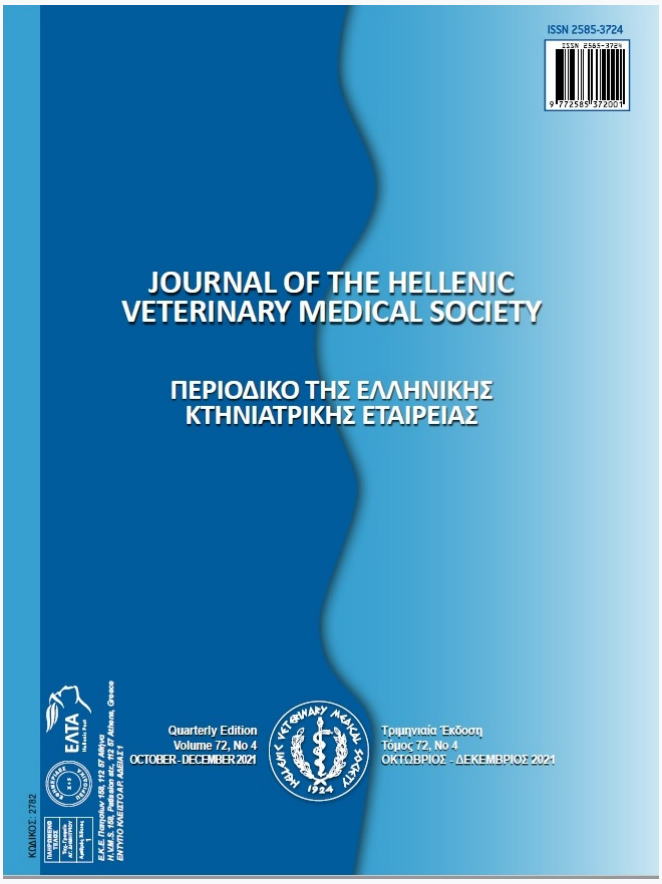
Περιοδικό της Ελληνικής Κτηνιατρικής Εταιρείας

Τόμ. 72, Αρ. 4 (2021)



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doi: 10.12681/jhvms.29544

Βιβλιογραφική αναφορά:

DAHMANI, A., AISSI, M., ZENIA, S., HARHOURA, K., & SAADI, A. (2022). Study of ovine cysticercosis in two slaughterhouses in the north of Algeria. *Περιοδικό της Ελληνικής Κτηνιατρικής Εταιρείας*, *72*(4), 3313–3320. https://doi.org/10.12681/jhvms.29544

J HELLENIC VET MED SOC 2021, 72(4): 3313-3320
ΠΕΚΕ 2021, 72(4): 3313-3320

Research article
Ερευνητικό άρθρο

Study of ovine cysticercosis in two slaughterhouses in the north of Algeria

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ABSTRACT: A total of 10696 randomly selected sheep have been collected in two slaughterhouses in the north of Algeria (El Harrach and Boufarik) to determine the prevalence of ovine cysticercosis, to find out the association between prevalence and potential risk factors as well as to assess the distribution of *C. tenuicollis* and *C. ovis* in surface's muscles, viscera and cavities (abdominal, thoracic and pelvic) of slaughtered sheep. Sheep were native breedsand originated from different sub-districts within the municipality and its environs. All the slaughtered sheep carcasses were visually and carefully inspected. Ovine cysticercosis was found in 461 sheep (4.31%). There were *Cysticercus tenuicollis* and *Cysticercus ovis* with respectively, 2.25% and 2.06% prevalence. The prevalence of *C. ovis* was significantly higher ($p<0.0001$) in females than males while all positive for *C. tenuicollis*sheep were male. The prevalence of the both species increased with age, and the difference was statistically significant ($p<0.0001$). For *C. ovis*, it didn't have significant difference between season, but, the incidence of *C. tenuicollis* was significantly higher ($p<0.0001$) in autumn. All the detected cysts of *C. ovis* were non-viable, and were more frequently detected in the heart (51.82%) followed by diaphragm (30.77%) and esophagus (17.41%). The predominant localization of *C. tenuicollis* were the liver (57.71%) and the omentum (42.29%), however, no vesicle was observed in the peritoneum. This anatomical distribution of *C. ovis* and *C. tenuicollis* cysts showed a significant variation ($p<0.001$) in different predilection sites. The present study has revealed a non-negligible prevalence of ovine cysticercosis in the two slaughterhouses in the north of Algeria,suggesting that ovine cysticercosisis present in the north of Algeria.Appropriate control measures need to be introduced to reduce the prevalence of these parasites in sheep.

