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Gastrointestinal helminths of backyard chickens in selected areas of West Shoa Zone Central, Ethiopia

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ABSTRACT

Gastrointestinal parasites of chickens are prevalent in many parts of the world including Ethiopia. This study was conducted with backyard chickens in Ambo, Holeta and, Dire Inchini in the West Shoa zone with the objectives of estimating the prevalence of gastrointestinal helminth infections, identifying the species present and determining associated risk factors. A cross-sectional study was conducted using 252 chickens purchased from local markets. Chickens were killed humanely and gastrointestinal tracts were examined for adult helminths. Identification of the helminths was performed using morphology and microscopy. The overall prevalence of helminth parasites in chickens was 92.1% (232/252) [95% confidence interval (CI): 88.0% - 95.1%]. 80.2% (204/252) [95% CI: 75.3% - 86.9%] and 77.8% (196/252) [95% CI: 72.1% - 82.8%] of chickens were infected with diverse nematode and cestode species, respectively. Parasitological examination revealed the presence of three nematode and five cestode species. *Ascaridia galli* (69.8%) and *Heterakis gallinarum* (13.5%) were the dominant nematode species and *Railletina tetragona* (54.0%) and *Railletina echinobothrida* (46.8%) were the most prevalent species of cestodes identified. A significant difference ($p < .05$) was observed between the prevalence of nematode parasites and sex, age, and origin of the chicken. Similarly, sex and origin of the chickens were significantly different with the prevalence of cestode infections. Higher prevalence was observed in male versus female chickens, in young versus adult chickens and in chickens from Holeta and Direinchin compared to Ambo. In contrast, weight, health status, diarrhea status, and age (for cestodes) were not significantly associated with nematode and cestode infection. In conclusion, the present study detected a high prevalence of diverse types of gastrointestinal helminths in backyard chickens, which could result in poor health and reduce productivity. Therefore, the present study strongly suggests appropriate and strategic control of helminthiasis to improve the health and output of backyard chickens in the study areas.

1. Introduction

Chickens play an important role in the provision of animal protein in the form of eggs and meat and other socio-economic benefits especially for rural communities (Matur, 2002). Backyard chickens contribute over 70% of poultry products and 20% of animal protein intake in Africa. In Ethiopia, the chicken population is estimated to be 56.87 million, of which 95.86%, 2.79% and 1.35% were reported to be indigenous, hybrid and exotic breeds, respectively. With regard to management systems, indigenous chickens are kept under the traditional backyard system, whereas hybrid and exotic chickens are raised under relatively improved management systems (CSA, 2015).

Reduction in the prevalence of most parasitic diseases of poultry has been achieved in intensive poultry farming systems, mostly due to improved housing, hygiene and management practices (Zeryehun et al., 2012). As opposed to intensive poultry farming systems, the prevalence of parasitic infection is high and widely distributed in rural backyard chickens (Hunduma et al., 2010), which signifies that chickens under backyard husbandry systems are exposed to parasitic infections.

Gastrointestinal helminth infections in chickens are widespread in many parts of the world including Ethiopia. Nematodes constitute the most important helminths infections of poultry in the extent of damage they cause. The main nematode genera include *Ascaridia, Heterakis* and *Capillaria* (Jordan et al., 2002), among which *Ascaridia galli* and

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Heterakis gallinarum are the most common species causing considerable losses when large numbers are present. The cestodes of significant importance are *Raillietina, Davainea,* and *Hymenolepis* (Simon and Emeritus, 2005). Of these, *Davainea proglottina* and *Raillietina echinobothridia* are the most pathogenic species. *Davainea proglottina* is highly pathogenic due to toxic metabolic waste products, whereas *R. echinobothridia* causes multiple nodules and hyperplastic enteritis at the attachment site. The life cycle of tapeworms requires intermediate hosts, usually beetles, snails, slugs and flies. Birds are infected by thousands of infectious worms after ingestion of only a few intermediate hosts such as snails or slugs (Pam et al., 2006; Luka and Ndams, 2007).

Investigation on the occurrence and identification of helminths in indigenous chickens under backyard systems is essential for understanding the epidemiological situation and for formulating effective preventive and control measures. However, there is lack of information regarding the prevalence of gastrointestinal helminth parasites of chickens in West Shoa Zone, Central Ethiopia. Therefore, the objectives of this study were to estimate the prevalence of gastrointestinal helminths of backyard chickens, to identify the most common species infecting indigenous chickens and to identify the possible risk factors.

