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Pathological Characteristics of Tuberculosis in Slaughtered Sheep and Goats in Algedarif State

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ABSTRACT

This study was carried out at Gadarif state in Eastern Sudan to detect the pathological characteristics of Tuberculosis (TB) lesions in carcasses of small ruminants (sheep and goats). A total of 4560 sheep and goats were examined between June 2017 and December 2018. The animals were brought from different localities of Gadarif State. The general body condition score (BCS) of the animals were observed and looked apparently active and healthy. Postmortem inspection was performed based on the principle of meat inspection; visualization, palpation and incision. Particular emphasis was given during examination to certain organs and lymph nodes that were carefully inspected for the presence of suspected TB lesions. All lobes of the two lungs and the lymph nodes were inspected externally and palpated for the presence of visible lesions. Moreover, organs such as liver, spleen, kidneys rumen and small intestine were examined. Any suspected tuberculous lesions with yellowish appearance, caseous, purulent, caseo-calcareous or calcified in consistency were collected. The results revealed that overall prevalence of granulomatous lesions in all inspected carcasses was 0.22%. The detected granulomatous lesions were typical caseous necrosis, with a whitish or yellowish color. They were of various sizes and enclosed in light grey fibrous tissue. The inspection in sheep and goats showed that 80% of the lesions were localized mainly in the abdominal cavity, thoracic cavity 20%, however, the predominant organs have tubercles in liver and lungs (55.5%, 16.7%) respectively, followed by mesenteric lymph node , mediastinal lymph node, intestine, kidney

Introduction:

Tuberculosis (TB) is caused by *Mycobacterium bovis* primarily in cattle and a wide range of animal species as well as human beings. TB in animals has a severe effect on animal productivity and public health significance. TB also leads to economic losses (Biet *et al*., 2005; Gelalcha *et al*., 2019). The disease has been effectively controlled in many countries but it is still prevalent in many others (Schiller *et al*., 2010). In Africa, zoonotic TB caused by *M. bovis* is common (Ayele *et al*., 2004; Smith *et al*., 2006; Kulchavenya, 2014, Shuaib *et al*., 2017).

Some previous studies have investigated the prevalence of TB-suggestive lesions in cattle carcasses in the central and western parts of Sudan (Osman, 2007; Manal *et al*., 2010; Asil *et al*., 2013; Ehsan and Nganwa, 2014; Aljameel *et al*., 2014, Shuaib *et al*., 2017) and in sheep and goats in western Sudan (Aljameel *et al*., 2017).

Epidemiological studies indicated that tuberculosis in sheep and goats has a wide global distribution and has been reported in various countries of the world including New Zealand, Spain, the United Kingdom, Italy, Algeria, Nigeria, Ethiopia and Sudan (Cordes *et al*., 1981; Tafess et al., 2011; Kassa *et al*., 2012; Aljameel *et al*., 2017).

Tuberculosis in sheep and goats is caused by members of *Mycobacterium tuberculosis* complex predominantly *M. bovis* and *M.caprae* (Crawshaw *et al*., 2008) and in some cases by *M.tuberculosis* (Cadmus *et al*., 2009).

Sheep is susceptible to the infection of *M. bovis* and *M. caprae*. Low incidence of sheep TB and there are individual cases which usually detected during routine post mortem inspection at the slaughterhouse (Boukary *et al*., 2012; Marianelli *et al*., 2010, Pesciaroli *et al*., 2014). Tuberculosis (TB) in sheep has been reported in New Zealand, Sudan, Italy, Ireland and the United Kingdom (Cordes *et al*., 1981; Davidson *et al*., 1981; Tag El Din and Nour Gamaan, 1992; Malone *et al*., 2003; Marianelli *et al*., 2010; Van Der Burgt, 2010).

The infection is likely acquired by sharing pastures or cohousing with infected cattle or goats (Malone *et al*., 2003; Marianelli *et al*., 2010; Munoz Mendoza *et al*., 2012).

