Gastrointestinal Parasites of Chickens Managed under Different Production Systems in Selected Areas of East Hararghe, Ethiopia

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Abstract: A cross sectional study was conducted from November 2017 to April 2018 to estimate the prevalence of gastrointestinal parasites of chicken managed in different production systems in selected areas of east Hararghe, Ethiopia. A total of 324 local and 126 exotic breeds of chicken were used in the study. Chickens in the farm and village were followed until drop feces and fecal samples were carefully collected from the top of freshly dropped feces excluding soil contamination for parasitological examination. Flotation and McMaster counting techniques were used for qualitative and quantitative evaluation of fecal samples, respectively. Out of the 450 chickens' feces examined, 27.1% and 49.5% were positive for *Eimeria* oocysts and nematode eggs, respectively. High prevalence (P<0.05) of coccidian infection was observed in exotic breed (48.4%) chickens as compared to the free-range local chickens (18.8%), while high prevalence (P<0.05, COR, 0.4) of nematode infection was observed in local (57.1%) than exotic (0%) chicken breeds. Nearly equal rate of prevalence was recorded in different sex groups for coccidia (male 27.4%, female 27%) and nematodes (male 41.7%, female, 40.8%). A higher nematodes prevalence was recorded in extensive (62.6%) than intensive (13.3%) and semi-intensive (12.9%) management systems (P<0.05). *Eimeria* infection was greater for intensive (31.7%) and semi-intensive (28.6%) than extensive (24.4%), management systems. Majority of the chickens harbored light degree of coccidia infection. *Ascaridia galli* (37.1%) was the dominant nematode followed by *Heterakis gallinarum* (10.4%) and *Dispharnx* (2%). In conclusion, *Eimeria* and gastrointestinal nematodes were important parasites in the study area. It was recommended that awareness should be created on the importance, prevention, and control of coccidiosis and gastrointestinal nematodes for exotic chicken producers and for chicken managed under extensive system, respectively.

Keywords: *Chicken, Eimeria, Nematode, Prevalence, Production systems*

Introduction

In east Africa, over 80% of the human population lives in rural areas, of which over 75% of households keep indigenous chickens (Kitalyi, 1998). In Ethiopia, an estimated 56 million native chickens of non-descriptive breed (96.6%), crossbreed (0.55%) and exotic breed (2.8%) are present and mainly kept in urban and peri-urban areas (CSA, 2014/15). Poultry production provides employment and plays a vital role in the national economy as revenue. In addition, it provides high-quality animal protein (meat and egg) to humans as well as fertilizer for crop cultivation (Jordan *et al*., 2002; Nnadi and George, 2010; Nghonjuyi *et al*., 2014).

Poultry production has been adversely affected by a variety of constraints among which are diseases such as coccidiosis and helminthiasis (Hagos and Eshetu, 2004; Dube *et al.,* 2010; Alemayehu *et al.,* 2012). Coccidiosis is an infectious disease caused by a host-specific protozoan parasite of the genus *Eimeria*. The different species of *Eimeria,* commonly known as coccidia, parasitize specific parts of the intestine (Taylor *et al.,* 2007). Coccidiosis remains one of the major disease problems of poultry despite advances made in prevention and control through chemotherapy, management and nutrition (Graat *et al*., 1996). The disease is endemic in most of the tropical and subtropical regions where ecological and management conditions favor an all-year-round development and propagation of the causal agent (Obasi *et al.,* 2006). Among nine species of *Eimeria* identified as causative agents of poultry coccidiosis, only seven of them were reported to be pathogenic (Morris *et al*., 2007). In Ethiopia, chicken coccidiosis caused by *E. acervulina, E. necatrix, E. maxima* and *E. tenella*, is endemic in all parts of the country and affects mainly young growing birds (Hagos *et al*., 2004). High incidences of coccidiosis were reported in Ethiopia, but quantitative losses due to coccidiosis are not well documented. A study by Kinung'hi *et al.* (2004) reported that coccidiosis contributed to about 8.4% and 11.86% loss in profit in large and small-scale chicken farms, respectively in Debre Zeit. Factors contributing to outbreaks of clinical coccidiosis include litter moisture, overstocking, poor feeding, inadequate ventilation and immune suppression (Singla *et al.,* 2007).

