



The Prevalence and Morphological Studies of *Sarcocystis* Species in Slaughtered Ruminants in Zakho City Abattoir, Duhok Province, Kurdistan Region, Iraq

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Abstract

Sarcocystis is an intracellular parasite belonging to the phylum Apicomplexa. More than two hundred species of *Sarcocystis* are capable of infecting different species of wild and domesticated animals and humans. This study aimed to determine the prevalence of *Sarcocystis* species and their morphological characteristics in the esophagi muscles of ruminants slaughtered at Zakho abattoir, Zakho City, Kurdistan Region/Iraq. Esophagi muscle specimens' of 1586 ruminants including, 764 sheep, 569 goats and 253 cattle were examined macroscopically and microscopically from April 2021 to March 2022 to determine the prevalence of macroscopic and microscopic sarcocysts. Results revealed a total rate of infection with macrosarcocysts at 18.03 % (286 / 1586), with the highest rate 26.85% (254/946) in local breeds versus 5% (32/640) of imported ones. The highest rate among local breeds 90.91% (10/11) was in cattle, while the highest rate in imported breeds 9.13% (21/230) was among sheep. The overall rate in males was higher than in females. The detected macrosarcocysts relying on morphological characters were assigned as *Sarcocystis gigantea*, *S. moulei*, *S. medusiformis*, *S. fusiformis*, and *S. hirsuta*. Histological examination revealed the presence of microsarcocysts in the esophageal muscles of the three hosts which were assigned as *S. tenella*, *S. arieticanis* in sheep, *S. capracanis* in goats and *S. bovis* or *S. hominis* in cattle. The study results show the widespread of sarcocystosis among ruminants in this region that poses a threat to livestock and humans. This condition necessitates the development of preventive strategies to minimize or eradicate this parasitic infection.

Keywords: Prevalence, *Sarcocystis*, Ruminants, Histological examination, Hematoxylin and eosin stains.

Introduction

Sarcocystis species are intracellular protozoan belonging to phylum Apicomplexa (family Sarcocystidae). They infect a wide range of vertebrates including ruminant other vertebrates and humans. More than 200 species of *Sarcocystis* have been identified, but the life cycles of only 26 species are known [1]. The life cycle requires two hosts, in general an herbivore or carnivore intermediate host and a carnivore or omnivore definitive host. Accordingly, ruminants can act as an intermediate host for several species of *Sarcocystis* (*Sarcocystis arieticanis*, *S. tenella*, *S. medusiformis* and *S. gigantea* in sheep), *Sarcocystis hircicanis*, *S. capracanis*, *S. moulei* and *S. cuprifelis* in goats and *Sarcocystis cruzi*, *S. hirsuta* and *S. hominis* in cattle;

with canids, felids and primates as definitive hosts [2–5]. The pathogenic species infecting ruminants can lead to placentitis, abortion, reduced milk production, neurologic signs, loss of weight and wall, anemia, and even death especially when large numbers of sporocysts are ingested [5–8]. Moreover, most species of *Sarcocystis* are known to cause economic losses through condemnation of infected parts of carcasses during meat inspection in abattoirs [7, 9].

Several species of *Sarcocystis* form macrocysts, which have a worldwide distribution, such as *Sarcocystis gigantea* (*S. ovifelis*) and *S. medusiformis* infecting sheep, in goats *S. moulei* (*S. caprafelis*) and in cattle *S. hirsute* (*S. bovis*) [10, 11]. The sarcocysts produced by these species can either have

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thin walls (as is the case with *S. cruzi* and *S. heydorni*) or thick walls (as is the case with *S. tenella*, *S. hirsuta*, *S. hominis*, and *S. rommeli*) [12]. On the other hand, *S. hominis* is a human pathogen that is well known for causing symptoms such as nausea, vomiting, and diarrhea [13].

Several *Sarcocystis* species can coexist in the same intermediate and definitive hosts [14]. Therefore, it is crucial to accurately identify *Sarcocystis* infections in different hosts to reduce their prevalence in humans and ruminants, especially cattle, as beef is a major source of protein for people all over the world [15]. Some studies have been performed among slaughtered ruminants in Kurdistan region and Iraq involved the prevalence of macrosarcocysts in slaughtered sheep and goats. In Sulaimani [16], reported a rate of 34.0 % among goats, in Erbil, [17] sheep and goats reported rates of 9.5% and 8.8%, respectively, In Duhok, [18] reported rates of 22.40% and 16.8% also among slaughtered sheep and goats, respectively. In Baghdad, [19] reported rates of 4.10% and 33.6%, in sheep and goats, respectively, and in Wasit, [20] reported a rate of 14.44% in goats. Due to the scarcity of information on the prevalence of *Sarcocystis* species in Zakho City, and the lack of the studies among cattle, this study was undertaken to determine their prevalence among the slaughtered ruminants in Zakho Abattoir, Zakho City, Duhok Province, Kurdistan region, Iraq.

