

# Prevalence of Sarcosporidiosis in Carcasses of Cattle Slaughtered at the Eucalyptus Slaughterhouse-Algeria

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## Abstract

Sarcosporidiosis is a parasitic disease due to the development of cystogenic coccidia of the genus *Sarcocystis* with dixene evolution and muscular localization, which can cause losses in cattle and generate an intestinal infection in domestic carnivores (dog, cat) and humans. The objective of our study was to determine the prevalence of *Sarcocystis* spp on 149 bovine carcasses at the Eucalyptus slaughterhouse in Algiers by macroscopic and microscopic examination and to evaluate the influence of certain risk factors (age, sex, breed and origin). Samples of esophagus and diaphragms were taken from slaughtered cattle and analyzed by enzymatic (pepsin) digestion and histological technique. The macroscopic examination was negative during carcasses inspection while the microscopic examination showed a prevalence of 100% for enzymatic digestion by revealing bradyzoites in the form of bananas and 47.7% at the histology with the detection of thin-walled cysts of *S. cruzi* (98.6%), of thick-walled cysts of *S. hominis* (15.5%) which was the zoonotic species and of *S. hirsuta* (1.39%). The risk factors studied significantly influenced the prevalence of *Sarcocystis* sp. This study revealed for the first time in the diaphragm a cyst of *Sarcocystis hirsuta*.

**Keywords:** bovines, enzymatic digestion, histology, risk factors, *Sarcocystis*

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## Introduction

Cattle were often exposed to multiple diseases, among them sarcosporidiosis, which affects both animal health and the quality of meat, as well as public health. Sarcosporidiosis is a parasitic disease caused by a protozoan of the genus *Sarcocystis* belonging to the phylum Apicomplexa, infesting humans and many animal species (Euzéby, 1997, 1998). These cystogenic coccidia have a dixene cycle, most of which involve herbivores or omnivores as intermediate hosts and carnivores and humans as final hosts (Cappelletti *et al.*, 2015).

The genus *Sarcocystis* infected generally the tissues of mammals, birds and reptiles and included more than 100 species that differ in pathogenicity, host specificity, structure and location of the *Sarcocyst* (Florin-Christensen and Schnittger, 2018).

Cattle were intermediate hosts for five species of *Sarcocystis*, namely *S. cruzi*, *S. hirsuta*, *S. hominis*, *S. rommeli*, and *S. heydorni* (Dubey *et al.*, 2016), while canids, felines, primates, and humans were their final hosts respectively (Yang *et al.*, 2018).

In cattle, *S. cruzi* was the most pathogenic species that caused fever, weight loss, anorexia, abortion, neurological signs and death (Dubey *et al.*, 2016). In contrast, *S. hominis* and *S. hirsuta* were less pathogenic and were associated with eosinophilic myositis lesions (Vangeel *et al.*, 2013; Cappelier *et al.*, 2014). Few reports on the pathogenicity of *S. rommeli* and *S. heydorni* in cattle and humans have been found.

In the majority of cases, cattle that have been infested with *Sarcocystis* spp. showed no clinical signs. If it has been described, the symptoms of bovine sarcosporidiosis were not specific, the parasite was only rarely sought, and the etiology of clinical sarcosporidiosis thus remained most often undetermined (Dubey and Lindsay, 2006). The importance of bovine sarcosporidiosis therefore has been seemed to be underestimated. In most parts of the world, the prevalence of *Sarcocystis* in cattle was extremely high (close to 100%) however, the prevalence of eosinophilic myositis was very low (0.002% to 5%) (Vangeel *et al.*, 2007).

In Algeria, several studies on bovine sarcosporidiosis have shown a high prevalence in different regions of our country but not all of them have been published. Nedjari (2002) and Harhoura *et al.* (2010) revealed prevalences of 63% and even reaching 100% on bovine carcasses at the slaughterhouses of Hussein dey and Rouiba respectively. Recently, the study which was carried out at the level of slaughterhouses in northern Algeria revealed a prevalence of 90% (Taibi-Meksoud, 2016).

For this, our study aimed to determine the prevalence of sarcosporidiosis in the carcasses of 149 cattle slaughtered at the Eucalyptus slaughterhouse and to assess the influence of risk factors such as age, sex, origin and breed on this prevalence.

