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Prevalence of Hydatid Cysts in Slaughtered Animals from Different Areas of Libya

Layla O. Elmajdoub[1], Wahab A. Rahman[2]

[1]Department of Zoology, Misurata University, Misurata, Libya
[2]School of Food Science and Technology, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia
Email: elmajdoublayla@yahoo.com

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Abstract

The present study reports on the infection rates of hydatid cysts in both sexes and different age groups of sheep, camels and cattle from government abattoirs in different parts of Libya. An infection rate of 10.06% was recovered among 32,971 all ruminants (sheep, camels and cattle). Out 25314 of sheep, 2659 (10.52%) were infected. Out 7496 of camels, 940 (12.54%) were infected. Out 161 of cattle, 17 (10.56%) were infected. As regards to the infected organs, liver was seen to be the most commonly infected organ in sheep and cattle (46.03%; 52.94%, respectively), but in camels, it was the lung (55.21%). The fertility rates of hydatid cysts were 80% in sheep, 84% in camels and 0% in cattle. In sheep, the fertility rate of liver hydatid cysts was higher than that in other organs (53.85%), but in camels, the fertility rate in the lung was higher than that of other infected organs (66.7%). Thus, the incidence of echinococcosis in slaughtered livestock is noticeably high and denotes some hazards in control measures in Libyan abattoirs.

Keywords

Echinococcus granulosus

1. Introduction

Unilocular hydatid cyst, also known as hydatidosis, is a zoonotic disease caused by the cystic larval stage of the tapeworm *Echinococcus granulosus*. Hydatid cysts in livestock are diagnosed when animals are sent to abattoirs for slaughter. This disease has a worldwide distribution and used to be particularly common in developing and undeveloped countries, including the Mediterranean region. However, the greatest prevalence of hydatid disease in livestock is found in countries of the temperate zones, including central Asia, China, Australia and parts of Africa [1]. For example, the prevalence of cystic echinococcosis is higher in livestock animals in North Africa,

especially in Libya [2] [3]. Studies conducted in the past four decades have revealed a high prevalence of hydatid disease in livestock animals in Libya. In addition, [4] the observed prevalence in Libya ranges from endemic to hyperendemic, and camels act as the most important intermediate hosts in the life cycle of the parasite. The problem in Libya is further compounded by the fact that in several regions in the country, the disease is endemic, and home slaughter is practiced, and few abattoirs have sufficient veterinary supervision. Apart from camels, dogs are usually the main source of infection for livestock animals when they graze on contaminated pastures and get infected with the eggs of the parasite.

For instance, past records in the government abattoirs indicated high rates of infection in slaughtered animals, especially in sheep and camels. Such a situation has a negative economic impact as the disease causes not only losses in yield in terms of internal organs and other products like milk and meat, but also productivity in general [5].

The high incidence of hydatidosis in the intermediate host animals has been noted by a number of researchers in Libya [6]-[11]. The objective of the present survey is to estimate the prevalence rate of hydatidosis infecting different organs of livestock slaughtered in Libya. In addition, the present survey will also investigate the relationship between the infected rates of slaughtered animals and seasonal variations. The fertility and sterility rates and localization of hydatid cysts are examined.

2. Material and Methods

2.1. Description of the Study Area

The present study was conducted from January to the end of December in 2010 in Libya. It is the fourth largest country in Africa with an approximate area of 1,754,000 km^2 and an approximate population of 6.6 million according to a 2006 census. Most of the population is found in the main coastal cities of Tripoli, Misurata, and Benghazi. The study was carried out in the main government abattoirs in different areas in Libya.

2.2. Examination of Slaughtered Livestock

The animals examined in the study were sheep, camels and cattle. All examined sheep (*Ovis aries*) were of the Libyan Barbary breed while the camels (*Camelus dromedaries*) were of Libyan breed. However, the examined cattle (*Bos taurus*) were of two breeds, namely, Jersey and local. A total of 32,971 different slaughtered animals in all the study areas were examined for hydatid cysts at the time of slaughter.

