flea infestation by risk factors

Variables	Parameters (Category)	No of flea Examined	No of flea Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	13	13	0.8	0.42287-1.4982	0.479*
	Exotic	668	71	10.63	Ref*	0.08343-0.2676	
Age	Adult	402	53	13.18	0.61	0.3817 - 0.9729	0.038*
	Young	366	31	8.47	Ref*	0.1138 - 0.2027	
Sex	Female	455	50	10.99	1.01	0.6385 -1.6073	0.956*
	Male	313	34	10.86	Ref*	0.0854 - 0.1740	
Mgt	Ext	356	78	21.91	18.99	8.1615 - 44.1653	0.000*
	Int	412	6	1.47	Ref*	0.0066 - 0.03311	

According to result of the above Logistic regression Table 18, local breed of chicken was found more prone to flea infestation than exotic breed with no statistically significant variation (OR=0.8; CI=0.42287- 1.4982; P=0.479). Statistically non significant variation finding has been observed in prevalence of flea infestation between different breed (local and exotic) consistent with previous finding reported from in Nigeria by (Jallailudeen *et al*., 2017) in which local breed of chicken were higher (OR=1.137; CI=0.5227-0.6649; P=0.1003) prevalent when compared to exotic chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.,* 2017) in which exotic chicken were higher (OR=0.89; CI= 1.713-3.04; P= 0.606) prevalent with flea when compared to local chicken. Regarding age of examined chickens, statistically significant variation was observed and adults were found more susceptible for flea infestation than young chickens (OR= 0.61; CI=0.3817 - 0.9729; P=0.038). The current finding has been observed in prevalence of flea between different age group (adult and young) conceded with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which adult group of chicken were higher (OR=6.29; CI= 3.745-10.587; P= 0.000) prevalent when compared to young chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.,* 2017) in which young chicken were higher (OR=0.58; CI= 0.3666-.971; P= 0.020) prevalent with flea when compared to adult chicken.

Similarly, there is no statistically significant variation was encountered between sexes of chickens as females were more infested with flea than male chicken in the current study (OR=1.01; CI=0.6385-1.6073; P=0.956). These finding are in agreement with studies reported in wolaita by Mekuria and Gezahegn (2010) in which female group of chicken were higher (OR=1.45; CI= 13 - 26; P= 0.243) prevalent with mite when compared to male chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.,* 2017) in which male chicken were higher (OR=0.79; CI= 0.508-1.21; P= 0.275) prevalent with flea when compared to female chicken. In th e same way, chickens kept under extensive manag ement were significantly prone to flea than that kept under intensive management system

(OR=18.99; CI=78.1615 - 44.1653; P=0.000). Statistically significant variation finding has been observed in prevalence of flea infestation between different management system consistent with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system chicken were higher (OR=8.12;CI=5.012-13.164; P=0.000) prevalent with mite when compared to intensive management system of chicken. There is no result previously findings disagrees with the current studies because management system is the only common hypothesized risk among all other risk factors due to scavengingsystem more susceptible to flea infestation.

Table 19 Multivariable Logistic regression of flea infestation by risk factors

Variables	Parameters (Category)	No of flea Examined	No of flea Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Age	Adult	402	53	13.18	0.91	0.5510 - 1.4910	0.699*
	Young	366	31	8.47	Ref*	Ref*	
Mgt	Ext	356	78	21.91	18.64	7.9745 - 43.5730	0.000*
	Int	412	6	1.47	Ref*	Ref*	

Generally, in the present study, chickens kept under extensive management were significantly prone to flea infestation than that kept under intensive management system (OR=18.64; CI=7.9745 43.5730; P=0.000). Statisticallysignificant variation finding has been observed in prevalence of ectoparasite between different management system consistent with previous finding those reported from studies in woalita sodo by by Mekuria and Gezahegn (2010) and from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system chicken were higher infected by lice infestation respectively. That indicates by multivariable logistic regression from all other risk factors management were hypotheses risk factors for flea infestation in poultry ectoparasite.

