Camel gastrointestinal parasites in southern Algeria

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Abstract

This study aimed to identify gastrointestinal parasites in camels (*Camelus dromaderius*) in the Laghouat region (southern Algeria). The study was carried out over a 5-month period on a total of 100 dromedaries. Dung samples were analysed using different methods such as flotation, sedimentation, and Ziehel-Neelsen staining for research of the cryptosporidiosis. Data showed an overall infestation rate of 78%, with the presence of the following parasites: *Cryptosporidium* spp. (60%), Nematodes: *Nematodirus* spp. (23%), *Strongyloides* spp. (4%), *Marshallagia* spp. (2%), and *Cooperia* spp. (3%), different protozoaires: *Eimeria* spp. (20%), *Neobalantidium* spp. (2%), *and Balantidium coli,* cestodes (6%), *Moniezia* sp. (3%), *Multiceps* sp. (2%), *Diphillobothrium* sp. (1%), and trematodes: *Fasciola hépatica* (4%) and *Paramphistomum* spp. (1%). The results showed a significant influence of study site on the parasitic infestation rate (P=0.039). Other factors (sex, age and clinical aspect) had no significant influence. To conclude, gastrointestinal parasites are a major problem of indigenous camels under traditional husbandry. Therefore, parasite control programmes are recommended to increase the productivity of this useful animal.

Key words: *dromedary; parasite; gastrointestinal; risk factors; Laghouat; coproscopy*

Introduction

Camel belongs to the class of Mammalia, order Artiodactyla, sub-order Tylopoda and family Camelidae (Al Haj and Al Kanhal, 2010). For centuries, the camel has been a very important animal in desert areas due to its ability to withstand very harsh conditions (high temperature and drought), to provide milk, meat, its use as a mean of transport (Faye et al., 2014;

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Đuričić et al., 2020a, b) and its ability to digest poor forage compared to other domestic ruminants (Kayouli et al., 1995).

The camel is present in 35 countries around the globe, 18 of which are African nations (Bourddane, 1998). In Algeria, the camel population is estimated at 140,000 individuals (Afoutni, 2011; Djireb, 2015). Camels in Algeria are not the major domestic animal, but are considered a good source of milk and meat to nomadic and urban habitants, and are used for other purposes such as transportation (Saidi et al., 2021).

This animal is frequently infested by gastrointestinal parasites, which decreases productivity (Richard, 1989, Mahmuda et al., 2014). Among the many pathologies caused by these parasites, helminthiasis represent an important internal parasitosis affecting camels. Several studies have reported the occurrence of different gastrointestinal parasites in camels in different parts of the world (Sharrif et al., 1997; Magzoub et al., 2000; Bekele, 2002; Dia, 2006). However, few studies have examined these diseases in Algeria. Under this context, this study was conducted to determine the prevalence rate of gastrointestinal parasitism and to identify the different parasitic species and influence of certain factors (sex, age, and site of the study) on the infestation rate in the Laghouat region.

Materials and methods

Study area description

The study was conducted in the Laghouat region of southern Algeria, located about 400 km south of Algiers, from February to May 2019. The area has a semi-arid climate. It is found at an average altitude of 900 meters. Average rainfall is 100 mm (50-150 mm) while the

Table 1. Characteristics of the selected farms

Criteria	Variables	Number	%
Localities	Hassi r'mel	4	57.1%
	Tadjmout	1	14.3%
	Laghouat	1	14.3%
	El Kheneg	1	14.3%
Rearing method	Nomad	2	28.6%
	Transhumance	3	42.9%
	Sedentary	2	28.6%
Alimentation type	Barley flour	1	14.3%
	Vegetables	1	14.3%
	Bread	1	14.3%
	Mixed	4	57.1%
Rearing interest	Milk	3	42.9%
	Fur and milk	2	28.6%
	Meat	1	14.3%
	All	1	14.3%
Vaccination	Yes	5	71.4%
	No	2	28.6%
Deworming	Yes	4	57.1%
	No	3	42.9%

annual average temperature is 22.5°C, ranging from 16°C to 29°C.

Study design and animals

A cross-sectional study was conducted on 100 local breed dromedaries in four localities administratively belonging to the Laghouat region: Laghouat, HassiR'mel, Tadjmout, and El Kheneg. Information on age, sex, and herd management were recorded during faecal sample collection. For this study, seven farms were selected with the following characteristics (Table 1).

