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Research Article

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Seroprevalence of Brucellosis and Q-Fever in Southeast Ethiopian Pastoral Livestock

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Abstract

To assess seroprevalences of *Brucella* and *C. burnetii* in pastoral livestock in southeast Ethiopia, a cross-sectional study was carried out in three livestock species (cattle, camels and goats). The study was conducted from July 2008 to August 2010, and eight pastoral associations (PAs) from the selected districts were included in the study. Sera from a total of 1830 animals, comprising 862 cattle, 458 camels and 510 goats were screened initially with Rose Bengal plate test (RBPT) for *Brucella*. All RBPT positive and 25% of randomly selected negative sera were further tested by ELISA. These comprise a total of 460 animals (211 cattle, 102 camels and 147 goats). Out of sera from total of 1830 animals, 20% were randomly selected (180 cattle, 90 camels and 98 goats) and tested for *C. burnetii* using ELISA. The seroprevalences of *Brucella* was 1.4% (95% confidence interval (CI), 0.8-2.6), 0.9% (95% CI, 0.3-2.7)b and 9.6% (95% CI, 5.2-17.1) in cattle, camels and goats, respectively. Goats and older animals were at higher risk of infection (OR=7.3, 95% CI, 2.8-19.1) and (OR=1.7 95% CI, 0.9-2.9), respectively. Out of 98 RBPT negative camel sera, 12.0% were positive for ELISA. The seroprevalences of *C. burnetii* were 31.6% (95% CI, 24.7-39.5), 90.0% (95% CI, 81.8-94.7) and 54.2% (95% CI, 46.1-62.1) in cattle, camels and goats, respectively. We found positive animals for *C. burnetii* test in all tested PAs for all animal species. Being camel and older animal was a risk factor for infection (OR=19.0, 95% CI, 8.9-41.2) and (OR=3.6, 95% CI, 2.0-6.6), respectively. High seropositivity of *C. burnetii* in all livestock species tested and higher seropositive in goats for *Brucella,* implies risks of human infection by both diseases. Thus, merit necessity of further study of both diseases in animals and humans in the area.

Keywords

Brucellosis; Q-fever; Seroprevalence; Pastoral livestock; Southeast Ethiopia

Introduction

Brucellosis is a disease of animals, especially livestock (cattle, goats, sheep, camels and pigs), but also wild animals. It is caused by bacteria of the genus *Brucella* spp. In livestock, it is primarily a reproductive disease characterized by late abortion, retained foetal membranes, orchitis and impaired fertility [1]. *B. melitensis* is considered to have the highest zoonotic potential, followed by *B. abortus,* and *B. suis*. Brucellosis remains one of the most common zoonotic diseases worldwide, with more than 500,000 human cases reported annually, particularly from developing countries [2-4].

The economic and public health impact of brucellosis remains of concern in developing countries [5]. The disease poses a barrier to trade of animals and animal products, causes a public health hazard, and is an impediment to free animal movement [1]. In Africa and Central Asia, the incidence of brucellosis is generally considered higher in livestock raised in pastoral production systems [6], however, increasing intensified peri-urban production leads nowadays often to higher prevalence than in pastoral production systems [7]. Brucellosis is endemic in humans and livestock in the Mediterranean region, Africa, the Near East, Central Asia and Central America [8]. Brucellosis in livestock and humans is re-emerging as a major epidemic in countries of the former Soviet Union [5].

In Ethiopia, serological studies of brucellosis have been carried out in farm animals. The presence in livestock varies between different parts of the country [9-12]. Only few serological studies of brucellosis have demonstrated the occurrence of the disease among Borana and Hamer pastoralists; however these have highlighted the public health significance [13].

Q-fever is a zoonotic disease caused by *Coxiella burnetii*. Livestock (cattle, sheep, camels and goats) are the main reservoirs of infection to humans [14,15]. It is also known as an occupational disease of veterinarians, farmers and abattoir workers [16]. *Coxiella burnetii,* the causative agent has been isolated from ticks. Infection in humans is often asymptomatic, but it can manifest as an acute disease (usually a self-limited flu-like illness, pneumonia or hepatitis), or as a chronic form (mainly endocarditis, but also hepatitis and chronic-fatigue syndrome). Q-fever is frequently misdiagnosed by physicians [14]. It is endemic, both in livestock and humans in North and Sub-Saharan Africa [17-20].

