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Full Length Research Paper

Prevalence and zoonotic implications of bovine tuberculosis in Northwest Ethiopia

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A cross sectional study on bovine tuberculosis (BTB) was conducted in Northwest Ethiopia, Gondar and Dembia districts, from October 2007 to March 2008 to determine the prevalence and assess its zonnotic impact. Both questionnaire survey and comparative intradermal tuberculin test (CIDT) were used for this study. For the comparative intradermal tuberculin test (CIDT) test 311 cross breed cattle were considered whereas a total of 77 households were interviewed for the presence of tuberculosis cases within their family and habit of raw milk consumption. The result of CIDT indicates that the overall prevalence of bovine tuberculosis was 7.1%. In the outdoor and indoor management system individual animal prevalence of BTB was 4.5% (4/88) and 8.1% (18/223) respectively. The herd prevalence of bovine tuberculosis in outdoor and indoor production systems were 12.9% (4/31) and 26.1% (12/46), respectively. There was no significant difference between the two production systems (x^2 = 1.2, df = 1, p > 0.05). The prevalence of BTB in age group 4 up to 7 year (12.1%), was significantly (x^2 = 9.76, df = 2, P<0.05) higher than that of age group up to 3 year (2.8%), and age groups greater than 7 year (3.45%). Similarly, the prevalence of BTB in fat, medium, lean and emaciated body condition was 40, 5.46, 2.27 and 0% respectively, showing highly significant difference (x^2 = 36.1, df =3, p < 0.01). There were no significant association between reactors and respiratory symptoms (P > 0.05). There was, however, no statististically significant difference among tuberculosis cases that had the habit of raw milk consumption and those who do not have the habit (P > 0.05). In conclusion, tuberculosis was found to occur both in Gondar and Dembia districts. The knowledge cattle raising family about BTB was poor and their milk consumption habit could favor the transmission of the diseases from animals to human. This study discloses the potential risk factors for BTB in Gondar and Dembia districts.

Key words: Bovine tuberculosis, Ethiopia, prevalence, zoonotic implications.

INTRODUCTION

Bovine tuberculosis is an infectious disease of cattle mainly caused by M*ycobacterium bovis (M. bovis*) and characterized by progressive development of tubercles in any tissue/organ of the body (Clarke, 1998). *M. bovis* is genetically very similar to M*ycobacterium tuberculosis* (*M. tuberculosis),* the major pathogens that causes human tuberculosis. It is one of the species of M*ycobacterium* belonging to the M*ycobacterium* tuberculosis complex. The complex comprises *M. tuberculosis*, *M. bovis,* M*ycobacterium microti (M. microti),* M*ycobacterium canetti (M. canetti),* and M*ycobacterium africanum* (*M. africanum*) (Collins and Grange, 1993).

These days, due to the rapid increase of tuberculosis cases worldwide, has been declared a, global emergency, gaining world wide emphasis together with human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS). Most species of

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domestic and wild animals are susceptible to *M. bovis*, with cattle, goats and pigs being most susceptible, and sheep and horse having a high natural resistance. Infected cattle are the main source of infection for other animals. Organisms are excreted in the exhaled air, sputum, feces (from both intestinal lesions and swallowed sputum from pulmonary lesions), milk and urine, vaginal and uterine discharges from open peripheral discharges and from open peripheral lymph nodes (De Lisle, 2002).

Conditions such as customs of consuming raw milk, keeping cattle in close proximity to the owner house and using cow dung for plastering wall or floor and as source of energy for cooking do exacerbate the chance of spread of tuberculosis as zoonosis in Ethiopia (Bogale, 1999).

The economic loss caused by this disease is enormous. Infected animal loses 10 to 25% of their productive efficiency. Direct losses due to the infection become evident by decrease in 10 to 18% milk and 15% reduction in meat production (Radostits and Blood, 1994).

In addition to this bottlenecks to the development of the dairy industry of animal production throughout the world in general and in developing countries in particular, the disease attains much of its importance from being zoonotic, causing human tuberculosis (Daborn et al., 1996). It is estimated that in countries where pasteurization of milk is rare and bovine tuberculosis is common, 10 to 15% human cases of tuberculosis are caused by *M. bovis* (Ashford et al., 2001). Bovine tuberculosis is the principal zoonotic problem transmitted to human primarily through consumption of raw milk and other products obtained from infected cattle and/or occasionally by aerogenous or respiratory route (ÓReilly and Daborn, 1995).

