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An Abattoir based Study on Bovine Tuberculosis in Debre Zeit, Ethiopia

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ABSTRACT

Members of the Mycobacterium complex group cause tuberculosis, it recognized as one of the most important threats to humans and animals causing mortality, morbidity and economic losses in many countries of the world, particularly in developing nations. Therefore, a cross-sectional study on bovine tuberculosis conducted in order to determine its prevalence in cattle at the ELFORA export abattoir in Debre-Zeit in the period from November 2014 to April 2015. Routine and detailed meat inspection methods used to detect lesions. Three hundred cattle inspected; their body condition scores and ages recorded before slaughtering. Of the total animals, 5.7% (17/300) had lesions of tuberculosis. Out of these, routine abattoir inspection had detected only 2.7% (8/300) with visible lesions and there was poor agreement (kappa=0.09) between routine and detailed inspection methods. The proportion of lesions found in the lung and associated lymph nodes, mesenteric lymph nodes and lymph node around head were determined to have been at 12.3%, 2% and 3.3%, respectively. The prevalence of the disease was significantly ($P < 0.05$) varying with body condition scores but it did not significantly ($P > 0.05$) vary with age groups of the animals. This study demonstrated the prevalence of bovine tuberculosis in cattle slaughtered at ELFORA export abattoir and low sensitivity of routine abattoir inspection. Hence, the carcass must thoroughly examine well to reduce the chance of missing lesions of tuberculosis.

Key words: Bovine tuberculosis, Meat inspection, Prevalence, Public health, Zoonosis

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INTRODUCTION

Bovine Tuberculosis (BTB) is a chronic bacterial disease characterized by progressive development of tubercles in any tissue/organ of the body (Hlokwe et al., 2013; Pal et al., 2014; Terefe, 2014). It has recognized from 176 countries as one of the important bovine diseases causing great economic loss (Awah-Ndukum et al., 2013). Tuberculosis (TB) remains a major global health problem and causes ill health among millions of people each year and ranks as the second leading cause of death from an infectious disease worldwide after the human immunodeficiency virus (HIV) (WHO, 2013 and 2014). Tuberculosis can be difficult to diagnose based only on the clinical signs. Regular surveillance by skin test, bacteriology and molecular methods is not feasible due to lack of resources. Thus, Routine Abattoir (RA) inspection will continue to play a key role for national surveillance. We evaluated the efficiency of RA inspection for diagnosis of *M. bovis* infection and discussed its public health implications in light of a high risk of human exposure. TB has been widely distributed throughout the world affecting all age groups. In humans, TB is being responsible for more deaths than any other bacterial disease ever today (Bhatia and Ichpujanti, 1994). Ethiopia has the largest livestock population in Africa, with an estimated 44.3 million cattle, 23.6 million sheep, 26.3 million goats and 2.3 million camels (CSA, 2005). Ethiopia's increasing human population, coupled with expanding urbanization and higher average income is putting an increasing pressure on the meat supply. To meet this demand, millions of food animals slaughtered every year

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throughout the country. In 2007, for example, a total of 18.8 million cattle, sheep, goats and camels slaughtered at municipal abattoirs, primarily for domestic consumption (FAO, 2009). For this reason, close monitoring of meat hygiene, including proper implementation of meat inspection procedures during slaughter, should be a vital part of the national public health protection program.

