

SIGNIFICANCE OF MEAT INSPECTION IN THE ESTIMATION OF ECONOMIC LOSS DUE TO BOVINE CYSTICERCOSIS

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ABSTRACT

The records of meat inspection carried out for 24 consecutive days at the Awka main abattoir in Anambra State, south-eastern Nigeria, was used to estimate the direct economic loss in carcass condemnation due to bovine cysticercosis. Among the 614 cattle slaughtered, 306 (49.8 %) were examined, out of which cysticerci were detected in 61.1 %, 61.1 %, 46.2 %, 45.2 % and 50.7 % of the Masseter, Tongue, Inter-costal, Diaphragmatic and Pectoral muscles from 221 (72.2 %) of infected cattle. This amounted to an estimated loss of ₦186892.38 in terms of condemnation of cysticerci-infected carcasses. Condemnation due to generalized infection of the specified organs amounted to ₦109467.50 (58.6 %), while moderately and locally infected organs contributed ₦28435.08 (15.2 %) and ₦48989.8 (26.2 %) to the total loss, respectively. This loss was equivalent to 4 heads of cattle in 24 days at ₦50000 per head, which translated to an annual loss of ₦12842321.61 or 57 heads of cattle at the Awka main abattoir alone. Since 10000 to 20000 trucks of beef-cattle are reported to be daily transported to abattoirs in different parts of Nigeria, the direct economic loss of revenue in the beef industry on account of cysticercosis would run into billions of naira. This result will promote evidence-based decision on the control of cysticercosis in the country and elsewhere.

Keywords: Meat inspection, Cysticercosis, Carcass condemnation, Economic loss, Management

INTRODUCTION

The usefulness of cattle is well known, as they provide the largest quantity of meat and milk, which are essential sources of animal protein. The bones, used in the form of bone meal, are source of calcium. Other by-products such as hides and skin are used in making leather bags, shoes, clothes, mats (Skjerve *et al.*, 1999; Ikpeze, 2004). In Nigeria, cattle rearing is largely transhumance; a situation in which farmers with permanent place of residence send their herds, tended by herdsmen, for long-periods of time to distant grazing areas (Ikpeze, 2004). During grazing, the cattle are constantly on the move, and are frequently exposed to eggs of beef tapeworm, *Taenia saginata*, passed in human excreta onto pasture (Nansen and Henniksen, 1998). After being ingested by cattle, the eggs of *Taenia saginata* hatch in the intestine and release the hexacanth embryos which penetrate the intestinal mucosa and reach the lymphatic and mesenteric veins from which they enter the blood circulation (Bathrick *et al.*, 2002). The embryos are disseminated throughout the body and the cysticerci develop in skeletal and cardiac muscles of cattle. Usually, the cysts are spread throughout the musculature because of the supply of arterial blood to the muscles, hence the name *Cysticercus bovis* (Saunders, 1996).

Cysticercus bovis is commonly called the bladder worm. The cysticerci give the meat a white spotted, glossy appearance when they occur in large numbers (Nansen and Henniksen, 1998). Each cyst produces only one adult tapeworm, *Taenia saginata*, when ingested by humans. Humans become infected

by eating raw or inadequately cooked beef contaminated with the bladder worm (Murray, 2000). The bladder worm is digested in the stomach and attaches to the intestinal lining and grows to maturity in 2-3months (Slonka *et al.*, 1994). The beef tapeworm forms a chain of 1000-2000 segments or proglottids which absorbs the available food nutrients of the host. The egg-bearing segments at the end of the chain break off and crawl from the anus or pass in the stool. One infected person can pass about 750,000 eggs each day in the feces as individual eggs, or as intact segments, each containing thousands of eggs (Pawlowski and Schultz, 1972). Indiscriminate defecation by infected humans could therefore contaminate grazing pasture, and when ingested by cattle results in bovine cysticercosis.