Material and Methods

Ethical Approval

This study was not based on *in vivo* experiments or live animals, samples were collected from slaughtered animals in Zakho slaughterhouse. Before starting the study, approval was obtained from the University of Zakho Committee for Ethics in Biomedical Research (NO.1054 / Feb-2021). In addition, every procedure was carried out in conformity with the pertinent guidelines as well as national and international regulations.

Study Location and Period

The study was conducted in Zakho slaughterhouse, Zakho city, Duhok province during the period from April 2021 to March 2022, in which 1586, specimens of esophagi including 764 sheep, 569 goats and 253 cattle of both sexes, were collected, these slaughtered ruminants belong to Blan Bazar supermarkets. All collected tissues were grossly inspected for the macrosarcocysts before taking samples. Each sample was placed in a plastic container fully labeled with animal species, sex, breed, type of tissue, date of collection, etc. according to a special questionnaire form designed for the study. Then they were placed inside a cooling bag and transported to Parasitology Laboratory,

College of Science, Zakho University for further processing.

Gross Examination and Specimen Collection

According to [21] a visual examination of the muscle tissues was able to detect the presence of macroscopic sarcocysts in the slaughtered animals. It was necessary to slice the superficial muscles of the esophagus, to make a gross inspection easier and more effective in locating any macroscopic sarcocysts and positive cases were recorded. In addition, to visual examination, some muscle specimens were taken from the esophagi of these animals and preserved in 10% formalin for subsequent histological examination to assess the presence of microsarcocysts.

Macroscopic Examination

Macroscopic examination of the macrosarcocysts was performed by the naked eye for each sample, followed by measuring the sizes and dimensions of the present macrosarcocysts using a ruler [22]. A small piece from each infected esophagus tissue with macroscopic sarcocysts was taken and kept in 10% formalin for histological examination to detect microscopic cysts and bradyzoites.

Microscopic Examination

Microscopic examination was performed by isolating the macrosarcocysts from infected tissue using sterile forceps and scalpels. Some of the isolated cysts were crushed and homogenized using a glass homogenizer, then the homogenate was filtered through a double layer of surgical gauze. A few drops of the supernatant were examined by microscope under 40x or 100x to detect bradyzoites. Moreover, dry smears were prepared, fixed with ethanol, and stained with Giemsa stain for more clarification [23].

Histological Examination

The sample from muscle fibers of esophagi were fixed in 10% formalin solution then dehydrated in ethanol solution after clearing with 100% xylene embedded in paraffin wax, sectioned at a thickness of 5 μ m, and lastly stained by Hematoxylin and Eosin, as described by [24]. A digital camera was used to document the findings.

Statistical analysis

The data were statistically analyzed using GraphPad Prisma software, version 6 (San Diego, CA, USA). The differences between the used parameters were analyzed by the Chi-square test. *P* values ≤ 0.05 were considered significant and above this as nonsignificant.

Results

The prevalence of macroscopic sarcocysts in the esophagi of slaughtered ruminants is shown in table

(1). The total prevalence of macrosarcocysts among slaughtered ruminants was 18.03% (286/1586), with a higher rate of 23.3 % (178/764) in slaughtered sheep, while the lower rate of 5.53 (14/253) was among cattle. Furthermore, the slaughtered ruminants were from both local and imported breeds, the total rate among local breed was 26.85% (254/946), while among imported ones was only 5.0% (32/640). As regards to animal species, 90.91% of local cattle were infected, followed by local sheep, among which 29.4% were infected. Statistical analysis revealed the presence of significant differences ($P < 0.05$) between the rates of infections among studied ruminants.

As regards to animal sex, the overall rate in slaughtered male animals was higher (19.37% vs 11.64%). With respect to animal species, the rate in males of sheep and goats were higher than that in females (26.06% vs 14.12%) for sheep and (18.28% vs 7.53%) for goats. While infection was not detected among females of cattle (Table 2). Statistically, the differences between these rates were highly significant ($P < 0.0001$).

