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ORIGINAL PAPER

Prevalence of parasites of the local scavenging chickens in a selected semi-arid zone of Eastern Kenya

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Abstract A study to identify and estimate the prevalence of parasites of local chickens in a semi arid area of Kenya was conducted between March 2005 and August 2006. Three hundred and sixty (360) local chickens purchased from Yathui division of Machakos were examined. Of those, 93.3% had helminths. Nematodes were recovered in 268 (74.4%) chickens whereas 245 (68.1%) had cestodes. *Tetrameres americana* (37.7%), *Ascaridia galli* (33.3%) and *Heterakis gallinarum* (22.8%) were the most important nematode species identified. *Raillietina echinobothrida* (33.3%) and *Davainea proglottina* (19.4%) were the two most important cestode species identified. Two coccidia species, namely *Eimeria necatrix* (6.7%) and *E. tenella* (16.7%) were isolated and identified as per location in the digestive system. Important ecto-parasites identified included *Echidnophaga gallinacea* (76.7%), *Menacanthus stramineus* (79.4%) and *Dermanyssus gallinae* (60.0%). Endo-parasites (helminths and coccidia) occurred in significantly ($p<0.05$) higher frequencies during the wet season than during the dry season. On the contrary, ecto-parasites were significantly ($p<0.05$) more fequent during the dry season. Male chickens generally exhibited increased odds for the occurrence of parasites than female birds. Further investigations are required to establish a plausible explanation for this. Overall, parasitism was a big constraint to chicken productivity in the study area. Urgent integrated parasite control approaches should be initiated to address parasitism in chickens in the Yathui cluster.

Keywords Chicken · Gastro-intestinal tract · Ectoparasites and endoparasites · Local · Prevalence · Semi-arid

Abbreviations

ASALs	arid and semi-arid lands
GIT	Gastro-intestinal tract
KARI	Kenya Agricultural Research Institute

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Introduction

In Kenya, poultry production is mostly subsistence and contributes close to 70% of the national egg and chicken meat output (Nzioka *et al*. 1997; Ministry of Livestock and Fisheries Development, 2005). Poultry also produces several tons of manure that has over the years together with other types of farmyard manure (crop and livestock wastes) been used for crop growing hence fostering a healthy interaction between livestock and crops production. This crop-livestock interaction is quite pronounced in the arid and semi-arid areas (ASALs) with livestock and crops production comprising 50% each of all farm enterprises. However, pests and diseases seriously undermine chicken productivity and the associated benefits. Parasites in particular rank high among the causes of low productivity in the rural poultry production systems of the ASALs (Nzioka *et al*. 1997). Chickens in rural production systems are at a constant risk of infestation by both ecto-parasites and endoparasites since they get little to no feed supplementation thus resorting to scavenging and foraging for feed to meet their nutritional requirements (Nzioka *et al*. 1997; Terregino *et al*. 1999; Dessie and Ogle 2001; Eshetu *et al*. 2001; Mungube *et al*. 2006). Inappropriate housing and lack of appreciable pest control efforts also lower their productivity potential because of parasitic infestation (Mungube *et al*. 2006).

The domestic fowl (*Gallus gallus* var. domesticus) like other domestic livestock species suffers from serious health and productivity consequences when infested by helminth parasites. Gastro-intestinal tract (GIT) worms in particular are known to cause poor feed conversion and utilization (Gordon and Jordan 1982; Soulsby 1982; Urquhart *et al*. 1996). Past investigations have shown that these GIT worms are a problem to the chickens in feed scarce rural/ scavenging production systems (Soulsby 1982; Abebe *et al.* 1997; Permin *et al*. 1997; Terregino *et al*. 1999; Eshetu *et al*. 2001; Mukaratirwa *et al*. 2001; Irungu *et al*. 2004). The feeds available to the scavenging chickens are inadequate both in quantity and in quality. Apart from the GIT helminths, coccidia can cause enormous economic losses to poultry farmers if not controlled (Gordon and Jordan 1982; Soulsby 1982; Permin *et al*. 2002). Little attempt has been made to establish the economic significance of coccidiosis in the rural scavenging chickens. Work on commercial poultry production systems has established that coccidiosis is a disease that should not be ignored in any control program (Permin *et al*. 2002; Kinung'hi *et al*. 2004; Lobago *et al*. 2005). It is therefore necessary to establish the extent to which coccidiosis afflicts the subsistence poultry industry to formulate the necessary control measures.

