Prevalence of helminth parasites in free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa

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ABSTRACT

A total of 79 chickens were randomly collected from 4 rural localities and processed to detect the presence of helminth parasites and their prevalences. Sixteen helminth species comprising 12 nematode and 4 cestode species were recorded from the 4 localities. *Syngamus trachea* and *Cyathostoma* spp. were the only helminth species recovered from the respiratory tract and the rest of the helminth species were from the gastrointestinal tract. The most prevalent nematode species across the 4 localities were *Heterakis gallinarum* (prevalence range 80–94.4 %), *Gongylonema ingluvicola* (43.3–86.7 %), *Tetrameres americana* (53.3–66.7 %) and *Ascaridia galli* (22.2–43.8 %) and for cestode species, *Raillietina tetragona* (16.7–40 %) and *Skrijabinia cesticillus* (3.3–13.3 %) were the most prevalent in that order. *Heterakis gallinarum* and *T. americana* had the highest intensity of infection in chickens across all the rural areas compared with other helminth species. There was no significant difference ($P > 0.05$) observed in the sex distribution for *As. galli, Baruscapillaria obsignata* (syn. *Capillaria obsignata*), *Eucoleus annulatus* (syn. *Capillaria annulata*), *Eucoleus contortus* (syn. *Capillaria contorta*) and *Subulura suctoria* among the 4 rural areas. However, a significant difference ($P < 0.05$) was observed in the intensity of infection of both males and females for *H. gallinarum* and *T. americana* across the 4 localities studied. *Tetrameres americana, A. galli, C. obsignata* and *C. annulata* had prevalence and number of females higher than that of males, while *H. gallinarum* showed the opposite. Prevalence of *H. gallinarum* and *T. americana* as determined by faecal egg count were much lower compared with the prevalence as determined by *post mortem* examination, confirming the limitation of using faecal samples in determining the prevalence of gastrointestinal helminth parasites in chickens.

Keywords: cestodes, faecal egg count, gastrointestinal parasites, infection, nematodes.

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INTRODUCTION

The estimated poultry census in the world is 14.718 billion and 75 % of this population is found in developing countries[6], where they are commonly kept as free-range chickens[9]. Rural free-range chickens provide eggs and meat which are important sources of protein[1] and also serve as a source of income[13].

Productivity of free-range chickens is generally low and mortality is high[5].

Causes of high mortality and low productivity include lack of proper management, lack of adequate nutrition, diseases and predation[6]. Lack of adequate nutrition and proper management force the free-range chickens to scavenge for food in contaminated environments, which predisposes them to arthropod-borne helminth infections[7].

Helminth parasites of free-range chickens have been reported to occur at a high prevalence in several developing countries[1,7,8,10,12,13]. To our knowledge there are no reports on the prevalence of gastrointestinal helminths of free-range chickens from rural and peri-urban communities of South Africa.

The objective of this study was to document the helminth species infecting free-range chickens in selected rural communities in KwaZulu-Natal (KZN) province, South Africa, and determine the prevalence and intensity of infection.

MATERIALS AND METHODS

Study area and study population

Four rural communities keeping free-range chickens namely Shongweni (SH) and Port Shepstone (PS) rural areas which are located on the South coast of KZN and Maphumulo (MP) and Mvoti (MV) rural areas, which are on the North Coast of KZN, South Africa, were randomly selected. Each selected rural community consisted of between 50 and 100 households, scattered throughout the community with short distances between the households. The free-range chickens normally scavenge in surrounding areas during the day and are confined during the night.

Sample collection

Adult free-range chickens were randomly collected from the localities and kept at the Biomedical Resource Center (BRC) of the University of KwaZulu-Natal (Westville campus) until slaughter. The sample size was determined using the equation $n = 1.96^2pq/L^2$, where n = sample size, p = expected prevalence, $q = 1 - p$ and L = limits of error on the prevalence[14] and the expected prevalence was set at 80 %. A minimum of 15 birds from each area were collected as a representative sample and birds of mixed sexes were randomly collected from each locality using a systematic sampling frame. Birds were collected from every 3rd household at each locality until the required number was achieved. Only apparently healthy birds were selected. Collected chickens were kept in cages at the BRC for a minimum of 4 days and supplied with food and water *ad libitum* until humanely slaughtered for helminths examination. Helminth parasites were checked in the gastrointestinal and respiratory tracts and eyes of birds[11].