In Ethiopia, the existence of antibody against *C. burnetii* was reported in goats and sheep slaughtered at Addis Ababa abattoir, and its peri-urban zone [21]. A seroprevalence of 6.5% was also reported in Addis Ababa abattoir workers [22]. To our knowledge, there was no study on Q-fever in Ethiopian herds or in pastoral zones, where people live in very close contact to their livestock. Information on both diseases is scarce in the study zones. The objective of the present study was to assess the seroprevalences of *Brucella* and *C. burnetii* in pastoral livestock in southern Ethiopia, and factors associated with seropositivity.

Materials and Methods

Study areas

A cross-sectional study with a cluster sampling design was conducted from July 2008 to August 2010 in South Eastern Ethiopian pastoral zones of the Somali and Oromia regional states (Figure 1).

Extensive pastoral livestock production is the main system and the basis of livelihood for millions of pastoralists in the study area. Climatic condition of the selected study areas is characterized by arid and semi-arid climate, with bimodal rainfall pattern. Two districts/woredas were conveniently selected based on accessibility and

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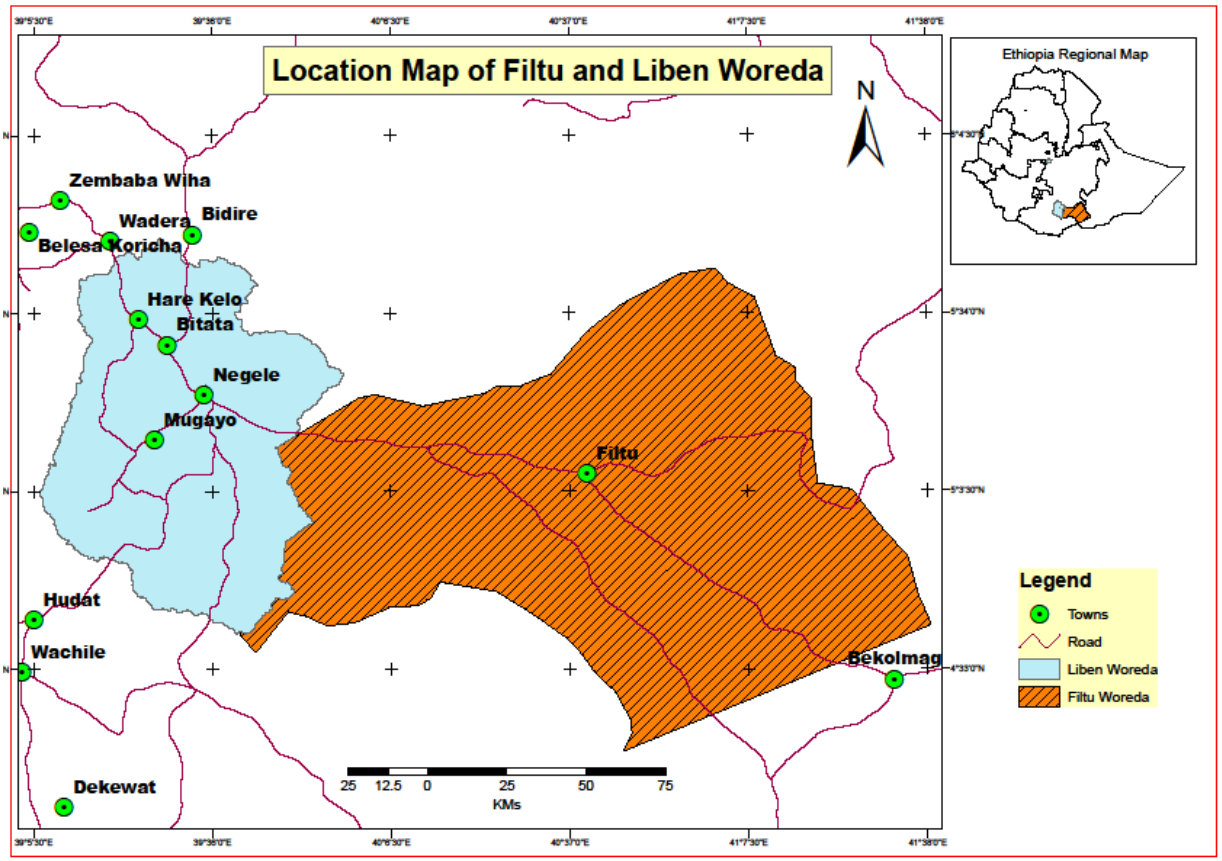

