International Journal of Agricultural Sciences ISSN 2167-0447 Vol. 10 (9), pp. 001-006, September, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Point prevalence study of gastro-intestinal parasites in village chickens of Centane district, South Africa

Marizvikuru Mwale[1] and Patrick J. Masika[2]*

[1]Department of Livestock and Pasture Science, University of Fort Hare, P. Bag X1314, Alice 5700, South Africa.
[2]Agricultural and Rural development Research Institute, University of Fort Hare, P. Bag X1314, Alice 5700, South Africa.

Accepted 09 July, 2020

Village chickens improve rural farmers' nutritional and income status. Nonetheless, chicken productivity is chiefly hampered by gastro-intestinal parasites and there is dearth of information on the prevalence of these parasites in village chickens in South Africa. Point prevalent study was, therefore, conducted in two villages of Centane district to determine the prevalence of gastro-intestinal parasites in village chickens. Seventy households were randomly selected for compound sampling of fresh faecal samples of chickens. Modified quantitative McMaster technique was used for examination of nematode and cestode eggs, and coccidial oocysts. Qualitative sedimentation technique was used to detect trematode eggs. About 99% of the chickens were infested with various gastro-intestinal parasites. *Hetarakis gallinarum* was the most prevalent (25.72% Qolora by-sea and 27.14% Nontshinga) together with coccidia (41.43% Qolora by-sea and 25.71% Nontshinga village). Trematodes and cestodes were the least prevalent. Prevalence of parasites varied between villages ($P < 0.05$); most parasites were prevalent in Nontshinga village. Generally gastro-intestinal parasites were prevalent in village chickens of Centane district. Sustainable ways of controlling these parasites need to be designed for improved village chicken production and ultimately rural livelihoods. Further studies on period prevalence of gastro-intestinal parasites in chickens in South Africa need to be conducted.

Key words: Parasites, prevalence, rural, village chickens.

INTRODUCTION

Approximately 20 billion poultry exist worldwide (Food and Agriculture Organization (FAO), 2007) and of this about 75% are in developing countries. Village chickens (*Gallus gallus*) are the predominant species in the rural poultry sector in Africa (Kitalyi, 1988; FAO, 2007) and in South Africa there are about 140 million chickens. Although, village chickens have a slow growth rate, they are of paramount importance to the African rural farmers (Alders et al., 2009) especially in Centane district which is one of the poorest districts in the Eastern Cape Province (Dold and Cocks, 2002) largely due to the extreme poverty found in the former homelands, where subsistence agriculture predominates. In addition, almost every household (93.5%) in the two villages, Qolora by-sea and Nontshinga of Centane district in South Africa owns chickens with an average flock size of 16 (±2.1 S.E.M) birds per household (Mwale and Masika, 2009).

The rural farmers in Centane district practice diversified livestock farming system. The majority of male farmers are mainly responsible for cattle, sheep and goats, while female farmers are responsible for pigs and poultry production. The pigs were, however, killed due to the advent of African swine fever (Eastern Cape Provincial Government, Department of Agriculture, 2008) and poultry production chiefly village chickens became the main enterprise. Most chickens in Nontshinga did not have housing while in Qolora by-sea some farmers provided housing for their chickens (Mwale and Masika, 2009). In both villages chickens scavenged for feed and were supplemented mainly with yellow maize once or twice a day. Village chickens improve the nutritional status together with income of rural households and landless communities (Permin et al., 2002) through the

*Corresponding author. E-mail: pmasika@ufh.ac.za. Tel: +27 40 602 2387. Fax: +27 40 602 2583.

provision of meat and eggs. The chickens are also used for socio-cultural purposes (Thekisoe et al., 2004) and have few social and religious taboos (Mafu and Masika, 2003).