The disease in goats spreads through head to head contact, sharing of contaminated food and water bowls as well as infected aerosols spread from breath (Danbirni *et al*., 2016). Tuberculosis can affect the udder leading to contamination of milk and also infected sputum coughed up can be swallowed and thus infect the gastrointestinal tract (Danbirni *et al*., 2016). Goats may also become infected with *M. bovis* when sharing pastures with infected cattle, at watering points, market places and shared shelters (Naima *et al*., 2011).

In South Darfur State, Sudan, Aljameel *et al*., (2017) detected TB among the slaughtered goats and sheep and they were found to be reservoirs of TB among the livestock in the region and respiratory pathway was the most site of infection in goats and sheep. Therefore, proper meat inspection procedures at abattoir with public awareness are important to control TB (Aljameel *et al*., 2017).

There is a need for awareness on the extent to which the public is exposed to certain zoonotic diseases detected in abattoirs and the financial losses through condemnation of affected organs and carcass especially due to tuberculosis in goats (Nfi and Alonge, 1987).

Postmortem inspection remains the most important and economically affordable diagnostic techniques can be used to investigate TB prevalence in livestock and to understand its epidemiology (Ramos *et al*., 2015).

In Sudan, knowledge on the prevalence of TB in ruminants is needed and its epidemiology is not very well understood. This is attributed to the lack of systemic surveys and monitoring programs (Asil *et al*., 2013; Shuaib *et al*., 2017).

The objective of the present study was to detect the pathological characteristics of tuberculosis (TB) in slaughtered small ruminants (sheep and goats) in Al Gedarif abattoir.

Materials and Methods:

Study area

The study was conducted from June 2017 to Dec 2018 at Gadarif State Sudan. This State was selected as it is one of the animal production and exporting sites in Sudan. It is located 410 km away from Khartoum in the east direction, 12° 17' N and 34° 36' E (Figure 1). Livestock and agriculture are the main components and factors for the livelihood of the community to undertake agricultural activities and also as source of income. An estimated population of approximately 1,369,300 with an annual population growth rate of 4.7% (CBS, 2012).

The state is bordered to the east by Ethiopia and Eritrea. The four Sudanese States surrounding Al-Qadarif State are Khartoum, Kassala, Gezira and Sinnar. The mean temperature in the Al-Qadarif town is 29°C, the mean maximum is 37°C and the mean minimum is 21°C. May is the hottest month of the year. The area is characterized by a uni-modal rainfall season most of which primarily occurs from June to September and controlled by the nature of the Inter Tropical Convergence Zone. The annual rainfall in the area ranges between less than 300mm in the North to more than 800 mm in the South (Sulieman, 2013).

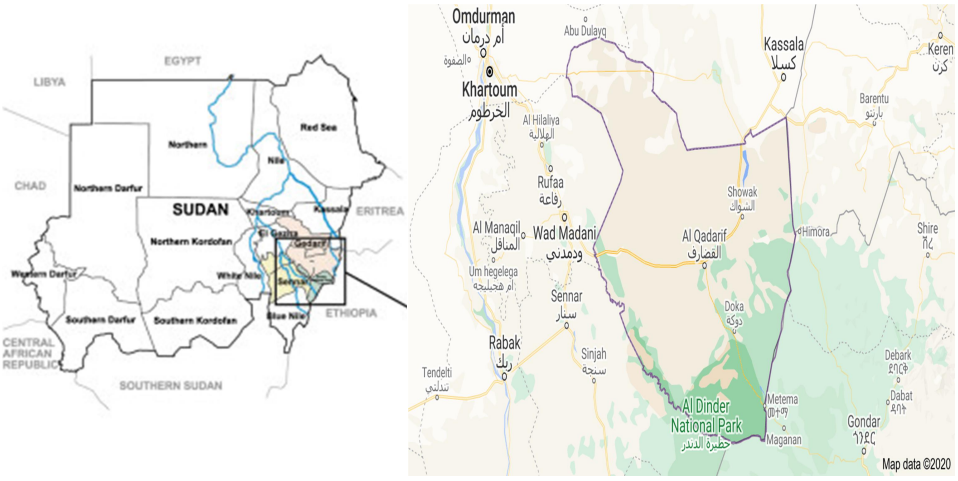

Figure1. Map of the Sudan showing the selected State (Study site).
Source: Google maps

Animal production is important in the state with over 6 million heads (Ministry of Animal Resources and Fisheries, Gadarif State, 2010). It includes 2.613 million sheep, 0.92 million goat, 1, 9 million cattle and 0.6 million camels (Hamad *et al.*, 2017).