Figure 1: Map showing study areas.

security reasons, from each of the two regional states. Liben and Filtu districts from Oromia and Somali Regional States were included. Eight pastoral associations (PAs)–each one of the cardinal directions per zonal capital were included in the study. These were Dhuko, Sirba, Arda-Bururi and Siminto PA`s from Oromia and Bifatu, Melkalibe, Hayadimtu and Bakaka PAs from Somali Regional State.

Sample size

The sample size estimation considered clustering of animals within herds [23], the sought precision of ± 3% (standard error of 1.5%), assumed an intra class correlation coefficient (rho) of 0.2, and an expected *Brucella* seroprevalence of 3%. The total sample size calculated was 480 per species of animals per study site, and a total of 128 herds. In Oromia, only cattle were sampled, whereas in Somali region, cattle, camels and goats were present for sampling. Twenty percent of the total sample was tested for *C. burnetii.*

Selection of pastoral households within PAs

In each of the 8 PAs, fifteen animals per herd and species were selected randomly in eight herds. After discussion and agreement on procedures at the general PA meeting of each site, interested households were asked to register for participation. Using a list of registered households per PA as sampling frame, 8 households were selected with random numbers.

Sample collection

About 10 ml of blood sample was collected from the jugular vein of each animal, using plain vacutainer tubes and needles. Each sample was labeled with unique identification number. The tubes were kept overnight at room temperature, to allow clotting of blood. The next morning sera was removed from the clot and stored in cryotubes at -20°C, until analyses in the laboratory.

Serology

All sera were initially tested by Rose Bengal Test (RBPT). For RBPT, 30 µl of serum and 30 µl of antigen (Rose Bengal stained *B. abortus* antigen obtained from BIO-RAD, Marnes-la-Coquette, France) were mixed and rotated on a glass plate for 4 minutes. Sera with no visible agglutination were recorded as negative, while sera showing agglutination were considered positive. For further analysis, all RBPT-positive and randomly selected 25% RBPT-negative sera were tested by using ELISA kits for *Brucella abortus*. In addition, another randomly selected 20% of sera from 862 cattle, 458 camels and 510 were tested for *Coxiella burnetii*. ELISA kit was obtained from IDEXX, Liebefeld-Bern Switzerland, and tests were performed according to manufacturer's instructions. All samples and controls in the *Brucella* and *C. burnetii* ELISA were tested in duplicate, and the mean OD values were used. Results were expressed as the percentage of the ratio between the sample OD and positive control OD (S/P-ratio), and were calculated as follows:

$$\frac{S}{P} = \frac{\text{mean OD sample} - \text{mean OD negative control}}{\text{mean OD positive control} - \text{mean OD negative control}} \times 100\%$$

The samples were considered seropositive for *Brucella* if the percentage of the ratio was ≥ 80% and negative if lower; and for *C. burnetii* seropositive if ≥ 40%; doubtful for values between 30% and

40% and negative if <30 %. These threshold-values for both tests were recommended by the manufacturers.

Data analysis

The data was double-entered in Microsoft Access 2002 (Microsoft Corp., USA), and validated with EpiInfo version 3.3.2, before being imported to STATA 10/SE (STATA Corp., College Station, TX) for analysis. We have used the xtgee model to determine the seroprevalence for each animal species, while considering clustering within herds, and to see if species, age category and sex were associated with sero-status. The xtgee model fits population-averaged panel-data models using generalized estimating equations.

