

Research Article

Sero-Prevalence and Associated Risk Factors of Camel Brucellosis in Southern lowland of Ethiopia

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Abstract

Brucellosis is a highly infectious bacterial disease of global significance, which affects a wide variety of animals as well as humans. A cross-sectional study was conducted in the Yabello and Gomole districts of Borena Zone, Oromia Region, and Southern Ethiopia, to determine the seroprevalence of camel brucellosis and associated risk factors in the selected pastoralist area. The two study districts were purposively selected based on their potential camel population and their accessibility due to a lack of sufficient logistics. Totally 368 of camels from selected districts were included in the study. All serum samples were tested and screened serologically using Rose Bengal Plate Test (RBPT) and confirmed using Indirect Enzyme-Linked Immunosorbent Assay (i-ELISA) test. As a result, 46 (12.5%) were the Rose Bengal Plate Test (RBPT) reactors in which 11 (3%) were confirmed to be positive by using Indirect Enzyme-Linked Immunosorbent Assay (i-ELISA) test. Associated risk factor analysis was also conducted using chi-square and logistic regression analysis. The statistical analysis indicated that body condition score ($\chi^2=6.004$; $p=0.050$ and $OR=2.503$; 95% $CI=0.066-95.951$), herd size ($\chi^2=8.560$; $p=0.014$ and $OR=8.195$; 95% $CI=0.289-232.523$), physiological status ($\chi^2=19.273$; $p=0.001$ and $OR=0.130$; 95% $CI=0.003-6.686$) and history of abortion ($\chi^2=29.354$; $p=0.001$ and $OR=119.159$; 95% $CI=5.051-28.818$) were statistically significant and the major risk factors for the presence and transmission of the disease between animals as the present study. But age, sex, parity, herd composition, and district (geographical location) were found statistically insignificant ($P>0.05$). Public awareness towards the diseases was interviewed with the structured questionnaire format and it was noted that most of the pastoralists had no knowledge about zoonotic disease transmission, consequences of consuming raw milk, meat and handling aborted animals without any protective material. In general, camel brucellosis is prevalent in this area of study and public awareness towards zoonotic importance is low. Therefore, fruitful and sustainable work is required from the government, animal health professionals, and other stakeholders in the prevention and control of the disease.

INTRODUCTION

Camels play an important socio-economic role within the pastoral and agricultural systems in dry and semi-dry zones of Asia and Africa [1,2]. Camel the population is numerous in the arid areas of Africa, particularly in the arid lowlands of Eastern Africa namely, Somalia, Sudan, Ethiopia, Kenya and Djibouti Farah et al [3]. Ethiopia is one of the largest camels populated countries in the world with 1,102,119 numbers of camels that rank third in Africa next to Somalia and Sudan, those are kept in the arid and semi-arid lowlands of the Borena, Ogaden and Afar regions, which accommodate 50% of the pastoralists [4].

Camels are even-toed ungulates belonging to the genus *Camelus* which distinguishes two species: the two-humped Bactrian camel (*Camelus bactrianus*) and the one-humped Arabian camel (*Camelus dromedarius*). Camels are known to have peculiar physiological features by which they regulate body temperature to changes in ambient temperatures, enabling them to survive and produce under harsh environmental conditions. The severity of the desert conditions particularly during the long dry season put the camels under severe stress conditions and

makes them susceptible to many diseases and illnesses [5]. Scarce of the studies on the camel disease in the past led some scientists to consider camels, as resistant to many disease-causing factors in many developing countries of Asia and Africa, camels are the most important source of income for the nomadic population [6].

Camel production could be a profitable venture for utilizing the vast arid and semi-arid areas of Ethiopia, where other animals survive with difficulty, especially due to the recurring drought conditions. Under such environmental conditions, camels thrive and form a source of milk and meat. But, complete exploration of camels for milk and meat production would only be possible when their reproductive performance is properly understood and improved. Unfortunately, dromedaries are reported to have low reproductive efficiency compared to other domestic species [7].

Camels ensure food security in pastoral communities by producing milk and meat. They are also sources of hides, which are used as bedsheets; serve as means of transportation and draught power [8]. Long lactation and the ability to maintain milk production over long dry spells are important facets of camel

production. In spite of all these advantages, camel production and productivity are constrained by a number of factors including infectious diseases, of which brucellosis is considered to play a major role [9].