2.3. Selection of Unilocular Hydatid Cysts for Examination

The hydatid cysts were identified according to the descriptions of the veterinarians in the slaughtered animals and were examined for degeneration and calcification. Generally, most of the cysts were recovered from the livers and lungs, with a few from spleen and mesentery illustrated in **Table 1**.

2.4. Assessment of the Fertility of Hydatid Cysts

The hydatid fluid from each cyst was aspirated by means of a sterile syringe and a large-sized needle and then transferred to a sterile container. The collected fluid was left to sediment after which a drop of each sample of cyst sand was placed on a slide together with a drop of lacto phenol and then covered with a cover slip in the presence of protoscoleces or brood capsules or fragments of the germinal layer under the microscope. If protoscolex was not present in the hydatid fluid, it was then centrifuged at 5000 RPM for 5 min. If still negative, the germinal layer was examined by immersing in glycerin between two microscope slides for the presentation of protoscoleces or brood capsules.

Table 1. Number of hydatid cysts from different organs in slaughtered animals.

	Liver	Lung	Spleen	Mesentery
Sheep	135	105	4	16
Camel	28	64	8	0
Cattle	6	6	0	0
				372

2.5. Examination of Viability of Protoscoleces

The viability of protoscoleces was determined by staining with 0.1% aqueous eosin solution and observing the motility of flame cells. Usually viable protoscoleces do not take up the stain immediately until 10 min later, but dead (enviable) protoscoleces will take up the stain immediately [12]. In this study, 5 fertile cysts were randomly selected from each of liver and lungs of slaughtered sheep and camel. In order to determine the viability of protoscoleces, each fertile cyst was examined in five replicates. Then 30 protoscoleces were randomly selected to estimate the number of viable protoscoleces.

2.6. Data Analysis

Prevalence was calculated according to the proportion of the infection rates of slaughtered animals. Analysis of variance was assessed to compare several groups using ANOVA, correlation coefficients (r) between infection rates, according to the season and intensity of infection and age, and sex. In all tests, a P-value of < 0.05 was considered indicative of a statistically significant difference. All statistical tests were performed using SPSS 19 software.

3. Results

3.1. Variations of Hydatid Cyst Infection Rates in All Examined Livestock

Table 2 shows the infection rates of all slaughtered animals in the study areas at different seasons of the year 2010.

From a total of 32,971 animals examined, the total prevalence rate was 10.96%. From a total of 6333 slaughtered animals examined in winter, 13.1% were infected, and for spring, out of 7754 slaughtered animals examined, 12.4% were infected. For summer and autumn, the values were 10.1% and 9.07% respectively; also, there was no significant difference between seasons for all infected animals.

The overall infection rate in slaughtered sheep was 10.52%. As shown in **Table 3**, the sheep were infected and the rate was high in winter and spring at 12.6% and 11.9% respectively, but low in summer and autumn. There were no statistical differences between slaughtered sheep, but analysis of all slaughtered animals (sheep, camels and cattle) in terms of the homogeneity test revealed a high significance ($P < 0.01$).

In this study, 7496 camels were examined, and 12.5% were infected. Also, 161 cattle were examined and 10.6% were infected with hydatid cysts (**Table 3**). It was also found that the infection rate for slaughtered camels during winter was high (16.2%), followed by spring and summer (13.7%; 13.09% respectively), whereas in autumn,

Table 2. Seasonal variation of infection rate in the livestock from overall regions.

	Winter			Spring			Summer			Autumn			Total
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Slaughtered animals	6333			7754			10667			8217			32971
Infected animals	831 (13.1%)			959 (12.4%)			1081 (10.1%)			745 (9.07%)			3616 (10.96%)
Mean ±S.E	47.7 ± 8.97^{NS}			53.3 ± 8.17^{NS}			59 ± 10.94^{NS}			41.4 ± 6.85^{NS}			50.4 ± 4.4^{NS}

NS = non-significant different $P > 0.05$.