Due to the fact that the moderate resistance of the etiological agent to the environment in one hand and the capacity of its survival in acid milk for not less than 15 days on the other and the habitual consumption of unpasteurized milk by humans make this important disease a vital zoonosis in developing countries like Ethiopia. In developing countries like Ethiopia where *M. bovis* infection is present in a number of animal species (Radostits et al., 2000; Thoen et al., 2006), having the knowledge of distribution, prevalence, risk factors and zoonotic implication of the disease is fundamental so as to look for effective control strategy. Gondar town and its surrounding is one of the areas of north western Ethiopia where dairying is commonly practiced using small herd size. However, the extent of tuberculosis in the area in both cattle and human is not well documented. Therefore this study was aimed to determine the magnitude and distribution of tuberculosis in dairy cattle under different management system, assess the zoonotic impact of the disease, and evaluate the association of clinical manifestations and risk factors with skin reactions using intradermal tuberculin test.

MATERIALS AND METHODS

Study area

The study was conducted in Gondar town and Dembia districts of North Gondar zone of Amhara National Regional state (ANRS). The study areas are located at about 750 km North of Addis Ababa. The two districts are located in the Northwestern part of Ethiopia, bordering Lake Tana at latitude 12.4° north, longitude of 27.2° east and stands at an altitude range of 1800 to 2200 m above sea level. The districts were selected based on number of crossbred cattle distributed to boost milk production of dairy cows of small-holder farmers.

Study subjects

A total of 311 cross (Holstein × Fogera) dairy cows were considered in this study for the purpose of intradermal tuberculin test.

Study design and sampling method

The study was conducted using cross sectional study to determine the prevalence of bovine tuberculosis in small dairy farms of the study area. The list of the head of the house holds were obtained from the Wereda Agricultural Department. Purposive sampling were used to sample the study herds and all female animals above one years except pregnant animals above 8 months gestation period were sampled. Accordingly, a total of 77 herds with an average herd size of 8 animals were tested.

Body condition scoring and age determination

All the study animals for intradermal tuberculin test (IDT) were graded based on their physical presentation; lean (c), medium (M) and fat (F), respectively according to Nicholson and Butter worth (1986). In addition, ages of the study animals were determined according to De Lahunta and Habel (1986).

Comparative intradermal tuberculin test

Comparative intradermal tuberculin test (CIDT) was used mainly to differentiate between animals infected with *M. bovis* and those sensitized to tuberculin due to exposure to other mycobacterium or related genera. Two sites at the middle of the neck were shaved and cleaned 12 cm apart on the same side of the neck, the areas were

Table 1. Comparative intradermal tuberculin tests in two production system.

Production system	Tuberculin test reaction {No. (%)}		Total (%)
	Positive	Negative	
Indoor	18 (8.1)	205 (91.9)	223 (71.7)
Outdoor	4 (9.1)	84 (90.9)	88 (28.3)
Total	22 (7)	289 (93)	311 (100)

examined for the presence of any gross lesions. The skin fold thickness at the two sites was measured by caliper and recorded. Each animal was then injected 0.1 ml (25,000 IU) avian PPD (Avituber, symbiotic corporation, France) and 0.1 ml (20,000 IU) bovine PPD (Bovituber, symbiotic corporation, France) intradermal using insulin syringe at the anterior and posterior parts respectively (OIE, 2002). The sites were examined and the skin thicknesses were measured 72 h after injection. The interpretation was made in the following ways: When the skin thickness is increased at both sites the difference of increase at bovine (B) and increase at avian (A) site were considered. Thus, when B-A was less than 2 mm, between 2 mm and 4 mm, or 4 mm and above, the animal was considered as negative, doubtful, or positive respectively (OIE, 2002).

Questionnaire survey

Questionnaire survey was conducted on 77 households (18 in Gondar and 59 in Dembia) which are engaged in dairy farming activity. The owners of the farm and attendants of cattle were interviewed on their habit of raw milk or meat consumption and recent history of tuberculosis upon them or in their family members.

Data collection

The data on CIDT were collected using record formats. On the other hand the public health aspects of BTB were investigated using questinaire survey. A predesigned questionnaire was administered of head of household whose cattle were tested. The questions were focused on information in line with the awareness of the respondents about BTB, habit of raw milk consumption and recent history of tuberculosis in their families.

Data analysis

The herd prevalence of BTB was defined as the total number of cattle with at least one CIDT positive per 100 animals examined, in percentage. Individual animal level prevalence was defined to be the number of positive reactors per 100 animals. Data was analyzed using statistical package for the social sciences (SPSS) version 16 (2007) where $p < 0.05$ was considered statistically significant.

