Preventive Veterinary Medicine 97 (2010) 77–82

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

A slaughterhouse survey of lung lesions in slaughtered stocks at Arusha, Tanzania

L.S.B. Mellau, H.E. Nonga*, E.D. Karimuribo

Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture, P.O. Box 3021, Chuo Kikuu, Morogoro, Tanzania

ARTICLE INFO

Article history:
Received 22 March 2010
Received in revised form 28 August 2010
Accepted 30 August 2010

Keywords:
Lung diseases
Abattoir records
Condemnation
Cattle
Sheep
Goats

ABSTRACT

An abattoir survey was conducted on clinically healthy 115,186 cattle, 61,551 sheep and 37,850 goats slaughtered in Arusha municipality, Tanzania, between 2005 and 2007. The objective was to determine the prevalence of disease conditions affecting the lungs. Routine meat inspection procedures were used to detect the presence of the pathological lesions. A total of 15,245 (13.2%), 4668 (7.8%) and 3192 (8.4%) lungs of cattle, sheep and goat, respectively, were condemned due to nine diseases/conditions namely pneumonia, hydatidosis, emphysema, abscesses, anthracosis, pleurisy, calcified cysts, melanosis and bovine pulmonary tuberculosis. Pneumonia was the leading cause of condemnations as it was responsible for 4594 (30.1%), 1495 (31.4%) and 1072 (33.6%) of all the condemned lungs in cattle, sheep and goats, respectively. Anthracosis, pleurisy, melanosis and pulmonary tuberculosis were only recorded in cattle attributing to 7.3%, 6.4%, 2.9%, and 0.7% of lung condemnations, respectively. The percentages of lung conditions recorded in 2005, 2006 and 2007 were not statistically different ($P > 0.05$) among cattle, sheep and goats. The different lung lesion percentages recorded in cattle were significantly higher ($P < 0.05$) compared to sheep and goats. There were no significant ($P > 0.05$) variations between lung condemnation percentages due to various diseases during the rainy and dry seasons. Because of their zoonotic nature, occurrence of hydatidosis and tuberculosis may pose a public health risk. The study showed that different lung diseases/lesions in domestic ruminants are prevalent in Tanzania. Thus, there is a need to introduce appropriate control measures of diseases affecting lungs to minimize the rate of infection and reduce the ensuing economic losses. The data obtained from this survey cannot be wholly relied upon as accurate, but it can be used as a baseline for more extensive epidemiological investigations.

1. Introduction

Tanzania has a large number of livestock due to the agro-ecological zones that make the country suitable for animal production. The country has approximately 50% of cattle, 29% of sheep, 40% of goats and 24% of chicken population of East Africa (FAO, 2003). The livestock population constitutes 17.7, 12.5 and 3.5 million cattle, goats, and sheep, respectively. Livestock plays an important role in the national economy and food security in Tanzania. Livestock contributes 18% of the total GDP, with cattle providing more than 70% of the meat consumed in Tanzania (MAFS, 2002). Like in many other developing countries, livestock production in Tanzania largely depends on the traditional sector which constitutes more than 98% of the total livestock population (MAFS, 2002). However, the traditional livestock keeping faces several challenges which include poor animal genetic makeup, poor management and diseases (Njombe and Msanga, 2009). High prevalence of animal diseases affects health and productivity of livestock population. As a result of devastating outcome

* Corresponding author. Tel.: +255 23 2604542; fax: +255 232604647.
E-mail addresses: nongahezron@yahoo.co.uk, hezron@suanet.ac.tz (H.E. Nonga).

0167-5877/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.prevetmed.2010.08.008

of livestock diseases, animal protein output has not been able to keep up with the national demands (Njombe and Msanga, 2009).

Indeed, the control of livestock diseases remains problematic because of the inadequacy of veterinary services extended to livestock keepers particularly in rural areas (Kambarage et al., 1995). In this respect, cattle brought in urban areas for slaughter come from villages where disease control is limited to tick-borne diseases and trypanosomosis (Swai et al., 2005). Factors contributing to unreliable veterinary services delivery in rural areas of Tanzania include shortage of veterinary staff, poor transport facilities, and limited diagnostic facilities and drugs. The lack of veterinary services in these livestock-rearing areas may contribute to a widespread prevalence of diseases in traditional sector. This further suggests that most of the animals brought to the abattoir for slaughter may harbour chronic or subclinical infections which are rarely detected during antemortem examination.