Gastro-intestinal parasites are, however, the most prevalent and most devastating parasites affecting village chicken productivity (Njunga, 2003). According to Muchadeyi et al. (2004) and Mwale and Masika (2009) village chickens are raised mainly under the free-range (scavenging) production system, with partial or no housing and this predisposes the chickens to diseases and parasites especially helminthes (Swatson et al., 2003). They cause anaemia due to blood loss, and can cause damage directly by causing diarrhoea, poor absorption of nutrients, anorexia, enteritis thereby affecting birds' growth and egg production. The parasites indirectly transmit diseases; for example, *Heterakis gallinarum* is an intermediate host of *Histomonas meleagridis* that causes histomoniasis. The disease is characterized by low growth rates and low egg production, and in chicks high mortality is predominant (Soulsby, 1982).

Several studies on the prevalence of gastro-intestinal parasites in village chickens have been conducted in different countries and varying species of endo-parasites were identified (Ssenyonga, 1982; Poulsen et al., 2000; Permin et al., 2002; Muhairwa et al., 2007). However, there is scanty information on the prevalence of gastro-intestinal parasites in village chickens in South Africa. Therefore, a point prevalence study was conducted to determine gastro-intestinal parasites prevalent in village chickens of Centane district in the Eastern Cape Province of South Africa.

MATERIALS AND METHODS

Study area and sample collection

A point prevalence study was conducted to determine the prevalence of gastro-intestinal parasites in village chickens of the two villages; Qolora by-sea (32°38'63"S and 28°24'36"E; elevation 50 m) and Nontshinga (32°29'65"S and 28°17'80"E; elevation 476 m); in Centane district in the Umnquma local municipality, of the Amathole district Municipality. This area forms part of the coastal Eastern Cape which is characterised by high regular rainfall throughout the year (700 - 1000 mm/annum) with most rains occurring in spring and summer months (October to March) particularly in the lowland coastal belt, extending 30 to 60 km inland (Eastern Cape Development Cooperation (ECDC), 2007). The average summer minimum temperatures range is 19 - 23°C and the maximum range is 28 - 31°C. In winter, the average minimum temperature is 7°C while the maximum temperature is 21°C.

Seventy households were randomly selected from farmers owning village chickens, in each of the two villages; Qolora by-sea and Nontshinga, in October 2007. The two villages were chosen following a questionnaire survey, previously conducted in the area by Mwale and Masika (2009), in which farmers considered gastro-intestinal parasites to be a hindrance in their chicken farming endeavours. Compound sampling was performed early morning for the collection of fresh faecal samples of village chickens from the ground and fowl runs. The collected samples were preserved in 10% formalin, and later stored in a fridge at 4°C before laboratory analyses.

Laboratory analyses

The floatation technique

The modified quantitative McMaster (floatation) technique was used for the examination of nematode and cestode eggs, together with coccidial oocysts (MAFF, 1986). Faecal samples (4 g) were mixed thoroughly in 56 ml of the floatation fluid; sugar: sodium chloride solution at a ratio of 4:3, according to procedures by Hansen and Perry (1994). The mixture was strained through a soft wire strainer into a test-tube. While stirring the filtrate in the test tube, a sub-sample was withdrawn using a Pasteur pipette, filled in both sides of the McMaster counting chamber, and left to stand for 5 minutes before the sub-sample of the filtrate was examined under a 10 × 10 magnification compound microscope. Helminth eggs and coccidial oocysts within the engraved area of both chambers were identified according to keys developed by Soulsby (1982), counted and recorded. The number of eggs per gram of faeces for each parasite species was calculated by multiplying the number of eggs counted in the McMaster chambers by the factor 50.

The sedimentation technique

The standard qualitative sedimentation technique was used to detect trematode eggs according to the procedure by Hansen and Perry (1994). Faecal samples (3 g) were mixed thoroughly in 45 ml of tap water in a beaker, strained through a soft wire strainer into a test tube, and the filtrate left to stand for 5 min. Using a Pasteur pipette, the supernatant was carefully withdrawn from the filtrate. The sediment was re-suspended in 5 ml of tap water and left to stand for 5 min, after which the supernatant was, discarded carefully using a Pasteur pipette. The sediment was stained by adding one drop of methylene blue solution, and the stained sediment was subsequently withdrawn using a 2 ml Pasteur pipette and transferred to a microscope slide. The slide was covered with a cover slip for sediment examination under a 10 × 10 magnification compound microscope. The eggs were identified according to keys developed by Soulsby (1982), and recorded. Eggs per gram of faeces were obtained through the multiplication of the total number of eggs identified by the factor 48.