Various ectoparasites have been reported in the local scavenging chickens. The most common ectoparasites in chickens include lice, fleas, mites (feather, body and leg mites), and *Argas persicus* (Gordon and Jordan 1982; Soulsby 1982; Permin *et al*. 2002; Mungube *et al*. 2006). *Argas persicus* is a bigger problem in dry hot areas than in the humid wet regions (Nzioka *et al.* 1997). *Argas persicus* control can easily be achieved by plastering walls of chicken houses with mud or cement to minimize cracks that serve as hiding points of these parasites. Isolating chickens bought from the market for observation and subsequent pesticide treatment of birds harbouring parasites minimizes the risk of introducing *A. persicus* in areas free from them. Many other ectoparasites other than *A. persicus* are endemic in drier areas and their control can easily be achieved through improved hygienic practices.

In general, parasitism negatively affects the productivity of the local scavenging chickens since they either compete for feed or cause distress to the birds. Empirical evidence shows that *Dermanyssus gallinae* (the poultry red mite) is the main cause of egg abandonment in brooding birds (Gordon and Jordan 1982; Soulsby 1982; Nzioka *et al*. 1997). *Argas persicus* on the other hand sucks blood from chickens which can result in anaemia and death of birds. The same is true for other external parasites. Internal parasites on the other hand lead to emaciation, poor weight gains and low off take rates. There is therefore need to understand the epidemiology of the various chicken parasites in order to plan strategies to bolster increased productivity of free-range chickens. The objective of this study was therefore to describe the prevalences of parasitic infections and infestations in the free-range village chickens in Machakos District of Kenya.

Materials and methods

Study area and population

The study was conducted in Yathui Division of Machakos District. The Division has a hot and dry climate with a bimodal rainfall of less than 400 mm/year (Ministry of Livestock and Fisheries Development 2005). Long rains come down in mid March to late May. The long dry season starts thereafter, lasting to mid October. Short rains set in from mid October to sometime late December when the short dry season starts. The division has one of the highest populations of local chickens standing at 250,000 (Ministry of Livestock and Fisheries Development 2005). Local chicken rearing is a major source of livelihoods in the division and is mainly a domain of women and children.

Sample size and sampling methods

This study started in March 2005 and ended in June 2006. Small-scale mixed farmers were recruited as participants. They fulfilled a selection requirement of having at least 10 free ranging chickens in their households at the commencement of the study. Details and implications of the study were explained to household heads to enable them to make informed consent on whether or not to participate before the final selection was done. Those who did not consent were replaced with others of similar characteristics. Sixty (60) households, which met the inclusion criterion, were randomly selected from a sampling frame of 150 households compiled from the District Livestock Production office.

Data collection methods

Parasite information was obtained from chickens bought from farmers. No set criteria like ages (chicks, growers and adults), health status of birds and sex guided the purchase of chickens. The birds were sold randomly but majority of the farmers tended to retain laying hens and cocks. Very few chicks were sold and where this occurred, their price was more or less the same as for the mature birds. Six visits were made and 60 chickens were bought during each visit. The visits were intentionally arranged to coincide with either the rain or dry season. Three purchases were done during rain season and another three during the dry season. Three hundred and sixty (360) chickens were purchased at the prevailing market prices and brought to KARI Katumani Research Centre where laboratory analysis took place. The consignment of birds was allowed at least an overnight stay on-station to facilitate collection and examination of external parasites before slaughtering the chickens. The collected external parasites were cleaned and fixed in 70% ethanol to allow for further identification with the help of a dissecting microscope.

The chickens were starved for 24 hours before they were humanely killed and examined for internal parasites in the following organs: trachea, oesophagus, crop, gizzard, proventriculus, intestinal tract and caecum. Double ligation using a thread was done to separate each of these organs before longitudinally dissecting them. The contents for each site were carefully scraped into a petri dish and a small amount of tap water added to soften whatever debris to facilitate recovery of worms from their lumen. All worms visible to the naked eye were removed using a thumb forceps. The recovered worms were put in another petri dish labeled according to predilection site and 10% ethanol added to help straightening before identification directly under a stereomicroscope using characteristics described by Soulsby (1982) and Troncy (1989). Before opening of the mid and hindguts, intestinal serosal walls of all the samples were thoroughly examined for signs of clinical coccidiosis (haemorrhages). This was followed by mucosal scrapings of the intestines for microscopical demonstration of the various developmental stages of coccidial parasites.