Keywords : ovine carcasses, slaughterhouses, *Cysticercus ovis*, *C. tenuicollis*.

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Date of initial submission: 09-07-2020
Date of acceptance: 10-06-2021

INTRODUCTION

Cysticercosis in livestock and wild animals is caused by the larval stages (metacestodes) of cestodes (taeniosis), the tape worm of humans, dogs and wild canids. Cysticercoses in sheep (in muscle, liver and peritoneal cavity) are caused by *Tænia ovis (*the adult stage of *Cysticercus ovis)*, and *Tænia hydatigena* (the adult stage of *Cysticercus tenuicollis)* of which adults develop in the intestines of dogs and wild canids (OIE, 2005).Infections with the larval stage of some species of *Taenia* are of veterinary importance because they cause economic losses. These losses are associated with total condemnation of infected offal or carcasses with generalized infestation and downgrading of carcasses which are subjected to refrigeration, in addition to the cost of refrigeration and transport (Kebede et al., 2009).Like beef and pork cysticercosis, ovine cysticercosis due to *Cysticercus ovis* is of special interest in meat inspection because it affects the musculature, that part of the animal which is at once the most valuable for food purposes and the most difficult to inspect thoroughly (Ransom, 1913). The cysticerci of *Taenia hydatigena* are responsible for a high degree of morbidity and mortality in livestock (Abidi et al., 1989). During the life cycle of the parasite, the oncosphere penetrates the small intestine and migrates to soft tissues such as the omentum and lungs. During its migration, the cyst damages the visceral organs, especially the liver (Kara, 2005),resulting in condemnation during meat inspection. The liver is very nutritious as it contains abundant glycogen and vitamin A, so condemnation deprives humans of these important health requirements (Samuel and Zewde, 2010). Also, heavy infections and traumatic hepatitis in young lambs are leading to death (Radfar et al., 2005).Different investigators around the world have reported the prevalence of cysticerci (Dada et al., 1978 ; Akinboade and Ajiboye, 1983 ; Georgieva and Yabulkarov, 1984 ; Bekele et al., 1988 ; Deka and Gaur, 1993 ;Radfar et al., 2005 ; Kanchev et al., 2008 ; Samuel and Zewde, 2010, Attindehou and Salifou, 2012 Soares et al., 2012 ; Braae et al., 2015). However, there are limited reports concerning ovine cysticercosis in slaughtered animals in Algeria. Considering the importance of these pathologies, and the lack of epidemiological information on these diseases in Algeria, the present work was conducted to determine the prevalence of cysicercosisfrom sheep in two slaughterhouses (El Harrach and Boufarik) in the north of Algeria.

MATERIALS AND METHODS

Inspection of sheep carcasses for *Cysticercus* spp. cysts

A total of 10,696 sheep carcasses slaughtered in two abattoirs in the north of Algeria (El Harrach and Boufarik) were examined during our study for *Cysticercus* spp. cysts. Sheep were native breeds and originated from different sub-districts within the municipality and its environs. The animals inspected, were of different sex and age. A few females were sampled only, because the females are kept for reproduction, the age was estimated and the animals were categorized into three age groups : ≤ 1 year, 1.5-3 years and 3 -5 years.All the slaughtered sheep carcasses were visually and carefully inspected. Visceral organs, such as liver, lung, omentum, and mesentery, as well, abdominal, thorax and pelvis cavities were investigated for the presence of *C. tenuicollis* cyst. Transparent cyst filled with clear fluid and with a long neck with white corn sized spots in the fluid were considered to be C. *tenuicollis.*For the presence of C. *ovis*, the muscles (skeletal muscle, diaphragm, esophagus, heart) were examined. Live vesicles namely translucent containing clear fluid, sometimes bloody, with a white point (protoscolex) or degenerate cyst was considered to be C. *ovis.*

Statistical analysis

For statistical analysis, we used the software program Microsoft Excel 2010. The comparison of the distribution of different populations were analysed by using Chi-Square test with the level of significance $p<0.05$.

