Review on Epidemiology of Bovine Tuberculosis in Ethiopia

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Abstract: Ethiopia is one among the nations that possesses the largest number of livestock population in the African continent estimated to be 56 million cattle, 29 million sheep and 29 million goats. 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. 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 bovine tuberculosis (BTB) at a national level is yet unknown. Detection of BTB in Ethiopia is carried out most commonly on the basis of tuberculin skin testing, abattoir meat inspection and very rarely on bacteriological techniques. 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 slaughterhouses in various places of the country. BTB in cattle remains to be a great concern due to the susceptibility of humans to the disease. The infections mainly take place by drinking raw milk and occur in the extra-pulmonary form, in the cervical lymphadenitis form in particular. This paper reviewed the current status of BTB in Ethiopia in relation with the existing animal husbandry systems, conducive Risk factors and Zoonotic and economic importance of the disease are also addressed.

Key words: Bovine tuberculosis (BTB) · Epidemiology · Risk factors · Ethiopia

INTRODUCTION

Bovine tuberculosis (BTB) is a chronic infectious disease of animals characterised by the formation of granulomas in tissues and organs, more significantly in the lungs, lymph nodes, intestine and kidney including others. BTB is caused by slowly growing non-photochromogenic bacilli members of the Mycobacterium tuberculosis complex: M. bovis and M. caprae species. However, M. bovis is the most universal pathogen among mycobacteria and 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 [1, 2].

BTB has been significantly widely distributed throughout the world and it has been a cause for great economic loss in animal production. In developed countries, BTB in animals is a rarity with occasional severe occurrences in small groups of herds. In developing countries, however, such as in 46% of African, 44% of Asian and 35% of the South American and the Caribbean countries, sporadic occurrences and (particularly in Africa 11%) enzootic occurrences of BTB have been reported [3].

BTB, apart from being the most important disease of intensification with a serious effect on animal production, also has a significant public health importance [2] TB caused by M. bovis is clinically indistinguishable from TB caused by M.tuberculosis is and can only be differentiated by laboratory methods. Specific data on zoonotic BTB transmission is very scarce in the developing world because the diagnosis of TB most often relies on sputum microscopy only [3].

Prevalence data on BTB infection in Africa is scarce. There is, however, sufficient evidence to indicate that it is widely distributed in almost all African countries and even...
is found at high prevalence in some animal populations [4-6]. However, in the tropical countries including Ethiopia, BTB has been found to affect a higher proportion of exotic breeds than local zebus, which has been conferred through prevalence studies of BTB in different parts of Ethiopia [7-9]. The economic impact of BTB has also been reported [10]. 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 [8, 11].

Objectives:
- To describe the impact of animal husbandry practices on bovine tuberculosis prevalence in cattle
- To describe the Risk factors conducive to the spreading of bovine tuberculosis infection in Ethiopia
- To describe the Zoonotic and economic importance of bovine tuberculosis in Ethiopia.

Literature Review
Bovine Tuberculosis: The Status 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 9.86 million equines, 1.2 million camels and 56.7 million chicken [12]. The distribution and the quantity of each species are different according to the type of prevailing animal production systems and agro-ecological zones. In contrast to the huge livestock resource, the livestock productivity is 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 and traditional way of husbandry systems. Among the diseases that affected introduction and performance of high yielding exotic dairy breed animals is bovine tuberculosis [13].

Ethiopia is one of the African countries where BTB is considered as protruding disease in animals. 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. However, the current status on the actual prevalence of BTB at a national level is yet unknown. In Ethiopia, Bovine TB has been shown to be endemic, with the prevalence ranging between 7.9 and 49% [14, 15].