BTB characterized by the formation of nodules called tubercles whose location depends largely on the route of infection. In calves, BTB usually transmitted by ingestion and lesions involve the mesenteric lymph nodes with possible spread to other organs. In older cattle, infection usually transmitted by the respiratory tract with lesions in the lung and dependent lymph nodes (Carter and Wise, 2004). Recently, there have been increasing reports of human cases due to *M. bovis* especially in patients with HIV (Russell, 2003). Thus, a greater degree of transmission of infection with bacteria to human and domestic farm animals could occur (Taracha et al., 2003). In industrialized countries, animal tuberculosis is controlled and eliminated with milk pasteurization, which has in turn drastically reduced the incidence of the disease caused by *M. bovis* in both cattle and human. In developing countries however, animals' tuberculosis is widely distributed, control measures not applied or applied sporadically and pasteurization rarely practiced. In Ethiopia, animals are kept in the same dwelling with their owners and use of cow dung for wall plaster, floor and as a source of energy for cooking, do exacerbate chance of spread of tuberculosis to human (Asseged, 1999). Thus, BTB is endemic and has reported from different regions of the country (Asseged et al., 2000). The disease in the country is associated with decreased productive efficiency and carcass or organ condemnation in abattoir (Shitaye et al., 2006). The nationwide distribution of the disease and the economic loss associated with it has not been fully determined due to lack of good diagnostic facilities (Asseged, 2004). The primary reason for post mortem examination of carcasses at slaughterhouse is for the protection of public health. TB status of slaughter cattle provides useful information and is a proxy indicator for the prevalence of TB-positive slaughter animals, and therefore likelihood of the human exposure through consumption of infected meat. Apart from providing data for regulatory programmatic awareness of the true prevalence of TB infection, carcass examination also provides clues as to whether the infection is in its early stage or has reached the transmissible stage (ADARDO, 2008). This provides better programmatic awareness with subsequent development of targeted guidance on how to reduce the risk of TB spread within the specific geographic area, as well as opportunities to trace back the source of infection to the herds. Hence, having the knowledge of distribution, prevalence and risk factors of the disease are fundamental to look for effective control strategy. Therefore, the objectives of this study were to determine the prevalence of bovine tuberculosis at the ELFORA export abattoir, in DebreZeit and to evaluate the efficiency of abattoir inspection for the diagnosis of *M. bovis* infection as well as to assess the distribution of tuberculous lesions in slaughtered animals.

MATERIALS AND METHODS

Ethical considerations

This research work conducted according to Organization International Epizootics (OIE, 2010) principles of the use of animals in research and education**.** As much as possible we prevent, alleviate and minimize pain, suffering, and distress and enhance welfare for the animals used for research during ant mortem.

Study area

This study conducted at the ELFORA export abattoir in DebreZeit, Ethiopia from November 2014 to April 2015. DebreZeit is located at 45 kms southeast of Addis Ababa. The area is located at 9°N latitude and 40°E longitudes at an altitude of 1850 meters above sea level in central high land of Ethiopia. It has an annual rainfall of 866 mm of which 84% is in the long rainy season (June to September). The dry season extends from October to February. The mean annual maximum and minimum temperatures are 26°C and 14°C, respectively, with mean relatively, humidity of 61.3% (ADARDO, 2007).

Animals

Animals used for the study were those, which were ready to slaughter at ELFORA export abattoir, in DebreZiet, came from surrounding areas and all of them were from local breeds (*Boss indicus*) and male. Most of the cattle kept in fattening for variable period, so their body condition was almost medium or good (Nicholson and Butterworth, 1986).

Study design

A cross-sectional study conducted to determine the prevalence of BTB. The efficiency of routine abattoir meat inspection to diagnose TB lesions also evaluated. A systematic random sampling procedure used to choose animals in the study. In general, 300 cattle and their carcasses examined.

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Ante-mortem inspection

Those cattle selected for the study had been examined physically before slaughtering; age and Body Condition Score (BCS) recorded. The body condition of each of the study animals scored using guideline established by Nicholson and Butterworth (1986) during ante-mortem examination. In the meantime, the age of the study animals had also been determined according to De-Lahunta, and Habel (1986). The age was categorized as young less than two years old, young adult between two to six years old and adult greater than six years old (Pace and Wakeman, 2003). All animals slaughtered during the study period were older than two years of age so they categorized as young adult and adult.

Routine abattoir inspection

Routine inspection for tuberculosis at the abattoir conducted according to the method developed by the meat inspector and quarantine division of the Ministry of Agriculture, Ethiopia (MOA, 1973). The method involves palpation and incision of the bronchial, mediastinal and pre-scapular lymph nodes, as well as visual inspection and if necessary incision of the lungs, liver, kidneys and lymph nodes around these organs.

Detailed post-mortem examination

Detailed post-mortem examination performed in such a way, that the lungs and lymph nodes removed for the investigation of tuberculous lesions. The seven lobes of the two lungs, including the left apical, left cardiac, left diaphragmatic, right apical, right cardiac, right diaphragmatic and right accessory lobes, inspected externally and palpated. Each lobe then sectioned into about two centimeter thick slices to facilitate the detection of lesions. Similarly, lymph nodes, namely, the mandibular, medial right apical, right cardiac, right diaphragmatic and right accessory lobes, were inspected externally and palpated, each lobe was then sectioned into about two centimeter thick slices to facilitate the detection of lesions. Similarly, lymph nodes, namely, the mandibular, medial retropharyngeal, cranial and caudal mediastinal, left and right bronchial, hepatic and mesenteric lymph nodes, were sliced into thin sections (23 millimeter thick) and inspected for the presence of lesions (Teklu et al.,2004).

