ORIGINAL RESEARCH

Low prevalence of bovine tuberculosis in Somali pastoral livestock, southeast Ethiopia

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Abstract A cross-sectional study of bovine tuberculosis
(BTB) detected by the comparative intradermal tuberculin
test (CIDT) was conducted in livestock of the Somali region
in southeast Ethiopia—in four pastoral associations from
January to August 2009. In 94 herds, each of 15 cattle,
camels, and goats was tested per herd leading to a total of
1,418 CIDT tested animals, with 421 cattle, 479 camels, and
518 goats. A herd was considered positive if it had at least
one reactor. Prevalence per animal species was calculated
using a xtgee model for each species. The individual animal
prevalence was 2.0% [95% confidence interval (CI), 0.5–
8.4], 0.4% (95% CI, 0.1–3%), and 0.2% (95% CI, 0.03–1.3)
in cattle, camels, and goats, respectively. Prevalence of avian
mycobacterium purified protein derivative (PPD) reactors in
cattle, camels, and goats was 0.7% (95% CI, 0.2–2.0%),
10.0% (95% CI, 7.0–14.0%), and 1.9 (95% CI, 0.9–4.0%),
respectively, whereby camels had an odds ratio of 16.5 (95%
CI, 5.0–55.0) when compared to cattle. There was no signifi-
cant difference between livestock species in BTB positivity. In
the present study, the prevalence of bovine tuberculosis was
low in Somali pastoral livestock in general and in camels and
goats in particular. The high proportion of camel reactors to
avian PPD needs further investigation of its impact on camel
production.

Keywords CIDT, bovine tuberculosis, camel, cattle, goats ·
Pastoralist · Somali region · Ethiopia

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Introduction

Bovine tuberculosis (BTB) is a chronic bacterial disease of
animals and humans and is a major infectious disease
among cattle, other domesticated animals, and certain wild-
life populations in a large number of countries (Cosivi et al.
1998; Schiller et al. 2010). Although cattle are considered to
be the main hosts of *Mycobacterium bovis*, isolations have
been made from many other livestock and wildlife species,
and transmission to humans constitutes a public health
problem (Ayele et al. 2004; OIE 2009). Aerosol exposure
to *M. bovis* is considered to be the most frequent route of
infection of cattle, but infection by ingestion of a contami-
nated material also occurs (Biet et al. 2005). The standard
method for BTB detection in live animal is the comparative
intradermal tuberculin test (CIDT) based on delayed hyper-
sensitivity reactions. The CIDT test includes bovine and
avian tuberculin and is used mainly to differentiate between
animals infected with *M. bovis* and those sensitized to
tuberculin due to exposure to other mycobacteria or related
genera (OIE 2009).

The occurrence of BTB became rare in humans and cattle in industrialized countries (Cosivi et al. 1998; Ayele et al. 2004). However, it remains an important disease in many countries of the world where BTB is endemic, causing significant economic losses (Zinsstag et al. 2006). BTB in animals has been reported from 33 of 43 African countries (Ayele et al. 2004). Human bovine tuberculosis cases have been described in some Sahelian countries like Ghana, Niger, Uganda, and Tanzania (Idigbe et al. 1986; Addo et al. 2007; Oloya et al. 2008) and in immigrants from Chad (Godreuil et al. 2010). The representative proportion of BTB in human tuberculosis is estimated at less than 5.0% worldwide (Cosivi et al. 1998; Michel et al. 2010). In Ethiopia, BTB is endemic in cattle. Prevalence varies from 3.5% to 50.0% depending on the geographical areas, the breeds, and the husbandry practices (Shitaye et al. 2007; Berg et al. 2009; Demelash et al. 2009; Regassa et al. 2010). Prevalence in traditionally kept zebu cattle varies between 0.9% and 4.0% based on different cutoff values used for interpretation (Tschopp et al. 2010). Based on gross pathology, prevalence of 5.0–10.0% was reported in camels slaughtered at Dire Dawa abattoir in eastern Ethiopia and in Addis Ababa abattoir (Mamo et al. 2009, 2011). Hiko and Agga (2011) reported 4.2% prevalence of bovine TB in goats slaughtered at Mojo export abattoir in central Ethiopia based on gross lesions.

To date, there are no reports on the CIDT status in Somali pastoral livestock in southeast Ethiopia, and information on BTB among the pastoral livestock is generally limited. Therefore, the objectives of the present study were to assess the prevalence of tuberculin reactors in the Somali pastoral livestock in southeast Ethiopia and to evaluate the determinants of tuberculin-reacting animals.