Brucellosis is an infectious disease of domestic and wild animals with serious zoonotic and economic implications in humans. The disease in dromedary camels can be caused by *B. abortus*, *B. melitensis*, *B. Suis* and *B. Ovis* [2]. The disease is an important public health problem in many parts of the world [10]. Infection is acquired mostly through consumption of raw camel milk, contact with aborted fetus or placenta, and other contaminated tissue samples [11]. High-risk groups are veterinary personnel, butchers, camel herders and consumers of raw milk [12].

Brucellosis causes heavy economic losses in camels resulting from infertility, abortions, mastitis, and decreased milk production. Infertility is characterized by increased inter calving period and abortion results in loss of neonatal calves [13-15].

In addition to these, brucellosis hinders international trade in live camels, their products and by-products [16]. Moreover, brucellosis is considered to be one of the major zoonotic diseases affecting man. Brucellosis in humans impairs public health [17] and hinders social and economic development. The disease can generally cause significant loss of productivity through late first calving age, long calving interval time, low herd fertility and comparatively low milk production, as in cattle may also happen in camels. The occurrence of Brucellosis in different animal species in Ethiopia, traditional management system and custom of consumption of raw or unpasteurized milk indicates the need to study Brucellosis and associated risk factors. In Ethiopia, various surveys have been carried out on the prevalence of brucellosis on livestock in different regions of the country by various investigations. However, the detailed status of brucellosis and its associated risk factors are not thoroughly studied in camels' particularly in Borena Zone, Oromia regional state, Southern Ethiopia and information is so far scanty. Therefore, the study designed to study sero-prevalence and associated risk factors of Camel Brucellosis

MATERIALS AND METHODS

Study area

The study was conducted from November 2018 to April 2019 in Yabello and Gomole district of Borana Zone, Oromia Region, Southern Ethiopia. Generally, the Borena area represents a vast lowland area in Southern Ethiopia covering about 95,000 km². The area is bordering with Kenya to the South, Somali region to the East, Guji zone to the North and Southern People, Nation and Nationalities Region to the West. Yabello and Gomole district is located at the southern part of Ethiopia in Oromia regional state at about 570 km and 535 km away respectively, from Addis Ababa in southern direction. The Borena plateau gently slopes from high mountain massifs (1650 m. a.s.l) in the North to (1000 m.a.s.l) in the South bordering Kenya with slight variation due to central mountain ranges, and scattered volcanic cones and craters [18].

The climate is generally semi-arid with annual average

rainfall ranging from 300 mm in the south to over 700 mm in the north. The rain pattern is the bimodal type with the main rainy season locally "Ganna" (65%) extending from March to May and small rainy season "Haggaya" from mid-September to mid-November. Annual mean daily temperature varies from 19 to 24 with moderate seasonal variation. The other two seasons are the cool dry season "Adoleessa" extending from June to August and the warmer dry season "Bonna" from December to February. Seasons affect herding strategies due to its effect on forage and water resource availability [18]. Consequently, herd splitting is practiced to cope up with a shortage of resources in case of cattle likewise, the camel herds are moving from areas with low water and feed to the areas with relatively good water and feed availability.

The vegetation is dominated by savannah type containing a mixture of perennial and woody plants. The savannah community varies from open grassland to bush encroached areas. There is a shift in composition in response to heavy grazing, browsing, burning, and drought. Grazing shifts the community to more trees whereas browsing and burning favors the grass. Several plant species in the area are recognized as valuable livestock forage. Acacia is dominating bushes species in the area [19].

Surface water is a serious problem in the area. Traditional deep wells "ellas", ponds, perennial springs, permanent rivers (Dawa and Genale), and seasonal sources (streams, ephemeral ponds, and shallow wells) are water sources for both human and livestock. Deep wells and large ponds (machine excavated) are used in dry seasons while seasonal streams, ephemeral ponds, and shallow wells are used in wet seasons [20]. Animal husbandry is characterized by an extensive pastoral production system and seasonal mobility. Cattle are the dominating animal species followed by goats, camels, and sheep. Camel and cattle herd splitting into mobile "forra" and home-based "warra" is practiced as a strategy to mitigate forage and water shortage [19].

Study population

The total livestock population including equine and chicken found in Borena Zone was estimated about 8,221,467 and also about, 319,040 and 328,244 were in the Yabello and Gomole district, respectively. According to Borana zone department of planning and economic development bureau (unpublished), the total camel population of Borena zone was estimated to be about 450,570 and also about 20,480 and 30,113 camel population were found in the Yabello and Gomole district, respectively.