Data analysis

The raw data was fed into Microsoft excel and the prevalence of bovine tuberculosis was calculated in percentage. The variation between different factors assessed by using Chi-square (X^2), and all statistical analyses conducted by SPSS statistical software version 20. A p-value less than 0.05 considered statistically significant.

RESULTS

Prevalence of bovine tuberculosis

The overall prevalence of BTB in cattle slaughtered at ELFORA export abattoir during the study period was at 5.7% (17/300) based on the detailed post-mortem examination. Macroscopically, the most common changes seen in the affected organs and/or lymph nodes were the presence of circumscribed yellowish white lesions of various sizes and numbers. However, only 2.7% (8/300) head of cattle found to have detectable tuberculosis lesions by the routine abattoir inspection. Thus, the proportion of lesion detected by detailed examination to that of routine abattoir inspection procedure was in the ratio of 2.1:1. The results of this study have indicated that the probability of missing an animal with tuberculosis during routine abattoir inspection was 3%.

Thus, a poor agreement (Kappa=0.09) was recorded between these two procedures. Distribution of tuberculosis lesions in organs of cattle slaughtered is higher in bronchial ln (3%) and lower in hepatic ln (Table 1). The lymph node and lung regions contribute a higher percentage of tubercle lesions than any other organs (Table 2). The prevalence of tuberculosis in abattoir slaughter cattle in relation with age and body condition score has been presented in table 3. There was no statistically significant (P> 0.05) difference between age groups. However, there was a variation in the occurrence of tuberculous lesions across body condition scores (medium and good), with a considerably higher prevalence recorded in medium scored cattle.

Distribution of tuberculous lesions

The distribution of tuberculous lesions in different tissues of cattle has presented in table 1. Eight organs and/or lymph nodes were containing tuberculous lesions. About 5.3% of the lesions observed in the lung. The lung region contributes a higher percentage of tubercle lesions than the lymph node around head and the gastrointestinal area (Table 2). The prevalence of tuberculosis in abattoir slaughter cattle in relation with age and BCS presented in Table 3 and 4, respectively. There was no statistically significant (P> 0.05) difference between age groups. However, there was a

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variation in the occurrence of tuberculous lesions across body condition scores (medium and good), with a considerably higher prevalence recorded in medium scored cattle.

Table 1. Distribution of tuberculosis lesions in organs of cattle slaughtered in central Ethiopia, during November 2014 to April 2015

Organs	Lung Tissue	Bronchial	Mediastinal	Retropharyngeal	Mandibular	Mesenteric	Liver And Hepatic	Carcasses
No. of lesions (%)	16 (5.3)	8 (3)	14(5)	7 (2.3)	3 (1)	6 (2)	2 (0.7)	5 (1.6)

*ln= lymph node

Table 2. Observation of tuberculosis lesions distributed in organs and lymph nodes of cattle carcasses collected in the central Ethiopia, during November 2014 to April 2015

Anatomical sites	lung tissues and lymph node	Mesenteric ly mph node	Liver and hepatic lymph node	Head lymph nodes	Carcasses	Total
No. of Lesions	37	6	1	10	5	59
Infected animal (%)*	12.3	2	0.3	3.3	1.7	--
Percentage of infected organ (%)**	62.7	10.2	1.7	17	8.5	--

*Percentage from total animal=lesion divided by/number of animal examined (300) multiplied by 100 **Organ proportion=lesion in the region divided by overall lesions (59) multiplied by 100

Table 3. Prevalence of bovine tuberculosis with respect to age of infected animals

Age	Young	Adult	Total
No. of Animals examined	123	177	300
Positive (%)	9 (7.3)	11 (6.2)	
P-value	0.99	0.99	

Table 4. Prevalence of bovine tuberculosis with respect to body condition score of infected animals

Body condition score	Good	Medium	Total
No. of Animals examined	237	63	300
Positive (%)	5 (2.1)	14 (22.2)	
P-value	0.00	0.00	