Morphological Characteristics of Revealed Macrosarcocysts

In this study two types of macroscopic sarcocysts were observed by naked eye on the wall of the esophagi of slaughtered ruminants, they were oval, and elongated of various sizes and thin, white (fusiform with pointed ends, also of variable sizes) in sheep and goats. In sheep (Figure 1) they were disseminated in all esophagus, appeared yellowish creamy in color and opaque, were readily separable by fine needle from the muscles of esophagus. They varied in shape (oval and fusiform with pointed ends) their sizes, ranged from 2.0- 8.5 mm in length to 1- 3 mm in width and 7.0-13.0 mm in length to 1-2.5 mm in width (Figure 2).

Goats' esophagi were heavily infected with macrosarcocysts (Figure 3 A and B) of different shapes (mostly fusiform and few oval) with variable sizes, the fusiform ranged from 7-9 mm in length x 2-4 mm in width, while the oval-shaped, were 5-7 mm in length x 3-4 mm. in width. Figure 3 (C and D) shows the cattle macrosarcocysts which were fewer in number but larger in size than those of sheep and goats covered with thin layers that can be removed easily, some were superficial others were located under the serosa. The cattle macrosarcocysts were elongated with pointed ends and oval in shape. The sizes of elongated macrosarcocysts ranged from 6 mm to 13mm in length and 4 to 7mm in width, while those oval in shape were 7mm to 9 mm in length and 5mm to 7mm in width, respectively.

Based on gross examination, the current study proposed that the oval macrosarcocysts belong to *S. gigantea* and *S. moulei*, while the fusiform with pointed ends look like *S. medusiformis* and *S.*

fusiformis and the elongated with pointed ends belongs to *S. hirsuta* macrosarcocysts.

Microscopical Examination of Homogenized Macrosarcocysts

The homogenized specimens of isolated macrosarcocysts from sheep, goats and cattle revealed the presence of sarcocysts bradyzoites with different numbers, shapes and sizes. The number varied from few to large number regarding shape and size, bradyzoites in sheep, were banana-shaped, ranged in size from $53 \times 24.72 \mu\text{m}$ (Figure 4 A), and in goats and cattle, the bradyzoites were crescent in shape (Figure 4 B and C) with variable dimensions measuring in average $3.80\text{--}9.73 \mu\text{m} \times 3.70\text{--}6.87 \mu\text{m}$.

Histological Examination of the Esophagi Muscles of the Sheep, Goats and Cattle

The histological examination of the infected esophagi (Figure 5) showed numerous microsarcocysts of different sizes distributed between muscle fibers of esophagi, in sheep appeared ovoid in shape, the average size of $53 \times 24.72 \mu\text{m}$ with thick cyst walls and had radial striations and others were surrounded by thin walls. These microsarcocysts were internally filled with banana-shaped bradyzoites of different dimensions measuring on average $3.80\text{--}9.73 \mu\text{m} \times 3.70\text{--}6.87 \mu\text{m}$, separated by internal septa that appeared white in stained sections with hematoxylin and eosin. The thick walled microsarcocysts were assigned as *S. tenella*. Whereas, cysts with thin walls were assigned as *S. arieticanis*. Figure (6) shows the microscopic sarcocysts in esophagi of goats, which appeared elongated and surrounded by thick walls and measured in length $11.3 \pm 1.2 \mu\text{m}$ and in width $7.2 \pm 0.8 \mu\text{m}$. Depending on the morphological characteristics, in addition to the type of the host, the infected organ and the epidemiological finding, the microsarcocysts in goats look like *S. capracanis*.

Histological study of infected cattle esophagi revealed the presence of sarcocysts of varying sizes elongated to ovoid scattered within the esophageal muscle fibers, elongated sarcocysts were on average size of $53 \times 24.72 \mu\text{m}$, while the ovoid measured $46 \times 43.65 \mu\text{m}$. Some of these microsarcocysts are surrounded by thin walls, while others with thick walls and both types contain internal partitions (Figure 7). These microsarcocysts were assigned as *S. bovifelis* or *S. hominis*

Discussion

Sarcocystosis is recognized as one of the most significant food-borne zoonotic parasitic diseases on a global scale [25]. This study, dealt with the prevalence of macrosarcocysts and microsarcocysts in the esophagi muscles of slaughtered ruminants at Zakho City slaughterhouse, Duhok Province, Iraq. The macroscopic cysts detected in the visual examination in the present study illustrated an overall

prevalence of 18.03% of all infected ruminants (both local and imported), with the highest rates among slaughtered sheep followed by goats of both breeds (23.3% and 16.52%), respectively. As regards to sex, the overall rate in male ruminants was higher than that of females (19.37% vs 11.64%), concerning animal species, the highest rate of infection (26.06 %) was in males of sheep. On the other hand, in goats, also, the rate in males was higher, while females of cattle were free from infection.

