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Morphological characterisation of *Cysticercus tenuicollis* (*Taenia hydatigena* cysts) in sheep and goat slaughtered in Bamenda municipality, Cameroon

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ABSTRACT

Aim: Purpose of the study was to determine and do comparative analysis of the morphological criteria of *Cysticercus tenuicollis* in sheep and goat in the Northwest region of Cameroon.

Method and materials: The visceral organs of 1106 slaughtered small ruminants (613 goats; 493 sheep) were examined for the presence of *C. tenuicollis*. Morphometric identification and morphological criteria (number, sizes, weights and locations of cysts; colour and volume of cystic fluid; scolex structure; and shape and arrangements of rostellar hooks) of cysts isolated from 380 small ruminants (160 sheep; 220 goats) was performed following standard procedures.

Results: The overall prevalence of *C. tenuicollis* infection in small ruminants was 34.36% (35.89 % goats; 32.45 % sheep) which was influenced ($p<0.05$) by season, physiological (pregnant or lactating) status and location of the animal. The proportions of infected animals with a single organ affected and harbouring 1 – 2 cysts were significantly higher ($p<0.05$) compared to those with double and multiple (≥ 3) organs affected and harbouring 3 and ≥ 4 cysts. The isolated cysts were predominantly ($p<0.05$) fertile and contained clear cystic fluid; and varied in sizes of cyst and cystic fluid colour. The results showed the scolex with four (4) suckers and mean hooks per cysts of 16.52 ± 14.11 with long and short hooks arranged in alternate rows. Overall, most cysts were medium-sized (46.05%) followed by small- (36.32%), and large-sized (11.05%). Location, sex, age and weight of animals and season significantly ($p<0.05$) influenced the fluid volume. Species, sex, age and weight of animals and physiological status of females and season, number of organs and number of cysts per animal significantly ($p\leq0.05$) influenced the size and hook characteristics of cysts in infected animal in this study.

Conclusion: It was concluded that cyst sizes, cyst fluid volumes and distribution of cysts on affected animals were influenced by the intrinsic (species, sex, physiological status of females, age, body condition score and weight of animal) and extrinsic (location, season) factors studied. Further parasitological research should be conducted to evaluate the epidemiology, haemato-biochemical, molecular and economic impacts of Taenia hydatigena Cysticercosis (*C. tenuicollis*) in other livestock species.

Keywords: Cysticercus tenuicollis, morphological characterisation, Northwest Cameroon, prevalence, Sheep and Goats

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Introduction

Livestock may act as intermediate hosts for tapeworms that infect humans and other animals. The adult cestode, *Taenia hydatigena* infects and lodges in intestines of domestic and wild canids where it lays eggs in faeces of host which are transmitted through ingestion to a wide range of intermediate hosts including ruminants and pigs. In these hosts, parasites may cause hydatidosis, cysticercosis or coenurosis (Flisser *et al.*, 1982; Eckert *et al.*, 1984; Thompson and Lymbery, 1995; Bayu *et al*., 2013; Yalelet *et al*., 2018; Khouloud *et al*., 2019).

The larval tapeworms (metacestodes) develop as fluid-filled cysts that may act as space-occupying lesions and cause organ condemnation at meat inspection (Radostits *et al.*, 2007). Stray dogs in the same environment with livestock increases the risk of spreading *Taenia hydatigena* Cysticercosis (Bayu *et al*., 2013; Khouloud *et al*., 2019; Cengiz *et al*., 2019, Mohammed and Kadir, 2020). Therefore, in communities where there are poor housing of dogs, irresponsible ownership where stray and scavenging dogs interact with livestock, tapeworm eggs may be released in dog faeces into the environment (Awah-Ndukum *et al*., 2004; Asmare *et al*., 2016; Al-Sudani and Al-Amery, 2022). Sheep and goats become infested through ingestion of infected eggs during grazing on contaminated

pasture (Yalelet *et al*., 2018 ; Khouloud *et al*., 2019). After ingestion, the eggs' shells are digested in the intestines releasing the oncospheres within 7 – 10 days, which migrate to the abdominal cavity through the bloodstream of the hepatic portal system (Rostami *et al*., 2015; Singh *et al*., 2015). The oncospheres increase in diameter to 6 – 8 cm and are often found on internal visceral surfaces such as the liver, omentum, mesenterium or abdominal serous surfaces where they become infective (Payan-Carreira *et al*., 2008; Al-Azizz and Essa, 2010; Farhan *et al*., 2022; Jarošová *et al*., 2022).

Infected animals may show signs such as abdominal pain, colic, loss of appetite, emaciation and unthriftiness (Singh *et al*., 2003). The migration of cysticerci through the liver may cause hepatitis cysticercosa leading to haemorrhagic and fibrotic tracts as well as serofibrinous peritonitis (Soulsby, 1982; Blazek *et al*., 1985; Taylor*et al.,* 2015). This can lead to the destruction of hepatic cells with eosinophilic infiltration, severe inflammation and possible death of the animal in very heavy infections (Saulawa *et al*., 2011). *Cysticercus tenuicollis* infection may constitute a health problem to sheep and cause economic loss in the meat industry (Flisser *et al*., 1982; Abidi *et al*., 1989). The maindiagnostic method of Cysticercosis in livestock is usually based on the identification of the metacestode attached on organs during meat inspection or necropsy (WHO / FAO / OIE, 2005; OIE, 2008, Gracey *et al*., 1999, Dey *et al*., 2022). Further characterisation is using microscopic examination to identify morphological features such as characteristics of rostellar hooks which are principally the number, length and sizes of hooks (Edwards and Herbert, 1981; Loos-Frank, 2000). Additionally, molecular characterization of *T. hydatigena* metacestodes to obtain genetic information such as genetic diversity for better understanding of the ecology, epidemiology and evolution of the parasite have been described (Omar *et al*., 2016; Zhang *et al*., 2018; Cengiz *et al*., 2019; Raissi *et al*., 2021). The length, number, size (fluid volume), colour of fluid of the cysts differ depending on organ affected and the period of infection (Ensieh et al., 2020; Jayousi *et al*., 2014; Ahmad *etal*., 2018; Mokhtaria *et al*., 2018, Alvi *et al*., 2020, Dirwal *et al*., 2020, Felefl and Laban 2020, El-Beskawy *et al*., 2021, Handoo *et al*., 2021a, Handoo *et al*., 2021b).

Taenia hydatigena Cysticercosis infection is of veterinary importance and causes enormous economic losses, especially in livestock production due to the condemnation of infected offal or meat, and cost related to diagnosis and inspection (Christodoulopoulos *et al*., 2008; Oryan *et al*., 2012; Braae *et al*., 2015) and mortality among infected animals (Scala *et al*., 2016).

The morphological characteristics or criteria of the larval stage *C. tenuicollis* include the composition and structure of the cyst and its branches, infected organs, number of cysts, and their sizes, as well as the rostellum hooks, their number and the length of both large and small hooks arranged in alternate rows (Gonzalez *et al*., 2006; Al-Hamzawi and Al-Mayali, 2020, Handoo *et al.,* 2021b). *C. tenuicollis* are oval-shaped and contain a long neck with a single white scolex bearing four suckers and a rostellum within a semi-transparent fibrous tissue sac filled with jelly-like cystic fluid (Singh *et al*., 2015; Ouchene-Khelifi and Ouchene, 2017; Mokhtaria *et al*., 2018; Hailu, 2019; El-Beskawy *et al*., 2021; Handoo *et al.,* 2021a, Handoo *et al.,* 2021b, Wang *et al*., 2021; Dey *et al*., 2022). The rostellum has variable numbers of large and small hooks which enable the larvae to anchor to epithelial cells in the host (Handoo *et al.,* 2021a, Handoo *et al.,* 2021b).

