



Prevalence of *Taenia ovis* and *Taenia hydatigena* Cysticercosis in Goat in Abeche Slaughterhouse in Chad

**Ahmota Romain Daïba¹, Issa Youssouf Adoum^{1,2},
Mahamat Hassan Abdel-Aziz¹, Abdel-Madjid Adoum¹,
John Maina Kagira³**

¹Institut National Supérieur des Sciences et Techniques d'Abéché (INSTA), Tchad

²Ecole normale supérieur de N'Djamena (ENS), Tchad

³Department of Animal Sciences,

Jomo Kenyatta University of Agriculture and Technology (JKUAT), Nairobi, Kenya

Corresponding author, E-mail: romaindaiba777@gmail.com

Abstract

Cysticercus ovis and *Cysticercus tenuicollis* are global diseases that infect farm animals and are caused by the larval stages of the carnivore tapeworms *Taenia ovis* and *Taenia hydatigena*. This study aimed to evaluate the prevalence of *T. ovis* and *T. hydatigena* cysticercosis in goats. The research was carried out at the slaughterhouse in Abeche, Chad, from August to October 2024. All goats slaughtered during this time were inspected and sampled. A total of 8,327 goats, including 3,513 males and 4,814 females, were examined postmortem for the presence of *C. ovis* and *C. tenuicollis* cysts during slaughter and evisceration. The findings revealed that *C. ovis* and *C. tenuicollis* cysts had an overall prevalence of 0.11% and 5.32%, respectively. The prevalence of cysticercosis (*C. ovis* and *C. tenuicollis*) in females (0.12 and 6.02%, respectively) was statistically higher than in males (0.09 and 4.35%, respectively). The study found that goats from periurban areas (0.09 and 5.40%, respectively) and transhumant breeders (0.17 and 6.10%) were more infected than those from urban areas (0.00 and 3.09%, respectively). All nine positive instances of *C. ovis* cysticercosis were detected in the heart, whereas *C. tenuicollis* was more often found linked to the liver (3.06%) and intestines (1.92%) than other organs and tissues. In conclusion, this study found that prevalence was high among animals raised in periurban areas and among transhumant breeders. To reduce infection levels, a focused deworming program for animals should be implemented, with a focus on efforts before and during rainy seasons when the risk of transmission is greatest. Controlling the spread of these larvae from slaughterhouses requires significant efforts, including the destruction of all contaminated offal.

Keywords: *Taenia ovis*, *Taenia hydatigena*, cyst, prevalence, goat, Abeche

Introduction

In the Sahel, goat farming is becoming more and more popular because of its significant socioeconomic significance. Livestock farming alone accounts for 53% of the country's rural sector's GDP, making it the second most lucrative industry outside of oil behind cotton. It accounts for 30% of the nation's commerce, 20% of GDP, and over 40% of the working population (PNDE, 2008).

In Chad, 85% of the population relies on agropastoral activities (INSED, 2009). In the present environment of widespread poverty affecting the majority, tiny ruminants, owing to their affordability and simplicity of care, are assuming an increasingly significant role in regions with limited fodder supplies (Zahraddeen et al., 2008; Chukwuka et al., 2010). Goat farming is very competitive owing to the accessibility of familial labor and necessitates little financial resources (Mc Dermott et al., 2010). The family diet in the arid regions of the country is primarily based on the milk produced by goats, as the majority of the livestock has been taken on transhumance (Mbaïndingatoum, 2011). Nevertheless, the production of goats is still constrained by a lack of access to animal health products and services, which results in ineffective disease control practices. Parasites and diseases are a significant public health issue that result in direct and indirect economic losses, resulting in significant financial waste (Magala et al., 2024). Parasitic diseases are prevalent in humid tropical and subtropical regions of the globe and are significant causes of morbidity and mortality in both humans and animals (Saulawa et al., 2011). Many parasite infections are common in Chad, causing decreased cattle productivity and leading to lower meat output owing to carcass or organ condemnation (Tadesse, 2019).

