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Review on the Prevalence, Risk Factors and Its Public Health Importance of Bovine Tuberculosis in Ethiopia

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Abstract

Mycobacterium bovis is an intracellular, non-motile, facultative, weakly Gram positive acid-fast bacillus which belongs to the Mycobacterium tuberculosis complex. The pathogen affects all age groups of susceptible hosts of domestic, wild animals and human. In cattle, Bovine tuberculosis is one of the endemic chronic diseases of cattle that have long been recorded in Ethiopia. The disease has been reported from several parts of the country mainly based on tuberculin tests and abattoir inspections. Studies undertaken in several parts of the country have indicated that, the individual animal and the herd level prevalence rate of Bovine tuberculosis. Recently undertaken studies indicated the prevalence rate of BTB with a range of 3.4% (in small holder production system) to 50% (in intensive dairy productions) and a range of 3.5% to 5.2% in slaughter houses in various places of the country. BTB in cattle remains to be a great concern due to the susceptibility of humans to the disease. *Mycobaterium bovis* was also confirmed to be a cause of human infections in the country. However, very little information on the extent of *Mycobaterium bovis* either as an animal or human health problem are available and the current actual prevalence rate of Bovine tuberculosis at a national level is yet unknown. No infection due to *Mycobaterium bovis* was reported in Ethiopia wildlife population so far. In Ethiopia, cattle breeds, age, sex, body condition score and herd size, management condition, geographical origin, consumption of raw milk and close contact to livestock are most commonly identified risk factors for spread of *Mycobaterium bovis*. Although, the disease represents a potential health hazard to all susceptible hosts, the economic effects of the disease are not well studied. With the exception of few attempts like condemnation of carcass and organs during meat inspection, culling of infected animals in some government owned farms and pasteurization of milk, effective disease control strategies do not yet established in our country.

Keywords: Bovine, Ethiopia, *Mycobaterium bovis*, Occurrence, Tuberculosis, Risk Factors.

Introduction

BTB (Bovine TB) is an infectious disease caused principally by *Mycobacterium bovis* (M.B.), which is a member of the Mycobacterium tuberculosis complex (MTC). Although cattle are susceptible to *M. bovis* infection and are the preferred host for *M. bovis*, the disease has been reported in many other domesticated animals, wildlife and humans [1- 3]. Aerosol exposure to *M. bovis* is believed to be the most frequent mode of transmission in cattle, but infection by ingestion has also been reported previously [4]. Human beings can also acquire the infection either by inhalation or ingestion [5, 6]. Thus, BTB is a disease of major socio-economic importance, with an impact of loss in animal productivity, international trade of animals and animal products [7].

Mycobaterium bovis is among a pathogenic species which belongs to the Mycobacterium tuberculosis complex (MTBC), a group of genetically closely related to mycobacteria [8]. *Mycobaterium bovis* (*M. bovis*) is an intracellular, non-motile, facultative, weakly Gram-positive acid-fast bacillus. The MTBC sub-group also comprises *M. tuberculosis, M. africanum, M. canettii, M. pinnipedii, M. microti* and *M. caprae* that are generally regarded as host adapted but with the ability to spill over into other species. *Mycobaterium bovis* is the primary cause of bovine tuberculosis (BTB). *M. tuberculosis, M. africanum, M. caprae* and *M. canettii* are human pathogens. M. caprae which causes infection in goats has been initially classified as subspecies of *M. bovis* but was recently recognized as a species on its own. *M. microti* affects rodents and *M. pinnipedii* have been isolated from seals [9]. *Mycobaterium bovis* has an exceptionally wide range of mammalian hosts and affects all age groups of susceptible hosts of domestic, wild animals and humans [9]. Cattle are the most common maintenance host for *M. bovis* infection from which transmission can occur to wildlife, or people animals [10].

