Review on Bovine Tuberculosis in Ethiopia

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Abstract: Bovine Tuberculosis is a contagious, bacterial disease of both animals and humans. It is a chronic infectious disease caused by *M. bovis*, characterized by progressive development of granulomas in tissues and organs. This disease is a significant zoonosis that spread to humans, typically by the inhalation of aerosols or the ingestion of un-pasteurized milk. BTB has been widely distributed throughout the world and it has been a cause for great economic loss in animal production. In developed countries, eradication programs have reduced or eliminated tuberculosis in cattle, and human disease is now rare; however Bovine tuberculosis is still common in less developed countries, and severe economic losses can occur from livestock deaths and trade restrictions. In developing countries, TB is the most frequent opportunistic disease associated with HIV infection. Ethiopia is one of the African countries where tuberculosis is wide spread in both humans and cattle mainly due to culture of drinking un-pasteurized raw milk.
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1. Introduction

Livestock plays very crucial economic, social and cultural roles in people's livelihoods. Ethiopia is one among the nations that possesses the largest livestock population in the African continent (CSA 2013; Tilahun and Schmidt 2012). An estimate indicates that the country is a home for about 54 million cattle, 25.5 million sheep and 24.06 million goats. From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds. 99.8% of the sheep and nearly all goat population of the country are local breeds (CSA 2013).

In contrast to the huge livestock resource, the livestock productivity is, however, found to be very low. The major biological and socio-economic 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 (Alemu, 1992).

Bovine tuberculosis (BTB) is a chronic infectious disease of wide ranges of mammals. BTB is caused by *Mycobacterium bovis* (*M. bovis*), a member of Mycobacteruim tuberculosis complex. It affects many vertebrate animals of all age groups including humans although, cattle, goats and pigs are found to be most susceptible, while sheep and horses are showing a high natural resistance (Radostits *et al*., 2000; Thoen *et al*., 2006). There is sufficient evidence to indicate BTB is widely distributed in almost all African countries and even is found at high prevalence in some animal population (WHO, 1994; Ayele *et al*., 2004; Zinstag *et al*., 2006).

BTB becomes the major obstacle for the intensification cattle production, it hamper the development of livestock industry in developing country together with other livestock disease. In addition to the impact on the livestock sector, Currently, the BTB in humans is becoming a rising concern in developing countries, as humans and animals are sharing the same micro-environment especially in rural areas and due to Human Immunodeficiency virus pandemic (Amanfu, 2006) and other concurrent infection. Bovine tuberculosis is transmitted to human primarily through consumption of raw milk and other products obtained from infected cattle and/or occasionally by aerogenous or respiratory route (Ameni *et al*., 2003).

Many studies have shown that, risk factors such as demography, eating habits, living and socio-economic status of families, illiteracy, culture and customs, the existence of Human Immuno Deficiency Virus (HIV)/ Acquired Immune Deficiency Syndrome (AIDS) and close proximity with animals which are conducive to the spreading and persistence of BTB. In Ethiopia generally milk consumers prefer raw milk as compared to treated milk because of its taste, availability and lower price. Therefore, the zoonotic risk of BTB is often associated with ingestion of unpasteurized dairy products (Edginton *et al.,* 2002; Ayele *et al.,* 2004; Regassa *et al.,* 2008).

Thus, BTB is still a great concern in many developing countries and Ethiopia is one of those where the disease is considered as prevalent disease in cattle populations. Its zoonotic implication has also significantly indicated an increasing trend to be of public health hazards (Kiros, 1998; Regassa, 2005).

Therefore, the objectives of this review paper include to review the impact of bovine tuberculosis and its public health significance and to highlight source of infection and method of transmission of BTB.