## Materials and methods

### Method of sampling

Samples of meat were collected between November 2018 and March 2019 on 149 cattle slaughtered at the Eucalyptus slaughterhouse located in the province of Algiers, represented by 91 males (58 local and 33 imported) and 54 local females. The females were between 4 and 8 years old and the males were between 2 and 4 years old. At the slaughterhouse, a post-mortem examination was carried out on bovine carcasses for research

macroscopic cysts. Esophagus samples of 8-12 cm length and 20 g of diaphragms were taken from each carcass and placed in identified freezer bags (sampling date, number, sex and the age of sampled cattle). The samples were transported to the parasitology and mycology laboratory of Higher National Veterinary School (ENSV) of Algiers

### Preparation of samples in the laboratory

The samples were washed, the same day, with water to remove blood and food from the esophagus. They were cleaned of all fats and aponeuroses until obtaining clean muscles. The samples were divided into two parts: one part was stored in the freezer at -20 ° C for enzymatic digestion and the other was fixed in formalin at 10% for histological study.

### Technical analysis

#### Technique of enzymatic digestion

The principle of this technique was to reconstruct an artificial gastric juice called solution of digestion (1.3 g pepsin, 3.5 ml of HCL at 25% and 2.5 g Na Cl in 500 ml of distilled water). The latter combined the factors promoting the digestion of cysts and the release of bradyzoites, creating an optimum pH (pH 1-3) which allowed the activation of pepsin (proteolytic enzyme) and the denaturation of proteins. For the peptic digestion of muscle samples (diaphragms and esophagus), we used the modified method of Seneviratna *et al.* (1975) which was cited by Latif *et al.* (1999). The samples were minced with a robot which was washed after each use and then weighed with an electronic scale.

10g of diaphragm and 10g of esophagus from each carcass were collected in a graduated plastic tube, in which 50 ml of digestion solution were added, the whole was homogenized using a spatula and incubated at 37° C with constant stirring for 30 minutes. The digest was then filtered with a sieve on which two gauze layers were deposited, to remove muscle debris. The obtained filtrate was centrifuged at 3000 rpm for 5 minutes, the pellet was taken up in PBS (pH 7.2); the same operation was carried out twice, in order to stop digestion. A few drops of the pellet were aspirated and deposited on a slide for the preparation of smears and then were dried in the oven at 37°C.

The dried smears were stained using the technique of May Grunwald Giemsa (Bussieras and Chermette, 1991) and were then observed

under an optical microscope (Leica DMLS ®) at magnification (x400, x1000). Sample was considered positive when typical bradyzoites of *Sarcocystis* were observed (banana shape).

#### Histological technique

The histological technique allowed not only the diagnosis of *Sarcocystis* infection but it also allowed the identification of the species involved. The steps of this technique were carried out at laboratories of Anatomy-pathology and Histopathology as well as Cytology of C.H.U. Nefissa Hamoud (Parnet) and Salim Zemirli in Algiers.

The histological technique was applied to all samples (diaphragms and esophagus). The method used was that cited by Hould *et al.* (1999), one square centimeter (1 cm<sup>2</sup>) of each muscle sample was processed by an automat device for complete dehydration and paraffin inclusion. The microtome section was then used to obtain sections of the order of 3 to 5 µm thickness, deposited on slide and stained with hematoxylin and eosin (H&E). The slides were read with an optical microscope at the magnification (x100, x 400, x 1000). The positive slides revealed presence of *Sarcocystis* cysts in the muscle fiber having a wall with variable thickness according to the species concerned (Gr.1000).

#### Statistical analysis

All the data collected were recorded and processed in Microsoft Excel 2016. The statistical analysis was performed using IBM® SPSS® statistics version 20 software, which was used to calculate descriptive statistics: prevalence of *Sarcocystis* according to risk factors (origin, breed, sex and age) with a confidence interval at 95%.

The data analysis was subjected to chi-square tests and to the calculation of the odds ratio in order to study the risk factors on the prevalence of *Sarcocystis*. The significance level was set at  $P < 0.05$ .

#### Results and discussions

During the inspection of carcasses at the slaughterhouse, no macroscopic cyst or lesions of eosinophilic myositis were found. In contrast, microscopic sarcosporidiosis lesions have been observed. Enzymatic analysis revealed the presence Bradyzoites of *Sarcocystis* sp banana-shaped on all of the muscles (esophagus and diaphragm) analyzed on 149 cattle, which represented an infestation rate of 100%. The bradyzoites of *Sarcocystis* sp. and numerous metrocytes were observed un-

der an optical microscope (Gr x 400 and 1000) (Figure 1).

