Seroprevalence and potential risk factors of bovine brucellosis at the livestock-wildlife interface area of Yankari game reserve, Bauchi State, Nigeria.

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Abstract

A cross-sectional study was conducted to determine the seroprevalence and associations with potential risk factors of brucellosis in indigenous cattle breeds at the livestock-wildlife interface area of Yankari Game Reserve, Bauchi State, Nigeria. A total of 1000 sera samples were examined from 44 herds using convenient and simple random sampling technique. Rose Bengal Plate Test (RBPT) and competitive Enzyme-linked Immunosorbent Assay (c-ELISA) were used as screening and confirmatory tests respectively. Of the 1000 samples, 23.5% samples were RBPT positive, and after the confirmatory test, the overall true animal-level prevalence was 4.1%. For the herd level prevalence, (47.7%) herds had at least one animal that is seropositive following both tests. Brucellosis seroprevalence was significantly associated with the following potential risk factors; herds that belong to a cooperative society member ($p < 0.042$), herds that keep only cattle ($p < 0.001$), herds that practice commercial farming system ($p < 0.011$), herds that possess a herd size of 51 to 100 cattle ($p < 0.009$) and herds that have no history of abortion and other reproductive disorder ($p < 0.009$). No statistically significant differences in brucellosis seroprevalence was obtained within sex, breed and age groups. It can be concluded that brucellosis is still endemic in the study area.

Keywords: Brucellosis, c-ELISA, Interface, Risk Factors, Yankari Game Reserve

Introduction

Bovine brucellosis caused by *Brucella abortus* is a chronic infectious disease affecting wide range of hosts, including domestic livestock, wildlife and humans. It is a major economic and public health concern. Presence of wildlife in several countries is a major obstacle to its eradication. In Nigeria, the disease has been reported from nearly all livestock producing areas with an overall prevalence of 26.3 %, 11.1 % and 20.0 % in cattle, sheep and goats respectively in northern Nigeria (Mai *et al.*, 2012; Zubairu *et al.*,

2014). Despite the earlier control programme undertaken in the country using *Brucella abortus* strain 19 vaccine and test-and-slaughter methods, the disease is still endemic and its incidence increasing (Bale, 1991). *Brucella melitensis*, *B. abortus* and *B. suis* cause abortion and infertility in their natural hosts, i.e. goats, sheep, cattle and swine (Godfroid *et al.*, 2011). *Brucella spp.* has also been isolated from a great variety of wildlife species. Consequently, different wildlife species may act merely as spill over hosts of *Brucella spp.* for other animal species and humans (Godfroid *et al.*, 2011),

especially in livestock, wildlife and human interface areas.

Among the members of the group, *B. abortus*, *B. melitensis*, and *B. suis* species are not host-specific, and may transmit to other animal species. Cross transmission of brucellosis can occur between cattle, swine, sheep, goats and other species including dogs, horses, feral swine, bison, rein deer, camels and humans (FAO, 2003). Typically, in all host species, *Brucella* grows intracellularly producing a variable bacteraemic phase followed by localization in the tissues of the genital tract and in the mammary gland. Abortion is typically the first clinical sign of the pregnant female, orchitis and epididymitis are typical clinical signs of the male (Corbel, 1998; England *et al.*, 2004). In particular, female animals that have reached sexual maturity are most susceptible to infection. Transmission within the hosts may occur via ingestion of *Brucella* contaminated feed, water or licking an infected placenta, calf or foetus, or the genitalia of an infected animal soon after it has aborted or gave birth (Alexander *et al.*, 1981; Godfroid *et al.*, 2004). The bacterial concentrations in fetal fluids or placenta after abortion can be as high as 109 to 1010 colony forming units (CFUs)/g and minimum infectious doses are estimated in the 10³ to 10⁴ CFU/g. Abortion events can laterally transmit brucellosis to many cattle that have contact with birthing materials (Olsen and Tatum, 2010). Moreover, transmission within the natural hosts can occur through milk, via semen or genital secretions during mating. Zoonotic transmission occurs most frequently via unpasteurized milk products in urban settings, while occupational exposure of farmers, veterinarians or laboratory workers can result from direct contact with infected animals, tissues or fluids associated with abortion (Olsen and Palmer, 2014). Only rare cases of vertical and horizontal (Wyatt, 2010) transmission