The animals included in this study had the following characteristics (Table 2).

Sample collection

Faecal samples were collected directly from the rectum and from freshly dropped faeces with great sanitation of 100 dromedaries using disposable gloves, and samples were placed in faecal sample bottles. Collected samples were properly labelled with the appropriate information and immediately transported to the Parasitology Laboratory of Laghouat University. Samples were processed and examined on the day of collection.

Faecal samples were examined using standard parasitological techniques (flotation, sedimentation, and Ziehl-Neelsen staining technique modified by Polack) and examined at 10x and 40x magnification. Identifications of eggs and larva were made on the basis of their morphology (Soulsby, 1982; Beugnet et al., 2004; Ollagnier, 2007). Information was obtained on the approximate age, sex, and mode of life of each dromedary.

All the experiments were carried out according to the guidelines of the Institutional Animal Care Committee of the Algerian Higher Education and Scientific Research (Agreement Number 45/DGLPAG/DVA.SDA.14).

Data management and analysis

Descriptive statistics were performed to analyse the data using SPSS version 20 statistical software. The chi-square ($\chi 2$) test was used to assess if there was a statistically significant difference in gastrointestinal parasites of the dromedary between sex, age, and management of animals (study site, breeding method, and clinical aspect). The level of significance was set at $P<0.05$.

Table 2. Characteristics of the animals included in the study

Criteria	Variables	Number of camels per site				Total number	%
		Hassi r'mel	Tadjmout	El Kheneg	Laghouat		
Sex	Female	55	10	5	17	87	87%
	Male	7	0	1	5	13	13%
Age	- 1 year	5	0	0	1	6	6%
	1 to 5 years	13	4	0	12	29	29%
	5 to 10 years	31	2	3	6	42	42%
	10 to 15 years	11	2	3	2	18	18%
	+ 15 years	2	2	0	1	5	5%
Clinical inspection	Healthy	61	10	6	12	89	89%
	Sick	1	0	0	10	11	11%

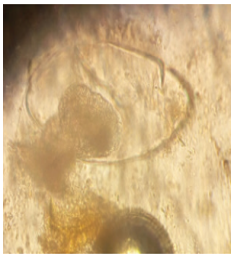
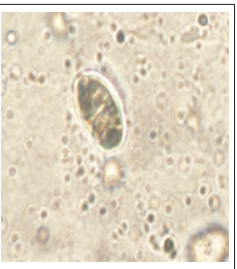
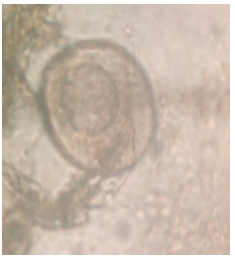
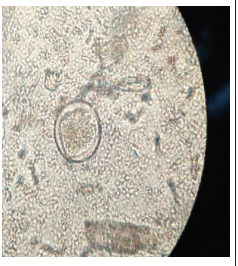
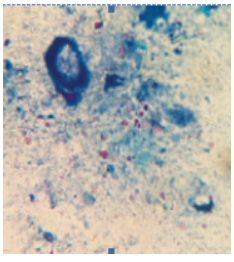
 *Marshallagia* spp. egg observed under optical microscope (GX400) by the sedimentation technique.	 *Nematodirus* spp. egg observed under optical microscope (GX400) by the sedimentation technique.	 *Nematodirus* spp. *Larva* observed under optical microscope (GX400) by the flotation technique (Digestive tract well developed and apparent. Clear anterior and posterior end).	 *Strongyloides* spp. egg observed under optical microscope (GX100) by the sedimentation technique.
 *Strongyloides* spp. Larva observed under optical microscope (GX100) by the sedimentation technique (Width: 150 - 200 µm)	 *Fasciola hepatica* spp. egg observed under optical microscope (GX400) by the flotation technique	 *Toxocara* spp. egg observed under optical microscope (GX400) by the flotation technique	 *Moniezia* spp. egg observed under optical microscope (GX400) by the sedimentation technique
 *Cryptosporidium* spp. oocysts observed under optical microscope (GX400) by the Ziehl-Neelsen staining technique (oocysts stained pink on a green background, ovoid spheroid).	 *Eimeria* spp. egg observed under optical microscope (GX100) by the sedimentation technique	 *Eimeria* spp. oocysts observed under optical microscope (GX100) by the flotation technique (ovoid oocysts, embryo with finely granular content with slightly pinkish cytoplasm, thin and colorless shell).	 *Trichuris* spp. egg observed under optical microscope (GX400) by the sedimentation technique (lemon-shaped, wall thick and brownish-yellow).

