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Ante mortem diagnosis of tuberculosis in cattle: A review of the tuberculin tests, γ-interferon assay and other ancillary diagnostic techniques

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Abstract

The early, preclinical stages of bovine TB can be detected in live animals by the use of tests of cellular immunity (the skin, γ-interferon and lymphocyte transformation tests). Tests of humoral (antibody) immunity, *Mycobacterium bovis* PCR probes on early tissue cultures or live cattle specimens, and tests based on "electronic nose" technology have been developed more recently. The key measure of diagnostic test accuracy is the relationship between sensitivity and specificity, which determines the false-positive and false-negative proportions. None of the tests currently available for the diagnosis of bovine TB allow a perfectly accurate determination of the *M. bovis* infection status of cattle. Although various factors can reduce the sensitivity and specificity of the skin tests, these remain the primary ante mortem diagnostic tools for TB in cattle, providing a cost-effective and reliable means of screening entire cattle populations. Despite the inescapable limitations of existing diagnostic tests, bovine TB has been effectively eradicated from many developed countries and regions with the implementation of sound programmes of regular tuberculin skin testing and removal of reactors, coupled with slaughterhouse surveillance for undetected infections, repeat testing and culling of infected herds, cattle movement restrictions to prevent introduction of infected animals and occasional slaughter of entire herds with intractable breakdowns. This is likely to remain the mainstay of bovine TB control programmes for the foreseeable future. Additionally, newer ancillary in vitro diagnostic assays are now available to TB control programme managers to supplement the skin tests in defined circumstances according to the specific disease situation in each country or region. The strategic deployment of ancillary in vitro tests alongside the primary skin tests has enhanced the detection of *M. bovis*-infected cattle and reduced the number of animals slaughtered as false positives.
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Keywords: Bovine tuberculosis; Diagnosis; Tuberculin test; γ-Interferon test; Sensitivity; Specificity

1. Introduction

'Tuberculosis' (TB) is a clinical or pathological diagnosis that, by convention, refers to the clinical signs (or lesions) caused by infection with bacteria of the *Mycobacterium tuberculosis* (MTB) complex. The cornerstone of TB control in cattle and other species is the accurate detection and removal of animals infected with *Mycobacterium bovis* (*M. bovis*), the member of the MTB complex responsible for the vast majority of TB incidents in cattle (bovine TB). Infection of cattle with this organism is usually chronic and can remain subclinical for a long period. Importantly, infected cattle can become infectious long before they exhibit any obvious clinical signs or lesions typ-

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RESEARCH ARTICLE

Spatial Dynamics of Bovine Tuberculosis in the Autonomous Community of Madrid, Spain (2010–2012)

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Data Availability: The authors confirm that, for approved reasons, some access restrictions apply to the data underlying the findings. Data used in this study are available upon request to the official veterinary services of the Autonomous Community of Madrid but cannot be made freely available to the general public due to legal restrictions. The reason for this is that data used here come from the official records of the bovine tuberculosis eradication campaigns in the region of Madrid, and contains private information that cannot be disclosed without the individual agreement of each of the farmers tested in the eradication program. Data may be provided to any interested party that request it to the official veterinary services provided that any information that could lead to the individual identification of a given farm (such as its individual spatial location - coordinates - or the results of any individual herd test) is conveniently removed. Aggregated data at the county/year level can be shared without any inconvenience if a request is made. Requests should be directed to the head of the livestock area of the regional government of the Autonomous Community of Madrid, Ms. Rosa Diaz (rosa.diaz@madrid.org).

Abstract

Progress in control of bovine tuberculosis (bTB) is often not uniform, usually due to the effect of one or more sometimes unknown epidemiological factors impairing the success of eradication programs. Use of spatial analysis can help to identify clusters of persistence of disease, leading to the identification of these factors thus allowing the implementation of targeted control measures, and may provide some insights of disease transmission, particularly when combined with molecular typing techniques. Here, the spatial dynamics of bTB in a high prevalence region of Spain were assessed during a three year period (2010–2012) using data from the eradication campaigns to detect clusters of positive bTB herds and of those infected with certain *Mycobacterium bovis* strains (characterized using spoligotyping and VNTR typing). In addition, the within-herd transmission coefficient (β) was estimated in infected herds and its spatial distribution and association with other potential outbreak and herd variables was evaluated. Significant clustering of positive herds was identified in the three years of the study in the same location ("high risk area"). Three spoligotypes (SB0339, SB0121 and SB1142) accounted for >70% of the outbreaks detected in the three years. VNTR subtyping revealed the presence of few but highly prevalent strains within the high risk area, suggesting maintained transmission in the area. The spatial autocorrelation found in the distribution of the estimated within-herd transmission coefficients in herds located within distances <14 km and the results of the spatial