2. Etiology and Epidemiology of Bovine Tuberculosis

2.1. Etiology

Bovine tuberculosis is caused by *M. bovis*, a Gram positive, aerobic, acid-fast bacterium in the *Mycobacterium tuberculosis* complex of the family Mycobacteriaceae (CFSPH, 2007). It is found that *M. bovis* best survive in frozen tissue and tissue preservative like sodium tetra borate has adverse effect on viability of the bacteria (Corner, 1994). In the environment *M. bovis* can survive for various months' especially in cold as well as in dark and conditions which is moist. The survival period vary from 18 to 332 day at 12-40^{o}C (54-75^{o}F) which is dependent of sunlight exposure. From soil or grazing pasture there is frequently isolation of this organism. It has been found that culture of organism can be done for approximately two years in a sample that are stored artificially (Bibrstein and Holzworth, 1987).

2.2. Epidemiology of Bovine Tuberculosis

2.2.1. Occurrence and distribution

Bovine tuberculosis is widely distributed throughout the world and causing great economic loss in animal production and the most frequent cause of zoonotic TB in man (Tenguria *et al*., 2011). In developed countries, mandatory pasteurization of milk combined with tuberculin testing and culling (slaughter) of infected cattle resulted in dramatic decline in the incidence of human TB due to *M. bovis* (Palmer *et al*., 2012). Nations currently classified as tuberculosis-free include Australia, Iceland, Denmark, Sweden, Norway, Finland, Austria, Switzerland, Luxembourg, Latvia, Slovakia, Lithuania, Estonia, the Czech Republic, Canada, Singapore, Jamaica, Barbados and Israel. Several Caribbean islands had not reported bovine TB (Ritacco *et al*., 2008). Eradication programs are in progress in other European countries, Japan, New Zealand, the United States, Mexico, and some countries of Central and South America. However in Africa; parts of Asia and some Middle Eastern countries BTB represents apotential health hazard to both animals and humans (Anonymous, 1994; CFSPH, 2007).

2.2.2. Host range

Mycobacterium bovis is the most universal pathogen among mycobacteria and affects many vertebrate animals of all age groups including humans. No other TB organism has a great host range as *M.bovis* which can infect all warm blood vertebrates (Radostits *et al*., 2000). Cattle, goats and pigs are found to be most susceptible, while sheep and horses are showing a high natural resistance (Thoen *et al*., 2006). More over a large number of wild animals like deer elephants, rhinoceroses, foxes, primates, opossums, bears, warthogs, and large cats are naturally infected with *M. bovis* (Radostits *et al*., 2006). Little is known about the susceptibility of birds to *M. bovis*, although they are generally thought to be resistant. Experimental infections have recently been reported in pigeons after oral or intra-tracheal inoculation and in crows after intra-peritoneal inoculation (CFSPH, 2007).

2.2.3. Source of infection and method of transmission

Infected cattle are considered important source of infection as they shed *M. bovis* in respiratory secretions, feces and milk, and sometimes in the urine, vaginal secretions and may act as source of intra-herd transmission (Amit *et al*., 2014). Transmission of *M. bovis* can occur between animals, from animals to humans and vice versa and rarely, between humans (Nwanta *et al*., 2010). The common mode of transmission is inhalation. Animal can be infected by inhalation of contaminated air droplet directly from infected animal or by inhalation of contaminated dust. Thus, overcrowding and poor ventilation of the house along with improper management facilitate the transmission. Moreover, the disease can also be transmitted by ingestion of through feed and water contaminated by feces and urine of infected animal. The infected bull may also transmitted isease or through artificial insemination with the use of infected semen (Amit *et al*., 2014). In endemic area young animals can be infected by drinking of infected milk. However, since mammary infection occurs late in the course of the disease it is less common route of transmission in countries with advanced control programs. Cutaneous, genital, and congenital infections have been seen but are rare (Radostits *et al*., 2006). The *M. bovis* is transmitted from animal to man through ingestion of unpasteurized dairy product, raw milk of infected cattle and undercooked meat. The disease can also spread alsooccur by inhalation (Figueroa and Ramon, 2008).