Under normal circumstances, many abattoirs and slaughter slabs in developing countries have poor meat inspection facilities and shortage of qualified meat inspectors (Edwards et al., 1997; Biu et al., 2006). Furthermore, in most abattoirs, it is standard practice to condemn diseased carcasses or organs wholly or partially, for health and aesthetic reasons. The level of such practices varies from place to place and sometimes unmarketable meat may still find its way to the market for public consumption. This practice may pose not only eating unsound, unwholesome but also unsafe meat. There are many published zoonotic diseases such as tuberculosis, hydatidosis, cysticercosis, Rift Valley fever and toxoplasmosis that are transmissible to humans through the consumption of infected meat (Edwards et al., 1997; Gracey et al., 1999). Despite the irregularities of abattoir meat inspection and the possible danger of zoonotic diseases that may emanate from ineffective meat inspection, the abattoir may serve as a source of invaluable information on the incidence of animal diseases and conditions including those of zoonotic importance. Animals showing no clinical signs of diseases may be detected at slaughter and the true picture of these diseases and conditions could be documented and made available to public. Therefore, the use of meat inspection records is an easy source of data for evaluation of the epidemiological aspects of animal diseases (Edwards et al., 1997; Schweizer et al., 2003).

In view of the importance of abattoir records in the epidemiology of animal diseases and to safeguard public health, the current study was aimed at investigating the prevalence of lung disease conditions in Arusha, Tanzania during a 3-year period (2005–2007).

2. Materials and methods

2.1. Study area and animals

This study was conducted at the Arusha municipal abattoir in Tanzania. The Arusha municipality lies between 1.6° and 4.0° latitude south and 34.5° and 37.5° longitude east. According to Tengeru meteorological station in Arusha, the municipality has unimodal and bimodal rainfall patterns, with short rains starting in September and ending in December, and the long rains starting in March and ending in May. The mean annual rainfall ranges from 800 mm to 1200 mm. During data analysis, a 'rainy season' was assigned to the periods from September 1 to December 31 and from March 1 to May 30 and the rest of the months were regarded as 'dry season'. The average monthly temperature of Arusha region is 20 °C, however, during the cooler period (June–August) the average temperature drops to 17 °C.

The study was a retrospective abattoir survey, undertaken for a period of 3-years from January 2005 to December 2007. During this period a total of 115,186 cattle, 61,551 sheep and 37,850 goats were slaughtered and their records formed a source of data for the current study. It was not possible to get the exact records on breed, sex and age for each slaughtered animal due to poor recording systems at the abattoir. With regards to the set up of livestock sector in Tanzania particularly Arusha, almost all animals sent for slaughter are adult and come from traditional sector. It is documented that more than 98% of the livestock population in the country is of indigenous types, kept in the traditional sector. For example, the indigenous cattle are dominated by the Tanzania Short horn Zebu (TSZ) and Ankole breeds (MAFS, 2002). It was also difficult to precisely trace back the geographical origins of all the animals slaughtered due to lack of reliable animal identification method making it difficult to relate the findings to a particular locality.

2.2. Criteria for selection of cases and procedures

Records of total number of cattle, sheep and goats slaughtered, lungs inspected during postmortem examination and lesion(s) observed and condemned were retrieved from Arusha abattoir record books. Such records were used to establish the prevalence of lung diseases and lesions affecting cattle, sheep and goats slaughtered in Arusha municipality. Routinely, meat inspectors carry out antemortem examination of all animals presented for slaughter a day before or shortly prior to slaughter. This is followed by postmortem meat inspection involving visual examination, palpation and systematic incision of carcasses and visceral organs particularly, lungs, liver, kidney, heart and spleen according to procedures described by Gracey et al. (1999) and the Tanzania general guidelines on meat inspection. Normally lung diseases and lesions are grossly diagnosed based on pathological changes of organ colour, size, morphology, consistence, presence of lesions and parasites. At the end of meat inspection all partial and total condemned organs are taken to the abattoir laboratory for further examination and identification of the lesions and parasites. In case of inconclusive diagnosis, the abattoir submits doubtful specimens to the Arusha Veterinary Investigation Centre (VIC) to confirm diagnosis of conditions detected during meat inspection.