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HSOA Journal of Archives of Zoological Studies
Review Article

A Review on: Current Diagnostic Techniques of Bovine Tuberculosis

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Summary

Bovine tuberculosis is an infectious disease caused by *M. bovis* which belongs to MTBC that affects cattle, other domesticated animals and certain free or captive wild species. Bovine tuberculosis occurs worldwide and because of the zoonotic implications of the disease and production losses due to its chronic and progressive nature, eradication programs have been introduced in many countries. Infection of bovine tuberculosis is often sub clinical; when present, clinical signs are not specifically distinctive. In live animals diagnosed based on the basis of delayed hypersensitivity reactions using various tuberculin tests such as single intra-dermal, comparative intra-dermal, short thermal and stormont tests. After death, infection is diagnosed by bacteriological and histopathological examination and biochemical tests like nitrate reduction, niacin production, deamination of pyrazinamide and susceptibility to thiophen-2-carboxylic acid hydrazide. Tests based on cell mediated immunity like gamma interferon assay, the lymphocyte proliferation assay, the indirect enzyme-linked immune sorbent assay, LAM test, Myco dot antibody test and Molecular tests; polymerase chain reactions, spoligotyping and restriction fragment length polymorphism can be used. The central purpose of this review is to address diagnostic tests for tuberculosis. Considering the course of the infection in cattle, at least two tests, ideally complementary to one another, may be necessary for an adequate diagnosis: the first based on the cellular response, and the second capable of identifying anergic animals by detection of specific anti-*M. bovis* antibodies.