Table 20 Univariable Logistic regression of mite infestation by risk factors

Variables	Parameters (Category)	No of mite Examined	No of mite Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	9	9	0.46	0.1618 - 0.8034	0.013*
	Exotic	668	24	3.59	Ref*	0.0499 - 0.1962	
Age	Adult	402	21	5.22	0.65	0.3110 - 1.3437	0.243*
	Young	366	12	3.28	Ref*	0.0334- 0.0821	
Sex	Female	455	23	5.05	1.54	0.7187 - 3.2977	0.267*
	Male	313	10	3.19	Ref*	0.0176 - 0.0620	
Mgt	Ext	356	31	8.71	18.87	4.4754 - 79.5221	0.000*
	Int	412	2	0.49	Ref*	0.0012 - 0.0196	

As we can observe from the result of the above Logistic regression Table 20, local breed of chicken was found more prone to mite infestation than exotic breed with statistically significant variation (OR=0.46;CI=0.1618-0.8034;P=0.013). Statistically significant variation finding has been observed in prevalence of mite infestation between different breed (local and exotic) consistent with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which local breed of chicken were higher (OR= 12; CI= 7.320-19.673; P= 0.000) prevalent by mite when compared to exotic chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which exotic chicken were higher (OR= 0.65; CI= 0.3110 - 1.3437; P= 0.606) prevalent with mite when compared to local chicken. Regarding age of examined chickens, no statistically significant variation was observed and adults were found more susceptible for mite infestation than young chickens (OR= 0.61; CI=0.3817 - 0.9729; P=0.243). The current finding has been observed in prevalence of mite between different age group conceded with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which adult group of chicken were higher (OR= 6.29; CI= 3.745-10.587; P= 0.000) prevalent when compared to young chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which young chicken were higher (OR= 0.58; CI= 0.3666-.971; P= 0.020) prevalent with mite when compared to adult chicken.

On the other hand there is no statistically significant variation was encountered between sexes of chickens as females were more infested with mite than male chicken in the current study (OR=1.54; CI=0.7187 - 3.2977; P=0.267). These finding are in agreement with studies reported in wolaita sodo by Mekuria and Gezahegn (2010) in which female group of chicken were higher (OR=1.45; CI= 13 - 26; P= 0.243) prevalent with mite when compared to male chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which male chicken were higher (OR=0.79; CI= 0.508-1.21; P= 0.275) prevalent with flea when compared to female chicken. In the same way, chickens kept under extensive management were significantly prone to mite than that kept under intensive management system (OR=18.99; CI=78.1615 - 44.1653; P=0.000). Statistically significant variation finding has been observed in prevalence of mite infestation between different management system consistent with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system chicken were higher (OR= 8.12; CI=5.012-13.164; P=0.000) prevalent with mite when compared to intensive management system of chicken. There is no result previously findings disagrees with the current studies because management system is the only hypothesized risk among all other risk factors due to scavengingsystem more susceptible to mite infestation.

Table 21Multivariable Logistic regression of mite infestation by risk factors

Variables	Parameters (Category)	No of mite Examined	No of mite Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	9	9	0.91	0.3990 - 2.0469	0.808*
	Exotic	668	24	3.59	Ref*	Ref*	
Age	Adult	402	21	5.22	0.96	0.45039 - 2.0138	0.898*
	Young	366	12	3.28	Ref*	Ref*	
Mgt	Ext	356	31	8.71	18.15	4.1890 - 78.6281	0.000*
	Int	412	2	0.49	Ref*	Ref*	

Generally, in the present study, chickens kept under extensive management were significantly prone to mite infestation than that kept under intensive management system (OR=18.15; CI=4.1890 78.6281; P=0.000). Statistically significant variation finding has been observed in prevalence of ectoparasite between different management system consistent with previous finding those reported from studies in wolaita sodo by by Mekuria and Gezahegn (2010) and from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system chicken were higher infected by mite infestation respectively. So this indicates that by multivariable logistic regression management was hypotheses risk from all other risk factors for mite infestation in poultry ectoparasite.

Table 22Univariable Logistic regression of tick infestation by risk factors

Variables	Parameters (Category)	No of tick Examined	No of tick Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	3	3	0.64	0.1796 - 2.2928	0.495*
	Exotic	668	13	1.95	Ref*	0.0098 - 0.0976	
Age	Adult	402	10	2.47	0.65	0.2351 - 1.8157	0.414*
	Young	366	6	1.64	Ref*	0.0136 - 0.0478	
Sex	Female	455	9	1.99	0.88	0.3250 - 2.3940	0.806*
	Male	313	7	2.24	Ref*	0.0108 - 0.0484	
Mgt	Ext	356	15	4.21	18.08	2.3760 - 137.564	0.005*
	Int	412	1	0.24	Ref*	0.0003 - 0.0173	