Ante mortem examination of animals:

Around 4560 sheep and goats were tested between June 2017 and December 2018. The animals were brought from different localities of Gadarif State. The general body condition score (BCS)

of the animals were observed and looked apparently active and healthy. All animals were examined 12 hours before slaughtering.

Post-mortem examination

Postmortem inspection was examined as described by Corner (1994). Also was performed based on the principle of meat inspection; visualization, palpation and incision (Ameni *et al*., 2007; Biffa *et al*., 2010; Aljameel *et al*., 2017). Particular emphasis was given during examination to certain organs and lymph nodes that were carefully inspected for the presence of suspected TB lesions. All lobes of the two lungs were inspected externally and palpated. Then, each lobe was sectioned into (2 cm) thick slices to facilitate the detection of lesions. Similarly, lymph nodes, namely, the parotid, mandibular, sub-maxillary, retropharyngeal, mediastinal, bronchial, mesenteric, pre-scapular, medial iliac, supra-mammary, portal and inguinal lymph nodes, were sliced into thin sections (about 2mm thick) and inspected for the presence of visible lesions. Moreover, organs such as liver, spleen, kidneys rumen and small intestine were examined in details during post-mortem (Aljameel *et al*., 2017).

In goats, the seven lobes of the two lungs, (left apical, left cardiac, left diaphragmatic, right apical, right cardiac, right diaphragmatic and right accessory lobes) were inspected, palpated and incised. The carcass including internal organs such as liver, kidneys, mammary gland, intestines and lymph nodes were inspected and palpated. Lymph nodes were not incised for fear of contaminating the carcasses and the environment. The cut surfaces of the organs were thoroughly examined for the presence of abscesses, cheesy masses and tubercles as described by Corner (1994). Where gross lesions suggestive of tuberculosis were found in any of the tissues, the animal was classified as having tuberculosis-like lesions. Whenever gross lesions suggestive of TB were detected in any of the tissue, the tissue was classified as having lesions.

Any suspected tuberculous lesions with yellowish appearance, caseous, purulent, caseo-calcareous or calcified in consistency were collected. Type of organ or tissue in which the lesion was located was recorded as well as the nature of the gross pathological lesion. Observation of localized tuberculous lesion in the various parts of the carcass led to partial condemnation of affected parts while generalized infection led to total condemnation.

Results:

In total 4560 small ruminants were slaughtered in Gadarif abattoir during the study period. The animals were mostly of indigenous breeds, e.g. Dubassy and Gaash sheep and Baladi, Garrage and Nubi goats. The overall prevalence of granulomatous lesions in all inspected carcasses was 0.22% (Table 1). The detected granulomatous lesions were typical caseous necrosis, with a whitish or yellowish color. They were of various sizes and enclosed in light grey fibrous tissue.

Distribution of lesions

The inspection in sheep and goats showed that 80% of the lesions were localized mainly in the abdominal cavity, thoracic cavity 20%, however, the predominant organs have tubercle is liver and lymph node (55.5%, 16.7%) respectively, followed by Mesenteric lymph node , mediastinal lymph node, intestine, kidney (Table 2).

Gross appearance showed lesion various sizes ranged between 0.3 mm to 4 cm capsulated by fibrous tissue and contain white, pale, yellowish cheesy calcified material in liver. Thick fibrous encapsulated yellowish central sticky mucoid pus was seen in the liver (Fig 3). Also lesions of tuberculosis on the surface of liver of a sheep were observed (Fig. 4). Fig. (5) Show granulomatous lesions in the lungs (white color) in the sheep Fig. (6) Shows mesenteric

lymphnode with yellowish caseous material in the sheep and Fig. (7) shows enlargement mesenteric lymph node with yellowish caseous material in a sheep.