During carcass inspection, these metacestodes are typically loosely filled cysts with transparent fluid predominantly in the abdominal cavity attached to abdominal viscera, mesentery, omentum, peritoneum and livers of infected animals (Samuel and Zewde 2010, Gomez-Puerta *et al*., 2015, Singh *et al*., 2015, Magala *et al*., 2024). Other locations such as lungs, kidneys, brain, ovaries, uterine tubes, uterus, cervix, and vagina have been reported (Utuk and Piskin 2012; Gomez-Puerta *et al*., 2015, Jarošová *et al*., 2022). However, the size of the cyst may also be influenced by the age of the cyst, period of cyst presence inside the animal's body, location of its growth / expansion and nature of the tissue structure (Al-Hamzawi and Al-Mayali, 2020).

Though there are growing concerns and strong evidence of endemicity, through the reporting of prevalence rates and intensity of *T. hydatigena* Cysticercosis infection in sheep and goats in some parts of Cameroon (Djonmaïla, 2016; Awe, 2017, Lawan *et al*., 2025), there is inadequate information on the associated factors and morphological criteria and characteristics of cysts such as heads

and hooks of the metacestode *C. tenuicollis* (*T. hydatigena* cysticerci) in sheep and goats in the country. Also, the level of awareness of livestock handlers of the disease such as its impacts to animal health and productivity, livelihoods (socio-economic, cultural and religious activities) of agro-pastoral communities is not known. In this context, the study was conducted to analyse the comparative morphology of *C. tenuicollis* in sheep and goats, in the Northwest region of Cameroon.

Materials and Methods

The study was carried out from October 2022 to September 2023 on sheep and goats originating from the administrative divisions of the Northwest region of Cameroon (5°45″ – 9°9″ N and 9°13″ – 11°13″ E) destined for slaughter in the Bamenda municipality. The Northwest region of Cameroon is located within an altitude of 500 – 3000 m above sea level, and characterized by fertile volcanic soils. The regional area has a subtropical type climate with average temperatures ranging from 21.6 to 27°C, annual rainfall of over 2259 mm, high humidity (75% - 80%) and savannah vegetation with forest galleries. The region has two seasons: the rainy season from March to October and dry season from November to February (Ernest, 2006; Molua and Lambi, 2006; Sedrique and Nfor, 2021; Tume, 2021). The choice of the study areas was due to the following: (1) The Northwest region is ranked as a major livestock production area including sheep and goats in the country (MINEPIA, 2021) and has several grazing pasture and assembling sites for ranch farming, communal grazing and other pastoral activities. The ethnic groups in the study area are mostly agropastoralists with passionate traditions for livestock rearing. (2) There was abundance of stray and scavenging dogs that share the same environment with livestock (Awah-Ndukum, 2003; Awah-Ndukum et al., 2004) and there was no documented evidence or study on the morphological characteristics of *C. tenuicollis* in small ruminants in the Northwest region of Cameroon. It was common to find mix-livestock husbandry, several domestic species (cattle, sheep, goats, horses, donkeys and fowls) and domestic dogs (owned and stray) cohabiting within the same farm or be present in the same microenvironment (such as livestock markets, communal pastures, watering points, mineral lick points, vaccination posts). (3) Cysticerci have been detected in slaughtered livestock such as pigs (Njila *et al*., 2003) and domestic ruminants (cattle, sheep and goats) (Lawan *et al*., 2025); and there are many communities with strong cultures of livestock rearing for livelihood with mix livestock husbandry being widely practiced in the region

Animal Population and selection for the study

A default prevalence of 50% was used to estimate the number of domestic small ruminants (sheep and goats) required to estimate the prevalence of cysticercoids cases at meat inspection with a desired 95% confidence and precision of ≥ 5% (Thrusfield, 2007). Small ruminants (sheep and goats) originating from all the seven Administrative Divisions (corresponding to 25 Administrative Subdivisions) in the Northwest region of Cameroon and imported into the small ruminant markets in the Bamenda Municipality, were targeted in the study. However, traders and/or butchers present in the markets were listed during weekly visits and all animals that were destined for slaughter and owned by willing trader-butchers who gave their verbal informed consent were included in the study. These trader-butchers and their animals (irrespective of the number) were accompanied by the researcher to slaughter slabs for general and intensified inspections – including post-mortem examination and harvesting of cysts in infected carcasses. Overall, 1106 slaughtered small ruminants (493 sheep and 613 goats) judged as fit for slaughter during ante mortem inspection were used in this study.

Information relating to location, husbandry practices, breed, physiological status, sex, age, and origin of the animals provided by the handlers, were recorded. In addition, the breeds were determined by phenotypic description (Meutchieye *et al*., 2014, Simo and Meutchieye, 2015); age by dental examination (Erbeto *et al*., 2010) and Body Condition Score (BCS) by ranking on a scale of 1 to 5 (Ghosh*et al*., 2019) and classified as lean (1 to 2), moderate (3 to 4) and fat (5) (Kassa *et al*., 2012). The small ruminants used in this study were reared traditionally with or without shelter such as free range (scavenging) or extensive systems and semi-intensive that depend on natural pasture in agro-pastoral communities where there are interactions between small ruminants and stray and scavenging dogs.

Detection of Cysticercus tenuicollis in sheep and goats

Subsequent to the slaughter of the selected sheep and goats in this study, systematic and thorough

meat inspections were carried out by PYL assisted by the veterinary staff at the slaughter slabs. This was in accordance with government's legislation regulating veterinary health inspection and notification of legally contagious animal diseases (MINEPIA, 2000). In addition, evidence of pathologies was supported by post mortem examination of carcasses as previously described (FAO, 1994, MINEPIA, 2000, Grist, 2011) and the inspection procedure employed systematic visual examination and palpation of all visceral organs in the thoracic, abdominal and pelvic cavities for bladder like cysts (Asmare *et al*., 2016, Yigizaw *et al*., 2017). A transparent bladder like structure containing a long-necked single scolex in a virtually translucent cyst fluid and rostellar hook morphology were considered as *C. tenuicollis* vesicle (Soulsby, 1982; OIE, 2008; Samuel and Zewde 2010, Rostami *et al*., 2015; Singh *et al*., 2015; Taylor*et al*., 2015; Hailu *et al*., 2019; Khouloud *et al*., 2019; Felefl and Laban 2020).

Collection and Morphological studyof Cysts of Cysticercus tenuicollis in sheep and goats

The cysts of *C. tenuicollis* larvae were isolated from different organs in the abdominal and pelvic cavities. The host tissue surrounding the collected cysts was removed manually and the cysts washed thoroughly with normal saline or distilled water (Braae *et al*., 2015, Rafiqi *et al*., 2016). They were transported directly from the abattoir to the Parasitology Laboratory at the Regional Veterinary Clinic and Laboratory in the Northwest region, placed in zip-lockbags containing normal saline and preserved in the refrigerator (4 – 8°C temperature; 60 – 80% humidity) (El-Beskawy *et al*., 2021) until further examination and morphological characterization within 24 – 48 hours.