Keywords: Bovine; Diagnostic techniques; *M. bovis*; *M. tuberculosis*

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Introduction

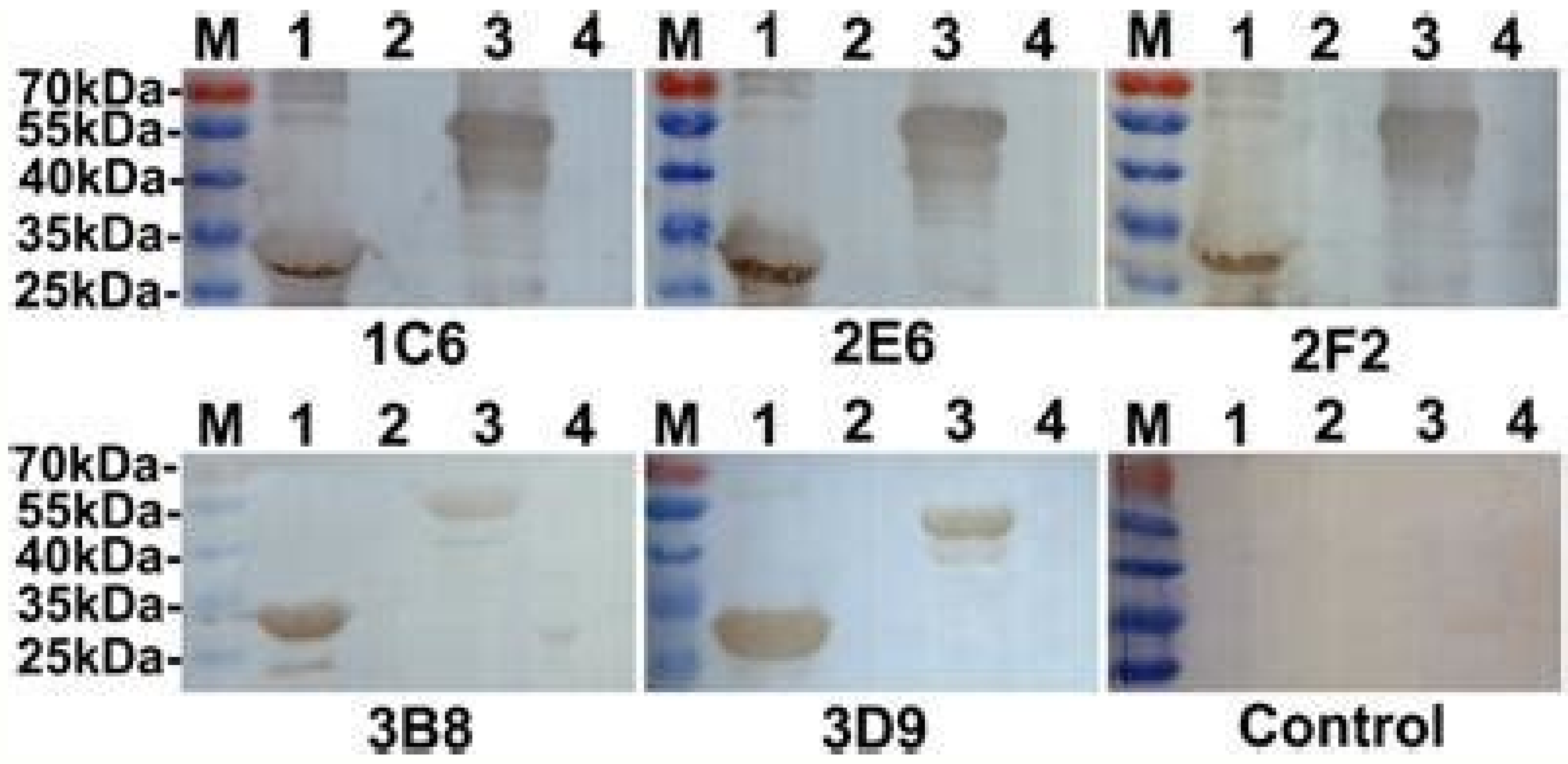
Bovine tuberculosis is an infectious disease caused by *M. bovis* which belongs to MTBC that affects cattle, other domesticated animals and certain free or captive wild species [1]. *B. tuberculosis* occur worldwide and because of the zoonotic implications of the disease and production losses due to its chronic and progressive nature, eradication programmes have been introduced in many countries [2]. *M. bovis* is obligate aerobic non-capsular, none spore forming bacteria. Its cell wall is rich in lipids which is responsible for acid fastness and hydrophobicity. Its waxy coat lipid layer, mycolic acid, contributes greatly to resistance of the bacteria towards many disinfectants, antibiotics and physical injuries. It may also reduce growth rate of some species by limiting the uptake of nutrients [3]. *B. tuberculosis* is a chronic debilitating and highly contagious disease of cattle characterized by nodular granuloma or tubercle formation with resultant caseation and calcification in many of the vital organs especially in the lungs, lymph nodes, intestine and kidney except skeletal muscles [4,5]. In developing countries, BTB is enzootic and has an impact on animal and human to causes significant economic loss due to high cost of eradication programs and has serious consequences for movements of animals and their products, biodiversity, public health and significant economic effects [6,7].

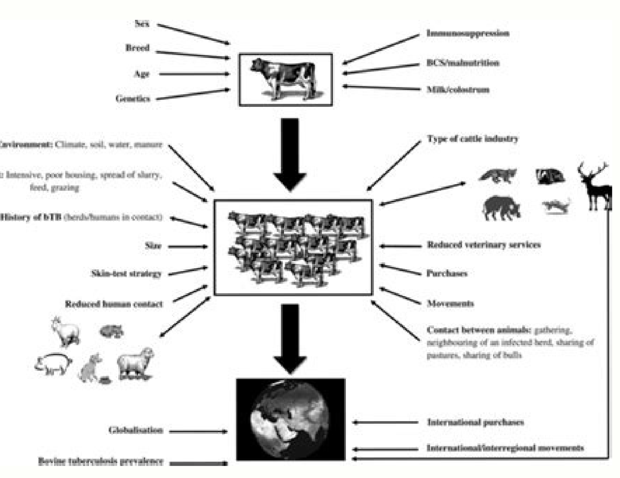
Existing strategies for long term *B. tuberculosis* control or eradication campaigns are being reconsidered in many countries because of the development of new testing technologies, increased global trade, continued struggle with wildlife reservoirs of *B. tuberculosis*, redistribution of international trading partner or agreements and emerging financial and animal welfare constraints on herd depopulation [8]. *M. bovis* shows a dysgenic colony shape on Lowenstein-Jensen medium and micro aerophilic growth, while *M. tuberculosis* shows eugenic colony shape and aerophilic growth [9]. New molecular methods have been developed that provide clear criteria for the identification of *M. bovis*. These comprise a variety of Polymerase Chain Reaction (PCR) methods, which is based on DNA sequence variations in the direct repeat region of *M. tuberculosis* complex strains [10]. Not only molecular methods but also there are serological tests such as tuberculin test, gamma interferon assay, enzyme linked immune sorbent assay, mycodot antibody test and LAM test for detecting circulating antibodies and lymphocyte transformation [11].