Figure 1. Microscopic identification of the different parasites

Results

Macroscopic observation

The macroscopic examination of the stool samples from 100 camels, revealed the presence of larvae in a single sample (1%).

Microscopic observation

The coproscopic examination of the faeces highlighted the presence of 15 parasitic species: two intestinal coccidia (*Eimeria* spp., *Cryptosporidium* spp.); protozoa (*Balantidium coli*, *Neobalantidium* spp.); six species of nematodes (*Strongyloides* spp., *Nematodirus* spp., *Trichuris* spp., *Marshallagia* spp., *Toxocara* spp., and *Cooperia* spp.); three species of cestodes (*Moniezia* spp., *Multiceps* spp., *Diphyllobothrium latum*), and two species of trematodes (*Fasciola hepatica and Paramphistomum* spp.).

Identification of parasite eggs was according to the recommendation of Beugnet et al. (2004); Guillaume (2007); Raskova and Wagnerova (2013). After analysing 100 samples collected using coproscopy, the results showed that 78 were positive (containing eggs and/or parasite larvae, for a total prevalence rate of 78%). Figure 1 provides an overview of the species mentioned above.

Prevalence of different parasite species

Of the 100 animals examined, the overall rate of positive coproscopy is 78%. *Cryptosporidium* spp. has the highest prevalence rate with 58%, followed by *Nematode* (32%); then by *Coccidia* (20%) and *Cestodes* (6%), while *Trematode* prevalence rate was the lowest (4%) (Figure 2).

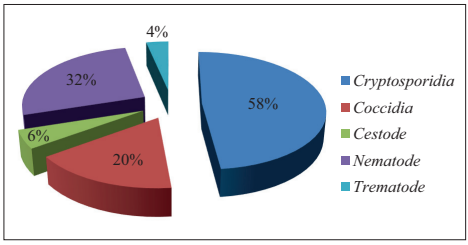


Figure 2. Prevalence of the various parasites

Figure 3 illustrates the distribution of parasite species detected in this survey. The prevalence rate of *Cryptosporidium* spp. (58%) was significantly higher than that of *Nematodirus* spp. (23%) and *Eimeria* spp. (20%), which were relatively low (26%). Positive cases were due to several types of parasites: *Strongyloides* spp. and *Fasciola hepatica* (4%), *Moniezia* spp. and *Cooperia* spp. (3%), *Marshallagia* spp., *Toxocara* spp., *Neobalantidium* spp., and *Multiceps* spp. (2%), *Balantidium coli*, *Trichuris* spp., *Diphyllobothrium latum*, and *Paramphistomum* spp. (1%).

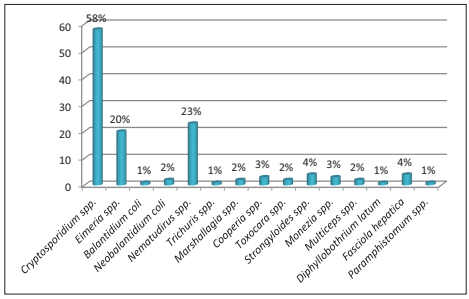


Figure 3. Prevalence of each type of parasite in camels

Parasites association rate (polyparasitism)

Parasite coexistence

The presence of a single parasitic species was reported in 42% of the positive cases.