Most of the surveys carried out in Ethiopia have been based on tuberculin skin testing and abattoir inspection reports of animals in a particular locality. BTB is one of the endemic infectious diseases that have long been recorded in Ethiopia [16, 17]. Besides, BTB has been shown to be endemic in cattle in Ethiopia, with the prevalence ranging between 15.6 and 50% have been reported in few studies conducted in dairy farms in the country. 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. In Ethiopia, several prevalence studies have been performed recently that show BTB is endemic in cattle; however, prevalence vary depending on the geographical areas, breeds and husbandry practices. Abattoir and dairy farm studies from central Ethiopia have reported prevalence between 3.5 and 13.5% and locally in peri-urban Addis Ababa up to 50% [15, 18-21]. In contrast, lower prevalence of 0.9% was reported in traditionally kept zebu cattle [22].

The Impact of Animal Production Systems on Bovine Tuberculosis Prevalence in Cattle: The livestock production systems in Ethiopia basically fall 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: (i) Extensive production systems:

Integrated Crop-livestock Extensive Production System: most notably crop production is the primary target, while animals are kept for draught power and for seasonal milk and meat production in the semi-arid and highland areas. This production system holds about 85% of the total livestock population of the country, though animal husbandry is a traditional practice with low hygienic standards.

The Pastoral Production System: denotes an economy that derives the bulk of its food supply from animals (milk and meat) using a variety of herding practices based on constant or partial herd mobility ("oscillatory type of movement") in the low land areas of the country. It covers 12% of the total livestock population and 61% of the total area of land in the country [23, 24].

- Small holder production system: a small number of herds are reared for milk and milk product productions and mostly located near peri-urban areas.
Table 1: Prevalence of bovine tuberculosis detected by tuberculin skin test in a traditionally managed extensive production system in 10 farming areas in different districts

<table>
<thead>
<tr>
<th>Study Area</th>
<th>No. of cattle Tested</th>
<th>Positive</th>
<th>Prevalence (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Wellega</td>
<td>353</td>
<td>12</td>
<td>3.4</td>
<td>Regassa, 2001 [9]</td>
</tr>
<tr>
<td>North Shewa</td>
<td>1041</td>
<td>169</td>
<td>16.2</td>
<td>Regassa, 2005 [10]</td>
</tr>
<tr>
<td>Asella*</td>
<td>584</td>
<td>2</td>
<td>0.3</td>
<td>TschoppR.2013 [11]</td>
</tr>
<tr>
<td>Afar*</td>
<td>1087</td>
<td>119</td>
<td>11</td>
<td>Mamo G. 2013 [12]</td>
</tr>
<tr>
<td>Meskan*</td>
<td>624</td>
<td>4</td>
<td>0.3</td>
<td>TschoppR.2015 [13]</td>
</tr>
<tr>
<td>Bako-Gazer*</td>
<td>492</td>
<td>9</td>
<td>1.8</td>
<td>TschoppR.2013 [11]</td>
</tr>
<tr>
<td>Filu (Somali)*</td>
<td>421</td>
<td>8</td>
<td>2</td>
<td>Guni B. 2012 [14]</td>
</tr>
<tr>
<td>Woldiya*</td>
<td>620</td>
<td>2</td>
<td>0.3</td>
<td>TschoppR.2015 [13]</td>
</tr>
</tbody>
</table>

*a comparative intradermal tuberculin skin test was used; positive results are given for bovine tuberculosis.

- Intensive production system: targeted for milk and milk products production, some intensive feed lots for meat production and mostly located near peri-urban and urban areas [25]. The small holders and intensive production systems in particular meet their target for milk and milk products production through the introduction of exotic breeds. However, in contrast, this introduction of exotic and cross-breed cattle, into the central highlands of Ethiopia in particular has created a conducive environment for the spread of BTB that puts the people, most notably those who drink raw milk, under the risk of BTB infection [26]. The prevalence of BTB is different in various production systems due to environmental and management factors (malnutrition, pregnancy and concurrent infection) that may suppress the immune responsiveness and these may be important in cattle herds [8, 27, 28].