Because of the dynamics of *M. bovis* transmission, the microscopic size of early lesions and the time it takes for an animal to mount a detectable immune response, no single ante (or post) mortem test for TB can be expected, on its own, to detect every infected herd and every infected animal in such herds [12]. As a result multidisciplinary approach must be employed based on current status of the disease [13]. Therefore; the objective of this review paper is to give concise review on various diagnostic techniques of bovine tuberculosis.

Specific objectives

- To address the current diagnostic test of bovine tuberculosis
- To address sensitivity and specificity of current diagnostic tests of bovine tuberculosis





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The translocation of the Kafue lechwe to game ranches was carried out without prescreening for BTB. bovis is smaller than that of M. Bovine tuberculosis (BTB), caused by Mycobacterium bovis (M. bovis infection in humans is still unknown more so that the disease is clinically indistinguishable from that caused by M. This figure may be higher considering that abattoir-based meat inspection relies heavily on visible gross lesions which may be missed if such lesions are discrete and small. YearNo. animalsReference197094,075Bell et al., 1973197193,215Bell et al., 1973197293,158Bell et al., 19731973109,612Osborne et al., 1975197580,774Osborne et al., 1975198145,867Howard et al., 1983198341,155Howard et al., 1983198750,715Howard et al., 1987198865,018Howard et al., 1988198947,145Jeffrey et al., 1991199044,538Jeffrey et al., 1991199168,872Jeffrey et al., 1991199364,940Kapungwe, 1993199450,000Jeffrey, 1994199945,000Kampamba et al., 1999200142,119Kamweneshe et al., 2002200538,000Chansa and Kapamba, 2010Host FactorsEnvironmental factorsPathogenHigh Cattle densitiesSwampy/Marshy environmentsShowed maintenance in lechwe antelopes for a very long time establishing reservoir host potentialHigh Lechwe densitiesMoist pastures for most parts of the yearShown potential for interspecies and intraspecies spreadHigh Cattle/lechwe interaction heightening potential of aerosol route of infectionMoist soil conditionsLechwe lekking behaviorShrinking grazing groundsAlien invasive weeds (Mimosa pigra) spreading on already shrinking pasturesOverlapping grazing grounds for lechwe antelopes and cattleBovine tuberculosis in the Kafue basin has persisted since 1969 during which after a cropping exercise, it was realized that 14.0% of the lechwe antelopes had BTB [25]. tuberculosis patterns [6].Although members of the Mycobacterium tuberculosis complex (MTC) are responsible for the majority of mycobacterial infections worldwide, nontuberculous (NTM) A group of atypical mycobacteria or mycobacteria other than tuberculosis (MSTT) is becoming increasingly becoming an importance of public health [1, 4]. In this, the cattle of different villages and families can be maintained in a large herd, especially during transhumance and those that are permanently resolved in the areas of the interface, away from the most reasons for security reasons. In Zambia, the general lack of knowledge about zoonotic tuberculosis [37] poses another risk factor for the ease of contracting the disease [37]. Therefore, it is imperative that a "free herd of" BBTB of Kafue Lechwe will be generated as breeding actions for the translocation of play ranches and for conservation purposes. Economic implications. The developed world that recognized the importance of eradicating livestock disease, most of African countries, including, argue that BTB is not a disease of national economic importance and, as such, there is a lack of political will and measures of Intervention of the respective ones. Governments Unfortunately, due to cost implications, such a scheme in most African countries still facing serious challenges.6. Publications Publications of Public Health Zambia, the burden of the implications of the conservation of M. to the decrease in the population in the Kafue Lechwe (Table 1), the Natural Life Authority of Zambia (Zawa) has embarked on strategies of conservation designed to save the remaining population of the possible extinction [16]. It has been observed that several factors associated with BTB have been observed in livestock herds [44]. It is also believed that annual temporal floods play a role in propagation and the diffusion of microorganisms in the environment (a point that needs an additional study and elaboration), while the of animals during lekking (mating season) with extra-wide assemblies at watering points increases The animal direct to animal transmission due to the contagious nature of the disease [39]. 