Age categories were for cattle and goats <= 1 years=1 (young animal), 1- <= 3 years=2 (juveniles) and >3 years=3(mature/old), and for camels <= 2 years=1 (young animal), 2- <= 4 years =2 (juveniles) and >4 years=3(mature/old). The different age cut off for different animal species was used, because the age at which they become matured and old age are different. This is to make easy for mixed analysis, using the same codes for all animal species. Since not all sera were tested with the *Brucella* ELISA, we present only results with the outcome of the RBPT- binarily classified sero-status.

Kappa statistics was used to determine the level of agreement between RBPT and i-ELISA in detecting positive animals.

Results

Brucella seroprevalence

A total of 862 cattle, 458 camels and 510 goats were tested for *Brucella* anti-body, from 59, 32 and 34 herds, respectively. The sero-prevalences per species were 1.4% (95% CI, 0.8-2.6), 0.9% (95% CI, 0.3-2.7%) and 9.6% (95% CI, 5.2-17.1%) in cattle, camels and goats, respectively (Table 1). In 10 out of 59 cattle herds and 5 of the 8 PAs, there was at least one positive animal. The three out of 32 camel herds and 2 of the 4 sampled PAs and 12 in 34 goat herds in all 4 sampled PAs were seropositive. Out of 98 RBPT negative camel sera, 12.0% was positive for ELISA. Univariable analysis of RBPT showed that goats and older animals were at higher risk of infection (OR=7.3, 95% CI, 2.8-19.1) and (OR=1.7 95% CI, 0.9-2.9), respectively.

The kappa statistics showed that there was substantial agreement between RBPT and i-ELISA for cattle. Only fair agreement was observed between the two serological tests in camels, while a perfect agreement was observed between them for goats (Table 2). The overall agreement observed was substantial.

Table 1: Associations with risk factors for *Brucella* seropositivity.

Risk factors		Number of test negative	Number test positive (%)	Univariable OR (95% CI)
Species	Cattle	850	12 (1.4)	1
	Camel	454	4 (0.9)	0.7 (0.2-2.1)
	Goat	462	48 (9.6)	7.3(2.8-19.1)***
Age class	1[a]	295	4 (1.2)	1
	2[b]	772	32 (3.8)	1.4 (0.9-2.2)
	3[c]	699	28 (4.0)	1.7(0.9-2.9)*
Sex	Female	1408	63 (4.0)	1
	Male	358	1 (0.3)	0.3(0.2-0.4)***

*p<0.05; ***p<0.001

[a]Age categories, for cattle and goats <= 1 years, and camels <= 2 years, [b]for cattle and goats 1- <= 3 years, and for camels 2- <= 4 years, [c]for cattle and goats>3 years, and for camels>4 years.

Table 2: Kappa test for agreement between RBPT i-ELISA tests.

Animal species	RBT	iELISA		Kappa value	Interpretation of kappa value
		+	-		
Cattle	+	8	4		
	-	2	197	0.71	Substantial agreement
Camel	+	3	1		
	-	12	86	0.27	Fair agreement
Goats	+	40	8		
	-	5	94	81	Perfect agreement
Overall	+	51	12		
	-	19	378	0.73	Substantial agreement

Table 3: Associations with risk factors for *C. burnetii* seropositivity.

Risk factors		Number test negative	Number test positive (%)	Univariable OR (95% CI)
Species	Cattle	123	57 (31.6)	1
	Camel	9	81 (90.0)	19.0(8.9-41.2)
	Goat	44	54 (54.2)	2.7(1.7-4.2)***
Age class	1[a]	43	17 (30.8)	1
	2[b]	77	77 (49.6)	2.2 (1.3-3.9)**
	3[c]	56	98 (62.7)	3.6(2.0-6.6)***
Sex	Female	140	170 (55.1)	1
	Male	36	22 (39.5)	0.6(0.4-1.1)

**p<0.01; ***p<0.001

[a]Age categories, for cattle and goats <= 1 years, and camels <= 2 years, [b]for cattle and goats 1- <= 3 years, and for camels 2- <= 4 years, [c]for cattle and goats>3 years, and for camels>4 years.

