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Cystic Echinococcosis in Wild Boars (*Sus scrofa*) and Slaughtered Domestic Ruminants in Algeria

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ABSTRACT

A total of 5592 cattle, 10974 sheep and 10066 goats in El Tarf; 49 cattle, 923 sheep and 198 goats in Tebessa and 951 cattle, 20350 sheep, 67 goats and 2731 dromedaries in Ouargla were carefully examined, between 2008 and 2009, for the presence of *Echinococcus granulosus* hydatid cysts during the routine meat inspection in abattoirs. Also, for the first time in Algeria, the study included 111 wild boars. The prevalence of cystic Echinococcosis in El Tarf was 24.86, 13.83 and 3.71% in cattle, sheep and goats, respectively. In Tebessa, it was 89.80% in cattle, 78.01% in sheep and 67.17% in goats and in Ouargla it was 17.77, 10.83, 8.35 and 7.46% in sheep, cattle, dromedaries and goats, respectively. Concerning Wild boars, the prevalence of cystic Echinococcosis was 6.81 (3/44) and 5.97% (4/67) in El Tarf and Annaba regions, respectively, which giving an overall prevalence of 6.3% (7/111). Livers and lungs were the only infected organs in domestic ruminants. Generally, the most affected organ was the lung. The total annual economic losses from organ condemnation due to hydatidosis was estimated at 28,286; 25,939; 3,309 and USD 3,747 in cattle, sheep, goats and dromedaries, respectively. This epidemiological study confirms the importance of cystic Echinococcosis in slaughtered domestic ruminants in Algeria. Thus, there is a need to introduce appropriate control measures to minimize the rate of infection and reduce the ensuing economic losses and public health consequences of cystic echinococcosis.

Key words: Cystic echinococcosis, domestic ruminants, wild boars, abattoirs, Algeria

INTRODUCTION

Echinococcosis is a zoonotic parasitic infection caused by several species of the genus *Echinococcus*. Human echinococcosis results following contact with canid hosts, which are themselves infected by various domestic and wild mammals. Echinococcosis in farm animals causes considerable economic losses as well, due to the condemnation of the affected organs and the consequent reduction in productivity (Ibrahim, 2010; Romig *et al.*, 2011; Kumsa and Mohammedzein, 2014). Several surveys on the frequency of cystic echinococcosis in farm animals were conducted in the world (Azlaf and Dakkak, 2006; Kebede *et al.*, 2009a; Lahmar *et al.*, 2013). In North Africa, cystic echinococcosis remains highly endemic (Dar and Alkarmi, 1997; Sadjjadi, 2006; Abu-Seida, 2014).

Hydatid disease, caused by the larva of *Echinococcus granulosus*, is a cosmopolitan disease which prevails in endemic state in parts of the world. It represents a public health problem in North Algeria. Epidemiological data on human infection is around 400 cases yearly according to official statistics from the National Institute of Public Health of Algeria, the actual data should be multiplied by three according to the service practitioners surgeries hospitals of Algeria (INSP., 2014).

Algeria has about 1,607,890 cattle, 19,615,730 sheep, 3,754,590 goats and 286,670 dromedaries in Algeria (MADR., 2006). These animals present an important component of the farming system. However, information about the prevalence of hydatidosis in domestic ruminants in Algeria is limited without any evaluation of economic losses caused by this infection and any information concerned Echinococcosis in wild mammals. Some studies were realized in slaughtered domestic ruminants only in Tiaret on the northwestern (Kouidri *et al.*, 2012; Mokhtaria *et al.*, 2013) and in Djelfa and Adrar on the southwestern of Algeria (Hamrat *et al.*, 2011a, b). Therefore, the objectives of present study were to determine the prevalence and organ distribution of hydatid cysts in three regions in the east of Algeria and to assess the economic losses due to condemnation of organs with cystic Echinococcosis in slaughtered domestic ruminants (cattle, sheep, goats and dromedaries). Also, this study records for the first the prevalence of cystic Echinococcosis in wild boars in Algeria.

MATERIALS AND METHODS

Study areas: A survey on cystic echinococcosis in slaughtered domestic ruminants was undertaken in abattoirs at three regions in Algeria: El Tarf, Tebessa and Ouargla during the period from January 2008 to December 2009. For wild boars, the study was conducted in 2011 in two regions: Annaba and El Tarf, which are located in the northeastern of Algeria and have a humid climate. Tebessa region is located in the northeastern and has a semi-arid climate. Ouargla region is located in the Sahara (southeastern) and has a Saharan climate.