2. Material and methods

2.1. Study area

The study was conducted in selected areas of West Shoa Zone, Central Ethiopia, from January 2016 to April 2017. The study sites were areas around the towns Ambo, Dire Inchini, and Holeta. Ambo is the administrative centre of the Zone, located 114 km West of Addis Ababa at an altitude of 2101 m above sea level (masl). Holeta is located 40 km west of Addis Ababa at an altitude of 2391 masl. and Dire Inchini is located 154 km west of Addis Ababa at an altitude of 2450 masl. In these areas, backyard chicken production is the most dominant, even though there are some initiations for introduction of exotic chickens in and around urban areas of the zone. Semi-intensive management systems are commonly employed for cross breed/hybrid egg laying types and a very few pure exotic chicken breeds are kept under an intensive management system (ATMA, 2010). The chicken population of each district in West Shoa Zone is approximately 350,000 to 500,000 (Etefa and Debaba, 2011).

2.2. Study population and study animals

The study population consisted of indigenous chickens reared in backyard systems in the study areas. The study animals were chickens brought for sale to open air markets by farmers from rural areas around Ambo, Dire Inchini, and Holeta. Chickens of both sexes (160 female and 92 male) and both age groups (82 young and 170 adult) were included in the study. Age of the chickens was determined through observation of color of the shank and growth of the spur and grouped as young/growers (4–12 weeks of age) and adult (> 12 weeks of age) as per Carol and Peter (2005).

2.3. Study design and sample size determination

The design of the study was cross-sectional. The required sample size was determined according to the formula of Thrusfield (2005) with expected prevalence of 91.5% (Eshetu et al., 2001) and desired absolute precision (d) = 0.05 at 95% confidence level. Accordingly, the calculated sample size was 113 chickens; to increase the precision a total of 252 chickens were purchased and transported to the veterinary parasitology laboratory of Ambo University for postmortem and parasitological examination.

2.4. Sample collection and examination procedure

Chickens were selected using systematic random sampling. Chickens were physically examined for any clinical signs of disease and categorized into apparently healthy and clinically sick (manifestations such as depression, diarrhea, etc.) with 82 apparently health and 170 clinically sick chickens purchased. Information about purchased chickens such as health status, whether diarrheic or not, age, sex, breed, and origin were recorded. After purchase, chickens were transported to the veterinary parasitology laboratory of Ambo University where they were euthanized via cervical dislocation. Necropsy was performed according to the standard procedures described by Lowenstine (1986). For the purpose of working on fresh samples only limited number of chickens (maximum of six) were purchased and killed per day.

Following evisceration, the viscera separated from the mesentery were separated into three sections: the esophagus and crop, gizzard with proventriculus and caeca and intestine. Each section was then incised longitudinally and adult worms visible macroscopically were collected using thumb forceps and the contents placed in separate beakers containing physiological saline. The mucosa of each section was washed to remove any adhering worms and added to the container containing intestinal contents, which were then sieved with the backwash collected onto petri dishes. Worms collected from each chicken were fixed in 70% ethanol alcohol and then separately stored in 10% formalin for later evaluation. The parasites were examined under stereomicroscope or low power microscopy (10×). To facilitate subsequent identification, worms were cleared with lactophenol and examined under higher magnification (40×). Identification of helminth parasites was carried out using the characteristic features described in Soulsby (1982).

2.5. Data management and analysis

The data were analyzed using STATA version 11.0 for Windows (Stata corp. College Station, TX, USA). Descriptive statistics were used to summarize the data. Prevalence was calculated by dividing the number of chickens positive for helminth parasites by the number of chickens examined and multiplied by 100. Chi-square test was used to analyze the association of putative risk factors such as sex (male, female), age (young, adult), origin (Ambo, Holeta and Dire Inchini), weight (< 1 kg, 1–1.5 kg. ≥1.5 kg), health status (clinically sick with manifestations such as depression, diarrhea, etc., and apparently healthy) and diarrheic status of the sick (diarrhea present, absent) with gastrointestinal helminth infection. In all the analyses, confidence level of 95% and significance level of $\alpha \leq 0.05$ were used.

2.6. Ethical considerations

Permission for this study was obtained from the Ambo University Animal Research Ethics Review Committee (ARERC) and conducted under the approved protocol Ref. No. RD/AREC/003/2015.

3. Results

Helminth parasites were collected from intestines and caeca but no helminths were found in the esophagus, crop, proventriculus, and gizzard. There were also no trematode species observed in any of the portions examined. The overall prevalence of helminth infection in the 252 chickens necropsied was 92.1% [95% confidence interval (CI): 88.0%, 95.1%]. Of the total chickens examined, 80.2% [95% CI: 75.3%, 85.1%] and 77.8% [95% CI: 72.1%, 82.8%] had nematode and cestode infections, respectively, while 65.9% [95% CI: 60.1%, 71.8%] had co-infections of nematodes and cestodes (Table 1).

Among the nematodes, *Ascarida galli* (69.8%), *Heterakis gallinarum* (13.5%) and *Cappillaria* species (5.6%) were detected. *Raillietina tetragona* (54.0%) was the most prevalent cestode identified followed by

Table 1
Overall prevalence of gastrointestinal helminth parasites in chickens in the study area ($N = 252$).

