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Bovine cysticercosis: a retrospective survey in the mountainous Region of Santa Catarina State, Brazil

Cisticercose bovina: levantamento retrospectivo na Região Serrana de Santa Catarina, Brasil

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Abstract

Bovine cysticercosis disease is prevalent worldwide, and is diagnosed frequently in slaughterhouses. This disease has an impact on animal production and public health due to *Taenia saginata*. In order to investigate the occurrence of bovine cysticercosis in the mountainous region of Santa Catarina state, Brazil, we performed a retrospective survey of beef carcasses that were positive for the parasite. We tabulated and analyzed the records of cattle that were slaughtered from 2003 to 2013, under the state inspection in Lages, Santa Catarina. These records were provided by Companhia Integrada de Desenvolvimento Agrícola de Santa Catarina (CIDASC). The data were analyzed using Chi-square test ($P \leq 0.05$) to correlate the cysticerci occurrence with the independent variables. The animals were from the 18 municipalities that represent Associação dos Municípios da Região Serrana (AMURES). Among the animals that were slaughtered during the study period, 7.06% (1698/24055) were confirmed positive for cysticercosis during the visual inspection. Among the total cysts that were inspected, 25.79% and 74.20% were classified as viable and calcified, respectively. The most frequently parasitized organs were the head, with 876 cases (51.59%) positive for cysticerci (321 [36.64%] viable and 555 [63.36%] nonviable) and the heart with 641 cases (37.75%) positive for cysticerci (54 [8.42%] viable and 587 [91.58%] non-viable). In addition to the generalized infection (4.48%), the tongue and the diaphragm were the next most commonly parasitized organs, with 3.71% and 2.47% cases positive for cysticerci, respectively. There was no correlation ($P > 0.05$) between sex or age, and positive infection or cyst location. We identified statistical variations among the results for each of the evaluated years ($P < 0.01$). These reports indicated a significant increase in the infection rate over time, from 4.58% (2005) to 9.94% (2013). We analyzed the correlation ($P < 0.01$) between the occurrence of cysticercosis and the origin of the animals as well as between the viability of cysts and their location in the body. These results suggest that the occurrence of bovine cysticercosis in the mountainous region of Santa Catarina is high and at an alarming rate. Bovine cysticercosis can lead to an economic loss and can endanger public health. Therefore, government agencies need to plan and implement measures in order to control this disease.

Key words: Beef cattle. *Cysticercus bovis*. *Taenia saginata*. Occurrence. Santa Catarina.

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Resumo

A cisticercose bovina é uma doença de ampla distribuição geográfica, diagnosticada diariamente nos frigoríficos, e que causa impacto tanto na produção animal quanto na saúde pública, consequência do parasitismo por *Taenia saginata*. Com o objetivo de investigar a ocorrência da cisticercose bovina na região serrana do estado de Santa Catarina, Brasil, foi realizado um levantamento retrospectivo de ocorrência da cisticercose bovina, no período de 2003 a 2013, por meio da tabulação e análise dos registros da Companhia Integrada de Desenvolvimento Agrícola de Santa Catarina (CIDASC), de bovinos abatidos sob regime de inspeção estadual em Lages, SC. Os dados foram analisados através do Teste do Qui-Quadrado ($P \leq 0,05$), para correlacionar os resultados observados com as variáveis analisadas. Os animais foram provenientes dos 18 municípios que integram a Associação dos Municípios da Região Serrana (AMURES). Dos animais abatidos no período, 7,06% (1.698/24.055) apresentaram cisticercos, na inspeção visual. Do total de cistos 25,79% e 74,20% foram classificados como viáveis ou calcificados, respectivamente. Os órgãos mais frequentemente parasitados foram cabeça, com 876 positivos (51,59%) [dos quais 321 estavam viáveis (36,64%) e 555 inviáveis (63,36%)], e coração com 641 notificações (37,75%) [sendo 54 cisticercos viáveis (8,42%) e 587 inviáveis (91,58%)], seguidos de localização generalizada, língua e diafragma com 4,48%, 3,71% e 2,47%, respectivamente. Não foi observada correlação ($P > 0,05$) entre sexo ou idade com a positividade e a localização dos cistos. Diferença estatística foi observada entre anos avaliados ($P < 0,01$), tendo a ocorrência variado de 4,58% (2005) a 9,94% (2013), indicando um aumento dos registros ao longo do tempo. Foi verificada correlação ($P < 0,01$) entre a ocorrência de cisticercose e a procedência dos animais assim como entre a viabilidade dos cistos e sua localização. A ocorrência da cisticercose bovina na região serrana de Santa Catarina é alta e alarmante, que pode levar a perdas econômicas e colocar em risco a saúde da população, necessitando uma maior atenção do poder público e a tomada de medidas que visem seu controle.