RESULTS

Out of the total 311 cattle subject to comparative intradermal tuberculin test, overall prevalence of BTB was 7.1% (22/311) positive. In the outdoor and indoor management system, a prevalence of BTB 4.5% (4/88) and 8.1% (18/223) were found respectively. Furthermore, prevalence of BTB at herd level 15.6% (5/32) and 37.8% (17/45) were obtained, respectively. But statistically there was no significant difference between the two production systems. The prevalence of BTB was 7.2% (15/207) and 6.7% (7/104) in Gondar and Dembia district, respectively but there was no significant difference in prevalence of BTB between districts. Results of the skin test are shown in Table 1.

Out of the total 77 households 11 TB cases were found out of which 81.8% (9/11) of them were consuming raw milk and 36.4% (4/11) had reactor herds. However, no statistical difference was obtained among TB cases that had the habit of raw milk consumption and those who do not have the habit ($p > 0.05$).

The prevalence of BTB in $4 \leq X \leq 7$ age group was affected significantly ($x^2 = 9.76$, df = 2, $p < 0.05$) higher than that of $1 \leq X < 4$ and $X > 7$ year age group. Similarly, there was significant difference ($x^2 = 36.1$, df = 3, $p < 0.01$) in prevalence of BTB in fat, medium, lean and emaciated body condition (Table 2 and Figure 1). On the other hand, the prevalence of BTB in those individuals with respiratory signs (2.6%) was found lower than those individuals without respiratory signs (4.5%). However, there were no any statistical differences ($p<0.05$) among individuals with and without respiratory clinical signs (Table 3).

But it was found that prevalence of BTB was not affected by housing, class of animals, management system, herd size and mean calving interval ($p > 0.05$).

DISCUSSION

Estimates of the sensitivity of tuberculin tests ranged from 68 to 95% (Managhan et al., 1994) and it has long

Table 2. Effect of body condition of the animal for comparative tuberculin skin test.

Body condition	Positive for TB test (%)	Negative for TB test (%)	Total (%)
Fat	8 (40)	12 (60)	20 (100)
Medium	13 (5.5)	225 (94.5)	238 (100)
Lean	1 (2.3\)	43 (97.7)	44 (100)
Emaciated	0 (0)	9 (100)	9 (100)
Total	22 (7.1)	289 (92.9)	311 (100)

Table 3. Associations between observation of coughing and positive reactions to comparative intradermal tuberculination in Gondar milk shed areas of North Western Ethiopia.

Test result	Respiratory symptom			Chi-square value	P value
	Not observed (%)	Observed (%)	Total		
Negative	213 (68.5)	76 (24.4)	289 (93%)	1.05	
Positive	14 (4.5)	8 (2.6)	22 (7%) 0.3		0.13
Total	227 (73)	82 (27)	311 (100%)		

Association of respiratory symptoms with positive reactors was non significant (p > 0.05).