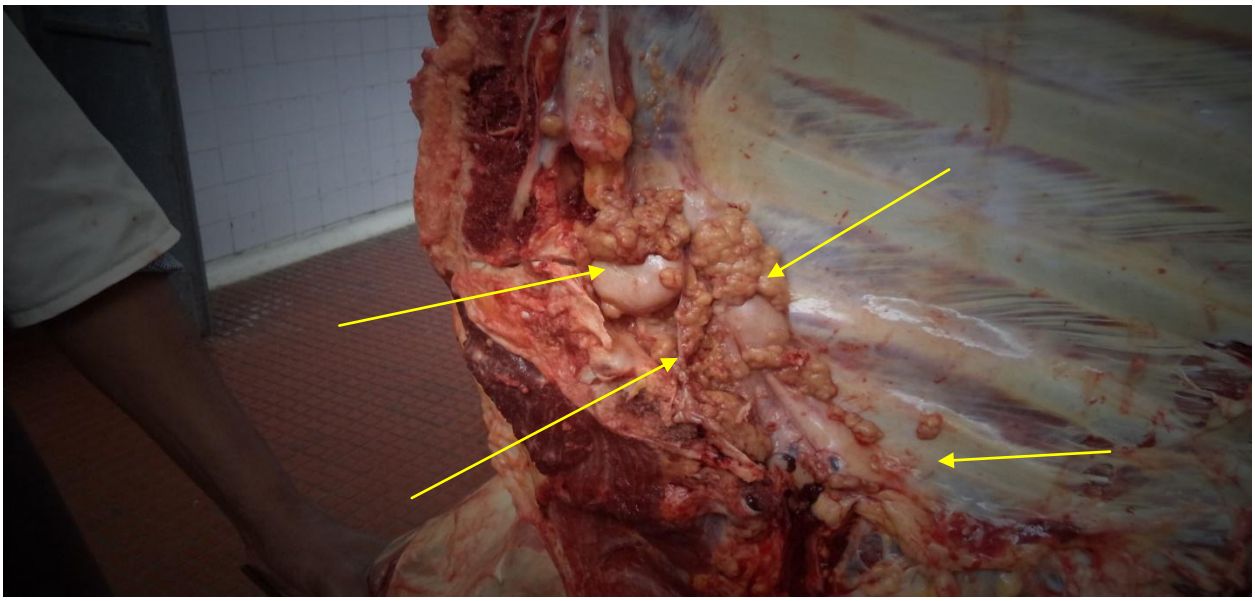

Figure 1. Tuberculosis lesions in the thoracic cavity of adult cattle at abattoir, in central Ethiopia, September 2015

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DISCUSSION

This study has documented the prevalence and distribution of lesions of BTB in cattle slaughtered at ELFORA export abattoir. The findings of overall prevalence of 5.7% tuberculosis reported in detailed post-mortem examination and 2.7% in routine abattoir inspection are in agreement with the results reported by Demelash et al. (2009; Teklu et al., 2004; Nasaka J, 2014) in Yabello municipal abattoir and Hosanna Ethiopia and Masaka district Uganda 4.2% 4.5% and2.7%respectively.