Data analyses

Since pooled or compound samples were used prevalence was calculated as the number of chicken flocks/household infested with a particular parasite species, divided by the total number of chicken flocks sampled. The obtained data were tested for normality with the aid of the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 2004) and thereafter the $\log_{10}$ transformation was performed, because the data was not normally distributed. The prevalence of gastro-intestinal parasites within villages was determined using the GLM procedures of SAS (2004). The same statistical package was used for the computation of Tukey's W procedure for the comparison of the mean number of EPG for the gastro-intestinal parasites between the two villages.

RESULTS

Ninety-nine percent of the chicken faecal samples collected from 70 households had gastro-intestinal

Table 1. Prevalence (%) of gastro-intestinal parasites in chickens of the two villages of Centane district.

Gastrointestinal parasite type	Prevalence (%)	
	Qolora by-sea (n = 35)	Nontshinga (n = 35)
Nematodes		
Ascaridia galli	14.28	31.43
Heterakis gallinarum	25.72	27.14
Subulura brumpti	0	1.43
Prosthogonimus species	1.43	0
Gongylonema ingluvicola	0	1.43
Syngamus trachea	1.43	0
Capillaria species	22.86	28.57
Strongyles	15.71	35.72
Cestodes		
Choanotaenia infundibulum	0	1.43
Amaebotaenia sphenoides	1.43	0
Raillietina cesticillus	1.43	1.43
Davainea proglottina	0	1.43
Protozoa		
Coccidia species	41.43	25.71
Trematodes		
Postharmostomum gallum	2.86	35.71
Postharmostomum communtatum	18.57	2.86

parasites. A total of 15 gastro-intestinal parasite species were identified; 8 nematodes, 4 cestodes, 1 protozoan, and 2 trematodes. Nematodes, particularly *H. gallinarum* and coccidia were the most prevalent parasites identified (Table 1). Different coccidia species could, however, not been distinguished due to the limitations with the testing method (equipment) utilized in the study. The prevalence of *Subulura brumpti* and *Gongylonema ingluvicola* was low (1.43%; Table 1) and these nematode species were found only in Nontshinga village. *Prosthogonimus* species and *Syngamus trachea* had also a prevalence of 1.43% but were found only in Qolora by-sea. Cestodes were the least prevalent parasites (Table 1) with *Amaebotaenia sphenoides* found only in Qolora by-sea (1.43%) and, *Choanotaenia infundibulum* together with *Davainea proglottina* were found only in Nontshinga (1.43%). *Postharmostomum gallum* and *Postharmostomum communtatum* were the only trematodes identified.

As indicated in Table 2, between the two villages, there was no significant difference in the mean EPG for cestodes, coccidia and nematodes identified save for *Ascaridia galli* and Strongyles. There was a difference ($P < 0.05$) in the mean EPG for trematodes, between villages. The prevalence of gastro-intestinal parasites varied between the two villages ($P < 0.05$); more parasites were prevalent in Nontshinga village except for *P. communtatum.*

DISCUSSION

The findings of varying gastro-intestinal parasite species in village chickens of Centane district concurs with earlier studies done in rural scavenging chickens in Ghana, Zimbabwe and Tanzania (Poulsen et al., 2000; Permin et al., 2002; Muhairwa et al., 2007). According to previous studies by Permin et al. (1997), *H. gallinarum* was the most prevalent parasite especially in the wet season, while in this particular study the nematode *Heterakis gallinarum* and the protozoa coccidia were the most prevalent parasites. There is, however, dearth of information on the prevalence of gastro-intestinal parasites in chickens in South Africa. Most studies have been conducted on Helmeted guinea fowls (Junker and Boomker, 2007; Davies et al., 2008; Junker et al., 2008). The authors reported that the prevalence of *Capillaria* and Strongyles was high while that of *H. gallinarum* and *Ascaridia galli* was low. Pertaining coccidia it could be that incidental cases were observed in the current study. The findings, nevertheless, set a basis for conducting a comprehensive study on the prevalence of respective species of coccidia that affect village chickens in the Eastern Cape Province in South Africa. In the current