The present study rates of macrosarcocysts in sheep and goats are comparable to the rates reported by [18] in ruminants slaughtered at Duhok abattoir which were 22.4% and 16.8%, respectively. However, variable rates of macrosarcocysts have been reported in Iraq among slaughtered sheep and goats such as 34% in goats in Sulaimani [16]. In Duhok city abattoir, [26] reported a rate of 97% among both sheep and goats slaughtered. Rates of 9.5% and 8.8%, respectively, in Soran city, Erbil [17]. While [20] reported a rate of 14.44% in Wasit among slaughtered goats only.

The rate of macrosarcocysts in cattle was lower accounting to 5.53% and this is the first study in this province in which macrosarcocysts were recorded in cattle, as previous studies in the same province didn't detect any macrosarcocysts in slaughtered cattle both local and imported [18, 27, 28]. Also, a study in Sulaimani province didn't record any macrosarcocysts in slaughtered cattle [25]. On the other hand, a slightly higher rate (6.2%) of macrosarcocysts was reported in cattle in Soran city/ Erbil [29].

As regards to animal breed, the rate of macrosarcocysts was higher among the slaughtered local breed of the investigated ruminants (26.85% vs 5.0%), while in a previous study also in Duhok province, only microsarcocysts were recorded in imported cattle [28].

Males of sheep and goats showed the highest rates with macrosarcocysts (26.06 % and 18.28%), respectively, while infection was not detected among females of cattle. The present results regarding the rate of infection among males and females of sheep and goats contradict those of [18] who reported the highest rates among females of both sheep and goats. While [29] reported a rate of 21.88% of macrosarcocysts in females of cattle only and males were free from infection which conflicts with the present study results as regards to cattle.

The variations in the prevalence of macrosarcocysts among slaughtered ruminants might be due to many variables including conditions of management, climatic conditions, the presence or absence of cats and dogs in the surrounding area to livestock, in addition to the number of sporocysts disseminated with their feces [30,31].

The detected species of macroscopic sarcocysts in this study in sheep, goats and cattle based on gross examination, were proposed, the oval macrosarcocysts belong to *S. gigantea* and *S. moulei*. The fusiform with pointed ends, look like *S. medusifomis* and *S. fusiformis*, while the elongated with pointed ends belongs to *S. hirsute*.

The assigned species based on the morphology of the macroscopic cysts, in sheep and goats were identified as *S. gigantea* and *S. moulei*. Similarly other studies reported *S. gigantea* macroscopic cysts [32,33]. Many studies found that *S. gigantea* was the predominant macroscopic species in sheep in addition it can be present at a lower rate in goats [34]. Also *S. gigantea* was recorded in the esophagi muscles of 2.22% of sheep and 2.0% of goats in Misan province, Iraq [35].

In the present study both *S. gigantea* and *S. moulei* were reported in the studied sheep and goats' esophagi muscles which is in accordance with the finding of [36] in Soran city/Erbil, who suggested that sheep and goats can be Cross-infected by both *S. gigantea* and *S. moulei*. In Duhok/Iraq,[37] also reported macroscopic sarcocysts in the esophagi and diaphragm of sheep and goats at rates of 16.77% and 13.62%, respectively. They further added that they identified 3 species of these cysts which were *S. gigantea*, *S. moulei* and *S. medusifomis* in sheep and goats, respectively.

