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PREVALENCE AND RISK FACTORS OF *EIMERIA SPP.* AND *GIARDIA SPP.* IN RABBITS OF LOCAL ALGERIAN POPULATION

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ABSTRACT

The objective of this study was to determine the prevalence and to identify the risk factors of *Eimeria* spp. and *Giardia* spp. infection in rabbits from the local population of four localities in northern Algeria. Dung samples were collected from 16 farms, totalling 111 rabbits, and were analysed by the flotation method. Additional, data regarding the farms and management practices were obtained by means of a questionnaire used in the surveys and interviews. The results revealed that the prevalence of *Eimeriaspp.* contamination was 68.75% (11/16) for farms and 58.56% (65/111) for rabbits, respectively. The prevalence of *Giardia spp.* was respectively 56.25% (9/16) for farms and 11.7% (13/111) for rabbits. The analyses showed that the prevalence of *Eimeria* spp. was significantly higher in the farms that did not comply with hygiene and non-conventional feeding and watering. However, the prevalence of *Giardia spp.* was significant in rabbits kept in poor conditions of rearing. In conclusion, this study showed that the prevalence of these two parasites in rabbits from the local population is relevant and may have important implications for the rabbit industry and public health, especially in rural areas.

Keywords: Algeria, digestive parasites, prevalence, rabbits, risk factors

Introduction

In Algeria, rabbit farming has developed considerably in rural areas (Berchiche *et al.*, 2012), in response to the increasing nutritional needs of the population, especially in terms of animal protein. The rabbit is considered an ideal animal for meat production, due to its short production cycle and high food conversion capacity (Lebaset *et al.*, 1997). Furthermore, rabbit meat contains low percentage of fat, cholesterol and sodium, which makes it particularly suitable for nutritional needs (Zotte and Szendrő, 2011).

According to Marlier *et al.* (2006), the environment in which rabbits live is an important factor for their productivity and health. Stress and pathogens are the main causes of diarrhoea in rabbits. Indeed, rabbit diarrhoea can have serious consequences for the rabbit industry. It can be caused by bacteria, viruses and/or parasites, and can occur in rabbits of all ages, although young rabbits at the time of weaning are more likely to be affected (Li *et al.*, 2012).

However, rabbits are hosts to a large number of parasites, particularly those that affect their economic performance such as *Eimeria* spp. Also, there are some parasites that are pathogenic, transmissible to humans,

causing serious public health problems and economic losses for the livestock industry, such as *Giardia* spp. (Li *et al.*, 2020a).

Eimeria spp. are the main constraint to the development of rabbit production. Eleven species are involved (Bhatet *et al.*, 1996). They have a hepatic (*E. Steidea*) and intestinal tropism, thus determining two distinct anatomical forms and sometimes are associated (Coudert *et al.*, 1995). Whereas *Giardia* spp. is a zoonotic parasite. It infects humans and a wide range of animals (Jiang *et al.*, 2012; Koehler *et al.*, 2014; Cai *et al.*, 2021). It usually parasitizes the small intestine, duodenum and gallbladder of the host, and can cause diarrhoea and chronic absorption disorders (Liu *et al.*, 2019).

The detrimental effects of these two pathogens parasites have been widely described in industrialised countries, due to their financial and especially health implications, while in Algeria, few studies have been conducted. Thus, the objective of our work was to evaluate the prevalence of these infections in rabbits. This, may help to assess the risk of infection for rabbits in different regions and environments, and to evaluate the risk factors of infection.

Materials and Methods

The study was carried out from January to May 2021. The dung samples were collected from 16 rabbit farms belonging to 4 districts. Three from the north-central region and subject to the same Mediterranean climatic influences (Boumerdes, TiziOuzou and Bouira), and one from Setif district, in the east of the country, which is characterised by a semi-arid continental Mediterranean climate (rainy and cool winter season and a dry and hot summer season). The rabbits used in this study belonged to the local Algerian population. The characteristics of this population were described by Zerrouki *et al.* (2007).

The faecal analysis was carried out in the laboratory of the Faculty of Sciences of the M'hamed Bouguera University

of Boumerdes. In total, 111 dung samples were collected (Boumerdes (n=29), TiziOuzou (n=29), Bouira (n=27) and Setif (n=26)). The dungs were collected using a small mesh net placed under each cage one day before each sampling. Twenty-four hours later, the dungs were collected in sterile vials and preserved in 2.5% potassium dichromate ($\text{Cr}_2\text{K}_2\text{O}_2$) at 4°C until their analysis. In order to isolate the parasites, the qualitative method was used. This enrichment technique is the most widely used in veterinary medicine (Beugnet, 2000).

Epidemiological data relating to intrinsic factors (age and sex) and extrinsic factors (type of housing (Figure 1), hygiene conditions and cages used, type of feed (Figure 2) and watering system) were collected by means of a questionnaire.



Fig. 1 : Artisan rabbitry.



Fig. 2 : Rabbits feed with mixed and concentrated food.