Data analysis

The prevalence of the parasite species was determined as the proportion of the host population that was infected with a specific parasite at a point in time (Thrusfield 1995). Cross tabulations to derive frequency of occurrence of the parasites based on season of slaughter or sex of birds was performed. Pearson chi square analysis was the statistical method used to establish associations between presence of parasites and characteristics such as sex of bird and or season of purchase.

Results

Helminths, coccidia and ecto-parasites

Three hundred and sixty (360) chickens were examined out of which 170 (47.2%) were males and 190 (52.8%)

females. Three hundred and thirty six (336) (93.3%) of the chickens were infested by helminth parasites. Two hundred and sixty eight (268) (74.4%) chickens had various nematode species inside their crop, oesophagus, proventriculus, gizzard, intestines and caecum (Table 1). Intestinal nematodes including *Ascaridia galli*, *Capillaria* species, *Strongyloides avium* and *Trichostrongylus tenius* accounted for 147 (40.8%) of all the nematodes recovered in the bought chicken. Of the 360 birds slaughtered and examined, 165 (45.8%), 89 (24.7%), and 14 (3.9%) had nematodes in 1, 2 or 3 sites, respectively. The sites with double or triple nematode infections were the intestinal tracts, proventriculi and the caeca. None of the nematodes was recovered from the eyes of chicken although they are also predilection sites for some nematodes.

Two hundred and forty five (245) (68.1%) of the birds had cestodes in their intestinal tracts. These cestodes included *Raillietina echinobothrida*, *Choataenia infundibulum, Davainea proglottina* and *Amoebotaenia sphenoides*. Coccidial parasites as well as numerous ectoparasites, which occurred in the purchased chicken in various predilection sites and their prevalence estimates, are summarized in Table 1.

Association of season of slaughter and sex of bird with prevalence of parasites

The association of season of slaughter and sex of bird with prevalence of the various parasites is summarized in Table 2. Generally, male birds were at increased risk ($p<0.05$) for the occurrence of most of the parasites except for cestodes, proventriculus worms and *D. gallinae* infections. Table 3 displays the association of various groups of parasites in the birds studied.

Table 1 Prevalence of the various chicken parasites by predilection site

Helminth species	Predilection site	% Prevalence (x/n)*	95% Confidence Interval
Cestodes			
Raillietina echinobothrida	Small intestines	33.3	28.5 – 38.5
Choataenia infundibulum	Small intestines	6.9	4.5 – 10.1
Davainea proglottina	Small intestines	19.4	15.5 – 23.9
Amoebotaenia sphenoides	Small intestines	8.3	5.7 – 11.7
Nematodes			
Ascaridia galli	All parts of intestines	33.3	28.5 – 38.5
Strongyloides avium	All parts of intestines	6.1	3.9 – 9.1
Trichostrongylus tenius	All parts of intestines	1.4	0.5 – 32.1
Capillaria contorta (annulata)	Crop and oesophagus	5.6	3.4 – 8.5
Gongylonema ingluvicola	Oesophagus	5.3	3.2 – 8.1
Syngamus trachea	Trachea	5.6	3.4 – 8.5
Tetrameres americana	Proventriculus	37.7	31.7 – 41.9
Dispharynx spiralis	Proventriculus	8.3	5.6 – 11.7
Cheilospirura spp	Gizzard	7.5	5.0 – 10.7
Heterakis gallinarum	Caeca	22.8	18.6 – 27.5
Coccidial parasites			
Eimeria necatrix	Small intestines	6.7	4.3 – 9.8
Eimeria tenella	Caeca	16.7	13.0 – 20.9
Ecto – parasites			
Echidnophaga gallinacean (Flea)	Comb, wattles, eyes and around ears	76.7	72.0 – 80.9
Dermanyssus gallinae (Red poultry mite)	Entire body of bird	60	54.7 – 65.1
Menacanthus stramineus	Skin of thigh, breast and areas near cloaca	71.4	66.4 – 76
Knemidocoptes mutans	Lower limbs	13.3	10 – 17.3
Argas persicus[a]	Cracks of houses	11.1	8.1 – 14.8

Argas persicus live in cracks of chicken houses. However, they could hide under wings. * x refers to number of samples positive for a given parasite and n, total number of samples examined.