According to result of the above Logistic regression Table 22, local breed of chicken was found more prone to tick infestation than exotic breed with no statistically significant variation (OR=0.64; CI=0.1796-2.2928;P=0.495). Statistically non significant variation finding has been observed in prevalence of tick infestation between different breed consistent with previous finding reported from in Nigeria by (Jallailudeen *et al*., 2017) in which local breed of chicken were higher (OR=1.137; CI=0.5227-0.6649; P=0.1003) prevalent by tick when compared to exotic chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which exotic chicken were higher (OR=0.89; CI= 1.713-3.04; P=0.606) prevalent with tick when compared to local chicken. Regarding age of examined chickens, no statistically significant variation was observed and adults were found more susceptible for tick infestation than young chickens (OR= 0.65; CI=0.2351-1.8157; P=0.414). The current finding has been observed in prevalence of tick between different age group (adult and young) conceded with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which adult group of chicken were higher (OR=6.29; CI= 3.745-10.587; P= 0.000) prevalent when compared to young chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which young chicken were higher (OR=0.58; CI= 0.3666-.971; P= 0.020) when compared to adult chicken.

Similarly, there is no statistically significant variation was encountered between sexes of chickens as females were more infested with tick than male chicken in the current study (OR=0.88; CI=0.3250-2.3940; P=0.806). These finding are in agreement with studies reported in wolaita sodo by Mekuria and Gezahegn (2010) in which female group of chicken were higher (OR=1.45; CI= 13 - 26; P= 0.243) prevalent with tick when compared to male chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which male chicken were higher (OR=0.79; CI= 0.508-1.21; P= 0.275) prevalent with tick when compared to female chicken. In th e same way, chickens kept under extensive manag ement were significantly prone to tick than that kept under intensive management system (OR=18.08;CI=2.3760 137.564;P=0.000). Statistically significant variation finding has been observed in prevalence of tick infestation between different management system consistent with pre vious finding reported from Southwestern Ethiopi a in Jimma by (Wario *et al*., 2018) in which exten sive management system chicken were higher (O R=8.12;CI=5.012 13.164; P=0.000) when compared to intensive management system of chicken. There is no result previously findings disagrees with the current studies because management system is only common hypothesized risk among all other risk factors due to scavenging system more susceptible to tick infestation.

Table 23 Univariable Logistic regression of mixed infection by risk factors

Variables	Parameters (Category)	No of mix Examined	No of mix Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	7	7	0.31	0.1212 - 0.7681	0.012*
	Exotic	668	15	2.25	Ref*	0.0349 - 0.1623	
Age	Adult	402	15	3.73	0.50	0.2028 - 1.2480	0.138*
	Young	366	7	1.91	Ref*	0.0231 - 0.0649	
Sex	Female	455	15	3.3	1.49	0.6005 - 3.6983	0.390*
	Male	313	7	2.24	Ref*	0.0108 - 0.0484	
Mgt	Ext	356	20	5.62	12.20	2.8318 -52.579	0.001*
	Int	412	2	0.49	Ref*	0.0012 - 0.0196	

According to result of the above Table 23, local breed of chicken was found more prone to mixed infestation than exotic breed with statistically significant variation (OR=0.31; CI=0.1212-0.7681;P=0.012). Statistically significant variation finding has been observed in prevalence of mixed infestation between different breed consistent with previous finding reported from in Nigeria by (Jallailudeen *et al*., 2017) in which local breed of chicken were higher (OR=1.137; CI=0.5227-0.6649; P=0.1003) prevalent when compared to exotic chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which exotic chicken were higher (OR=0.89; CI= 1.713-3.04; P= 0.606) prevalent by mix infection when compared to local chicken. Regarding age of examined chickens, statistically non significant variation was observed and adults were found more susceptible for mixed infestation than young chickens (OR= 0.50; CI=0.2028-1.2480; P=0.138).

The current finding has been observed in prevalence of mixed infection between different age group conceded with previous finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which adult group of chicken were higher (OR=6.29; CI= 3.745-10.587; P= 0.000) prevalent with mixed infestation when compared to young chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which young chicken were higher (OR=0.58; CI= 0.3666-.971; P= 0.020) prevalent with mixed when compared to adult chicken.

Similarly, there is no statistically significant variation was encountered between sexes of chickens as females were more infested with mixed than male chicken in the current study (OR=1.49;CI=0.6005-3.6983;P=0.956). These finding are in agreement with studies reported in wolaita sodo by Mekuria and Gezahegn (2010) in which female group of chicken were higher (OR=1.45;CI=13 - 26; P= 0.243) prevalent with mixed when compared to male chicken. The result is in contrast with finding in and around Jimma Town by (Asefa *et al.*, 2017) in which male chicken were higher (OR=0. 79;CI=0.508 1.21;P=0.275) prevalent with mixed infection when compared to female chicken. In th e same way, chickens kept under extensive manag ement were significantly prone to flea than that kept under intensive management system (OR=18.99;CI=78.1615 44.1653; P=0.000). Statis tically significant variation finding has been obser ved in prevalence of mixed infestation between di fferent management system consistent with previo us finding reported from Southwestern Ethiopia in Jimma by (Wario *et al*., 2018) in which extensive management system chicken were higher (OR= 8.12;CI=5.012 13.164; P=0.000) prevalent with m ixed infection when compared to intensive manag ement system of chicken. There is no result previously findings disagrees with the current studies because management system is hypothesized risk among all other risk factors.