Animals: A total of 5592 cattle, 10974 sheep and 10066 goats in El Tarf and 49 cattle, 923 sheep and 198 goats in Tebessa and 951 cattle, 20350 sheep, 67 goats and 2731 dromedaries in Ouargla, were carefully inspected for the hydatid cyst during routine meat inspection in abattoirs at these regions.

For wild boars and after post mortem examination, the study concerned the number of 44 and 67 in El Tarf and Annaba, respectively.

Economic evaluation in abattoirs: Economic losses due to infected organs condemnation were evaluated according to the weight of condemned organs (kg) multiplied by the price of one kilogram.

For cattle, sheep and goats, the price of one kilogram of liver is 2000 Algerian Dinar (DA) and for lungs is 300 DA. For dromedaries, the price of one kilogram of liver is 1500 DA and for lungs is 300 DA based on information collected from butchers and customers.

Statistical analysis: Data was analyzed by R i386 3.0.2 for Windows GUI front-end. The prevalence of cystic echinococcosis in the slaughtered domestic ruminants at the different regions of the study was carried out with ANOVA. Chi² test (95% confidence interval) was used to study the relationship of the prevalence of cystic echinococcosis with the organ affected and regions of study. The significance was considered when the probability value $p < 0.05$.

RESULTS

The prevalence of cystic echinococcosis in slaughtered domestic ruminants depended very significantly upon the study area ($p < 0.01$). In El Tarf region, the prevalence of cystic echinococcosis was 24.86, 13.83 and 3.71% in cattle, sheep and goats, respectively. In Tebessa, the prevalence was 89.8, 78.01 and 67.17% in cattle, sheep and goats, respectively. In Ouargla, the prevalence in cattle, sheep, goats and dromedaries was 10.83, 17.77, 7.46 and 8.53%, respectively (Table 1).

The highest prevalences of cystic echinococcosis in domestic ruminants were observed in Tebessa region ($p < 0.001$).

Cattle had the highest prevalence compared to small ruminants ($p < 0.04$). Sheep were more infected than goats ($p < 0.001$).

The cystic echinococcosis was observed in 3 wild boars (6.81%) in El Tarf and in 4 wild boars (5.97%) in Annaba. The overall prevalence of echinococcosis in wild boars was 6.3% (7/111).

Within the three studied regions, the prevalence of cystic echinococcosis in the affected organs depended very significantly upon the different slaughtered domestic ruminants ($p < 0.001$). Livers and lungs were the only infected organs in this study. The overall results showed that the lungs, in different domestic ruminants, were the mostly affected organ with cystic echinococcosis ($p < 0.05$).

In El Tarf, cystic echinococcosis in cattle and sheep was found to infect the liver and lungs equally (45.46 and 41.36% in cattle and 40.18 and 47.76% in sheep). The lowest prevalences were found in liver and lungs together (13.16% in cattle and 12.05% in sheep) ($p < 0.001$). In goats, the lungs were the most commonly infected organ with cystic echinococcosis (70.51%) ($p < 0.001$) (Table 2).

In Tebessa, the prevalence of cystic echinococcosis was higher in animals that had cysts in the lungs and liver together compared to those had cysts in the liver or lungs alone ($p < 0.001$) (Table 2).

Table 1: Prevalence of cystic echinococcosis in different slaughtered animals in El Tarf, Tebessa and Ouargla abattoirs, Algeria

Regions	Cattle		Sheep		Goats		Dromedary	
	Examined animals	Infected animals (%)	Examined animals	Infected animals (%)	Examined animals	Infected animals (%)	Examined animals	Infected animals (%)
El Tarf	5592	1390 (24.86±3.7)	10974	1518 (13.83±4.1)	10066	373 (3.71±2.7)	-	-
Tebessa	49	44 (89.80±1.8)	923	720 (78.01±2.8)	198	133 (67.17±2.1)	-	-
Ouargla	951	103 (10.83±1.9)	20350	3616 (17.77±4.4)	67	05 (7.46±0.1)	2731	228 (8.35±0.8)

Table 2: Predilection sites of hydatid cyst in the different organs of examined animals