Table 2 The influence of season and sex of bird on both internal and external parasite prevalence

Parasites stratified by sex of bird	% Seasonal influence on prevalence	
I). Internal parasites	Dry	Wet
[1]Oesophageal worms		
Female	5.0	4.4
Male	16.3	6.7
Tracheal worms *(Syngamus trachea)*		
Female	5.0	6.7
Male	6.3	4.4
Crop worms *(Capillaria annulata)*		
Female	0	2.2
Male	7.5	3.3
[2]Proventriculus worms		
Female	46.0	46.7
Male	35.0	40.0
Gizzard (*Cheilospirura spp.*)		
Female	6.0	5.6
Male	7.5	11.1
[3]Intestinal nematodes		
Female	29.0	40.0
Male	41.3	54.4
[4]Intestinal tapeworms		
Female	72.0	82.2
Male	52.5	63.3
Caecal worms *(Hetarakis gallinarum)*		
Female	14.0	25.6
Male	22.5	30.0
Intestinal coccidia (*Eimeria necatrix*)		
Female	2.0	4.4
Male	5.0	15.6
Caecal coccidia (*Eimeria tenella*)		
Female	10.0	24.4
Male	8.8	23.3
II). External parasites		
Echidnophaga gallinacea (fleas)		
Female	78.0	65.6
Male	90.0	74.4
Dermanyssus gallinae (Red poultry mite)		
Female	66.0	55.6
Male	63.8	54.4
Menacanthus stramineus (Poultry body lice)		
Female	75.5	58.4
Male	85.5	65.6
Knemidocoptes mutans (scaly leg mite)		
Female	14.0	13.3
Male	12.5	13.3
Argas persicus (soft tick)		
Female	13.1	6.7
Male	13.2	6.7

[1] *Capillaria annulata* and *Gongylonema ingluvicola*;
[2] *Tetrameres americana* and *Dispharynx spiralis*;
[3] *Ascaridia galli*, *Strongyloides avium* and *Trichostrongylus tenius*;
[4] *Raillietina echnobothrida, Choataenia infundibulum, Davainea proglottina* and *Amoebotaenia sphenoides.*

Discussion

Cestodes

Raillietina echinobothrida was the most prevalent (33.3%) cestode identified in the studied chickens. Its prevalence was slightly higher than 25.8% reported in Ethiopia (Eshetu *et al*. 2001). Other workers reported a higher prevalence (34% – 81%) for the same parasite (Permin *et al*. 1997; Poulsen *et al*. 2000; Permin *et al*. 2002; Irungu *et al*. 2004). However, a study in Somalia reported 8.5%, which is lower than the current estimate (Terregino *et al*. 1999). Although *R. echinobothrida* is to a limited extent associated with enteritis, haemorrhages and hypovitaminosis B, heavy infestations may cause mortality in young chickens and loss of egg production in laying birds (Gordon and Jordan 1982; Soulsby 1982). *Davainea proglottina*, the most pathogenic cestode occurred at a frequency of 19.4%. Season and sex affected the occurrence of the tapeworms in chickens. The population of beetles, ants and orbatid mites that serve as transport hosts for most of the cestodes increases during the rain seasons. Consequently, cestodes will occur in higher frequencies during rain season than during dry season. There was sex predisposition to the occurrence of this parasite. Females tended to be more heavily infested than males (Table 2). The explanation for this is unclear since there were no differential feeding habits between female chickens and their male counterparts.