Sampling methods and sample size determinations

Camels were sampled using a combination of multi-stage cluster and simple random sampling to select pastoralist associations (PAs), villages and herd. The two districts (Yabello and Gomole) were selected purposively due to easier accessibility to villages by vehicle and camel population. Two districts from the zone, four PAs from each district and a maximum of seven proportionally camels from each respective herd were included as the study population. The total numbers of camels were proportionally sampled from all districts. Accordingly, a total of 368 camels (177 camels from Yabello and 191 camels from Gomole) were included in this study.

The study animal selection strategy was by categorizing animals in the herds into old, adult and young animals. Herds were visited and sampled early in the morning before released to the field. Finally, for the prevalence study, a total of 368 animals of above two years of age with no history of vaccination against brucellosis and both sex (36 from Dida Yabello, 51 from Haro Bake, 48 from Cholikasa and 42 from Areri in PAs of Yabello district) and (45 from Surupa Badiya, 47 from Buya, 60 from Bildimi Raso and 39 from Dhaka Barru in PAs of Gomole district were selected from 89 different herds.

The sample size for this study is determined by the following formula given by (Thrusfield, 2007) [21]. $n = [1.962 \text{ Pexp} (1 - \text{Pexp})] / d^2$, Where: n = sample size, Pexp = minimum expected prevalence, 1.96 = the value of Z at 95% confidence interval d = desired accuracy the level at 95% confidence interval. Therefore, by using the above formula and taking the previous prevalence of 3.1%, the minimum sample size at 95% confidence interval and at 5% precision or accuracy level, the sample size was calculated to be 46 which, inflated into 368 samples were to increase the significance, reality, and accuracy of the study area.

Study Design

A cross-sectional study design was conducted from November 2018 to April 2019 by using serological tests, the Rose Bengal Plate test (RBPT) and Indirect Enzyme Linked Immunosorbent Assay (i-ELISA) test to determine the sero-prevalence of camel Brucellosis Brucellellosis and associated risk factors in Yabello and Gomole district of Borena Zone, Oromia region, Southern Ethiopia.

Study Protocol

Blood Sample Collection: Approximately 6 to 8 ml of the blood sample was collected from the jugular vein of each camel using plain vacutainer tubes. The collected blood samples could clot at room temperature and serum was separated from clotted blood by decanting to plastic cryo-vials. A separated serum was stored at -20°C for further serological tested.

Rose Bengal plate test (RBPT): All collected sera were initially screened for antibodies against Brucella by the Rose Bengal plate test (RBPT). The test was performed using commercially available antigen (Institute Pourquer, 3409 Montpellier Cedex 5, France) following the method described by Alton et al. and OIE 2004 [22].

Indirect Enzyme-Linked Immunosorbent Assay (i-ELISA): The samples that were screened positive by RBPT were further confirmed by i-ELISA for the detection of Brucella antibodies. I-ELISA seems to be an important alternative to the conventional serodiagnosis of camelid brucellosis. I-ELISA is used to discriminate between the presence of specific IgM and IgG antibodies and to roughly access the stage of illness [23].

Questionnaire Survey: Verbal consent was obtained from the respondents, and the objectives of the survey were explained to them before the start of the interview. The interviews were conducted in the local language (Afaan Oromoo). Two questionnaire formats, one for the serum sampled individual animal history and the other with a structured questionnaire

format for the herders, were developed and used in this study. The questionnaire focused on animal husbandry and housing practices, knowledge about zoonotic diseases, the habits of animal product consumption and handling, and dead-animal/aborted fetus disposal practices.

In total, forty-six (46) pastoralists twenty-three (17) from Yabello and twenty-nine (29) from Gomole district respectively, whose animals tested for brucellosis were interviewed. The information gathered relates to livestock structure, the composition of camel herds, camel management (milking, herding, watering, and delivery and mating assistance), milk consumption habits and purpose of camel rearing. Additionally, age, sex, herd size, parity and physiological status of sampled camels were recorded. In doing so, the risk factors that have possible associations with the occurrence of brucellosis were investigated and used to support the serological results.