3. Pathogenesis and Clinical Signs

Tuberculosis spreads in the body by two stages; the primary complex and post primary dissemination. The primary complex consists of the lesion at the point of entry and in the local lymph node. A lesion at the point of entry is common when infection is by inhalation. When infection occurs via the alimentary tract, lesion at the site of entry is unusual, although intestinal ulcers may occur. More commonly the only observable lesion is in the pharyngeal or mesenteric lymph nodes. A visible primary focus develops within 8 days of entry being affected by the bacteria.

Calcification of the lesions commences about 2 weeks later. The developing necrotic focus is soon surrounded by granulation tissue, monocytes, and plasma cells and the pathognomonic' tubercle' is established. Bacteria pass from this primary focus, which is inthe respiratory tract 90-95% of cases. In cattle, to a regional lymph node and cause the development of a similar lesion there. The lesions in the lungs in cattle occur in the caudal lobes in 90% of cases (Radostits *et al*., 2006).

In calves fed tuberculous milk the primary focus is likely to be in the pharyngeal or mesenteric lymph nodes, with hepatic lesions as the major manifestation of post-primary spread. Post-primary dissemination from the primary complex may take the form of acute military tuberculosis, discrete nodular lesions in various organs, or chronic organ tuberculosis caused by endogenous or exogenous re-infection of tissues rendered allergic to tuberculo-protein. In the latter case there may be no involvement of the local lymph node (Radostits *et al*., 2006).

Depending up on the sites of localization of infection, clinical signs vary but, because the disease is always progressive, there is the constant underlying toxemia which causes weakness, debility, and the eventual death of the animal. In cattle, horses, sheep, and goats, the disease is progressive and, although generalized tuberculosis is not uncommon in pigs, localization as non-progressive abscesses in the lymph nodes of the head and neck is the most common finding. Tuberculosis is usually a chronic debilitating disease in cattle, but it can occasionally be acute and rapidly progressive. Early infections are often asymptomatic. In the late stages, common symptoms include progressive emaciation, a low grade fluctuating fever, weakness and in-appetence. Animals with pulmonary involvement usually have a moist cough that is worse in the morning, during cold weather or exercise, and may have dyspnea or tachypnea. In the terminal stages, animals may become extremely emaciated and develop acute respiratory distress. In some animals, the retropharyngeal or other lymph nodes enlarge and may rupture and drain. Greatly enlarged lymph nodes can also obstruct blood vessels, airways, or the digestive tract. If the digestive tract is involved intermittent diarrhea and constipation may be seen (CFSPH, 2007).

4. Disease Status In Developing Countries

Currently, the BTB in humans is becoming increasingly important in developing countries, as humans and animals are sharing the same micro-environment and dwelling premises, especially in rural areas. At present, due to the association of mycobacteria with the HIV/AIDS pandemic and in view of the high prevalence of HIV/AIDS in the developing world and susceptibility of AIDS patients to tuberculosis in general, the situation changing is most likely (Amanfu, 2006).

In countries where surveillance and control activities are often inadequate prevalence data on bovine tuberculosis in Africa is generally scarce although some information on occurrence and control of the disease exists (Cosivi *et al.,* 1998b). In Africa though BTB represents a potential health hazard to both animal and human populations as in most developing countries, *M. bovis* infection remains largely un-investigated. Its epidemiology and public health significance remains largely unknown due to several factors including the high cost of testing program, social unrest due to political instability, ethnic wars resulting in displacement of large numbers of people and animals and a lack of veterinary expertise and communication networks (Michel, 2010).

In underdeveloped countries particularly in Africa, 11% of enzootic occurrences of BTB have been reported and are still prevalent and responsible for significant economic loss in animal production and increase in human health problems (Joelia, 2014). Approximately 85% of the cattle and 82% of the human population of Africa live in areas where animal tuberculosis is either partially controlled or uncontrolled. In contrast however, only a few African countries have applied disease control measures as part of the “test and slaughter” strategy and consider the disease to be notifiable (Joelia, 2014).