Table (1). Distribution of TB lesions in organs of sheep and goats slaughtered in Gadarif abattoir during the period 2017 – 2018

Organ/tissue	No. TB –suspected lesions (%)
Lung	1 (6.25)
Mesenteric lymph node	2 (12.5)
Mediastinal lymph node	1 (6.25)
Liver	10 (62.5)
Intestine	1 (6.25)
Kidney	1 (6.25)
Total	16

Table (2) Prevalence of tuberculosis in slaughtered sheep and goats in Gadarif abattoir during the period 2017 – 2018

Animals	Slaughtered	Infected	Localized lesions	Generalized lesions
Sheep and goats	4560	10	8	2
	0.22%	0.17	0.04	

Fig. 2. Bovine tuberculosis in sheep thick fibrous encapsulated yellowish central sticky mucoid pus in the liver

Fig.3. Lesion of tuberculosis in surface of liver in the sheep

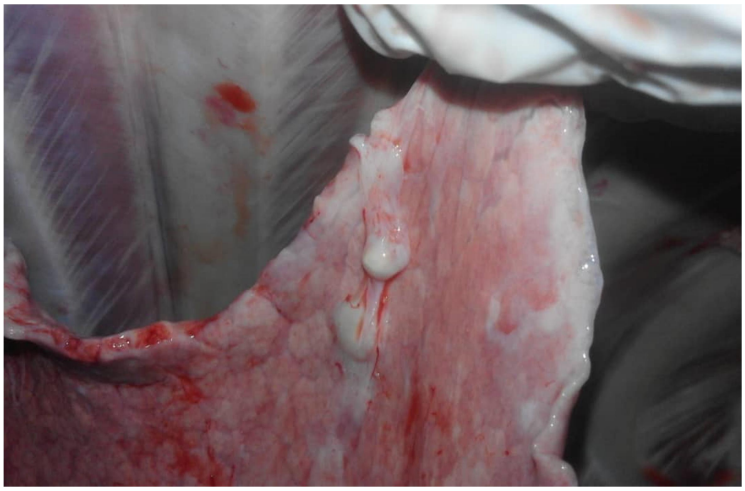

Fig. 4. Granulomatous lesions in the lungs (white color) in the sheep

Fig. 5. Embedded yellow lesions of tuberculosis in the small ruminants

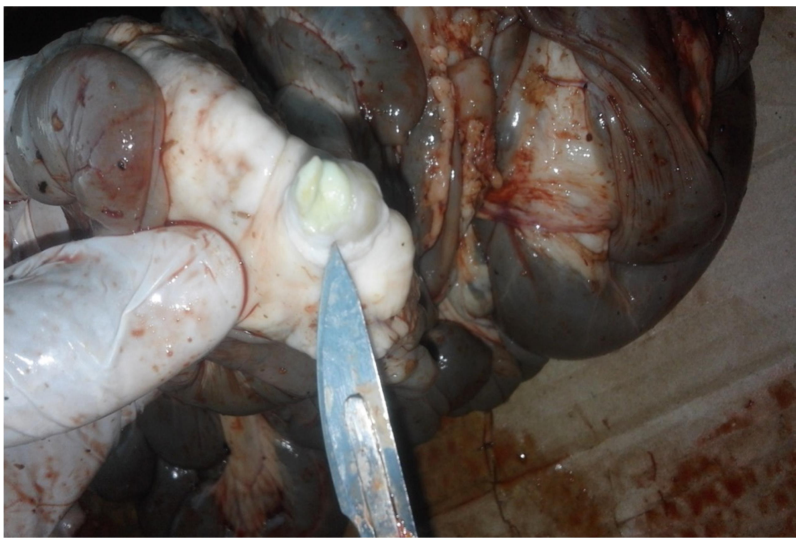

Fig. 6. Mesenteric lymphnode with yellowish caseous material in the sheep

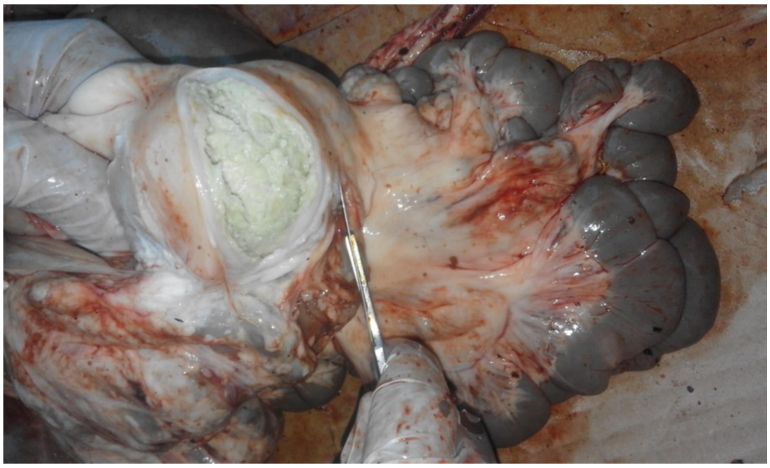

Fig.7. Enlargement mesenteric lymph node with yellowish caseous material in the sheep

Discussion:

The present study showed low incidence of TB in sheep and goats, and individual cases are usually detected during routine post mortem inspection at the slaughterhouse (Boukary et al., 2012; Marianelli et al., 2010). Small ruminants carcasses typically undergo a less detailed post mortem examination than that performed in cattle, and this could explain the fewer reports of TB infection (van der Burgt et al., 2013).

Boukary et al., (2012); Kassa et al., (2012); Ereqat et al., (2013) reported that The practices of farming and behaviour of small ruminants and the close physical contact of pastoralists with their animals may represent a potential risk factor for transmission of *M. tuberculosis* complex members from animals to human or vice versa.

The infection has been described with TB lesions were mostly confined to the respiratory tract, demonstrating that the transmission of the disease in sheep can occur through aerosols. The TB lesions affected the gastrointestinal tract and the extent and the severity of the lesions observed in the lungs likely suggest that sheep were shedding high amounts of mycobacteria through nasal discharge and hence were able to transmit the disease. Nevertheless, cases of generalization of the infection have been also reported (Marianelli *et al*., 2010). The pathological findings in small ruminants infected with TB suggest that sheep and goats could act as a reservoir of infection. The presence of lesions in the respiratory tract, suggest that they have the potential to act as domestic reservoir for TB (Bezos *et al*., 2012; Napp *et al*., 2013; Zanardi *et al*., 2013).