Palavras-chave: Bovinos de corte. *Cysticercus bovis*. *Taenia saginata*. Ocorrência. Santa Catarina.

Introduction

Cysticercosis was reported for the first time in the 16th century. However, its pathogenesis was not understood until the mid-19th century, when it was shown that tapeworm larvae (cysticerci) were responsible for cysticercosis in animals and humans (MEDEIROS et al., 2008). There are three species that affect humans: *Taenia solium*, *T. saginata* and *T. asiatica* that occur as the larval forms *Cysticercus cellulosae*, *C. bovis* and *C. viscerotropic*, respectively (EOM; RIM, 1993).

Bovine cysticercosis is a parasitic infection caused by the immature forms (metacestodes) of *T. saginata*. Humans are the only definitive hosts and harbor the adult form of the parasite (*T. saginata*), whereas the metacestode (*C. bovis*) has low host specificity (SOUZA et al., 2007a) and parasitize cattle, buffaloes, sheep, goats, reindeer, and giraffes.

Macroscopically, the viable cysts show a cystic appearance and a translucent wall, whereas

the degenerated cysts show a calcareous cranial appearance with a diameter of approximately 0.5 cm, a whitish to yellowish color, and firm consistency (ALMEIDA et al., 2006).

This is the most frequently diagnosed parasite in slaughterhouses and is the main cause of rejection because of the deterioration of carcass traits for human consumption (BAVIA et al., 2012; RONDINELLI et al., 2011). Infected carcasses and/or organs with cysticercosis may be used for salting, canning, freezing or may be completely condemned depending on the severity of infection, which causes serious damage to the productive chain (PEREIRA et al., 2006).

The prevalence of cysticercosis in Brazil tends to be underestimated as it is based primarily on the records obtained from post-mortem inspection, which is a method considered to have low sensitivity especially for mild infections (BAVIA et al., 2012). Routine inspection detects only 27% of

the infected animals (WALTHER; KOSKE, 1980). Despite various limitations, activities such as careful inspection of meat in slaughterhouses, judicious post-mortem sampling, and proper disposal of parasitized carcasses are important measures to prevent human infection. Additionally, these precautions will provide an early warning about the onset of infection in a community (CORREA et al., 1997; MORAIS et al., 2011; SOUZA et al., 2007b).

Cysticercosis is a human and animal health problem which has negative repercussions on meat production (REZENDE et al., 2006) and on raising of cattle in several states of Brazil. This issue poses limitations on the opportunities for meat export owing to reduced confidence of customers and reduced value of meat products. Therefore, cysticercosis requires a special attention from the inspection services of Brazil (RONDINELLI et al., 2011).

The present study provides updated information on this important zoonosis as so far very little has been known about the distribution and occurrence of bovine cysticercosis in the mountainous region of Santa Catarina state, Brazil.

Materials and Methods

We performed a retrospective survey of bovine cysticercosis records over a period of 11 years (2003 to 2013). We achieved this by tabulating and analyzing the data from the State Inspection Service of CIDASC on cattle slaughtered under state inspection in a slaughterhouse located in the municipality of Lages, in the mountainous region of Santa Catarina state, Brazil. The slaughtered animals were from 18 municipalities that form a part of AMURES (Associação dos Municípios da Região Serrana).