between humans have been reported (Ruben *et al.*, 1991; Mantur *et al.*, 1996; Çelebi *et al.*, 2007; Meltzer *et al.*, 2010) and humans are generally considered to be incidental, or dead-end hosts for *Brucella* species (Meltzer *et al.*, 2010). The spill over of brucellae from wildlife to domestic ruminants is also possible (Mick *et al.*, 2014). Prevalence of bovine brucellosis varies widely across Nigeria and between herds in the same area, with reported seroprevalence of 0.2% to 80% (Pam, 1995; Bertu *et al.*, 2012). In institutional farms, abattoir surveys and other ranches or dairy farms in southern Nigeria, bovine brucellosis prevalence ranges between 3.7% to 48.8% (Esuruoso, 1979), whereas in the traditional nomadic Fulani cattle herds in the North, it was around 21.3% to 26.3%. Milk prevalence of 7.6% and herd-level prevalence of 77.5% were also recorded (Mai *et al.*, 2012; Zubairu *et al.*, 2014). A recent study performed in northern Nigeria, reported a RBPT seroprevalence of 45.1% (nomadic), 22% (semi-nomadic), 23.8% (commercial) and 15.9% (Zero-grazing), but higher prevalence in the extensive than intensive system was recorded (Marie *et al.*, 2014). The risk factors of brucellosis in indigenous cattle are yet to be described fully (Muma *et al.*, 2007a). Several factors such as types of livestock production, herd size, interaction with wildlife, ecological and socio-economic factors play important role in the epidemiology of the disease (Kadohira *et al.*, 1997; Orner *et al.*, 2000; Kabagambe *et al.*, 2001). Interaction of cattle with wildlife in livestock-wildlife interface areas has been implicated because of sharing of grazing land and water between wildlife and domestic animals (Pandey *et al.*, 1999). However, the extent to which wildlife, livestock and human interaction and other risk factors contribute to brucellosis seroprevalence has not been described (Muma *et al.*, 2007a). The objectives of this

study were to determine the prevalence of bovine brucellosis, identify some risk factors associated with the spread and distribution of bovine brucellosis, and to determine the prevalence of human brucellosis in the study area.

Materials and methods

The study was conducted using domestic cattle kept traditionally in the livestock and wildlife interface areas of Yankari Game Reserve, Bauchi, Bauchi State, Nigeria. Bauchi State is located between latitude 9° 30' and longitude 8° 42' to 11° 50' and lies 690.2 m above sea level (BSADP, 1998). Yankari Game Reserve formally known as Yankari National Park is a large wildlife park located at 9.50° north and 10.30° east in the south-central part of Bauchi State, in north-eastern Nigeria in the southern portion of the Sudan Savannah zone (Omondi *et al.*, 2006). It covers an area of about 2,244 square kilometers and is home to a significant number of mammalian wild animal species, which include, the Buffalo (*Syncerus caffer*), Elephant (*Loxodonta africana*), Baboon (*Papio anubis*), Waterbuck (*Kobus ellipsiprymus*), Bush buck (*Tragelaphus scriptus*), Roan antelope (*Hippotragus equinus*), Western Hartebeest (*Alcelaphus buselaphus major*), Hippopotamus (*Hippopotamus amphibius*) and Warthog (*Phacochoerus aethiopicus*) (Omondi *et al.*, 2006). The basin of the Gaji River and its tributaries is the only watershed in the park where Elephants and other animals depend on especially in the dry season (Omondi *et al.*, 2006). Samples were taken from Cattle reared traditionally by pastoralist and agro-pastoralist, which comprised mainly of the Bunaji, Rahaji and Bokoloji breeds.

Study design and sample size determination

Cross-sectional study was conducted using serological procedures and questionnaire. Area familiarization, introduction and

awareness about the virtues of the research were made to the farmers/herdsmen. Blood collection and administration of the questionnaire were performed. The farmers/herdsmen were interviewed using the questionnaire to determine the management and husbandry risk factors likely to influence the spread and persistence of brucellosis. Reproductive parameters that are known to be affected by brucellosis were also incorporated in the questionnaire. The serological survey was carried out with the intention of determining both individual and herd level prevalence. Sample size was determined using a combination of convenience sampling and random sampling methods (Sedgwick, 2015). The calculation for the sample size was based on the multistage random sampling formula, $n = Z^2 P \exp (1 - P \exp) / L^2$ as described by Thrusfield (2005), where, Z = confidence level given as 1.96, L = desired absolute precision ($\pm 5\%$) and $P \exp$ = expected prevalence (20%). Although, the actual sample size was found to be approximately 246 cattle based on the calculations, but the total adult cattle randomly selected were 1000 in order to increase precision and power of the test.

