Gastrointestinal helminths and their predisposing factors in different poultry management systems; Haromaya, Ethiopia

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Abstract

Among several diseases, gastrointestinal parasites affect poultry production through retarded growth and reduced productivity. The severity varies according to management system and associated predisposing factors. Epidemiology of chicken gastrointestinal helminths were studied using coprological and necropsy examination, with the objectives to estimate the prevalence, identify species of helminths and associated predisposing factors in Haromaya town from November 2011 to April 2012. Fecal samples from selected chicken were collected from both intensive and extensive farms. Coprological examination on 384 chicken and 24 post mortem examinations were conducted. Out of 384 samples examined, 51.8% were positive of which a high prevalence of 110(28.6%) *Ascaridia galli* followed by 33(8.6%) of *Heterakis gallinarum,* 11(2.8%) of *Raillietina* species and 44(11.5%) mixed infection were recovered. Factors for the occurrence of GIT helminths were investigated using logistic regression models; where each assumed predisposing factor analyzed using uni-variable and followed by multi-variable logistic regression to determine the interaction and power of influence among factors. Accordingly, statistically significant difference ($p<0.05$) was observed when prevalence of helminths compared with breed, sex, age and management system separately using uni-variable logistic regression; whereas, when all predisposing factors subjected together using multi-variable backward stepwise analysis, it showed that the odds of local, Fayoumi and White Leghorn breeds had odds of (OR= 6.4, 50.8 and 6.9) more likely to be affected than Bovan Brown breed with significant difference ($p<0.05$). Male birds were 1.9 times more likely to be affected than female birds and birds in extensive management system were 2.8 times more likely to be affected than intensive farming system. The study indicated that gastrointestinal (GIT) helminths were more prevalent in extensive management system than in intensive management system, the finding was associated with poor management system or due to poor bio-security. Therefore, there is a need to improve hygienic situation, especially in area where extensive management system prevails.

Keywords: Gastrointestinal; Haromaya; Helminths; Poultry; Production systems;

Introduction

Unlike developed countries where poultry production is under intensive management system, 95% of poultry production in Ethiopia is under free scavenge production system (Anon, 2004; Dawit Abebe *et al.*, 2008). Currently due to policy shift towards privatization and mixed economy intensive poultry management is flourishing in certain institutions and private farms. A total of 56 million chickens are estimated to be present in the country (CSA, 2014/15). Urbanization and population growth has become a driving force for high poultry egg and meat demand in the country; whereas, modern production and management systems are at their infant stage in the country in general.

Beyond the source of food, poultry production is well known as an immediate cash source for rural community; where the community sale few numbers of chicken according to their cash need (Bremner and Johnston, 1996; Sainsbury, 1992). Rural poultry production is well integrated with other farming activities because they require little space, labor and initial investment compared to other farming activities; and plays a significant role in cultural and social life of rural people (Sonaiya, 1990).

Despite significant economic and nutritional contribution, quality management is still a major problem in this subsector. Consequently, an estimated 20% to 50% of mortality occurs due to various diseases (Alamargot, 1987; Alemu Yami, 1995). Among diseases, internal parasites are known to reduce productivity of poultry kept under different management systems. Infection of parasites exists after ingestion of helminths eggs or intermediate hosts like cockroaches, grass hoppers, ants and earthworms (Soulsby, 1986). Helminths infection results in reduction in food intake, injury to the intestinal wall and hemorrhage which causes poor absorption of nutrients and leads to weight loss (Soulsby, 1986). Particularly free scavenging chickens are infected with helminths because the environment can be easily contaminated by wild birds' droppings (Amin-Babjee *et al*., 1997; Magwisha *et al*., 2002).

Therefore, this study was designed to estimate gastrointestinal helminths prevalence and to determine predisposing factors in poultry farm managed under extensive and intensive management systems in Haromaya district.

Materials and Methods

Description of the study area

The study was conducted from November 2011 up to April 2012 within Haromaya district which is located in Eastern Ethiopia where Haromaya University exists. It is located 512 km away from Addis Ababa. The altitude is 2000 meters above sea level (m.a.s.l.) within 09^{0} 24' 10" E and 41^{0} 19' 58'N. The area have a relative humidity of 65% and annual rainfall of approximately 900mm; which includes bimodal distribution pattern, where short period rainfall is in March and April, whereas long rainfall is in July to September of the year (CSA, 2014/15).