The 18 municipalities that constitute the AMURES occupy an area of approximately 16085km², corresponding to 16.87% of the territory of Santa Catarina state (AMURES, 2014). This area

has 286291 inhabitants, corresponding to 4.63% of the population of Santa Catarina (IBGE, 2010).

The cattle herd in the municipalities of AMURES is estimated to be 631,400 animals that represent 14% of the total cattle in Santa Catarina state (IBGE, 2017). These animals are mostly distributed in small and medium family farms with an average of up to 20 animals (DAS, 2007), with the predominance of an extensive exploration system.

Among the total 24055 samples, 7211 (30%) and 16844 (70%) were from male and female cattle, respectively. The animals were grouped on the basis of age, according to the Guia de Trânsito Animal (GTA): below 24 months of age (n = 4659, 19.4%) and above 24 months of age (n = 19396, 80.6%). Additionally, infected animals were categorized according to the location of cysts (head, heart, tongue, and diaphragm) and animals with cysts in or more different sites were classified into a generalized infection category.

We analyzed the data (R DEVELOPMENT CORE TEAM, 2009) using Chi-Square Test ($P \leq 0.05$) in order to correlate the results with the independent variables (age, sex, origin, period, and location of the cysts).

The present study was approved by the Ethics Commission on the Use of Animals (CEUA) of the Universidade do Estado de Santa Catarina, under the protocol number 01.41.13.

Results and Discussion

In our study, the analysis of 24055 records of cattle that were slaughtered during the period from 2003 to 2013 led to the identification of 1698 infected animals, indicating an occurrence of 7.1% in the mountainous region of Santa Catarina state, Brazil (Table 1). This result was similar to the 7.14% reported by Carvalho and Machado (2011) in Campina Verde, state of Minas Gerais. However, it was higher than the infection rates in other locations: 4.6% in the region of Muzambinho, Minas Gerais

(RONDINELLI et al., 2011); 3.83% (SOUZA et al., 2007b), 4.1% (SOUZA et al., 2007a), and 5.50% (OLIVEIRA et al., 2013) in Paraná; 0.7% in Goiás (SILVEIRA NETO et al., 2011); and 1.95% in Rio de Janeiro (PEREIRA et al., 2006). Thus, bovine cysticercosis can be considered as an endemic parasitosis in the municipalities from AMURES, because the Pan American Health Organization

and the World Health Organization consider the rates higher than 5% to be endemic for animal cysticercosis (OPAS, 1994).

In our analysis, we observed that animals of both the sexes and of variable ages had the same risk of infection (Table 1) as there were no statistically significant variations ($P = 0.3941$ and $P = 0.4984$, respectively).

Table 1. Total number (N) of animals slaughtered and carrying cysticercosis in the municipality of Lages, Santa Catarina - Brazil, from 2003 to 2013; distributed by municipality, sex and age.

Categories	Animals					Positive						
	N	%	N	% ¹	% ²	cv	% ¹	% ²	cc	% ¹	% ²	
Lages	12731	52.9	884	6.9	52	242	1.9	55	642	5.0	51	
São José do Cerrito	1643	6.83	108	6.6	6.4	38	2.3	8.7	70	4.3	5.6	
Painel	778	3.23	67	8.6	3.9	11	1.4	2.5	56	7.2	4.4	
Ponte Alta	566	2.35	59	10	3.5	16	2.8	3.7	43	7.6	3.4	
Capão Alto	3208	13.3	220	6.9	13	51	1.6	12	169	5.3	13	
Correia Pinto	1704	7.08	138	8.1	8.1	33	1.9	7.5	105	6.2	8.3	
Bom Retiro	34	0.14	4	12	0.2	0	0	0	4	12.0	0.3	
Cerro Negro	330	1.37	17	5.2	1	3	0.9	0.7	14	4.2	1.1	
Palmeira	248	1.03	21	8.5	1.2	4	1.6	0.9	17	6.9	1.3	
Anita Garibaldi	167	0.69	15	9.0	0.9	2	1.2	0.5	13	7.8	1	
Urubici	13	0.05	1	7.7	0.1	1	7.7	0.2	0	0	0	
Campo Belo do Sul	1532	6.37	81	5.3	4.8	26	1.7	5.9	55	3.6	4.4	
Urupema	82	0.34	11	13	0.6	0	0	0	11	13.0	0.9	
Bocaina do Sul	238	0.99	11	4.6	0.6	2	0.8	0.5	9	3.8	0.7	
Bom Jardim Serra	114	0.47	11	9.7	0.6	3	2.6	0.7	8	7.0	0.6	
Otacílio Costa	351	1.46	31	8.8	1.8	4	1.1	0.9	27	7.7	2.1	
São Joaquim	306	1.27	16	5.2	0.9	2	0.7	0.5	14	4.6	1.1	
Rio Rufino	10	0.04	3	30.0	0.2	0	0	0	3	30.0	0.2	
Sex	Male	7211	30	493	6.8	29	133	1.8	30	360	5.0	29
	Female	16844	70	1205	7.2	71	305	1.8	70	900	5.3	71
Age	< 24 Months	4659	19.4	340	7.3	20	86	1.9	20	254	5.5	20
	> 24 Months	19396	80.6	1358	7.0	80	352	1.8	80	1006	5.2	80
Total		24055	100	1698	-	100	438	1.8	100	1260	-	100