Table 3. Seasonal variation of infection rate according of infected animals.

	Winter			Spring			Summer			Autumn		
	Sheep	Camel	Cattle	Sheep	Camel	Cattle	Sheep	Camel	Cattle	Sheep	Camel	Cattle
Slaughtered animals	5279	1006	48	5718	1990	46	8125	2483	59	6192	2017	8
Infected animals	665 (12.6%)	163 (16.2%)	3 (6.25%)	679 (11.9%)	274 (13.7%)	6 (13.04%)	750 (9.23%)	325 (13.09%)	6 (10.2%)	565 (9.12%)	178 (8.82%)	2 (25%)
Mean ± S.E	55.4 ± 7.9	$54.3 \pm 4.06^{*}$	1 ± 0.57	69.1 ± 6.5	$91.3 \pm 6.34^{*}$	2 ± 1.53	62.5 ± 8.1	$108.3 \pm 7.5^{*}$	2 ± 0.57	47.1 ± 8.2	59.3 ± 106	0.67 ± 0.6

*Slight significant difference $P < 0.05$.

the camels' infection rate was lowest (8.82%). Also, it was found that while there were significant differences between infection rates for winter, spring, and summer ($P < 0.05$), there was no significant difference between infection rates for autumn and the other seasons. In the case of slaughtered cattle, it was observed that there was a high infection rate in autumn (25%), followed by spring (13.04%), summer (10.2%), and winter (6.25%), but with no significant differences.

3.2. Distribution of Hydatid Cysts According to Sex

The overall rate of infection for male slaughtered livestock was 50.8%, while for female it was 49.2%; but not significantly different between the sexes, the infection rates of hydatid cysts in slaughtered sheep based on sex which was 50.8% and 49.2% respectively. It was also found that there was no significant difference between their infection rates. Also, it was observed that slaughtered female livestock had the highest rate of infection in cattle and camels (76.5%; 50.6%, respectively) (**Table 4**). However, it was observed that there was no significant difference between the infection rate for all male and female livestock.

3.3. Infection Rates of Organs

The liver and lungs were the most commonly infected (43.1%; 42.9%, respectively), followed by other organs such as the mesentery (0.5%) and spleen (0.4%). Based on the seasons, the infection rates for liver and lung were comparable (43.1%; 42.1%, respectively) for all seasons, unlike for organs such as mesentery and spleen. A statistical analysis observed a non-significant difference (**Table 5**).

The most commonly infected organ in sheep and cattle was the liver (46.03%; 52.9%, respectively). But in the case of camel, the lung was the most commonly infected (55.2%). It was also observed that the double infection of liver and lung in cattle was higher than in sheep (14.5%) and camels (9.47%), whereas organs such as mesentery and spleen had lower rates of infection compared to the liver and lung (**Table 6**). However, when statistical analysis was carried out among the infected organs, it was observed that there was a non-significant difference for all infected organs. Furthermore, the correlation relationship among the locations of infection was found to be a positive, but weak correlation ($r = 0.132^{NS}$) for all infected livestock.

NS = non-significant differences.

Table 4. The mean and infection ratio of hydatid cysts based on sex.

	Male			Female		
	Sheep	Camel	Cattle	Sheep	Camel	Cattle
Total infection	1836 (50.8%)	464 (49.3%)	4 (23.5%)	1780 (49.2%)	476 (50.6%)	13 (76.5%)
Mean ± S.E	25.5 ± 2.5^{NS}	38.7 ± 3.82^{NS}	0.33 ± 0.19^{NS}	24.9 ± 2.3^{NS}	39.7 ± 4.46^{NS}	1.08 ± 0.29^{NS}

Table 5. The infection rate of hydatid cysts in different organs.