The coexistence of two parasitic species was observed in 24 animal samples (24%), while the cohabitation of three parasitic species in the same individual was found in 11% of samples. Finally, the coexistence of four parasite species in a single animal faeces sample was found in 1%. Table 3 describes the

Table 3. Association of parasites in the examined camels

2 parasites association	*N*	%	3 parasites association	*N*	%	4 parasites association	*N*	%
Cryptospridium spp. +*Toxocara* spp.	1	1	*Cryptospridium* spp. + *Eimeria* spp. + *Nematodirus* spp.	2	2	*Cryptospridium* spp. + *Eimeria* spp. + *Marshallagia* spp. + *Nematodirus* spp.	1	1
Cryptospridium spp. + *Nematodirus* spp.	5	5	*Cryptospridium* spp. + *Eimeria* spp. + *Strongyloides* spp.	1	1			
Cryptospridium spp. + *Strongyloides* spp.	2	2	*Cryptospridium* spp. + *Eimeria* spp. + *Balantiduim* coli	1	1			
Cryptospridium spp. + *Eimeria* spp.	10	10	*Cryptospridium* spp. + *fasciola hepatica* + *Nematodirus* spp.	2	2			
Cryptospridium spp. + *Cooperia* spp.	1	1	*Eimeria* spp. + *Nematodirus* spp. + *Neobalantidium* spp.	1	1			
Cryptospridium spp. + *Neobalantiduim* spp.	1	1	*Cryptospridium* sp + *Eimeria* spp. + *Toxocara* spp.	1	1			
Paramphistomum spp. + *Fasciolahepatica*	1	1	*Cryptospridium* spp. + *Eimeria* spp. + *Diphylobothrium latum*	1	1			
Eimeria spp. + *Multiceps* spp.	1	1	*Cryptospridium* spp. + *Eimeria* spp. + *Fasciola hepatica*	1	1			
Moniezia spp. + *Nematodirus* spp.	1	1	*Cryptospridium* spp. + *Moniezia* spp. + *Nematodirus* spp.	1	1			
Nematodirus spp. + *Marshallagia* spp.	1	1						

association of two parasitic species in the same sample.

The results show that the association of *Cryptosporidium* spp. and *Eimeria* spp. in camels is the most frequent with a rate of 10%. Considering triple parasitism, the association *Cryptosporidium* spp., *Eimeria* spp. and *Nematodirus* spp. and the combination of *Cryptospridium* spp., *Fasciola hepatica* and *Nematodirus* spp. in camels were most frequent association with a rate of 2%. *Cryptosporidium* spp., *Eimeria* spp., *Nematodirus* spp. and *Marshallagia* spp. is the only quadruple parasitism association in the camels with a rate of 1%.

Relationship between parasitism and other parameters

Several risk factors such as age, sex, clinical aspect, breeding method, certain symptoms (diarrhoea) were statistically analysed to evaluate their influence on parasitism rate.

Camel infestation by parasites according to age

Parasitic infestation in young animals (less than 1 year old) was higher than in other age groups (100%). Animals older than 15 years had the lowest infestation rate. The statistical analysis illustrated

that the gap was not significant (P=0.20) (Figure 4).

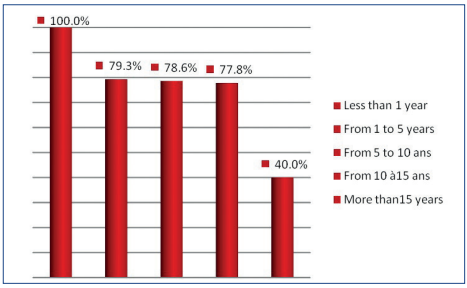


Figure 4. Relationship between parasitism and age

Parasite infestation by sex

Figure 5 shows that males (with a parasitic infestation rate of 84.6%) were more susceptible to parasites than females (77%). However, difference was not statistically significant (P=0.53).

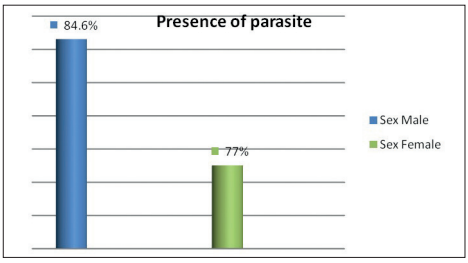


Figure 5. Relationship between parasitism and sex

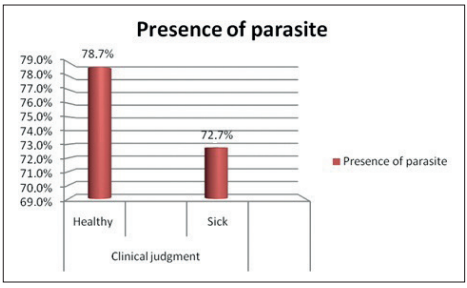


Figure 6. Relationship between parasitism and clinical examination

Parasite infestation according to clinical inspection

Figure 6 shows that the presence of the parasite in healthy individuals was greater (78.7%) than in animals that appeared clinically sick (72.7%), though this difference was not statistically significant (P=0.65).

