Prevalence of the gastro-intestinal parasites of domestic chicken *Gallus domesticus* Linnaeus, 1758 in Tunisia according to the agro-ecological zones

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Abstract Helminthosis is a very important disease affecting the poultry industry, especially the traditionally reared free ranging chickens. In Tunisia, the poultry production is considered as the most important source of protein in as much as chickens provide 53 % of animal protein production. The traditionally reared poultry farming system exposes chickens to many types of parasites, however, very little work has been done to establish the extend of helminth infection in Tunisia. The aim of this work is to investigate various aspects of helminth infections. A significant difference ($p < 0.01$) was found between the prevalence rates of helminth parasites in the different agro-ecological zones. The highest prevalence was observed in lowland areas of northern Tunisia (Siliana district). This suggests that agro-ecology has a major influence on the distribution of helminth parasites. Recovered nematodes included *Heterakis* spp. (100 %), *Ascaridia galli* (53.33 %) and *Acuaria hamulosa* (37 %). The principal cestode species encountered were *Hymenolepis* spp. (73.33 %) and *Raillietina* spp. (33.33 %).

Keywords Gastro-intestinal helminths · Parasites · Tunisia · Chickens

Introduction

In Tunisia, rural poultry production represents a significant contribution to rural economy, as a source for smallholder farmers. In addition, both poultry meat and eggs are

affordable sources of protein. Indeed, chickens play an important role in the provision of animal protein for the rural population. The total poultry production of Tunisia is estimated at 118.300 tonnes per year, which represents more than 53 % of the total animal protein production. Helminthiasis is considered as one of the most significant constraints on poultry production in humid tropical climatic conditions which are favorable for faster propagation and development of the larval stages of helminth parasites (Matta and Ahluwalia 1981; Malhotra 1983; Kulkarni et al. 2001). Although, these helminthic infections are rarely fatal and are often neglected they cause heavy economical loss to poultry farmers due to reduced productivity (meat and eggs), beside some helminths also act as carriers of pathogenic agents. In addition to helminthiasis, other infectious diseases such as Salmonellosis, coccidiosis and some others pathological protozoa are considered to be a considerable causes of mortality, while predators are an additional source of loss.

The traditionally reared poultry farming system exposes chickens to many types of parasites, however, very little work has been done to establish the extend of helminth infection in Tunisia. The aim of this research is to study the prevalence of gastro-intestinal helminths in traditional reared free ranging chickens with the objective of collecting base line data. The prevalence of gastro-intestinal helminths parasites was evaluated in poultry with three different districts in order to assess the impact of agro-ecosystems on the prevalence of helminths.

Material and methods

The study area

The study was carried out from February to June 2005. Three districts were selected to conduct a cross-sectional

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study on gastro-intestinal helminths of poultry. These regions present climatic and geographic differences:

- Siliana with a sub humid climate, is located at the north of the country (rainfall = 600 mm/year, mean temperature = 18 °C),
- Boumerdes with coastal east location, is characterised by superior semi-arid climate (rainfall = 300 mm/year, mean temperature = 19 °C),
- Ghomrassen is a south mountainous region characterised by Saharan climate (rainfall = 76 mm/year, mean temperature = 21 °C). It should be emphasized that all these areas are characterised by a softly winter.

Examination of chickens to evaluate the prevalence of helminthic infections

Ten chickens from each area are used in this study. They are apparently healthy. They were bought from farmer; all of them are domestic reared according to traditional system. In the laboratory, age (juvenile/adult) and sex of each individual were determined. The chickens were then euthanized and eviscerated. The alimentary canal, from the oesophagus down, was separated into crop, gizzard, proventriculus, small intestine (cut into nine equal fragments) and caeca. After, each region was cut and opened by dissection. The intestinal scrapping and flotation methods were used to collect the parasite.

Data analysis

All worms visible to the naked eye were removed using thumb forceps. All the adult worms were identified directly under the stereomicroscope using the characteristics described by Soulsby (1965). Variations in the prevalence of gastro-intestinal helminths in relation to the different agro-ecosystems were analysed using the Chi square statistics. In this study, the prevalence was estimated by Thrusfield (1995) equation:

$$P = 100 \times \frac{\text{Number of infected chicken}}{\text{Total number of observed chicken.}}$$

The abundance is calculated as:

$$A = \frac{\text{Number of parasite species isolated}}{\text{Total number of observed chicken.}}$$

Results and discussion

In the three aforementioned areas, all the chickens observed were infected leading to a prevalence of the parasitic infection equal to 100 %. The same prevalence is

found in Ghana (Poulsen et al. 2000), in Zimbabwe (Permin et al. 2002) and in Tanzania (Magwisha et al. 2002). This strong prevalence indicates that all these chickens present subclinic signs of infection (Magwisha et al. 2002). These signs are less important in Sudan (Saad et al. 1989), in Ethiopia (Ashenafi and Eshetu. 2004) and in Kenya (Irungu et al. 2004), with 86.3, 94.7, 90.8 and 77.3 %, respectively.