C. *burnetii* seroprevalence

A total of 368 sera were tested for antibodies against *C. burnetii*, (180 cattle, 90 camels and 98 goats), where by the median of samples tested per herd was 3 for all species, with range of 1-5 per herd. The seroprevalences were 31.6% (95% CI, 24.7-39.5%), 90.0% (95% CI, 81.8-94.7%) and 54.2% (95% CI, 46.1-62.1%), in cattle, camels and goats, respectively (Table 3). We found positive animals in all tested PAs for all animal species. Being camel and older animal were identified as risk factors for infection (OR=19.0, 95% CI, 8.9-41.2) and (OR=3.6, 95% CI, 2.0-6.6), respectively.

Discussion

Seroprevalence of brucella

The RBPT seroprevalence result of the present study is lower than many of the earlier reports. Seroprevalence, as high as 38.7% and 22%, have been reported from dairy farms in western and north-eastern parts of Ethiopia by Rashid [24] and Sintaro [25], respectively. Slightly higher individual serological prevalence of 5.6% was reported in cattle under different production systems in Eritrea [26], 5.9% cattle in Tanzania, 6.5% cattle in Sudan, 6.6% in cattle under pastoral production system in Chad, 9.9% cattle in Kenya, and 15.8% in dairy cattle in Uganda have also been recorded [18,27-29]. Differences in seroprevalence observed in this study, as opposed to those recorded by previous researchers, may be due to differences in herd size, different management systems, and the presence or absence of infectious foci, such as *Brucella*-infected herds, which could spread the disease among contact herds.

The seroprevalence of 9.6% of goats *Brucella* in this study is inline with the report of Ashenafi et al. [30]; however, higher than the results of Teklye and Kasali [31] from central Ethiopia, Teshale et al. [32]

from Somali region, and Megersa et al. [12] from Borena pastoralist. Management could be a factor for lower prevalence reported by Teklye and Kasali [31], since they studied goats under small holder mixed crop-livestock systems of central Ethiopia. Zero seroprevalence was reported in goats from Chad [18], and Zambia [33]. Difference in the management system used in different countries, or absence of infected goat herds may attribute to such variations. In addition, *Brucella* transmission is favored by a more humid climate, which prolongs the survival of the bacteria in the environment. However, our study sites were in arid and semi-arid regions.

The seroprevalence of <1% in camel is lower than previous reports from Borena pastoralists [12,34], and Jordan [35]. A comparable report was from Chad [18]. Inter-study variation may be due to differences in camel husbandry practices in different communities.

In our study, more camel reactors to ELISA than RBPT test were observed. Kappa statistic also shows fair agreement between the two serological tests in camels at kappa value of 0.27. This observation needs further evaluation of both tests, to validate their diagnostic use in camels.

The seroprevalence of *Brucella* was higher in goats than in the other two species of animals studied. It could be due to the highly contagious nature of the disease in goats. The higher pathogenicity of *B. melitensis,* and the close contact caused by the high density of the herds of goats, the intermixing of herds of different owners, and heavy exposure to housing during the night, can also contribute to this higher prevalence. The seroprevalence was also higher in females and older animals than in males and younger counterparts. This is in consent with the previous works [36]. It has already been shown that susceptibility to brucellosis is greater in sexually mature animals. Young animals are often resistant, although it should be noted that latent infections can occur, and such animals may present a hazard when mature [37].

Seroprevalence of *C. burnetii*

The seroprevalence of *C. burnetii* found in this study is high in all the three animals species studied. The higher prevalence in camels is in agreement with previous reports from Chad [18]. But the seroprevalence in sera from cattle and goats are higher than previous reports from Central African Republic [38] and Chad [18]. The highest seroprevalence observed in camels may be due to genetic susceptibility of camels to *C. burnetii,* or host preference of tick vectors to camel. However, this observation needs further investigation.

Limitations

Since we use the cluster sampling technique with fixed number of animals per herd and per village, in cases of low prevalent site, positive animals might be missed, and village or herd might be considered as negative. This study gives baseline information on Q-fever in pastoral livestock production in study area. However, before generalizing this result it needs further study, which includes large study population and area coverage.