Helminthosis is also considered to be an important problem of local chickens. According to available literature, nematode parasites of chickens are noted to

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become the major causes of ill-health and loss of productivity in different parts of Ethiopia (Hagos and Eshetu, 2004; Heyradin *et al.,* 2012; Tesfaheywet *et al.,* 2012; Kessewdeg *et al.,* 2014; Beruktayet and Mersha, 2016; Solomon and Mekonnen, 2017). Poultry nematodes such as *Ascaridia galli*, *Heterakis gallinarum*, *Syngamus trachea* and *Capillaria annulata* constitute the most important group of helminth parasites of poultry both in the number of species they affect and the extent of damage they cause (Matur *et al.,* 2010). Infection with these parasites occurs after ingestion of helminths eggs or intermediate hosts like cockroaches, grasshoppers, ants and earthworms (Taylor *et al.,* 2007).

Despite the economic significance of coccidiosis and helminthosis to commercial and small-scale poultry production in Ethiopia, no substantial research was conducted, particularly in East Hararghe. Therefore, the objectives of this study were to estimate the prevalence of gastrointestinal parasites and associated risk factors of poultry under different management systems in selected areas of eastern Ethiopia.

Materials and Methods

Study Area

Haramaya district is located in Eastern Ethiopia and Haramaya University is situated near the town Haramaya. The district town is located 512 km away from Addis Ababa, within 09° 24' 10" E and 41° 19' 58"N and altitude of 2000 meters above sea level (m.a.s.l.). The area has a relative humidity of 65% and annual rainfall of about 900 mm with a bimodal distribution pattern, where short-period rainfall is in March and April, whereas long rainfall is in July to September (CSA, 2014/15). Bedeno is a district in Eastern Ethiopia. The altitude of the district ranges from 1200-3100 m.a.s.l. The average temperature of the area is 15.4 °C and the average rainfall of 1004 mm (CSA, 2007, CSA, 2014/15). Gara Muleta is located at an altitude of 1000-3,405 m.a.s.l within 9°4´59.99" latitude, 41°43´0.02" longitude (CSA, 2007).

Study Chicken and Production System

The study animals constitute indigenous and exotic chicken breeds kept under extensive, intensive and semi-intensive management systems in Haramaya, Bedeno and Gara Muleta districts. Nearly equal numbers of samples were collected from Haramaya (188) and Gara Muleta (169) while samples from Bedeno were only 93 due to its relatively long from the laboratory. When the chickens are kept under open-door conditions and depend mainly on scavenging and thus mix with people and other livestock, and share their living quarters with their owners or animals, the production system was considered as an extensive production system. An intensive production system is a system where chickens are kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health and a modern management system. The semi-intensive production system is characterized by having one or more pens in which the birds can forage on natural vegetation and insects to supplement the feed offered to them.

Study Design and Sampling Strategy

A cross-sectional study was conducted from November 2017 to April 2018 to assess the gastrointestinal parasites of poultry reared under different management systems. Samples were collected from 324 local and 126 exotic breeds of both sexes and diverse age groups kept under different management systems. Free-ranging and semi-intensive chickens were collected from the village, while samples from Haramaya University and Adelle poultry farms representing the intensive production system containing different breeds were included. The two farms are also the main exotic chicken breed suppliers to the local communities in the area. Information about age, breed, sex and management system were recorded during sample collection. The age of the chickens was classified as young (less than or equal to eight weeks) and adult (greater than eight weeks) based on the method followed by Diriba *et al.* (2012). Districts were purposively selected for proximity to Haramaya University; availability of households who owned flocks of indigenous and exotic (pure or crossbreed) chicken and lack of previous comprehensive study on similar topics. Sample collectors were selected from veterinary medical students assigned in the externship program at Haramaya University and trained well for a day on sample collection techniques.