Table 24 Multivariable Logistic regression of mixed infection by risk factors

Variables	Parameters (Category)	No of mix Examined	No of mix Positive	Prevalence (%)	Odd ratio	CI (95%)	P value
Breed	Local	100	7	7	0.71	0.2751- 1.8401	0.483*
	Exotic	668	15	2.25	Ref*	Ref*	
Age	Adult	402	15	3.73	0.71	0.2827 - 1.7965	0.473 *
	Young	366	7	1.91	Ref*	Ref*	
Mgt	Ext	356	20	5.62	10.30	2.2854 - 46.4689	0.002*
	Int	412	2	0.49	Ref*	Ref*	

Generally, in the present study, chickens kept und er extensive management were significantly prone to mixed infestation than that kept under intensiv e management system (OR=10.30; CI=2.2854 46. 4689; P=0.000). Statistically significant variation finding has been observed in prevalence of ectopa rasite between different management system cons istent with previous finding those reported from st udies in wolaita sodo by by Mekuria and Gezaheg n (2010) and from Southwestern Ethiopia in Jimm a by (Wario *et al*., 2018) in which extensive mana gement system chicken were higher infected by mixed infestation respectively. So this indicates that by multivariable logistic regression management was hypotheses risk from all other risk factors for mixed infestation in poultry ectoparasite.

4.7 Housing and cleaning activities

In intensive chicken farm to minimize external parasite problem, they were cleaning the premises regularly between batches of chicken, during all-out and all-in flock replacement. There was smooth wall house contraction with mesh, to keep away from wild birds and to maintain ventilation. The chickens were kept based on age groups such as brood, pullet and parent stock. The houses fumigated and cleaned for a week before the new batch entered. This practice holds true at regular basis every time between the periods of all-out and all-in program. In backyard chicken production system, the chickens were sharing the same house with their owners as well as with other animals. The home was made of grass-thatched, mud and local wood, where there were cracks and craves in the house which allows the external parasites to hide them and multiply. All age group of chicken kept together. Cleaning of chicken litter was not frequent in many of the house hold in the study area. There was high chance of contact between infested and cleaned ones, while feeding around the house (Mekuria and Gezahegn,2010).

4. Conclusion and Recommendations

Poultry production has been a major source of poultry meat and egg production in Ethiopia and yet is still the most neglected in husbandry practices and particular health care. The study can be concluded that lice, fleas, mites and ticks are the common types of ectoparasites of poultry in Wolaita Sodo town and Sodo Zuriya distnict. The overall prevalence rate of chicken ectoparasites (45.18%), of these lice infestation (25%); was higher than that of stick tight fleas (10.94%), mite (4.30%) and ticks (2.08%) in study area. Four species of lice, *Lipeurus caponis*, *Menopon gallinae*, *Menacanthus stramineus*, *Goniocoptes gallinae*and and one species of mite: *Knemidocoptes mutans*, one species of flea *Echidnophaga gallinacean* and one species of tick *Argas persicus* were identified. Among the species of lice identified, *Menacanthus stramineus* (12.6%) was the most prevalent whilst *Echidnophaga gallinacea*(10.94%), *Knemidocoptes mutans* (4.3%) and *Argas persicus*(2.08%) were found the only species of fleas, mites and ticks, respectively.

Generally, the study indicated that ectoparasites are highly prevalent in backyard production systems than in intensive farming system and in local chickens than exotic ones., which is associated with lack of due attention with respect to hygienic system, treatment and control practices. The occurrence and intensity of parasitic infestations may be influenced by a number of epidemiological factors including host, sex, age, and breed and management system. Based on the above conclusions the following recommendations are forwarded:

- Proper sanitation, good hygiene, use of specific tested chemicals should be practiced.
- An integrated poultry ectoparasitism control strategy should be implemented.
- Provision of regular training on poultry production and health care need to be done in order to enhance the awareness of poultry producers.
- Veterinary service delivery to poultry producers in rural, peri-urban and urban areas should be improved.
- Further detailed investigation on poultry ectoparasite infestation should be carried out.

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