The BTB is a chronic contagious debilitating disease of animals associated with progressive weakness/emaciation and tubercle (granuloma) formation, mainly confined to respiratory system (primarily in the lungs) and occasionally in other organs [11]. The infection to bovine can occur through the colostrum/milk to calves, ingestion of feed contaminated with feces of infected animals, aerosol, contact with each other and other wildlife [12]. The causative agent of tuberculosis (Mycobacterium) can remain viable in the environment/soil for about two years [13]. Various risk factors responsible for the occurrence of disease include calving site, herd size, the length of time calves kept in groups, the breed, the source of replacement, presence of wild animals and the region in which they are kept, presence of mixed (dairy and beef) production, age, housing systems [14].

Ethiopia is ranked top in the list of African countries with large livestock populations and it has been contributing considerable portion to the economy of the country. The 2012/13 livestock survey estimated the total number of cattle, sheep and goat population in the country to be 54 million, 25.5 million and 24 million, respectively. And Amhara Regional State owns 13.8 million cattle, 8.8 million sheep and 5.1 million goats [15]. About 98.9% of the total cattle populations in the country were local breeds and the remaining were hybrid (0.94%) and exotic (0.11 %) breeds. Among a total of 3.4 million cattle population aged _'.S.3-10 years, 12.5% were used for milk production [15]. Even though the livelihood of the people in Ethiopia is extremely dependent on livestock, several constraints including feed shortage, poor genetic performance and diseases prevalence are limiting the livestock production and productivity. BTB is one among the major disease problems reported widely in cattle from different regions of the country [16 - 24].

Prevalence data on BTB infection in Africa is scarce. There is, however, sufficient evidence to indicate that disease is widely distributed in almost all African countries and even is found at high prevalence in some animal populations [25]. However, in the tropical countries including Ethiopia, BTB has been found to affect a higher proportion of exotic breeds than local zebus [26- 28]. Thus BTB is still a great concern in many developing countries and Ethiopia is one of those where BTB is considered as prevalent disease in cattle populations. Its zoonotic implication has also significantly indicated an increasing trend to be of public health hazards [27, 29]. So, the objectives of this seminar paper are to review available literatures on the status of bovine tuberculosis in Ethiopia. Therefore, the objective of this paper was to highlight the occurrence of bovine tuberculosis in Ethiopia.

General information on bovine tuberculosis

Etiology

Bovine tuberculosis is a chronic bacterial disease of animals and humans and is a major infectious disease among cattle, other domesticated animals, and certain wildlife populations in a medium number of countries [5, 30]. Although cattle are considered to be the main hosts of *Mycobacterium bovis* (*M. bovis),* isolations have been made from many other livestock and wildlife species, and transmission to humans constitutes a public health problem [25, 31]. Aerosol exposure to *M. bovis* is considered to be the most frequent route of infection of cattle, but infection by ingestion of a contaminated material also occurs [32].

In addition, a new species, *M. bovis* sub-species caprae, previously classified as *M. tuberculosis* sub-species caprae has been identified as a cause of infection in humans, goats, cattle, deer, and swine [33].

Bovine tuberculosis is mainly caused by *M. bovis* of which cattle are the maintenance hosts. The organism is a Gram positive, acid-fast bacterium in the M. tuberculosis complex of the family Mycobacteriaceae [34]. Taxonomically, Mycobacteria are classified under the order Actinomycetales, which includes among others the genera Mycobacterium, Rhodocccus and Nocardia. *Mycobacteria* are aerobic, non-motile, non-spore forming, straight or slightly curved roads 1.5 to 4 micro meter long and 0.3 to 0.5 micro meter wide [35]. Their cell wall contains a high content of lipids which once stained with carbol fuchsin, cannot be decolorized by acid alcohol: thus the name 'acid fast bacteria' [35]. Therefore, the criterion of inclusion in to this genus is: acid fastness, presence of mycolic acids containing between 60 and 90 carbon atoms and a G+C mole between 61% - 71% [36].

Occurrence

All species, including humans, and age groups are susceptible to *M. bovis*, with cattle, goats, and pigs most susceptible and sheep and horses showing a high natural resistance [37]. In developed countries that have had rigorous tuberculosis (TB) control programs in place for many years, tuberculosis in animals is now a rarity, with occasional severe outbreaks occurring in a small group of herds. The presence of the disease is usually signaled by detection in carcasses at abattoirs [38].