A total of 324 samples were collected from local chickens under semi-intensive (70) and extensive managements (254). Before sample collection, households were briefed on the research objective and the importance of the research and their participation is based on a volunteer basis. Volunteer households have chickens visited early morning for sample collection. Chickens in the households followed until drop feces and fecal samples were carefully collected from the top of freshly dropped feces excluding soil contamination after wearing disposable plastic gloves. Around two to three chickens were sampled from each household to allow for the participation of other households in the area. The numbers of chickens sampled were 62, 93 and 169 in Haramaya, Bedeno and Gara Muleta respectively. In addition, 126 exotic chicken fecal samples were collected from two farms under an intensive management system. The fecal sample collection was done similarly as done from local chicken, waiting for the chicken until they drop. Dye was used to marking the head of sampled chicken to avoid double sampling.

Sample Size Determination

The sample size was calculated based on Thrusfield (2005) formula for simple random sampling using the formula, $n = 1.96^2 \times Pexp\ (1-Pexp)/\ d^2$. Where, Pexp, is the expected prevalence, and d, is the precision. Fifty percent expected prevalence of coccidiosis and 5% absolute precision were used to estimate the minimum sample size required. By substituting the value in the above formula, the sample size was calculated to be 384. However, 450 chickens were sampled.

Parasitological Examination

The collected samples were transported to Haramaya University Veterinary Parasitology Laboratory for parasitological analysis. Analysis was done on the same day of sample collection but in a few delayed cases, samples were stored at 4°C for days. Three gram of feces was suspended in 35 ml of sodium chloride floatation fluid. The suspension was filtered through a tea strainer into a beaker to harvest oocyst and nematode eggs (Bowman, 2003; Nematollahi *et al.,* 2009). The McMaster technique was used to quantify the oocyst and nematode eggs per gram of feces (OPG) (Taylor *et al.,* 2007). The level and severity of the infection were determined by comparing OPG with previously used standard categories that are described as light (<10.000 oocytes), moderate (10,000-15,000) and heavy (>15,000) (Lunden *et al.,* 2000).

Data Analysis

The data were entered into a Microsoft Excel worksheet and analysis was made by Statistical Packages for Social sciences (SPSS 20). Descriptive statistics was used to express the prevalence of infection while chi-square (χ^2) test and univariate analysis using crude odds ratio (COR) were used to compare the association between variables at $p < 0.05$.

Results and Discussion

The result of this study showed an overall prevalence of 27.1% and 49.5% for coccidia and gastrointestinal nematodes, respectively (Table 1). Coccidiosis and gastrointestinal nematodes are considered the most prevalent intestinal parasitic disease in commercial chicken production systems worldwide and pose a remarkable economic loss to small-scale and large-scale poultry farms (Hagos and Eshetu, 2004; Kisia *et al.,* 2004; Dube *et al.,* 2010; Yazwinski *et al.,* 2013; Berhanu *et al.,* 2014; Negbenebor and Ali, 2018; Waktole *et al.,* 2019). Helminths compete for nutrients with the host and cause inflammation and lesions in the intestinal tract that interfere with digestion and assimilation of nutrients which leads to reduced feed efficiency, weight loss, and mortality (Berhanu *et al.,* 2014). Chickens with coccidiosis suffer from intestinal tissue damage that consequently results in lower feed intake, interference with normal digestion and nutrient absorption, and chickens quickly become less productive (Pangasa *et al.*, 2007; Nematollahi *et al.*, 2009). The negative consequence of gastrointestinal parasites in the poultry industry occupies an important place in reducing the provision of high-quality animal protein (meat and egg), manure for crops and role in the national economy as revenue and provides employment (Nnadi and George, 2010; Roy, 2013; Nghonjuyi *et al.*, 2014; Quiroz-Castañeda and Dantán-González, 2015).