Processing of samples

Processing of collected helminth parasites was done according to the method described elsewhere[11]. Parasitological examination included macroscopic and microscopic examination of various organs. Eyes were examined macroscopically for the presence of *Oxyspirura mansoni* and the trachea was washed for recovery of *Syngamus trachea* and other helminths. The crop, proventriculus and gizzard were directly examined for the presence of *Gongylonema ingluvicola, Tetrameres* spp. and *Acuaria hamulosa,* respectively. After opening the gastrointestinal tract, macroscopic examination was carried out and visible helminths were collected, followed

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Table 1: **Prevalence** (%), **geometric mean abundance** (GMA ± SEM) **and range** (in brackets) **of nematode species of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Nematode species	Maphumulo (*n* = 18)		Mvoti (*n* = 15)		Port Shepstone (*n* = 30)		Shongweni (*n* = 16)	
	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM
Tetrameres americana	66.7	1.49 ± 0.34[a] (0–39)	60.0	0.96 ± 0.25[a] (0–12)	53.3	1.04 ± 0.20[a] (0–21)	56.3	0.73 ± 0.20[a] (0–7)
Heterakis gallinarum	94.4	3.45 ± 0.29[a] (0–107)	93.3	2.36 ± 0.26[ab] (0–52)	80.0	1.92 ± 0.25[b] (0–105)	81.3	2.71 ± 0.44[ab] (0–245)
Gongylonema ingluvicola	72.2	0.86 ± 0.18[a] (0–18)	86.7	1.68 ± 0.27[b] (0–30)	43.3	0.30 ± 0.64[c] (0–1)	75.0	1.30 ± 0.25[ab] (0–15)
Acuaria hamulosa	27.8	0.23 ± 0.09[a] (0–3)	33.3	0.38 ± 0.16[a] (0–6)	0	0 (0)	6.2	0.12 ± 0.12[a] (0)
Dispharynx nasuta	11.1	0.15 ± 0.11[a] (0–4)	0	0 (0)	3.3	0.02 ± 0.02[a] (0–1)	12.5	0.25 ± 0.21[a] (0–27)
Ascaridia galli	22.2	0.23 ± 0.11[a] (0–4)	26.7	0.42 ± 0.20[a] (0–10)	43.3	0.43 ± 0.11[a] (0–29)	43.8	0.72 ± 0.25[a] (0–13)
Subulura suctoria	5.6	0.08 ± 0.08[a] (0–3)	6.7	0.07 ± 0.07[a] (0–3)	6.7	0.09 ± 0.06[a] (0–4)	0	0 (0)
Baruscapillaria obsignata	0	0 (0)	0	0 (0)	20.0	0.22 ± 0.09[a] (0–6)	56.3	1.12 ± 0.32[b] (0–57)
Eucoleus annulatus	0	0 (0)	0	0 (0)	16.7	0.15 ± 0.09[a] (0–4)	25.0	0.36 ± 0.22[a] (0–9)
Eucoleus contortus	0	0 (0)	0	0 (0)	10.0	0.18 ± 0.08[a] (0–8)	18.8	0.35 ± 0.18[a] (0–15)
Syngamus trachea	0	0 (0)	0	0 0 (0)	6.7	0.04 ± 0.04 (0–2)	0	0 (0)
Cyathostoma spp.	0	0 (0)	0	0 (0)	3.3	0.02 ± 0.02 (0–1)	0	0 (0)

n = Sample size.
Data with a different superscript letter in the same row for each nematode species are significantly different ($P < 0.05$).

by scraping off the mucosa and washing contents through a 63 μ aperture sieve. The remaining contents captured on the sieve were examined for the presence of helminth parasites under a stereo-microscope and observed helminths were collected and preserved in 70 % alcohol.

Identification of parasites

Cestode scolices and mature proglottids were processed[2], identified and counted under a light microscope at ×10 magnification and nematodes were cleared in lacto-phenol and examined under a light microscope at ×10 magnification. Helminth parasites were identified using the descriptions as documented elsewhere[2,11].