Farmers practice mixed livestock and crop production. Among livestock production, free ranging poultry production is the most common practice; in addition, Haromaya University has intensive poultry farm in the study area.

Study population

Poultry of local and exotic breeds of both sexes and all age groups which were kept under different management systems in the study area were used. Study populations were all those chickens' from selected kebeles, intensive farm of Haromaya University and multiplication and distributing center of Haromaya Woreda Agriculture Office. Therefore, all free ranging poultry and two intensive production center were included for the sampling purpose. Among the exotic breeds found in the village White Leghorn was predominant. In most extensive farming system feeding style was scavenging whereas shelter was provided at night. Supplementary feed was given less frequently; major source of concentrate feed includes sorghum and maize, given in the morning and/or after noon and allowed to scavenge the whole day. Water was provided near shade area using container.

In case of intensive farming system, chickens were kept indoor with medium to high bio-security. Feeding and watering of these birds were done via common trough for both deep-litter and cage systems.

Study design and sample size determination

Cross-sectional study design was conducted, where snap-shot fecal sample collection and postmortem examination were used. Sample size was determined using formula given by (Thrusfield, 2005) for simple random sampling technique. No previously published data was available in this area; therefore, 50% expected prevalence and 5% desired absolute precision was taken to calculate the required sample size using the formula $n = 1.96^2 \times P_{exp} (1-P_{exp}) / d^2$; Where n= sample size, P_{exp}= expected prevalence, d= desired absolute precision, 1.96^2 = Z value at 95% confidence interval. Therefore, 384 fecal samples were collected and purposively 24 chickens were used for postmortem examination.

Sample collection and coproscopic examination

Fecal samples were collected using hand gloves directly from the vent or top surface of freshly voided feces and placed in airtight screw cup universal bottles. Samples were transported to parasitology laboratory of Haromaya University, College of Veterinary Medicine and stored at 4^oC until examined. During sample collection information about predisposing factors like breeds, sex, age and all other management systems were recorded for each collected sample. Age groups were categorized as young (<6months), middle age (between 6 months and one year) and older age (above 1 year up to 2.5 years) for the purpose of statistical analysis.

Samples were processed using floatation technique with saturated sodium chloride solution. Three grams of fecal sample were weighed and put into universal bottle and 42ml of floatation fluid was added then mixed thoroughly and allowed to settle in test tube, then presence or absence of egg was appreciated using cover slip on test tube method (Hendrix, 1998; Urquhart *et al.*, 1996). Identification of helminths was done using a standard microscope under 10X objective magnification and helminthological standard manual used for identification of helminths eggs in poultry (Soulsby,1986).

Data management and analysis

Data generated during the study period was entered into Microsoft Excel spread sheets and summarized using descriptive statistics. Further risk factors were analyzed using uni and multiple logistic regressions by STATA soft ware program; risk factor was considered significant when p-value was less than 0.05.

Results

Prevalence and species of helminths identified

In the present study, an overall prevalence of 51.8% of GIT helminths was observed (Table 1). Out of 384 fecal samples examined 110(28.6%) *Ascaridia galli*, 33(8.6%) *Heterakis gallinarum*, 11(2.8%) *Raillietina spp*, 1(0.26%) *Syngamus trachea* and 44(11.5%) were mixed infection with two or more species of helminths mentioned above were observed as shown in Table 2.

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Table 1. Prevalence of gastrointestinal parasites of poultry under extensive and intensive management system

Farming system	No examined	Positive	Prevalence (95%CI)	X^2	p-value
Cage	58	8	13.8[6.6,25.1]		
Deep-litter	134	57	42.5[34.1,51.4]	54.9	0.00
Backyard	192	134	69.8[62.7,76.0]		
Total	384	199	51.8[46.7,56.9]		

The study result revealed that there was significant difference ($p<0.05$) between intensive and extensive management system, (where intensive management were categorized as cage and deep-litter system, whereas extensive management were termed as backyard system). Therefore, the prevalence of 13.8%, 42.5% and 69.8% was observed in cage, deep-litter and backyard management systems, respectively. Parasite infection under different management systems indicates that cage system had only *Ascaridia galli* species of helminths, whereas both deep-litter and backyard harbored different parasite species as shown in Table 1&2.