Sample collection

Approximately 10 mL of blood was collected using a 10 mL syringe and needle from the jugular vein of each animal aged above two years of age by physically restraining them. Each sample was labelled using codes specific to the individual animal and the herd. The syringes were tilted and kept either overnight or for several hours at room temperature to allow clotting, then the serum was properly decanted into a labelled plain test tube and was stored at -20 °C until it was tested using Rose Bengal Plate Test and Competitive-Enzyme-Linked Immunosorbent Assay (c-ELISA).

Blood samples were taken from the veterinary assistants and the herdsmen with

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the help of a laboratory scientist at Gaji primary health center. Only the people that agreed to be screened for brucellosis were bled and a total of fifty (50) sera samples were obtained and screened to ascertain the prevalence of brucellosis in humans in the study area.

Serological testing

Rose Bengal Plate Test (RBPT) antigen was obtained from Onderstepoort Biological Products (OBP) Ltd, South Africa and used as a screening test for detection of *Brucella* antibodies. Positive samples were confirmed using competitive-ELISA (COMPELISA 400, RAI 2006) for the diagnosis of brucellosis obtained from Animal and Plant Health Agency (APHA), New Haw, Addlestone Surrey, UK. The reagents were prepared according to the protocol described by the APHA, UK.

Statistical analysis

Microsoft Office Excel® 2013 (Microsoft Corporation, One Microsoft Way, Redmond, 98052-7329, USA) was used to store the data. Data obtained were analysed using descriptive statistics and Chi-square

test for association (SPSS version 20).

Results

Presented in Table 1 is the herd-level seroprevalence of Bovine brucellosis at the livestock, wildlife and human interface area, Yankari Game Reserve, Nigeria. Of the 44 herds studied, there were 95.5% with at least one animal testing positive based on RBPT and 47.7% based on c-ELISA. Therefore, the herd-level seroprevalence of brucellosis in the study area was estimated to be 47.7%. Animal-level seroprevalences for the three areas following RBPT and c-ELISA were shown in Table 2. A total of 1,000 samples was tested with RBPT of which 23.5% were positive. Of these, 4.1% were confirmed to be seropositive for brucellosis upon further testing by c-ELISA. The overall true seroprevalence for animal-level in the study area was estimated to be 4.1% based on c-ELISA, giving the overall false positives to be 82.6%. The association within breed, sex and age and *Brucella* seropositivity did not differ significantly ($p > 0.05$) (Table 3).

Table 1: Herd-level seroprevalence of Bovine brucellosis at the livestock-wildlife interface area of Yankari Game Reserve, Bauchi State, Nigeria.

Study Area	N	Number of Positives (%) RBPT	Number of Positives (%) ELISA
Gaji	15	15 (100)	11 (73.3)
Bayan gari	14	12 (85.7)	2 (14.3)
Duguri	15	15 (100)	8 (53.3)
Overall	44	42 (95.5)	21 (47.7)

N= Number of herds sampled, RBPT= Rose Bengal Plate test, c -ELISA= Competitive enzyme-linked immunosorbent assay, %= Prevalence of brucellosis.

Table 2: Animal-level seroprevalence of Bovine brucellosis at the livestock -wildlife interface area of Yankari Game Reserve, Bauchi State, Nigeria.

Study Area	N	Number of Positives (%) RBPT	Number of Positives (%) c-ELISA	X ²	P-value	False Positive (%)
Gaji	275	70 (25.5)	25 (9.1)	30.874	0.000	45 (63.4)
Bayan gari	320	86 (26.9)	14 (4.4)			72 (83.7)
Duguri	405	79 (19.5)	2 (0.5)			77 (97.5)
Overall	1000	235 (23.5)	41 (4.1)			194 (82.6)

N= Number of cattle sampled, RBPT= Rose Bengal Plate test, c -ELISA= Competitive enzyme-linked immunosorbent assay, %= Prevalence of brucellosis, and X²= Chi-square.