Nematodes

The prevalence of *S. trachea* in the current study was higher (5.6% vs. 2% – 4%) than reported elsewhere in the region (Irungu *et al*. 2004; Ondwassy *et al*. 1999; Permin *et al*. 1997). A study in Cameroon reported a prevalence of 13.7% for *S. trachea*, which is higher than that in the East African region (Mpoame and Agbede 1995). *S. trachea* is a differential diagnosis for other respiratory diseases in chickens caused by bacteria and viruses (Gordon and Jordan 1982). Other helminths in the foregut included *G. ingluvicola* and *C. annulata*. Foregut nematodes tended to occur in higher frequencies during the dry season than in the wet season.

In the midgut, the prevalence of *Tetrameres americana* was higher (37.7%) compared to *Cheilospirura* species and *Dispharynx spiralis* in the same

Table 3 Interaction amongst various parasites in the study chicken

Parasites	Oesophageal worms	Proventriculus worms	Intestinal nematodes	Intestinal tapeworms	*Hetarakis gallinarum*	*Eimeria necatrix*	*Echidnophaga gallinacea*	*Menacanthus stramineus*	*Knemidocoptes mutans*	*Argas persicus*
Hetarakis gallinarum		3								
Eimeria necatrix		−2	2							
Eimeria tenella		1		1	1	2			1	1
Echidnophaga gallinacea		−2	−2							
Knemidocoptes mutans		−1		−2			3			
Argas persicus	2	−2		1			1	1	3	

Positive values mean significant positive interactions at 1 for $p<0.05$; 2, $p<0.01$ and 3, $p<0.001$. Negative values mean negative interactions.

location(s). Other studies reported even higher prevalences of between 54.3% – 94% for the same parasite (Permin *et al*. 1997; Magwisha *et al*. 2002; Permin *et al*. 2002). Ondwassy *et al*., (1999) working in a different agro-ecological zone of Kenya reported a 14.2% prevalence of *T. americana*. Heavy infestation by *D. spiralis* interferes with enzymatic digestion because of nodules formed on the mucosa of the proventriculus. Gordon and Jordan (1982) reported that chickens experimentally infected by *D. spiralis* had low body weight gains (reduced feed efficiency), delayed sexual maturity, and a drop in egg production. More male chickens suffered from *Cheilospirura* species infestation than females which were at a higher risk for *T. americana* and *D. spiralis*. The difference in infestation pressure for the worm species based on sex should be investigated further.

Ascaridia galli had the highest prevalence (33.3%) amongst the intestinal nematodes identified in the studied chickens. Other studies in Kenya reported a lower prevalence of 10% –14.5% (Irungu *et al*. 2004; Ondwassy *et al*. 1999). In other African countries, the prevalence of *A. galli* was comparable to the current estimate ranging between 24% and 36% (Magwisha *et al*. 2002; Permin *et al*. 2002; Eshetu *et al*. 2001 and Poulsen *et al*. 2000). Rains increased the prevalence of *A. galli*, an observation that is in agreement with findings in Tanzania (Permin *et al*. 1997). Wet and humid conditions are necessary for the development of eggs to infective stages. The population of earthworms, paratenic hosts for these parasites increases during the rainy season. *Ascaridia galli* infestation is associated with reduced growth rates and weight losses due to intestinal mucosa damage (Gordon and Jordan 1982; Soulsby 1982; Permin *et al*. 1997). Acute *A. galli* infestation causes occlusion of the intestinal lumen leading to rupture of the intestines hence death of affected birds because of haemorrhage/shock (Soulsby 1982; Urquhart *et al*. 1996; Permin *et al*. 1997). Other nematodes identified in the intestines included *Stronyloides avium* (6.1%) and *Trichostrongylus tenius* (5.6%).

In the hindgut (caecum), *Heterakis gallinarum* occurred at a prevalence of 22.8%, which was comparable to a prevalence of 21.3% established earlier in Kenya (Irungu *et al*. 2004). Ondwassy *et al.* (1999), working in the sub-humid areas of Kenya established a higher (44.6%) prevalence. Reports from other countries indicate a 17.3% – 60% rate of occurrence for this parasite (Poulsen *et al*. 2000; Eshetu *et al*. 2001; Permin *et al*. 2002). *Heterakis gallinarum* itself is associated with very little to no pathology in chickens but plays a major role in the epidemiology of histomoniasis. Eggs of *H. gallinarum* contain *Histomonas meleagridis* and when fed on by young turkeys (poults) will cause histomoniasis (black head) (Gordon and Jordan 1982; Soulsby 1982; Urquhart *et al*. 1996). Like the rest of the intestinal nematodes, *H. gallinarum* was more prevalent during the rain seasons since the population of earthworms rises that serve as the transport hosts of this worm.