Table 2. Different GIT helminths parasites recovered in the fecal examination under different management system

			Species of helminths observed				
Housing system	**no.**	**Positive (%)**	***Syngamus***	***A. galli***	***H.gallin arum***	**Raillie tina spp**	**mixed infection***
Cage	58	8(13.8%)	-	8	-	-	-
Deep-litter	134	57(42.5%)	-	29	11	6	11
Backyard	192	134(69.8%)	1	73	22	5	33
Total	384	199(51.8%)	(1) 0.25%	110(28.6%)	33(8.6%)	11(2.9%)	44(11.5%)

*= indicates infection of two or more helminths co-existence

Prevalence of helminths as compared with biotic risk factors

Prevalence was analyzed using uni and multi variable logistic regression against breeds, sex, and age. It has indicated that all breeds were more or less infected by different helminths species and there was no refractory breed in the study. However there was prevalence difference among breeds.High prevalence was recorded in local breeds followed by White Leghorn, then followed by Fayoumi and Bovan Brown with prevalence of 40(95.2%), 133(57.4%), 16(37.1%) and 10(13.5%), respectively. High prevalence was observed in males 79(71.8%) than in females 120(43.79%). Among age groups older chickens' had higher prevalence 90(66.17%), followed by middle age group with prevalence of 84(49.4%) and low prevalence 25(32.5%) was observed in young age group. The finding was significantly different ($p<0.05$) among different breeds, sexes, age groups and management systems (Table 3).

Table 3. Logistic regression analysis of prevalence of GIT helminths compared with biotic factors

Factor	Examined	Positive	Prevalence (95%CI)	OR 95%CI	p-value
Breed					
Bovan Brown	74	10	13.5[7.0,23.9]	1	
White Leghorn	233	133	57.1[50.4,63.4]	8.5[4.2,17.4]	0.00
Fayoumi	35	16	45.7[29.2,63.1]	5.3[2.1,13.8]	0.00
Local	42	40	95.2[82.1,99.1]	128 [26.7,614.5]	0.00
Sex					

Factor	Examined	Positive	Prevalence (95%CI)	OR 95%CI	p-value
Female	274	120	43.8[37.8,49.8]	1	
Male	110	79	71.8[63.3,79.7]	3.2 [2.02,5.28]	0.00
Age group					
< 6 months	78	25	32.1[22.1,43.7]	1	
6≤ 1 year	170	84	49.4[41.7, 57.9]	2.0 [1.17,3.63]	0.01
1 < 2 ½ year	136	90	66.2[57.4,73.9]	4.1 [2.29,7.50]	0.00

Prevalence of gastrointestinal parasite when compared with abiotic factors: The prevalence of gastrointestinal parasite was compared against abiotic factors like watering, feeding, bedding and frequency of litter cleaning using univariable logistic regression as shown in Table 4.

Table 4. Comparison of prevalence of GIT helminths with abiotic factors using univariable logistic regression analysis

Management system	No. examined	Positive	Prevalence (95% CI)	OR(95% CI)	P. value
Farming system					
Intensive	192	65	33.9[27.3,41.0]	1	
Extensive	192	134	69.8[62.7,76.0]	4.5 [2.9,6.9]	0.00
Watering system					
Water trough	134	57	42.5[34.1,51.3]	1	
Water pipe	58	8	13.8[6.5,25.6]	4.7[2.0,11.1]	0.00
Scavenge	192	134	69.8[62.7,69.0]	3.1 [1.96,4.9]	0.00
Feeding system					
Feed trough	134	57	42.5[34.1,51.3]	1	
Cage system	58	8	13.8[6.5,25.6]	4.7[2.0,11.1]	0.00
Scavenging	192	134	69.8[62.7,76.0]	3.1[1.9,4.9]	0.00
Frequency of cleaning					
3-6 month	134	57	42.5[34.1,51.4]	1	
Daily	58	8	13.8[6.5,25.9]	0.2 [0.09,0.49]	0.00
Irregularly	192	134	69.8[62.7,76.0]	3.2[1.96,4.94]	0.00
Fecal consistency					
Semi solid	257	124	48.2 [42.0,54.5]	1	
Soft	120	71	59.2[49.8,67.9]	1.5 [1.0,2.4]	0.04
Diaharric	7	4	57.1[20.2,88.1]	1.4 [0.3.6.5]	0.64

It was observed that all considered risk factors showed significant difference ($p<0.05$). Multi variable backward stepwise analysis using logistic regression showed that few risk factors were significantly different ($p<0.05$), whereas others were dropped out due to co-linearity. Feeding, watering, frequency of cleaning, bedding and age group were dropped. Therefore, predisposing factors like local breeds, Fayoumi, White Leghorn, male, and extensive management showed statistically significant ($p<0.05$) differences. The odds of local, Fayoumi and White Leghorn breeds (OR= 6.4, 50.8 and 6.9) were more likely to be affected than Bovan Brown breed. Male birds were affected with odds of 1.9 times more likely than female birds, whereas birds in extensive management system were affected with odds of 2.8 times more likely than intensive farming system as shown in Table 5.