Post mortem examination of small ruminants infected with *M. bovis* frequently reveals circumscribed pale yellow, white, caseous or caseocalcareus lesions of various sizes, often encapsulated, especially in the lungs and mediastinal lymph nodes, or in the mesenteric lymph nodes. Similar gross lesions have been described in goats infected with *M. caprae* (Alvarez et al., 2008; Bezos et al., 2010).

In some European countries, including Greece, Italy, Spain and Portugal, which have high small ruminants census figures and are not officially TB free (OTF), there may be a risk of spread of TB between cattle and small ruminants, especially when animals share pastures (EFSA, 2009). Surveillance of TB in goats in non-OTF countries is therefore important, and given its zoonotic potential, goats used for raw milk production living in mixed cattle-goat herds must be tested for

TB (Regulation (EC) 853/2004). However, most non-OTF countries lack an active ante-mortem TB surveillance programme in caprine flocks that are not in close contact with cattle.

TB cases are therefore usually detected in the post mortem examination at the slaughterhouse, though TB in small ruminants is more rarely detected at the abattoir due to a lower quality of the meat inspection than that commonly carried out in cattle.

Gross lesions observed in sheep were similar to those described earlier in the same species by other researchers (Sharp 2000; Neill et al., 2005).There appears to be agreement that lesions are mostly caseous and well encapsulated. In the present study, three of the infected sheep showed extensive and multiple lesions (in both thoracic and abdominal cavities), making the determination of the route of entry difficult to ascertain

It was indicated that the route of transmission of *M. bovis* within the same species or between different species can be deduced by the pattern of lesions observed in slaughtered animals (Pollock and Neill, 2002). Animals with lesions restricted to the thoracic cavity are presumed to have been infected by the inhalation of aerosols, while those with lesions restricted tomesenteric lymph nodes are thought to have acquired the infection by ingestion (Deresa et al., 2013).

The present stud concluded that TB lesions were detected among slaughtered goats and sheep in Gidarif State eastern Sudan. Meat inspection procedures at abattoir is good tool to detect the prevalence of diseases.

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