Data Analysis

The data collected were stored in Microsoft Excel spreadsheets (Microsoft Corporation) and analyzed using SPSS version 20. Variables with more than two categories were transformed into indicator (dummy) variables. Herds containing at least one seropositive camel were considered positive. Seroprevalence was calculated by dividing the number of camel tested positive (i-ELISA) by the total number of camels tested. Similarly, herd-level seroprevalence was calculated as the number of herds with at least one positive camel divided by the total number of herds tested.

The difference between the effects of some risk factors on prevalence were analyzed using the Pearson chi-square (χ^2) test. Logistic regression analyses were used to assess the strength of association and were also calculated to quantify the association of different risk factors with the prevalence of Brucellosis disease. The statistically significant association between variables was said to exist if the calculated P-value is less than 0.05 and the degree of association was computed using odds ratio (OR) signified by 95% confidence intervals [24].

RESULTS

In this study, out of 368 camels examined 46(12.5%) were positive on RBPT screening test. but, on further confirmation by i ELISA only 11(3%) camels were seropositive to Brucella infection. Therefore, the true prevalence of camel brucellosis in the selected pastoral area was 3% (Table 1).

Results of Chi-square a logistic regression analysis of potential risk factors at animal level revealed that all the variables investigated had no significant association with Brucella seropositivity ($P > 0.05$). The seroprevalence of camel brucellosis seems higher in Gomole (4.2%) than Yabello (1.7%) regarding district, but the difference was statistically insignificant ($p > 0.05$) (Table 2). Table 2 shows that risk factor at animal level district, age, sex, parity, and herd the composition was found not statistically significant ($p > 0.05$) while, body condition, herd size, physiological status and history of abortion were found highly statistically significant ($\chi^2 = 6.004$; $p = 0.050$, $\chi^2 = 8.560$; $p = 0.014$, $\chi^2 = 19.273$; $p = 0.000$, $\chi^2 = 29.354$; $p = 0.000$; respectively).

Table 1: The overall seroprevalence of camel brucellosis by RBPT and i-ELISA in Yabello and Gomole districts of Borena Zone, Oromia Regional State and Southern Ethiopia in 2019.

District	No. tested camel	Positive (in RBPT)	Prevalence	Positive (in ELISA)	Prevalence
Yabello	177	19	10.70%	3	1.70%
Gomole	191	27	14.10%	8	4.20%
Total	368	46	12.50%	11	3%

No=Number

Table 2: Summary results of the chi-square and binary logistic regression analysis of potential risk factors with dependent i-ELISA brucella seropositivity in camel in Yabello and Gomole district, Borena Zone, Oromia Regional, Southern Ethiopia in 2019.

Variable	Category	No. tested	I-ELISA (%)	X ²	P-value	OR (95% CI)	
						Lower	Upper
District	Yabello*	177	3(1.7%)	0.97	0.16	----	
	Gomole	191	8(4.2%)			3.878(0.637-23.612)	
Age	Young*	72	1(1.4%)	0.826	0.662	----	
	Adult	179	6(3.4%)			0.864(0.049-15.162)	
	Old	117	4(3.4%)			0.745 (0.113-4.904)	
Sex	Male*	59	1(1.7%)	0.021	0.884	----	
	Female	309	10(3.2%)			0.067(0.002-2.585)	
Body condition	Poor*	138	8(5.8%)	6.004	0.05	--- -	
	Medium	151	2(1.3%)			0.422(0.021-8.431)	
	Good	79	1(1.3%)			2.503(0.066-95.951)	
Parity	No parturition*						
	Single parturition	98	1(1.0%)	3.773	0.152	- - - -	
	Two or more						
Herd size		105	3(2.9%)			0.007(0.000-0.492)	
	Small*	165	8(4.8%)			1.804(0.027-118.480)	
	Medium	105	3(2.9%)	8.56	0.014	--- -	
	Large	101	7(6.9%)			8.195(0.289-232.523)	
Herd composition	Camel alone*	47	1(2.1%)	2.56	0.465	--- -	
	Camel & Bovine						
	Camel & Shoat	51	1(1.9%)			0.254(0.023-2.764)	
	Camel, Bovine & Shoat						
Physiological status		59	1(1.7%)			0.551(0.029-10.401)	
	Pregnancy*	211	8(3.8%)			146.924 (0.000-)	
	Lactating	75	8(10.7%)	0		- - - - 0.130(0.003-6.686)	
	Dry off	145	2(1.4%)			0.113(0.002-5.152)	
		148	1(0.7%)				

No=Number, OR=Odd ratio, CI=Confidence interval, X²=Pearson chi-square, -*=Reference category.