Materials and methods

Study area

A cross-sectional cluster sampling study was conducted from January to August 2009 in Filtu Woreda of Liben zone in the Somali regional state in southeast Ethiopia (Fig. 1). Pastoralists in the study area kept their animals extensively. Climatic condition of the area was characterized by arid weather with bimodal rainfall pattern. Considering Filtu town (zonal capital) as the reference center, four pastoral associations (PAs) were selected for this study that were located geographically on the three directions, except Bakaka PA, and in a distance of 25–40 km from Filtu, namely Hayadimtu in the northwest, Bifatu PA in the southeast, Melkalibe PA in the northeast, and Bakaka PA was conveniently included from the nearby Filtu town due to security reason.

Sample size

The sample size for tuberculin testing was calculated using a cluster sampling formula provided by Bennett et al. (1991). Herds were considered as clusters. We assumed an intraclass correlation coefficient (rho) of 0.2, an expected prevalence of 3%, and a standard error of 1.5%. The total sample size calculated was 1,440 animals in 96 herds for all livestock species. The calculated sample size per livestock species was 480 in 32 herds.

In all four PAs, a list of households interested to participate in the study was established during general PA meetings and used as a sampling frame. Eight households were randomly selected from the list for each PA (using random number technique).

For each livestock species, 15 animals with age of greater or equal to 1 year were selected per herd, and unique identification numbers were given for each tested animal together with sex, age, and body condition score (BCS). The animals were categorized into the following age groups: young (1–2.5 years), adult (2.6–6 years), and old (>6 years). BCS was assessed using a modified guideline described by Msangi et al. (1999), and cattle were classified as emaciated (score 1), thin (score 2), normal (score 3), musculous (score 4), and fat (score 5). For camels, BCS was based on hump scoring (amount of fat in the hump) which ranged from 1 to 5 http://www.camelsaust.com.au/livebodycond.htm. Goats were categorized as emaciated (1), normal (2), and well conditioned (3).

Tuberculin skin testing

The CIDT was performed using both bovine and avian purified protein derivative (PPD) obtained from the Veterinary Laboratories Agency, Addlestone, Surrey, UK. Two injection sites were in the middle third of the side of the neck, one above the other, separated at least 12 cm for cattle and camels, while injection sites were on both sides of the neck in goats. The hair was shaved around the sites to a radius of about 2 cm. Skin fold at both sites was measured with a caliper and the measurements recorded. An aliquot of tuberculin containing 2,500 IU/0.1 ml bovine PPD was injected into the skin intradermally at the lower injection site, and similarly, tuberculin containing 2,500 IU/0.1 ml avian PPD was injected at the upper site for cattle and camels, and for goats, avian PPD on the right and bovine PPD on the left side of the neck. After 72 h, the thickness of the same skin fold at both sites was measured and recorded.