2.3. Definition of some lung conditions encountered in this study

Pleurisy (pleuritis) is an inflammation of the pleural membrane that surrounds and protects the lungs. It is a condition normally associated with pneumonia and at a

certain stage it may cause fibrinous adhesions between the parietal pleura and the lung surface.

Pneumonia is an inflammation of the lung characterized by enlargement, hyperaemia and sometimes oedema, and it is most commonly caused by infectious or non-infectious agents.

Pulmonary emphysema is an excessive abnormal permanent accumulation of air in the lungs associated with some disease conditions and is caused by an obstruction to the outflow of air or by extensive gasping respiration during slaughter procedures. Grossly, the emphysematous lungs look pale, enlarged greyish-yellow, pearl like shiny lesion with puffy and crepitant feel upon palpation.

Hydatidosis (hydatid cysts) is a tapeworm larval stage of genus *Echinococcus*; made of large bladder (capsule), fluid or semi-solid material with an inner germinal layer from which daughter cysts and scolices develop. The hydatid cysts may develop in different organs preferably viscera like lungs in the intermediate hosts in particular ruminants which grossly appear as a palpable enlargement with fluctuating fluid.

A *cyst* is a closed capsule made of distinct membrane and division on the nearby tissue which may contain fluids or semi-solid material. When there is deposition of calcium salts in the semi-solid materials, it is termed as calcified cyst. Calcified cysts have a gritty sound upon incision with a knife and when observed grossly the cyst is white or grey, and irregularly rounded and frequently honey combed.

An *abscess* is a localized collection of pus (dead neutrophils) separated from the surrounding tissue by a fibrous capsule formed following an infection. Grossly, it is an enlarged palpable lesion with fluctuating fluid. The most common pyogenic bacteria which cause abscess in animals include *Arcanobacterium* (*Actinomyces*) *pyogenes*, *Streptococcus* spp., *Staphylococcus* spp., and *Fusobacterium* (*Sphaerophorus*) *necrophorum*.

Pulmonary tuberculosis is a contagious and usually chronic disease in animals and man caused by a bacterium of genus *Mycobacteria* spp. which pathologically is characterized by tubercle formation in the lungs and associated lymph nodes.

Anthracosis is the deposition of black dust matter in the lung parenchyma which occurs as a result of the long-term inhalation of carbon particles in animals and humans. The carbon particles are found as a black pigment in tissues particularly in the lungs and corresponding lymph nodes in animals raised in urban areas.

Melanosis is an abnormal accumulation of melanin pigments in various organs which causes dark pigmentation of the tissues resulting from a disorder of pigment metabolism.

2.4. Data analysis

The data for this study were analysed using Epi Info version 6 statistical software (Coulombier et al., 2001). Using statcalc, the proportions of categorical variables were computed and further compared using chi-square test at critical probability of $P < 0.05$. The strength of associations between dependent and independent variables was determined using 2×2 contingency tables. The variables compared included proportions of lung lesions by years, seasons and species.

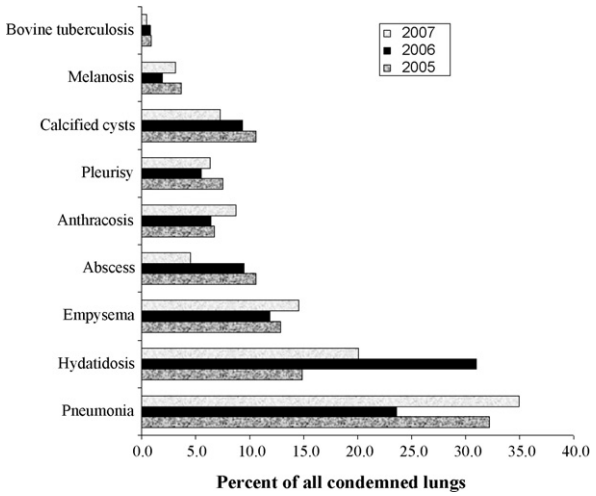

Fig. 1. Causes (%) of cattle lung condemnations in Arusha, Tanzania, 2005–2007.