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Bovis within LECHWE's own antípes [22, 29, 38]. This requires greater research on the determinants of ecological and biological disease of mycobacteria infections in cattle / wild wildlife a odanitsed saitoozipe sal artnoc ahcul ed odnof nu rop sadadlapser ratse nebed lortnoc ed sadidem satsE .n³Âicnitxe ed orgilep ne ,)sisneufaK ehcel suboK(ewhcel eufaK epolÂtna le arap adeuq euq larutan tatib¡Âh ocinºÂ le se eufaK led acneuc al ed ametsisoce lE .]21[setneyulcnoc etnemetneicifus ol odis nah on soidutse sotse euqnua ,anamuh y anivob n³Âicalbop al ertne BTB ed n³Âicaicosa elbisop anu odiregus nah aibmaZ ed aÂredanag atla ed sanoz ne sodazilaer socig³Âloimedipe soidutse ,ograbme niS .]32²â²â¢Â91[socits©Âmod omoc sertsevlis selamina ne otnat BTB ed aicnelaverp adinetsos y adavele al rop odazanema ev es euq otneimiconocer nu ,aredanag n³Âiccudorp ed anoz etnatropmi anu omoc adacifitnedi odis ah n©Âibmat acneuc aL .M y munacirfa .ewhcel sepolÂtna sol a etnemacinºÂ ³Âtimil es dademrefne aL .M a adibed)asoiccefni(atreiba ranomlup sisolucrebut ed ollorrased ed ajab etnemavitaler aicnedicni aL .M o sivob .sonairetcabocim soneg³Âtap sol ed n³Âicagaporp y otneiminetnam le ne etneibma oidem le y socits©Âmod selamina sol ,ertsevlis anuaf al ed lepap le ranimreted etnatropmi se ,ertsevlis adiv/oredanag zafretni ed saer¡Â sal ne anivob sisolucrebut al ed lortnoc le arap sacitÂlop otsiverp nah es euq zev anUn³ÂisulcnoC .9.elbacitcarpmi odneis eugis otnemom le rop sanucav ed osu le ,ollorrased ne sesÂap sol ed aÂroyam al ed sosrucer ed n³Âicautis al adaD .seicepse ertne lortnoc ed saigetartse ed aen¡Âtlumis n³Âicacilpa al noc sertsevlis y socits©Âmod selamina ertne n³Âiccaretni al ratimil adneimocer eS .ertsevlis adiv/odanag zafretni al ne n³Âiccefni ed ladomib aÂv anu odalutsop ah es ,BTB al ed n³Âisimsnart ed senortap sol y lausac lepap le recelbatse arap etneicifed se lautca arutaretil al euq ed rasep A .]82 ,31 ,21[eufaK ed acneuC al ed areuf y ortned sadavresbo saicnerefid sal arap sovitacifingis socig³Âloportna setnanimreted adidem royam ne odiregus nah n©Âibmat soidutse sol ,socig³Âloib y socif¡Ârgoeg serotcaf noc n³Âicanibmoc nE ed ed lanoicceridib odom nu ed dadilibaborp al a odibed n³Âicautis al s¡Âm nºÂa acilpmoc ertsevlis o aredanag n³Âicalbop anu ed aicnetsixe al ,s¡ÂmedA .soredanag sol a With a possible contamination of the environment [43]. The compilation of slaughterhouses carried out by the Veterinary Department in the same report indicates that 1.6% of cattle slaughtered in a slaughterhouse of Lusaka had tuberculous injuries; 2% in a slaughterhouse of Livingstone; 5.2% in Mazabuka and 16.8% in Namwala [10]. The studies on the Epidemiology of BTB in Zambia indicate that the disease is not distributed as a homogenous manner. However, high prevalence rates have been recorded inside and around the Kafue basin, an area where the pastures of wild and domestic animals [11â € ™ ²13] are widely superimposed. Given that all the Kafue Lechue Antípes currently raised in Zambia Hunting Farms come from the Kafue basin, particularly the northeastern region of Lochinvar, it is likely that the disease has been introduced from LECHWE transferred from the basin of Kafue In Zambia, the BTB was notified in bovines already in 1947, when the Veterinary Department diagnosed the disease in Nega Nega, Kabwe and Mazabuka cows [10]. As a result, there is a great exchange of livestock between families and towns, which implies that the cattle is not maintained in locations closed or stable due to these movements inside and between herds and kraals. In order to foster the success of these animals in the hunting farms, it is imperative that a reproductive livestock "free of BTBÂ" is created for transfer to the game farms. The presence of bovis in man is almost certainly owed to immunological factors that can be suppressed in HIV / AIDS. However, it is believed that the gregarious nature of the LECHWE antilapes with higher herd densities obtained in more dry stations facilitates the intraespecia transmission of M. It is likely that, despite the shortage of information in this region, together with the non-milk pasteurization, the Bovine is predisposed as a possible source of zoonotic TB for man [36]. The reference epidemiological data have persistently notified bovine tuberculosis findings (BTB) (BTB) Both wild and domestic animals, although in the notified observations have not been described direct tests of the role of LECHWE or livestock antilopes. When control measures are foreseen, it is important to take into account the factors that intervene in the epidemiology of the disease. The bibliography available on the crude pathological distribution of tuberculous lesions in both bovine and lechwe antotes indicates a respiratory time of infection [13, 15, 22] with more than 60% of tuberculous lesions in bovines (Figure 3) As in lechwe anti-items (Figure 4) confined to the lungs (Figure 3 and 4). These herds return to the villages