Coccidia

Two coccidia species, *Eimeria necatrix* and *E. tenella* were isolated from the studied chickens. None of the infected birds manifested clinical signs for the disease. This could be a sign of increased tolerance to these parasites. The current study reported a coccidiosis prevalence of 20.6% despite the moisture stress characteristic of the semi-arid areas. Coccidia occurred more (28.9%) during the rain season than during the dry (12.2%) season. Studies in Tanzania, Ethiopia, India and Argentina, reported a higher prevalence of coccidiosis as compared to the current work (Lobago *et al*. 2005; Kinung'hi *et al*. 2004; Permin *et al*. 2002; Abdul and Rajavelu 2000; Dougald *et al*. 1997). Beside the climatic conditions, many of these investigators did their work on intensive poultry management systems where differences in breed and general husbandry practices would account for the difference in findings. The birds used in the current study were older and the majority of them were beyond the age of 3 to 8 weeks that is considered the risk age-group for coccidiosis.

Ectoparasites

The majority of the ectoparasites were associated with poor hygiene in the farm/chicken house and the absence of parasite control practices. Ectoparasites are bloodsuckers and if reported in high frequencies they become a major constraint to productivity of chickens. *Echidnophaga gallinacea* (stick tight flea), for instance occurred at 76.7% of the chickens showing the neglect the indigenous chickens are subjected to as no insecticides are used to control these. This frequency of occurrence of stick tight fleas was comparable to 73% reported in Zimbabwe (Permin *et al*. 2002). Human and chicken housing units made of grass-thatched roofs and mud walls reported higher cases of fleas as compared to those with cemented walls and iron roofs. Rodents like rats are alternative hosts for fleas and tend to hide in mud walled and grass-thatched structures. Homes where dogs and cats were kept also reported many cases of fleas in chicken (Mungube *et al*. 2006). Other than chicken, fleas also parasitize humans and other mammalian hosts like goats, dogs, cats and sheep (Gordon and Jordan 1982; Soulsby 1982).

Argas persicus (soft ticks) occurred at a frequency of 11.1%, which compared well with results of 6% and 14% for adult and young chickens in Zimbabwe (Permin *et al*. 2002). Apart from being prolific bloodsuckers, *A. persicus* also transmits *Borrelia anserina* that causes spirochaetosis and *Aegyptianella pullorum*, a rickettsial infection in fowl (Gordon and Jordan 1982; Soulsby 1982). Although this study or previous ones never attempted to investigate the presence of the diseases transmitted by *A. persicus*, presence of the parasite in the production systems should guide the scope of disease control strategies to include the two diseases. *Dermanyssus gallinae* (red poultry mite) was also quite prevalent in the study area. This parasite is responsible for egg abandonment in brooding hens. Where chickens share the same house with humans, its presence is a big problem to people as well.

Interaction amongst parasites was noted in the studied chickens (Table 3). The interaction could have been more to chance than to any scientific logic. Despite this, some patterns were observed. For instance, most blood sucking parasites tended to occur together with a strong positive association. Coccidia interacted positively with *Knemidocoptes mutans, Argas persicus* and *Echidnophaga gallinacea*. This group is composed of blood sucking parasites. Chicken that had coccidial parasites were also affected by intestinal nematodes. Whether or not this was related to the blood letting tendencies of coccidia is yet to be established. There was significant interaction noted amongst the various classes of ectoparasites. The explanation for this is that they occur in environments that are hygienically not sound and where insecticides and or acaricides to control them are rarely used. The exact cause of parasite interaction is a subject that needs to be investigated further.

Conclusion

Parasitism is a problem in the indigenous chicken production systems of the ASALs. It thus calls for integrated parasite control strategies to be put in place since there is little effort directed towards this problem currently. The results also indicated that season of the year when purchase of birds was done as well as sex of birds were important factors affecting the prevalence of the various parasites in chickens. While the contribution of season could easily be explained, the role of sex of birds needs to be investigated further. In addition, the relationship of helminth infections and age of birds needs to be established.

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