The high seroprevalence of *C. burnetii* in all animal species studied, and the higher prevalence of *Brucella* in goats is a particularly important finding that pinpoints the hazard to the health of the pastoralists. The importance of these zoonotic diseases in impairing the health of the community needs to be further studied in the future.

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References

1. Zinsstag J, Schelling E, Solera X, Blasco J, Moriyon I (2011) Brucellosis. In: Oxford Textbook of Zoonoses 54-64.
2. Boschiroli ML, Foulongne V, O'Callaghan D (2001) Brucellosis: a worldwide zoonosis. Curr Opin Microbiol 4: 58-64.
3. Skalsky K, Yahav D, Bishara J, Pitlik S, Leibovici L, et al. (2008) Treatment of human brucellosis: systematic review and meta-analysis of randomised controlled trials. BMJ 336: 701-704.
4. Seleem MN, Boyle SM, Sriranganathan N (2010) Brucellosis: a re-emerging zoonosis. Vet Microbiol 140: 392-398.
5. Roth F, Zinsstag J, Orkhon D, Chimed-Ochir G, Hutton G, et al. (2003) Human health benefits from livestock vaccination for brucellosis: case study. Bull World Health Organ 81: 867-876.
6. McDermott JJ, Arimi SM (2002) Brucellosis in sub-Saharan Africa: epidemiology, control and impact. Vet Microbiol 90: 111-134.
7. Kebede T, Ejeta G, Ameni G (2008) Seroprevalence of bovine brucellosis in smallholder farms in central Ethiopia (Wuchale-Jida district). Revue Méd Vét 159: 3-9.
8. Pappas G, Papadimitriou P, Akritidis N, Christou L, Tsianos EV (2006) The new global map of human brucellosis. Lancet Infect Dis 6: 91-99.
9. Teshome H, Molla B, Tibbo M (2003) A seroprevalence study of camel brucellosis in three camel-rearing regions of Ethiopia. Trop Anim Health Prod 35: 381-390.
10. Berhe G, Belihu K, Asfaw Y (2007) Seroepidemiological Investigation of Bovine Brucellosis in the extensive cattle production system of Tigray region of Ethiopia. Intern J Appl Res Vet Med 5: 65-71.
11. Asmare K, Asfaw Y, Gelaye E, Ayelet G (2010) Brucellosis in extensive management system of Zebu cattle in Sidama Zone, Southern Ethiopia. Afr J Agric Res 5: 252-263.
12. Megersa B, Biffa D, Abunna F, Regassa A, Godfroid J, et al. (2010) Seroprevalence of brucellosis and its contribution to abortion in cattle, camel, and goat kept under pastoral management in Borana, Ethiopia. Trop Anim Health Prod 43: 651-656.
13. Regassa G, Mekonnen D, Yamuah L, Tilahun H, Guta T, et al. (2009) Human Brucellosis in traditional pastoral communities in Ethiopia. International Journal of Tropical Medicine 4: 59-64.
14. Kaabia N, Letaief A (2009) Q fever in Tunisia. Pathol Biol 57: 439-443.
15. Angelakis E, Raoult D (2010) Q Fever. Vet Microbiol 140: 297-309.
16. De Rooij MMT, Schimmer B, Versteeg B, Schneeberger P, Berends BR, et al. (2012) Risk factors of Coxiella burnetii (Q fever) seropositivity in veterinary medicine students. PLoS One 7: e32108.
17. Kelly PJ, Matthewman LA, Mason PR, Raoult D (1993) Q fever in Zimbabwe. A review of the disease and the results of a serosurvey of humans, cattle, goats and dogs. S Afr Med J 83: 21-25.
18. Schelling E, Diguimbaye C, Daoud S, Nicolet J, Boerlin P, et al. (2003) Brucellosis and Q-fever seroprevalences of nomadic pastoralists and their livestock in Chad. Prev Vet Med 61: 279-293.
19. Steinmann P, Bonfoh B, Péter O, Schelling E, Traoré M, et al. (2005) Seroprevalence of Q-fever in febrile individuals in Mali. Trop Med Int Health 10: 612-617.
20. Mazyad SAM, Hafez AO (2007) Q fever (Coxiella burnetii) among man and farm animals in North Sinai, Egypt. J Egypt Soc Parasitol 37: 135-142.
21. Philip CB, Hoogstraal H, Reiss-Gutfreund R, Clifford CM (1966) Evidence of rickettsial disease agents in ticks from Ethiopian cattle. Bull World Health Organ 35: 127-131.