The present coccidia prevalence rate was very close to that reported in Addis Ababa (Shubisa *et al.*, 2016), Kombolcha poultry breeding and multiplication center (Abadi *et al.*, 2012) and in central Ethiopia (Hagos *et al.*, 2004) poultry farms. The present percentage prevalence was higher than in Nekemte town (Firamye *et al.*, 2015) and in and around Ambo town (Diriba *et al.*, 2012). A higher prevalence was also reported in other places (Getachew *et al.*, 2008; Dinka and Yacob, 2012; Hadipour *et al.,* 2013; Sharma *et al.*, 2013; Hadas *et al.*, 2014). The variation in prevalence may be due to differences in agroecology of the study areas which affects the epidemiology of coccidian infection, immunity against coccidiosis and differences in management systems (Olanrewaju and Agbor, 2014; Alemayehu *et al.,* 2012).

Table 1. The overall prevalence of *Eimeria* oocytes and gastrointestinal nematode parasites of chickens

Parasites	No. examined	Total infected	Prevalence (%)
Eimeria oocytes	450	122	27.1
Ascaridia galli	450	167	37.1
Heterakis gallinarum	450	47	10.4
Dispharnx	450	9	2
Mixed (E+N)	450	42	9.3
Mixed (A+H)	450	25	5.6

A= Ascaridia galli; H= Heterakis gallinarum; E= Eimeria oocytes; N= All nematodes.

The mean oocyst per gram count of *Eimeria* oocytes was higher in exotic breed chicken than local chicken (Table 2). In the present study, out of 122 chickens positive for coccidia oocyst, 96.7% of the chickens had light infections while the rest 1.6% each had moderate and heavy infections (Table 3). A similar rate of infection was reported by Getachew *et al.* (2008) who reported a higher prevalence in exotic breeds (25.10%) than local breeds (12.41%). Several researchers also reported a high degree of coccidian infection in exotic breed chickens as compared to the free-range local chickens (Jatau *et al.*, 2012; Diriba *et al.,* 2012: Firamye *et al.*, 2015). This could be due to the exotic chickens being reared in confinement and were likely to be most exposed to the infective stages of the organism in litters and feeds while the local breeds of chickens were usually found roaming and scavenging around the surroundings. They may not come into contact with the infection or may not ingest the infective stages of the organism (Hagos *et al.*, 2004; Shirzad *et al.*, 2011).

Table 2. Mean egg per-gram excretion of gastrointestinal nematode parasites and *Eimeria* oocytes of chickens from the study area

Parasites	Mean ± SEM		Min and Max No. counted
	Local	Exotic	
Eimeria oocytes	148.5±35.7	1,723±518	50-48,000
Ascaridia galli	716±94.8	0	50-15,600
Heterakis gallinarum	76.5±20.3	0	50-5,000
Dispharnx	12.04±7.4	0	100-2,200

Min= Minimum, Max= Maximum number counted eggs.

Table 3. Degree of infection based on the oocyst per gram of feces count

Oocytes count range	Degree of infection	No chickens	Percentage
<10.000 oocytes	Light	118	96.7
10,000-15,000 oocytes	Moderate	2	1.6
>15,000 oocytes)	Higher	2	1.6

Exotic chickens harbored high percentage (48.4%) of coccidia compared to the indigenous chickens (18.8%) (p =0.001, COR 0.3) (Table 4). A similar pattern of prevalence was reported by different scholars (Getachew *et al*., 2008; Jatau *et al*., 2012; Diriba *et al.,* 2012; Firamye *et al*., 2015; Quiroz-Castañeda and Dantán-González, 2015) who also reported a high prevalence of coccidian infection in exotic breed chickens as compared to the local free-range chickens. This may be due to intensive management of exotic chickens and disease pathogenesis which is influenced by host genetics, nutritional factors, concurrent disease, and species of Eimeria (Jordan *et al.,* 2002; Mcdougald, 2003).

The prevalence of coccidia was 24.4% and 30.6% in the extensive and intensive management system, respectively (Table 4). The result is consistent with reports of Taylor *et al.* (2007), who stated coccidiosis was the most common problem to chickens kept under an intensive management system. Management of poultry houses plays a significant role in the spread of coccidiosis because coccidial oocysts have high sporulation potential and easily spread in the poultry house environment which leads to infection in susceptible chicken (Adhikari *et al.,* 2008; Dakpogan and Salifou, 2013).