during the rainy season (from November to April). The situation is widely widened by the adequate habitation reduction due to the rapid invasion of the invasive alien geese (mimosa pygra) and the interruption of the flood cycle by the dam of the river Kafue upstream in Itezhi- Tezhi [24]. However, in the wild fauna populations that live, control measures, such as testing and sacrifice plans applicable to cattle, are not practical. The LECHWE and livestock anti-items are usually grazing together during this period (Figure 5). In addition, the choice of measures and viable control strategies must take into account all the key factors typical of each ecosystem. Bovis has suffered numerous suppressions in comparison with M. However, the arguments that BTB in the cattle and wildlife of African countries does not need an intervention based on economic reasoning may not be totally justified. In this complex social system of mutual obligation, livestock is often used as a means of change instead of money. However, the reasons for spatial variations observed in the prevalence of BTB in Zambia need a more detailed explanation .acneuc .acneuc al ne BTB al ed otnetsus le y aicneserp al ed satsinimreted serotcaf sol etneyulcnoc arenam ed ranimreted redop Animals Examined Infected InfectednessElling Reference195 622 * 100% Leroux, 19 561 962Â »14.0% Anonymous, 196 219 711 254 536.0% Gallagher et al., 19 721 972 862 933.7% Gallagher et al., 19 721 973Â» 19 763 009 030.0% Dillman , 19 761 976-197 714 632.6% Rottcher, 19 781 976-1 977 383 323.4% Rottcher, 19 781 976-197 714 753.4% Rottcher, 1 978 19777 * 100% CLANCE, 19 771 977 633 352.4% clancey, 197 719 864 133 * 80.5% Krauss et al., 19 861 990 921 516.3% 119 981 773 419.2% Pandey, 19 982 004Â »200 811 924.3% Munyeme et al., 2010 * Samples of chatatic / and dead animals collected on the Kafue floors. The other species examined by Rottcher [26, 27], the BTB only was detected in an adult ELAND (Taurotragus oryx) that had widespread injuries that affect To the lungs, the pleural and mediastinal lymph nodes [26, 27]. However, some transhumant rebar becomes very large to be kept around the villages, and those rebeans often reside within the wetlands and return to higher lands when there are floods, but without returning to the villages . When these different types of companies were studied in detail, it was found that their prevalence of BTB varied between them [19]. This is because most of the benefits obtained from traditional animals in the rural communities of Zambia are intangible and immeasurable, such as social security, social condition, means of transport and solvency, among others. Oloya and collaborators observed that the BTB was associated with different types of drinking water sources [45]. In summary, it is important to base control policies in objective and emprict evidence that have taken into account critical deterministic factors of maintenance, dissemination, occurrence and susceptibility of the disease. Department of author Ã, © 2011 Musso Munye and Hetron Mweeemba Munangâ € ™ Andu. It is characterized to a greater extent A high prevalence of the BTB level in bovine cattle, around 50%, while a comparatively lower prevalence in the sheath, an average of 5.6%. 5.6% Determined in areas outside the basin [11, 19]. Bovis [5]. Despite the continuous reduction of annual rain figures, the Kafue Basin still is one of the few ecosystems of Lacerkan wetlands in Zambia that support a livestock population estimated at 300,000 animals [17] to a density of transport of 50 animals per square kilometer and approximately 38,000 Lechwe antílopes [16] in a wetland of 6,000 square kilometers [18]. The disease has a historical presence in the Kafue basin that grants the identification of the area as a protected ecosystem and Ramsar site No.530 [16]. The antilage of Kafue Lechwe, which is endless only for the Kafue basin of Zambia, is particularly vulnerable, given the persistent reports of high tuberculosis prevalence, high-scale rates and high human liquidation pressure, together With the increase in grazing pressure in few grasslands available to resurface the cattle shelves. Among other biological and anthropological factors (Table 2). The additional benefits are through an increase in the efficiency of production to subsistence agriculture with most resources, traditional farmers deficient depend totally from livestock as the only source of sustenance. It has been shown that the first six M. ancestral M. In addition, other molecular biological studies involving DNA writing have shown that the cultivation of M. selective old-weakened animals can also be used to eliminate chronic liquids of the illness. In the same way, it is not known how much (BTB) has the potential to cause diseases in humans. Therefore, despite the low returns perceived in BTB's control by many African countries, the benefits that accompanies the eradication of the problem are incomparable. All in all, these factors Vital to formulate work control strategies for BTB livestock. Given the lack of diagnostic services in most rural environments where BTB prevalence is high in livestock populations, the possible cases of BTB can become undetected [12]. 