Among the parasitic burden, *Taenia ovis* (*T. ovis*) and *Taenia hydatigena* (*T. hydatigena*), the metacestode stage of the tapeworm parasites, cause cystic lesions in the skeletal and cardiac

muscle of goats. This can lead to the condemnation of the entire carcass (Idowu et al., 2024; DeWolf et al., 2013). Infection in goats as intermediate hosts (IH) with larval parasites results in medically and economically significant disorders referred to as cysticercosis. Cysticercosis caused by *T. ovis* and *T. hydatigena* presents a public health issue (Hajipour et al., 2020; Hashemnia and Frajani, 2016). The zoonosis risk is particularly elevated in poorer nations, especially in rural areas where people live in close proximity to animals, coupled with inadequate sanitation and little knowledge (Winarso et al., 2018). Canines and other carnivorous species, including foxes, wolves, jackals, lynx, raccoons, bears, and felines, serve as prevalent definitive hosts for the majority of cestodoses affecting goats (Idowu et al., 2024; Corda et al., 2020). Humans may get infected by ingesting undercooked or raw tissues from ruminants containing juvenile stages of *T. ovis* or *T. hydatigena*. Consequently, humans serve as both the definitive host and an accidental intermediate host in their life cycle by harboring the larval stage (Arji et al., 2023).

C. ovis and *C. tenuicollis* do not pose a flock health or zoonotic threat; however, they adversely affect food quality. The presence of calcified and viable cysts renders the meat unpalatable and may lead to carcasses being downgraded or condemned at the abattoir (DeWolf et al., 2012). The United Nations Food and Agriculture Organization (FAO) meat inspection guidelines stipulate that carcasses should be condemned if the infection is significant, defined as two or more organs harboring cysts (Herenda et al., 1994). The condemnation of entire carcasses and the trimming of affected meat can result in substantial economic losses for producers and the industry (Hajipour et al., 2020).

In Chad, very few studies have been conducted on the occurrence of taenia cysts in livestock, especially in small ruminants. The little investigations performed are too old (Graber and Chailloux, 1970; Graber and Thome, 1964). Goats serve as a major source of meat and milk

and have significant socio-economic importance in Chad (Djalal, 2011). Considering the economic impact of taenia cysts, namely *T. ovis* and *T. tenuicollis* infections in small ruminants, notably goats, it is essential to ascertain the epidemiological characteristics of the parasite, including prevalence and economic effect, to enhance control and treatment efforts. This study aimed to evaluate the prevalence of cysticercosis infections caused by *T. ovis* and *T. tenuicollis* in goats slaughtered at the Abeche abattoir in Chad.

Materials and Methods

Study period and location

The study was conducted over a three-month period, from August 2024 to October 2024. The study was carried out at the Slaughterhouse in Abeche, which is located in the Ouaddaï district of eastern Chad. Abeche is situated at 13° 48'584"

north latitude and 20° 50'139" east longitude. It is subject to the intertropical climate, which is characterized by a 9 months' dry season (October to June) and a 3 months' rainy season (July to September). The average annual rainfall is 300 mm, and the average temperature is 28°C (with a range of 16 to 35°C in the cold season and 25 to 45°C in the hot season).

Study animals' population

Samples were taken from all goats that were slaughtered between August and October of 2024. At the abattoir, a total of 8,327 goats, including 3,513 males and 4,814 females, were postmortem examined for the presence of *C. ovis* and *C. tenuicollis* cysts during the evisceration and slaughter process. The periurban area of the city of Abeche is the source of the majority of animals slaughtered (61.38%) (Table 1).