Chickens of young age (29.4%) had a higher prevalence of coccidia than the older age group (24.8) but the difference is not statistically significant (Table 4). The result concurrence with previous reports (52.9%, 36.7%, Muazu *et al.,* 2008) and (68.1%, 37.5%, Hadas *et al.,* 2014) in young and adult birds, respectively. Moreover, several studies also reported the predominance of coccidial infection among younger age chicken than adults (Diriba *et al.,* 2012; Bachaya *et al.,* 2012; Ali *et al.,* 2014; Lawal *et al.,* 2016). The high infection in the young could be due to underdeveloped immunity in the young. Adult birds could have developed acquired immunity to infection due to previous repeated exposure with several coccidia species in the litter (Chapman *et al.,* 2005). Contrary to the present study, a higher prevalence rate was recorded in adult chickens (Dakpogan and Salifou 2013; Bachaya *et al.,* 2015).

Table 4. Prevalence of coccidiosis based on animal's related factor and management factors

Variables	Category	No. examined	Positive	Prevalence	χ^2	p- value	COR	95% CI	
								Lower	Upper
Sex	Male	168	46	27.4%	0.01	0.921	1.02	0.7	1.6
	Female*	282	76	27%					
Age	Adult	222	55	24.8 %	0.9	0.2	1.24	0.8	1.9
	Young*	228	67	29.4%					
Breed	Local	324	61	18.8%	38.7	0.001	0.3	0.2	0.4
	Exotic*	126	61	48.4%					
Managements	Intensive	126	40	31.7%	0.5	0.48	1.2	0.6	2.2
	Semi-intensive	70	20	28.6%	0.2	0.6	0.86	0.4	1.6
	Extensive*	254	62	24.4%					
Study area	Haramaya	188	46	24.5%	0.2	0.64	0.9	0.5	1.4
	Bedeno	93	32	33.3%	1.3	0.25	1.4	0.8	2.4
	Gara Muleta*	169	45	26.6%					

**used as a reference category.*

The result reported a slight difference in nematode infection between different age groups (adult, 41.9% and young 40.4%) (Table 5) which was in agreement with previous studies of Permin *et al.* (2002), Solomon *et al.* (2016), and Solomon and Mekonnen (2017) who documented the presence of slight difference in the prevalence and severity of the parasites between young and adult chickens. Contrary to ours, the results of other studies have shown that young hens up to the age of 3 months are highly susceptible to nematode infections including *A. galli* (Idi *et al.,* 2004; Gauly *et al.,* 2005). The difference may be associated with sample size, age limit classification, and chicken management practices. In the current study chickens of all age groups were kept together.

The degree of infection with coccidia and GIN in different sex groups showed a nearly equal rate of prevalence (Table 4 and 5). In this study, coccidial infection was found to occur 27.4%, 27% in male and female chickens, respectively. This finding agrees with Firamye *et al*., (2015) who reported a 20.0% and 19.27% prevalence of coccidiosis in male and female chickens, respectively. Similarly, Diriba *et al.* (2012) also reported 21.43% and 19.38% prevalence in female and male chickens, respectively. Several scholars also reported consistent results in the occurrence of coccidiosis between male and female chickens (Alemayehu *et al.,* 2012; Hadas *et al.,* 2014; Olanrewaju and Agbor 2014; Jajere *et al.,* 2018). Nearly equal helminth infection between males (70.45%) and females (67.2%) was also reported by Solomon *et al.,* (2016). The absence of difference in the degree of infection between females and males might be due to an equal chance of risk exposure for the coccidiosis and GIN infection during feeding and watering.