The number, sizes, weights and locations of cysts, colour and volume of cystic fluid, and the total number of large and small hooks were recorded. Each cyst was placed in petri dish and the length of the longest axis of each cyst measured with the aid of a ruler in millimetres, while avoiding damage to the cyst and scolex structure. The number of large and small hooks per rostellum (Large number, Small number) as well as the shape and arrangement of rostellar hooks were considered. Changes in the cystic fluid were observed based on deviation from a clear or clear yellow jelly-like liquid (Al-Hamzawi and Al-Mayali, 2020) and the weight (electronic scale : g±0.019) of each cyst (Ouchene-Khelifi and Ouchene, 2017) were noted as previously described. The size of each cyst was measured and ranked as small-sized (diameter ≤ 1 cm), medium-sized (1 < diameter ≤ 3 cm) and large-sized (diameter > 3cm) during analysis (Khaled *et al*., 2019). The fluid from each of the cysts was aspirated aseptically using a sterile disposable syringe and needle gauge 20 (Al-Bayati *et al*., 2012) and ranked as small (<5ml), medium (5 – 20 ml) and large (>20 ml) during analysis (Yigizaw *et al*., 2017).

Morphometric identification and characterization of the rostellar hooks was done as previously described (Singh *et al*., 2015; Gomez-Puerta *et al*., 2015;Mokhtaria *et al*., 2018; Al-Hamzawi and Al-Mayali 2020; Felefl and Laban, 2020). Briefly, following aspiration of the cystic fluid, the invaginated scolexes of*C. Tenuicollis* cyst samples were subjected to morphometric characterization of the rostellar hooks. The presence of protoscolex was indicated by a white spot viewed through the membrane of the cyst walls. The scolexes of the bladder cysts were stored in 70% ethyl alcohol when not examined immediately for analysis in 24 – 48 hours. After incision of *C. tenuicollis*, the protoscolex was recovered and placed between two microscopic slides and at sufficient digital pressure to flatten the hooks but not to damage them. A light microscope at X10 objective was used to confirm the *C. tenuicollis* scolex and its content (sucker, hooks, vitality fluid) (Felefl and Laban, 2020), while the components of the hooks was done at X40 objective (Singh *et al*., 2015; Gomez-Puerta *et al*., 2015). The sizes (large; small), shape and arrangement of the rostellar hooks were determined as previously described by Rostami *et al*. (2015) and Al-Hamzawi and Al-Mayali (2020).

All measurements including observations under the microscope were made by the same person. All data obtained from sampling of study animals through detection Cysts of *Cysticercus tenuicollis* at carcass examination and morphological criteria of Cysts of *Cysticercus tenuicollis* were entered in pre-prepared data sheets.

Data analysis

All obtained data were initially entered into Excel 2010, and then transferred to SPSS 20 for further analysis. The data were subjected to descriptive statistical analysis using percentages in determining the infection rates in the different breeds, sex, body condition scores and locations.

Appropriate statistical methods previously described by Thrusfield (2007) were used in the present study. Chi-square test and Fisher exact (where observations were less than 5) were used to assess the association between the different factors and the proportions of *C. tenuicollis* cysticerci in the study animals. The 95% confidence interval of the proportion was calculated according to Wilson's equation $p \pm \boldsymbol{z}\sqrt{\frac{\boldsymbol{p(1-p)}}{\boldsymbol{n}}}$, where p is the sample proportion, n is sample size and z is 1.96, the z-score for a 95% confidence interval. The student t- test was used to compare mean values obtained from morphological criteria of cysts, heads and hooks of metacestode *C. tenuicollis* isolated from animals. The statistical significance was set at $P<0.05$.

Ethical consideration: Risk assessments of project were performed by researchers to avoid hazards to all persons and animals involved in the study. Permission for the study and ethical approval were obtained from the required authorities in Cameroon [Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) before carrying out the study. The purpose of the study was explained to targeted participants (traders and butchers at the small ruminant markets and slaughter slabs in the present study) usually with the assistance of resident veterinarians, local leaders and/or trusted intermediaries. An animal was included in the study after an informed verbal consent was given by the owner or trader-butcher. Apart from procedural restraining manipulations for safety purposes, the animals used in the present study were not subjected to suffering. Slaughtering and dressing of sheep and goat carcasses were done following standard procedures as described by the Cameroon Veterinary Services (MINEPIA, 2000) and supported by manuals on routine meat inspection (FAO, 1994, Grist, 2011).

Results and Discussion

Overall, 380 of the 1106 (34.36%) animals sampled in the study were infected with the *Cysticercus tenuicollis* larval stage and prevalence rates were similar (p>0.05) for infected goats [220/613: 35.89%] and sheep [160/493: 32.45%]. The overall prevalence for both species was influenced (p<0.05) by season, physiological (pregnant or lactating) status and location of origin of animal (division). There were more factors that affected infection rate in goats [season, location of origin, weight, body condition score and physiological (pregnant or lactating) status of females] than sheep [age] (Table 1).

The effect of endogenous and exogenous factors on examined morphological characteristics of metacestode *C. tenuicollis* isolated from 380 infected small ruminants was analysed. Isolated cysts of various sizes, fluid volume and colour as well as single and multiple attachments of cysts on organs in abdominal and pelvic cavities were observed (Fig. 1).

The number of affected organs, number and fluid volume of *C. tenuicollis* cysts isolated from infected sheep and goats were noticed. Location of origin, sex, age and weight of the animals and season significantly (p<0.05) influenced the fluid volume in this study. Higher (p<0.05) fluid volume were in male, > 2 years old, ≤ 20 kg and >40 kg weight animals, and rainy season compared to female, ≤ 2 years old, 20 – 40 kg weight animals and dry season, respectively. The proportion and fluid volume varied with the location origin of the infected animals. Though infected sheep showed significantly higher (p<0.05) fluid volume during the dry season than infected goats, the fluid volume was significantly (p<0.05) higher in goats than in sheep with regards to sex, age, weight, body condition score, physiological status of females, and location of origin of animals (Table 2).

Infected goats showed significantly higher cystic fluid volumes than infected sheep irrespective of number of affected organs, number and fluid range volumes of *C. tenuicollis* cysts isolated from infected animals. The study showed that mean fluid volume per cyst was 11.70±12.89 ml corresponding to 14.06±15.87 ml per cyst for infected goats and 8.81±8.14 ml per cyst for infected sheep. The mean fluid volume was 28.08±37.39 ml corresponding to 33.19±38.66 ml for infected goats and 19.68±33.68 ml for infected sheep. Similarity (p>0.05) of proportions of infected animals with cystic fluid volume ranging from 5-20 ml (11.44±4.33 ml) and > 20ml (58.27±44.94 ml) was observed which were significantly higher (p<0.05) than proportions of infected animals with cystic fluid volume of ≤ 5 ml (2.49±1.34 ml). However, highest (p<0.05) proportion of infected goats (28.95%) and sheep (18.95%) showed cystic fluid volumes ranging from > 20ml (57.06±42.64 ml per cyst) and 5-20 ml (10.79±4.13 ml) compared to proportion for other cystic fluid volume ranges, respectively (Table 2).