Bovine cysticercosis can only be detected during post-mortem examination of carcasses and remains one of the major causes of meat condemnation at the abattoir. The cysts can be seen with the naked eye, 2-4 weeks after infection, as nodules in the striated muscles, particularly of the chest, masseter, tongue, diaphragm and pectoral regions of cattle (Belino, 1997). Many prevalence studies have been reported on bovine cysticercosis in Nigeria (Babalola, 1976; Osiyemi, 1978; Onah and Chiejina, 1986; Okafor, 1988; Okolo, 1996; Fabiyi, 1997; Belino, 1997; Dada and Uzman, 1999; Coker *et al.*, 2000; Ohaegbulu *et al.*, 2004) but no official figures were quoted in terms of direct economic loss arising from meat condemnation. Daily, in Nigeria, 10,000 to 20,000 trucks of cattle are transported down to the abattoirs round the country where they are killed (Dada and Uzman, 1999), is therefore

incumbent on veterinary personnel to carry out official routine inspection of carcasses of slaughtered cattle to detect and destroy meat not fit for human consumption due to *Cysticercus bovis* infection. The major aim of this study was to carry out routine post-mortem meat-inspection on cattle slaughtered at Awka main abattoir in Anambra State, south-eastern Nigeria to estimate the direct economic loss arising from carcass condemnation due to bovine cysticercosis. The result will throw much light on the importance of bovine cysticercosis and promote evidence-based decision making policy on the need for control of cysticercosis in the country and elsewhere.

MATERIALS AND METHODS

Study Area: The study was carried out at the Awka Abattoir, Awka South Local Government Area, Anambra State, Nigeria. The post-mortem meat inspection was undertaken for 24 consecutive days between February and March 2008. About 50 – 60 animals were slaughtered daily among which 20 – 30 were cattle. Time scheduled for slaughtering of animals was between 6.30 am and 7.45 am, during which time dressing of the carcasses simultaneously went on. By 8.45 am, meat was already being sold by the butchers to customers.

Post-mortem Meat Inspection: The procedure for the post-mortem meat inspection of beef carcasses required several deep incisions into suspected organs. The surfaces and substances of the tongue were examined visually. Then a longitudinal incision was made in the under surface and closely examined for cysts. Each masseter muscle was incised, making two cuts parallel to the jaw bone from the lower border of the jaw, to the higher muscular insertion, and the parts closely examined for cysts. The surface of the heart was examined visually for inflammation or any sign of infection. A longitudinal incision was made extending from the base to apex, so as to open both atria and ventricles. The cut surfaces and inner surfaces of the ventricle were examined for cysticerci. The peritoneum of the diaphragm and its pillars were examined visually and about 2 longitudinal incisions made on the pillars. The intercostals and pectoral muscles were also thoroughly examined for cysticerci. The cysts can be seen with the naked eye as nodules in the striated muscles, particularly of the chest, masseter, tongue, diaphragm and pectoral regions of cattle when present. When present, the organ is condemned depending on the extent of distribution of cysticerci in the organ. But if no cysticercus was detected, the meat was certified 'fit for human consumption' at the time of inspection.

RESULTS

Of the 614 cattle slaughtered in Awka main abattoir during the study period, 306 (49.8 %) were inspected for bovine cysticercosis and the muscles from 221 (72.2 %) of these were infected with *Cysticercus bovis* (Table 1).

Table 1: Cattle examined in 24 consecutive days for bovine cysticercosis at Awka main abattoir

Cattle	No.	%
<i>Cattle slaughtered</i>	614	100
<i>Cattle inspected</i>	306	49.8 ^a
<i>Cattle infected with Cysticercus bovis</i>	221	72.2 ^b

Key: a = % of cattle slaughtered; b = % of cattle inspected

About 135 (61.1 %) of the massetter muscles, 135 (61.1 %) of the tongues, 102 (46.2 %) of the inter-costal muscle, 100 (45.2 %) of the diaphragmatic muscles and 112 (50.7 %) of the pectoral muscles were infected to various degrees (Table 2).