The histology revealed presence of sarcosporidian cysts, ellipsoidal in shape elongated in the direction of the muscle fibers, in 71 cattle, with an average prevalence of  $47.7\% = 48\% \pm 5.93\%$  (39.60 - 55.7) %. According to Wouda *et al.*, 2006, the identification of the species involved was carried out by studying the wall of the cysts using morphological criteria during the observation of histological sections under an optical microscope. The enumeration of *Sarcocystis* cysts has revealed two types of cysts, thick-walled and thin walled, located inside the muscle fibers. Thin-walled *Sarcocystis* were characteristic of *S. cruzi* (Figure 2), while thick-walled *Sarcocystis* were represented either by *S. hominis* which was the zoonotic species (Figure 3), or *S. hirsuta* (Figure 4).

For these last two species, the differentiation of the two types of cysts was made by observing the cytophaners composing the wall of the cysts which can be long in shape, cylindrical at the base and almost perpendicular to the surface of the wall (in shape of fingers), characteristic of *S. hominis* (zoonotic species) (Figure 3), or long in shape, constricted at the base, conical and inclined in the distal part ( $45^\circ - 90^\circ$ ) for *S. hirsuta* (Figure 4).

Of the 71 parasitized cattle, 70 were infested with thin-walled cysts (98.6%) and 11 with thick-walled cysts (15.5%), of which 10 cattle were double infested with thin and thick-walled cysts (14%) at the same time and only one cattle (1.39%) showed a double infestation with thick-walled cysts of *S. hominis* and *S. hirsuta* (Figure 5).

For the intensity of cysts in both muscles, a total of 287 cysts were counted with 268 thin-walled and 18 thick-walled. The prevalence of sarcosporidian cysts in the infested diaphragms and esophaguses showed that thin-walled cysts remain dominant regardless of the parasitized muscle, with a high prevalence of 91% (101/111) in the esophagus and 97% (167/176) in the diaphragm.

Conversely, the prevalence of thick-walled cysts was very low (9%) (10/111) and 5% (9/176) in each of the muscles respectively. Indeed, all cysts were observed in 52 diaphragms and 47 esophagi. On the other hand, the prevalence of *S. hirsuta* was very low (0.57%) and refound only in the diaphragm so for the intensity of parasitism, the diaphragm was more infested than the esophagus (Figure 6)

### Risk factors analysis

#### Sex factor

30.8% (28/91) of males were infested with the *Sarcocystis* spp cysts compared to 74.1% (43/58) females. The difference between the prevalence of the infestation for both sexes was highly significant ( $P < 0.0001$ ), the females were more infested than males. In addition, an Odd ratio value of 6.45 was recorded, which means that infestation with *Sarcocystis* sp cysts was 6-fold more frequent in females than in males (Table 1). The infestation according to the type of cyst reveals that thin-walled cysts of *S. cruzi* were predominant, regardless to the sex of carcass.

#### Age factor

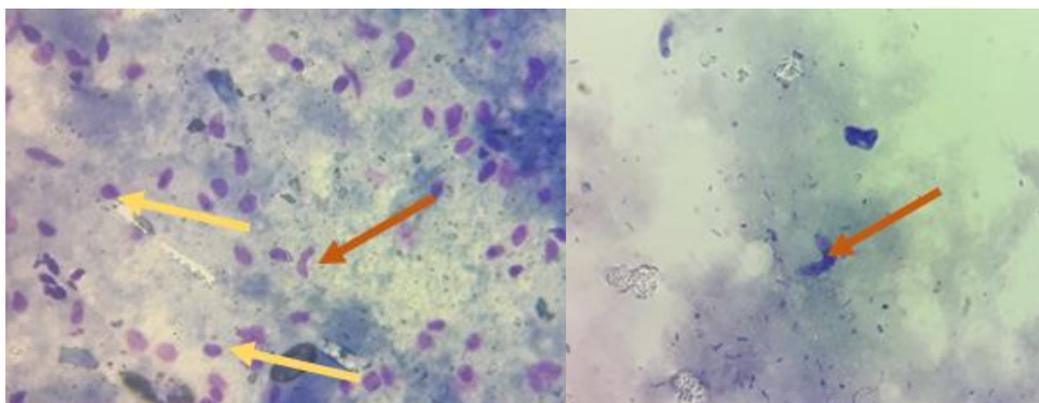
149 cattle inspected were divided into three age groups. The first group consists of cattle under 2 years old with infestation prevalence of 28.8%

(15/52). The second group consists on cattle between 2 and 4 years old with an infestation prevalence of 39.4% (13/33) and the final group consists of cattle over 4 years old with an infestation prevalence of 67.2% (43/64). A highly significant difference ( $P < 0.0001$ ) was recorded between the infestation prevalences of the three age groups.