On the contrary, the present results are less than of the previous reports from Ghana 34% (Atiadeve et al., 2014), Camerron 12-17% (Egbe et al., 2016), Ethiopia 8.4% (Aylate et al., 2013), Butajira municipality abattoir 11.50% (Abdurrahman, 2009), Addis Ababa and Adama 10.10% (Demelash et al., 2009), Adama municipal abattoir 24.70% (Tefera, 2009) and 19.8% record from cattle slaughter in rural Tanzania (Cleaveland et al., 2007). This could indicate the endemic nature of the disease and the high infection rate prevailing in the general population of slaughter cattle in Ethiopia. This study has revealed that the probability of missing an animal with TB lesion during routine abattoirinspection is 95.24%. Previous studies have also indicated probabilities of 84.85% (Tefera, 2009), 84% (Corner, 1994.) and 70.59%, (Teklu et al., 2004). Therefore, detailed post-mortem examination can considered as a better procedure to detect tuberculous lesion. This study had also revealed a much low sensitivity of routine meat inspection to detect carcasses with tuberculous lesion, implying that large proportion (95.24%) of tuberculosis infected carcasses pass undetected and the meat is approved for human consumption. The most probable explanation for the failure of standard meat inspection correctly detect tuberculosis infection could be due to the manner of examination (Corner, 1994). It noticed that in standard meat inspection procedure only few sites (organs) often inspected at a glance due to heavy duty of inspecting large number of animals each day. Argued that in abattoir smaller lesion could missed due to limited time available for the examination of each tissue (Corner, 1994). Furthermore, a lack of competence in meat inspection training could be another reason for inefficiency of the service as most of the lack of adequate trained personnel in the area of meat inspection. In the present study, gross tuberculosis lesions were found most frequently in the lymph nodes of lung (12.3%), lymph nodes of the head (3.3%) followed by mesenteric lymph node (2%). This finding is consistent with previous studies done by (Firdissa 2006; Abdurrahman, 2009 and Tefera, 2009) that reported 11.7, 14 and 14.7% TB lesions in lungs and associated lymph nodes, respectively. However, Corner (1994) described that up to 95% of cattle with visible TB lesions could identified by the examination of the lungs and associated lymph nodes. This finding indicated that inhalation might be the principal route of TB infection in cattle. Therefore, during post-mortem examination, focus should give on lungs and its associated lymph nodes. The presence of lesions in mesenteric lymph nodes indicated that the infection occurs through ingestion (Radostits et al., 2007). The prevalence of the diseases was statistically insignificant in age categories, which agree with previous reports (Bekele and Belay, 2011). This might be due to type of animals slaughtered in the abattoir in which both were greater than two years of age, which is enough to develop the lesions once infected. It should noticed that, there was a statistically significant difference ($P< 0.05$) in the prevalence of the disease between BCS. The prevalence was higher in medium (22.2%) than good (2.1%) body conditioned animals. Our findings run parallel with previous reports, which had indicated that animals with good BCS have relatively strong immunological response to the infectious agent than animals with medium BCS and the results could indicate the wasting nature of the disease (Radostits et al., 2007). Our current work is a continuation of the work published earlier describing prevalence of BTB in Ethiopian slaughter cattle *(*Demelash et al., 2009). With generation of new additional data from laboratory work (culture and microscopy and molecular analysis), we wanted to evaluate how well abattoir meat inspection protocols in Ethiopia are performing to detect cattle infected with *M. bovis*. Public health implications of the findings have also discussed.

CONCLUSION

This study demonstrated the limited capacity of current meat inspection procedures in Ethiopia to detect carcasses infected with *M. b*ovis.in Ethiopia and other countries where dietary preferences mean that a significant proportion of meat customarily consumed raw, lack of effective slaughter inspection protocols represents significant risk. Thus, meat borne zoonotic TB continues to be an ongoing and an important threat to public health in a nation that has significant populations of vulnerable HIV-infected citizens. Therefore, it is necessary to understand that the detailed abattoir meat inspection prevails than routine meat inspection, giving safe meat consumption risk and minimize the other risk factors. It deduced that BTB is prevalent in cattle slaughtered at ELFORA export abattoir, Debre-Zeit, Ethiopia. Tuberculous lesions were detected using detailed meat inspection. This should practice giving more attention to the lungs and associated lymph nodes.

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Recommendations for improving the service within the context of the prevailing cultural and socio-economic situation generated as an important outcome of these efforts. Further studies needed to characterize the organism by cultural isolation and implementing molecular techniques.

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Competing interests

The authors have declared that no competing interest exists in relation to this manuscript.

Author's contribution

NigusZenebe designed the experiment, collected data, Tsedale Amare collected data, TeferaWoldemariam helped in manuscript writing, commenting and approval, Mahendra Pal designed the experiment, wrote, commenting and approval of the paper. All authors have read and approved the final manuscript.

REFERENCES

Abdurrahman M (2009). Cross-sectional study of bovine tuberculosis in Butajira municipal abattoir; DVM Thesis, University of Gonder, Faculty of Veterinary medicine, Gondar, Ethiopia.

ADARDO (2007). Ada'a District Agricultural and Rural Development Office, Ethiopia. Doi: 10.5829/idosi.ejas.2012.4.5.66111

Asseged B (1999). Bovine tuberculosis a cross-sectional and epidemiological study in and around Addis Ababa, MSc thesis, Addis Ababa University, Faculty of Veterinary Medicine, DebreZeit, Ethiopia.

