Cysticercus bovis in cattle in two beef feedlots in southern Ontario

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Bovine cysticercosis is caused by the larval stage of *Taenia saginata*. Humans may be infected by eating raw or undercooked beef containing larval cysts. They, in turn, may provide the supply of eggs to cattle in feces deposited in areas accessible to cattle. In Canada, bovine cysticercosis is a reportable disease under the Health of Animals Act and Regulations (1) due to its public health implications.

The larval stage of *T. saginata* in the muscles of cattle may be fully developed within 2 to 3 mo postinfection (2) and remain viable for 3 to 30 mo (3,4). Degeneration and mineralization may occur within 1 to 8 mo (2–4). Previous investigative reports have identified possible sources of infection as application of sewage sludge to fields, flooding with leakage of raw sewage onto fields, arrival on the farm of previously infected cattle, and fecal contamination of feed and/or water by farm employees (5).

Lesions of cysticercosis were initially discovered in December 1992 (farm A) and on 3 occasions during October 1992 (farm B) on routine postmortems by inspectors of Agriculture and Agri-Food Canada. They were confirmed at the Animal Diseases Research Institute in Nepean, Ontario, to contain larvae of *Cysticercus bovis.*

Animals at these farms were quarantined, according to requirements of Agriculture and Agri-Food Canada (6), and shipped under license to slaughter. The attack rate for farm A was 13.13% and for farm B, 4.34% (Table 1).

Owners of the farms were interviewed to determine feed sources, feeding practices, water sources, numbers and sources of employees, sewage and septic disposal and potential for leakage, availability of toilet facilities on the farm, and the origins of the animals. Locations of feed storages, water sources, barns, pens, residences, septic systems, and proximity to municipal sewage disposal sites were also determined.

On farm A, all work with the cattle was done by the farm owner and his son. Some cattle arrived at the farm with brands or flapper ear tags, which were not removed. This permitted limited tracking of origins of animals and length of time on the farm. The cattle were purchased from multiple sources in Manitoba, Saskatchewan, and Ontario.

The water source on this farm was the local municipal supply. Feed used was home-grown corn, roasted peanut skins, sugar residue from a processing plant, wet seed corn, soybean screenings, hay, haylage, corn silage, and seed corn "shucklage". Shucklage is the stalks, leaves, and empty cobs remaining after the seed corn is harvested. The ensiled feeds were stored in four silos located near the barn.

Toilet facilities were located within the house, a short distance from the barn, and cattle had no access to the septic tile bed. The owner reported no flooding or drainage problems, despite heavy rainfall in the area during the summer and autumn of 1992.

None of a group of 64 branded cattle was found to have lesions of *C. bovis* upon slaughter. These were the smallest and youngest cattle on the premises and were added to the farm during November 1992. These cattle were not exposed to haylage from one of the four silos on the farm, but had received all of the other feedstuffs fed to the other cattle.

In a follow-up interview, the farm owner recalled that 3 workmen had been inside the silo containing haylage repairing an unloader in September 1992. None of the 3 exited the silo to use the toilet facilities, although the repair work involved a full day. Immediately after repairs had been completed, the owner unloaded haylage from this silo into a second empty silo. As this haylage was being unloaded, a portion was also fed directly to the cattle. The length of time from feeding the haylage contacted by the workmen to the discovery of the index lesions in carcasses at slaughter was 80 to 86 d. Although one voluntary test was negative for *T. saginata*, repeated fecal analyses on the 3 repair workers were unobtainable.

Farm B is both a market garden and feedlot cattle operation. Cattle were continually moved into, through, and out of the feedlot portion. Stocker cattle entering were initially fed by-products from the food-processing industry and hay for 7 to 14 d. Cattle were not uniquely identified upon entry to the feedlot. Two-thirds of the animals were purchased from various sources in eastern Ontario and the remainder from several sources in western Canada.

Drilled wells were the primary source of water. Untreated water from Lake Erie was piped directly to the farm from a branch of the municipal supply and was used to water cattle in one yard. Cattle were fed pasture, hay, silage, haylage, corn shucklage, home-grown grain as concentrate, and vegetable by-products from various local vegetable processors. Feed was stored in horizontal silo-type feed bunkers near the barns on the home premises and transported from there to the other premises where the cattle were fed.

There were 14 full-time employees, who worked primarily with the cattle, and 38 to 44 seasonal workers, who worked primarily in the vegetable fields. Three toilet facilities were available on the home premises. Limited additional portable self-contained toilet facilities were available in the fields for field workers. One of

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Table 1. ***Cysticercus bovis*** **— Cattle affected by lesions of cysticercosis at slaughter from farms A and B**

Farm A			Farm B		
Shipment number	Number in lot	Percentage affected	Shipment number	Number in lot	Percentage affected
1[a]	45	24.4	1[a]	45	8.9
2	46	8.7	2[a]	89	7.9
3	45	17.8	3[a]	45	4.4
4	43	25.6	4	136	9.6
5	45	8.9	5	184	8.7
6	45	6.7	6	136	4.4
7	45	11.1	7	90	10.0
8	44	2.3	8	135	3.7
Total	358	13.1	9	145	4.1
			10	136	2.9
			11	88	4.6
			12	90	1.1
			13	90	1.1
			14	90	0
			15	90	0
			16	70	0
			17	64	0
			18	74	0
			Total	1797	4.3

[a] Indicates shipments containing index cases

these was located in a 100-acre field of tomatoes located contiguously with the bunkers at the home premises. Cattle were not exposed to septic tile beds.