Table 1: Infection rates of *Cysticercus tenuicollis* in sheep and goats slaughtered in Bamenda municipality of Northwest region, Cameroon, according to sex, age, weight, body condition score, and origin of animal and season

Factor	Variable	Goats			Sheep			Total		
		Number examined	Number infected	Percentage	Number examined	Number infected	Percentage	Number examined	Number infected	Percentage
Sex	Female	396	146	36.87a	246	86	34.96a	642	232	36.14a
	Male	217	74	34.10a	247	74	29.96a	464	148	31.90a
Age (years)	Age ≤ 2	207	74	35.75a	214	67	31.31a	421	141	33.49a
	Age > 2	406	146	35.96a	279	93	33.33a	685	239	34.89a
Weight (W) of animal (Kg)	W≤ 20	68	30	44.12a	20	5	25.00a	88	35	39.77a
	20<W≤ 40	414	153	36.96a	377	122	32.36a	791	275	34.77a
	W>40	131	37	28.24b	96	33	34.38a	227	70	30.84a
Body condition score	Fat	143	39	27.27a	147	56	38.10a	290	95	32.76a
	Medium	385	151	39.22b	304	91	29.93a	689	242	35.12a
	Thin	85	30	35.29a	42	13	30.95a	127	43	33.86a
Physiological status of Female animals*	Pregnant or lactating	184	92	50.00a	140	52	37.14a	324	144	44.44a
	Not Pregnant and not lactating	212	54	25.47b	106	34	32.08a	318	88	27.67b
Origin of animal (Administrative division in Northwest region)	Boyo	108	27	25.00a	77	22	28.57a	185	49	26.49a
	Bui	170	71	41.76b	44	21	47.73b	214	92	42.99b
	Donga Mantung	131	53	40.46b	21	7	33.33ab	152	60	39.47b
	Menchum	18	9	50.00b	18	6	33.33ab	36	15	41.67a
	Mezam	80	16	20.00a	111	36	32.43ab	191	52	27.23a
	Momo	82	37	45.12b	216	65	30.09a	298	102	34.23a
	Ngoketunjia	24	7	29.17ab	6	3	50.00ab	30	10	33.33a
Season	Rainy season	459	193	42.05a	368	121	32.88a	827	314	37.97a
	Dry season	154	27	17.53b	125	39	31.20a	279	66	23.66b
Overall		613	220	35.89A	493	160	32.45A	1106	380	34.36

* : Total number of female goats: N= 396; Total number of female sheep: N=246; Total number of female small ruminants : N=642

a, b, c, d : same letter in the column of a category(infected goats, infected sheep or total infect) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different ($p<0.05$);

A, B : same letter in the row between categories (infected goats and infected sheep) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different ($p\leq0.05$)

Table 2: Number of affected organs, number and volume of fluid of *C. tenuicollis* cysts isolated from infected sheep and goats slaughtered in Bamenda municipality, Cameroon

Factor	Variable	Infected goats (n=220)			Infected sheep (n=160)			Total infected (n=380)		
		N	%	V, mean±STD	N	%	V, mean±STD	N	%	V, mean±STD
Sex	Female	146	62.93a	35.29±38.41A	86	37.07a	21.96±38.92B	232	61.05a	31.35±39.05a
	Male	74	50.00b	29.04±39.08A	74	50.00b	17.03±26.35B	148	38.95b	23.04±33.75b
Age (years)	Age ≤ 2	74	52.48a	30.54±40.79A	67	47.52a	11.36±17.74B	141	37.11a	21.42±33.29a
	Age > 2	146	61.09b	34.53±37.61A	93	38.91b	25.68±40.59B	239	62.89b	31.09±38.96b
Weight (W) of animal (Kg)	W≤ 20	30	85.71a	36.57±47.76A	5	14.29a	14.20±16.92B	35	9.21a	33.37±45.20a
	20<W≤ 40	153	55.64b	31.48±32.75A	122	44.36b	14.82±21.34B	275	72.37b	24.09±29.41b
	W>40	37	52.86b	37.51±51.81A	33	47.14b	38.50±58.47A	70	18.42c	37.98±54.65a
Body condition score of animal	Thin	30	69.77a	39.06±54.69A	13	30.23a	9.12±9.98B	43	11.32a	30.00±47.83a
	Medium	151	62.40a	33.94±37.70A	91	37.60a	18.00±35.72B	242	63.68b	27.95±37.70a
	Fat	39	41.05b	25.75±25.15A	56	59.94b	24.86±33.34A	95	25.00c	26.23±30.16a
Physiological status of Female animals*	Pregnant or lactating	92	63.89a	34.21±35.85A	52	36.11a	25.93±44.09A	144	62.07a	31.25±39.08a
	Not Pregnant and not lactating	54	61.36a	37.06±42.71A	34	38.64a	15.90±28.87B	88b	37.93b	28.88±39.18a
Origin of animal (Administrative division in Northwest region)	Boyo	27	55.10	22.67±18.95A	22	44.90	21.76±26.96A	49	12.89	21.83±22.52a
	Bui	71	77.17	37.92±49.44A	21	22.83	41.2±69.55A	92	24.21	38.67±54.27bc
	Donga Mantung	53	88.33	30.90±31.04A	7	11.67	13.64±13.64A	60	15.79	28.88±29.99ac
	Menchum	9	60.00	32.89±24.28A	6	40.00	30.00±31.03A	15	3.95	31.73±26.13ac
	Mezam	16	30.77	29.21±24.13A	36	69.23	17.51±24.15A	52	13.68	21.11±24.52a
	Momo	37	36.27	33.14±38.34A	65	63.73	13.88±21.20B	102	26.84	20.87±29.92a
	Ngoketunjia	7	70.00	52.79±61.37A	3	30.00	6.13±4.13A	10	2.63	38.79±54.98ac
Season	Rainy season	193	61.46a	35.38±39.91A	121	38.54a	23.51±37.75B	314	82.63a	30.81±39.46a
	Dry season	27	40.91b	7.80±7.41A	39	59.09b	17.44±23.17B	66	17.37b	11.74±16.42b
Fluid volume (V) per cyst	V≤ 5 ml	30	7.89a	2.07±1.30	52	13.63a	2.73±1.33	82	21.58a	2.49±1.34
	5 < V ≤ 20 ml	80	21.05b	12.03±4.45	72	18.95ba	10.79±4.13	152	40.00b	11.44±4.33
	> 20 ml	110	28.95c	57.06±42.64	36	9.47a	61.97±51.84	146	38.42b	58.27±44.94
Number of organs affected per animal	1	186	48.95a	27.44±30.31A	147	38.68a	17.99±32.32 B	333	87.63a	23.27±31.52a
	2	32	8.42b	62.94±60.78A	12	3.16b	40.7±44.88 A	44	11.58b	56.88±57.26b
	≥ 3	2	0.53c	91.50±40.31	1	0.26c	16.00	3	0.79c	66.33±52.08b
Number of cysts per animal	1	62	16.32a	14.06±15.87A	62	16.32a	8.81±8.14B	124	32.63a	11.70±12.89a
	2	72	18.95a	26.15±25.75A	52	13.68a	16.61±19.52B	124	32.63a	22.15±23.73b
	3	36	9.47b	46.32±35.87A	29	7.63b	27.93±36.36B	65	17.11b	38.12±36.97c
	≥ 4	50	13.16b	56.91±57.24A	17	4.47b	54.66±74.71A	67	17.63b	56.34±61.53d
Overall		220	57.89	33.19±38.66A	160	42.11	19.68±33.68B	380	100	28.08±37.39

N = number of infected animals; % = proportion of infected animals; V = Volume of fluid (ml) per animal, mean ±Standard deviation. a, b, c, d : same letter in the column of a category (infected goats, infected sheep or total infect) for a parameter (Number of organs affected and number of cysts per anima) are not significantly different (p≤0.05); A, B : same letter in the row between categories (infected goats and infected sheep) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different (p≤0.05)