Risk Factors

The major risk factors affecting the occurrence of BTB are environmental, host and pathogen risk factors. Housing predisposes to the disease, as does high stocking intensity and a medium number of animals on a farm so that the disease is more common and serious where these forms of husbandry are practiced [39]. The closer the animals are in contact, the greater is the chance that the disease will be transmitted [35]. In spite of the low overall incidence in countries where cattle are at pasture all the year round, individual herds with 60-70% morbidity may be encountered [40].

Zebu (*Bos indicus)* type of cattle is thought to be much more resistant to tuberculosis than European cattle [41]. The effect of the disease on these cattle are much less severe but under intensive feedlot conditions, a morbidity rate of 60% and a depression of weight gain can be experienced in tuberculous Zebu cattle [38]. The causative organism is moderately resistant to heat, desiccation, and many disinfectants. It is readily destroyed by direct sunlight unless it is in a moist environment. In warm, moist, protected positions, it may remain viable for weeks [42].

Source of Infection and Transmission

As to source of infection, infected cattle are the main source of infection for other cattle. Cattle in the early stages of the disease, before any lesions are visible, may also excrete viable mycobacteria in nasal and tracheal mucus [37]. Inhalation is the almost invariable portal of entry in housed cattle, and even in those at pasture it is considered to be the principal mode of transmission [42].

Diagnosis, Clinical Symptoms and Treatment

Bovine tuberculosis cannot be diagnosed simply because of its clinical symptoms, and the symptoms of the disease are similar with some other livestock diseases. Treatment of BTB is not effective, and the drug used is furthermore excreted with the milk and after termination of the treatment the disease may recur.

Diagnosis

The diagnosis of bovine tuberculosis is not that easy and simple because of its clinical findings. For eradication of BTB on a herd bay her basis, the tuberculin test is applied [37]. The inspection of the carcass of slaughtered animal as an identification technique will give enough indications to ensure the diagnosis. Besides, it is easy to demonstrate the characteristic acid-fast, slender rods in their typical position microscopically with Ziehl-Neelson staining in impression smears from caseous tubercles of affected organs or lymph nodes [33]. The fastidious cultural isolation and identification of the pathogen or the transmission of tissue from affected organs to guinea-pigs will only be required in exceptional case [33].

Clinical symptoms

Although signs referable to localization in a particular organ usually attract attention to the possible occurrence of tuberculosis, some general signs are also evident [37]. Some cows with extensive miliary tubercular lesions are clinically normal but in most

cases progressive emaciation associated with other signs occur, and should arouse suspicion of tuberculosis [37]. A capricious appetite and fluctuating temperature are also commonly associated with the disease [43]. The hair coat may be rough or sleek. Affected animals tend to become more docile and sluggish but the eyes remain bright and alert. These general signs often become more pronounced after calving [38].

Treatment

The risk of shedding organisms, hazards to humans and potential for drug resistance make treatment controversial [37] and, in some countries, it may be illegal. Antimicrobial treatment has been attempted in some species of animals, but the treatment must be long term, and clinical improvement can occur without bacteriological cure. In many cases, the pathogens will not be eliminated from the organisms [37].

The tuberculous process will only be encapsulated and the chronic stage of the disease stabilized. Thus, treated animals will remain carriers and excrete the pathogen. Furthermore, the drug is excreted with the milk and after termination of treatment the disease may recur [37]. Because of the progress being made in the treatment of human tuberculosis with some drugs, the treatment of animals with tuberculosis has undergone some examination and claims have been made for the efficiency of long-term oral medication with both as treatment and as prophylaxis [37].

Public Health Significance

Bovine tuberculosis is a chronic bacterial disease of cattle that occasionally affects other species of mammals [32]. This disease is a significant public health hazard that can spread to humans, typically by the inhalation of aerosols or the ingestion of unpasteurized milk (www: bovine tuberculosis). In developed countries, eradication programs have reduced or eliminated tuberculosis in cattle, and human disease is now rare; however, reservoirs in wildlife can make complete eradication difficult [32].