RESULTS

Overall prevalence

Of 10 696 carcasses examined, ovine cysticercosis was found in 461 sheep (4.31%), 241 (2.25%) sheep were found to be infected with *C. tenuicollis* cysts, followed by those of *C. ovis* cysts with 220 (2.06%) carcasses. No significant difference was found between the prevalence of the two types of ovine cysticercosis (muscular and hepato-peritoneal cysts).

Prevalence of ovine cysticercosis according to the predilection sites

The rate of cysticerci in different organs is represented in Table 1.

Muscular cysticercosis (*C. ovis* cysts)

All muscular cysticercosiscysts found in sheep slaughtered were dry, in the form of hard whitish vesicles, pearlescent sometimes yellowish, about 1 cm in diameter on average, which could correspond to *C. ovis.* These cysts had a tendency to be located more in the heart (Figure 1), followed by diaphragm. However, a low percentage were found in esophagus and this difference between infections rate of heart and other organs was highly significant ($p<0.001$).

Hepato-peritoneal cysticercosis (*C. tenuicollis* cysts)

The prevalence of *C. tenuicollis* in the liver (Figure 2) was higher than in the omentum**.** However, no vesicle was observed in the peritoneum during our study. This anatomical distribution of cysticerci showed a significant variation ($p<0.001$) in different predilection sites.

Table 1: Prevalence of ovine cysticercosis according to the predilection sites

Organs	Infected organs with muscular cysticercosis of *C.ovis*		Organs	Infected organs with *C. tenuicollis*	
	N	%		N	%
Heart	128	51.82	Liver	146	57.71
Diaphragm	76	30.77	Omentum	107	42.29
Esophagus	43	17.41	Peritoneum	0	
Total	247	100	**Total**	253	100

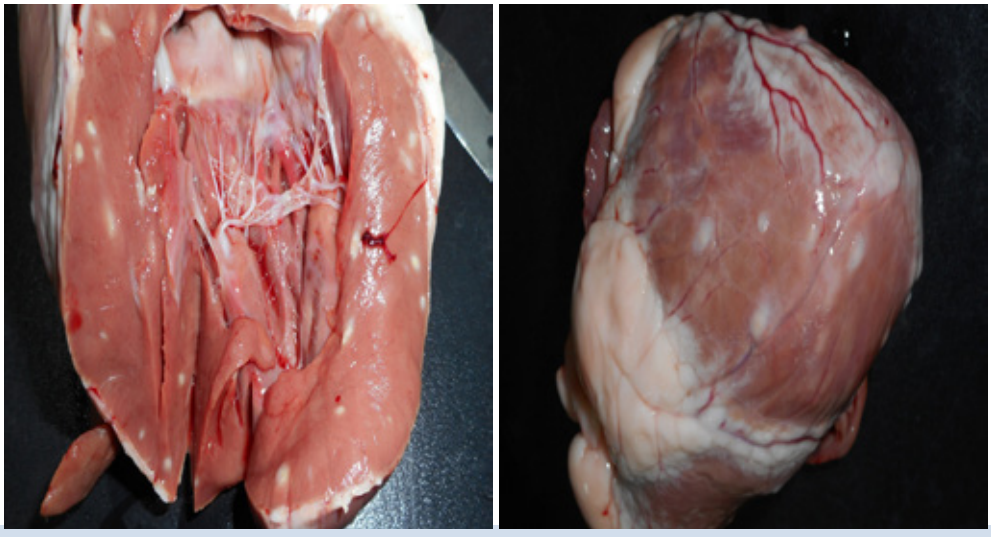

Figure 1: Degenerated *C. ovis* cysts in the heart of sheep

Figure 2: *C. tenuicollis* cyst in the liver of sheep

Intensity of parasitism by cysts of cysticercosis in the predilection sites

Muscular cysticercosis(*C. ovis* cysts)