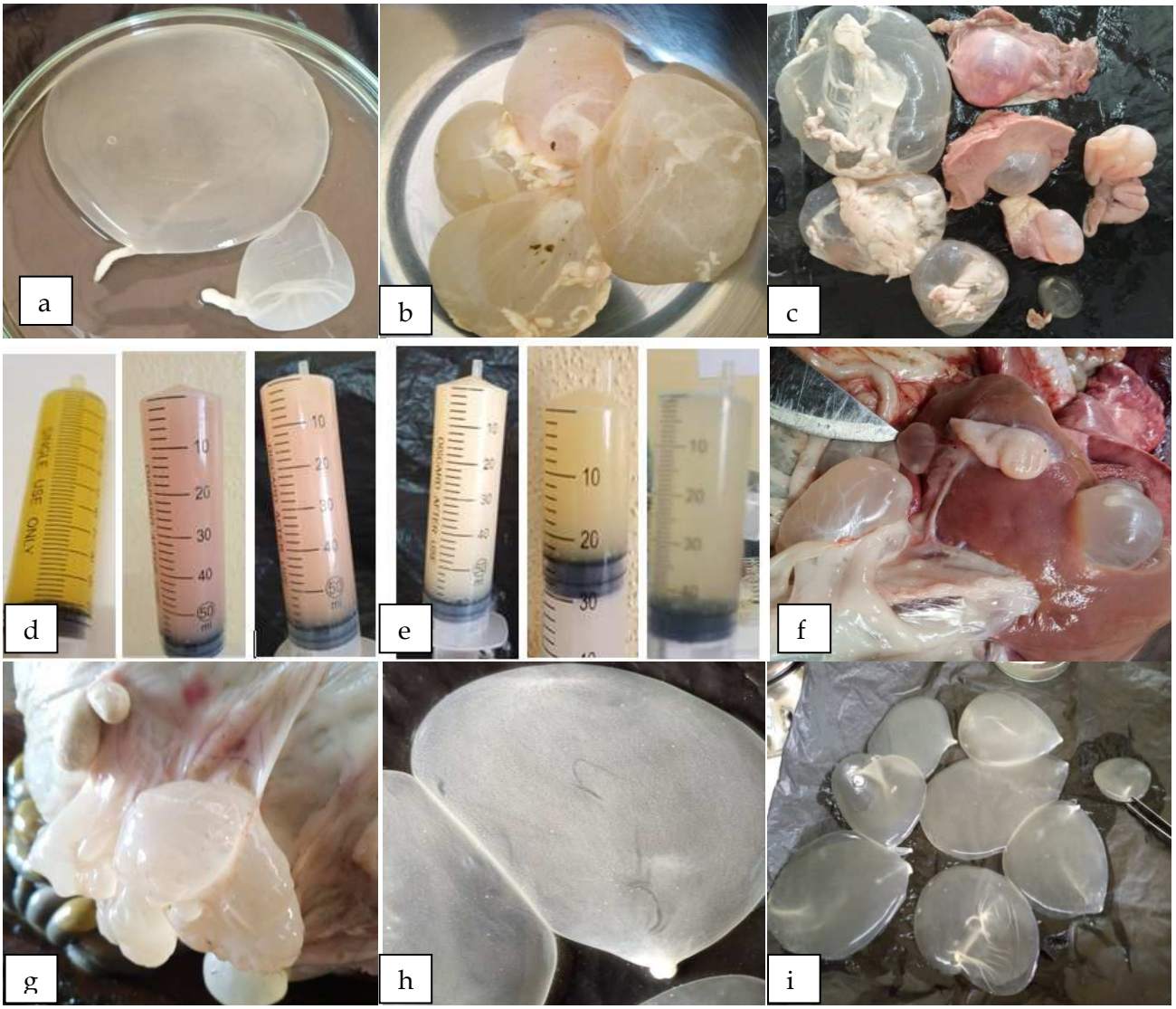

Fig. 1: Presentation of isolated cysts from the pelvic cavity (a, b) and abdominal cavity (c) of various sizes; different colour and fluid volume of aspirated cystic fluid (d, e); multiple attachments of cysts on abdominal organs (f, g) and cysts with scolex (white spot) (h, i),

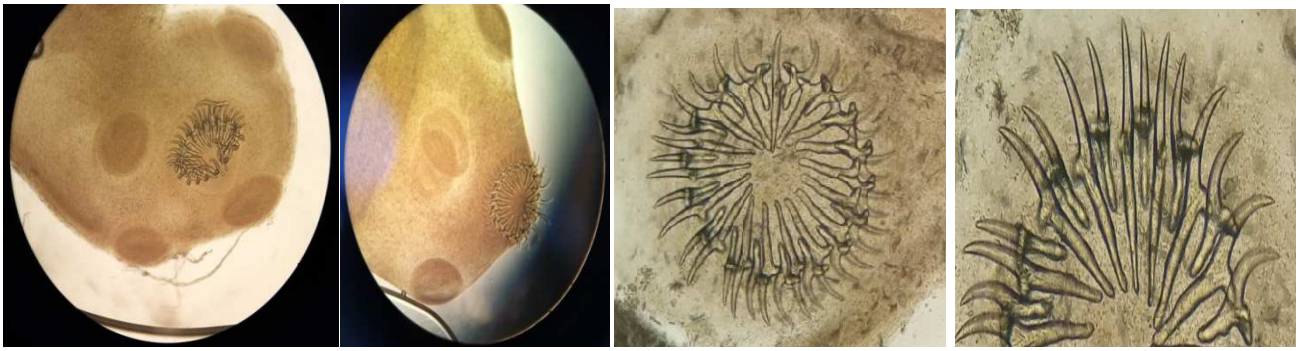

Fig. 2: The scolex of *C. tenuicollis* cysts isolated from infected sheep and goats showing four suckers and large and small rostellum hooksarranged in alternate rows

Table 3: Distribution of *C. tenuicollis* larval stage isolated in infected sheep and goats slaughtered in Bamenda municipality of Northwest region, Cameroon according to fertility status, size, fluid content colour, and number of hooks of cysts

Factor	Variable	Infected Goats (N=220)		Infected Sheep (N=160)		Total infected (N=380)	
		N	%	N	%	N	%
Fertility status of cyst	Fertile cysts : NO	19	5.00aA	9	2.37aB	28	7.37a
	Fertile cysts : YES	201	52.89bA	151	39.74bB	352	92.63b
Sizes of cysts* isolated from infected animal	L	33	8.68A	9	2.37B	42	11.05
	LM	8	2.11A	1	0.26B	9	2.37
	LMS	2	0.53	1	0.26	3	0.79
	LS	0	0.00	1	0.26	1	0.26
	M	109	28.68A	66	17.37B	175	46.05
	MS	11	2.89A	1	0.26B	12	3.16
	S	57	15.00A	81	21.32B	138	36.32
Fluid Colour	Clear	155	40.79A	126	33.16B	281	73.95a
	Yellow	3	0.79A	1	0.26A	4	1.05b
	Cloudy	16	4.21A	12	3.16A	28	7.37c
	Milky	23	6.05A	7	1.84B	30	7.89c
	Straw	23	6.05A	14	3.68B	37	9.74c
Number of hooks	≤ 20 hooks	11	2.89aA	17	4.47aA	28	7.37a
	20< hooks (number) ≤ 30	89	23.42bA	50	13.16bB	139	36.58b
	30 < hooks (number)	39	10.26cA	22	5.79aB	61	16.05c
	Total without hook	81	21.32aA	71	18.68aA	152	40.00a
	Total with hooks	139	36.58bA	89	23.42bB	228	60.00b

N = number of infected animals; % = proportion of infected animals

* : L = Large size cyst, LM = Large and Medium size cysts, LMS = Large, Medium and Small size cysts, LS = Large and Small size cysts, M = Medium size cysts, MS = Medium and Small size cysts, S = Small size cysts

a, b, c, d : same letter in the column of a category (infected goats, infected sheep or total infect) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different (p≤0.05);

A, B : same letter in the row between categories (infected goats and infected sheep) for a parameter (Number of organs affected and number of cysts per anima) are not significantly different (p≤0.05)

The proportions of infected animals with a single organ affected and animals harbouring 1 – 2 cysts were significantly higher ($p<0.05$) than the proportions of animals with double and multiple (≥ 3) organs affected and animals harbouring 3 and ≥ 4 cysts. However, infected animals with multiple (≥ 2) organs affected and animals harbouring ≥ 4 cysts showed the highest ($p<0.05$) cystic fluid volumes than infected animals with single organs affected and animals harbouring ≤ 3 cysts (Table 2).