cv = viable cysticercosis; cc = calcified cysticercosis; n = number of animals.

¹Proportion between number of positive animals per variable and number of animals within each category.

²Proportion between number of positive animals of each variable and overall total of that variable.

We found a statistical correlation between the presence of *C. bovis* and the origin of inspected animals ($P < 0.01$). In general, animals from municipalities with low municipal human development index (MHDI) averages, presented

high prevalence of cysticercosis (Table 2). The low socio-economic and cultural levels of the population and the precariousness of sanitary conditions contribute to the contamination of pastures which is responsible for the occurrence of cysticercosis in

cattle (BAVIA et al., 2012). Cysticercosis appears to be associated with small rural farmlands, where there may be close contact between humans and animals as well as a lack of basic sanitation and health education (SANTOS et al., 2010).

Table 2. Municipal Human Development Index (MHDI) versus average prevalence of cysticercosis in cattle slaughtered under state inspection in the municipality of Lages, SC, from 2003 to 2013.

Municipalities	MHDI ¹			Average	Average prevalence of cysticercosis (%)
	1991	2000	2010		
Lages	0.551	0.674	0.77		
São Joaquim	0.491	0.589	0.687		
Otacílio Costa	0.51	0.635	0.74		
Correia Pinto	0.475	0.587	0.702		
Urubici	0.483	0.592	0.694	0.573	7.71
Bom Retiro	0.45	0.56	0.699		
São José do Cerrito	0.355	0.502	0.636		
Anita Garibaldi	0.396	0.544	0.688		
Campo Belo do Sul	0.344	0.488	0.641		
Ponte Alta	0.418	0.52	0.673		
Bom Jardim da Serra	0.395	0.553	0.696		
Bocaina do Sul	0.388	0.505	0.647		
Cerro Negro	0.325	0.475	0.621		
Capão Alto	0.321	0.506	0.654	0.524	10.79
Palmeira	0.361	0.544	0.671		
Urupema	0.462	0.578	0.699		
Rio Rufino	0.333	0.544	0.653		
Painel	0.425	0.528	0.664		

¹Source: Brazilian Institute of Geography and Statistics (IBGE).

Among the 1698 infected animals, 438 (25.80%) and 1260 (74.20%) showed viable and calcified cysts, respectively. Statistical correlation was not observed between the viability of cysts and the age ($P = 0.8675$) or the sex ($P = 0.5148$) of the animals. The occurrence of viable and calcified cysts was observed in several animals and may be related to variable longevity of *C. bovis* in various tissues of the animal (PAWLOWSKI; SCHULTZ, 1972). Alternatively, the infections may have been acquired at different instances, or have had different rates of progression.