Parasite infestation and diarrhoea

The rate of parasitism in diarrheal subjects was higher (100%) than in non-diarrheal subjects (78%). However, this difference was not statistically significant (P=0.05) (figure 7).

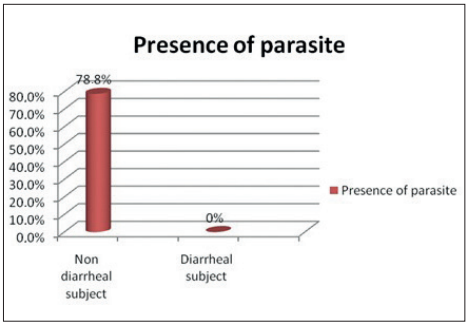


Figure 7. Parasite infestation rates according to diarrhea

Parasite infestation according to breeding method

Figure 8 shows that the nomadic breeding method had the highest rate of parasitism (82.6%), while the two farm types also revealed a high infestation rate. These differences, however, were not statistically significant (P=0.591).

Parasite infestation according to study site

According to Figure 9, two study sites (7 of Hassi R'mel and 5 of Laghouat) were found to have the highest recorded prevalence of parasitism (94.1% and 90.9%, respectively), and this difference was statistically significant (P=0.039).

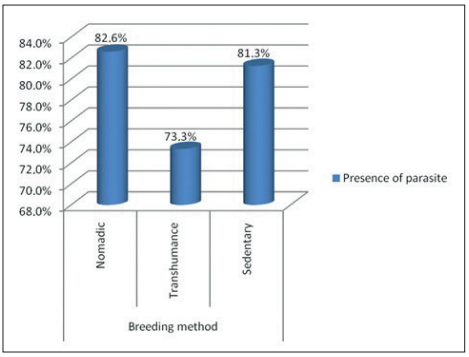
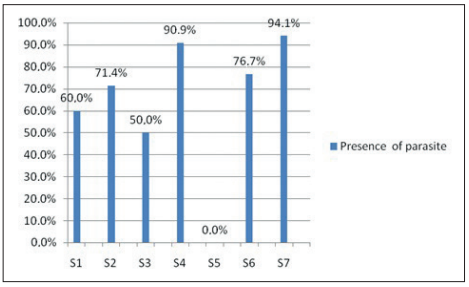
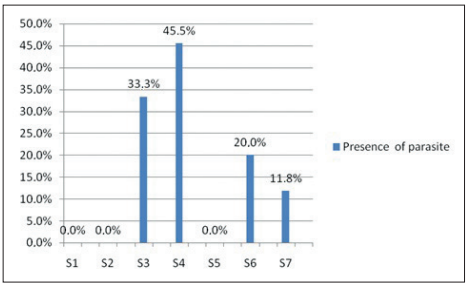


Figure 8. Parasite infestation rates according to the breeding method



(S1=Tadjmout; S2, S5, S6, and S7=Hassi R'mel; S3=El Kheneg; S4= Laghouat).

Figure 9. Parasite infestation rates according to the study site



(S1=Tadjmout; S2, S5, S6, and S7=Hassi R'mel; S3=El Kheneg; S4= Laghouat).

Figure 10. Infestation rates by coccidia *Eimeria* spp. according to study site

Coccidial infestation rate according to study site

Figure 10 shows that site 4 presented the highest prevalence of parasitism (45.5%), and this difference was statistically significant between sites (P=0.011).

Discussion

This study focuses on the gastrointestinal parasites present in camels (*Camelus dromedarius*) in different municipalities of Laghouat. To our knowledge, there are no previous studies conducted in this region with this objective. The results obtained showed a high prevalence of different species of gastrointestinal parasites (78%). Our data is important in comparison with those found by Abdalla et al. (2016) in Mogadishu (50.3%), and in Pakistan (60%) by Mahfooz (2006) and by Azhat et al. (2013) (37.33 %). However, our results are comparable to those found in Somalia (Magan et al., 2017), in Sokoto (Mahmuda et al., 2014), and in Ethiopia (Demelash et al., 2014) with rates of 79%, 78%, and 80.73%, respectively, and lower than those reported in Egypt (90.9%) (Khalif, 2009), Nigeria (92.4%) (Bamaiyi and Kalu, 2011), and Jordan (98%) (Sharrif et al., 1997).