Faecal egg counts

Faecal specimens were collected from the caeca of birds during slaughter. They were stored at 4 °C to prevent hatching of eggs until they were processed. Processing of faecal egg counts was done following a modified formol-ether concentration technique[3] and identification of helminth eggs was done according to keys described elsewhere[11].

Data analysis

Prevalence of infection (%) of identified helminth species in each area was calculated as the number of individual chickens infected by a specific helminth species at the time of study divided by the total

Table 2: **Prevalence** (%)**, geometric mean abundance** (GMA ± SEM) **and range** (in brackets) **of cestode species of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Cestode species	Maphumulo (*n* = 18)		Mvoti (*n* = 15)		Port Shepstone (*n* = 30)		Shongweni (*n* = 16)	
	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM	Prevalence (%)	GMA ± SEM
Raillietina tetragona	16.7	0.33 ± 0.20[a] (0–14)	40.0	0.58 ± 0.22[a] (0–15)	23.3	0.45 ± 0.16[a] (0–10)	37.5	0.46 ± 0.17[a] (0–4)
Skrijabinia cesticillus	11.1	0.22 ± 0.15[a] (0–7)	13.3	0.24 ± 0.19[a] (0–16)	3.3	0.02 ± 0.02[a] (0–1)	12.5	0.27 ± 0.19[a] (0–11)
Raillietina echinobothrida	0	0 (0)	0	0 (0)	0	0 (0)	12.5	0.09 ± 0.06 (0–1)
Choanotaenia infundibulum	0	0 (0)	6.7	0.07 ± 0.07 (0–2)	0	0 (0)	0	0 (0)

n = Sample size.
Data with a different superscript letter in the same row for each nematode species are significantly different ($P < 0.05$).

Table 3: **Intensity of infection and sex distribution of nematode species of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Nematode spp.	Maphumulo ($n = 18$)			Mvoti ($n = 15$)			Port Shepstone ($n = 30$)			Shongweni ($n = 16$)		
	Total count	M (%)	F (%)	Total count	M (%)	F (%)	Total count	M (%)	F (%)	Total count	M (%)	F (%)
Tetrameres americana	141	26 (18)^{a1}	115 (82)^{a2}	45	1 (2.2)^{a1}	44 (97.7)^{a2b1}	141	74 (52)^{a1}	67 (48)^{b1}	30	10 (33)^{a1}	20 (66)^{b1}
Heterakis gallinarum	824	431 (52)^{a1}	393 (48)^{a2}	216	103 (48)^{b1ef}	113 (52)^{a2b2}	432	222 (51)^{c1e}	210 (49)^{b2}	662	367 (55)^{a1d1f}	295 (45)^{a2b2}
Ascaridia galli	8	3 (38)^{a1}	5 (62)^{a2}	19	9 (47.4)^{a1}	10 (52.6)^{a2}	57	15 (26)^{a1}	42 (74)^{a2}	42	9 (21)^{a1}	33 (79)^{a2}
Allodapa suctoria	3	2 (67)^{a1}	1 (33)^{a2}	2	0	2 (100)^{a2}	6	2 (33)^{a1}	4 (67)^{a2}	0	0	0
Acuaria hamulosa	7	0	7 (100)^{a2}	13	6 (46.2)^{a1}	7 (53.8)^{a2}	0	0	0	6	3 (50)^{a1}	3 (50)^{a2}
Dispharynx nasuta	6	3 (50)^{a1}	3 (50)^{a2}	0	0	0	0	0	0	28	10 (35.7)^{a1}	18 (64.3)^{a2}
Baruscapillaria obsignata	0	0	0	0	0	0	17	7 (41)^{a1}	10 (59)^{a2}	106	22 (21)^{a1}	84 (79)^{b2}
Eucoleus annulatus	0	0	0	0	0	0	12	2 (17)^{a1}	10 (83)^{a2}	17	5 (29)^{a1}	12 (71)^{a2}
Eucoleus contortus	0	0	0	0	0	0	13	2 (15)^{a1}	11 (85)^{a2}	25	15 (60)^{a1}	10 (40)^{a2}
Syngamus trachea	0	0	0	0	0	0	2	1 (50)	1 (50)	0	0	0
Cyathostoma spp.	0	0	0	0	0	0	1	0	1 (100)	0	0	0