Bovine and avian positive reactors were obtained using the formula: $[(Bov_{72} - Bov_0) - (AV_{72} - Av_0)]$ and $[AV_{72} - Av_0) - (Bov_{72} - Bov_0)]$, respectively. Bov_0 and Av_0 indicated skin thickness before injecting bovine and avian tuberculin, and Aov_{72} and Bov_{72} were the corresponding skin fold thickness
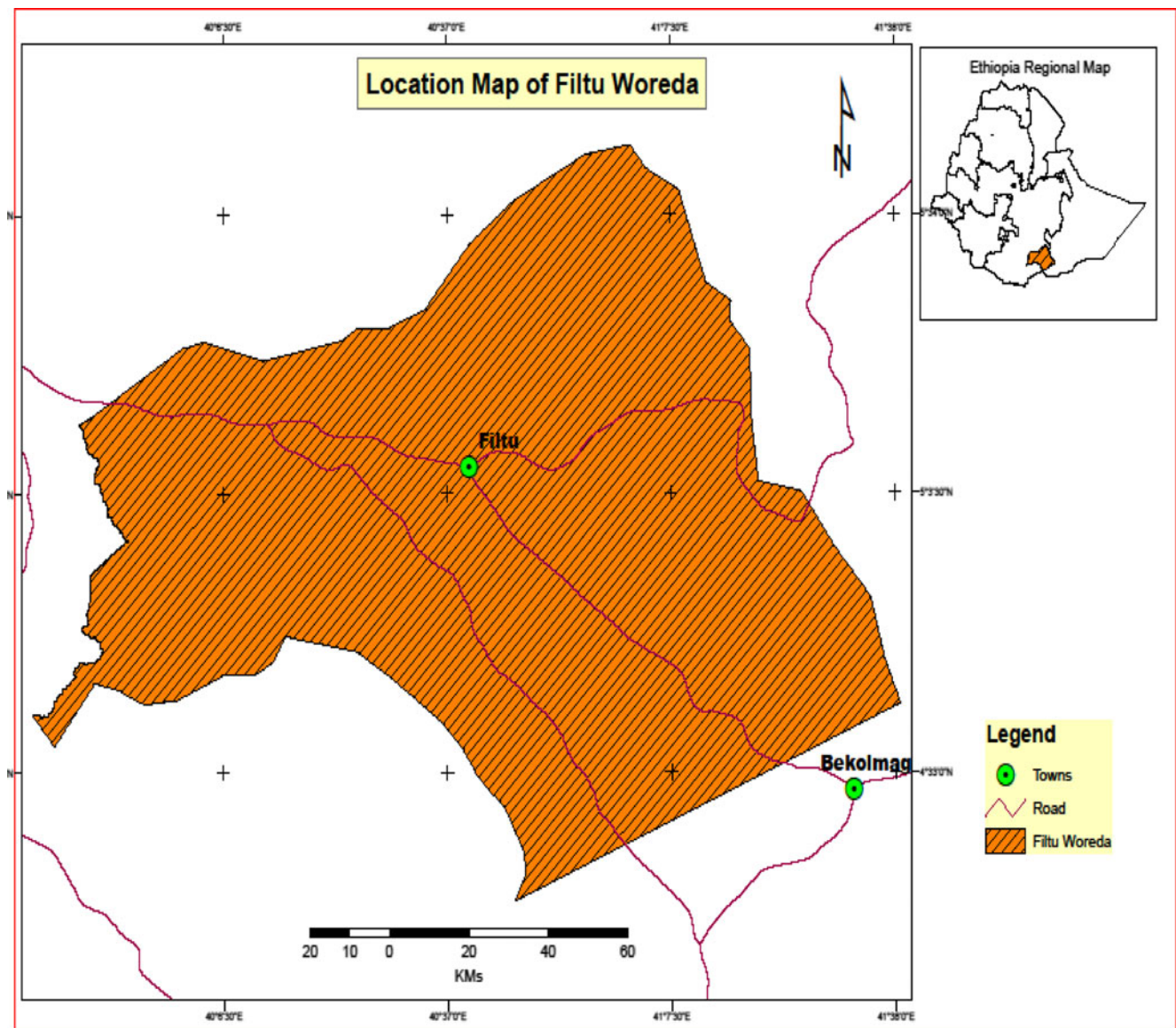
Fig. 1 Location map of the study area

72 h post-injection. The tuberculin test results were interpreted based on OIE-recommended cutoff of >4 mm. Increase in skin fold thickness of >4 mm was regarded as positive reactor, 1 to 4 mm doubtful reactor, and negative if the increase in skin thickness at the bovine site of injection was less than the increase in the skin fold thickness at the avian site of injection. Increase in skin fold thickness of >1 mm with visible reaction at avian site than at the bovine site was considered as positive for *Mycobacterium avium* spp.

Questionnaire survey

To assess possible risk factors associated with husbandry practices and production system for tuberculin positivity and

exposure to BTB infection, all herd owners of tuberculin-tested animals were interviewed using pre-tested structured questionnaires.

Data entry and analysis

The data were double entered in Microsoft Access 2002 (Microsoft Corp. Redmond, USA) and validated with Epi Info version 3.3.2 before being imported to Stata 10/SE (Stata Corp., College Station, TX) for analysis. The outcome of all statistical analyses was individual animal species and herd-level binary outcomes. A herd was considered positive if it had at least one tuberculin reactor. Prevalence was calculated using xtgee model for each species.

Result

Individual animal prevalence

A total of 1,418 animals from 94 randomly selected herds with 34 goat herds, 32 camel herds, and 28 cattle herds in Hayadimtu, Bifatu, Melkalibe, and Bakaka PAs were tuberculin tested. A total of 421 cattle, 479 camels, and 518 goats were tested. The individual animal prevalence was 2.0% [95% confidence interval (CI) 0.5–8.4], 0.4% (95% CI, 0.1–3%), and 0.2% (95% CI, 0.03–1.3%) in cattle, camels, and goats, respectively (Table 1). There was no significant difference in tuberculin positivity between animal species.