Table 5. Prevalence of gastrointestinal nematodes based on animal's related factors and management factors

Variables	Category	No. examined	Positive	Prevalence	χ^2	P-value	COR	95% CI	
								Lower	Upper
Sex	Male	168	70	41.7%	0.01	0.92	1.04	0.7	1.6
	Female*	282	115	40.8%					
Age	Adult	222	93	41.9%	0.6	0.8	0.9	0.6	1.4
	Young*	228	92	40.4%					
Breed	Local	324	185	57.1%	119	0.001	0.4	0.38	0.49
	Exotic*	126	0	0 %					
Management	Intensive	126	17	13.5%	66.4	0.001	10.7	6	18.9
	Semi-intensive	70	9	12.9%	40.8	0.001	11.3	5.4	23.8
	Extensive*	254	159	62.6%					
Study area	Haramaya	188	100	53.2%	48.9	0.001	5.9	3.6	9.8
	Bedeno	93	58	62.4%	52.1	0.001	8.7	4.8	15.7
	Gara Muleta*	169	27	16%					

**used as reference category.*

Concerning the nematode infection, a high prevalence was observed in chicken reared in extensive than intensive management systems and the difference was statistically significant (p= 0.001, COR, 10.9) (Table 5). Infection of domestic birds with multiple helminth species is common in poorly managed poultries where birds are reared in large numbers without movement restrictions (Taylor *et al.,* 2007). Helimnthosis is considered to be an important problem of local chickens and incriminated as a major cause of ill-health and loss of productivity in different parts of Ethiopia (Hagos and Eshetu, 2004). This is due to the feeding habits of local chickens where chickens move from place to place in search of feed that includes various arthropods and earthworms that serve as the intermediate and paratenic hosts for most helminths of poultry (Soulsby, 1982). The local chickens used in this study were raised traditionally under extensive management with little or no supplementary feeding and without veterinary care. Consequently, these chickens might have high risks of harboring gastrointestinal helminths compared with other chickens managed under intensive systems.

Our study reported a 49.5% prevalence of nematode infection which was comparable with the 51.8% report of Solomon and Mekonnen (2017) and 46.9% of Kessewdeg *et al.* (2014). On the contrary, the result was higher than the 33.6% prevalence report of Beruktayet and Mersha (2016) in Hawassa and Shashemene towns. The variation in the prevalence may be associated with different factors such as the climatic condition of the study area, the incidence of the infective stages, availability of the intermediate host, and the season research is conducted. A high prevalence of parasites was observed; indicating that GIT parasites were a problem in the study area and there was no experience of providing prophylactic measures to control helminths.

Among reported nematodes*, A. galli* (37.1%) was the dominant nematode followed by *Heterakis gallinarum* (10.4%) and *Dispharnx* (2%) (Table 1). The finding was consistent with the finding of Solomon and Mekonnen (2017) who reported *A. galli* (28.6%) as a dominant nematode followed by *Heterakis gallinarum* (8.6%). In addition, studies showed *A. galli* is major intestinal helminth of free-range chickens worldwide and contributes to the raised rates of mortality in free-range chickens (Gomes *et al.,* 2009). Infection with *A. galli* also leads to severe pathological conditions when there is concurrent infection with other pathogens and is also reported in the transmission of Salmonella in chicken (Eigaard *et al.,* 2006). *H. gallinarum* is regarded as a relatively less pathogenic parasite (Taylor *et al.,* 2007) but its ability to transmit *Histomonas meleagridis*, the causative agent of 'Blackhead diseases', increases the importance of this nematode (McDougald, 2005).

Conclusion

This study showed that *Eimeria* and gastrointestinal nematodes are important parasites of chicken. Age, breed and management systems were among the risk factors associated with the occurrence of chicken coccidiosis and gastrointestinal nematodes. The findings also implied that coccidiosis was one of the most important diseases under intensive management, while nematodes infection was most important in an extensive management system. Generally, the low prevalence of coccidiosis and light infection in the study area indicated good poultry management practices, especially in intensive farms. *Ascaridia galli* was the dominant nematode affecting the health of poultry followed by *Heterakis gallinarum* and *Dispharnx*. Hence, integrated control strategies including awareness on the importance of the disease and possible factors that exacerbate the disease like environment, management factors and animal-related factors need to be carefully sorted out for strategic control.

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Conflict of Interests

The authors declare that they have no competing interests.

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