M = Male, F = Female, *n* = sample size.
Data with a different superscript letter in the same row for sex of each nematode species for each locality are significantly different ($P < 0.05$).
Data with a different superscript number in the same row for the same sex of each nematode species are significantly different ($P < 0.05$).

number of chickens examined multiplied by 100, and the mean abundance (MA) of infection was calculated as the total number of a specific helminth species infecting chickens at a given locality divided by the total number of chickens examined[4]. Data for helminth counts and egg counts were log transformed (count + 1) and geometric means (GM) for nematodes, cestodes and egg counts were calculated from the transformed data. Helminth eggs were expressed as the number of eggs per gram (epg) of faeces. Analysis of variance was used to determine the differences in the prevalence of species, sex and egg counts among the selected rural communities and the level of significance was set at $P \leq 0.05$. The computer software STATISTICA was used for data analysis.

RESULTS

Sixteen helminth species were identified from the 4 localities and comprised twelve nematode species (Table 1) and 4 cestode species (Table 2). PS had the highest number of nematode species (11) followed by SH (9) and MP and MV had the lowest with 7 and 6 species respectively. SH and MV had the highest diversity of cestode infection (with each having 3 cestode species) followed by MP and PS with 2 cestode species recorded in each area.

The most prevalent species of nematodes across all areas was *Heterakis gallinarum* with a prevalence range of 80–94.4 % followed by *G. ingluvicola* (43.3–86.7 %), *Tetrameres americana* (53.3–66.7 %) and *Ascaridia galli* (22.2–43.8 %). A significant difference in the prevalence of *H. gallinarum, G. ingluvicola, A. hamulosa* and *Baruscapillaria obsignata* (syn. *Capillaria obsignata*) among the 4 rural areas was observed. In PS, *B. obsignata, Eucoleus annulatus* (syn. *Capillaria annulata*) and *E. contortus* (syn. *Capillaria contorta*) prevalence ranged from 10 to 20 % and in SH from 18.3 to 56.3 % and no Capillariinae were observed in MP and MV areas (Table 1). *Dispharynx nasuta* was reported in the MP, PS and SH at low prevalence (3.3–12.5 %). *Acuaria hamulosa* was present in MP, MV and SH. Only 2 birds were infected with *S. trachea,* a single one of which harboured *Cyathostoma* spp. as well, and both these birds were from PS.

The overall intensity of infection by nematodes per locality is shown as the total count in Table 3. The intensity of the infection by *H. gallinarum* was high in chickens from MP (826), followed by SH (671), PS (436) and MV (216). *Tetrameres americana* also showed a high intensity of infection in chickens from MP (141), PS (141), MV (45) and SH (30), while *As. galli*

Table 4: **Infection status with nematodes of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Infection status	Maphumulo (*n* = 18)		Mvoti (*n* = 15)		Port Shepstone (*n* = 30)		Shongweni (*n* = 16)	
	n	**Prevalence (%)**	***n***	**Prevalence (%)**	***n***	**Prevalence (%)**	***n***	**Prevalence (%)**
1. No infection	0	0	0	0	0	0	0	0
2. Single infection	2	11.1	1	6.2	6	23.3	0	0
Tetrameres americana	0	0	1	6.2	0	0	0	0
Heterakis gallinarum	1	5.6	0	0	2	6.7	0	0
Gongylonema ingluvicola	1	5.6	0	0	3	10.0	0	0
Ascaridia galli	0	0	0	0	1	3.3	0	0
3. Double infection	4	22.2	3	20.0	8	30.0	0	0
4. Multiple infection	12	66.7	11	73.3	16	53.3	16	100