The fertility status and arrangement of hooks and suckers of *C. tenuicollis* cysts isolated from infected sheep and goats. The scolex has four (4) suckers and a mean number of hooks per cysts of 16.52 ± 14.11 with long and short hooks arranged in alternate rows at a ratio of 1:1 (Fig 2).

The fertility status, size, fluid colour, and number and type of hooks per rostellum of isolated cysts were recorded. Though the cysts isolated from infected animals in the study were predominantly ($p<0.05$) fertile and contained clear cystic fluid, there were varied sizes of cyst and cystic fluid colour (Table 3). Overall, most of the cysts were medium (46.05%) in size followed by Small (36.32%), and large (11.05%). For goats most of the cysts were medium (28.68%) in size followed by small (15.00%), large (8.68%) while for sheep most of the cysts were small (21.32%) in size followed by medium (17.37%) and large (11.05%) (Table 3). Among the isolated cysts, there were more cysts with hooks ($p<0.05$) compared to those without hooks while all non-fertile cysts were without hooks (Table 3). In this study, factors such as species, sex, age, weight, and physiological status of females as well as season, number of organs affected per animal and number of cysts per animal significantly ($p\leq0.05$) influenced the size of cysts isolated from infected animal (Table 4). While species, sex, weight, and physiological status of females of the animals as well as season, number of organs affected per animal and number of cysts per animal significantly ($p\leq0.05$) influenced the hook characteristics in the cysts isolated in infected animal in this study (Table 5).

Cysticercus tenuicollis is the metacestode larval stage of *Taenia hydatigena* that infect livestock including ruminants and pigs (Gessese *et al*., 2014, Miran *et al*., 2017, Khouloud *et al*., 2019). Diagnosis of the infection is usually based on demonstration of the metacestode attached on organs during meat inspection in abattoirs and post-mortem

examination of carcasses (WHO / FAO / OIE, 2005, OIE, 2008,Singh *et al*., 2015, Taylor *et al*., 2015, Abdollahi *et al*., 2023). Abattoir and slaughterhouse play a vital role in the transmission of this parasite with the definitive host being infected through the consumption of contaminated offal (Dey *et al*., 2022). Parasitic and nonparasitic round / oval metacestode larval stages with transparent walls and colorless fluid contents, a single scolex attached to the thin cyst wall and the rostellum of the scolex possessing two rows of alternating large and small hooks with the nonparasitic cysts revealing epithelial cell columns and sub-epithelial tissue have been recovered from abdominal and pelvic organs of sheep and goats (Handoo *et al.,* 2021b). However, post mortem and meat inspection records provide important information on food-borne diseases including parasitic diseases such as *T. hydatigena C. tenuicollis*.In countries where inspection of meat is not strictly surveyed, slaughterhouses are essential for estimating the burden of food-borne diseases.

Free roaming and scavenging dogs that contaminate the environment with the developmental stage of parasites passed with faeces are major risk factors for the prevalence of taeniid tapeworm (Dey *et al*., 2022). However, improper disposal of carcass, free access of dogs at slaughterhouse and grazing areas, lack of awareness of butchers in managing offals and backyard slaughtering practices especially in open field and road-side areas have great impacts on the existence of the disease (Tolosa *et al*., 2009,Harandi *et al*., 2011, Varcasia *et al*., 2011).*T. hydatigena* cysticercosisis endemic in parts of Cameroon (Assana *et al*., 2010, Djonmaïla, 2016; Awe, 2017, Djiatche, 2017, Assana *et al*., 2019)and the prevalence, intensity and associated risk factors of *C. tenuicollis* infection in sheep and goats in the Northwest Region of Cameroon, have been well reported (Lawan *et al*., 2025). Though livestock owners placed great importance on their animals, close interactions between dogs (definitive host of *T. hydatigena*) and livestock are common in country (Awah-Ndukum *et al*., 2004,Assana *et al*., 2010, Djonmaïla, 2016, Awe, 2017) including present study region (Awah-Ndukum *et al*., 2004, Lawan *et al*., 2025). The metacestode *C. tenuicollis* prevalence was 34.36% in small ruminants (35.89% for goat and 32.45% for sheep) and associated risk factors were seasons and weight, physiological (pregnant or lactating) status and location of animal in Northwest Cameroon. However, prevalence rate was significantly influenced by location of origin, weight, body condition score and physiological (pregnant or lactating) status of females as well as season for goats, and only age for sheep (Lawan *et al*., 2025).

Morphologically, adult *T. hydatigena* is divided into three parts; scolex, neck and strobila and a scolex containing rostellum and four suckers (Soulsby, 1982; Taylor*et al.,* 2015). The metacestode larval stage of *C. tenuicollis* is grossly visible as a bladder containing clear jelly–like fluid hanging on the visceral organs with a single scolex (Handoo *et al.,* 2021a, Handoo *et al.,* 2021b, Dey *et al*., 2022), and arrangement and morphometry of hooks in rostellum is considered as vital features of scolex for morphological identification (Singh *et al*., 2015). In this study, large and small hooks were alternately present in two rows. The average number of hooks and the ratio of large to small hooks found in the present study confirms previous studies (Radfar *et al*., 2005, Behrestaghi *et al*., 2018, Gonzalez and Thomas 2018, Mokhtaria *et al*., 2018,Al-Hamzawi and Al-Mayali, 2020, Sarvi *et al*., 2020, Handoo *et al.,* 2021b, Dey *et al*., 2022) and was useful for the preliminary identification of the metacestode. Themorphological characteristics of the *C. tenuicollis* in the present study are in line with previous findings (Soulsby, 1982, Essa and Al-Azizzes, 2011, Singh *et al*., 2015,Taylor*et al.,* 2015; Ouchene-Khelifi and Ouchene, 2017, Mokhtaria *et al*., 2018, Hailu, 2019, Khaled *et al*., 2019, Mohammed and Kadir, 2020,Tolossa *et al*., 2019, Dirwal *et al*., 2020, Felefl and Laban 2020, Celİk *et al*., 2021, El-Beskawy *et al*., 2021, Wang *et al*., 2021, Dey *et al*., 2022) who reported that *C. tenuicollis* cysts are oval-shaped and contain a long neck with a single white scolex bearing four suckers and a rostellum within a translucent to semi-transparent fibrous tissue sac filled with jelly-like cystic fluid. However, variations in morphological identifications and characterization linked to differences in the hosts and strains of *T. hydatigena C. tenuicollis* (Radfar *et al*., 2005, Ensieh et al., 2020, Rostami *et al*., 2015, Cengiz *et al*., 2019, Ohiolei *et al*., 2021, Farhan *et al*., 2022) and variations in rostellar hooks morphometry, developmental pattern and cross-infectivity have been reported (Cengiz *et al*., 2019, Ohiolei *et al*., 2021).