Table 1: animal's effective and origin

Variable		Animals number	Percentage (%)
Goats	Males	3,513	42.19
	Females	4,814	57.81
Origin	Urban	938	11.26
	Periurban	5,111	61.38
	Transhumant	2,278	27.36
Period	August	2,321	27.87
	September	3,023	36.30
	October	2,983	35.82

Postmortem inspection

The presence of *C. ovis* and *C. tenuicollis* cysts in the carcass and/or internal organs was determined by detecting the vesicular larvae encysted through visual inspection and palpation in accordance with the procedure previously described (Wilson, 2005). Next, the results were recorded. The skeletal muscles, heart, esophagus, diaphragm, liver, kidneys, lungs, masseter muscle (internal and external), and peritoneal cavity were examined, palpated, and incised to detect *C. ovis*

and *C. tenuicollis* cysts, as per the FAO regulation. The animal was proclaimed infected upon the discovery of *C. ovis* and *C. tenuicollis* cysts in the aforementioned tissues. The Food and Agriculture Organization of the United Nations (FAO, 2000) deemed animals with two or more lesions at the standard inspection sites to be severely infected and condemned them. The predilection sites, size, and morphology of the cyst samples collected were used to corroborate their identity as *C. ovis* or *C. tenuicollis* cysts (Figure 1).