Asseged B, Lubke-Becker A, Lemma E, Taddele K and Britton S (2000). Bovine tuberculosis: A cross-sectional and epidemiological study in and around Addis Ababa. Bull Animal Health Production Africa, 48(2): 71-80.

Asseged B, Woldesenet Z and Yimer E (2004). Evaluation of abattoir inspection for the diagnosis of M. bovisinfection at Addis Ababa abattoir. Tropical Animal Health Production, 36: 537–546. Doi: http://link.springer.com/article/10.1023/B:TROP.0000040934.32330.44

Atiadeve SK, Gyamfi OK, Mak-Mensah E,Galyuon IKA, Owusu D and Bonsu FA (2014). Slaughter surveillance for tuberculosis among cattle in three metropolitan abattoirs in Ghana. Journal of Veterinary Medicine and Animal Health, 6(7): 198-207. Doi: 10.5897/JVMAH2014.0291

Awah-Ndukum J, Kudi AC, Bradley G, Ane-Anyangwe IP, Titanji VK, Fon-Tebug S and Tchoumboue J (2013). Prevalence of bovine tuberculosis in cattle in the highlands of Cameroon based on the detection of lesions in slaughtered cattle and tuberculin skintests of live cattle. Veterinary Medicine, 57:59-76.

Aylate A, Shah SN, Aleme H andGizaw TT (2013). Bovine tuberculosis: prevalence and diagnostic efficacy of routine meat inspection procedure in Woldiyamunicipality abattoir north Wollo, Ethiopia. Tropical Animal Health Production, 45:855–64.

Bekele B and Belay I (2011). Evaluation of Routine Meat Inspection Procedure to Detect Bovine Tuberculosis Suggestive Lesions in Jimma Municipal Abattoir, South West Ethiopia. Global Veterinaria, 6 (2): 172-179.

Bhatia R and Ichpujanti R (1994). Mycobacterium. In: Essentials of medical Microbiology, first edition, New –Delhi, pp: 285-292.

Carter G and Wise D (2004). Essentials of Veterinary Bacteriology and Mycology. 6th edition. Iowa State Press, a Blackwell Publishing Company, pp: 207-213. http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813811791.html

CentralStatistical Authority (CSA) (2006). Agricultural Sample Survey, (2004/2005). Report on livestock and livestock characteristics. Statistical Bulletin 361, Addis Ababa, Ethiopia. http://homepages.wmich.edu/~asefa/Conference%20and%20Seminar/Papers/2007%20papers

Cleaveland S, Shaw S, Mfinanga G, Shirima R, Kazwala E, Eblate and Sharpe M (2007). Mycobacterium bovis in rural Tanzania: risk factor for infection in cattle and human populations. Tuberculosis, 87**:** 30-43. Doi: https://doi.org/10.1016/j.tube.2006.03.001

Corner LA (1994). Post mortemdiagnosis of M. bovisinfection in cattle. Veterinary Microbiology, 40, 53–63. Doi: https://doi.org/10.1016/0378-1135(94)90046-9

De-Lahunta A and Habel R (1986). Applied Veterinary Anatomy. USA. W. B. Sounders Company, pp: 4-16.

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Journal homepage: www.wvj.science-line.com

Demelash B, Oloya I, Asseged B, Badaso M, Yilkal A and Skjerue E (2009). Prevalence of bovine tuberculosis in Ethiopia slaughter cattle based on post-mortem examination. Tropical Animal Health and Production, 41: 755-765. Doi: 10.1007/s11250-008-9248-9

Department of Agriculture and Rural Development (DARD) (2008). Northern Ireland. Bovine tuberculosis in Northern Ireland. https://www.daera-ni.gov.uk/articles

Egbe N, Muwonge A, Ndip L, Kelly R, Sander M, Tanya V and NguNgwa V (2016). Abattoir-based estimates of mycobacterial infections in Cameroon.Under-review. Scientific Reports,6:24320. doi:10.1038/srep24320

FAO (2009). Livestock production primary. Food and Agriculture Organization of the United Nations, Rome, Italy.

Firdissa R (2006). Preliminary study on bovine tuberculosis in and around Sulultatown, North shoa zone of Oromia.DVM Thesis, Addis Ababa University, Faculty of VeterinaryMedicine, DebreZeit, Ethiopia.