As regards to cattle, the detected macroscopic sarcocysts were assigned depending on the morphological characters as *S. hirsuta*. This species was also, reported in 6.2% of slaughtered cattle in Soran City/Erbil, Iraq [29]. In Egypt [14] reported *S. hirsuta* in 7.5% of slaughtered cattle in the El-Kharga abattoir. The low prevalence of macroscopic sarcocysts in cattle could be attributed to the definitive host which is feline, since the association between cattle and feline in the pasture is less frequent than that with canine definitive hosts that cause infection with microsarcocysts. Also, cats burrow their feces in the soil, this habit can reduce the rate of environmental contamination with the parasite infective stages thus minimizing the rate of infection in the intermediate host. Furthermore, the development of macroscopic cysts of *Sarcocystis* species requires many years and cattle usually are slaughtered before the maturation of the cysts [38]. Additionally, [39] in Iran and [40], in Egypt reported a low number of macroscopic sarcocysts in cattle.

Depending on morphological characteristics as revealed in stained histological sections with Eosin and Hematoxylin stains, indicated the presence of microcysts with variable shapes and sizes. Some are surrounded with thick cyst walls as *S. tenella* and *capracanis*, whereas, others with thin cysts walls as *S. arieticanis* in sheep. While in goats they were elongated and surrounded with thick walls and

assigned as *S. tenella* and *S. capracanis*. Cattle microscopic sarcocysts were assigned as *S. bovis* or *S. hominis*.

Previous studies in Duhok, other parts of the Kurdistan region, and Iraq documented the presence of various species of microscopic sarcocysts in slaughtered ruminants. [26] reported *S. tenella* and *S. capracanis* in the Tongue muscles of sheep and goats, respectively. In Duhok also, [28] detected thin and thick walled microscopic sarcocystosis in the esophagus, diaphragm and heart muscles of cattle, but they didn't assign them to any species. In Sulaimani, [25] detected *S. tenella* and *S. arieticanis* in sheep, *S. cruzi* and *S. bovis* were in cattle. In Soran city/Erbil, [29] reported *S. cruzi* in cattle. In Mesan, Iraq, [35] reported *S. tenella* and *S. arieticanis* in sheep, while in goats only *S. capracanis* was reported.

Moreover, in Saudi Arabia, [41] molecular studies confirmed the presence of *S. tenella* and *S. capracanis* in sheep and goats, respectively. In Egypt, [31], identified *S. tenella* and *S. arieticanis* in sheep, with higher prevalence of *S. tenella*. In Algeria, [42], reported *S. tenella* and *S. arieticanis* in esophagus and diaphragm muscles of sheep. In Lithuania, [43] identified *S. tenella* and *S. arieticanis* in sheep and *S. capracanis* in goats. These studies indicate that these species of microscopic *Sarcocystis* spp. have a worldwide distribution, and this could be attributed to the close association between ruminants and shepherd dogs which act as definitive hosts for these species of sarcocysts and play a potential role in their spread among ruminants and even humans. These findings bring to light the dangers that the

ruminant *Sarcocystis* spp. poses to the public health in Duhok Province, and other parts of Iraq.

Conclusion

Infection with various *Sarcocystis* spp. is common mainly among sheep and goats, but to a lesser extent among cattle in Duhok and other parts of the country. This is obvious due to the existence of different species of *Sarcocystis* that had been detected in the present study and other performed studies. Therefore, the consumed meat must be either frozen before being eaten or cooked well to destroy the present sarcocysts. Furthermore, strict control measures must be applied for controlling stray dogs and cats since they play a major role in disseminating the infection.

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Declaration of Conflict of Interest

The authors state unequivocally that they do not have any known competing financial interests or personal relationships with third parties that would have given the appearance of influencing the work disclosed in this study.

Ethical of approval

This study follows the ethics guidelines of the University of Zakho Committee for Ethics in Biomedical Research, Iraq (ethics approval number; 1054/Feb-2021).

TABLE 1. Prevalence of macro sarcocysts among local and imported slaughtered animals

Animal species	No. Examined			No. Infected		Local		Imported	
	Total	Local	Imported	Total	%	Infected	%	Infected	%
Sheep	764	534	230	178	23.3	157	29.4	21	9.13
Goats	569	401	168	94	16.52	87	21.7	7	4.17
Cattle	253	11	242	14	5.53	10	90.91	4	1.65
Total and %	1586	946	640	286	18.03	254	26.85	32	5.0

P value = 0.05 and $\chi^2 = 5.648$

TABLE 2. The relationship between sex and the rate of infection among slaughtered ruminants

Animal species	No. Examined	Infected		Examined Males			Examined Females		
		No.	%	Total	Infected	%	Total	Infected	%
Sheep	764	178	23.30	587	153	26.06	177	25	14.12
Goats	569	94	16.52	476	87	18.28	93	7	7.53
Cattle	253	14	5.53	248	14	5.65	5	0	0
Total and %	1586	286	18.03	1311	254	19.37	275	32	11.64

P value < 0.0001 and $\chi^2 = 208.82$.