3. Results

A total of 115,186 clinically healthy cattle, 61,551 sheep, and 37,850 goats were slaughtered and inspected between January 2005 and December 2007. The percentage of lung condemnations in different species and years and possible causes are shown in Table 1. During this period, 15,245 (13.2%), 4668 (7.8%) and 3192 (8.4%) cattle, sheep and goat lungs, respectively, were condemned. Pneumonia was the leading cause of lung condemnation in all three animal species slaughtered in Arusha municipality. Pleurisy, melanosis and bovine pulmonary tuberculosis were recorded only in cattle (Table 1). The percentages of lung lesions recorded were significantly higher ($P < 0.05$) in cattle than those recorded in sheep or goats (Table 1). The annual contribution of each condition among the condemned lungs is shown in Table 2 and Fig. 1. There was no significant difference ($P > 0.05$) in the percentages of lung diseases/conditions recorded during 2005, 2006 and 2007 in cattle, sheep and goats. It was further observed that there were no significant ($P > 0.05$) variations between lung condemnation percentages recorded during the rainy and dry seasons in all three animal species under investigation (see Table 2).

4. Discussion

This study demonstrates that lung diseases and lesions represent a serious problem and may continue to be a drawback to livestock industry and may pose health risks to meat consumers from contrasting zoonotic diseases in northern Tanzania. High prevalence of different lung disease conditions have been recorded as the major cause of condemnations which included pneumonia, hydatidosis, emphysema, abscesses, anthracosis, pleurisy, calcified cysts, melanosis and bovine tuberculosis. The fact that only clinically healthy animals are slaughtered implies that the

Table 1
Major causes of lung condemnations in Arusha municipal abattoir from 2005 to 2007.

Disease condition	Number (%) of lungs condemned in cattle, sheep and goats														
	2005			2006			2007			Total			Means (std)		
	Cattle (n = 31,080)	Sheep (n = 14,501)	Goat (n = 9088)	Cattle (n = 40,069)	Sheep (n = 20,266)	Goat (n = 14,020)	Cattle (n = 44,037)	Sheep (n = 26,784)	Goat (n = 14,742)	Cattle (n = 115,186)	Sheep (n = 61,551)	Goat (n = 37,850)	Cattle	Sheep	Goat
Pneumonia	1576 (5.1)	416 (2.9)	327 (3.6)	1252 (3.1)	508 (2.5)	396 (2.8)	1766 (4.01)	571 (2.1)	349 (2.4)	4594 (4.0)	1495 2.4	1072 (2.8)	1531.3 ± 259.9	498.3 ± 77.9	357.3 ± 35.2
Hydatidosis	727 (2.3)	271 (1.9)	149 (1.6)	1642 (4.1)	291 (1.4)	179 (1.9)	1015 (2.3)	353 (1.3)	221 (1.5)	3384 (2.9)	915 (1.5)	549 (1.5)	1128 ± 467.9	305 ± 42.8	183 ± 36.2
Emphysema	630 (2.03)	259 (1.8)	159 (1.8)	630 (1.6)	317 (1.6)	199 (1.4)	734 (1.7)	279 (1.04)	213 (1.4)	1994 (1.7)	855 (1.4)	571 (1.5)	664.7 ± 60.1	285 ± 29.5	190.3 ± 28.0
Abscesses	519 (1.7)	305 (2.1)	239 (2.7)	502 (1.3)	245 (1.2)	186 (1.3)	228 (0.5)	131 (0.5)	87 (0.6)	1249 (1.1)	681 (1.1)	512 (1.4)	416.3 ± 163.3	227 ± 88.4	170.7 ± 77.2
Anthracosis	329 (1.1)	0 (0.0)	1 (0.01)	340 (0.9)	0 (0.0)	0 (0.0)	443 (1.01)	0 (0.0)	0 (0.0)	1112 (1.0)	0 (0.0)	1 (0.0)	370.7 ± 62.9	0	0.3 ± 0.5
Pleurisy	369 (1.2)	0 (0.0)	0 (0.0)	295 (0.7)	0 (0.0)	0 (0.0)	319 (0.7)	0 (0.0)	0 (0.0)	983 (0.9)	0 (0.0)	0 (0.0)	327.7 ± 37.8	0	0
Calcified cysts	518 (1.7)	230 (1.6)	134 (1.5)	493 (1.2)	179 (0.9)	93 (0.7)	367 (0.8)	413 (1.5)	260 (1.8)	1378 (1.2)	822 (1.3)	487 (1.3)	459.3 ± 80.9	274 ± 123.1	162.3 ± 87.0
Melanosis	180 (0.6)	0 (0.0)	0 (0.0)	104 (0.3)	0 (0.0)	0 (0.0)	158 (0.4)	0 (0.0)	0 (0.0)	442 (0.4)	0 (0.0)	0 (0.0)	147.3 ± 39.1	0	0
Bovine tuberculosis	42 (0.1)	0 (0.0)	0 (0.0)	43 (0.1)	0 (0.0)	0 (0.0)	24 (0.1)	0 (0.0)	0 (0.0)	109 (0.1)	0 (0.0)	0 (0.0)	36.3 ± 10.7	0	0
Total	4890 (15.8)	1481 (10.2)	1009 (11.1)	5301 (13.2)	1540 (7.6)	1053 (7.6)	5054 (11.5)	1747 (6.6)	1130 (7.7)	15245 (13.2)	4768 (7.7)	3192 (8.5)			