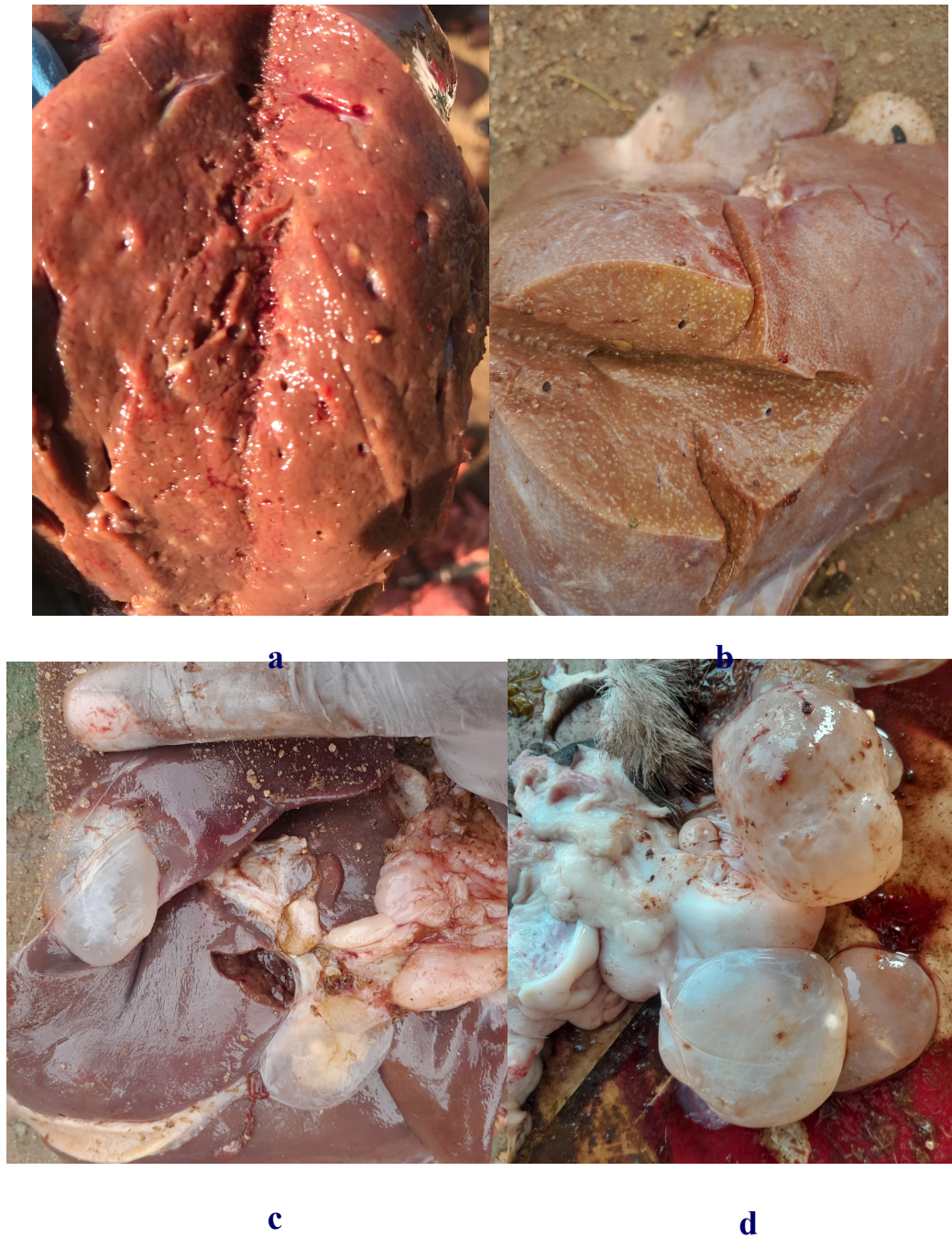


Figure 1: Photos of the few live and calcified cysts found during inspections (a. *C. ovis* in the liver, b. Calcified cysts in the liver, c. *C. tenuicollis* (water ball) in the liver, d. *C. tenuicollis* collected on the intestines).

Data analysis

The collected data were entered in Microsoft Office Excel and the XL-STAT software (versions 6.1.9 and 2009 Copyright© 2002, and

2008 Addinsoft) was used to perform descriptive statistics (means and incidence), and analysis of variances (ANOVA) with the Newman-Keuls multiple comparison test, with $p < 0.05$ indicating statistical significance.

Results

Prevalence of *Cysticercus ovis* (*C. ovis*) et *Cysticercus tenuicollis* (*C. tenuicollis*) cysts

Out of a total of 8,327 examined carcasses of goats, 9 (0.11%) and 443 (5.32%) revealed the presence of *C. ovis* and *C. tenuicollis*, respectively. The prevalence of both cysts (*C. ovis* and *C. tenuicollis* cysts) reported in females was statically higher than that in males ($p < 0.05$) (Table 2). All positive cases of *C. ovis* recorded during the study were observed in goats from the urban area (five cases) and those from transhumant breeders (four cases), and all nine cases were reported during the month of August (Table 4). While *C. tenuicollis* was observed in all

animals from the three areas with a high prevalence in animals from transhumant breeders (6.10%), followed by those from the periurban area (5.40%) (Table 3). The month of August (8.83%) recorded a significant *C. tenuicollis* cysts infestation compared to September (6.23%) and October (1.59%) (Table 4).

The heart was the site of all nine positive cases of *C. ovis* cysticercosis cysts during the postmortem examination, whereas the distribution of *C. tenuicollis* cysts was dispersed across all organs and tissues. The liver (3.06%) and intestines (1.92%) were the most frequently found to be affixed by *C. tenuicollis* among the tissues examined (Table 5).

Table 2: Prevalence of *Cysticercus ovis* and *Cysticercus tenuicollis* by sex of goats

Sex	Number of examined goats	<i>Cysticercus ovis</i>		<i>Cysticercus tenuicollis</i>	
		Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
Male	3,513	3	0.09 ^a	153	4.35 ^a
Female	4,814	6	0.12 ^b	290	6.02 ^b

For the same column, values carrying the same superscript letter are not significantly different at $p \geq 0.05$.

Table 3: Prevalence of *Cysticercus ovis* and *Cysticercus tenuicollis* by origin of goats

Origin	Number of examined goats	<i>Cysticercus ovis</i>		<i>Cysticercus tenuicollis</i>	
		Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
Urban	938	0	0.000 ^a	29	3.09 ^a
Periurban	5,111	5	0.098 ^b	276	5.40 ^b
Transhumant	2,278	4	0.176 ^b	139	6.10 ^b

For the same column, values carrying the same superscript letter are not significantly different at $p \geq 0.05$.

Table 4: Prevalence of *Cysticercus ovis* and *Cysticercus tenuicollis* by study period

Study Period	Number of examined goats	<i>Cysticercus ovis</i>		<i>Cysticercus tenuicollis</i>	
		Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
August	2,321	9	0.39 ^a	205	8.83 ^a
September	3,023	0	0.00 ^b	48	1.59 ^b
October	2,983	0	0.00 ^b	186	6.23 ^a

For the same column, values carrying the same superscript letter are not significantly different at $p \geq 0.05$.