	Liver	Lung	Both liver & lung	Mesentery	Spleen
Total infection	1557 (43.1%)	1551 (42.1%)	478 (13.2%)	17 (0.5%)	13 (0.4%)
Mean ± S.E	21.5 ± 2.07	21.8 ± 2.16	6.63 ± 0.59	0.24 ± 0.074	0.18 ± 0.061

Table 6. The rate of infection of hydatid cysts based on organ infected.

	Sheep	Camel	Cattle
Liver	1224 (46.03%)	324 (34.5%)	9 (52.9%)
Lung	1027 (38.6%)	519 (55.2%)	5 (29.4%)
Both liver & lung	386 (14.5%)	89 (9.5%)	3 (17.7%)
Mesentery	17 (0.64%)	Non	Non
Spleen	5 (0.19%)	8 (0.85%)	Non

3.4. Fertility of Hydatid Cysts

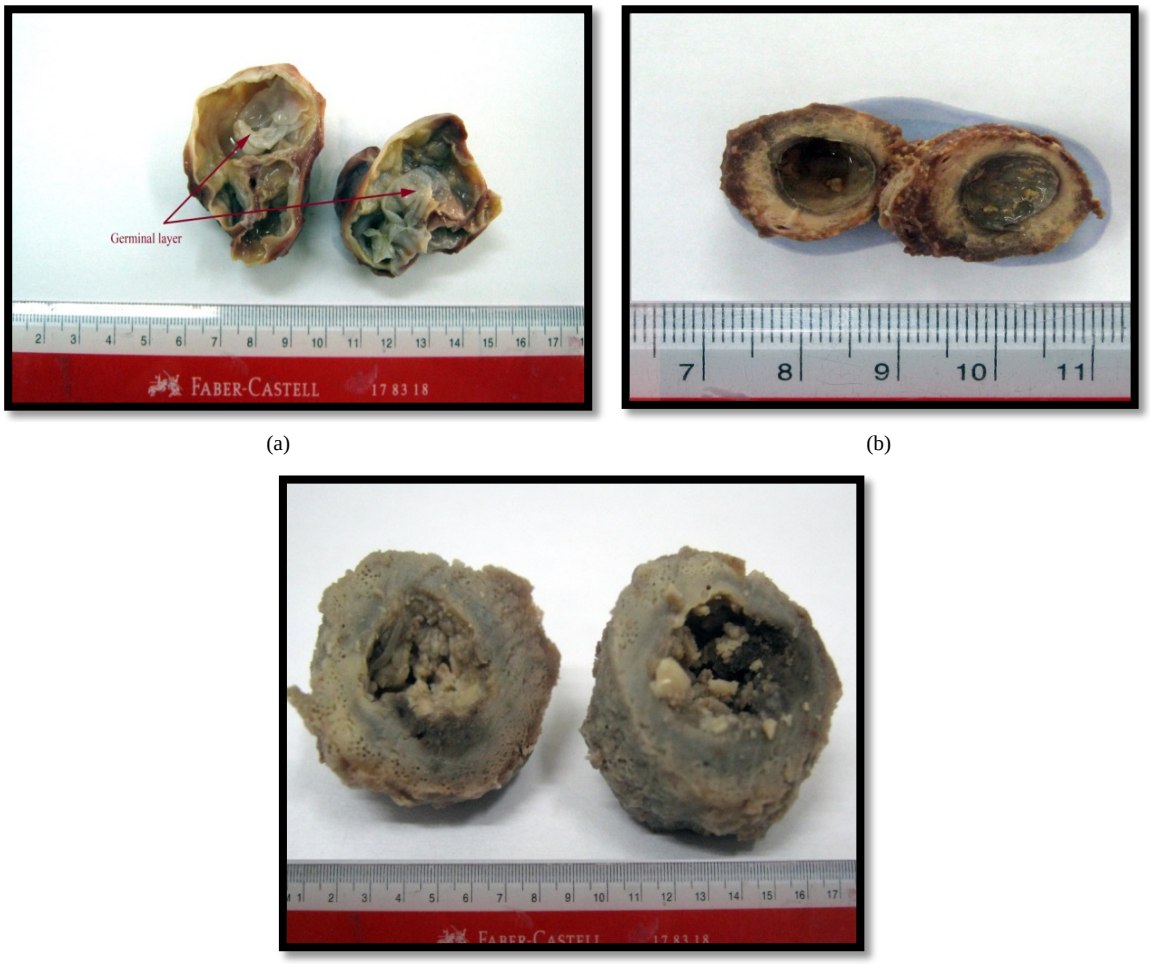
The fertility rate of 372 examined hydatid cysts selected from overall slaughtered livestock was observed to be 78.5%, while 15.1% of the cysts were sterile, and 6.5% cysts were calcified, **Figure 1** shows fertile, sterile and calcified cysts.