Hlokwe TM, van Helden P and Michel A (2013). Evaluation of the discriminatory power of variable number of Tandem Repeat Typing of Mycobacterium bovis isolates from Southern Africa. Transboundary and Emerging Diseases, 60: 111-120: DOI: 10.1111/tbed.12096

Mario R (2014). The end TB strategy. Geneva: World Health Organization. pp. 1–20.

MOA (1973). Ministry of Agriculture, Meat Inspection Regulation; Legal Notice Number 428 NegaritGozete. Addis Ababa, Ethiopia.

Nasaka J (2014). Occurrences of bovine tuberculosis in slaughtered cattle. MSc thesis. Environment and Natural Resources Management, pp.1-86. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.904.8928&rep=rep1&type=pdf

Nicholson M and Butterworth M (1986). A guide to condition scoring of zebu cattle, ILRI/FAO, Addis Ababa, Ethiopia. http://pdf.usaid.gov/pdf_docs/PNAAV664.pdf

Pace JE and D Wakeman (2003). Determining the age of cattle by their teeth. Animal science Department, Institute of Food and Agricultural Sciences, University of Florida USA. https://pdfs.semanticscholar.org/1cb1/24144fd8aab7dbdb568d922950fb71e46826.pdf

Pal M, Zenebe N and Rahman MT (2014). Growing significance of mycobacterium bovisin human, health. Microbes and Health, 3:29-34.

Radostits O, Gay C, Kenneth WH and Constable P (2007). Veterinary Medicine. A textbook of the disease of cattle, horses, sheep, pigs and goats; 10 ed., London, Ballieri Tindals, pp: 1007-1021.

Russell D (2003). Highlighting the parallels between human and bovine tuberculosis. Journal of Veterinary Medicine Education, 30: 140-142. Doi: https://doi.org/10.3138/jvme.30.2.140

Shitaye B, Getahun T, Alemayehu M, Skoric F, Treml P, Fictum V, Vrbas I and Pavlik J (2006). A prevalence study of bovine tuberculosis by using abattoir meat inspection and tuberculin skin testing data histopathological and IS6110 PCR examination of tissues with tuberculous lesions in cattle in Ethiopia. VeterinarianMedicinal, 51: 512-522.

Taracha E, Bishop A, Musoke A, Hill S and Gilbert S (2003). Heterologous priming boosting immunization of cattle with mycobacterium tuberculosis 85aindces antigen specifics T-cell response. Infection and Immunity, 71: 6906-6914. Doi: 10.1128/IAI.71.12.6906-6914.2003

Tefera D (2009). A cross-sectional study of bovine tuberculosis in Adama municipal abattoir. Central Ethiopia, DVM Thesis, Gondar University, Faculty of Veterinary Medicine, Gondar, Ethiopia. https://www.idosi.org/aejsr/9(5)14/1.pdf

Teklu A, Asseged B, Yimer E, Gebeyehu M and Woldesenbet Z (2004). Tuberculous lesions not detected by routine abattoir inspection: the experience of the Hossana municipal abattoir, Southern Ethiopia. Revue scientifiqueet technique (International Office of Epizootics) Rev. Sci. Tech. Off. Int. Epiz., 23(3): 957-964.

Terefe D (2014). Gross pathological lesions of bovine tuberculosis and efficiency of meat Inspection procedure to detect infected cattle in Adama municipal abattoir. Journal of Veterinary Medicine and Animal Health, 6: 48-53. Doi:10.5897/JVMAH12.015

WHO (2013). Fast Facts on Tuberculosis (TB) Stop TB Partnership. World Health Organization, Geneva, Switzerland. http://www.stoptb.org/assets/documents/resources/publications

WHO (2014). Global tuberculosis report. World Health Organization, Geneva, Switzerland, pp.1-32. Doi*:* http://apps.who.int/iris/bitstream/10665/137094/1/9789241564809_eng.pdf

To cite this paper: Pal M, Zenebe N, Amare T and Woldemariam T (2017). An Abattoir based Study on Bovine Tuberculosis in Debre Zeit, Ethiopia. *World Vet. J.* 7(3): 101-107. DOI: http://dx.doi.org/10.5455/wvj.20170899
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