Table 5: Prevalence and distribution of *Cysticercus ovis* and *Cysticercus tenuicollis* in different organs

Organs	<i>Cysticercus ovis</i>		<i>Cysticercus tenuicollis</i>	
	Number of infested	Prevalence (%)	Number of infested	Prevalence (%)
Liver	9	0.11 ^a	255	3.06 ^a
Heart	0	0.00 ^b	25	0.30 ^b
Lung	0	0.00 ^b	2	0.02 ^c
Intestine	0	0.00 ^b	160	1.92 ^d
Peritoneum	0	0.00 ^b	4	0.05 ^c
Thorax	0	0.00 ^b	0	0.00 ^c

For the same column, values carrying the same superscript letter are not significantly different at $p \geq 0.05$.

Others calcified cysts in liver

Postmortem visual examination revealed that, 8,327 livers, 941 (11.30%) were likely infected

with calcified cysts. There was no statically significant different ($p > 0.05$) in prevalence of calcified cysts among sexes (Table 6).

Table 6: Prevalence of calcified cysts in liver by sex of goats

Sex	Number of examined goats	Number of infested	Prevalence %
Male	3,513	375	10.67 ^a
Female	4,814	566	11.76 ^a
Total	8,327	941	11,30

For the same column, values carrying the same superscript letter are not significantly different at $p \geq 0.05$.

Discussion

The data obtained during postmortem inspection at the Abeche abattoir in east Chad was the primary focus of this study. The visual inspection and palpation of carcasses and internal organs were conducted to detect larval metacestodes, including *C. ovis* and *C. tenuicollis*, in animals, as previously described (Wilson, 2005). All goats that were slaughtered at the slaughterhouse during the study period were sampled and inspected. The study revealed that the overall mean prevalence of *C. ovis* and *C. tenuicollis* cysts was 0.11% and 5.32%, respectively, during the study period. There is no recent investigation on the prevalence of ruminant cysticercosis in Abeche, Chad, that we can compare the results of our study with (Arji et al., 2023). Nevertheless, the oldest research conducted in Chad were on swine and cattle cysticercosis (Assana et al., 2001; Graber and Chailloux, 1970; Graber and Thome, 1964). In 1970, Graber and Chailloux reported a prevalence of *Cysticercus cellulosae* (Rudolphi) of 6.78% in pigs in Chad. While Assana et al. (2001) demonstrated a higher prevalence of parasitic lesions (26%). Assana et al. (2001) reported that the majority of the pig farms they visited lacked latrines, which resulted in a high infestation rate, and that pigs were confined in poor hygienic conditions. Graber and Thome (1964) identified 8 to 12% of the prevalence of *Cysticercus bovis* in bovines.

The prevalence of goats cysticercosis with *C. ovis* in our study was significantly lower than that of other regions of the globe. In eastern Ethiopia, a prevalence of 22% was reported (Sissay et al., 2008), in Iran, 1.2% (Hajipour et al., 2020; Oryan et al., 2012), and in imported goats in Saudi Arabia, 1.7–5.3% (Bakhraibah and Alsulami, 2018). In contrast, Khalida et al. (2023) reported a higher prevalence of 31.9 and 47.5% in male and female goats, respectively. According to the findings of this investigation, the lesions were situated in the liver in all nine cases of infection. The liver and the lung are the most frequently predilection sites in domestic animals. According to Luka et al. (2023), the liver's

numerous capillaries facilitate the efficient filtration of ingested onchosphere from the blood, which in turn results in the displacement of cells in the organs. This is achieved by the formation of a fibrous capsule around the parasite, which expands as the cyst grows to accommodate it.