Table 2: Muscles of 221 cattle infected with *Cysticercus bovis* at Awka main abattoir

Muscles	No.	%
<i>Massetter muscles</i>	135	61.1
<i>Tongue</i>	135	61.1
<i>Inter-costal muscles</i>	102	46.2
<i>Diaphragm</i>	100	45.2
<i>Pectoral muscles</i>	112	50.7

The intensity of infection is shown in Table 3. There was generalized distribution of cysticerci in 10 (7.4 %), 4 (3 %), 4 (3.9 %), 4 (4 %) and 15 (13.4 %) of the massetter, tongue, inter-costal and pectoral muscles respectively. These extensively infected organs were totally condemned. Cysticerci was moderately distributed in 25 (18.5 %), 19 (14.1 %), 14 (13.7 %), 12 (12 %) and 21 (18.7 %) of the massetter, tongue, inter-costal and pectoral muscles respectively. About 15 % of these moderately affected organs were also condemned. Localized distribution of cysticerci was however observed in 100 (74.1 %), 112 (82.9 %), 84 (82.47 %), 84 (84 %) and 76 (67.9 %) of the infected massetter, tongue, inter-costal and pectoral muscles. About 5 % of these locally affected organs were condemned. All affected parts were excised from the healthy portions, condemned and promptly destroyed by pouring petrol on them and burnt to ashes in the presence of the officer in-charge of Veterinary Public Health at Awka main abattoir. Table 4 shows the estimated direct loss of arising from meat condemnation due to *C. bovis* infection in cattle inspected at Awka main abattoir. Total estimated loss of revenue from meat condemnation due to cysticercosis was ₦186892.38. Condemnation due to generalized cysticerci infection in affected organs accounted ₦109467.50 (58.6 %) of the loss, while condemnation of moderately and locally infected organs contributed ₦28435.08 (15.2 %) and ₦48989.8 (26.2 %) to the total loss, respectively.

DISCUSSION

From our result, it was observed that about 50 % of the cattle slaughtered were inspected, perhaps due to shortage of manpower. Adequate number of trained veterinary personnel is needed to accomplish this task of meat inspection in the country.

Table 3: Intensity of cysticerci in muscles from 221 cattle infected at Awka main abattoir

Muscles	Muscles Infected with cysticerci		Distribution of cysticerci in infected organs					
	No.	%	Generalized No.	Generalized %	Moderate No.	Moderate %	Localized No.	Localized %
Masseter muscles	135	61.1	10	7.4	25	18.5	100	74.1
Tongue muscle	135	61.1	4	3.0	19	14.1	112	82.9
Inter-costal muscles	102	46.2	4	3.9	14	13.7	84	82.4
Diaphragmatic muscles	100	45.2	4	4.0	12	12.0	84	84.0
Pectoral muscles	112	50.7	15	13.4	21	18.7	76	67.9

Generalized distribution: Cysticerci distributed in $\geq 21\%$ of the affected muscle, warranting total condemnation of organ

Moderate distribution: Cysticerci distributed in $> 5\% \leq 20\%$ of the affected muscle. About 15% of the muscle condemned

Local distribution: Cysticerci in $\leq 5\%$ of the affected muscle: About 5% of the muscle condemned

Table 4: Estimation of economic loss due to bovine cysticercosis at Awka main abattoir