Generally, the hydatid cysts of camels (84%) were more fertile than those of sheep (80%), whereas all cattle cysts were sterile and calcified (58.3%; 41.6% respectively) (**Table 7**). Also, it was observed that there was a non-significant difference in fertility rates of all slaughtered animals.

In terms of the fertility rate for hydatid cysts selected from different slaughtered animal species in all the study areas, it was observed that in pulmonary cysts, it was 47.3%, which was higher than that for liver (46.2%) and other organs, such as the mesentery (3.76%) and spleen (2.71%). However, most of the calcified cysts were found in hepatic cysts (45.8%), followed by pulmonary cysts (41.6%) and mesentery (8.3%) and spleen (4.17%).

Table 8 illustrates that the pulmonary cysts from slaughtered camels (66.7%) were more fertile than that in other organs in the same animal as well as in slaughtered sheep as the hepatic cysts were the most commonly infected organs in slaughtered sheep (53.8%). On the other hand, the hepatic cysts were more calcified than the pulmonary cysts in slaughtered sheep and cattle (50%, 60%), whereas, in camels, the pulmonary cysts (57.1%) were more calcified than that of hepatic cysts.

In contrast, all examined cysts from slaughtered cattle were sterile. The statistical difference appeared significant ($P < 0.05$) among fertile cysts from infected organs of slaughtered sheep. However, among infected organs of slaughtered camels there was a non-significant difference (**Table 9**).



(a) (b)

(c)

Figure 1. Unilocular hydatid cysts from slaughtered animal: (a) fertile cyst; (b) sterile cyst; (c) calcified cyst.

3.5. Viability Rate of Hydatid Cysts

The viability rate of protoscoleces that were recovered from all slaughtered livestock was 75.6% for the first 5 min using 1% eosin and 54.7% after 10 min. In terms of the different groups of slaughtered animals, the viability rate of protoscoleces for the first 5 min was 76.1% in sheep which was higher than that for camels (75.2%). However, after 10 min, the protoscoleces in camels that were still viable was 60.9%, which was higher than that in sheep (48.4%). In terms of the viability rate of protoscoleces for organ, it was 79.7% of the lung of camels which was higher than that in sheep (75.6%) for the first 5 min, whereas, for sheep liver it was (76.5%) which was higher than that in camels (70.7%) for the first 5 min. However, after 10 min, it was found that the viability rate of protoscoleces for the liver and lung of camels was 60.93% and 6.93%, respectively, which were higher than those of sheep (50.7%; 46.13%, respectively).

It was observed that there was a statistical difference between the viability rate of protoscolex sheep liver and camel liver at 10 min ($P < 0.05$). It was also the case of the lung of sheep and camel at 10 min ($P < 0.01$). However, for the first 5 min no statistical difference was observed between the viability rate of protoscolex for sheep and camel ($P > 0.05$), as illustrated in **Table 9**. In addition, it was observed that there was no correlation relationship among the different organs of sheep and camel, but it was also observed that there was a correlation between the same organ of the same animal between 5 and 10 min: liver sheep ($r = 0.845$); lung sheep ($r = 0.818$); liver camel ($r = 0.758$), and lung camel ($r = 0.435$) illustrated in **Table 10**.