Table 2. The eggs per gram of faeces mean (± standard error) of gastro-intestinal parasites found in chickens at Centane district.

Gastrointestinal parasite type	Village	
	Qolora by-sea (n = 35)	Nontshinga (n = 35)
Nematodes		
Ascaridia galli	0.65^{b}±0.183 (0-450)	1.33^{a}±0.183 (0-1 350)
Heterakis gallinarum	1.14±0.204 (0-1 300)	1.25±0.204 (0-2 200)
Subulura brumpti	0.00±0.051 (0)	0.07±0.051 (0-350)
Prosthogonimus species	0.05±0.034 (0-50)	0.00±0.034 (0)
Gongylonema ingluvicola	0.00±0.034 (0)	0.05±0.034 (0-50)
Syngamus trachea	0.05±0.034 (0-50)	0.00±0.034 (0)
Capillaria species	1.00±0.204 (0-4 700)	1.34±0.204 (0-1 050)
Strongyles	0.58^{b}±0.180 (0-700)	1.83^{a}±0.180 (0-2 300)
Cestodes		
Choanotaenia infundibulum	0.00±0.034 (0)	0.05±0.034 (0-50)
Amaebotaenia sphenoides	0.05±0.034 (0-50)	0.00±0.034 (0)
Raillietina cesticillus	0.05±0.049 (0-50)	0.05±0.049 (0-50)
Davainea proglottina	0.00±0.046 (0)	0.07±0.046 (0-200)
Protozoa		
Coccidia species	2.02±0.226 (0-4 650)	1.52±0.226 (0-14 550)
Postharmostomum gallum	0.12^{b}±0.233 (0-300)	2.50^{a}±0.233 (0-202 950)
Postharmostomum communtatum	0.89^{a}±0.173 (0-1 650)	0.18^{u}±0.173 (0-11 000)

Means with different superscript in the same row significantly differ ($P < 0.05$); Figures in parenthesis represent the range for the actual values (untransformed data) of eggs per gram of faeces.

study the prevalence of *H. gallinarum* was high, which is contrary to the previous findings where the prevalence was low (4%) in guinea fowls (Verster and Ptasinska-Kloryga, 1987; Junker and Boomker, 2007). High prevalence of *H. Gallinarum* is however, in agreement with earlier findings by Saayman (1966).

The fairly high prevalence findings for *Capillaria* worm spp. were concurrent with the findings by Magwisha et al. (2002) in Tanzania. *Ascaridia galli* prevalence findings in the current study were in agreement with the *A. galli* prevalence reported in guinea fowls in South Africa (Verster and Ptasinska-Kloryga, 1987). The virtually low prevalence of *S. brumpti, G. ingluvicola, Prosthogonimus* spp. and *S. trachea* could be attributed to compounding effects of management, chicken breeds and agro-ecological zone and, therefore, could be explained after conducting seasonal prevalence study. The *Cestode* spp. identified agree with the findings in earlier studies (Poulsen et al., 2000; Permin et al., 2002) conducted in free-range village chickens. Mean EPG for *A. galli,* Strongyles (other various nematode worms of the family Strongylidae, often parasitic in the gastrointestinal tract) and *P. gallum* were more in Nontshinga compared to Qolora by-sea. This could probably be attributed to differences in the way chickens were managed in the two villages since it was observed that chicken farmers in the two villages employed different management aspects (Mwale and Masika, 2009). The fact that parasites were mainly prevalent in Nontshinga village could be accredited to the poor poultry management system applied by farmers. The majority of whom (66.7%) did not have housing for chickens (Mwale and Masika, 2009) thus increasing chickens' scavenging period and hence further exposure to gastro-intestinal parasite infestation, and contact with intermediate hosts (such as insects and earthworms).