Control Options, Test and Slaughter and Prevention of Spread

Eradication of bovine tuberculosis has been virtually achieved in many developed countries. The methods used have depended on a number of factors but ultimately the *test and slaughter* policy has been the only one by which effective eradication had been achieved [5].

Control in a herd rests on removal of the infected animals, prevention of spread of infection and avoidance of further introduction of the disease [37].

Bovine tuberculosis in Ethiopia

Ethiopia is one among the nations that possesses the largest livestock population in the African continent with an estimated 56.7 million cattle, 29.3 million sheep, 29.1 million goats and 9.86million equines, 1.2 million camels and 56.7 million chicken [15]. In contrast to the huge livestock resource, the livestock productivity is, however, found to be very low. The major biological and socio-economical factors attributing to the low productivity includes the low genetic potential and performance, poor nutrition (in quality and quantity terms), the prevailing of different diseases, traditional way of husbandry systems and inadequate skilled manpower among others.

Ethiopia is one of the African countries where BTB is considered as protruding disease in animals [43]. Bovine tuberculosis is considered as one of the major livestock diseases that results in high morbidity and mortality [44]. However, still there is lack of knowledge about the actual prevalence and distribution of the disease at a national level. Despite this, the economic impacts and zoonotic importance of the BTB infection are either not well studied or documented [43].

Among the recently undertaken studies, the prevalence rate of BTB ranges from 3.4% in a small holder production system to 50% in intensive dairy productions has been reported in various places of the country [27, 29, 45]. Exotic breeds were found to be more susceptible than cross and local breeds to *M. bovis* with manifestation of high incidence and prevalence rates in Ethiopia [27 - 29]. A herd prevalence rate of 42.6% to 48.6% was found to be higher than the prevalence rate of individual animals (7.9% to 18.7%), that may indicate that the herd size can favour the transmission of BTB in intensive dairy farms in particular [46].

Animal Production Systems and Bovine Tuberculosis

The livestock production systems in the country basically falls into three categories according to the mode of animal
husbandry and/or the production system, as well as the use of livestock products. These production systems include [47].

Integrated extensive and/or pastoral production system

In pastoral areas in particular, the study process can be more complicated by the frequent movement of animals for water (watering points) and to livestock markets. To this effect, animals come together from different directions and due to the enclosure of animals overnight may expose to the increased transmission of BTB, leading to a high prevalence of the disease [48]. This scenario can be more aggravated during a severe dry season, when drought takes place for a longer time in particular, so as animals will get enough time to be in contact with others, that favours the transmission of the infection. From the very few undertaken studies, in an integrated extensive production system in the highlands, the prevalence rates of BTB ranging from 3.4% Regassa [29] to 22.6% Tadele [49] have been reported.

Table 1. Prevalence of bovine tuberculosis detected by tuberculin skin taste by traditionally managed extensive production system.

Area of study	No of cattle			Reference
	Tested	Positive	%	
Assella	281	25	8.9	[50]
Debre-birhan	76	11	14.5	[49]
Kombolcha	53	12	22.6	[49]
Dessie	34	4	11.8	[49]
West-wellega	353	12	3.4	[29]
North shewa	1041	169	16.2	[29]
Total	1838	233	12.9	

Small holder production system

The small holder production system is dominantly practiced in highland areas near towns where dairy animals are reared for subsistence and/or commercial milk production purposes. Under this production system, prevalence studies on BTB have not been conducted adequately, although some cross sectional studies have been undertaken. Among these few conducted studies the prevalence rates of BTB of 5.1% Teshome [50], 4.2%Gemta [51] and 16.2% Regassa [29], have been reported.

Table 2. Prevalence of bovine tuberculosis in small holder dairy farms based on tuberculin test.