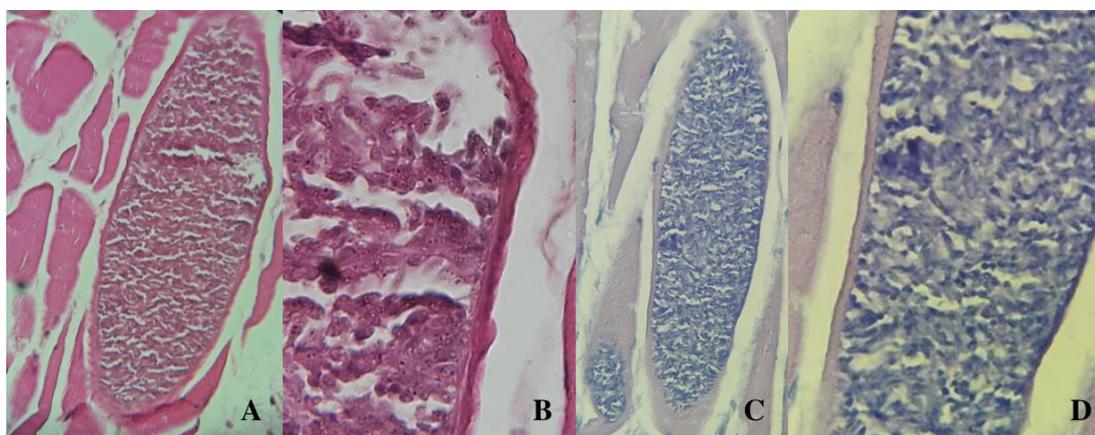
The prevalence of parasitism was very high in cattle over 4 years old, the study also revealed that infestation with *Sarcocystis* sp. cysts was 4 times more frequent in this age group compared to other age groups (odds ratio = 4.48) (Table 1). Thin-walled cysts of *S. cruzi* were predominant regardless of the age of cattle.

#### Breed factor

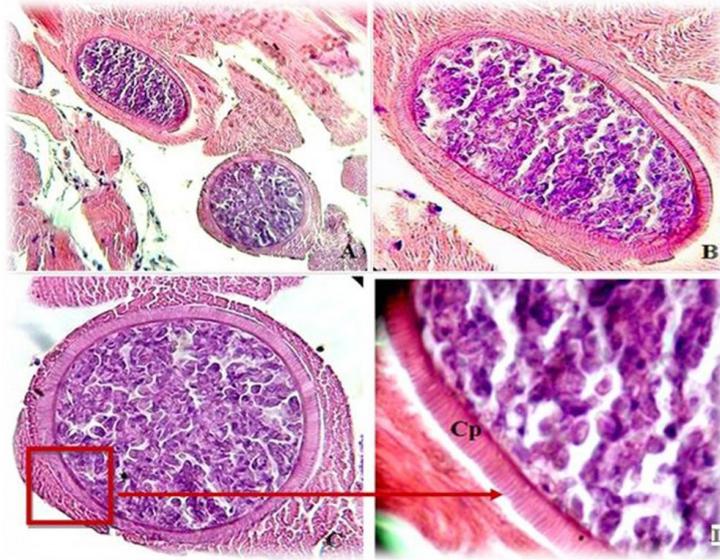
The cattle examined were from different breeds, among the beef carcasses which revealed



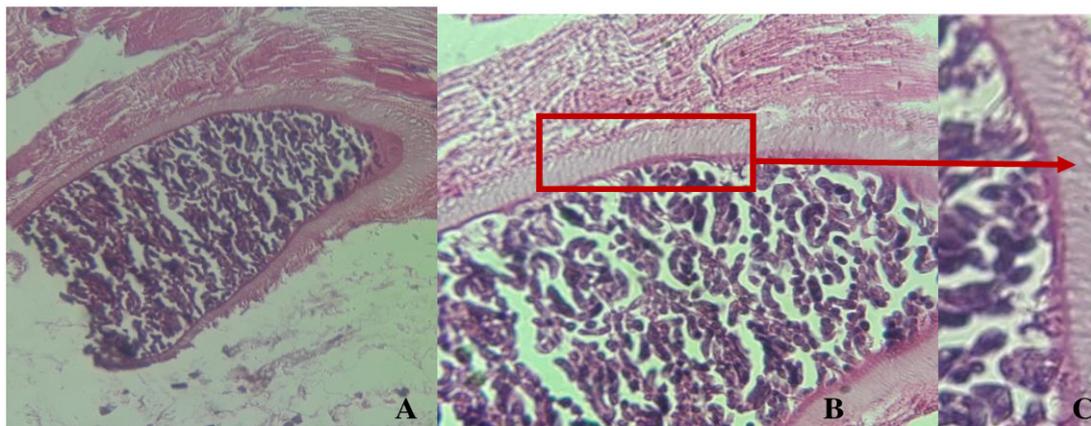
**Figure 1.** Bradyzoites (orange arrow) and metrocytes (yellow arrows) of sarcocystis sp. Stained with May Grunwald Giemsa, observed under a light microscope Gr x 400 (A); Gr x 1000 (B)