Four off-farm sources of vegetable by-products were identified. Vegetable processor 1 supplied bean, pea, celery, pepper, apple pomace, squash, cauliflower, and onion. This processor was viewed in operation during August 1993. All aspects of the process where vegetable waste was generated were observed. Three to four workers trimmed vegetables upon receipt at the loading dock. At the tables, vegetable waste was collected in small bins with an upper rim located approximately 60 cm above floor level. These bins were then emptied into larger shipping containers. Some vegetable waste went directly into these large containers from other areas of the plant. Toilet facilities were located some distance from the loading dock.

Vegetable waste from vegetable processor 1 was delivered to 2 other farms by the transporter used by farm B. One of these farms used the waste as fertilizer and the other spread it on pasture for cattle (cow/calf operation) to access free choice. No infection was reported from this farm.

Vegetable processor 2 supplied sweet corn canning waste and carrot waste. All vegetable waste generated by vegetable processor 2 was transported directly onto trucks by a system of conveyor belts. The use of these belts appeared to preclude contamination by virtue of their height above the floor and continual movement.

Vegetable processor 3 supplied carrot waste. Further investigation was not possible as this company had permanently ceased operation after the 1992 summer season.

Vegetable processor 4 supplied cucumbers, which were washed upon entry to the plant, inspected, and graded. Oversized cucumbers were separated out and picked up daily by employees of farm B. Contamination of this product appeared to be unlikely due to its texture and method of collection.

Fecal samples were not obtainable from employees of the farms and processing plants, because human infections of *T. saginata* are not reportable in the province of Ontario.

It appears that the concurrent infection at the 2 farms was coincidental. Cattle on both farms were purchased from several sources, none of which they shared. Neither farm spread sludge or sewage on fields. The only feed common to both was the seed corn shucklage, which does not appear to be a plausible source. Human contact for this feed source was limited to work crews who had detassled the corn during the summer of 1992. Harvesting of the seed corn in October was by a mechanical combine harvester. Previous reports indicate that eggs survive longer in winter than in summer (7). It would appear that the 6 to 8 wk period between tassling and harvesting of the seed would preclude survival of eggs on the corn plants during the summer months. Contamination of the water sources was unlikely.

The source of infection for farm A was probably the 3 repair workers who serviced the silo unloader. It is possible that the augers and other equipment used to unload the haylage distributed the ova sufficiently to infect a high percentage of the animals. Suspected human carriers should be tested by fecal examination of at least 3 anal swabs (8), and using serological tests (9).

On farm B, the cattle may have received repeated doses of *T. saginata* eggs. The level of infection initially seen indicates that the eggs were probably received directly by the cattle in a feed source. Reports indicate that *T. saginata* eggs survive longer in winter than in summer (7). If these cattle were exposed between May and August 1992, the human feces to which the cattle were exposed were likely relatively fresh. It is possible that the higher than average rainfall experienced during the period might have enhanced survival of ova by increasing humidity. Two possible sources of infection were identified: contamination of the feed contained in the feed bunkers, or direct contamination of the vegetable waste at vegetable processor 1. At some periods during the day, the feed bunker area is very quiet and accessible to employees working in the barns or neighboring fields. It is possible that the cubicle-like areas created in the feed by front-end loaders would be tempting sites to use as toilet facilities.

Transmission of cysticercosis by field (harvest) contamination of vegetables received by vegetable processor 1 seems unlikely, because, due to the volume of vegetable processed and the large numbers of suppliers of each commodity, it might reasonably be expected that the infection rate would have been lower.

Contamination of the vegetable waste received from vegetable processor 1 could have occurred prior to its leaving the processing plant. The small bins located on the loading dock were at an accessible height for the deposit of human feces. If this were the route of infection, it might be reasonable to have expected other premises to have experienced cysticercosis as well. The two other farms receiving waste from vegetable processor 1 via the same carrier as farm B did not feed this product directly to their cattle and could not be used to confirm vegetable processor 1 as a source.

Identification of an individual carrying the parasite was not possible on either farm. The situation described on farm A indicates that a person visiting the farm on a single day might have had profound effects on the safety of the meat produced. The possibility of the contamination arriving on farm B via the by-product of vegetable processing raises concerns in light of recent interest in recycling food wastes into animal feeds in order to reduce wastes entering landfill sites.

There is increased pressure from environmental groups and government organizations to find ways to reuse some of these food products as animal feeds. Some producers are interested in using this material as an inexpensive alternate source of feed. In Canada, swine and poultry producers who wish to feed food wastes must obtain a license from Agriculture and Agri-Food Canada, and they must thoroughly cook the food wastes before allowing animals to have access to them. This requirement does not apply to other classes of livestock. Studies are needed to determine handling and processing needs to render such materials safe for consumption by livestock to ensure the safety of the food products derived from them. Education of producers and vegetable processors is also important.

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