Helminth	Infection status	Number of chickens positive for helminths	Prevalence (%)
Nematode species	Infection with single species	152	60.3
	Infection with multiple species	52	20.6
	Total nematodes	202	80.2
Cestode species	Infection with single species	104	41.3
	Infection with multiple species	92	36.5
	Total cestodes	196	77.8
Helminths	Nematode only	36	14.3
	Cestode only	30	11.9
	Nematode + Cestode	166	65.9
	Total helminths	232	92.1

Table 2
Gastrointestinal nematode and cestode species of chickens in the study area (N = 252).

Helminth parasites	Helminth species	Number of positive chickens	Prevalence (%)
Nematode	*Ascarida galli*	176	69.8
	Heterakis gallinarum	34	13.5
	Cappillaria species	14	5.6
Cestode	*Raillietina tetragona*	136	54.0
	Raillietina echinobothridia	118	46.8
	Raillietina cesticillus	40	15.9
	Davainea proglotina	42	16.7
	Choanotaenia infundibulum	37	14.7

Raillietina echinobothridia (46.8%), *Raillietina cesticillus* (15.9%), *Davainea proglotina* (16.7%), and *Choanotaenia infundibulum* (14.7%) (Table 2).

The prevalence of nematode infection showed significant association ($P < .05$) with sex, age and origin of the chicken. Accordingly, higher prevalence was observed in males (91.3%) than females (73.5%), in young (90.2%) than adult chickens (75.3%), and in Holeta and Dire Inchin (86.7%) than Ambo (74.2%). There was no significant difference in the prevalence of nematode infections with weight, health status and diarrhea status ($P > .05$) (Table 3). Similarly, presence of a cestode infection showed significant association with sex and origin with males (84.8%) higher than females (73.8%) and chickens in Holeta and Dire Inchin (83.3%) higher than in Ambo (72.7%). No significant difference was observed with the age, weight, health and diarrhea status of chickens ($P > .05$) (Table 3).

4. Discussion

A total of eight species of gastrointestinal helminths were encountered in this study. Mixed infection with different helminth parasites was common. Similar findings were reported by Eshetu et al. (2001). The present study revealed relatively high overall prevalence of gastrointestinal helminths (92.1%) in indigenous chickens raised under a backyard system. This finding was lower than the reports of Yousfi et al. (2013) who found 100% prevalence from southern Ethiopia and Algeria, respectively. The current finding was almost similar to the report of Eshetu et al. (2001) and Ashenafi and Eshetu (2004), who reported a prevalence of 91% from northeastern Amhara Regional State, and 86.3% from central Ethiopia, respectively. Much lower than the present finding (42.5%) was reported by Jegede et al. (2015) from backyard chickens in Nigeria and 10.5% by Offifiah et al. (2012) for broiler chickens in Trinidad. The discrepancies in prevalence of gastrointestinal helminths of chickens in these studies could be related to the different chicken management systems, study methods, sample size and parasite control practices employed among the studied localities. The higher prevalence of gastrointestinal helminths in the study reported here could be due to the management system. The chickens were obtained from a backyard system with little or no supplementary feeding and no veterinary care. Therefore, chickens are scavenging daily to meet their nutritional need and under continual exposure to infective helminth stages and their intermediate hosts such as the arthropods (Yousfi et al., 2013).

The prevalence of *A. galli* (69.8%) in the present study was in line with the prevalence report of 69.0% from Tanzania (Magwisha et al., 2002), 69.5% from across Europe (Thapa et al., 2015) and 71.6% from Addis Ababa, Ethiopia (Abebe et al., 1997). However, it is higher than the 35.6% prevalence reported from Ethiopia (Eshetu et al., 2001). The prevalence of *H. gallinarum* in the hindgut (13.5%) was nearly comparable to the 17.3% prevalence in Ethiopia (Eshetu et al., 2001) but

Table 3
Association of potential risk factors for gastrointestinal nematode and cestode infection in chickens in the study area.

Factors	Category	No. examined	Nematode infection			Cestode infection		
			No. positive (%)	X^2	*P*-value	No. positive (%)	X^2	P-value
Sex	Female	160	118(73.5)	11.32	0.001	118 (73.8)	4.11	0.043
	Male	92	84(91.3)			78(84.8)		
Age	Young	82	74(90.2)	7.77	0.005	68(82.9)	1.86	0.172
	Adult	170	128(75.3)			128(75.3)		
Origin	Ambo	132	98(74.2)	6.10	0.014	96(72.7)	4.09	0.043
	Holeta & Dire Inchini	120	104(86.7)			100(83.3)		
Weight	< 1 kg	74	64(86.5)	2.84	0.241	64(86.5)	4.62	0.099
	1to1.5 kg	138	108(78.3)			102(73.9)		
	> 1.5 kg	40	30(75.0)			30(75.0)	0.005	0.943
Health status	Clinically sick	170	134(78.9)	0.58	0.444	64(78.0)		
	Apparently healthy	82	68(82.9)			132(77.6)	0.000	1.00
Diarrhea	Absent	126	98(77.8)	0.89	0.343	98(77.8)		
	Present	126	104(82.5)			98(77.8)		

less than the prevalence of 32.6% in central Ethiopia (Ashenafi and Eshetu, 2004) and 21.3% in Kenya (Ondwassy et al., 1999). The variation might be due to differences in management systems, deworming practice and agro-ecological conditions of the study areas.