Table 5. Multivariable logistic regression analysis of biotic and abiotic risk factors as compared with prevalence of GIT helminths

Risk factor	n	Positive	%, 95%[CI]	Adjusted OR,95%[CI]	p-value
Breed					
White Leghorn	233	133	57.1[50.4,63.4]	6.9[2.6,18.7]	0.00
Fayoumi	35	16	45.7[29.2,63.1]	50.8[10.1,254.2]	0.00
Local	42	40	95.2[82.1,99.1]	6.4[3.1,13.4]	0.00
Sex					
Male	110	79	71.8[63.3,79.7]	1.9 [1.12,3.26]	0.01
Extensive farming	192	134	69.8[62.7,76.0]	2.8 [1.7,4.7]	0.00

Post-mortem findings

Twenty four chickens (nine from backyard and 15 from deep-litter management systems) were examined for helminths infection, thirteen were positive for different types of helminths; which showed 54% of prevalence based on adult worm recovery and it was almost similar to that of coproscopic finding (51.8%). The findings of postmortem examination revealed a prevalence of 29.2% *A. galli*, 12.5% *H. gallinarum*, 4.2% *Raillietina* spp. and 8.3% mixed infection. The prevalence of species of parasite recovered from necropsy was in consistent with the findings of coproscopic examination.

Discussion

In this study the overall prevalence of GIT helminths was 51.8% and 54% based on coprological and post mortem examination, respectively. The finding of the present study is higher than 33.5% reported by (Irungu *et al*., 2004) in South Eastern Kenya. The difference in prevalence might be due to management and agro-climatic variation in the two study areas.

In this study *Ascaridia galli* with prevalence of 28.6% and *Heterakis gallinarum* 8.6% followed by mix of nematode and *Raillietina spp* 11.5%, and *Raillientina* spp alone 2.8% were identified. The same trend in prevalence was observed in necropsy finding. Even though coproscopic examination is less sensitive to diagnose than adult worms count, high prevalence of parasite was observed, which indicates that GIT parasites were a problem in the study area and there was no experience of providing prophylactic measure to control helminths. Similar findings of *A. galli* and *H. gallinarum* followed by cestode spp were recorded by (Permin *et al.,* 1997; Birhanu Mekibib *et al.,* 2014), but high cestode spp followed by nematodes recovered by Irungu *et al.,* (2004). Only *A. galli* spp and different cestode spp have been identified in semi-intensive management system at Debre Zeit agricultural research center by (Yacob Hailu and Hagos Ashenafi, 2013). This variation in prevalence by different researchers might be due to management and ecological variation in respective study areas.

There was a significant difference in the prevalence of GIT nematode (*Ascaridia galli* and *Heterakis gallinarum*) and cestode (*Raillietina* spp) in deep-litter and backyard than cage system. In cage system only *A. galli* with low prevalence of 13.8% was observed. Similar findings were observed by (Permin *et al.,* 1995), where free ranging and deep-litter chicken had high prevalence of nematodes and cestode spp. than in cage system. Birhanu Mekibeb *et al.,* (2014) have reported high prevalence of nematode species from scavenging chickens in outskirts of Hawassa town. Current and previous studies confirmed that there is high prevalence in backyard and deep-litter management system than cage system, which indicated the role of hygienic management that play significant impact to increase productivity of poultry. Different predisposing factors like breed, sex, extensive management system had statistically significant ($p<0.05$) differences in the prevalence of GIT nematode and cestode parasites. However, breed and sex might be confounding factors of management system, as these biotic factors have no biological plausible effect on infection, but it requires further study to verify the findings in this study.