In our study, the strong prevalence of the endoparasitism can be explained by continuous chickens' exposure to conditions supporting their infection. They feed on one place to another and sought their food in the surface layer of the ground. This latter is generally infected with a large variety of living organisms including insects and worms which could be intermediated hosts of certain parasites.

The cestodes are *Hymenolepis* species (73.33 %) and *Raillietina* species (33.33 %). According to Eshetu et al. (2001), *Raillietina* species were more prevalent in Ethiopia (45.7 %). The nematodes are *Acuaria hamulosa* (37 %), *Ascaridia galli* (53.33 %), and *Heterakis* spp. (100 %). The same results were established by Jansen and Pandey (1989) in Zimbabwe.

Our results agree with those found in Denmark where *Heterakis* spp. are more prevalent (72.5 %) among 5 recorded species having a prevalence of infection of 100 % (Permin et al. 1999). These differences are attributable to environmental conditions, mainly the temperature and moisture which support the development of the helminths. The geographical variations in the distribution of the parasites or the intermediate hosts of the worms could be also the reasons of this difference (Table 1).

Geographical distribution of helminths

According to Table 1, the helminth species and their percentages differ from one area to another.

- *Siliana* The chickens of this area are infested by four species of helminths at the same time: *A. hamulosa*, *A. galli*, *Heterakis* spp. and *Hymenolepis* spp. They have the highest level of infestation (100 %). However, *Raillietina* spp. misses in this sample.
- *Boumerdes* The chickens of this area are infested by the three species of helminths but the percentage of chickens infected by each one of them is different: *A. hamulosa* (10 %), *A. galli* (60 %), *Heterakis* spp. (100 %), *Hymenolepis* spp. (73.33 %) and *Raillietina* spp. (33.33 %). In Boumerdes, *Heterakis* spp. is more prevailing.
- *Ghomrassen* Within this area, three species of helminths were detected in the digestive tractus of chickens with different percentages: *Heterakis* spp. (100 %), *Hymenolepis* spp. (60 %) and *Raillietina* spp.

Table 1 Helminth prevalence

Species	Infected chicken number			Prevalence (%)
	Siliana	Boumerdes	Ghomrassen	
<i>Acuaria hamulosa</i>	10	1	0	37
<i>Ascaridia galli</i>	10	6	0	53.33
<i>Heterakis</i> sp.	10	10	10	100
<i>Hymenolepis</i> sp.	10	6	6	73.33
<i>Raillietina</i> sp.	0	7	3	33.33

(30 %) with absolute predominance of *Heterakis* spp. (100 %).

Only *Heterakis* spp. and *Hymenolepis* spp. are common between the three samples. The sample of Boumerdes is only infected by the five species but with moderate prevalence. Siliana area presents the highest prevalence. The chickens from Ghomrassen are infected by three helminth species with a low prevalence.

A statistical analysis by the test of Chi square revealed a significant difference in the distribution of the following parasites between the three areas:

Acuaria hamulosa $\chi^2_{(2)} = 26.12$, $p < 0.001$

Ascaridia galli $\chi^2_{(2)} = 20.357$, $p < 0.001$

Raillietina spp. $\chi^2_{(2)} = 11.10$, $p < 0.004$

The same analysis did not show significant difference between geographical distributions of *Heterakis* spp. and *Hymenolepis* spp.: $\chi^2_{(2)} = 2.25$, $\chi^2_{(2)} = 5.45$ respectively. This significant relationship between the prevalence of the parasites and agro-ecosystems was highlighted in several studies such as in Ghana (Poulsen et al. 2000) and Ethiopia (Eshetu et al. 2001; Ashenafi et al. 2004).

The prevalence was inversely proportional with the altitude of the study zones. The very low temperature, in the mountainous areas, inhibits the development and the survival of the larvae and limits their passage to the intermediate or final hosts. However, the moderate temperature supports the transmission and the survival of the parasites. This means that the difference between the climates influences the biological cycle of those helminths depends on the presence of micro-environment favourable for the survival and the transmission of the infesting larvae and of eggs of the parasites.

Association of the parasites in chickens

Several chickens are infected by more than one parasite at the same time. According to several studies (Fakae et al. 1991; Mpoame and Agbede, Mpoame and AgbedeG, 1995; Permin et al. 1997; Poulsen et al. 2000; Shamsul-Islam 1985; Yadav and Tandon 1991), this multiple infection

appears as a common phenomenon in chickens. Studies carried out in Ethiopia revealed that 73.8 % of chickens had an association from one to six species (Eshetu et al. 2001). In Botswana, *A. galli* was found with *Raillietina* spp. (Mushi et al. 2000). In our study, the majority of the poultry (86.66 %) had a multiple infection (from two to four species). This suggests that the environmental conditions and the system of traditional breeding are favourable for the simultaneous development of the various helminth species (Table 2).

Average abundance of the parasites according to areas

First and foremost, nematodes and cestodes have variable intrinsic abundance. This abundance is also variable from one area to another (Table 3). The abundance of *A. hamulosa* is equal to 2.5, 0.2 and 0 in Siliana, Boumerdes and Ghomrassen, respectively. The chickens of Siliana present the highest load of *A. galli*. They are infected by fairly 27 specimens each one. This average charge decreases in Boumerdes' chickens and vanishes all at those of Ghomrassen.