Animals	El Tarf			Tebessa			Ouargla		
	Liver (%)	Lungs (%)	Liver+ Lungs (%)	Liver (%)	Lungs (%)	Liver+ Lungs (%)	Liver (%)	Lungs (%)	Liver+ Lungs (%)
Cattle	632 (45.46±3.4)	575 (41.36±2.7)	183 (13.16±2.1)	8 (18.18±0.2)	9 (20.45±0.1)	27 (61.36±0.8)	25 (24.27±0.8)	67 (65.04±1.2)	11 (10.68±0.4)
Sheep	610 (40.18±3.2)	725 (47.76±4.1)	183 (12.05±2.2)	7 (0.97±0.1)	278 (38.61±2.6)	435 (60.42±2.9)	520 (14.38±3.1)	2996 (82.85±4.7)	100 (2.76±1.3)
Goats	58 (16.43±1.7)	263 (70.51±2.6)	52 (13.94±0.9)	13 (9.77±0.8)	35 (26.32±0.8)	85 (63.91±1.2)	3 (60±0.0)	2 (40±0.0)	0 (-)
Dromedaries	-	-	-	-	-	-	43 (18.86±1.5)	178 (78.07±1.6)	7 (3.07±0.2)

Table 3: Evaluation of the economic losses due to condemnation of the affected organs by cystic echinococcosis

Regions	Cattle (kg)		Sheep (kg)		Goats (kg)		Dromedaries (kg)	
	Liver	Lungs	Liver	Lungs	Liver	Lungs	Liver	Lungs
El Tarf	1854.5	1070.5	958.5	1144.7	135	252	-	-
Tebessa	110.5	78	355	492	77.5	58	-	-
Ouargla	59	210	253	1539.5	1.5	1	166.5	1135
Total	2024	1358.5	1566.5	3176.2	214	311	166.5	1135

In Ouargla, the lungs were the most commonly infected organ with cystic echinococcosis in cattle (65.04%), sheep (82.85%) and dromedaries (78.07%) ($p < 0.001$). However, only five goats were infected with cystic echinococcosis and three of them showed cysts in the liver and two in the lungs (Table 2).

For wild boar, cysts were observed in the liver of four out of seven wild boars (57.14%) and the peritoneum in the other three wild boars (42.85%).

The weight of condemned liver and lungs in the examined animals has been represented in Table 3.

In cattle, the economic loss due to condemnation of the affected organs with cystic echinococcosis in different regions for years 2008-2009 was 4,455,550 DA.

So, the annual economic losses were 2,227,775 DA (~ 28,286 USD). For sheep the annual economic losses were 2,042,930 DA (~ 25,939 USD). In goats, the annual economic losses were 260,650 DA (~ 3,309 USD). Concerning dromedaries the annual economic losses were 295,125 DA (~ 3,747 USD).

DISCUSSION

The current study, conducted in several abattoirs and in wild boars, indicated that cystic echinococcosis is a highly endemic in Algeria.

The prevalence of cystic echinococcosis infection recorded in El Tarf region was 24.86, 13.83 and 3.71% in cattle, sheep and goats, respectively. In general, the same prevalences were previously reported in Tiaret and Djelfa regions, Algeria (Hamrat *et al.*, 2011b; Kouidri *et al.*, 2012; Mokhtaria *et al.*, 2013).

In Ouargla region, the prevalence of cystic echinococcosis in sheep and goats was close to that reported in the Adrar region which has the same climate as Ouargla, Algeria (Hamrat *et al.*, 2011a). While dromedaries marked a higher prevalence of 16.62-25.88% than the present result (8.53%). However, the prevalence of cystic echinococcosis in cattle at Ouargla was 10.83% which is slightly lower than that recorded in previous studies at both Tiaret and Djelfa regions (Hamrat *et al.*, 2011b; Kouidri *et al.*, 2012).

Moreover, these results are close to what has been reported in other regions in the North Africa as Tunisia (Lahmar *et al.*, 2013), Morocco (Azlaf and Dakkak, 2006), Libya (Kassem *et al.*, 2013) and consistent with those obtained in other studies (Kebede *et al.*, 2009a, b).

In this study, the prevalence of cystic echinococcosis at Tebessa region was high (89.80, 78.01 and 67.17% in cattle, sheep and goats, respectively) ($p < 0.001$). Several factors have been contributed to increase the prevalence of cystic echinococcosis in domestic ruminants in this region including absence of routine deworming of domestic dogs (Buishi *et al.*, 2006), the risk practices related to family slaughter (Traub *et al.*, 2005) and presence of high numbers of wild dogs (Grainger and Jenkins, 1996; Jenkins and Morris, 2003).