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Bovine tuberculosis in Lechwe Antelopes (Kobus leche kafuensis) It has been reported that over the past 75 years, the lechwe kafue population has decreased by 85% from 250,000 animals in 1931 to 38,000 in 2005 (Table 1) [16]. africanum are all human pathogens with M. This is complicated when the probability of cattle movement on that farm is high [32], an important point to take into account in the Kafue Basin due to the high patterns of interaction between the different cattle herds and domestic animals. africanum are all human pathogens with M. This is complicated when the probability of cattle movement on that farm is high [32]. wildlife populations. Before proposing intervention strategies, factors relating to patterns of interaction within cattle and wildlife herds should be analysed and possible transmission routes determined [35]. The 1956 annual veterinary report highlighted a number of areas where the disease was diagnosed: Abercorn (today Mbala), Broken Hill (today Kabwe), Mazabuka, Monze, Namwala and Kalomo [10]. BTB has also been shown to be associated with communal grazing, animal breed type and livestock practices [44]. Since then, BTB of Kafue lechwe has been inadvertently detected on hunting ranches [34]. The net results of these economic benefits of disease-free livestock and wildlife can have a significant stimulus and drip effect on the country's Gross Domestic Product (GDP).This BTB-free status can be achieved by developing rational and realistic strategies able to control M. More recent studies by Pandey [13] showed a prevalence of 19.2% () in the Lochinvar NP, while Munyeme and his companions [15] recorded a prevalence of 24.3% () for the period from 2004 to 2008 on the northern shores. and southern Kafue flats, indicating the continued existence of BTB in the Kafue lechwe (Table 3). environmental, host and agent attributes are optimal for transmission [34, 39], a characteristic that some some some have drawn up remotely remember the region of the Kafue basin [19]. Non-tuberculous mycobacteria (NTM) include both slow-growing mycobacteria (SMG) that require at least seven days to form colonies, and fast-growing mycobacteria (SMG) that form colonies in less than seven days [1]. With M. tuberculosis it has been present longer than M. Observations like these are very important for establishing viable control programs in the future when looking for public awareness and education campaigns. It can be argued that Western methods of cost-benefit analysis may underestimate the value of a cow's loss due to the condemnation of a carcass at the slaughterhouse as a result of widespread BTB, not to mention the threat it poses to slaughterhouse workers [7, 8]. Similarly, Rothschild and colleagues successfully applied spoliotyping to a skeletal specimen of an extinct 17,000-year-old American bison and the patron revealed that the respective bacteria were probably not related to M. microti, but M. microti. Studies have also shown that herd size influences the prevalence of BTB [12, 30, 31, 46, 47]. These results suggest that environmental contamination of pastures may be a less effective method of interspecies transmission between lechwe and cattle in the Kafue Basin. As the size of herds increases, most livestock owners begin to take their animals to wetlands (deep in grazing areas) for pasture during the drier months (May to October), where pastures are abundant. As far as wildlife is concerned, the identification and elimination of infected animals and the creation of disease-free ex situ populations for future repopulation in depleted national parks is concerned. of the most viable control options. In addition, LECHWE antilapes have been described as wild reservoirs from BTB in Zambia [14, 15]. In addition, the increase in human settlements within and around the Kafue basin has led to a decrease in grazing pasture For antelopes Kafue Lechwe, despite a corresponding increase in the population of cattle that share the same pasture. BOVIS is M. BOVIS being naturally resistant to a first-line anti-tuberculosis drug (pyrazamide) and a threat of its possible circulation in humans may cause concern even though the probability is remote. Transmissionin The Kafue Basin, M. This is an Open Access article licensed under a Creative Commons Attribution License, which allows its use, distribution and reproduction without restriction in any medium, as long as the original work is cited correctly. The danger of translating animals infected with BTB is that they could serve as a source of new infection in new areas of NaÃÂ¯ve, subsequently introducing the disease to other ex situ canned animal species that would eventually reach the human food chain. Between 1973 and 1974, they recorded a prevalence rate of 49% [25]. This paper aims to highlight those areas that need further research and to update the available data on BTB in the Kafue Basin with respect to prevalence, distribution, risk factors, threats to wildlife conservation, livestock production, public health implications and possible mitigation measures.. 