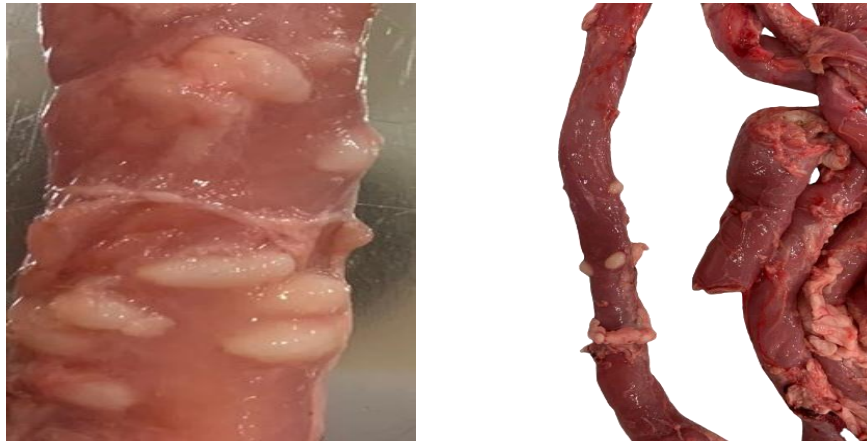


Fig. 1. The macroscopic sarcocysts in the esophagi of the examined sheep.



Fig. 2. showing the gross appearance of macroscopic sarcocysts in sheep esophagi.

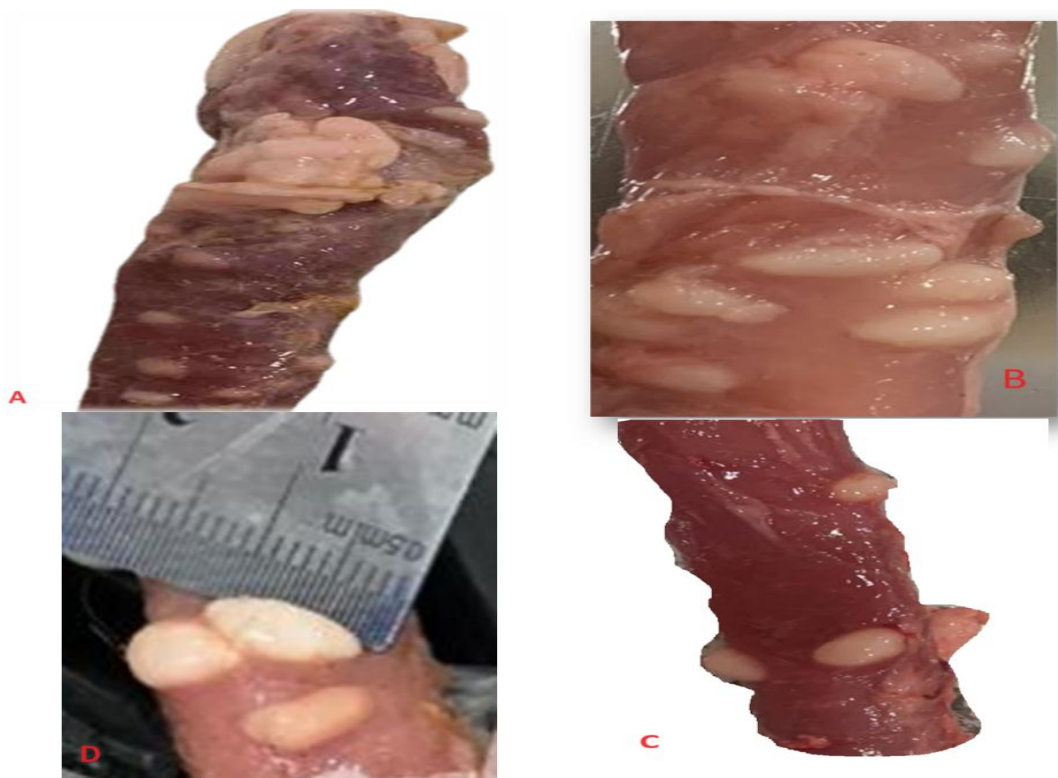


Fig. 3. Showing the gross appearance of macroscopic sarcocystosis in the esophagus of, A and B Goats which were heavily infected, C and D cattle