Of 55 African countries, 25 reported sporadic/low occurrence of bovine TB; six reported enzootic disease and Malawi and Mali, were described as having a high occurrence. On the other hand, four did not report the disease and the remaining 18 countries did not have data (Cosivi, 1998). Within the Asian region, seven countries apply disease control measures as part of a test-and-slaughter policy and consider bovine TB notifiable. In the remaining 29 countries, bovine TB is partly controlled or not controlled at all. Among the total Asian cattle and buffalo populations, 6% and less than 1%, respectively, are found in countries where bovine TB is notifiable and a test-and-slaughter policy is used. However 94% of the cattle and more than 99% of the buffalo populations are found either the disease is partially controlled or not controlled at all. Thus, 94% of the human population lives in countries where cattle and buffaloes undergo no control or only limited control for bovine TB (Cosivi, 1998). In Latin American and Caribbean Countries the regional prevalence of bovine TB has been estimated at 1%. Among 26% of the cattle population are free of the disease or the disease is approaching the point of elimination (De Kantor, 1994).

Study area	No. of cattle tested	Number positive	Prevalence (%)	References
Assella*	281	25	8.9	Teshome, 1986
Debre-Birhan	76	11	14.5	Tadele, 1998
Kombolcha	53	12	22.6	Tadele, 1998
Dessie	34	4	11.8	Tadele, 1998
West Wellega	353	12	3.4	Regassa, 2001
North Shewa	1 041	169	16.2	Regassa, 2005
Tigray	423	31	7.3	Sissay *et al.,* 2007

4.1. Disease status in Ethiopia

Ethiopia is one of the African countries where tuberculosis is wide spread in both humans and cattle and the endemic nature of tuberculosis in humans and cattle has long been documented. The disease is considered as one of the major livestock diseases that results in high morbidity and mortality, although the current status on the actual prevalence rate of BTB at a national level is yet unknown (Shitaye, 2007). In exotic breeds were found to be more susceptible than cross and local breeds to *M. bovis* with manifestation of high incidence and prevalence rates (Kiros, 1998; Regassa 2005; Ameni *et al*., 2006).

Detection of BTB in Ethiopia is carried out most commonly on the basis of tuberculin skin testing, abattoir meat inspection and rarely on bacteriological techniques. In Ethiopia, screening of cattle by the tuberculin skin test was sporadic until 1984. But, while the higher prevalence rate of the disease has been observed after the two year survey in government and some ‘parastatal’ dairy farms, then it was decided to embark on a routine BTB survey, on these dairy farms, in particular using single and comparative intra-dermal skin tests (Alemu, 1992). Since then tuberculin skin test and abattoir meat inspection surveillances have been undertaken in different parts of the country at various times (Shitaye, 2007).

Different scholar has reported the disease occurrence from different intensive and extensive production system. Among these few of them are summarized in Table 1. Tadele, (1998) has reported the prevalence rate of 22.6%, 14.5% and 11.8% from Kombolcha, Debre-Birhan and Dessie respectivelyin traditionally managed cattle. Regassa (2005) has also reported prevalence of 16.2% from north showa.

Tabe:. Prevalence of bovine tuberculosis detected by single tuberculin skin tests in a traditionally managed extensive production system.

5. Diagnosis and Treatment

Diagnosis of BTB is helpful to reduce the risk of zoonosis, together with increasing public awareness and proper hygienic in food chain from animal source which may result in eradication (Acha and Szyfres, 2001).

Detection of bovine tuberculosis in cattle and other susceptible animal species is often made on history, clinical and necropsy findings, tuberculin skin tests, abattoir meat inspections, culture with morphological appearance, biochemical tests and molecular biological techniques like PCR (Boddinghaus *et al*., 1990; Cousins *et al*., 2003).