In the present study, cattle were the mostly infected domestic ruminants with cystic echinococcosis ($p < 0.04$). Similar finding was mentioned by Kouidri *et al.* (2012) in Tiaret, Algeria; Azlaf and Dakkak (2006) in Morocco and Haridy *et al.* (2006) in Egypt. Also, this study revealed a low incidence of cystic echinococcosis in goats which may be a reflection of animal husbandry practices where goats may have a lower contact with dogs and due to their grazing behaviour. This observation was reported in other studies (Torgerson *et al.*, 1998; Mokhtaria *et al.*, 2013). Interestingly, this work is the first study carried out in wild boars in Algeria. The prevalence of cystic echinococcosis was 5.97 and 6.81% in Annaba and El Tarf regions, respectively which give an overall incidence of 6.3%. In this respect, the prevalence of cystic echinococcosis in wild boars in Italy was 3.7% (Varcasia *et al.*, 2008) which correlates with our result.

The major economic impacts caused by cystic echinococcosis in animals are losses in productivity such as milk production, fertility, reductions in carcass weight, birth rate and fecundity, delayed performance and growth, condemnation of organs especially liver and lungs (Ibrahim, 2010; Romig *et al.*, 2011; Kumsa and Mohammedzein, 2014).

Livers and lungs were the only organs infected by cystic echinococcosis in the present study. This is explained by the fact that liver and lungs have the first great capillaries sites encountered by the migrating *Echinococcus oncospheres* (hexacanth embryo) which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved (Kebede *et al.*, 2009a). However, development of hydatid cysts occurs occasionally in other organs and tissue when oncospheres escape into the general systemic circulation (Abunna *et al.*, 2012).

In Tebessa region, the prevalence of co-infection (liver and lungs) in the examined domestic ruminants was the highest. This result is in line with other study in Tiaret, Algeria (Kouidri *et al.*, 2012). However in Egypt, Omar *et al.* (2013) recorded that the livers harbored a higher percentage of cystic echinococcosis.

In cattle, cystic echinococcosis was found to infect the liver and lungs equally in El Tarf. The present data agree others of previous studies (Ibrahim and Craig, 1998; Kebede *et al.*, 2009b; Omar *et al.*, 2013).

In Ouargla, hydatid cysts were found to occur preferentially in the lungs which correlate with the findings of other authors (Khan *et al.*, 2001; Daryani *et al.*, 2006; Kebede *et al.*, 2009a, c; Getaw *et al.*, 2010).

In sheep, in El Tarf and Ouargla, the prevalence of lungs hydatid cysts was higher than that of liver hydatid cysts alone and of liver and lungs hydatid cysts. This result is in line with other studies (Khan *et al.*, 2001; Daryani *et al.*, 2006; Getaw *et al.*, 2010). However, in previous studies in Algeria, the highest distribution of cystic Echinococcosis in sheep was in co-infection (liver and lungs) (Kouidri *et al.*, 2012; Mokhtaria *et al.*, 2013).

Hydatid cysts were found to occur preferentially in the lungs in goats (El Tarf) and in dromedaries (Ouargla) which is in agreement with previous reports (Sangaran and John, 2009; Mokhtaria *et al.*, 2013; Omar *et al.*, 2013; Elham *et al.*, 2014).

In Ouargla, cystic echinococcosis was observed mainly in the liver in goats, the same result was observed in other studies (Azlaf and Dakkak, 2006; Daryani *et al.*, 2006; Getaw *et al.*, 2010; Lahmar *et al.*, 2013).

Co-infection of both liver and lungs was less common in dromedaries than infection of liver or lungs alone. Similar findings were reported before (Lahmar *et al.*, 2013; Omar *et al.*, 2013).

Economic losses due to the cystic echinococcosis are depending on the number of slaughtered animals and the study area. In the present study, direct financial losses due to bovine hydatidosis was estimated at USD 28,286 per annum. Other studies have found different results; USD 51,883 (Kebede *et al.*, 2009c), USD 1,38,563 (Regassa *et al.*, 2010), USD 30,202 (Bekele and Butako, 2011).

For sheep and goat, economic losses were 25,939 USD and 3,309 USD per annum, respectively in this study. The total annual economic losses incurred due to cystic Echinococcosis in sheep and goats was also estimated to be USD 99,938 and USD 49,373, respectively (Kumsa and Mohammedzein, 2014). Ahmadi and Meshkehkar (2011) found the following values: USD 1,23,490 for sheep (n = 2,815,982) and USD 3,5,549 for goat (n = 427,790).

For dromedaries, financial losses were estimated in this study at 3,747 USD. In Ethiopia, the economic losses in dromedaries were estimated by Gizachew *et al.* (2013) at 61,222 USD.

CONCLUSION

Finally, cystic echinococcosis is widespread in slaughtered domestic ruminants causing huge economic losses in Algeria and cattle are the most highly infected animals. Therefore, more epidemiological studies on the role of other intermediate host species, definitive hosts, zoonotic impact of cystic echinococcosis are urgently needed in different parts of Algeria.

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