Statistical analysis

Statistical analysis of the data was carried out using SPSS 26 software. The data were analysed using descriptive statistical techniques, such as the calculation of prevalence with 95% confidence intervals. Statistical tests were also applied, including the chi-square test to assess the significance of associations between risk factors and the prevalence of *Eimeria* spp. and *Giardia* spp. infection in rabbits.

Results and Discussion

The results showed higher prevalence of contamination by *Eimeria* spp. which was 68.75% (11/16) for farms and

58.56% (65/111) for rabbits (Table 1). The prevalence of *Eimeria* spp. is higher than those reported by several authors in Algeria (42.5%, Henneb and Aissi (2012); 43%, Maziz-Bettahar *et al.* (2018) and 47.6%, Bachene *et al.* (2019)), as well as those reported in Iran (26.87%, Tehrani *et al.*, 2013). However, it is lower than those reported in Kenya (85.1% and 79.4%) by Okumu *et al.* (2014) and Ogolla *et al.* (2017), respectively. The prevalence of *Eimeria* spp. was affected by the origin of the animal ($p < 0.0001$). Our results agreed with those reported by Deng *et al.* (2017) showing parasite digestive infections is related to many factors such as geographical and ecological environment, health status of rabbits and sample size.

Table 1 : Prevalence of *Eimeria spp.* and associated factors risk in rabbits of local Algerian population.

Variables	Categories	Total	Positive	Prevalence (%)	OR (95% CI)	p-value
Districts	TiziOuzou	29	9	31 (15.3 - 50)	Reference	<0.0001
	Boumerdes	29	13	44.8 (26.7 - 63)	1.80 [0.617 - 5.29]	
	Bouira	27	18	66.7 (46 - 83)	4.44 [1.44 - 13.65]	
	Setif	26	25	96.15 (80.4 - 100)	55.55 [6.48 - 475.9]	
Gender	Female	61	34	55.7 (43.3 - 68)	Reference	0.505
	Male	50	31	62 (48.5 - 75)	1.296 [0.60-2.77]	
Age	Young	74	46	62.2 (51.1 - 73)	1.556 [0.70-3.45]	0.276
	Adult	37	19	51.4 (35.2 - 67)	Reference	
Hygiene status	High	45	7	15.6 (5 - 26)	Reference	<0.0001
	Low	66	58	87.9 (80 - 96)	39.357 [13.18- 117.49]	
House type	Modern rabbitry	88	42	47.7 (37.3 - 58)	Reference	<0.0001
	Artisan rabbitry *	23	23	100	2.095 [1.68-2.61]	
Feed	Standard concentrated	43	6	14 (3.6 - 24)	Reference	<0.0001
	Mixed feed**	68	59	86.8 (78.7 - 95)	40.420 [13.29-122.88]	
Water source	Pipe water	39	6	15.4 (4.1 - 27)	Reference	<0.001
	Container	72	59	81.9 (73.1 - 91)	24.960 [8.674-71.83]	
Total		111	65	58.6 (49.4 - 68)		

*: rabbitry buildings are designed in an artisanal manner and/or outdoor rearing.

** : household waste, grass and grains.

The prevalence of *Giardia spp.*, however, was relatively low (56.25% (9/16) of *Giardia spp.* at farm, while 11.7% rabbits were infected (13/111)) (Table 2). It is important to note that studies on the prevalence of *Giardia spp.* in rabbits in Algeria are limited. The prevalence found in this study is within the range of those reports from several regions in China (8.40%, Qi *et al.* (2015); and 11.20%, Li *et al.* (2020b)), as well as in Europe (7.6%; Pantchev *et al.*, 2014). In contrast, the reported prevalence rate in Nigeria is very high (72.30%) according to Akinkuotu *et al.* (2018). Moreover, prevalence rate variation's observed in different studies could be due to the different detection methods used.

For example, in a study conducted in European countries, the detection method used was ELISA coproantigen (Pantchev *et al.* 2014). However, in studies conducted in Chinese provinces, the detection method used was Lugol's iodine staining combined with microscopic analysis. However, according to Rousseau *et al.* (2018), the staining and flotation technique is considered non-specific and unreliable compared to the PCR test for *Giardia spp.* cysts. These techniques may underestimate the prevalence of infection; as they cannot detect low intensities of infection as well as cysts may be excreted intermittently and may not be present in all stools.

Table 2 : Prevalence of *Giardia* spp. and associated factors risk in rabbits of local Algerian population.