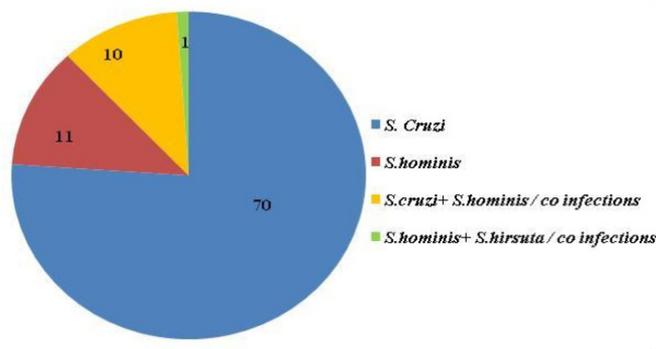
**Figure 2.** Thin-walled cyst of *S. cruzi* in longitudinal section observed under a light microscope (H &E): Gr x 400 diaphragm (A); Gr x 1000 (B), Esophagus Gr x 400 (C); Gr x 1000 (D)



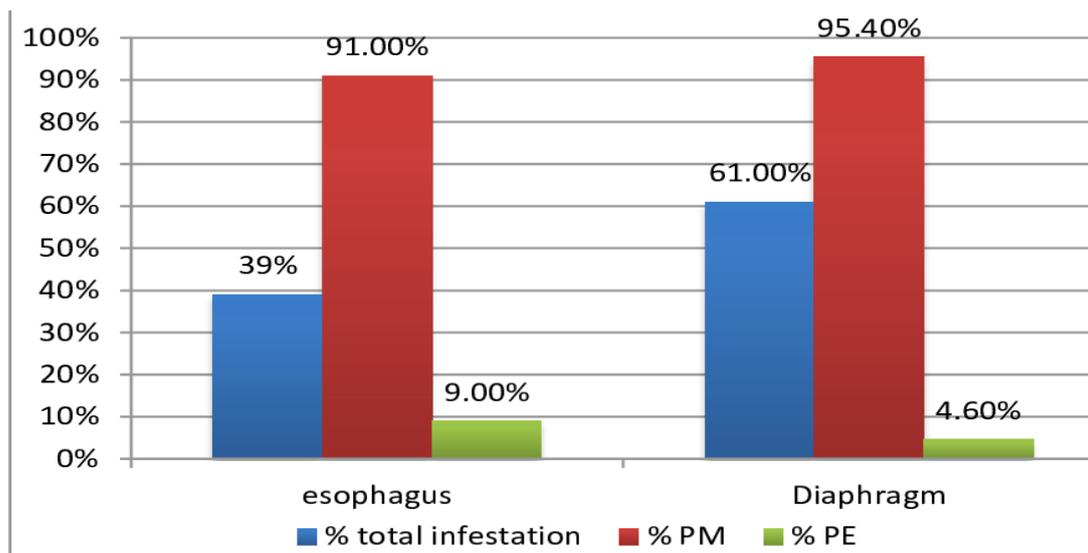
**Figure 3.** *S. hominis* cysts at the diaphragm (A); Longitudinal section (B); Cross section (C); (Cp): Cytophaners (D), observed under a light microscope (H&E; Gr x 400; x 1000)



**Figure 4.** Thick-walled cyst of *S. hirsute* in longitudinal section at the level of the diaphragm, observed under a light microscope (H&E): Gr x 400 (A); Gr x 1000 (red box) (B); observation of inclined and constricted cytophaners at the base (arrow) (Cp) Gr x 1000 (C)



**Figure 5.** Cattles infested with Sarcocystis species



**Figure 6.** Prevalence of thin-walled (PM) and thick-walled (PE) sarcosporidia cysts in the diaphragm and esophagus

**Table 1.** Cattle prevalence by sex, age, breed and origin with their confidence interval at 95% and significance level p