In Ethiopia, the extensive production system ("two categories"), that are mainly practiced as the integrated extensive husbandry system (more in the highland areas) and the pastoral production systems (in the lowland areas) of the country. Although the highland areas hold a large number of livestock populations, the cattle breeding however, is a welcome secondary activity to diversify the crop production. Thus, animals are reared and managed traditionally for draught power purpose. On the other side, the lowland areas where the pastoral production system is predominant, animals are the main source of beef, goats, camel meat and milk products to the nation including for export earnings. In both production systems drinking raw milk is a common practice, in rural areas in particular, which may expose the community to contagious diseases most notably BTB. From the very few undertaken studies, in an integrated extensive production system in the high-lands, the prevalence rates of BTB are ranging from 3.4% [11, 29] have been reported (Table 1).

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 of BTB is 3.5% in assella [30] 4.2 in fiche 31] and 14.2 in Wolaita-Sodo [32] (Table 2).

Intensive Production System: Although few intensive feed lots 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 [15] (Table 3).

Risk Factors Conducive to the Spreading of Bovine Tuberculosis Infection in Ethiopia

Husbandry and Management: Housing predisposes to BTB, as does zero grazing, so that the disease is more common and serious where this form of husbandry is practiced. The direct or indirect effect on the infection rate...
of BTB is depending on the farm managements [30]. Herd size and farm size have also great contribution for the occurrence and increase in prevalence of BTB [30]. Zebu (Brahman) type cattle are thought to be much more resistant to BTB than European breeds and the effect on these cattle are decreased as being much less severe. However, under intensive feedlot conditions a morbidity rate of 60% and a depression weight gain can be experienced in tuberculous zebu cattle. In Ethiopia Redi [30] reported high prevalence (55%) in pure Holsteins than in cross breeds which is relatively low (23%) on dairy farms around Debre Zeit. Older cattle are more affected by the disease than yearlings and calves.

Demography, Socio-economic Status and Feeding Habits:
From the total population of Ethiopia, about 85% of the people are engaged in agriculture. To this effect, very close contact with potentially infected animals may be high, which eventually leads to exposure of the BTB infection. For the urban residents, milk is considered as the main source of BTB infection, while abattoir workers and farmers are predominantly exposed to the aerosol infection as a result of close contact with infected animals [4]. All these causalities and/or habits are the daily practices most notably of rural communities in Ethiopia. In particular, milk borne infection is the main cause of non-pulmonary tuberculosis in areas where BTB is common and uncontrolled [8, 31]. Professional occupation or workers such as, abattoir workers, veterinarians and laboratory technicians, animal care taker in zoos and those who are working in animals reservations and at national parks can also acquire the infection in due course of regular work [32-34]. Furthermore demographic factors, such as income, education, age, number of family, number of individuals dwelling per m2 and sanitation etc. are also contributing to the epidemiology of BTB [5]. Moreover, reports indicated that infants are more vulnerable to food-borne M. bovis infection, whereas older individuals averting BTB may occur as a result of endogenous reactivation [32, 34-36].

Role of Wild Life Reservoirs: In Africa a high prevalence of bovine tuberculosis was reported in monkeys [37], in buffaloes [38] and deer [39]. Recent reports in South Africa indicated that there were four outbreaks of BTB in the buffaloes during the years 1996 to 2003. In addition to this, the disease has been prevalent in an Eastern province of South Africa in the 1930s and there are strong indications that greater kudu (Tragelaphusstrepsiceros) act as maintenance hosts. Despite this, kudu have been the source of M. bovis infection in one wildlife reserve in Kwazulu-Natal in a group of BTB-free African buffaloes [40]. 4. Impact of HIV/AIDS epidemic in Ethiopia.
Available data suggest that the incidence of tuberculosis in humans has risen in recent years, partly as a result of the HIV/AIDS epidemic impact [41]. In addition to this, the incidence of BTB in humans has also risen in recent years as a result of the impact of the HIV/AIDS epidemic [3, 5, 42]. Tuberculosis and other mycobacterial infections are major opportunistic infections in HIV/AIDS infected individuals [32, 43], while HIV/AIDS is a major predisposing factor for tuberculosis including reactivation of the disease. The current spreading pandemic of HIV/AIDS infection in developing countries, especially where BTB is prevalent in domestic and wild animals, poses an additional serious public health threat ranging from 4.2 to 90.8% the highest being commercial dairy farms. Analysis of risk factors revealed that prevalence of BTB was significantly associated with management and breeds [15].