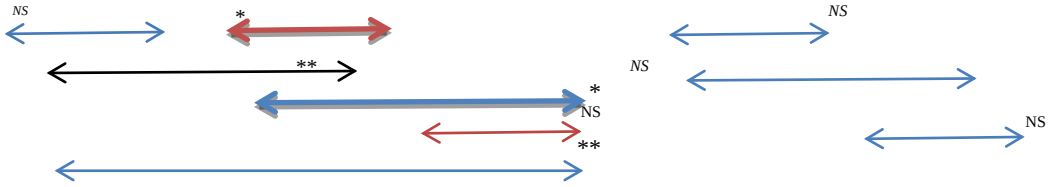
Table 7. Fertility rate of hydatid cysts of all slaughtered livestock.

	Sheep	Camel	Cattle	All livestock
Fertile cysts	208 (80.0%)	84 (84.0%)	0 (0.0%)	292 (78.5%)
Sterile cysts	40 (15.4%)	9 (9.0%)	7 (58.3%)	56 (15.1%)
Calcified cysts	12(4.6%)	7 (7.0%)	5 (41.6%)	24 (6.5%)

Table 8. Fertility rate of hydatid cysts of different slaughtered livestock based on organ.

	Fertile cysts			Sterile cysts			Calcified cysts		
	Camel	Sheep	Cattle	Camel	Sheep	Cattle	Camel	Sheep	Cattle
Liver cysts	23 (27.4%)	112 (53.6%)	0 (0.0%)	3 (33.0%)	17 (43.0%)	3 (43.0%)	2 (29.0%)	6 (50.0%)	3 (60.0%)
Lung cysts	56 (66.7%)	82 (39.4%)	0 (0.0%)	4 (44.0%)	19 (47.0%)	4 (57.0%)	4 (57.0%)	4 (33.0%)	2 (40.0%)
Mesentery cysts	0 (0.0%)	5 (2.4%)	0 (0.0%)	0 (0.0%)	3 (7.5%)	0 (0.0%)	0 (0.0%)	2 (17.0%)	0 (0.0%)
Spleen cysts	5 (5.9%)	3 (1.44%)	0 (0.0%)	2 (22.0%)	1 (2.5%)	0 (0.0%)	1 (14.0%)	0 (0.0%)	0 (0.0%)

Table 9. Statistical variation of fertile cysts in slaughtered sheep and camel based on organ.

	Sheep				Camel		
	Liver	Lung	Mesentery	Spleen	Liver	Lung	Spleen
Mean ± S.E	56 ± 5	41 ± 6	5.5 ± 0.5	1.5 ± 1.2	11.5 ± 2.5	28 ± 2	2.5 ± 0.5
Sig							

NS = non-significant difference; *significant difference $P < 0.05$.

Table 10. Viability rate of protoscolex of hydatid cysts in slaughtered sheep and camels.

	Sheep				Camel			
	Liver		Lung		Liver		Lung	
	5 min	10 min	5 min	10 min	5 min	10 min	5 min	10 min
Mean ± S.E	22.96 ± 1.1	15.2 ± 1.4**	22.7 ± 0.61	13.8 ± 1.2**	21.2 ± 0.52	18.3 ± 0.4*	23.9 ± 0.57	18.3 ± 0.65**

*Significant difference $P < 0.05$; **High significant difference $P < 0.01$.