Risk factors	Category	Cattle tested	Positive cattle	Prevalence (%)	CI (%)	p-value	Odds Ratio	CI (%)
<b>Sex</b>	Male	91	29	31.9	[22.29-41.44]	P< 0.0001	0.163	[0.078-0.340]
	Female	58	43	74.1	[62.87-85.41]		6.13	[2.939-12.778]
<b>Age</b>	< 2 years	52	15	28.8	[16.53-41.16]	P< 0.0001	0.284	[0.138-0.586]
	< 4 years	33	13	39.4	[22.72-56.07]		0.628	[0.286-1.380]
	> 4 years	64	44	68.8	[57.39-80.11]		4.479	[2.234-8.980]
<b>Breed</b>	PN crossroads	57	24	42.1	[29.29-54.92]	P<0.003	0.667	[0.342 -1.298]
	PR cross	63	40	63.5	[51.60-75.38]		2.935	[1.496 - 5.758]
	Other (Charolais + Limousine + Brown Swiss)	29	8	27.6	[12.73-47.24]		0.381	[0.161 - 0.900]
<b>Origin (District)</b>	Center	73	46	63.0	[51.94-74.09]	P<0.002	3.276	[1.675-6.410]
	West	34	12	35.3	[19.23-51.36]		0.500	[0.226-1.105]
	East	9	5	55.6	[21.20-86.30]		1.362	[0.351-5.285]
	Importation	33	9	27.3	[13.30-45.52]		0.315	[0.135-0.737]

positive, 63.5% (40/63) were of cross-breeds PR, against 40.4% (23/57) cross-breeds PN and only 27.6% (8/29) for other breeds (Charolais, Limousin and Swis Brown). The difference between prevalence's infestation according to the breed of cattle has been highly significant ( $P < 0.002$ ), infestation was very important in crossbred PR cattle. Analysis indicated that the presence of *Sarcocystis* sp. was 3 times more frequent in the cross breed PR than in the other infested breed (Odd Ratio = 3.086) (Table 1).

#### Regarding the origin (provenance)

87.3% (62/71) of infested cattle were of local origin of which 63% (46/73) come from the provinces of central Algeria, 55.6% (5/9) from the east and 32.4% (11/34) from the west against 27.3% of imported origin (France, Spain and Portugal). The prevalence of carcass infestation with *Sarcocystis* sp cysts by region has been highly different ( $P < 0.001$ ). In addition, the analysis revealed that carcasses from central region provenance were three times more infested with *Sarcocystis* sp cysts (Odd Ratio: 3.476) (Table 1).

Comparison of prevalences between import and local cattle showed that 19 out of 60 local male cattle were parasitized (31.7%) compared to 9 out of 31 imported male cattle that were infested (29%).

In our study, no macroscopic cysts specific for sarcocystosis were detected on the 149 carcass inspected, our results were in agreement with the works of Nedjari (2002), Harhoura *et al.* (2010) and Taib *et al.* (2016) in the slaughterhouses of Algiers, Rouïba and El Harrach in Algeria, on the other hand, Taibi-Meksoud (2016) was reported a prevalence of 0.2%. In Iraq, the same prevalence (0.2%) was noted by Latif *et al.* (1999) and in Iran, Mirzael and Rezaei (2016) were detected a prevalence of 8.2% of macroscopic *Sarcocystis* cysts. Shekarforoush *et al.* (2013), were reported the first occurrence of macroscopic *Sarcocystis* of *S. hirsuta* distributed in different striated muscles (intercostal and diaphragm) in cow of 2 years old slaughtered at the Shiraz slaughterhouse in southern Iran. The greatest prevalences were recorded in China by Shi and Zhao (1987) detected macroscopic cysts of *Sarcocystis* sp to 64, 78%, this supposes that cat species of *S. hirsuta* was more predominant.

In our samples, the absence of macroscopic cysts was probably related to the low prevalence of

the feline specie (Latif *et al.*, 1999, Nourollahi Fard *et al.*, 2009). This hypothesis could be explained by the fact that cats were rarely in contact with cattle on pastures and farms and also by the fact that cats bury their faeces after defecation, which makes the pasture soil less contaminated with feline oocysts. Generally, no macroscopic lesions were observed in cattle and diagnosis depends on microscopic examination of muscle samples taken from target tissues such as the heart, tongue, esophagus and diaphragm (Dubey *et al.*, 2016).

Experimental infestations with macroscopic cysts isolated from bovine skeletal muscle on two cats, two dogs and a volunteer human showed that only cats excreted oocysts, from which the authors concluded that the macroscopic cysts were those of *S. hirsuta* (Bottner *et al.*, 1987).