From parasitized sheep, 493 muscular cysts were counted on inspected organs, the distribution of the cysts countedis summarized in Figure 3. The heart was the most infested organ with 354 cysts, followed by diaphragm and esophagus with 83 and 56 cysticerci respectively. The statistical test detected a highly significant difference ($p<0.0001$) between the level of parasitism by muscular cysticercosisbetween the three organs namely the heart, the diaphragm and the esophagus.

Hepato-peritoneal cysticercosis (*C. tenuicollis* cysts)

We obtained a total of 465 cysts of *C. tenuicollis* from parasitized organs. In omentum, we observed 246 cysts, while 210 cysts were counted in liver (Figure 4). The chi-square test was very significant ($p< 0.0001$) between the level of infestation with cysts of *C. tenuicollis* in the omentum and liver.

Prevalence of ovine cysticercosis according to the risk factors

The prevalence of ovine cysticercosis in relation to the season, the age and sex of sheep is shown in Table 2.

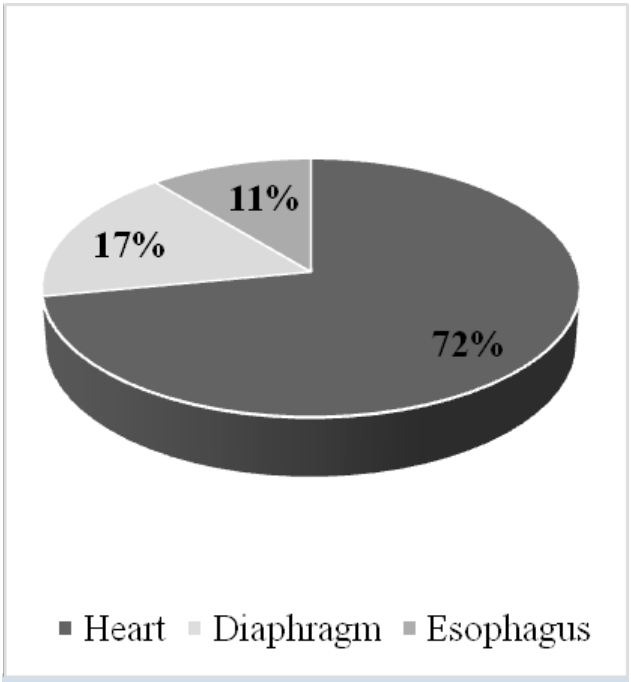

Figure 3: Intensity of parasitism by cysts of *C.ovis* in the predilection sites

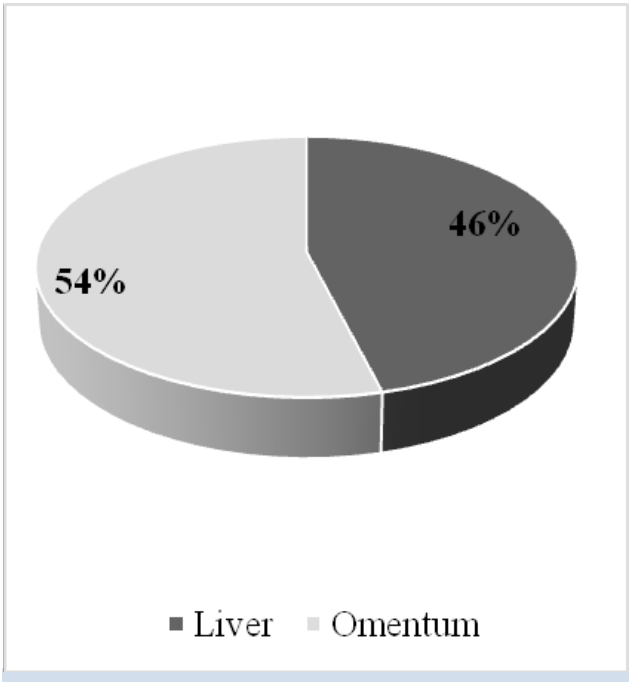

Figure 4: Intensity of parasitism by cysts of *C. tenuicollis* in the predilection sites