In total, 15 species of gastrointestinal parasites were found in 100 animals examined, with varying prevalence. The predominant presence was *Cryptosporidium* spp. eggs (58%). This value is significantly higher than those reported in Iran (3.3%, Nouri et al., 1995; 37.6%, Razavi et al., 2009; 16.9%, Nazifi et al., 2010; 20.3%, Sazmand et al., 2012;, 2.4%, Radfar et al., 2013; and 0.5%, Shahraki et al., 2016).

Cryptosporidiosis is a contagious parasitic disease that affects several animal species and even humans. Their oocysts are highly infectious with a high environmental resistance capacity; this could explain their high prevalence rate encountered in this survey. They are also known for having an extremely common self-infestation ability (Lakhal and Labyadh, 2017).

In this study, *Eimeria* spp. was encountered at a rate of 20%. This frequency was similar to that reported by Abubakr (2000) in Bahrain. However, there results were lower than those recorded in Iran (24%) by Radfar et al. (2013). In a study by Rewatkar et al. (2009), the prevalence of *Eimeria* spp. was 25%. Mirza (1976) recorded a rate of 40% in Iraq, Gill (1976) recorded a rate of 11% in India, and Kawasem et al. (1983) reported a rate of 14% in Saudi Arabia.

Coccidia are usually self-limiting because they lack the ability to re-contaminate, and the asexual cycle can only be performed three times in the same host (Fowler, 1995). This could partially explain the infestation rate reported in this study.

Nematodirus spp. were found with a prevalence rate higher than a report from Egypt (13.7%) by Ismail et al. (2004). A study performed by Rewatkar et al. (2009) recorded a rate of 10.71% which is significantly lower than the rate recorded by Mostapha et al. (2013) in Jordan (98%). *Nematodirus* parasitosis is frequent during spring and early summer. This coincides with the period of our field study. It is due to a sudden infestation by large amounts of *Nematodirus larvae*, and these parasites' eggs have a particularly strong resistance. If the temperature rises above 10°C, the eggs will be stimulated and hatch rapidly to give several larvae over a short period of time (Autef, 2008).

Strongyloides spp. were present with a rate lower than those recorded in Ethiopia (67%, Kashun et al., 2014; 56%, Abdalla et al., 2016; 23%, Magan et al., 2017), in Pakistan (8%, Mahfooz et al., 2006), and in Sokoto (9.26%, Radfar et al., 2013). However, our results were higher than reports from Egypt (1.2%, Khalif, 2009).

In this study, the infestation rate of *Fasciola hepatica* was higher than reports from Ethiopia (2.1%, Magan et al., 2017), and Mogadishu (0.6%, Abdalla et al., 2016). The prevalence rate of *Moniezia* spp. was lower than recorded in Pakistan (4%, Mahfooz et al., 2006), Egypt (8.16%, Nagwa et al., 2013), Mogadishu (4.2%, Abdalla et al., 2016), and Ethiopia (8.4%, Magan et al., 2017). *Balantidium coli,* had a prevalence rate similar to Yakaka et al. (2017) in Nigeria (1%), and lower than what Rewatkar et al. (2009) found in Iran (74%). *Marshallagia* spp. prevalence rate was lower to that recorded in Iran by Borji et al. (2010) (4%).

Trichuris prevalence rate is significantly lower than that noted in Iran (14%, Radfar et al., 2013) and in Egypt (17.36%, Nagwa et al., 2013). In contrast, Sahnoune (2011) recorded an infestation rate of 45.45% in Oued Souf (Algeria). This huge difference between the results is likely due to the research techniques (coproscopy) and highlighting of adult worms.