The body condition score, level differences in seroprevalence was statistically significant ($P=0.050$) was observed and the seroprevalence was more common in poor than medium and good (5.8%, 1.3%, and 1.3%), respectively by using i-ELISA test.

Herd size from which individual camels selected were categorized into three(3) categories, small herd size was the group of animals in which the herd size ranges from (5-10), medium herd size ranges from(11-20) and large herd size considered when the number of camels in the group ranges above

(>21) heads of camels. Seroprevalence of brucella in relation to herd sizes, were (0.6%, 2.9%, and 6.9%) in small, medium and large herd size showed a relation to high seroprevalence and was observed differently statistically significantly ($p=0.014$).

The physiological status was considered as a risk factor for seropositivity of camel Brucellosis that was observed as statistically significantly ($p=0.001$), where pregnant and lactating camels were more infected than dry off ones (10.7%, 1.4%, and 0.7%), respectively. Seropositivity was higher 10(11.8%)

in females with the history of abortion than females without history of abortion 1(0.4%) that was observed as statistically significant ($p=0.001$). Generally, the present study also showed physiologically status and history of abortion seroprevalence of brucellosis ranging from 2(1.4 %) to 8(10.7%) and 1(0.4%) to 10(11.8%) respectively by using the confirmatory test, ELISA which had shown highly significant difference ($p=0.001$).

Questionnaire survey Forty-six (46) animal owners were interviewed as input for the serological testing sample and assessing public awareness towards diseases and zoonotic importance with associated risk factors. It was observed that 90% of Borena pastoralists kept different species of the animal along with a camel. Moreover, the mixing of the different species during migration, at watering or in night enclosures (resting), between camels and small ruminants was recorded. Eighty-two point-six (82.6%) of the respondents consumed raw milk and in the Borena pastoralist traditionally, it is not applicable at all to boil camel milk. However, Gebra pastoralist about (16) out of the forty-six (46) respondents said they use boiled with tea camel milk. Ninety-five percent (95%) of the animal, owners had no awareness about zoonotic importance. Abortion material and other excreta were handled with bare hands, and they do not destroy these materials.

On the other hand, several activities and existing habits might have role in the transmission of the disease from animal to human. Raw fresh milk is habitually consumed by the majority of the inhabitants (82.6%) whereas no groups consume sour milk and only about (34.8%) milk boiled with tea. To the contrary meat is consumed cooked by almost all except for chopped raw liver and hump (39.1%) that is liked by some groups of pastoralists. Besides consumption of camel products, owners are usually in close contact with their animals. They do mating and delivery assistance, clean thin membrane from newborn, assist suckling and carry the newborn from field to home without any self-protection.

DISCUSSION

Pastoral communities of Borena lowland produce camels for multi-purpose, primarily for transportation followed by milk, cash income by sale and meat production. Bekele [20] also reported similar reasons for camel keeping while Coppock [18] stated, as transportation is the main purpose in Borena except for Gebra and Somali ethnic groups who keep camels mainly for milk production. Borena and Gujis are basically cattle herders and recently started camel husbandry as asset diversification for uncertainties, drought mitigation and coping up with changing rangeland ecology [25]. As a result, they had less herding experience ranging from 3 to 30 years, resulting in less indigenous knowledge in camel husbandry.

Previous serological surveys in Ethiopia showed that camel brucellosis is an endemic and widespread disease in Ethiopia [26]. In this study, the overall seroprevalence of camel brucellosis in selected districts recorded was 12.5% by the RBPT and 3% by i-ELISA. The true prevalence of 3% recorded in the present study that agrees with the results recorded by [27] in Borena with a prevalence of 4.2% and Hadush et al. [10] in the Afar with a prevalence of 4.1% [27]

However, the result of this study was higher than the observation recorded by [28] in Dire Dawa (1.6%), [29] in Jijiga and Bible districts, Eastern Ethiopia (2.43%) and [30] in the Afar (2.09%). But, it was noted to be lower than the observation by [31] and [32] who reported a prevalence of (5.7%) and (7.6%), respectively indifferent districts of the Afar region. That, higher and lower of seroprevalence rates could be due to variations in topography, management system, collected of sample size, unpredictable nature of the environmental condition of pastoral and reoccurrence of the disease contribute to the fluctuation of prevalence.