Table 2: Prevalence of ovine cysticercosis according to risk factors

Factors	Category	Number of sheep examined	Carcasses with muscular cysticercosis of *C. ovis*		95%CI	Degree of significance and pvalue	Carcasses with *C. tenuicollis*		95%CI	Degree of significance and pvalue
			N	%			N	%		
Gender	Male	10641	200	1.88	[1.6 - 2.10]	p< 0.0001	241	2.26	[1.98 - 2.55]	
	Female	55	20	36.36	[23.6-49.1]		0			
Age Year (s)	≤ 1	2267	5	0.22	[0 - 0.40]	p< 0.0001	31	1.36	[0.89 - 1.85]	p< 0.0001
	[1.5-3]	5269	79	1.50	[1.2- 1.8]		118	2.24	[1.84 - 2.64]	
	[3-5]	3160	136	4.30	[3.6- 5]		92	2.91	[2.33 - 3.50]	
Season	Winter	2280	56	2.46	[1.8- 3.1]	p> 0.05	34	1.50	[0.99 - 1.99]	p< 0.0001
	Spring	1439	45	3.13	[2.2 - 4]		22	1.52	[0.89 - 2.16]	
	Summer	3655	71	1.94	[1.5- 2.4]		48	1.31	[0.94 - 1.68]	
	Autumn	3322	48	1.44	[1 - 1.8]		137	4.12	[3.45 - 4.80]	

DISCUSSION

Overall prevalence

The prevalence of ovine cysticercosis during our study was 4.31%. In the world, results lower than ours were observed in Romania (1.73%) (Lezeriuc et al., 2002),andin Egypt (1.2%) (Elmonir et al., 2015). While a higher prevalence compared to our results were recorded in Greece where a prevalence of 29.41% was noted (Christodoulopoulos et al., 2008).

In an epidemiological survey conducted by Christodoulopoulos et al. (2008), the most common risk factors that may increase the risk of exposure of sheep to cysticercosis were the improper disposal of dead animals, the access of farm dogs to the offal of slaughtered sheep, the carelessness of farmers to treat farm dogs with anthelmintics, and the grazing of flocks in fields where stray dogs have free access(Christodoulopoulos et al., 2008).

In Algeria, the traditional extensive farming method used exposes the sheep to an intensive parasitism. Also, the need for frequent movement of the herd to fetch water and food, when they are lacking, weakens the animals and increases their susceptibility to infestation. Water points, wetter pastures, areas with high animal density are high places of contamination.

In the present study a prevalence of muscular cysticercosis was found to be 2.06%. Similar finding was reported in Benin (3.44%) (Attindehou and Salifou, 2012), in Bulgaria (2.4% and 3.1%) in 1980 and 1981 respectively (Georgieva and Yabulkarov, 1984), in southern Australia (2.39%) (Whiting, 1972) and in Nigeria (1 %) (Dada and Belino, 1978).

While, higher prevalence compared to current result was reported from other countries : 7% in England (Eichenberger et al., 2011) and 11.14% in USA (Jensen et al., 1975).

The role of dogs is important in the transmission of pathology. In a study done in the Netherlands, it was concluded that the abattoir dogs had introduced the parasite because the affected sheep had spent a «long time» on a field adjacent to the abattoir, and the infection was absent from the flocks of origin, but the tapeworms were present in abattoir dogs, which had been fed offal from the sheep (Borgsteede et al., 1985). In another study, Eichenberger et al. (2011) showed that the frequent use of fields by dogwalkers represented a high risk for transmission of *T. ovis* (Eichenberger et al., 2011). In Australia, White and Chaneet (1976) noted that the incidence of *C. ovis* fell from 6.9% to 0.3%, in a 4 year programme to control *Taenia ovis* cysticercosis on farms. In this program, the farmers were advised not to feed dogs any raw sheep meat or offal and were supplied with sufficient cestocide to treat all dogs every two months, recommendations were also given on the control of movement of dogs and the disposal of offal from home-killed sheep (White and Chaneet, 1976).