Table 4 : Distribution of the size *of C. tenuicollis* larval stages isolated from infected sheep and goats slaughtered in Bamenda municipality, Cameroon according to sex, age, weight, body condition score, and origin of animal and season

Factor	Variable	Sizes of cysts isolated from infected animal (N=380)													
		L		LM		LMS		LS		M		MS		S	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Species	Goat	33	8.68a	8	2.11a	2	0.53	-		109	28.68a	11	2.89a	57	15.00a
	Sheep	9	2.37b	1	0.26b	1	0.26	1	0.26	66	17.37b	1	0.26b	81	21.32b
Sex	Male	7	1.84a	3	0.79a	-		-		77	20.26a	3	0.79a	58	15.26a
	Female	35	9.21b	6	1.58a	3	0.79	1	0.26	98	25.79b	9	2.37b	80	21.05b
Age (X)	Young (X≤ 2years)	4	1.05a	4	1.05a	-		-		68	17.89a	4	1.05a	61	16.05a
	Adult (X> 2 years)	38	10.00b	5	1.32a	3	0.79	1	0.26	107	28.16b	8	2.11a	77	20.26a
Weight (W)	W ≥ 20 kg	1	0.26a	1	0.26a	1	0.26	-		21	5.53a	3	0.79a	8	2.11a
	20 < W ≥ 40 kg	27	7.11b	7	1.84b	1	0.26	1	0.26	121	31.84b	8	2.11b	110	28.95b
	W > 40 kg	14	3.68c	1	0.26a	1	0.26	-		33	8.68a	1	0.26a	20	5.26c
Body Condition Score	Lean	3	0.79a	2	0.53ab	1	0.26	-		18	4.74a	1	0.26a	18	4.74a
	Medium	25	6.58b	6	1.58a	1	0.26	1	0.26	114	30.00b	9	2.37b	86	22.63b
	Fat	14	3.68c	1	0.26b	1	0.26	-		43	11.32c	2	0.53a	34	8.95c
Physiological state*	Pregnant or lactating	21	9.05a	5	2.16a	2	0.86	-		60	25.86a	7	3.02a	48	20.69a
	Not pregnant and not lactating	14	6.03a	1	0.43b	1	0.43	1	0.43	38	16.38b	2	0.86b	32	13.79b
Season	Rainy season	38	10.00a	8	2.11a	3	0.79	-		169	44.47a	12	3.16	84	22.11a
	Dry season	4	1.05b	1	0.26b	-		1	0.26	6	1.58b	-		54	14.21b
Number of organs affected per animal	1	33	8.68a	6	1.58a	2	0.53	1	0.26	154	40.53a	8	2.11a	130	34.21a
	2	8	2.11b	3	0.79a	1	0.26	-		19	5.00b	4	1.05a	8	2.11b
	≥ 3	1	0.26c	-		-		-		2	0.53c	-		-	
Number of cysts per animal	1	10	2.63a	-		-		-		62	16.32a	-		52	13.68a
	2	13	3.42a	4	1.05a	-		1	0.26	53	13.95a	5	1.32a	48	12.63a
	3	10	2.63a	3	0.79a	-		-		32	8.42b	-		20	5.26b
	≥ 4	9	2.37a	2	0.53a	3	0.79	-		28	7.37b	7	1.84a	18	4.74b
Total		42	11.05	9	2.37	3	0.79	1	0.26	175	46.05	12	3.16	138	36.32

* : Total number of female goats = 396; Total number of female sheep = 246; Total number of female small ruminants = 642

L = Large size cyst; LM = Large and Medium size cysts; LMS = Large, Medium and Small size cysts; LS = Large and Small size cysts; M = Medium size cysts; MS = Medium and Small size cysts; S = Small size cysts; N = number of infected animals; % = proportion of infected animals

a, b, c, d : same letter in the column of a category(Size of cysts isolated from infected animal) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different (p≤0.05).

Table 5: Number of hooks in *C. tenuicollis* larval stages isolated from infected sheep and goats slaughtered in Bamenda municipality, Cameroon according to sex, age, weight, body condition score, and origin of animal and season

Factor	Variable	Number of hooks in the cysts in infected animal (N= 380)									
		Total without hook		hooks ≤ 20		20 < hooks ≤ 30		hooks > 30		Total with hooks	
		N	%	N	%	N	%	N	%	N	%
Species	Goat	81	21.32aA	11	2.89a	89	23.42a	39	10.26a	139	36.58aB
	Sheep	71	18.68aA	17	4.47a	50	13.16b	22	5.79b	89	23.42bB
Sex	Male	70	18.42aA	16	4.21a	41	10.79a	21	5.53a	78	20.53aA
	Female	82	21.58aA	12	3.16a	98	25.79b	40	10.53b	150	39.47bB
Age (X)	Young (X ≤ 2years)	67	17.63aA	16	4.21a	41	10.79a	17	4.47a	74	19.47aA
	Adult (X > 2 years)	85	22.37bA	12	3.16a	98	25.79b	44	11.58b	154	40.53bB
Weight (W)	W ≥ 20 kg	12	3.16aA	3	0.79a	16	4.21a	4	1.05a	23	6.05aB
	20 < W ≥ 40 kg	119	31.32bA	21	5.53b	92	24.21b	43	11.32b	156	41.05bB
	W > 40 kg	21	5.53aA	4	1.05a	31	8.16c	14	3.68c	49	12.89cB
Body Condition Score	Lean	19	5.00aA	4	1.05a	11	2.89a	9	2.37a	24	6.32aA
	Medium	93	24.47bA	20	5.26b	94	24.74b	35	9.21b	149	39.21bB
	Fat	40	10.53cA	4	1.05a	34	8.95c	17	4.47a	55	14.47cB
Physiological state*	Pregnant or lactating	50	21.55aA	5	2.16a	64	27.59a	24	10.34a	93	40.09aB
	Not pregnant and not lactating	32	13.79bA	7	3.02a	34	14.66b	16	6.90a	57	24.57bB
Season	Rainy season	117	30.79aA	21	5.53a	122	32.11a	54	14.21a	197	51.84aB
	Dry season	35	9.21bA	7	1.84b	17	4.47b	7	1.84b	31	8.16bA
Number of organs affected per animal	1	139	36.58aA	25	6.58a	123	32.37a	47	12.37a	195	51.32aA
	2	13	3.42bA	3	0.79b	14	3.68b	13	3.42b	30	7.89bB
	≥ 3	-	-	-	-	3	0.79c	-	-	3	0.79c
Number of cysts per animal	1	64	16.84aA	9	2.37a	38	10.00a	13	3.42ab	60	15.79abA
	2	48	12.63aA	7	1.84a	48	12.63a	21	5.53a	76	20.00aB
	3	16	4.21bA	6	1.58a	32	8.42b	11	2.89b	49	12.89bB
	≥ 4	24	6.32bA	6	1.58a	21	5.53b	16	4.21ab	43	11.32bB
Total		152	40.00	28	7.37	139	36.58	61	16.05	228	60.00

N = number of infected animals; % = proportion of infected animals

* : Total number of female goats = 396; Total number of female sheep = 246; Total number of female small ruminants = 642

a, b, c, d : same letter in the column of a category(Number of hooks in the cysts in infected animal) for a parameter (Number of organs affected and number of cysts per animal) are not significantly different (p≤0.05);