Prevalence of avian PPD reactors in cattle, camels, and goats was 0.7% (95% CI, 0.2–2.0%), 10.0% (95% CI, 7.0–14.0%), and 1.9 (95% CI, 0.3–4.0%), respectively. Camels had an odds ratio (OR) of 16.5 (95% CI, 5.0–55.0) for avian PPD positivity when compared to cattle.

Herd prevalence

Prevalence of bovine PPD reactor herds in cattle, camels, and goats was 14.3% (95% CI, 0.5–28.0%), 3.1% (95% CI, −3.2–9.5%), and 2.9% (95% CI, −3.0–9.0%), respectively, with no significant differences (Fisher's exact test) among herds of different animal species in BTB positivity (Table 2). No significant association was found between reactor herds and various numbers of hypothesized risk factors.

Discussion

The low BTB prevalence (<1.0% for camels and goats, and 2.0% for cattle) in our study was comparable with the reports from different regions of Tanzania: 0.9% (Cleaveland et al. 2007), 0.7% (Weinhäupl et al. 2000), 1.3% (Shirima et al. 2003), 0.2% (Jiwa et al. 1997), Uganda 1.3% (Inangolet et al. 2008), 1.4% (Oloya et al. 2006), and Ethiopia 0.9% (Tschopp et al. 2010). However, various other results were reported from Pakistan (2.4% in goats; Javed et al. 2010), Eritrea (14.5% in cattle; Omer et al. 2001), Zambia (6.8% in cattle; Munyeme et al. 2009), Tanzania (13.2% in

cattle; Kazwala et al. 2001), and from cattle in different regions of Ethiopia: 46.8% (Ameni et al. 2003), 19% (Shitaye et al. 2006), 11% (Ameni and Erkihun 2007), 9.7% (Fetene and Kebede 2009), and 11.6% (Regassa et al. 2010). The inter-study variations may be due to differences in management practices, production system, types of animal species and breeds, or differences in ecological zones. A higher BTB prevalence rate of 5.5% was reported in neighboring Oromia pastoralist in cattle (Gumi et al. 2011). The pastoralist and agro-pastoralist production systems in neighboring Oromia pastoralist may explain this difference between the communities.

Avian PPD prevalence of 10.0% detected in camel in the present study is in line with a report of 10.0% (Shirima et al. 2003) and 11.0% (Fetene and Kebede 2009) in cattle from Zambia and Ethiopia, respectively. However, in contrast to our study, in these studies cattle and goats also showed relatively high proportions of avian PPD reactors. The observed differences in prevalence of avian PPD among three livestock species that are kept and pastured together might be due to different susceptibility to non-BTB mycobacteria.

In our observations, the herd prevalence of BTB is much lower compared to other authors (Kazwala et al. 2001; Omer et al. 2001; Ameni et al. 2003; Oloya et al. 2006, 2007; Shitaye et al. 2006; Munyeme et al. 2008; Fetene and Kebede 2009; Regassa et al. 2010) in the cattle herds in Ethiopia and the different countries of the region. This could be due to difference in agro-ecological zones and production systems.

Risk factors such as herd size, herd keeping with other livestock species, contact with other herds, and annual migration dynamics, recent introduction of new animals to herd, and other risk factors could not be associated with

Table 2 Herd prevalence among three livestock species in the study area

Animal species	Number of herd tested	Positive herd (%)	95% CI
Cattle	28	4 (14.3)	0.5–28
Camel	32	1 (3.1)	−3.2–9.5
Goats	34	1 (2.9)	−3.0–9.0

Table 1 Prevalence of bovine and avian PPD reactor in cattle, camels, and goats in the study area

Animal species	Bovine PPD		Avian PPD		Univariate analysis	
	Number test negative	Number test positive (%), 95% CI	Number test negative	Number test positive (%), 95% CI	Bovine PPD OR (95% CI)	Avian PPD OR (95% CI)
Cattle	411	10 (2.0), 0.5.0–8.4	317	3 (0.7), 0.2–2.0	1	1
Camel	477	2 (0.4), 0.1–3.0	429	50 (10.0), 7–14.0	0.2 (0.01–4)	16.5 (5.0–55.0)
Goats	517	1 (0.2), 0.03–1.3	508	10 (1.9), 0.9–4.0	0.2 (0.01–3.0)	2.7 (0.7–10.0)

herd positivity to BTB. The high degree of similarities in a livestock management in pastoralist communities in study area may mask the effect of risk factors related to husbandry practices.

In the present study, prevalence of BTB was low in Somali pastoral livestock. The high proportion of camel reactors to avian PPD deserves further investigation of the responsible mycobacterial agent and a possible impact on livestock, in this case, camel productivity.

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