4. Discussion

4.1. Prevalence of Variation of Hydatid Cysts in Slaughtered Livestock

Cystic hydatid disease is one of the most widespread and serious helminthic zoonotic infections in the world. Usually, livestock species are more susceptible to infection by contamination through the viable eggs of *E. granulosus* [13]. In most studies which were conducted on the prevalence of cystic hydatid disease in livestock, the main source of data is obtained from abattoirs. However, in many countries, it is only in the government-run abattoirs in the urban centers that have veterinarians who supervise the slaughter. In contrast, most of the abattoirs that are not run by the government do not have veterinarians to supervise the slaughter. Also, none of the abattoirs, especially in the rural areas of the Middle Eastern countries, have veterinarians to supervise the slaughter. Furthermore, in such areas, it is common to slaughter livestock in the backyards, especially during religious festivals like Aid Eladha.

The rate of infection in camels (12.5%) was higher than that in sheep and cattle (10.5%; 10.6%, respectively). This finding concurred with that from Egypt [14], where they reported camels played the important role in the local sustenance of the life cycle. However, the infection in camels from Tunisia and Morocco was similar to that of the present study [15] [16], thus implying that camels are the main host for transmission of the hydatid infection in North Africa. Moreover, the infection rate in sheep from Morocco was similar to that of the present study [16], but the infection in cattle (22.98%) was higher in Morocco than that of the present study (10.56%). The infection rate in sheep from Tunisia (10.41%) was similar to the rate in the present study [5]. In Algeria, the infection rate in camels and cattle (24.8%; 13.9%, respectively) were higher than that in the present findings [17], meaning that the hydatid infection rates between countries in North Africa were similar, indicating that similar factors effect on the transmission of this disease between the farm animals for the different countries.

Only some abattoirs from the present study had veterinarians to supervise the slaughters. However, when the residents needed camel meat for wedding celebrations, the camels were not slaughtered in the abattoir under the supervision of a veterinarian. It was only in the few abattoirs that different livestock were slaughtered under the supervision of a veterinarian.

One possible reason for the variation in the infection rate for all the slaughtered livestock in overall study areas could be the variations in environmental factors, such as temperature, humidity and the nature of the pasture. Furthermore, these variations could be related to the different strains of *E. granulosus* [18].

For the findings of the present research, there were some significant differences in infection rates in some seasons, but not for others. This was shown in slaughtered camels, where differences were only seen between spring and autumn and between winter and summer. Similarly, found significant differences in infection rates between spring and autumn in Saudi Arabia, while found significant differences in infection rates between autumn and winter in Iran [12] [19].

4.2. Infection Rate of Hydatid Cysts in Livestock Based on the Organ

The findings of this current study indicated that the rate of infection differed non-significantly according to the sex of the slaughtered livestock. For instance, in the case of slaughtered sheep, males were more likely to have hydatid cyst infections than females while the highest rate of infection in slaughtered female camel and cattle compared to males because the people there preferred to slaughter females, especially the oldest females than males. The findings of this present study are reflected in the findings from Saudi Arabia, Libya and Jordan [10] [19] [20].

These differences could be due to a number of reasons. For instance, the inhabitants preferred to slaughter young male sheep rather than juvenile females, while the older animals were more likely to be infected with hydatid cysts than the younger animals [19].

In the present study, the livers of sheep and cattle were found to be more commonly infected with hydatid cysts than the lungs and other organs. These findings were supported by other studies conducted in Libya for sheep and cattle [7] [8] [10] [21] [22]. The reason why the liver in sheep and cattle is most commonly infected is because the bile duct in the liver receives the blood with the oncospheres after the blood has passed the duodenum [23].

In the case of camels, the lung was the organ most frequently infected by hydatid cysts, as similarly reported

by other workers [9]-[11] [22] [24]-[27]. Unlike sheep and cattle, camels do not have bile ducts, thus the oncosphere passes through the blood and flows to the lungs and stays there. In addition the tissue of camel liver is tough and solid, making it difficult for the oncosphere to grow normally, whereas, the lung tissue is smoother and softer, making it easier for the oncosphere to grow faster.