The differences could be due to variations in animal management and production systems, whereas in the camel rearing areas of Ethiopia, large numbers of different species of animals are raised on communal pastures and watering areas [29]. Since brucellosis is considered as a disease of herd importance. In this study, lower in herd level that seropositivity of 6.9% was found but, 16% recorded by [20] in Borena. This could be due to the presence of the high number of camels in the herds and mixing of aborting camels with normally parturient camels. Even though brucellosis was detected in all the two districts with slight variation in prevalence, however, it was not a statistically significant difference ($P=0.160$). This could be attributed to the similarity in agro-ecological conditions and livestock management systems in the districts.

Age categorization was made to assess an association of the seroprevalence with the disease. Despite, the increment in seropositivity with age no signs were observed in camels with age 2-4 but a significant difference was observed in camels with age 5-10 years. However, the higher seroprevalences of (3.4%) in animals aged above 10 years equal by those in the 5-10 age group had seroprevalences of 3.4% and those in the 2-4 age group with (1.4%) was observed as this study. Overall in three age groups, no significant differences ($p=0.662$) were observed. This finding is consistent with [27], [33,34] who found similar seroprevalences of brucellosis in very old camels, while the seroprevalences in other age-groups for example young and adult camels were (2.9%, 6.1%; 1.0%, 2.2%, and 1.7%; 2.6%), respectively. The increase in infection with advances in ages agrees with the report of [35].

This indicates that more seropositivity to the camel, brucellosis was seen in adults and old than young camels as it is the disease of sexually matured animals. Sexually matured animals are more prone to *Brucella* infection than sexually immature animals since sexually matured animals are at risk of infection and diseases transmission due to sexual mating and sugar erythritol development, which favors the multiplication of the pathogen [36-39] recorded age at puberty and first calving to be 4 and 5 years, respectively for females whereas males were 5 years at puberty in eastern Ethiopia.

The analysis result also revealed that the prevalence of brucellosis between sexes did not show significant association ($P=0.884$). However, the presence of seropositive breeding males and she-camels were considered as risk factors playing a role in the transmission of the disease to other animals [40] The prevalence was higher in females (3.2%) compared to prevalence in males (1.7%). On the contrary, with the findings of [27] in the

Afar region and [34] in the Somali region that seroprevalences of (7.2 and 2.8%) in males and (4.9 and 2.3%) in females, respectively. Relatively higher susceptibility of she-camels could be due to the fact that they have more physiological stresses than males [41]. In addition, [42] have reported that male animals are less susceptible to *Brucella* infection due to the absence of sugar erythritol. The presence of growth factors such as erythritol and hormones favor infection in mature animals [43]. But the current finding might be due to the number of breeding males kept by the pastoralists in the camel herds of the present study was very small in which was applied and this predictably biases the statistical analysis.

The body condition of the camels was considered in this study to see the distribution of the infection in different body condition scores. Since underfed animals are expected to have a poor body condition that is manifested by decreased immunity against various infections [44]. Even though in this study body condition the score was statistically significant ($P=0.050$), high seropositivity was found in camels with poor (5.8%) than camels with medium (1.3%) body condition score and camels with good (1.3%) body condition score. This is contrary, with the finding [45] from the Afar region revealed that high seropositivity was found in camels with good (5.7%) and fair (3.6%) body condition score than camels with poor (3.3%) body condition score but, the difference was not statistically significant ($P>0.05$). This illogical finding could be due to the condition that the majority of the camels sampled (81.4%) were with good and fair body condition score and only 18.6% of the total samples were with poor body condition.

This concept coincides with the current study that the seroprevalence of brucellosis among three categorized herd sizes, 5-10 camel, 11-20 camel and >21 camel had significant ($p=0.014$) variations. Where higher seropositivity was recorded in the large herd size. This may be due to easy contacts between infected and susceptible camels. The significantly higher seropositivity in the large herd size categories is in concordance with several reports that large herd sizes are at risk for occurrence high prevalence of brucellosis [27,33,34]. A large number of camel herds always congregate at watering points thus facilitating the spread of brucellosis. Rivers, lakes and artificial wells are major permanent water sources in this study area. Camels have direct access to water points and contaminate by discharges and hence a higher infection rate was recorded in large-sized camel herds. Nevertheless, the mobility natures of camel herds do not restrict them to a specific category of the water resources, making the conclusion to specific watering points difficult on that observation.