Table 5: **Infection status with cestodes of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Infection status	Maphumulo (*n* = 18)		Mvoti (*n* = 15)		Port Shepstone (*n* = 30)		Shongweni (*n* = 16)	
	n	**Prevalence (%)**	***n***	**Prevalence (%)**	***n***	**Prevalence (%)**	***n***	**Prevalence (%)**
1. No infection	13	72.2	7	46.7	23	76.7	8	50.0
2. Single infection	5	27.8	7	46.7	6	31.1	7	43.8
Raillietina tetragona	3	16.7	5	33.3	6	31.1	5	31.3
Raillietina echinobothrida	0	0	0	0	0	0	1	6.2
Skrijabinia cesticillus	2	11.1	1	6.7	0	0	1	6.2
Choanotaenia infundibulum	0	0	1	6.7	0	0	0	0
3. Double infection	0	0	1	6.7	1	3.3	0	0
4. Multiple infection	0	0	0	0	0	0	1	6.2

had a high intensity in chickens from PS (57), SH (42) and MV (19).

Intensity of infection by nematode species by sex shows that female *T. americana* were predominant in all areas except for PS where more males were recorded. The prevalence of *T. americana* females, *H. gallinarum* females and males and *B. obsignata* females differed significantly among the 4 rural areas studied. Prevalence and intensity of *As. galli* females and males, *B. obsignata* males, *E. annulatus* females and males, *E. contortus* females and males and *Al. suctoria* females and males were not significantly different across the 4 rural areas. Prevalence of male *T. americana* in MP, MV and SH was lower than that of females (M = 2.2–33 %; F = 66.0–97.7 %). However, this was not the case for PS, which had the highest male prevalence of *T. americana* (PS: M = 52 %, F = 48 %). The prevalence of infection with male *H. gallinarum* in MP, PS and SH was higher than that of female infections (M = 51–55 %; F = 45–49 %). This was not true for MV chickens, in which females had a slightly higher prevalence than males (M = 48 %, F = 52 %). In both cases the differences were not significant. Females of *As. galli, B. obsignata, E. annulatus* and *Cyathostoma* spp. had a higher prevalence than males in all 4 rural areas.

Infection status of chickens with nematodes from the 4 localities is shown in Table 4.

SH and MV had the highest number of cestode species infection (with each having 3 different cestodes species) (Table 2). The most prevalent cestodes were *Raillietina tetragona* with a range of 16.7–40 % followed by *Skrijabinia cesticillus* (3.3–13.3 %) in all rural areas. *Raillietina echinobothrida* was only present in SH, and *Choanotaenia infundibulum* only in MV. There was no significant difference in the prevalence of *R. tetragona, S. cesticillus* and *Ch. infundibulum* among the 4 localities.

Results for the status of infection with cestodes species are shown in Table 5. The percentage of birds not infected with cestodes species ranged from 46.7–76.7 % in the study areas. Only 1 chicken in SH had multiple infections and none in the other 3 localities.

Faecal egg count results are shown in Table 6. *Tetrameres americana* and *H. gallinarum* varied significantly among the 4 localities. *Gongylonema ingluvicola, T. americana* and *H. gallinarum* had the highest faecal egg count among the 4 localities. Of note is that the prevalence of *H. gallinarum* and *T. americana* as determined by faecal egg counts did not correspond with the actual prevalence from slaughtered birds. However, the faecal egg count prevalence for *A. galli* and Capillariinae corresponded well with the prevalence of the actual helminth parasites (Table 1 and 6).

DISCUSSION

Our study has shown that helminth parasites are common in rural free-range chickens of KwaZulu-Natal province, South Africa. Several species of nematodes have been reported in rural free-range chickens in African countries[7,8,10,12,13]. The number of nematode species (12) recorded from this study is comparable with that recorded by other authors[7,13] who recorded a total of 11 species of nematodes in free-range chickens from rural Zimbabwe and Ghana respectively. Among the nematode species recorded in Ghana, 6 were the same as those recovered in our study. Nine species were recorded in Goromonzi district of Zimbabwe[10] and of those, 8 species were similar to those recorded from our study. Prevalences of *A. galli, G. ingluvicola* and Capillariinae in the Goromonzi district of Zimbabwe[10] are comparable to the prevalences recorded in this study.