In our study, all the cysts detected were non-viable. Broadbent (1972) noted that 99.8% of the cysts detected were non-viable and viable cysts were found only in lambs under 12 months of age. Sheep probably have a good immune system that allows them to fight cysticercosis cysts. In effect, Euzeby (1998) noted that this evolution of the lesions is due to the immune reaction of the host.

The reason for the low prevalence of muscular cysticercosis recorded in this study may be related to the low level of environmental contamination, also, our findings were based on surveys carried out on carcasses subjected to routine meat inspection procedures. This can possibly underestimate the incidences reported. Jensen et al. (1975) noted that young cysticerci were not easy to detect. Moreover, according to Euzéby (1966) in experienced meat, inspectors could most likely miss out quite number of viable cysticerci, which blend with the pinkish-red color of the meat, or which are lodged in the intermuscular connective tissue, generally infiltrated with fat (Euzéby, 1966). Dornyet al. (2010) reported that currently the only affordable, workable and available test is visual inspection of the meat, but it is not sufficient, its sensitivity is considered low (<30%). However, it is believed that visual inspection of the meat can identify heavily infected carcasses, which also poses the greatest risk (Dornyet al.2010).

A prevalence of 2.25% for *T. hydatigena* cysticercosis was found in the examined sheep. Our observation is in agreement with those obtained in Italy by Scavone et al. (1999), who found prevalence of 2.6 %. Also, similar results were observed in Egypt by Taher and Sayed, (2011) where a incidence of 4.8% were reported. However, low prevalence was observed in the present study compared to those obtained in some localities from : Bulgaria (11.30%) (Kanchev et al., 2008), Iran (12.87%) (Radfar et al., 2005), Australia (13.6%) (Broadbent, 1972), Italy (14.6%) (Scala et al., 2015), India (20.25%) (Deka and Gaur, 1993), Nigeria (21.4%) (Dada and Belino, 1978) and (23%)

(Akinboade and Ajiboye, 1983), Belarussia (23.2 %) (Nikulin and Karasev, 1975), Brazil (35.2%) (Soares et al., 2012), Ethiopia (37.1%) (Bekele et al., 1988) and (40.0%) (Samuel and Zewde, 2010), Tanzania (51.9%) (Braae et al., 2015), Benin (55.57%) (Attindehou and Salifou, 2012), Spain (85.5%) (Peris Palau et al., 1987).

The infection is often associated with a lack of hygiene and poor farming practices. According to Nikulin and Karasev (1975), the incidence of the disease among sheep was attributed to their special grazing behaviour on pastures contaminated by infected dogs. Also, Samuel and Zewde (2010) concluded that the prevalence is influenced by the type and stocking density and husbandry practices. In Iran, from Radfar el al. (2005), the prevalence of cysticerci was reported in wild animals, this suggested that a sylvatic cycle between wild carnivores and wild herbivores occurs and that interaction between domestic cycle and sylvatic cycles may occur (Radfar et al., 2005).

Prevalence of ovine cysticercosis according to the risk factors

Muscular cysticercosis (*C. ovis* cysts)

This study used samples from abattoir where the majority of the slaughtered animals were male, and only females less than 5 years old were slaughtered in accordance with Algerian regulations because females are preserved by breeders for reproduction.This may not reflect the reality of difference between gender in the occurrence of muscular cysticercosis.

Results from our study showed an increase in prevalence of ovine muscular cysticercosis with age confirming that a major source of infection for sheep is likely to be through the consumption of *Taenia* eggs from the environment. These results are similar to those of some previous investigations (Whiting, 1972 ; Christodoulopoulos et al., 2008 ; Attindehou and Salifou, 2012) indicating that age was an important factor for being positive as a measure of the cumulated life-time risk.

In Benin, Attindehou and Salifou (2012) noted that the infection was prevalent all seasons with nevertheless high rates in rainy seasons. In USA, Jensen et al. (1975)found that the prevalence was higher in the autumn than spring. The authors assumed that the lambs reached the infection from summer pastures contaminated by *T.ovis* eggs (Jensen et al., 1975).