1. Introduction The origins of mycobacterial infections despite being ancient diseases have been the subject of much debate [1, 4]. Studies have indicated a high proportion of pastoralist communities within the Kafue basin that do not pasteurize their milk, because they want to consume it in a sour way such as taste or traditional local yogurt [28, 37]. Tuberculosis [7, 12]. The lack of empirical evidence on the factors contributing to the significant decrease in the population of Kafue Lechwe has several academics to postulate different Causes [13, 22, 23, 33]. In 1972, they examined a total of 86 animals and recorded a prevalence of 33.7% (29/86) (Table 3) [25]. Tuberculosis implies that the origin of M. tuberculosis and M. 4. Saids are known as interface interface (IFR). By 1971, Gallagher and the collaborators of him had examined 125 Lechwe antotes sacrificed in a cultivation exercise and recorded a prevalence of 36% (45/125) [25]. Until now, approximately 700 Kafue Lechwe antíbles have been transferred from the Kafue basin to hunting ranches. Studies have shown elevated interaction points in bovine and lechwe during the most dried months (Figure 2) [40]. Therefore, to evaluate the real economic impact of the BTB in the traditional livestock sector of Zambia, reliable and precise epidemiological and socioeconomic information is needed on the exact impact of the disease, therefore its propagation, maintenance, prevalence, socioperturbance disturbances , convictions in the slaughterhouses, etc. The diagnosis of tuberculosis in wildlife has long-range and severe consequences both nationally and internationally. In the Kafue basin there are three types of livestock farms according to the grazing strategy and the size of the reduction. However, the real value of an animal in a Pastora Zambian community is not based on the commercial value at the point of sale. However, what is common among all scholars is that they sign the likelihood that BTB perform a primary primary immunosuppressive paper due to its chronic nature or proxy role for other coinfections such as parameses and possible factors of Nutritional and related stress [13, 22, 23, 33]. In response to Zawa's call to preserve the remaining Lechwe antotes, ex-situ Conservaciones have begun to raise Kafue Lechwe outside the harasses protected by The Government in public-private partnerships (PPP), where preserved animals are maintained in private hunting ranches but are still considered government property. The same study also indicated that the BTB is linked to certain geographic regions of ne ne euq laugi la ,socinºÂ soÂfased sus eneit ametsisoce adac ,s¡ÂmedA .7 .]54[n³Âicavresbo atse nabacilpxe euq serotcaf sol etneyulcnoc amrof ed nabacidni es on euqnua Kafue basin where control strategies should take into account the complex nature of the property of livestock and other local practices of livestock owners [35]. Due to the impracticability of other control measures, the key factor in the livestock / wildlife interface area is to reduce or completely eliminate the contact of interspecies. This practice of taking animals to the flood plains in the dry months is known as transhumance, and the herds of cattle that are practiced by this type of grazing strategy are known as rebar of transhumants (TH). Therefore, tuberculous animals live longer and have a long period of transmitting the disease to other animals. (A) (b) (a) (b) 8. However, with wildlife, the detection of infected animals is difficult for restriction mode that is prohibitively expensive, since it is based on the delivery of chemical products through © s of the darts (projectiles) triggered of special weapons. However, through the works of Brosch and Works of work, they have been able to demonstrate that the genome of M. The lack of infectious accounting diseases in wildlife populations can mean greater ecotourism, which is a source Direct foreign income much needed in Zambia and other developers. equal equals. Bovis infection has persisted both LECHWE and livestock for a long time without understanding the conditions the causative relationship between LECHWE livestock and antilopes [15]. [fifteen].

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