Tentative and presumptive diagnosis can be made by ante-mortem examination on the base of clinical sign. But, the disease diagnosed more clearly after post mortem examination based on the presence of gross lesion compatible with BTB in the lung and/or associated with lymph node and these are not confirmatory. Typical lesion or gross lesions are found at necropsy in macroscopic detection and histopathological examination of lesion may confirm the diagnosis but the definitive diagnosis is done only by isolation of *M. bovis* from lesion, bacteriologically (Corner, 1994). For instance, the diagnosis of bovine tuberculosis in live animals, we take sputum, pleural fluid, cerebrospinal fluid, synovial fluid, blood, lymph node biopsy, fluid from the trachea and bronchi or other (Hassani, 2002; Rahimi, 2004).

Cattle should not be treated at all and as such farm animals with tuberculosis must be slaughtered (culled). This is because the risk of shedding the organisms, hazards to humans and potential for drug resistance make treatment controversial (Nwanta *et al*., 2010). In human tuberculosis, drugs like isoniazid, combination of streptomycin and Para-amino salicylic and other acids are commonly used (Amit *et al*., 2014).

6. Public Health Significance of Bovinetuberculosis

It is well known that humans and animals have had close interactions. The interaction is becoming largely increased in the 21st century due to the shift from extensive rural production system into the combined urban and peri-urban intensified livestock husbandry to satisfy the rise in animal products. This largely contributes to the ongoing transmission of shared infectious zoonotic diseases from cattle to humans (Mbugi *et al*., 2012).

Bovine tuberculosis is a zoonotic disease that can have serious consequences for public health. Transmission of *M. bovis* from cattle to humans was once common in developed countries, but human infections have been virtually eliminated in countries with effective programs for eradicating the disease in cattle, and high standards of food safety, particularly the pasteurization of milk. The incidence of human tuberculosis due to *M. bovis* varies considerably among countries, depending on the prevalence of the disease in cattle, socio-economic conditions, consumer habits, and food hygiene practices. In developed countries, *M. bovis* generally accounts for an insignificant share of total tuberculosis cases in humans (CDC, 2011).

In developing countries, the occurrence of human tuberculosis due to *M. bovis* is difficult to determine accurately, and probably remains underreported owing to the diagnostic limitations of many laboratories in isolating the microorganism and distinguishing *M. bovis* from *M. tuberculosis*. Prevalence of the disease is likely to be higher in countries where *M. bovis* infection is endemic in cattle, and milk is not routinely pasteurized. Some reports have speculated that *M. bovis* accounts for 10 to 15 percent of human tuberculosis cases (Cosivi *et al*., 1998), while other estimates range from 0.4 to 8 percent, demonstrating that *M. bovis* is an important factor in human tuberculosis (Grange, 2001). Consumption of untreated dairy products from infected cows is the usual mode of transmission of tuberculosis from animals to people. This mode is particularly dangerous for children, who appear to be most susceptible to the disease in rural areas. The infection can also occur through airborne transmission, especially where humans work in the immediate vicinity of infected cattle or carcasses and/or share premises with infected animals. People suffering from *M. bovis* tuberculosis can retransmit the infection to cattle, but this is not common. Mounting evidence supports the likelihood of human-to-human airborne transmission of *M. bovis* from patients with pulmonary disease, but the relative contribution of this mode to new infections in humans is unknown (Lo Bue *et al*., 2004).

Human tuberculosis can be divided into pulmonary form and extra pulmonary forms of the disease. Pulmonary tuberculosis may progress directly to involve extra-pulmonary sites including lymph nodes, pleura, pericardium, meninges, kidney, bones and joints, larynx, skin, intestines, peritoneum, or eye. Serious outcome from initial infection is more common in infants, adolescents, and young adults. The more prevalent form of *M. bovis* in man involves extra-pulmonary sites, with children being primarily affected. Humans with pulmonary tuberculosis of bovine origin can retransmit the infection to cattle (Dolin *et al*., 1994).

The actual impact of BTB on human health is generally considered low in developed and developing countries, which may be based on the rare identification of *M. bovis* isolates from human patients (Amanfu, 2006). In Africa, the BTB is wide spread and is affecting the animal industries and human health, posing serious public health threats (Cosivi *et al*., 1998; Ayele *et al*., 2004; Thoen *et al*., 2009). Africa is assumed to bear the highest consequences of zoonotic TB worldwide because of the frequent and concurrent presence of multiple risk factors (Muller *et al*., 2013).