Among the results reported in this study, the rates of cases of single and polyparasitism were lower rates than those recorded by Mahmuda et al. (2014) in Sokoto (60.28% for single infestations and 39.74% for double infestations and more). On the contrary, in Pakistan the authors reported higher prevalence rates (7.36%, (Alvi et al., 2014). In Egypt, Nagwa et al. (2013) reported a comparable prevalence rate for single parasitism (40%). Polyparasitism is explained by the fact that some portions are more parasitized than others. This difference in parasite association could be explained by the difference in several environmental factors that can positively or negatively affect the distribution of parasites and the excessive disproportion when referring to infested gastrointestinal compartments (Tamssar, 2006). It can be also due to the distribution of camels, the study site or certain unfavourable conditions, such as an unbalanced diet, climate or age (Radfar et al., 2013). The presence of polyparasitism confirms the

existence of favourable environmental indices to the survival and perpetuation of parasites (Mahmuda et al., 2014).

In the present study, statistical analysis revealed that site study was the only parameter to cause a significant difference.

Parasite infestation by sex showed that males were more infested than females, in agreement with the results of Anwar and Khan (1998) in Pakistan, while Bamaiyi and Kalu (2011) revealed that females were more infested than males. Statistical analysis however did not reveal a significant difference.

Parasitic prevalence in animals less than 1 year old was higher than in other age groups, with the lowest infestation rate in animals older than 15 years, though this difference was not statistically significant. In contrast, the parasitic prevalence rate in adults was higher than in the younger ages groups in studies conducted by Duguma et al. (2014) and Yakaka et al. (2017).

Symptomatology is mainly represented by diarrhoea, though there was no statistically significant association between parasitism and diarrhoea. This data showed that the infested subjects do not always present a clinical symptomatology (diarrhoea does not reflect the existence of parasite infestations). Therefore, positive camels are considered asymptomatic carriers; thus representing a source of contamination and spread of these infections in their environment. The remaining cases are linked to viral or bacterial disease or even nutritional problems (Daouia, 2012; Šmit et al., 2017).

The prevalence rate of *Coccidia*, *Eimeria* spp. varied by study site. A higher prevalence rate was recorded in Laghouat than elsewhere, and this difference was significant, which is likely explained by the high density of the camels in this area. The remaining species appear to be stable and do not vary with the study site.

Conclusions

This study examined the gastrointestinal parasites in camels of the Laghouat region. The results indicate that camels are important reservoirs for different parasites which are responsible for several diseases. For future studies, it is suggested to widen and deepen our knowledge of the host-parasite interaction and to follow their evolution over time, while including other parameters, namely the effects of ecological factors.

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Gastrointestinalni paraziti deva na jugu Alžira

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Ova je studija imala za cilj identificirati gastrointestinalne parazite deva (*Camelus dromaderius*) u regiji Laghouat na jugu Alžira. Istraživanje je provedeno tijekom razdoblja od 5 mjeseci na 100 jednogrbih deva. Uzorci su analizirani koproskopijom uporabom različitih metoda: flotacije, sedimentacije i Ziehel-Neelsen bojenja za pretragu kriptosporida. Podatci su pokazali sveukupnu stopu infestacije od 78 %. Ova je studija otkrila prisutnost sljedećih parazita: *Cryptosporidium* spp. (60 %), oblića: *Nematodirus* spp. (23 %), *Strongyloides* spp. (4 %), *Marshallagia* spp. (2 %), i *Cooperia* spp. (3 %), različitih protozoa: *Eimeria* spp. (20 %), *Neobalantidium* spp. (2 %), i *Balantidium coli*. Ostali paraziti zamijećeni u ovom radu su: trakavice (6 %), *Moniezia* spp. (3 %), *Multicips* spp. (2 %), *Diphillobothrium* spp. (1 %), metilji: *Fasciola hépatica* (4 %), *Paramphistomum* spp. (1 %). Rezultati su pokazali značajan utjecaj lokacije studije na stopu infestacije parazitima (P=0,039). Ostali čimbenici (spol, dob i klinički aspekt) nisu imali značajniji utjecaj. Rezultati našeg istraživanja su pokazali da su gastrointestinalni paraziti veliki problem autohtonih deva u tradicionalnom stočarstvu, stoga se preporučuju programi kontrole parazita za povećanje produktivnosti ovih korisnih životinja.

Ključne riječi: *jednogrba deva, parazit, gastrointestinalno, faktori rizika, Laghouat, koproskopija*