Regarding the location of the cysts, 876 (51.6%)

animals had parasites in the head, 641 (37.8%) in the heart, 63 (3.7%) in the tongue, 42 (2.5%) in the diaphragm, and 76 (4.5%) in two or more sites of the body (referred to as generalized infection). There were no statistical variations between the cyst location in the body and the sex ($P = 0.2828$) or the age ($P = 0.223$) of the cattle. However, there was a strong statistical correlation between the viability of cysts and the cyst location ($P < 0.01$), with a high percentage of viable cysts in the head (73.3%) and calcified cysts in the heart (46.6%) (Table 3). Additionally, Rondinelli et al. (2011) observed a statistical variation ($P < 0.05$) between the location

of viable and calcified cysticerci, as viable cysts were more frequently found in the heart and head, followed by the tongue and diaphragm. We observed statistical variations ($P < 0.01$) among the years that were analyzed, as the highest incidence of infection was recorded in the years 2012 and 2013 (Table 4). Several factors that may have contributed to this variation are: (i) animals with different

rates of infection from multiple regions of origin, (ii) modifications in the post-mortem examination technique that was employed for the inspection, (iii) the number of cysticerci present in the carcass, and more specifically, (iv) the ability, criterion, and motivation of the inspectors (COSTA et al., 2012; SOUZA et al., 2007a).

Table 3. Distribution of cysts (total, viable and calcified) of *Tania saginata*, according to their anatomical location, in cattle slaughtered under state inspection in the municipality of Lages, SC, from 2003 to 2013.

Anatomic location	Cysts (total, viable and inviable)							
	N	%	cv (N)	% ¹	% ²	cc (N)	% ¹	% ³
Head	876	51.6	321	36.6	73.3	555	63.4	44
Heart	641	37.8	54	8.42	12.3	587	91.6	46.6
Tongue	63	3.71	13	20.6	2.97	50	79.4	3.97
Diaphragm	42	2.47	3	7.14	0.69	39	92.9	3.1
Generalized	76	4.48	47	61.8	10.7	29	38.2	2.3
Total	1698	100	438	25.8	100	1260	74.2	100

cv = viable cysticercosis; cc = calcified cysticercosis; N = number of animals.

¹Relation between viable or calcified cysts and the total number of cysts in each location.

²Relation between viable cysts in a given location and the total of viable cysts.

³Relation between calcified cysts in a given location and the total of calcified cysts.

Table 4. Annual occurrence (%) of cysticercosis in cattle slaughtered under state inspection in the municipality of Lages, SC, from 2003 to 2013.

Year	Total slaughtered animals	Positives					
		N	%	cv	%	cc	%
2003	817	58	7.1	16	27.6	42	72.4
2004	1574	75	4.8	17	22.7	58	77.3
2005	1265	58	4.6	14	24.1	44	75.9
2006	2069	159	7.7	41	25.8	118	74.2
2007	4304	320	7.4	70	21.9	250	78.1
2008	3737	243	6.5	68	28	175	72
2009	2223	164	7.4	37	22.6	127	77.4
2010	2364	158	6.7	37	23.4	121	76.6
2011	1964	111	5.7	33	29.7	78	70.3
2012	1907	170	8.9	49	28.8	121	71.2
2013	1831	182	9.9	56	30.8	126	69.2
Total	24055	1698	7.1	438	25.8	1260	74.2

cv = viable cysticercosis; cc = calcified cysticercosis; n = number of animals.

Bovine cysticercosis is responsible for a loss of approximately USD 164 million per year in Latin America (SCHANTZ et al., 1994) and an estimated loss of up to 30% in the price of slaughtered animals with viable cysts (GUIRRA, 2002). Thus, if we consider the 438 animals with viable cysts (Table 1), the mean fat ox weight of 67.5 kg (15 arrobas) (BEEFPOINT, 2009), and the carcass price of USD 2.64 kg⁻¹ (BEEFPOINT, 2017; BCB, 2017), the economic depreciation can be estimated as USD 78051.60. These data demonstrate the economic importance of the necessity to control cysticercosis disease.

Conclusion

The occurrence of cysticercosis in the cattle present in the mountainous region of Santa Catarina Brazil was high (7.1%) between the years 2003 and 2013, which resulted in economic loss and endangerment of public health. In conclusion, government agencies should exhibit more focused commitment in order to control this disease.

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