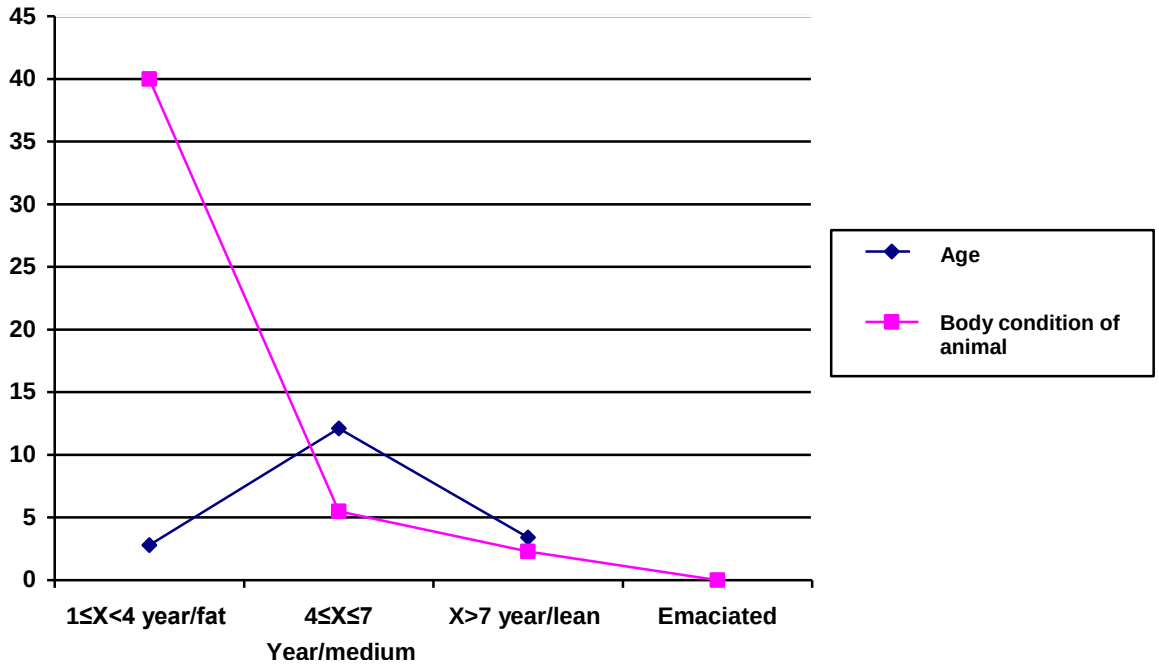

Figure 1. Association of different age groups and body condition with comparative tuberculin skin test.

been known that the sensitivity of tuberculin tests is affected by the potency and dose of tuberculin administered, the post infection interval, desensitization, postpartum immune suppression and observer variation (Radostits and Blood, 1994) to this effect doubtful reactors were added to the positive reactors in calculating the overall prevalence due to the fact that sensitivity of tuberculin test is low which may miss infected animals and under estimate the actual prevalence of BTB.

The individual animal prevalence recorded by this study was higher than the report by Tschopp et al. (2007) in rurar livestock production system in Ethiopia. The increment might be attributed to the fact that the prevalence of BTB is influenced by breed of cattle. This

situation is most evident in study areas where European breeds of cattle have been used to establish a dairy industry, as imported breeds of dairy cattle may also be less resistant to bovine TB than the indigenous breeds of cattle (Kleeberg, 1984). A significant numbers of animals were also reacted to avian tuberculin indicating the occurrence of M*ycobacterium avium*, *M. Paratuberculosis*, and exposure to environmental mycobacterium (Managhan et al., 1994).

On the other hand, the prevalence of BTB in this study is also lower than the previous study by Shitaye et al. (2006) in fact the previous studies were conducted on both exotic and cross breed animals that were under intensive production system. However, the present study was purely conducted on cross breeds under both in-door and out-doors management system. In addition individual variation of allergic reactivity to tuberculin is a major limitation of intradermal tuberculin tests. Intensity of reaction may vary between individual and absence of reaction (anergy) is common especially in case of intercurrent disease occurrence, length of infection with *M. bovis* (terminal anergy). Studies by Ameni et al. (2000, 2007) showed that infections of cattle with gastrointestinal parasites such as Fasciola and strongyle compromised the immune response to tuberculin test by shifting the immunity from Th1 to Th2 response thereby promoting the emergence of false negatives.

Furthermore, old animals above 5 years commonly show lower reaction to tuberculin tests (Laval and Ameni, 2004) and in the study area more animals were above 5 years than young animals may be additional factors that contribute to explain the apparently low prevalence of bovine tuberculosis.

Analysis for the effect of risk factors revealed that the animal prevalence of BTB increased with age up to the age of 7 years, and was then observed to decrease slightly. This finding is consistent with other reports (Cook et al., 1996; ÓReilly and Daborn, 1995; Regassa et al., 2007). ÓReilly and Daborn (1995) reported that the reaction to tuberculin test in cattle increases uniformly by 7.5% at 6 to 7 years old. As explained by other reports (Barwinnek and Taylor, 1996), this could be because as the age increases the probability of acquiring TB infection also increases. On the other hand the decrease in prevalence is associated with immune status of the animal. In other words, the level of reaction is directly related to the maturation and wasting of organs of immune system that is, immature and very old animals rarely react to tuberculin injection regardless of the status of infection (Buddle et al., 2003). Further, Tizard (1996) stated that lowered response to intradermal tuberculin test in older animals is due to the immune depression resulting from old age.

Tuberculin reactivity was significantly affected by the body condition of the animal cattle. This could be because the tuberculin reaction is dependent on immune competence, which inturn may be associated with the physical condition of the animal such that animals with better physical condition are immune competent and thus give a better reaction to tuberculin. But animal with poor body condition could be immune compromised and hence may not react to tuberculin although they might have been infected by Mycobacterium De Lahunta and Habel (1986).

CONCLUSION AND RECOMMENDATION

This study has shown the occurrence and prevalence of BTB in the study area is parallel with the expansion of dairy industry. The prevalence of this disease is higher in indoor management system; showing bovine tuberculosis is a disease of intensification. The disease was prevalent in more than 1/3 of the herd examined by tuberculin test which is a great threat due to possible transmission to the flock. The prevalence of this disease was affected by age groups and body condition of the animal. Therefore emphasis should be given on controlling and preventing this disease especially in dairy intensification area.

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