Among the breeds of chicken examined lower prevalence was observed in *Bovan Brown*, this could be also a confounding factor since most of these *Bovan Brown* breed samples were collected from cage system and most of the other breeds were sampled from deep-litter and backyard systems. Therefore, difficult to conclude *Bovan Brown* breed of chickens appear to be resistant to GIT parasites. In cage farming system which has relatively good hygiene, regular cleaning, chickens are less exposed to infective larval stage and that might be the main factor for low prevalence in this breed, but it is still important to verify the finding through further research.

There was significant difference between male and female chickens in the prevalence of GIT helminths. This may be due to management factor because most of the female chickens were sampled from cage system. Almost all males were sampled from backyard production system which can lead to expose more to contaminated feed, intermediate host than caged ones. Therefore, sex couldn't be a contributing factor rather it is confounder. Among the age groups the adult chicken had higher prevalence than middle and young age groups. This could be due to the adult chickens that might be exposed repeatedly for infective larval stage, coupled with backyard management system that might have contributed for higher prevalence in older age group than younger groups.

The management system like watering, feeding, bedding and frequent cleaning of the litter are confounding factors; where feeding, watering and cleaning varies according to the management systems. Cage system has better hygienic activity in feeding, watering and cleaning than backyard. Bedding system also directly coincides with management system, where deep-litter and backyard management being relatively unhygienic than cage system. Logistic regression shows that the odds of deep-litter and backyard systems were (OR=4.6; CI= [2.0, 10.5]) and (OR=3.1; CI= [1.9, 4.9]), respectively; more likely to be exposed for high prevalence of helminths than cage system.

Previous studies indicate that there was high prevalence of *Ascaridia galli* 69% in Iran, 90.7% in Kenya and 88.7% in Bangladesh as reported by (Ananda *et al.,* 2008, Eslami *et al.,* 2009; Kaingu *et al.*, 2010) respectively. However, in this study there was lower prevalence (28.6%); this may be due to sampling technique where the current study was conducted using fecal samples, whereas most other studies were conducted using adult worms' count, through post mortem examination, which is more sensitive and gold standard than egg count.

Ascaridia galli has a major effect on the health of chicken sharing feed from one source, thus cause stunted growth and low productivity as the result of intestinal mucosa damage (Gordon and Jordan, 1982; Soulsby, 1986; Permin *et al.,* 1995). *Heterakis gallinarum* was recorded as the second most prevalent nematode species in this study. It was lower when compared with that of (Irungu *et al.,* 2004) in Kenya (21.3%), (Hagos Ashenafi and Eshetu Yimer, 2002) in the central Ethiopia (24%). This may be due to differences in management (Indoor, outdoor, feeding, bedding etc) and favorable condition for the survival and transmission of infective larval stages as well as availability of intermediate hosts.

Heterakis gallinarum itself has very little to no pathogenic effect in chicken but plays a major role in the epidemiology of Histomoniasis. Eggs of *Heterakis gallinarum* contain *Histomonas meleagridis* and ingested by young, will cause histomoniasis (black head) (Gorden and Jordan, 1982; Soulsby, 1986; Urquhart *et al.,* 1996). The third prevalent GIT helminth parasite in the study area was cestode mixed with helminths. It was lower than the report by (Hagos Ashennafi and Eshetu Yimer, 2002) in central Ethiopia 86.32%, (Kaingu *et al*.,2010) in Kenya 13.24% and (Haider *et al.,*1999) in Pakistan 16.0%. The major difference could be due to sampling technique, where coproscopic examination was used in this study. Though, the number was small, post mortem examination has also revealed consistent result in prevalence. Therefore, ecology and season of the study period might have affected the occurrence of the parasite in different study areas.

Conclusion and recommendations

Despite the significant role of poultry production as a source of animal protein and immediate cash income generation, both intensive and extensive poultry production systems in the study were highly exposed with high parasitic burden; which of course leads to low area productivity. Especially in deep-litter and free scavenging management systems there were high parasites prevalence. In addition significant prevalence difference was observed in certain assumed predisposing factors.. Therefore, the present study clearly indicates that chicken kept under intensive production system had a better bio-security than extensive farming system. On the other hand, those kept under extensive production system might have been highly exposed to infective stage larvae or intermediate host due to their free scavenging nature. Further study involving the role of predisposing factors should be conducted. In addition, proper sanitation and good husbandry practices should be employed to interrupt the life cycle of gastrointestinal parasites of poultry. Furthermore, traditional poultry production system has to be improved into small scale intensive farming system inorder to leverage the existing poor production output.

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