Area	No of cattle			Reference
	Tested	Positive	%	
Holleta	381	25	6.4	[50]
Selale	1528	18	5.1	[50]
Wolayta-sodo	416	59	14.2	[29]
Fiche	235	31	4.2	[51]
Wuchale-jida	263	60	7.9	[52]
Assella	514	18	3.5	[53]
Addis Ababa	473	61	12.9	[43]
Total	4818	332	6.9	

Intensive production system

Although some few intensive feedlots exist, dairy production is the major practice of this system, which is targeted for the production of milk and milk products. The total number of the cattle population under this production system is insignificant compared to the national livestock population; however, it is the main source of milk for the city dwellers. Unlike other production systems, better prevalence studies have been undertaken and frequently incidences and higher prevalence rates of BTB have been observed. Based on the undertaken tuberculin skin tests, in different intensive dairy farms, a prevalence rate of 24.3% to 65.8% [28] and 18.7% [46] have been reported

Tables 3. Prevalence of bovine tuberculosis detected by tuberculin skin test in intensive dairy farms.

Area of study	No of cattle			Reference
	Tested	Positive	%	
Addis Ababa	2098	392	18.7	[46]
Ambo	133	37	27.8	[28]
Asella	281	23	8.2	[43]
Debre-Birhan	51	3	5.9	[49]
Debre-Zeit	788	234	29.7	[27]
Debre-Zeit	281	185	65.8	[28]
Dessie	121	89	73.6	[52]
Holleta	70	17	24.3	[52]
Kombolcha	197	96	48.7	[49]
Mojo	493	338	68.6	[50]
Repi	481	310	64.4	[54]
Sebeta	37	4	10.8	[28]
Sellale	44	3	6.8	[28]
Ziway	205	56	27.3	[52]

Meat Inspection at Slaughterhouses

In Ethiopia the routine abattoir inspection involves visual examination and palpation of intact organs like the liver and kidney as well as palpation and incision of the head, lung and other lymph nodes [55]. During observation of the miliary tuberculous lesions in various parts of the carcass (lung, intestine, liver and multiple lymph nodes), the whole carcass is condemned, while condemnation of organs is undertaken if localised tuberculous lesions are observed in parenchymatous organs and their associated lymph nodes [55].

Detection of Tuberculous Lesions at Slaughter Houses

Detection of tuberculous lesions in slaughterhouses takes place by observation of the visible tuberculous lesions in infected cattle; however, the level of the quality of such practices may vary from place to place and/or abattoir to abattoir in the country. The very few studies in Ethiopia have indicated that not all cattle infected with *M. bovis* have visible tuberculous lesions at slaughter [45, 56]. This may limit the sensitivity of this detection technique at abattoirs, although detection of tuberculous lesions through abattoir inspection is so far the common procedure in Ethiopia. Among the undertaken abattoir studies, prevalence rates of7.96% Regassa [29], 5.2% Ameni *et al.* [52], 4.5% Teklu *et al.*[56] and 3.5% Shitaye *et al.* [46], have been reported in different abattoirs in the country (Table 4). The infection rate in cattle has been found to differ greatly from place to place, especially in slaughterhouses recorded as having a low prevalence of the infection. This difference is most probably linked to the type of the production system [46].

Tables 4. Prevalence of bovine tuberculosis detected by abattoir meat inspection in cattle.

City abattoirs	Positive %	Reference
Adama	24.7	[57]
Hawassa	8.8	[57]
Addis Ababa	3.46	[46]
Debre-Zeit	0.18	[55]
Dire-Dawa	0.05	[55]
Gonder	0.02	[55]
Hossana	4.53	[56]
Kombolcha	0.46	[44]
Makele	1.83	[55]
Nazareth	5.16	[58]
Wolaita-Sodo	7.96	[29]
Dilla	2.6	[59]
Nekemte	5.9	[60]

Economic Importance of Bovine Tuberculosis.