The most prevalent cestode recorded in the study area, *R. tetragona* (54.0%), was similar to the 56.5% prevalence reported from Eastern Shoa Zone of Ethiopia (Hussen et al., 2012). The prevalence of *R. echinobothrida* (46.8%) was higher than the 25.8% prevalence reported from Amhara regional state (Eshetu et al., 2001). Prevalence of *R. cesticillus* (15.9%) was higher than the 5.6% prevalence previously reported from Ethiopia (Eshetu et al., 2001) and the 2.0% prevalence reported from Ghana (Poulsen et al., 2000).

Analysis of risk factors for nematode and cestode infections did show significant variation with sex, age and origin. The significant difference ($P < .05$) in the prevalence of gastrointestinal nematodes and cestodes in male and female chickens was partially in agreement with reports from Mpoame and Agbede (1995), Abdelqader et al. (2008) and Zeryehun et al. (2012). Other reports indicate that there is no natural affinity of gastrointestinal nematode species to males versus females (Permin and Hansen, 1998; Hussen et al. 2012). According to Martin et al. (1987) sex differences might be due to some hormonal differences. It could also be due to nutritional deficiency in male chickens, as most farmers in the region have a practice of throwing some grain to hens when they start laying to obtain more eggs. Another explanation could be disproportionate sampling with more females examined in this study than males.

In the current study nematode infections were significantly higher in younger chickens, which is in agreement with reports from some African countries (Permin et al., 2002). The lower prevalence in adult chickens was explained by the development of immunity due to longer exposure that decreases the pathogenesis of the helminths. On the contrary, Wuthijaree et al. (2017) from Italy found higher prevalence of nematode infection in older layer chickens in free-range condition, which is associated not only with age but also with higher risk of re-infection in heavily contaminated environments and due to production load as well.

In this study chickens from a higher altitude (Holeta and Dire inchin) had higher prevalence than chickens from lower altitudes (Ambo). A recent study from Italy also reported that laying hens kept in free-range systems under mountain farming conditions were at higher risk of nematode infection (Wuthijaree et al., 2017). The higher prevalence at higher altitude could be related to climatic conditions which are more conducive for the environmental development and survival of helminth infective stages (Soulsby 1982; Abebe et al., 1997).

Though the difference is not significant, higher prevalence in lighter local chickens than heavier ones in the present study was in agreement with a report from Zambia (Phiri et al., 2007). Generally, helminth infections in poultry can lead to stunted growth and reduced egg and meat production. Moreover, severe infection might be accompanied by damage to the intestinal wall, leading to blood loss and secondary infections resulting in loss of productivity (Permin et al., 1997). Cestodes, for example, are known to cause retarded growth, enteritis, diarrhea and heavy infection, they might also be associated with mortality in young and loss of egg production in laying chickens (Simon and Emeritus, 2005).

While this study demonstrates a high prevalence of parasites in backyard chickens, there are some limitations in the study. First, identifying the genotypes of chickens (differentiation of some of the exotic breeds from crosses) is somewhat objective. Second, the study did not include seasonal dynamics of helminths which could have resulted in higher or lower prevalence. Third, some farmers might provide anthelmintic when chickens are sick; these data could not be determined but might have influenced prevalence.

5. Conclusions

This study showed that gastrointestinal helminths were highly prevalent in indigenous chickens in West Shoa Zone, Central Ethiopia. The most common helminths identified were nematodes and cestodes among which *A. galli*, *R. tetragona* and *R. echinobothridia* were the most dominant species. Sex, age and origin of chickens were the risk factor detected for nematode infection. The high prevalence of nematode and cestode infections in chickens in the study areas might be associated with considerable losses of productivity. Therefore, the present study strongly suggests appropriate and strategic control of helminthiasis to improve the health and output of backyard chickens in the study areas.

Ethical considerations

This study involves killing of chicken for collection of gastrointestinal tract. The method of killing was assessed and permission was obtained from Ambo University Animal Research Ethics Review Committee (ARERC) on March 10, 2016, with its reference number RCCSD/ AREC/020/2016.

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Conflict of interest statement

The authors declared that they have no competing interests.

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