Std means standard deviation.

true prevalence of different lung diseases could probably be much higher and many cases are likely to remain unnoticed or undiagnosed because of meat inspectors' personal error, non-cooperativeness of the butchers, use of gross pathology in the diagnosis of the diseases and general poor record keeping. Nevertheless, information on high prevalence of zoonotic hydatidosis and tuberculosis in animals illustrates both the possible public health problem and environmental infection.

It has been observed that pneumonia was the leading cause of lung condemnations and it accounted for 30.1%, 31.4% and 33.6% of all the condemned lungs in cattle, sheep and goats, respectively (Table 2). Pneumonia in ruminants is a complex condition involving interaction between the host (i.e. immunological and physiological), multiple agents (e.g. bacterial, viral, mycoplasma) and environmental factors (Brodgen et al., 1998). A number of factors may explain the high prevalence of pneumonic lungs recorded in this study. These include stress factors such as exposure to dust from the environment or exhaustion during long treks of pastoral livestock in search of pasture and water and; when animals are taken to livestock markets or abattoirs and parasitism (Kusiluka and Kambarage, 1996; Kusiluka et al., 1997; Blood et al., 2007). Poor housing and overcrowding which are common in the study area subject the animals to various stresses like cold, wind, rain and dust, as a result opportunistic bacteria like *Pasteurella* spp. and *A. pyogenes* are likely to attack the lungs. Indeed, many cases were encountered during dry chilly months (i.e. end of May to early September), a factor which might also have contributed to occurrence of pneumonia in slaughter animals. A similar observation of pneumonia, particularly in small ruminants, contributing to heavy losses of livestock has been reported in Tanzania (Kusiluka and Kambarage, 1996). The above records show that the proportion of lungs condemned due to pneumonia in the affected animals constituted an economic loss to the traders as well as depletion of animal protein for consumers in the study area.

Pleurisy (pleuritis) on the other hand was also recorded in cattle contributing 6.4% of total lungs condemned. The percentage of lungs condemned due to pleurisy in this study is significantly lower than what was reported in Morogoro municipality (22%) in Tanzania (Kambarage et al., 1995). This difference may be due to differences in geographical locations, aetiologies, different definitions used or due to subjective assessments and diagnosis of pleurisy between the two studies.

Hydatidosis is considered to be an endemic disease in Nothern Tanzania. The prevalence of lung hydatidosis recorded during this study was 22.2%, 19.2% and 17.2% in cattle, sheep and goat, respectively (Table 2). Unlike the results of the present study, Ernest et al. (2008) recorded a prevalence of 42.9%, 56.5% and 59.6% in cattle, sheep and goat, respectively, in Ngorongoro district which is located in the same Northern zone of Tanzania. However, this variation probably could have arisen due to data collection method. While the current study employed retrospective approach with records being retrieved from archives, the study by Ernest et al. (2008) employed active surveillance when raw data were collected by researchers at five slaughter slabs in Ngorongoro district. Further-

Table 2
Number (%) of condemned lungs due to lung diseases among the condemned lungs between 2005 and 2007 in slaughter stock at Arusha abattoir, Tanzania.