High prevalence and a wider range (Table 2) for the various gastro-intestinal parasites identified in the current study could be attributed to the scavenging habit of village chickens which lead them to remain in permanent contact with other flocks of chickens, soil and intermediate hosts thereby increasing the chances of parasite infestations (Permin and Hansen, 1998). In addition, while chickens peck at the ground during the day or when provided with poor housing; they inadvertently ingest helminth eggs and coccidial oocysts, which when they sporulate, the infective larvae infect the chickens' gut tissue, which may interfere with the birds' nutrient uptake (Muchadeyi et al., 2004; Jenkins, 2007; Muhairwa et al., 2007). Several studies across Africa show that there is poor housing for free-range chickens (Soinaiya, 1994; Eshetu et al., 2001; Pedersen, 2002) and this predisposes the chickens to helminth infections. In Qolora by-sea and Notshinga, the chicken houses were

poorly constructed with zinc metal material having little/no ventilation thereby resulting in high humidity and temperatures which are conducive for the hatching and/or sporulation and development into infective stages of most gastro-intestinal parasites. Therefore, there is need to provide the chickens with proper housing, nutritious uncontaminated feed and clean water in order to reduce losses in chickens.

In this study, trematodes were generally few and this observation is concurrent with previous findings (Ssenyonga, 1982; Jenkins, 2007; Abdelgader et al., 2008) where few or not at all trematodes were found in local chickens. Trematodes are rare because a vast number of trematodes, together with poultry tapeworms require a wide range of hosts which may not be available. In most cases the prevailing environmental conditions might not be conducive for the perpetuation of the intermediate hosts (Junker and Boomker, 2007; Abdelgader et al., 2008). Thus, the life cycle of the parasites is rarely completed. In addition, trematodes are more important parasites of wild water-fowl, domesticated ducks, geese and not chickens (University of Reading, 2007). However, in the present study, albeit only *P. communtatum* and *P. gallum* were identified, their mean EPG values were fairly high indicating that water for the hatching of eggs, and intermediate hosts such as dragonflies and freshwater snails for the trematodes' life cycles were present since the study area was near the sea. However, in most cases, birds have mixed infections but normally with little/no trematodes (Abdelgader et al., 2008).

Gastrointestinal parasites remarkably lower chicken productivity and hence flock size (Magwisha et al., 2002; University of Reading, 2007). This in turn reduces the nutritional status (animal protein intake) and income generation of the rural households thereby adversely affecting their livelihoods. Therefore, studies have to be done on how best to sustainably control gastro-intestinal parasites in village chickens to improve chicken health and productivity. Subsequently, farmer awareness on gastro-intestinal parasites that are prevalent and affect village chicken productivity in their area is important. Ultimately, farmers need to be trained on how to practice sound and appropriate village chicken management techniques to limit losses of chickens. This will presumably lead to improved rural livelihoods.

Conclusion

Various species of gastro-intestinal parasites were prevalent in village chickens at Centane district. *H. gallinarum* and coccidia were the most prevalent. *P. gallum* and *P. communtatum* were the only trematodes identified while a range of nematodes was identified. The prevalence of parasites did not vary within villages, but it however varied between villages, and it was higher in Nontshinga. Furthermore, studies on seasonal prevalence, involving dissection of the gastro-intestinal tracts for the determination of gastro-intestinal parasites prevalent in village chickens in the Eastern Cape Province need to be conducted. This is crucial for the comprehensive documentation of village chicken gastro-intestinal parasites prevalent in the area for future planning on improved village chicken productivity and hence rural livelihood.

ACKNOWLEDGEMENTS

The authors are grateful to the National Research Foundation of South Africa for funding the Research. Authors are also indebted to staff and colleagues of the Agricultural and Research Institute and the Department of Livestock and Pasture Science of the University of Fort Hare for technical support rendered.