The overall prevalence of cysticercosis with *C. tenuicollis* cysts in goats in this study is lower than that in East Africa countries, including Uganda, Tanzania, and Ethiopia, where a prevalence of 51.4%, 61.1%, and 68% was reported, respectively (Magala et al., 2024; Miran et al., 2017; Sissay et al. 2008). In 2011, a higher prevalence of 71.8% was reported in western African countries, including Nigeria (Wondimu et al., 2011). However, in 2024, Idowu et al. reported a reduced prevalence of 38.2%. In the semi-arid region of Brazil, Morais et al. (2017) discovered a 39% prevalence of cysticercosis in goats caused by *Taenia hydatigena* in South America. In contrast, Tunisia (Khaled et al., 2020) and Indonesia (Winarso et al., 2018) reported a prevalence of 8.9% and 6.8%, respectively, which is comparable to our study.

The infestation prevalence of females was considerably higher than that of males in both cysticercosis cases (*C. ovis* and *C. tenuicollis*) in the current study. Khaled et al. (2020) reported a comparable finding in Tunisia, where the prevalence of *Taenia hydatigena* cysts was 3.37 and 2.3% in females and males, respectively. Bouhalit and Zerdoudi (2020) reported that 61.65% and 39% of Algeria's population were female and male, respectively. In Tanzania, 46.7% of females and 40% of males were reported (Miran et al., 2017). The low number of males in the flocks could account for the higher infestation prevalence in female goats. Farmers prefer to maintain a smaller number of males in their herds. The males are typically the ones that are sold or slaughtered during a feast. Due to this, females are significantly more frequently sold and transported to slaughterhouses when there is a scarcity of males.

The results of this investigation indicate that the periurban and transhumant breeder's areas are the most contaminated and yield the highest number of slaughtered animals. These animals were in close vicinity to the population and carnivores (dogs), which are the reservoirs of parasitosis par excellence (Hashemnia & Frajani, 2016). This observation demonstrated that the population's hygienic conditions in the periurban area, which was characterized by the absence of latrines, were substandard, and that the uncontrolled wandering of carnivores (dogs) and goats contributed to an increase in infestations. During a study on the prevalence of porcine cysticercosis in Mayo-Danay, Cameroon, and Mayo-Kebbi, Chad, Assana et al. (2001) reported the same observation.

The present study's results indicated that the majority of *C. tenuicollis* cysts were located in the liver and intestinal mesentery. The same results were reported in Tunisia, Indonesia, Nigeria, and Uganda (Khaled et al., 2020; Winarso et al., 2018; Magala et al., 2024; Idowu et al., 2024). Magala et al. (2024) reported that the liver had a prevalence of 20.7%, the lungs 17.8%, the kidneys 3.5%, and the amniotic sac 15.7%. Khaled et al. (2020) discovered that all cysts were located in the mesentery. Cysticerci are observed to be affixed to the surfaces of visceral organs in the thorax and abdomen cavity by Winarso et al. (2018). Idowu et al. (2024) reported that *C. tenuicollis* lesions were disseminated throughout the liver (6.4%), mesentery (34.9%), and omentum (58.7%).

The present finding indicated that goats have a higher incidence of calcified nodules in their livers. The presence of this substance can be attributed to the fact that all blood from the gastrointestinal tract is directed through the liver prior to reaching the lungs. Consequently, the liver is the site of more oncospheres being confined than the lungs. The presence of cysts in the liver induces an immune response that culminates in the calcification of the cysts, as the liver serves as the primary detoxifying organ (Baldock et al., 1985; Njoroge et al., 2002; Kebede et al., 2009).

Conclusion

The current study's findings indicate that the overall prevalence of *C. ovis* and *C. tenuicollis* in goats slaughtered in Abattoir of Abeche in Chad recorded were 0.11% and 5.32%, respectively. The infection was high in females than males with both cysts. Prevalence was also high in animals breeding in the periurban area and in transhumant breeders. To control infection levels, a targeted deworming programme should be established for animals with concentrated efforts before and after rainy periods when the risk of transmission is highest. Grazing practices should avoid areas contaminated by dog faeces, and ruminants should not be kept with dogs on the same farm to limit environmental exposure. Given that larval cestodiasis is a global veterinary and human health problem, it is necessary to strengthen measures to control transmission of these larvae from slaughterhouses by destroying all infected offal to prevent consumption by dogs, the final host.

Conflict of interest

The authors declare that they have no competing interests.

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