22. Abebe A (1990) Prevalence of Q fever infection in the Addis Ababa abattoir. Ethiop Med J 28: 119-122.

23. Bennett S, Woods T, Liyanage WM, Smith DL (1991) A simplified general method for cluster-sample surveys of health in developing countries. World Health Stat Q 44: 98-106.

24. Rashid M (1993) Reproductive wastage in cattle due to bovine brucellosis. In: 4th National Livestock Improvement Conference. Addis Ababa, Ethiopian Institute of Agricultural Research, Ethiopia 270-272.

25. Sintaro T (1994) The impact of brucellosis on productivity in an improved dairy herd of Chaffa state farm, Ethiopia.

26. Omer MK, Skjerve E, Holstad G, Woldehiwet Z, MacMillan AP (2000) Prevalence of antibodies to Brucella spp. in cattle, sheep, goats, horses and camels in the State of Eritrea; influence of husbandry systems. Epidemiol Infect 125: 447-453.

27. Kagumba M, Nandokha E (1978) A survey of the prevalence of bovine brucellosis in East Africa. Bull Anim Health Prod Afr 26: 224-229.

28. Hellman E, Staak C, Baumann M (1984) Bovine brucellosis among two different cattle populations in Bahr el Ghazal Province of Southern Sudan. Tropenmed Parasitol 35: 123-126.

29. Faye B, Castel V, Lesnoff M, Rutabinda D, Dhalwa S (2005) Tuberculosis and brucellosis prevalence survey on dairy cattle in Mbarara milk basin (Uganda). Prev Vet Med 67: 267-281.

30. Ashenafi F, Teshale S, Ejeta G, Fikru R, Laikemariam Y (2007) Distribution of brucellosis among small ruminants in the pastoral region of Afar, eastern Ethiopia. Rev Sci Tech 26: 731-739.

31. Teklye B, Kasali O (1989) The prevalence of brucellosis in small ruminants in central Ethiopia. Bulletin AHPA 37: 97-98.

32. Teshale S, Yibeltal M, Abaineh D, Awoke K (2006) Seroprevalence of small ruminant brucellosis in selected districts of Afar and Somali pastoral areas of eastern Ethiopia: the impact of husbandry practice. Revue Méd Vét 157: 557-563.

33. Muma JB, Samui KL, Siamudaala VM, Oloya J, Matop G, et al. (2006) Prevalence of antibodies to Brucella spp. and individual risk factors of infection in traditional cattle, goats and sheep reared in livestock-wildlife interface areas of Zambia. Trop Anim Health Prod 38: 195-206.

34. Megersa B, Molla B, Yigezu L (2006) Seroprevalence of brucellosis in camels (Camelus dromedarius) in Borena Lowland, Southern Ethiopia. Bull Anim Health Prod Afr 53: 252-257.

35. Al-Majali AM, Al-Qudah KM, Al-Tarazi YH, Al-Rawashdeh OF (2008) Risk factors associated with camel brucellosis in Jordan. Trop Anim Health Prod 40: 193-200.

36. Mohammed FU, Ibrahim S, Ajogi I, Olaniyi BJO (2011) Prevalence of Bovine Brucellosis and risk Factors assessment in cattle herds in Jigawa State. ISRN Vet Sci 2011: 1-4.

37. Corbel M (2011) Brucellosis in humans and animals. World Health Organisation, Geneva, Switzerland.

38. Nakouné E, Debaere O, Koumanda-Kotogne F, Selekon B, Samory F, et al. (2004) Serological surveillance of brucellosis and Q fever in cattle in the Central African Republic. Acta Trop 92: 147-151.

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