Tuberculosis can be transmitted either by the respiratory route or ingestion. In cattle, aerosol spread is more common. Infectious bacteria can be shed in the respiratory secretions, feces, milk and in some individuals in the urine, vaginal secretions, or semen. Not all infected animals transmit the disease; asymptomatic and anergic carriers occur. M. bovis can survive for several months in the environment, particularly in cold, dark and moist conditions [46].

In Ethiopia, where pasteurization of milk is very limited the most likely route of transmission is through consumption of raw milk, but few studies have demonstrated the shedding of mycobacterium organisms through milk. Tuberculosis in humans is also increasing at an alarming rate and affects mainly the active working age group (15 - 45 years). This may have a negative influence on the national economy. More than 30% of TB patients have extra-pulmonary tuberculosis and the majority of them were directly or indirectly in contact with cattle. This suggests the possible association that may exist between extra-pulmonary TB and M. bovis. Although cattle are considered the principal animal reservoir of M. bovis [47], infection can also be transmitted from wild animals. In most cases, M. bovis is introduced from infected livestock to susceptible wild populations. Some anthropogenic factors have facilitated transmission, such as the intrusion of humans and domestic animals into wildlife habitat. The main concern about the eradication of bovine TB and, therefore, of zoonotic infection is the role of infected wildlife as a reservoir since it is not possible to establish the same surveillance and control programs in wildlife as in domestic livestock, eliminating the latent threat of a wildlife reservoir of...
mycobacteria is challenging. The most common wildlife hosts of mycobacteria and, therefore, potential sources of infection through interaction with livestock [47] are the badger (Meles meles) in the UK and the Republic of Ireland, the white-tailed deer (Odocoileus virginianus) in Michigan, United States, the brushtail possum (Trichosurus vulpecula) in New Zealand, the Cape buffalo (Syncerus caffer), the Kafue lechwe antelope (Kobus lechekafuensis) in Africa and the European wild boar (Sus scrofa) in the Iberian Peninsula.

**Economic Importance of Bovine Tuberculosis:** The economic importance and public health significance of tuberculosis has been established in many countries [48]. Recently, [45] reviewed the economic effects of BTB on cattle productivity, the burden of disease in different settings and at different stages of public health development and the transsectoral (Public health, Agricultural, Environment) economic analysis of BTB control. However, in Ethiopia, the economic impact of BTB on cattle productivity, BTB control programmes 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, [49] 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, [50] 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 and other related economic effects of the disease are not yet well documented or studied. Few abattoir meat inspection surveillances have shown the condemnation rate of the total or partial carcass and organs. With this respect, [51] reported that out of 29 956 slaughtered cattle in Dire-Dawa city abattoir, a total of 31.2% and partial of 16.4% condemnation rates that may result in economic losses significantly. Lately [10] demonstrated that from 1.2 million slaughtered cattle in eight export abattoirs had an estimated cost of more than 600 000 ETB (300 000 USD) during a respective time, resulted due to condemned carcasses and organs. [49] 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.

**Control of Tuberculosis in Ethiopia:** The effective control and eradication of BTB from herds and/or farms of cattle depend on identifying and isolating potential sources of infection from the herds, through test-and-slaughter-strategy. However, there are also various modifications of eradication and control programmes adopted in different countries. 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 [52-53].