A, B : same letter in the row between categories (Number of hooks in the cysts in infected animal) for a parameter (Number of organs affected and number of cysts per anima) are not significantly different (p≤0.05)

The study animals were predominantly females and > 2 years old and majority of cysts recovered were mature, fertile and viable. The finding suggest poor biosecurity measures, environmental contamination with developmental stage of parasites including eggs of *T. hydatigena* and inadequate or lack of antiparasite control including anthelmintic therapy of small ruminants in the study region. Therefore, given the age and sex of most of the animals and that females have long life spans than male animals, the animals would have been exposed and infected sufficiently by the parasite few weeks or months before the study period, and then grew and develop to the mature fertile cyst with little or no challenge of the immunity of the animals. The growth rate of cysts is slow and variable and dependent on the species or strains of the parasite (Kinkar *et al*., 2018) and the species of the host and the degree of infection (Corda *et al*., 2020). In relation to the growth rates of the cysts and its influence on the reliability of the diagnosis, the larval stage of *Taenia hydatigena* continues to grow (1 – 5 cm in diameter per year) in visceral organs of intermediate hosts like sheep, goats, and cattle and becomes infective when they reach to a diameter of 6 – 8 cm (Taylor et al., 2015,Corda *et al*., 2020). The existence of variants and intraspecific variability in the genetic structure of *T. hydatigena*, consistent with differences in biochemical and morphological characteristics have been described (Boufana *et al*., 2015,Corda *et al*., 2020) and suspected in the different rates of growth of *T. hydatigena* cysticerci (Corda *et al*., 2020). Compared to the acute form of *T. hydatigena* cysticercosis (*C. tenuicollis)*, the chronic form is much more common, usually asymptomatic, and detected during meat inspections in the slaughterhouse as large larval cysts (benign cysts) on the omentum, mesentery, peritoneum and, less frequently, in the pleura and pericardium (Singh *et al*., 2015, Taylor *et al*., 2015, Abdollahi *et al*., 2023). The acute form is a rare condition and usually results in death because of parasitic hepatitis, caused by the simultaneous migration of a large number of growing cysticercoids (Taylor *et al*., 2015). However, *T. hydatigena* cysticercosis (*C. tenuicollis)* can be life threatening for young animals as well as cause economic problems for farmers and the meat industries (Scala *et al*., 2015, Corda *et al*., 2020).

The proportion of infected animals with a single organ affected and animals harbouring ≥ 2 cysts was significantly higher compared to animals which had double and multiple (≥ 3) organs affected and harbouring ≥ 3 cysts. However, infected animals with multiple (≥ 2) organs affected and animals harbouring ≥ 4 cysts showed the highest ($p<0.05$) cystic fluid volumes than infected animals with single organs affected and animals harbouring ≤ 3 cysts. The finding is similar 1 – 2 cysts (Al-Hamzawi and Al-Mayali, 2020), 1 – 4 cysts (Al Bakri, 2012) and 1 – 3 cysts (Mohammed and Kadir, 2020) per affected organ in infected sheep, and 1 – 2 cysts (Al-Hamzawi and Al-Mayali, 2020), 4 – 6 cysts (Al Bakri, 2012) per affected organ in infected goats in parts of Iraq. Also, Ouchene-Khelifi et al., (2017) isolated 4 and 12 cysts from sheep and goats, respectively, in Algeria while Al-Hamzawi and Al-Mayali (2020) and Khaled et al., (2019) isolated up 34 and 13 cysts from an infected sheep in Iraq and Tunisia, respectively.

The study showed thin and transparent, white or milky bladder cysts of different diameter and sizes containing clear, yellow, cloudy, milky or straw colour jelly liquid which confirmed previous studies (Al-Hamzawi and Al-Mayali 2020, Dey et al., 2022, Felefl and Laban 2020, Handoo et al., 2021a, Handoo et al., 2021b). The sizes and diameters of the isolated cysts varied according to the type of organs affected and period of the infection in sheep and goats. Similar to the overall results, more medium-sized cysts followed by small and large-sized cysts in goats contrary to more small-sized cysts followed by medium and large-sized cysts in sheep were recorded. This finding agrees with Khaled et al., (2019) who reported an overall proportion of 70% small or medium-sized cysts in sheep (70.3%) and goats (63.2%). Previous studies have reported varying diameters of C. tenuicollis cysts isolated from small ruminants such as diameters of ≤ 3 cm (Payan-Carreira et al., 2008,Utuk and Piskin, 2012,Zhang et al., 2018,Felefl and Laban 2020, Khouloud et al., 2020, Muku et al., 2020) and diameters of > 3 cm (Payan-Carreira et al., 2008, Essa and Al-Azizzes, 2011, Singh et al., 2015,Jayousi et al., 2014,Ouchene-Khelifi and Ouchene, 2017,Ahmad et al., 2018,Dirwal et al., 2020,Felefl and Laban 2020, Muku et al., 2020, El-Beskawy et al., 2021). The type and nature of affected organ, larval stage of cysts and season of the infection were associated to the differences in diameter and size of C. tenuicollis cysts reported (Payan-Carreira et al., 2008, Essa and Al-Azizzes 2011,Al-Hamzawi and Al-Mayali 2020, Dey et al.,

2022). The larval stage of the cyst, physiological state of the animal and nature of the tissue structure of the site of attachment in the animal such as the omentum, peritoneal cavity, lung and bile sac (Singh et al., 2015, Taylor et al., 2015,Al-Hamzawi and Al-Mayali 2020, Abdollahi et al., 2023) where its growth and expansion is favored compared to liver and other organs can cause differences in the size of cysts isolated form infected animals (Al-Hamzawi and Al-Mayali 2020).

In the present study, the mean fluid volume per cyst was 11.70±12.89 ml corresponding to 14.06±15.87 ml per cyst for infected goats and 8.81±8.14 ml per cyst for infected sheep. While the mean fluid volume per animal was 28.08±37.39 ml corresponding to 33.19±38.66 ml for infected goats and 19.68±33.68 ml for infected sheep. More infected animals with cyst fluid volume ranging from 5 – 20 ml and > 20ml were observed compared to animals with cyst fluid volume of ≤ 5 ml. Though the finding agrees with Handoo et al., (2021a) who reported colourless cystic fluid volume ranging from 1.5 to 7.5 ml, the variation in the cyst fluid volume according to the examined intrinsic and extrinsic factors was due to differences between the diameter and sizes of the cysts isolated in the study.

Conclusion

It was concluded that the first report of morphological and morphobiometric characteristics of C. tenuicollis isolated from sheep and goats in the Northwest Region of Cameroon where the parasitic disease is endemic among small ruminants. The study showed thin and transparent, white or milky bladder cysts of different diameters and sizes containing clear to yellowish, milky or straw coloured jelly-like liquid with a single scolex and characteristic arrangements and morphometry of hooks in rostellum. The characteristic large and small hooks at ratio of 1:1 were alternately present in two rows. The cyst size, cyst fluid volume, and distribution of cyst on affected organs and in infected animals were influenced by intrinsic (species, sex, physiological status of female, age, BCS, and weight of animal) and extrinsic (location, season) factors in the study at different degrees. Further parasitological, haemato-biochemical, molecular and economic impact studies would be necessary to improve on the epidemiological knowledge and determine the magnitude of the disease for development of appropriate control measures to mitigate the burden of the disease for animal farmers and the meat industries in the study region in particular and Cameroon in general.

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