Parameters	Masseter	Tongue	Inter-costal	Diaphragm	Pectoral muscle	Total loss (₦)
Generalized Infection						109467.50
Approx. Wt. of specific organ	0.7kg	0.88kg	4.53kg	2.27kg	3.17kg	
No. of organs affected	10	4	4	4	15	
Approx. Wt. of organ affected	7kg	3.52kg	18.10kg	9.08kg	47.55kg	
100% of organ condemned	7kg	3.52kg	18.10kg	9.08kg	47.55kg	
Value of organ per kg (₦)	300	1200	750	700	1750	
Value of organ condemned (₦)	2100	4224	13575	6356	83212.5	
Moderate Infection						28435.8
Approx. Wt. of specific organ	0.7kg	0.88kg	4.53kg	2.27kg	3.17kg	
No. of organs affected	25	19	14	12	21	
Approx. Wt. of organ affected	17.5kg	16.72kg	63.42kg	27.24kg	66.57kg	
15% of organ condemned	2.63kg	2.51kg	9.51kg	4.09kg	9.99kg	
Value of organ per kg (₦)	300	1200	750	700	1750	
Value of organ condemned (₦)	787.5	3009.6	7134.75	28.60	17474.63	
Localized Infection						48989.8
Approx. Wt. of specific organ	0.7kg	0.88kg	4.53kg	2.27kg	3.17kg	
No. of organs affected	100	112	84	84	76	
Approx. Wt. of organ affected	70kg	98.56	380.52	190.67kg	240.92kg	
5% of organ condemned	3.5kg	4.93	19.03	9.53	12.05	
Value of organ per kg (₦)	300	1200	750	700	1750	
Value of organ condemned (₦)	1050	5916	14269.5	6673.8	21080.5	
Total loss due to Cysticercosis	3937.5	13149.6	34979.3	13058.4	121767.6	186892.4*

*Loss of ₦186892.38 = 4 cattle per 24 days @ ₦50000.00 per cattle = annual loss of ₦2842321.61 or 57 cattle

However, about 72.2 % of the cattle inspected were positive for *C. bovis*, indicating that bovine cysticercosis is endemic in Nigeria, since these cattle were derived from the Northern states of the country. The predilection sites to watch out for cysticerci during meat inspection, as observed in this study, are the massetter muscles, tongue, pectoral muscles, inter-coastal muscles and diaphragm. From our result we found cysticerci in 61.1 %, 61.1 %, 46.2 %, 45.2 %, and 50.7 % of the massetter, tongue, intercostals, diaphragm and pectoral muscles from the affected cattle; accounting for losses of about ₦3937.5, ₦13149.6, ₦34979.25, ₦13058.4 and ₦121767.63 respectively. This in line with the report that the localization of cysts in Nigerian cattle was in the tongue (73 %), inter-costal muscle (63 %) and massetter (63 %) (Belino, 1997).

It was estimated that about £45.0Million was lost annually as a result of the effect of cysticercosis on cattle productivity in the United Kingdom (Nelson *et al.*, 1996). Such estimates in Africa would be higher due to poor nutrition which substantially enhances the pathogenic effects of the parasite as cysts can survive in cattle anywhere from weeks to years thereby presenting economic problems to the beef industry (Fabiyi, 1997).

In Kenya, cysticercosis alone leads to losses estimated at £7 million annually through a combination of poor productivity, death of stock, condemnation of infected organs and reduction in carcass quality (Harrison, 1986), while cysticercosis impacted heavily on Botswana's livestock economy which is more dependent on meat exports (Grindle, 1978). In 24 days, we were able to estimate losses amounting to ₦186892.38 from 221 infected cattle in one abattoir alone. This would translate to a loss of billions of naira in Nigeria's beef industry, where 10000 to 20000 trucks of cattle are daily transported down to the abattoirs around the country for slaughter (Dada and Uzman, 1999).

Since outbreaks of cysticercosis were often associated with human fecal waste or use of sewage fertilizer on pasture; a potential source of viable tapeworm eggs to grazing cattle (Sinnecker, (1995), the measures that would prevent infection include maintenance of a high standard of sanitation which can be achieved by proper disposal and treatment of sewage, in order to prevent contamination of pasture. Provision of toilet facilities in rural areas, and at reasonable intervals along grazing routes to discourage nomads from defecating on pasture.

Periodic de-worming of herds will reduce infection in cattle and keep them protected from other parasitic diseases. To prevent human infection, proper meat inspection should be carried out by using modern meat inspection facilities to ensure that only wholesome meat passed for sale. Infected carcasses must be condemned or facilities provided to treat infected meat by boiling or freezing, to destroy the cysticerci. It is necessary that commensurate compensation be paid to livestock owners whose infected carcasses are destroyed, so as to encourage them to cooperate with meat inspection officials at the abattoir. Records from meat inspection could therefore be used effectively to estimate the direct economic effect of bovine cysticercosis as demonstrated by this study.

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