Animal tuberculosis is a disease of high economic relevance within the context of livestock farming as it directly affects animal productivity. The disease considerably reduces milk and meat production of infected animal and affect animal reproduction as well as it reduce pulling power in traditional farming system [7]. Tuberculosis has also an economical and financial burden to society human health costs. The disease become is an obstacle to socio-economic development; 75% of people affected by TB are within the economically productive age group of 15-54 years. This may have a negative influence on the national economy [61].

Lately, Gezahegne. [75], demonstrated that from 1.2 million slaughtered cattle in eight export abattoirs had an estimated cost of more than 600,000 ETB during a respective time, resulted due to condemned carcasses and organs. Asseged *et al.* [62], demonstrated that, based on the ten years retrospective analysis of the detection of BTB lesions in the Addis Ababa abattoir, there was a cause of 0.024% for whole carcass condemnation. Recently, Shitaye *et al*. [46], indicated that, in both Addis Ababa and Debre-Zeit abattoirs tuberculous lesions that, causes condemnation of carcasses and/or organs have also been found to be highly significant economically.

Zoonotic Importance of Bovine Tuberculosis in Ethiopia

Regassa [29], demonstrated the association of *M. tuberculosis* and *M. bovis* in causing tuberculosis between humans and cattle. The cattle owned by tuberculous patients had a higher prevalence (24.3%) than cattle owned by non-tuberculous owners with 8.6%. The author also noted that 73.8% and 16.7% of 42 human isolates were identified as *M. tuberculosis* and *M. bovis* and from cattle isolates 18.1% and 45.5% of 11 were found to be *M. tuberculosis* and *M. bovis* species, respectively. This showed that the role of *M. bovis* in causing human tuberculosis seemed to be significantly important. On the other hand, in Ethiopia, consuming raw meat is a welcome tradition, thus meat may also remain to be another area of concern or threat to be a source of BTB infection.

Control of Tuberculosis in Ethiopia

The effective control and eradication of *M. bovis* depend on identifying and isolating potential sources of infection [63]. Limiting the number of receptive individuals using Bacillus Calmette-Guérin (BCG) vaccination and decreasing the number of infected animals through test-and-slaughter policy are commonly used methods for control and eradication of TB [45]. However, there are also various modifications of eradication and control programmes adopted in different countries [25].

In developed countries BTB has nearly been eradicated or drastically reduced in farm animals to low levels by control and eradication programmes. In Ethiopia these measures, however, cannot be adopted in practice due to various reasons such as: lack of knowledge on the actual prevalence of the disease, the prevailing technical and financial limitations, lack of veterinary infrastructures, cultural and/or traditional beliefs and geographical barriers, though certain control measures are in place [25].

Conclusion and Recommendations

Bovine tuberculosis is a chronic bacterial disease of animals and humans characterized by the formation of granulomatous lesion in different organs. The causative agent of this disease is *M.bovis* and is a significant zoonotic disease. Wherever milk and dairy products are consumed without heat treatment, the disease is an important zoonosis. In Ethiopia, the endemic nature of infection due to *M. bovis* has long been confirmed and the prevailing low standard of hygienic status in the production farms are potential risk factors that favors the spreading of infection. Even though the disease is endemic in Ethiopia, there is great gap of information on the prevalence of disease at national level. The prevalence rate of tuberculosis in livestock varies among different production system. The disease represents a very significant economic and public health problem; however the magnitude of economic impact of bovine TB is not yet well studied in Ethiopia. Condemnation of carcasses at slaughterhouses, test and slaughtering of tuberculin positive cattle in some government farms and pasteurization of milk are among few attempts performed to control bovine TB. However, these measures, as compared to the cattle population of the country, are found to be insignificant.

Based on these conclusions, the following recommendations are forwarded:

- Improvement of management and hygienic practices,
- At national level, efforts should be taken to control the disease in the animal,
- Awareness should be created among the people in order to meet the standard hygienic requirement and to improve husbandry practices.
- Sound testing and meat inspection should be conducted in all abattoirs,
- Further studies should be conduct on the prevalence of BTB in Ethiopia,
- Restriction of cattle movements and reducing the size of herd particularly in traditional extensive production systems.

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