Disease conditions	Number (%) of lungs condemned		
	Cattle (n = 15,245)	Sheep (n = 4768)	Goats (n = 3192)
Pneumonia	4594 (30.1)	1495 (31.4)	1072 (33.6)
Hydatidosis	3384 (22.2)	915 (19.2)	549 (17.2)
Emphysema	1994 (13.1)	855 (17.9)	571 (17.9)
Abscesses	1249 (8.2)	681 (14.3)	512 (16.0)
Anthracosis	1112 (7.3)	0 (0.0)	1 (0.0)
Pleurisy	983 (6.4)	00 (0.0)	0 (0.0)
Calcified cysts	1378 (9.1)	822 (17.2)	487 (15.3)
Melanosis	442 (2.9)	0 (0.0)	0 (0.0)
Bovine tuberculosis	109 (0.7)	0 (0.0)	0 (0.0)

more, Ngorongoro is a focal district mostly inhabited by the Maasai pastoral community with large herds of livestock, free-roaming dogs and is in the wildlife-domestic animal interphase area (Ernest, 2004; Kaare et al., 2008). This is supported by earlier findings by Ernest (2004) who established the prevalence of *Echinococcus granulosus* in dogs in Arusha to be 12.4%. Since dogs are the definitive host for *E. granulosus*, the possibility for environmental contamination is high and the disease can easily be transmitted to ruminants and humans. Therefore the abattoir lung hydatidosis observed in domestic ruminants in the region gives more evidence of the disease endemicity. We further could not observe seasonal variations of hydatidosis in all slaughter stocks. The epidemiologic implication of this finding might be attributed to chronicity of the disease. Once the animal is infected, the lesions of hydatidosis usually remain for the life of the animal. This may be the reason for non-seasonal patterns of the disease.

Pulmonary emphysema in animals is normally secondary to some respiratory disease conditions like infectious bovine rhinotracheitis, pneumonic pasteurellosis, malignant catarrhal fever, mycoplasmal infection, leptospirosis and some different cases of septicaemia and endocardiasis (Aiello and Mays, 1998; Herenda et al., 2000; Blood et al., 2007). Due to a well-developed interlobular septa and lack of collateral ventilation, sheep, pigs, and particularly cattle are susceptible to interstitial emphysema. Any pathologic process that results into forced expiration, for example, East Coast fever a disease of cattle which is endemic in most parts of Tanzania can cause air to be forced into interlobular septa. Sometimes, some cases of emphysema are recorded in slaughter animals due to extensive gasping respiration during slaughter especially when animals are slaughtered without stunning (Gracey et al., 1999). Furthermore, slaughter of very old cows is reported to be associated with emphysema (Gracey et al., 1999). In the current study, emphysema caused 13.1%, 17.9% and 17.9% of all the condemned organs in cattle, sheep and goats, respectively. This is in agreement with other studies which reported emphysema to be responsible for 22% of the cattle lungs condemned at Morogoro abattoir (Kambarage et al., 1995). Because of poor veterinary service and uncoordinated diseases control programmes in most areas of Tanzania, respiratory conditions of varying aetiologies are very common and cannot be ruled out as possible causes of emphysema recorded in this study too. Furthermore, the set up of most slaughterhouses is poor such that lack of stunning facilities and using of the same place for slaughter and bleeding, may subject the slaughtered animal to stress before slaughter.

The current study recorded lung abscesses at 8.2%, 14.3% and 16.0% of lungs condemned from cattle, sheep and goats, respectively. Lung abscess may originate from infected emboli in blood coming from other septic organs/areas as in case of endocarditis, lymphadenitis, mastitis and metritis. It is documented that *Pasteurella* spp. and *A. pyogenes* are the main causes of lung abcesses in cattle (Gracey et al., 1999; Herenda et al., 2000).