Herd composition (high number of camels, cattle and small ruminant) diversifications were noticed in the study district. Such animal species distribution and diversification are common to other areas and have economic and ecological advantages [46]. However, it increases the chance of brucellosis and another disease transmission from other infected ruminants to dromedaries [47] and [35]. In the present study, seroprevalence in camel made contact with other ruminants, such as camel alone, camel and bovine, camel and small ruminants and camel, bovine and small ruminants were (2.1%, 1.9%, 1.7%, and 3.8%)

respectively. However, no statistically significant difference ($P=0.465$) was observed between these four camel groups. The present finding was in line with the observation from Somalia [47] and Saudi Arabia [48]. The results of my study go parallel with the findings of [40] and [30] in Afar and [26] in Mehoni District, South Eastern Tigray, Ethiopia. A contributing factor to the spread of the disease may be the movement of animals for grazing and watering during the dry season as aggregating the animals around watering point might increase the contact between infected and healthy animals and thereby facilitate the spread of the disease [36-38].

The seropositivity of she-camels with the history of parity with two or more was (4.8%) and which is higher than those with single and no parturition (2.9% and 1.0%) respectively. But here was not a statistically significant association ($P=0.152$) between parity and the seroprevalence of the disease. The seroprevalence of the parity groups of the present finding agrees with the findings of [34], who reported (1.6%, 2.5%, and 2.7%) for no parturition, single parity, and more than one parities, respectively. This finding is also, consistent with the report of [13] who indicated that animals that which has not given birth tended to be more resistant to infection. Another possible explanation for this is that because the repeated exposure of the she-camels to parturition and other physiological stress increases the probability of acquiring *Brucella* infection.

Physiological status showed a highly statistically significant difference ($P=0.001$) in this study. On the contrary, in with the findings of (Hadush and co-investigators, 2013) in Afar. In this study, pregnant camels were found higher (10.7%) in seropositivity than lactating and dry off (1.4% and 0.7% respectively) that, consistent with the scientific view since pregnant and lactating camels more prone to stress and immune-suppressed than dry and the concentration of sugar erythritol contributes to variation in seropositivity [36]. Among the three categorized reproductive status that is pregnant, lactating and dry off, only high sero-reactors were recorded in pregnant camels.

Brucellosis can generally cause significant economic losses through abortion, late first calving age, long calving interval time, low herd fertility, culling and comparatively low milk production [14]. In the current the study, among the abortions a significant association ($p=0.001$) was found with seropositivity of the infection and the proportion of abortion rates were (0.4%) in those herders who reported no history and (11.8%) in those who reported history of abortion was recorded. This happened due to herds of study districts with history abortion.

CONCLUSION AND RECOMMENDATIONS

The data obtained in the present study determined seroprevalence of camel brucellosis and associated risk factors in Yabello and Gomole District of Borena Zone, Oromia Region, Ethiopia. The findings of positive serological reactors do not only suggest the presence of the disease in camel populations of the area but also indicates the presence of foci of infection that could serve as sources of infection of the disease in naive camel herds. This emphasizes the high prevalence of brucellosis in both camels and camel herders (public health) that is calling

for need to implement suitable control strategies of brucellosis in the study area. Public awareness towards the diseases was interviewed with the structured questionnaire format and it was noted that most of the pastoralists had no knowledge about zoonotic disease transmission, consequences of consuming raw milk, meat and handling aborted animals without any protective material. The associated risk factor contributing to the presence and transmission of the disease from animal to animal was age, sex, body condition, herd size, parity, herd composition, physiological status and history of abortion. However, according to the statistical analysis, the main major risk factors identified for the transmission of the disease from camel to camels were included body condition the score, herd size, physiological status and having a history of abortion as the present study indicates.

- Based on the above conclusion the following recommendation is forwarded; Awareness creation and continuous extension education on modern camel husbandry practices and control, prevention with the eventual aim of eradicating this zoonosis among the pastoral communities.
- They should avoid bare-handed handling of aborted materials of camels and should safely dispose of them to a drugged ground where dogs and other carnivores couldn't reach.
- Camel pastoralists are often marginalized from public services, facilities and information. Thus, awareness (public health education) on modern animal husbandry, disease Prevention and risk of zoonotic diseases is quite necessary.
- Therefore, fruitful and sustainable work is required from the government, animal health professionals, and other stakeholders in the prevention and control of the disease.

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