Hepato-peritoneal cysticercosis (*C. tenuicollis* cysts)

The difference in the occurrence of *C. tenuicollis* cysts between genders was not considered. However gender-related tendency of prevalence had been reported previously and some data had suggested that the sex was a significant factor in determining previous exposure to *C.tenuicollis* in sheep (Akinboade and Ajiboye, 1983 ; Taher et al., 2011) who indicated that female animals were more susceptible than males to infection with *C.tenuicollis*. However, according to Soares et al. (2012), it didn't have significant difference between the sexes in the prevalence of *C.tenuicollis.*

Adults were more heavily infected than young animals. These results are similar to the findings of Akinboade and Ajiboye (1983) ; Samuel and Zewde (2010) ; Attindehou and Salifou (2012). The higher rate of infection in adult animals may be attributed to age itself. Adult animals might have picked more eggs of *T. hydatigena* during their life (Samuel and Zewde, 2010). In contrast, Soares et al. (2012) noted that the frequency of parasitism was high among young animals and that cestode parasites produce significant quantities of antigens in adult animals, which protect small ruminants from infection.

Higher prevalence was observed during the autumn, this indicated that sheep picked up the infection from summer pastures contaminated by faeces of dogs infected.Our finding does not support the reports of Deka and Gaur (1993) who found high incidences during the winter. However, Akinboade et al. (1983) and Attindehou and Salifou (2012) showed that the prevalence of infection was higher in the wet season than in the dry season.

Prevalence of ovine cysticercosis according to the predilection sites

Muscular cysticercosis (*C. ovis* cysts)

The present abattoir study revealed that among the organs accessible for detailed inspection, the heart, was the most affected. This preferred predilection was similar with earlier findings reportes by Bilan and Tassin (1969); Jensen et al. (1975) and Kebede (2008).

Euzéby et al. (2005) noted that the elective muscular localizations were the heart, the masseter and pterygoid, the diaphragm and the tongue.From Kebede (2008), the distribution of lesions on the various

organs can be influenced by several factors such as muscle activity, age, and the geographic area (Kebede, 2008).

Hepato-peritoneal cysticercosis *(C. tenuicollis* cysts)

C. tenuicollis was more frequently detected in the liver followed by the omentum. Deka and Gaur (1993) found that cysts were commonly found in the liver as well as mesentery and omental fat (Deka and Gaur, 1993). In a another hand, Radfar et al. (2005) reported taht the predominant sites of *C. tenuicollis* was the omentum followed by the liver, the peritoneum, and finally the lung, heart and bladder with similar proportions (Radfar et al., 2005). Similarly, in another study, *C. tenuicollis* was more frequently detected in the omentum, followed by the liver, peritoneum and finally the lung (Samuel and Zewde, 2010). Akinboade and Ajiboye (1983) found that the commonest sites for cysts were the mesenteries and omentum (Akinboade and Ajiboye, 1983). Also, Soares et al. (2012) noted that the predominant localization of *C. tenuicollis* were the omentum, followed by the abomasal serosa (Soares et al., 2012). Howerver, Cassali and Nascimento (1994) showed that the examination of the genital system of 225 ewes revealed three cases of genital cysticercosis in different parts of the uterus and in ligamentum latum (Cassali and Nascimento, 1994).

CONCLUSION

The present study has revealed a non-negligible prevalence of ovine cysticercosis in the two slaughterhouses in the north of Algeria, suggesting a dispersion of *T. hydatigenae* and *T. ovis* eggs and parasite reservoir hosts in the environment. We noted a dominance of *C. tenuicollis* compared to *C. ovis*, *C. tenuicollis* vesicles were mainly present in the liver. All the cysts of muscular cysticerci detected were non-viable probably due to the efficiency of the immune system of the sheep; these cysts seem to have the heart as their predilection. This study highlights the impact of these parasitic diseases in the study region, further studies are needed to determine the impact of ovine cysticercosis in different regions in order to stimulate better efforts towards the control and possible eradication of these deseases.

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