7. Control and Prevention

The basic strategies required for control and elimination of bovine tuberculosis are well known and well defined (Nwanta *et al.,* 2010). BTB can be controlled by test-and-slaughter or test-and-segregation methods. Affected herds are re-tested periodically to eliminate cattle that may shed the organism; the tuberculin test is generally used. Infected herds are usually quarantined, and animals that have been in contact with reactors are traced. Only test-and-slaughter techniques are guaranteed to eradicate tuberculosis from domesticated animals. However, some countries use test-and-segregation programs during the early stages of eradication, and switch to test-and-slaughter methods in the final stage (CFSPH, 2007).

Once eradication is nearly complete, slaughter surveillance, with tracing of infected animals, may be a more efficient use of resources. Sanitation and disinfection may reduce the spread of the agent within the herd. *M. bovis* is relatively resistant to disinfectants and requires long contact times for inactivation. Effective disinfectants include 5% phenol, iodine solutions with a high concentration of available iodine, glutaraldehyde and formaldehyde. In environments with low concentrations of organic material, 1% sodium hypochlorite with a long contact time is also effective. *M. bovis* is also susceptible to moist heat of 121°C (250°F) for a minimum of 15 minutes. Rodent control may also be advisable on affected farms; meadow voles and house mice can be infected experimentally and voles shed *M. bovis* in feces (CFSPH, 2007). In developed countries BTB has nearly been or drastically reduced in farm animals to low levels by control and eradication programs knowledge (Cosivi *et al.,* 1998; Ayele *et al.,* 2004).

In Ethiopia these measures, however, cannot be adopted in eradicated practice due to various reasons such as: lack of 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 (Acha and Szyfres, 2001).

In order to reduce the risk associated with consumption of contaminated milk and meat, it is necessary that specific hygiene rules for food of animal origin be laid down to prevent infected animals from entering the food chain. Meat inspection system should be strengthened and designed to prevent the consumption of contaminated products by people. All animals entering the food chain should be subjected to ante-mortem and postmortem inspection (FSAI, 2008). Milk should be pasteurized or effectively treated with heat prior to human consumption or further processing, measure to prevent transmission of zoonotic tuberculosis through milk (FSAI, 2008).

8. Conclusion And Recommendations

In almost every country of the world, bovine tuberculosis is prevalent and causes loss of productivity. The disease has an importance public health issue due to its zoonotic significance. Human tuberculosis due to *M. bovis* has become very rare in countries with pasteurized milk and bovine tuberculosis eradication programs. However, this disease continues to be reported from areas where bovine disease is poorly controlled. The incidence is higher in farmers, abattoir workers and others who work with cattle. In developed countries, mandatory pasteurization of milk combined with tuberculin testing and culling (slaughter) of infected cattle resulted in dramatic decline in the incidence of human TB due to *M. bovis*. In contrast, spread from animals to humans in developing countries remains a very real danger, mostly from infected milk. In Ethiopia, the epidemiology of BTB is not well established in livestock, because of most studies have been focused mainly around the central part of the country. In rural areas of Ethiopia most people drink raw milk and do have extremely close attachment with cattle (such as sharing shelter) that intensifies the transmission and spread of BTB.

Therefore, based on the above concluding remarks the following recommendations are forwarded:

- Create awareness among the people about the public health significance of the disease.
- Government should be enforcing strict rule on test and slaughter policy and compensate affected farmers to elimination of the disease at source.
- Movement control with respect to trade and export from endemic areas into disease free area.
- Should avoid drinking of unpasteurized raw milk.
- Avoid living in humid, ill-ventilated, overcrowded place/house to prevent the zoonosis.
- Sound test, meat inspection and tuberculin regular skin test should be done in all animals.

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