The same experiment was reproduced by the team of Aissi *et al.* (2013), who found oocysts *S. cruzi* after infestation of cats, dogs and primates (maggot monkeys) by portions of muscle infested with microscopic cysts.

For the detection of *Sarcocystis* by the enzymatic digestion technique, according to Euzéby, 1987 and Fassi-Fehri *et al.*, 1978, the infestation of muscles by *Sarcocystis* was similar.

Also, we have in our study, mixed two muscles (esophagus and diaphragms) for enzymatic digestion technique. Microscopic examination of our samples revealed a prevalence of 100%. The majority of studies on bovine sarcosporidiosis had related high prevalences and appeared to be widespread in all countries and slaughterhouse screenings reported that 100% of animals have been affected (Zenner *et al.*, 2005) as the works of Nourollahi Fard *et al.*, 2009 in Iran and Italy, where prevalences of 96% (Bucca *et al.*, 2011), greater than 80% (Domenis *et al.*, 2011) and 91% (Chiesa *et al.*, 2013) were detected.

In Algeria, similar results have been reported by Harhoura *et al.*, 2010 (100%) and Taib *et al.*, 2016 (95%). In contrast, in Egypt, Nahed *et al.*, (2014) revealed the presence of bradyzoites in 60% of cattle taken from different slaughterhouses in Cairo and Giza.

In our study, the heavy infestation of cattle with *Sarcocystis* could be attributed to extensive pollution of pastures and farms by sporocysts excreted in the faeces of definitive hosts. *Sarcocystis* sp. was remarkably high because on the one hand, the dog, the cat and the man could

be behind this strong infestation if they emitted significant quantity of sporocysts in faeces (Fayer, 1974; Fassi- Fehri *et al.*, 1978).

Furthermore, a study in the north of Western Australia showed that 31.2% of cattle were infested by *Sarcocystis* spp. This low prevalence can be explained by an unfavorable climate for the survival of cysts in fact the northern part of Western Australia was characterized by a very arid climate; the survival of cysts was not favored in this environment (Savini *et al.*, 1994).

Histological examination of muscles showed that 47% of cattle were infested with cysts of *Sarcocystis*. This was in agreement with those which were obtained by Savini *et al.* (1992) in Australia, Algeria (Nedjari, 2002), Nigeria (Obijiaku *et al.*, 2013), Malaysia (Latif *et al.*, 2013), Italy (Meistro *et al.*, 2015) and China (Yang and *al.*, 2018), on the other hand, higher prevalences in other countries (70-98%) were published as in Ethiopia by Woldemeskel and Gebreab, 1996 and Mekibib *et al.* (2019), in France (Mary, 2005), in Morocco (Fassi-Fehri *et al.*, 1978), in Iran (Nourani *et al.*, 2010), in Hungary (Hornok *et al.* 2015) and in Lithuania (Januskevicius *et al.*, 2019).

Also, the histology showed that 97% of parasitized cattle were infested with thin-walled cysts (*S.cruzi*), while only 16% have thick-walled cysts (*S.hominis* and *S.hirsuta*). Our results were similar to those obtained by Taibi-Meksoud (2016) who has noted a prevalence of 98% of infested cattle with thin-walled cysts and 9% with thick-walled cysts, and Benamghar (2019) with 92.63% thin-walled cysts, while only 17.89% thick-walled cysts. Nedjari (2002), noted the prevalence of *S.cruzi* cysts in 60.22%, 36.46% of *S.hirsuta* cysts and 3.31% of *S.hominis* cysts in esophagus and Harhoura *et al.*, (2010) found an infestation rate of *S.cruzi* cysts of 60.8% in the esophagus and 79.8% in the diaphragm and a thick-walled cysts infestation rate of 7.5% in the esophagus and 23.5% in the diaphragm. On the other hand, in France some authors noted a predominance of thick-walled cysts of *S.hominis* with prevalence varying from 66 % to 88.6% (Bertin *et al.*, 2014; Lemieux, 2014). In Italy, prevalence vary from 80% for *S.cruzi*, 68% for *S.hominis* and 4% for *S.hirsuta* (Meistro, 2015). In Japan, the existence of *S.hirsuta* infection in cattle was first reported by Inoue *et al.* in 1990. In our study, thick-walled cysts were found only in the diaphragms with a very lower

prevalence. Our results were consistent with the work of Ruas *et al.* (2001) which also showed that *S.hirsuta* cysts were found only in the diaphragm with a lower prevalence (1.4%).