REFERENCES

Abdelgader A, Gauly M, Wollny CBA, Abo-Shehada MN (2008). Prevalence and burden of gastro-intestinal helminthes among local chickens, in northern Jordan. Prev. Vet. Med., 85: 17-22.

Alders RG, Pym RAE, Rushton J (2009). Village poultry: still important to millions, eight thousand years after domestication. World Poult. Sci. J., 65: 181-190.

Davies OR, Junker K, Jansen R, Crowe TM, Boomker J (2008). Age- and sex-based variation in helminth infection of helmeted guinaefowl (*Numida meleagris*) with comments on Swainson's spurfowl (*Pternistis swainsonii*) and Orange River francolin (*Scleroptila lavaillantoides*). S. Afr. J. Wildl. Res., 38(2): 163-170.

Dold A, Cocks ML (2002). The trade in medicinal plants in the Eastern Cape Province. S. Afr. J. Sci., 98: 586-597.

Eastern Cape Development Cooperation Website (ECDC) (2007). Climate. Available at: http://www.ecdc.co.za/easterncape/ec.asp?pageid=22 (Retrieved November 28, 2007).

Eastern Cape Provincial Government, Department of Agriculture (2008): Eastern Cape Department of Agriculture keeps classical swine fever outbreak under control. Available at: http://www.info.gov.za/speeches/2006/06050210451003.htm (Retrieved November 02, 2008).

Eshetu Y, Mulualem E, Ibrahim H, Berhanu A, Aberra K (2001). Study of gastro-intestinal helminths of scavenging chickens in four rural districts of Amhara region, Ethiopia. Revue Sci. Tech.-Office Int. Des., 20(3): 791-796.

Food and Agriculture Organization (FAO) (2007). Statistical databases. FAO, Rome.

Hansen J, Perry B (1994). Techniques for parasite assays and identification in faecal samples: In Management of Vertisols in Sub-Saharan Africa- FAO Corporate document repository. The International Laboratory for Research on Animal Diseases, Nairobi.

Jenkins M (2007). Curbing Coccidiosis in Chickens: A Fine-tuned Approach. Agric. Res. Mag., 55(2).

Junker K, Boomker J (2007). Helminths of guineafowls in Limpopo Province, South Africa. J. Vet. Res., 74: 265-280.

Junker K, Debusho L, Boomker J (2008). The helminth communit of Helmeted Guineafowls, *Numida meleagris* (Linnaeus, 1758), in the north of Limpopo Province, South Africa. J. Vet. Res., 75: 225-235.

Kitalyi AJ (1988). Village chicken production systems in rural Africa-household food security and gender issues: FAO Animal Production and Health Papers 142. Publishing Management Group, FAO Information Division, Rome.

MAFF (1986). Manual of Veterinary Parasitological Laboratory Techniques. ADAS, HMSO, pp 6-10.

Mafu JV, Masika PJ (2003). Small-scale broiler production by rural farmers in the central Eastern Cape Province of South Africa. Fort Hare Papers, 12 (1): 25-34.

Magwisha HB, Kassuku AA, Kyvsgaard NC, Permin A (2002). A Comparison of the Prevalence and Burdens of Helminth Infections in Growers and Adult Free-Range Chickens. Trop. Anim. Health Prod., 34(3): 205-214.

Muchadeyi FC, Sibanda S, Kusina NT, Kusina J, Makuza S (2004). The village chicken production system in Rushinga District of Zimbabwe. Livest. Res. Rural Dev., 16(6): Available at: http://www.cipav.org.co/lrrd/lrrd16/6/much16040.htm (Retrieved October 28, 2008).

Muhairwa AP, Msoffe PL, Ramadhani S, Mollel EL, Mtambo MMA, Kassuku AA (2007). Prevalence of gastro-intestinal helminths in free-range ducks in Morogoro Municipality, Tanzania. Livest. Res. Rural Dev. 19(4) Available at: http://www.cipav.org.co/lrrd/lrrd19/4/muha19048.htm (Retrieved October 28, 2008).