Calcified cysts were also recorded and caused substantial lung condemnations. The actual causes of the cysts were not established but a number of parasitic conditions such as *Cysticercus bovis*, lung worms (*Dictyocaulus viviparous*, *Dictyocaulus filarial* and *Mullerius capillaries*) could lead to formation of calcified cysts in ruminants (Blood et al., 2007).

Tuberculosis was recorded only in cattle and accounted for 0.7% loss of the overall lung condemnations recorded. This is lower than the 3.3% previously reported in Morogoro, Tanzania (Kambarage et al., 1995). Elsewhere, the findings of the current study are inline with that of Awah-Ndukum et al. (2007) and Asseged et al. (2004) who reported 0.8% and 1.5% prevalence of tuberculosis in Cameroon and Ethiopia, respectively. These findings are in contrast with those by Cadmus et al. (2008) and Cadmus and Adesokan (2009) who reported 4.3% and 7.9%, respectively, in cattle lungs condemned in most abattoirs in Nigeria. The low prevalence recorded in this study reflects the bovine tuberculosis prevalence in live animals which was reported to be 1.3% (Shirima, 1999). Regardless Despite of lower prevalence recorded in the current study, the significance of this finding cannot be underestimated considering the zoonotic implication of this disease and the husbandry system being practiced by the farmers. For instance, majority of the Maasai share the same micro-environment and water sources with domestic and wild animals especially during the dry seasons consequently increasing the risk of tuberculosis transmission from infected to uninfected individuals. Moreover, the Maasai habit of drinking fresh blood and raw milk, and eating raw/partially cooked meat further predispose them to bovine tuberculosis infection. It is therefore recommended that there is a need to intensify the screening of dairy and

beef animals for this disease with the aim of reducing risks to humans.

Other conditions observed at a lower percentage in cattle lungs only during this study included anthracosis and melanosis. The rarity of these lesions would suggest that they are likely to be of minor concern and would be expected to appear only sporadically.

The condemnation of cattle, sheep and goat lungs represents a significant economic loss to traders and the livestock industry at large. The meat inspection abattoir records show a wide spectrum and types of lung diseases and pathological conditions occurring in traditional livestock herds. The presence of zoonotic diseases such as hydatidosis and tuberculosis may pose a health risk to meat consumers and this suggests a need for a rigorous meat inspection procedure, to minimize the chance of consumers acquiring infection through contact with and/or consumption of infected meat.

Acknowledgements

The authors are indebted to the Arusha abattoir management, meat inspectors and Ministry of Livestock Development and Fisheries for their cooperation and accepting to use the records as data for this paper.

References

Aiello, E.S., Mays, A., 1998. The Meck Veterinary Manual, 8th ed. Merck & Co., Inc., Whitehouse Station, NJ, USA.

Asseged, B., Woldesenbet, Z., Yimer, E., Lemma, E., 2004. Evaluation of abattoir inspection for diagnosis of *Mycobacterium bovis* infection in cattle at Addis Ababa abattoir. Trop. Anim. Health Prod. 36 (6), 537–546.

Awah-Ndukum, J., Tchoumboue, J., Niba, A.T., 2007. Current status of bovine tuberculosis and other pathological conditions at the SODEPA Douala abattoir, Dschang, Cameroon (1995–2003). Trop. Vet. 25, 58–64.

Biu, A.A., Ahmed, M.I., Mshelia, S.S., 2006. Economic assessment of losses due to parasitic diseases common at the Maiduguri abattoir, Nigeria. African Sci. 7 (3), 143–145.

Blood, D.C., Radostits, O.M., Gay, C.C., Hinchcliff, K.W., Constable, P.D., 2007. Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats, 10th ed. Saunders, Ltd, 2065 pp.

Brodgen, K.A., Lehmkuhl, Howard, D., Cutlip, Randall, C., 1998. *Pasteurella haemolytica* complicated respiratory infections in sheep and goats. Vet. Res. 29 (3–4), 233–254.

Cadmus, S.I.B., Adesokan, H.K., 2009. Causes and implications of bovine organs/offal condemnations in some abattoirs in Western Nigeria. Trop. Anim. Health Prod. 41, 1455–1463.