The average charge in *Heterakis* spp. is strong in the three samples and exhibits some differences. The highest one is noticed in Siliana area (334), the middle in Boumerdes area (132.1) and the lowest in Ghomrassen area (85). *Hymenolepis* spp. has a load which decreases from 11 to 8 and 7.2 for Siliana, Ghomrassen and Boumerdes, respectively. *Raillietina* spp. is the unique cestode which is not encountered in Siliana. The average charge is equal to 3.3 and 2.66 in Boumerdes and Ghomrassen, respectively.

Parasites location

The helminths vary from an organ to another in species and in a number. The oesophagus and the proventricule were deprived of parasites in the three areas. Only *A. hamulosa* was detected on the level of the gizzard. The percentage of infestation was 100 % in Siliana and 30 % in Boumerdes. The cestodes were insulated with difficulty in as much as they were completely inserted in the muscle.

Table 2 Percentage of chickens with multiple infections

Number of species of parasite per chicken	Number of infected chickens	Percentage of infected chickens
1	4	13.33
2	6	20
3	5	16.66
4	15	50
5	0	0
Total	30	100

Table 3 Average abundance of the helminths according to areas

Helminths species	Average abundance of the helminths		
	Siliana	Boumerdes	Ghomrassen
Nematodes			
<i>Acuaria hamulosa</i>	2.5	0.2	0
<i>Ascaridia galli</i>	27	3.4	0
<i>Heterakis</i> sp.	334	132.1	85
Cestodes			
<i>Hymenolepis</i> sp.	11	7.2	8
<i>Raillietina</i> sp.	0	3.3	2.66

The caeca of the chicken of the three areas was infected by *Heterakis* spp. with a rate of 100 %. The intestine was infected by more than one parasite species. In Siliana, we isolated *Ascaridia galli* and *Hymenolepis* spp. In Boumerdes, we detected *Ascaridia galli*, *Hymenolepis* spp. and *Raillietina* spp. These latter were only found in Ghomrassen.

According to Fig. 1, the parasitic load varies from the inlet end to the distal end of the intestine. *A. galli* and *Hymenolepis* spp. were located preferentially on the first half of the intestine (between fragments one and six) with a

maximum parasitic number between fragments three and four. *A. galli* was observed in the middle of the intestine. However, *Raillietina* spp. extended throughout the intestine except the first fragment. The highest parasitic numbers of these cestodes were recorded in fragments four and six. The whelming majority of parasites were concentrated in the central zones between fragments two and six.

Relationship between age and parasitic infection

The Chi square test shows significant relationship between the age and the rate of infection: $\chi^2_{(2)} = 12.10$, $p < 0.004$. Several studies were devoted to this relationship. A study carried out in Tanzania revealed a significant difference between the prevalence of infection between the young and old chickens (Mgwisha et al. 2002). In addition, another study performed in Zimbabwe proved a minor difference in the prevalence and severity of the parasites between juvenile and adult chickens (Permin et al. 2002). This last result is explained by the development of immunity in the adults that decreases the pathogenesis of the helminths.

Relationship between sex and parasitic infection

The Chi square test shows no significant relationship between the sex and the parasitic infection. This result corroborates the conclusion of the study carried out in Cameroun which did not reveal any relationship between the sex of chickens and their rate of infection by the helminths (Mpoame and Agbede 1995). However, *A. galli* was more prevalent in males (Mpoame and Agbede 1995). The difference of the prevalence of cestodes and nematodes between males and females in Ghana, Tanzania and in Ethiopia was not statistically significant (Ashenafi and Eshetu 2004; Magwisha et al. 2002; Poulsen et al., 2000).

Fig. 1 Distribution of the parasites on the level of the intestine

These studies show the absence of a natural affinity between helminth species and sex hosts.

Conclusion

Although cestodes in poultry are known to cause retarded growth, enteritis, diarrhoea, haemorrhages and hypovitaminosis B, heavy infections may also be associated with mortality in young birds. These diseases generate loss of egg production. Furthermore *Raillietina tetragona* is considered to be harmful to chickens, in same way some cystic forms of *Raillietina echinobothrida* were observed on the serosa of the intestinal tract, abdomen and lungs, which may interfere with the normal functioning of the organs.

Nematodes are the most widespread parasite infecting chickens in Tunisia. In the regions of concern, the most prevalent nematode was *Heterakis* spp. ($p = 100\%$). This result is conforming to literature. The variation of nematode prevalence is attributable to differences in local environmental conditions, which support larval development and facilitate transmission.

Infection with nematodes causes reduction in the growth rate and weight loss. This behaviour is related to damage of the intestinal mucosa. The parasite was sometimes observed in the abdominal cavity after penetrating intestinal lumen. This may be accompanied by damage of intestinal wall, blood loss and secondary infections causing loss of weight and low production. Generally, nematode significantly affects the health of chickens by sharing the feed consumed by the host, thus stunting growth and reducing egg and meat production. Hence firm measures should be undertaken to control this economically important parasite.

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