Mwale M, Masika PJ (2009). Ethno-veterinary control of parasites, management and role of village chickens in rural households of Centane district in the Eastern Cape, South Africa. Trop. Anim. Health Prod., 41: 1685-1693.

Njunga GR (2003). Ecto- and haemoparasites of chickens in Malawi with emphasis on the effects of the chicken louse, *Menacanthus cornutus*. M. Sc. Thesis. the Royal Veterinary and Agriculture University, Dyrlægevej 2, Denmark.

Pedersen CV (2002). Production of semi-scavenging chickens in Zimbabwe. PhD Thesis. The Royal Veterinary and Agricultural University, Copenhagen, Denmark.

Permin A, Esmann JB, Hoj CH, Hove T, Mukaratirwa S (2002). Ecto-, endo- and haemoparasites in free range chickens in the Goromonzi District in Zimbabwe. Prev. Vet. Med., 54(3): 213-224.

Permin A, Hansen J (1998). The Epidemiology, diagnosis and control of poultry parasites. FAO, Rome.

Permin A, Magwisha H, Kassuku AA (1997). A cross-sectional study of helminths in rural scavenging poultry in Tanzania in relation to season and climate. J. Helminthol., 71 (3): 233-40.

Poulsen J, Permin A, Hindsbo O, Yelifari L, Nansen P, Bloch P (2000). Prevalence and distribution of gastro-intestinal helminths and haemoparasites in young scavenging chickens in upper eastern region of Ghana, West Africa. Prev. Vet. Med., 45: 237-245.

Saayman J (1966). A study of the diet and parasites of *Ardeola (Bubulcus) ibis, Numida meleagris* and *Gallus domesticus* from the Eastern Cape Province, South Africa. PhD. Thesis, University of South Africa. In: Junker and Boomker, 2007b (eds) A check list of the helminths of guineafowls (Numididae) and a host list of these parasites. J. Vet. Res., 74: 315-337.

Soinaiya EB, Atunbi OA, Dare AL (1994). An assessment of some health and production costs for smallholder poultry in south-western Nigeria. Kenyan Vet. J., 18(2): 252-254.

Soulsby EJL (1982). Helminthes; Arthropods and Protozoa of Domesticated Animals (7th edn). Bailli÷re Tindall, East Sussex.

Ssenyonga GSZ (1982). Prevalence of helminth parasites of domestic fowl (G*allus domesticus*) in Uganda. Trop. Anim. Health Prod., 14 (4): 201-204.

Statistical Analytical Systems (SAS) (2004). SAS/STAT User's guide (Release 8.1 Edition). SAS Institute Inc. Cary, North Carolina.

Swatson HK, Tshovhote J, Nesamvumi E, Ranwedzi NE, Fourie C (2003). Characterization of indigenous free-ranging poultry production systems under traditional management conditions in the Vhembe district of the Limpopo Province, South Africa. Available at: http://www.ilri.org/Link/Files/Theme3/Avian%20Flu/characterization%20of%20indegenous%20free%20ranging%20poultry%20SA.pdf. (Retrieved October 28, 2008).

Thekisoe MMO, Mbati PA, Bisschop SPR (2004). Different approaches to the vaccination of free ranging village chickens against Newcastle diseases in Qwa-Qwa, South Africa. Vet Microbiol., 10i(1): 23-30.

University of Reading. Index of Poultry Diseases: Helminths. Available at: http://www.organic-vet.reading.ac.uk/poultryweb/disease/helm/helm.htm. Accessed 03 November, 2007.

Verster A, Ptasinska-Kloryga Y (1987). Helminths of helmeted guineafowl in southern Africa. S Afr. J. Wildl Res. Supplement 1, 36-38. In: Junker and Boomker, 2007b (eds) A check list of the helminths of guineafowls (Numididae) and a host list of these parasites. J. Vet. Res., 74: 315-337.