**Control in the Cattle Populations:** Despite the presence of the above constraints, attempts have been undertaken in government state farms in particular. For example, based on tuberculin skin testing results in Mojo State Dairy Farm (Central Ethiopia) 50% of the positive reacted cattle were culled and slaughtered. In addition to this measure, the farm was closed and healthy cattle were transferred to other farms [55]. On government owned dairy farms, test and isolation of reactors combined with pasteurization of milk are the currently undergoing control practices. However, these measures, as compared to the cattle population of the country, are found to be insignificant. Unlike state dairy farms, in other "parastatal" dairy farms (small holders in particular), these control measures are not well practiced. This scenario is worse by far in most of the extensive production systems. In general terms, control measures in the traditional extensive production systems are more difficult and complex. This is the virtue of the large numbers of livestock involved, the mobility of animals (pastoral production) and the social and economic factors involved. In Ethiopia so far, control of BTB through the test-and-slaughter policy is not yet established. Most commonly culling of infected animals (especially in government owned farms) and improving sanitary and hygienic standards in other dairy farms is the actual control measure of BTB infection. Currently there is an attempt to establish an infection/disease free area which enables the country to control zoonotic and economic important diseases including BTB [23].

**Control in the Human Populations:** The health policy in Ethiopia, dating as far back as 1993, gives priority to the control of communicable diseases, including tuberculosis...
and HIV/AIDS. The health system is being progressively decentralized under the country's primary health-care delivery strategy and the system of tuberculosis control has been designed [41]. The DOTS strategy is being implemented in most districts and almost all hospitals and health centres provide DOTS services, although basic health services are not yet accessible to about 40% of the population [41]. In general, tuberculosis can be effectively controlled through BCG vaccination and employment of chemotherapy. The conventional anti-tuberculosis drugs (isoniazid, rifampicin, pyrazinamide, thiacetazone and ethambutol) are used to control and prevent the spread of the disease. The treatment course can be either short (2 months) or the standard treatment regime (6 to 8 months). Treatment success among new patients was only 76% in the 2002 cohort, considerably lower than Ethiopia's maximum of 80% reported for 2000 [41]. Furthermore, the country has carried out the first ever drug resistance survey and found with a preliminary results indicating 1.7%, the multi-drug resistance (MDR) among new cases is somewhat lower than the WHO estimate of 2.3%. Moreover, health education is practicing as one of the pivotal means to control through sanitization and increasing awareness of the community about the epidemiological characters of the disease and other effective measures are being made to ensure better access throughout the country [41].

CONCLUSIONS AND RECOMENDATIONS

From this seminar paper it could be concluded that the different livestock production system of different studied area of Ethiopia showed that there is no uniform prevalence distribution within the country. The prevalence of bovine tuberculosis in different livestock production system of the country ranges from 0.3 to 32.2% showed that there is a wide prevalence range and there are no sufficient studies to conclude the prevalence at national level. The disease in intensive diary production system showed higher prevalence up to 50% than other production system. This is of great epidemiological and public health significance and it requires urgent attention by all stakeholders.

For the effective control of BTB in Ethiopia, it is worthwhile to apply the following measures as fundamental practice:

- Identification of animals: Before embarking on any control programme it is essential that all dairy farms should be registered and that all dairy cattle older than six months of age are identified with permanent marks (ear tags).
- Improvement of management and hygienic practices: In most parts of Ethiopia, animals are kept near dwellings and maintained under very poor management and hygienic status, thus increasing the risk of acquiring infection for animals and humans as well.
- Legislation: For enabling enforcement of control measures, there is a need for a legislation that makes it obligatory to register dairy farms and to notify the veterinary personnel about any animal purchase, sales or transfer of farms.
- Insurance of dairy farms: Although this principle is not yet familiarized; however, insuring dairy farms may encourage owners to cull their infected cattle after testing for BTB and other economically important contagious diseases.
- Sound testing and meat inspection: Regular tuberculin skin testing and routine abattoir meat inspection procedures have to be made for the detection of tuberculous lesions and the result can be upgraded when Ziehl-Neelsen staining is simultaneously used.
- Establishment of areas and/or farms free of BTB: A bi-annual testing programme could be introduced to establish a "provisional disease free status in some herds/farms or areas".

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