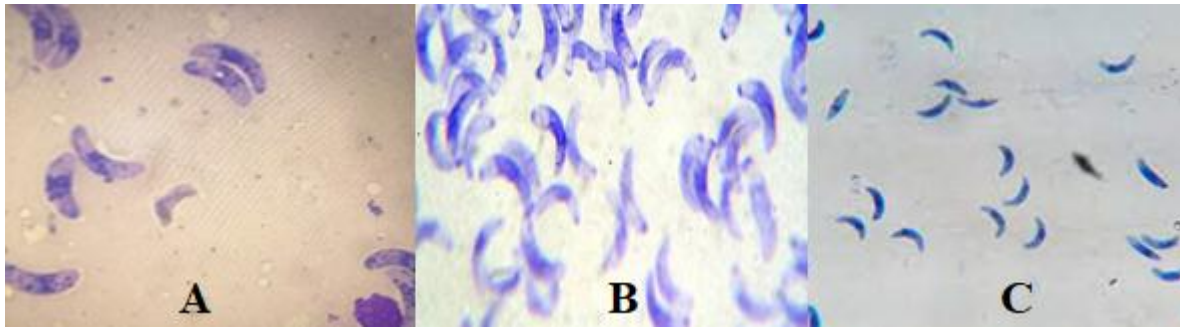


Fig. 4. A: Showing sheep macrosarcocysts bradyzoites that were banana-shaped stained with Giemsa stain, B: goats macrosarcocysts bradyzoite crescent-shaped (100x) and C: demonstrates the bradyzoites of cattle macrosarcocysts that also appeared crescent-shaped (40x).

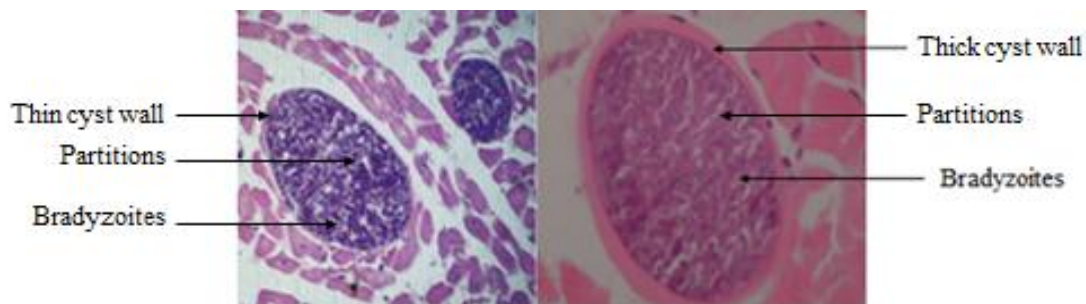


Fig. 5. Microscopic sarcocysts in the histological section of sheep esophagi, showing thick-walled (right) with radial striations and white partitions between the bradyzoites (100x). The left image reveals a thin-walled oval microscopic cyst (100x).

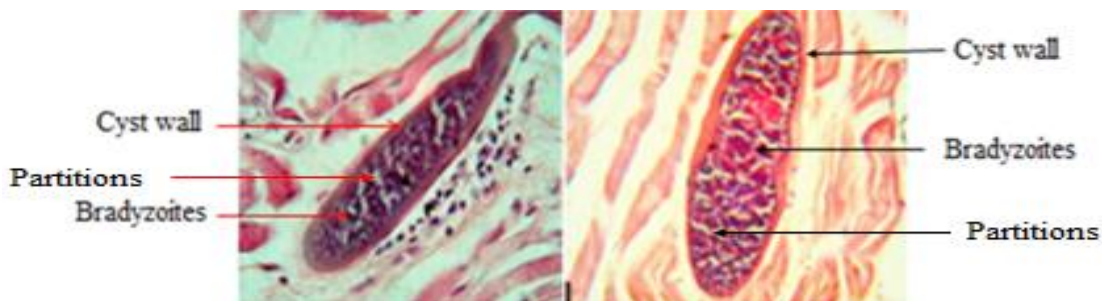


Fig. 6. Showing elongated microscopic sarcocysts in the histological section of goat's esophagi muscles (100x).