4.3. Fertility and Viability of Cystic Echinococcosis

Data on the fertility and viability of hydatid cysts in various livestock animals play an important role in providing credible indicators of the importance of each livestock as a possible source of infection of final hosts, especially dogs. Usually, depending on the host, the size and location of cysts, hydatid cysts have different rates of fertility. In this regard, a number of studies have been conducted in Libya to estimate the fertility and viability rates of protoscoleces in a variety of slaughtered animals [10] [11] [21] [25]. In addition, studies had also been conducted in other countries in Italy, Pakistan and Iran [28]-[30].

In the present study, it was observed that the cysts in camels were more fertile than those of sheep, but all examined cysts from cattle were sterile. The fertility rates of cysts from sheep in some areas were higher than those from other areas, because the sheep strains in those areas were more abundant than other regions, whereas, one area may have different strains of *E. granulosus*. Thus, infection may occur as a result of mixtures of strains.

In terms of hepatic cysts, the fertility rate was higher in slaughtered sheep than camels. The reverse was noticed in pulmonary cysts, where the fertility rate was higher in camels than in sheep because the lung of the camel is a more suitable organ for fertile cyst, as it is known to have a more conducive habitat for the growth of the metacestode [31]. The findings from the present study are supported by those from Libya and Iran [10] [11] [29]. Furthermore, the findings from Iran observed that the hepatic cysts of sheep were more fertile than pulmonary cysts, while other from Jordan found hepatic cysts from sheep were more fertile than those from the camel [27] [32].

Sterile hydatid cysts were noticed as early as 1928 by Dew [33]. He stated that the sterility of the acephalocyst might be due to the inherent inability to reproduce, but in the majority of cases it was due to some abnormal local conditions. He added that the availability of nourishment was probably the most important factor and was influenced by the location of the parasite and the condition of the adventitious coat. Sterile hydatid cysts may also be due to infection by unspecific strain.

The findings of the present study indicated that all cysts from cattle were sterile (58.3%) and calcified (41.6%). These findings were similar to those from Libya [11] [21]. However, there were few fertile cysts in slaughtered cattle found in eastern Libya [10]. It argued that the cysts from cattle never appeared to be fertile; thus it seemed impossible that cattle could play any major role in the transmission of *E. granulosus* [9]. This would indicate that cattle were an unsuitable source of transmission of *E. granulosus* in Libya.

In their study, from Ethiopia, it recorded that the fertility rate increased with the age of the cyst, but the age of the animal had no effect on the fertile cyst [34]. Such an observation is similar to the findings of the present study which demonstrated that the fertility rates of sheep and camel slaughtered at several ages were comparable. The rate of viable protoscoleces from fertile cysts from sheep and camel slaughtered were comparable within the first five minutes, but after 10 min, the findings from this present study demonstrated that the protoscoleces from camels were still viable compared to those from sheep. In a study that was conducted in Saudi Arabia, it was found the viable protoscoleces from sheep were higher than those of camels, an observation similarly noted [19] [32]. However, the findings from the present study showed the viable of protoscoleces in camels (60.93%) were higher than those in sheep (48.4%) after 10 min.

The differences in the findings may be due to the fact that in the process of determining the viability rate using 1% eosin stain, it might be necessary to estimate the time taken by the protoscoleces to absorb the stain, because the viable protoscoleces did not absorb the stain until they were dead, but if the protoscolex is dead or not viable, the stain would enter into the protoscolex after 5 - 10 min. The data in the present study recorded high, significant differences between the viable protoscoleces from liver and lung hydatid cysts in both sheep and camels. Usually, the variation in the viability of protoscoleces might be related to the difference in the immunological response of each host. It might be also related to the calcareous corpuscles in the protoscoleces, of which a large number were non-viable. In summary, it could be argued that the fertility rate of the cysts determines the actual role of a particular species of livestock in the cycle of hydatid infection.

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