Cadmus, S.I.B., Adesokan, H.K., Awosanya, A.E.J., 2008. Public health issues and observations made during meat inspection at Bodija Municipal Abattoir, Ibadan, Oyo State, Nigeria. Nigerian Vet. J. 29 (2), 43–47.

Coulombier, D., Fagan, R., Hathcock, L., Smith, C., 2001. Epi Info 6 Version 6.04. A Word Processing, Database and Statistical Program for Public Health. Centers for Disease Control and Prevention, Delaware, USA.

Edwards, D.S., Johnston, A.M., Mead, G.C., 1997. Meat Inspection: an Overview of Present Practices and Future Trends. Vet. J. 154, 135–147.

Ernest, E., 2004. Studies on the epidemiology of echinococcosis/hydatidosis in Ngorongoro district, Arusha region, Tanzania. A thesis submitted for the award of a master's degree of Sokoine University of Agriculture, Morogoro, Tanzania, pp. 96.

Ernest, E., Nonga, H.E., Kassuku, A.A., Kazwala, R.R., 2008. Hydatidosis of slaughtered animals in Ngorongoro district of Arusha region, Tanzania. Trop. Anim. Health Prod., doi:10.1007/s11250-008-9298-z.

FAO, 2003. Global Livestock Production and Health atlas (GLiPHA), pp. 1–2 http://www.fao.org/ag/aga/glipha/index.jsp.

Gracey, J.F., Collins, D.S., Huey, R.J., 1999. Meat Hygiene, 10th ed. W.B. Saunders Company, Ltd, pp. 261–287.

Herenda, D., Chambers, P.G., Ettriqui, A., Seneviratna, P., da Silva, T.J.P., 2000. Manual on meat inspection for developing countries. FAO Animal Production and Health Paper 119. Food and Agriculture Organization of the United Nations, Rome, Italy.

Kaare, M., Lembo, T., Hampson, K., Ernest, E., Estes, A., Mentzel, C., Cleaveland, S., 2008. Rabies control in rural Africa: evaluating strategies for effective domestic dog vaccination. Vaccine 27, 152–160.

Kambarage, D.M., Kimera, S.I., Kazwala, R.R., Mafwere, B.M., 1995. Disease conditions responsible for condemnation of carcasses and organs in short-horn Zebu cattle slaughtered in Tanzania. Prev. Vet. Med. 22, 249–255.

Kusiluka, L.J.M., Kambarage, D.M., 1996. Diseases of Small Ruminants in Subsaharan Africa: A Hand Book on Common Diseases of Sheep and Goats in Sub-Saharan Africa, VETAID. Capital Print, Ltd.

Kusiluka, L.J.M., Kambarage, D.M., Harrison, L.J.S., Daborn, C.J., Matthewman, R.W., 1997. Causes of morbidity and mortality in goats in Morogoro district, Tanzania: the influence of management. Small Rum. Res. 29, 167–172.

MAFS, Ministry of Agriculture Food Security, 2002. Basic Data-Agriculture Sector 1994/95-2000/2001. Statistics Unit, MAFS, Dar es Salaam, Tanzania, August 2002, 72 pp.

Njombe, A.P., Msanga, Y.N., 2009. Livestock and Dairy Industry Development in Tanzania, http://www.mifugo.go.tz (accessed 06.04.10).

Schweizer, G., Plebani, G.F., Braun, U., 2003. Prevalence of *Fasciola hepatica* and *Dicrocoelium dendriticum* in the cow: inspection in an east Switzerland abattoir. Schweiz. Arch. Tierheilkd. 145, 177–179.

Shirima, G.M., 1999. Epidemiology of Bovine Tuberculosis in cattle in different farming systems in the eastern zone of Tanzania. A dissertation submitted for the award of a master degree at Sokoine University of Agriculture, Morogoro, Tanzania. pp. 72.

Swai, E.S., Mbise, A.N., Kessy, V., Kaaya, E., Sanka, P., Loomu, P.M., 2005. Farm constraints, cattle disease perception and tick management practices in pastoral Maasai community-Ngorongoro, Tanzania. Liv. Res. Rural Dev. 17, Art. #17, http://www.lrrd.org/lrrd17/2/swai17017.htm (retrieved 26.06.10).