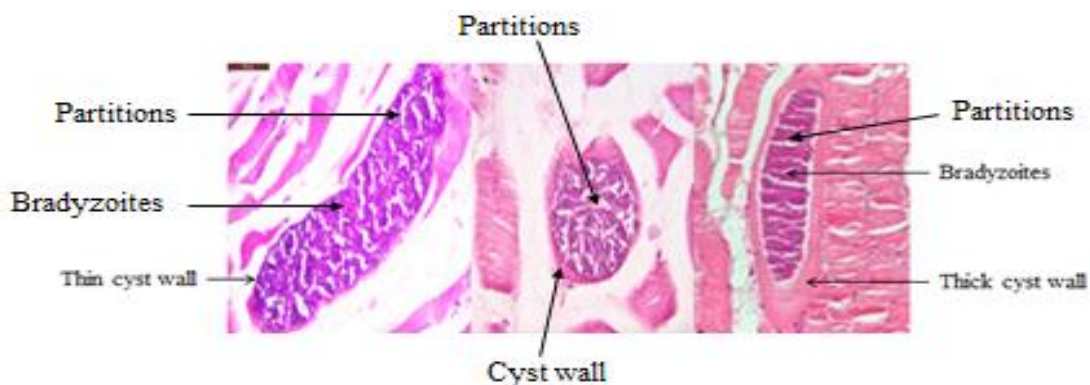


Fig. 7. Showing the micro-sarcocysts in esophagus muscles of cattle stained with H&E. Appeared elongated and surrounded by thick cyst-wall (right) and thin cyst-wall cyst walls (left) and one oval micro-sarcocysts (middle image) (100x).

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انتشار ودراسه شكلية لأنواع المتكيسات العضليه من المجترات المذبوحة في مسلخ زاخو، مدينة زاخو، محافظة دهوك، إقليم كردستان، العراق

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الملخص

المتكيسات العضليه Sarcocysts هي طفيليات داخل خلويه تنتمي إلى شعبة معقدات القمه Apicomplexa. يوجد أكثر من مائتين نوعاً من هذه المتكيسات Sarcocysts. لهذه الطفيليات القدرة على إصابة أنواع مختلفة من الحيوانات الاليفة والبريه والبشر. الهدف من هذه الدراسة هو تحديد مدى انتشار أنواع المتكيسات والتعرف على خصائصها الشكلية وأنواعها في عضلات المريء للمجترات المذبوحة في مسلخ زاخو، مدينة زاخو، إقليم كردستان/العراق. تم فحص 1586 عينه من عضلات المريء من الحيوانات المجتره المحليه والمستورده، بما في ذلك 764 من الأغنام و 569 من الماعز و 253 من الأبقار. خلال الفتره من نيسان 2021 إلى اذار 2022 لتحديد مدى انتشار الأورام العضليه العيانيه والدقيقه. أظهرت النتائج أن المعدل الكلي للإصابة بالمتكيسات العيانيه بلغ 18.03% (1586/286)، وجدت أعلى نسبة 26.85% (946/254) في السلالات المحليه مقابل 5% (640/32) في السلالات المستورده. كان أعلى معدل بين السلالات المحليه 90.91% (11/10) في الأبقار، بينما أعلى معدل في السلالات المستورده 9.13% (230/21) كان في الأغنام. وكان المعدل العام عند الذكور أعلى منه عند الإناث. تم التعرف على الأكياس العيانيه اعتماداً على الخصائص التشخيصيه الشكلية على أنها المتكيسات العضليه العملاقه *Sarcocystis gigantea* و *S. moulei* و *S. medusiformis* و *S. hirsuta* و *fusiformis*. أظهر الفحص النسيجي وجود متكيسات دقيقه ايضاً في عضلات المريء لدى العوائل الثلاثة والتي تم تصنيفها على أنها *S. tenella* و *S. arieticanis* في الأغنام و *S. capracanis* في الماعز و *S. bovis* أو *S. hominis* في الأبقار. وأظهرت نتائج الدراسة انتشار مرض المتكيسات العضليه على نطاق واسع بين الحيوانات المجتره في هذه المنطقه مما يشكل خطراً على الماشيه والبشر. وتتطلب هذه الحاله تطوير استراتيجيات وقائيه لتقليل أو القضاء على هذه العدوى الطفيليه.

الكلمات الداله: انتشار، المتكيسات العضليه، المجترات، الفحص النسيجي، صبغة الهيماتوكسيلين والأيوسين.