In Germany, *S.cruzi* (52%), *S.sinensis* (37%), *S.hirsuta* (6.6%) and *S.hominis* (6.2%) were found in samples from cattle studied (More *et al.*, 2014). The study carried out in Hungary showed that *S.cruzi* (64%), *S.hominis* (19%) and *S.sinensis* (17%) were the most widespread species (Hornok *et al.*, 2015). In our study, the species *S.sinensis* was not found.

Given the predominance of thin-walled cysts, it can be concluded that cattle were therefore contaminated by ingestion of sporulated oocysts rejected by domestic carnivores, especially dogs and secondarily by humans through the transmission of the zoonotic species *S.hominis* (thick-walled cyst). Excretion of oocysts and sporocysts by final hosts was the key factor in the propagation of infection (Dubey and Lindsay, 2006).

#### For risk factors

Based on sex, in general, we have noted a significant difference between the degree of infestation of males and females. Noted that females were more infested than males. The same results were found by Mohanty *et al.* (1995) and Bertin (2013). Unlike, Najafan *et al.* (2008), Nourollahi Fard *et al.*, (2009) how noted no influence of sex on the prevalence of *Sarcocystis*.

Regarding age, the cattle older than 4 years were more infested (67%). Our results were in agreement with those of Seneviratna *et al.* (1975), Savini *et al.* (1992), Parky *et al.* (1994), Guenegan (2009). All these studies have shown that age influenced the prevalence of microscopic cysts and that infestation increased with age. These results could be explained by the fact that older animals were in contact with oocysts and sporocysts that infested pastures for a longer time period and consequently more infested than younger animals. On the other hand, calves begin to become infested at about 3-4 months of age. Indeed, at this age, they increased their grass consumption and were therefore more in contact with sporocysts (More *et al.*, 2009). In Algeria, no influence of age has been revealed by Nedjari (2002) and Taibi *et al.* (2016).

In our analysis, the prevalence of microscopic cysts of *Sarcocystis* sp. was influenced by the breed factor. In fact, red and black crossbred and

Charolais cattle influenced the prevalence of *Sarcocystis* sp. Our results were similar to those of Nourollahi Fard *et al.* (2009). On the other hand, Harhoura *et al.*, (2010) showed that there was no significant difference between breeds.

Concerning the origin of the animals, cattle from the region of center Algeria appeared to be more infected. In Algeria, prevalences ranging from 38% to 89% were found in the center region and with variable rates for the other zones: East (34.43%), West (15.65%) and South (1.91%) (Lardjane *et al.*, 2014 and Taibi-Meksoud, 2016). The influence of these regions on the prevalence of *Sarcocystis* sp. could be explained by the Mediterranean climate known for long, hot and dry summers with mild and wet winters. According to Seneviratna *et al.* (1975), transmission took place during the rainy season (July to October) during which conditions were favorable for the development of Sporocysts.

Other factors may influence the prevalence of infestation by *Sarcocystis* species, such as environmental and management factors such as the method of husbandry and grazing practice (Meshkov, 1975). Indeed, this author found that the weakest cases of infestations were observed in calves which were kept in closed farms, which revealed a low parasite load in calves grazing on grass in uncontaminated areas respecting good hygiene and therefore not exposed to risk factors such as contaminated pastures.

## Conclusion

This study confirmed that cattle slaughtered at Eucalyptus slaughterhouses (Algiers) were not free from sarcosporidiosis. The results showed a strong infestation of 100% thanks to the enzymatic digestion method. Histological examination, on the other hand, allowed us to highlight two types of *Sarcocystis* cysts, those with thin walls of *S. cruzi* which was the predominant species in bovine carcasses and thick walls of *S. hominis* and *S. hirsute*, which were less numerous. Our study also has demonstrated the important role of the dog in the circulation of *Sarcocystis* and in a weaker way of the man and the cat. The detection of the zoonotic species of *S. hominis* was in favor of a human contribution in the contamination of cattle by *Sarcocystis*; moreover, this would also reflect certain dietary habits such as the consumption of raw or undercooked meat

with harmful consequences for public health. To consolidate these results, a study on the molecular identification of isolated species may be necessary.

Finally, to conclude, the health and economic aspects of bovine sarcosporidiosis were difficult to estimate because it was often an asymptomatic parasitosis. The economic losses associated with infection were very poorly documented. Due to the high prevalence of infection, they could be significant and result in stunted growth, impaired reproduction and reduced milk production. Therefore, in order to reduce the prevalence of this parasite and thus its zoonotic and economic impact, efforts should be made to break the life cycle through awareness rising.

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