The absence of Capillariinae in MP and MV could be explained by the difference in the climatic conditions of the 2 areas[10]. MP and MV are found on the North Coast of KwaZulu-Natal, which is characterised by low humidity compared with PS and

Table 6: **Prevalence** (%)**, geometric mean** (GM) **and range** (in brackets) **of gastrointestinal nematode faecal egg counts of free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa.**

Nematode species	Maphumulo (n =18)		Mvoti (n =15)		Port Shepstone (n =30)		Shongweni (n =16)	
	Prevalence (%)	GM ± SEM	Prevalence (%)	GM ± SEM	Prevalence (%)	GM ± SEM	Prevalence (%)	GM ± SEM
Tetrameres americana	44.4	1.98 ± 0.56^{a} (0–660)	7.0	0.20 ± 0.20^{b} (0–20)	33.3	1.18 ± 0.31^{ab} (0–80)	12.5	0.42 ± 0.29^{ab} (0–40)
Heterakis gallinarum	11.1	4.33 ± 0.54^{a} (0–940)	6.7	2.32 ± 0.63^{ab} (0–900)	46.7	3.05 ± 0.40^{ab} (0–300)	31.3	1.92 ± 0.60^{b} (0–900)
Gongylonema ingluvicola	83.3	1.14 ± 0.55^{a} (0–1580)	53.3	0.45 ± 0.31^{a} (0–40)	70.0	1.56 ± 0.37^{a} (0–400)	43.8	0.19 ± 0.19^{a} (0–20)
Ascaridia galli	22.2	0.83 ± 0.38^{a} (0–80)	20.0	0.61 ± 0.33^{a} (0–20)	16.7	0.59 ± 0.25^{a} (0–80)	6.2	0.19 ± 0.19^{a} (0–20)
Capillariinae	22.2	0.34 ± 0.23^{a}	13.3	0.27 ± 0.27^{a}	40.0	2.12 ± 0.44^{b} (0–1080)	6.2	1.17 ± 0.45^{ab} (0–60)

n = Sample size
Data with a different superscript letter in the same row for each nematode species are significantly different (P < 0.05).

SH on the south coast which is characterised by high humidity, moisture and temperature.

Results of faecal egg counts did not reflect the diversity and intensity of helminth infections found in the slaughtered chickens. This emphasises the limitations of faecal samples for diagnosis of gastrointestinal helminth infections in live birds[11].

Several prevalence studies have been done for cestodes in free-range chickens in Sub-Saharan African countries[8,10,13]. Nine species of cestodes were reported in rural Zimbabwe[8], while only 4 were reported during this study, 3 of the species which had prevalences comparable with the previous authors' findings. Other authors[13] recorded 5 species of cestodes and 4 were the same species as reported in this study, but only the prevalence of *S. cesticillus* was comparable with our findings.

Some helminth species reported in this report appear to have a low or high prevalence when compared with previous studies. *Heterakis gallinarum* had a prevalence range of 80–94.4 % in our study while the prevalence recorded in Ghana and Zimbabwe ranged from 31–64 % and 6.7–20 %, respectively[7,13]. Cestodes in this study had prevalences lower than those reported in previous studies in Zimbabwe and Ghana[7,13]. The variation in helminth species distribution may be attributed to the distribution of the intermediate hosts of some of these parasites[13]. This might also be attributed to the way these chickens are managed and geographical differences in the areas of study[10].

The prevalence of *As. galli* was higher in PS and SH than in MP and MV and this might be due to the fact that PS and SH localities are characterised by high temperature, moisture and humidity. Since the embryonation of the *As. galli* eggs in the environment is dependent on these factors[11], it is most likely the cause of the high prevalence.

The intensity of infection with female *T. americana* was higher than that of males, and this was expected since after mating the males leave the glands of the proventriculus and die[11]. PS had female counts lower than that of males, and this could have been due to the fact that the males observed were still immature.

In conclusion, prevalence and diversity of helminth parasites in free-range chickens are high in the 4 rural localities of KwaZulu-Natal province of South Africa and climatic conditions might play a role in the differences in distribution and diversity of the helminth species. It is highly recommended that further studies be done to evaluate the impact of helminth infections on the health and production of rural free-range chickens and the options for sustainable control.

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