Variables	Categories	Total	Positive	Prevalence (%)	OR (95% CI)	p-value
Districts	Tizi-Ouzou	29	0	0	0.81 (0.68 - 0.975)	0.560
	Boumerdes	29	4	13.8 [3.89-31.66]	1.13 (0.25 - 5.091)	
	Bouira	27	5	18.52 [6.30-38.03]	Reference	
	Sétif	26	4	15.4 [4.36-34.87]	0.8 (0.189- 3.382)	
Gender	Female	61	6	9.8	Reference	0.497
	Male	50	7	14	1.49 [0.467- 4.766]	
Age	Young	74	13	17.6 (8.9 - 26)	Reference	0.007
	Adult	37	0	0	1.213 [1.09 -1.348]	
Hygiene status	High	45	0	0	1.245 [1.105 - 1.403]	0.002
	Low	66	13	19.7 (10.1 - 29)	Reference	
House type	Modern rabbitry	88	7	8	Reference	0.041
	Artisan rabbitry *	23	6	26.1	4.084 [1.219 - 13.686]	
Feed	Standard concentrated	43	0	0	1.236 [1.101 - 1.388]	0.002
	Mixed feed**	68	13	19.1 (9.8 - 28)	Reference	
Water source	Pipe water	39	0	0	1.22 [1.095 - 1.36]	0.005
	Container	72	13	18.1 (9.2 - 27)	Reference	
Total		111	13	11.7 (5.7 - 18)		

*: rabbitry buildings are designed in an artisanal manner and/or outdoor rearing.

** :household waste, grass and grains.

Giardia spp. is a parasite with a zoonotic aspect that has been the subject of many studies on sequencing and molecular identification (Akinkuotu *et al.*, 2018; Jiang *et al.*, 2018). However, there is little research on the risk factors of Giardiasis in rabbits (Tang *et al.*, 2021).

In this study, the statistical analysis showed that the risk of *Eimeria* spp. infection was not significant according to gender and age. Tang *et al.* (2021) found that this species was detectable in rabbits of all ages, but more frequently in young rabbits less than 30 days of age. This is in contrast to the results of Li *et al.* (2020b), who stated that rabbits older than six months were more susceptible than young rabbits. In fact, the vulnerability of rabbits to *Eimeria* spp. infection is

probably due to their still immature immune system. Or, it can be attributed to environmental and management factors (Peeters *et al.*, 1995; Rashwan and Marai 2000; Gidenne and Licois, 2005). In addition, several authors reported that the main source of infection in young rabbits was adult rabbits considered to be healthy carriers (Pakandl, 2009; El-Ashram *et al.*, 2019).

Eventually, traditional and archaic husbandry significantly influenced the presence of *Eimeria* spp. and *Giardia* spp. oocysts, as poor hygiene had a significant risk of infection (OR: 39.357; [95% CI: 13.18-117.49]; p<0.001). In addition, the prevalence was 100% for rabbits reared outdoor (OR = 2.095; [95% CI: 1.68 - 2.61]); p<0.001). The

recorded results also indicate that the probability of contracting both parasites was higher in farms fed a diversified diet compared to those fed a conventional rabbit diet (86.8% vs. 14%) with a risk (OR = 86.8; [95% CI: 13.29-122.88]; $p < 0.001$). Also, the contamination rate of rabbits that drink in containers was highly significant (OR = 81.9; [95% CI: (8.674-71.83)]; $p < 0.001$).

Our results have shown several significant factors associated with the risk of parasitic infection in rabbits. These factors included unsanitary conditions, rabbit husbandry, feeding and watering practices. Poor hygienic conditions are positively correlated with a high infection rate of both parasites. This correlation was observed in several studies conducted in Cameroon by Lukefahr *et al.* (2000), in Nigeria by Oseni *et al.* (2008), and in Kenya by Serem *et al.* (2013). According to Coudert and Grézel (2006), although *Eimeria* spp. oocysts are specific to rabbits, their high resistance in the environment and their transmission by the faecal-oral route explain the contamination of livestock.

Similarly, housing conditions and non-compliance of buildings have an impact on the contamination of rabbits. According to Jiang *et al.* (2018), rabbits kept outdoors have a higher prevalence of *Giardia* spp. than those kept indoors, due to the increased risk of contact with a contaminated environment. In addition, several studies have indicated that rabbits raised on the ground are at higher risk of parasitic infections (Jiang *et al.*, 2018; Li *et al.*, 2020b; Tang *et al.*, 2021).

Non-conventional feeding (water and food) increased the risk of contamination of rabbits by both parasites. Similar results were reported by Akinkuotu *et al.* (2018). Certain foods such as vegetables and herbs can be a source of contamination for rabbits. Faeces contaminated with parasite oocysts can be more easily ingested in the diet. It is important to note that *Giardia* oocysts can remain infective in water for a long time (Razakandrainibe et al., 2014). Therefore, watering containers can be a significant risk factor for contamination. Rabbits using containers have a higher contamination rate than those using automatic drinking nipples. Furthermore, if these containers are spilled on the bedding, this makes the bedding wet, which only increases the rabbits' vulnerability to coccidiosis (Duszynski and Couch, 2013).

Conclusion

In conclusion, parasites are ubiquitous in the environment and are often transmitted by the faecal-oral way in rabbits. Contamination can be avoided by regular monitoring of rabbit health and by maintaining good hygiene on the farm. In addition, farmers should be aware of the risk factors for the health of their animals and take the necessary measures to prevent parasitic infections, which will help to improve the productivity and profitability of the farm.

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