Table 3: Influence of breed, sex and age on the seroprevalence of Bovine brucellosis

Factors	Group	N	Number of Positives (%) RBPT	Number of Positives (%) c-ELISA	X ²	P-value
Breed	Bunaji	936	221 (23.6)	39 (4.2)	1.402	0.496
	Rahaji	28	5 (17.9)	0 (0)		
	Bokoloji	36	9 (25.0)	2 (5.6)		
Sex	Maale	195	42 (21.5)	8 (4.1)	0.000	0.998
	Female	805	193 (24.0)	33 (4.1)		
Age groups (Years)	3-5	434	105 (24.2)	19 (4.4)	0.649	0.885
	6-8	321	98 (23.3)	15 (3.6)		
	9 and above	144	32 (22.2)	7 (4.9)		

N= Number of cattle sampled, RBPT= Rose Bengal Plate test, c -ELISA= Competitive enzyme-linked immunosorbent assay, %= Prevalence of brucellosis, and X²= Chi-square.

The associations between brucellosis seropositivity and management risk factors are shown in Table 4. There were significant differences statistically within the following potential risk factors; membership in an association (7.3% to 3.6%; p=0.042), multiple animal species (15.2% to 3.7%; p=0.001), herd size (5.3% to 0.8%; p=0.009), quarantine practice (25.0% to 3.9%; p=0.003) and history of abortion (15.8% to 3.9%; p=0.009). The

following risk factors however recorded no significant differences; ownership of multiple herds (4.6% to 1.7%; p=0.073), care during parturition (4.1% to 4.0%; p=0.924), access to veterinary services (4.2% to 0%; p=0.316), history of vaccination (4.3% to 1.4%; p=0.222), proper disposal of aborted materials (4.3% to 2.0%; p=0.279) and contact with wild animals (4.4% to 0%; p=0.073) as shown in Table 4.

Table 4: Potential risk factors associated with brucellosis in Yankari Game Reserve area, Bauchi State, Nigeria.

Potential Risk Factors	Groups	N	Number of Positives (%) RBPT	Number of Positives (%) c-ELISA	X ²	P-value
Membership in cooperative/association	Yes	137	44 (32.1)	10 (7.3)	4.132	0.042
	No	863	191 (22.1)	31 (3.6)		
Ownership of multiple herds	Yes	178	38 (21.3)	3 (1.7)	3.211	0.073
	No	822	197 (24.0)	38 (4.6)		
Multiple animal Species	Cattle+others	963	225 (23.3)	36 (3.7)	10.601	0.001
	Cattle only	33	10 (30.3)	5 (15.2)		
Source of replacement /additional stock	Within herd	770	177 (23.0)	33 (4.3)	1.191	0.551
	Across herds	132	33 (25.0)	6 (4.5)		
	Market	98	25 (25.5)	2 (2.0)		
Farming system	Agro-pastoral	655	153 (23.4)	28 (4.3)	8.995	0.051
	Pastoral	345	82 (23.8)	13 (3.8)		
Herd size	1-50	53	11 (20.8)	2 (3.8)	9.388	0.009
	51-100	699	169 (24.2)	37 (5.3)		
	101 above	248	55 (22.2)	2 (0.8)		
Quarantine practices	Yes	8	4 (50.0)	2 (25.0)	8.959	0.003
	No	992	231 (23.3)	39 (3.9)		
Care during parturition	Yes	201	52 (25.9)	8 (4.0)	0.009	0.924
	No	799	183 (22.9)	33 (4.1)		
Contact with Wildlife	Yes	930	221 (23.8)	41 (4.4)	3.218	0.073
	No	70	14 (20.0)	0 (0)		
Access to Veterinary services	Yes	977	228 (23.3)	41 (4.2)	1.006	0.316
	No	23	7 (30.4)	0 (0)		
History of any vaccination	Yes	73	13 (17.8)	1 (1.4)	1.493	0.222
	No	927	222 (23.9)	40 (4.3)		
History of abortion and other reproductive disorders	Yes	981	230 (23.4)	38 (3.9)	6.731	0.009
	No	19	5 (26.3)	3 (15.8)		
Method of disposing aborted foetus	Proper	98	25 (25.5)	2 (2.0)	1.172	0.279
	Improper	902	210 (23.3)	39 (4.3)		

N= Number of cattle sampled, RBPT= Rose Bengal Plate test, c -ELISA= Competitive enzyme-linked immunosorbent assay, %= Prevalence of brucellosis, and X²= Chi-square.

Discussion

The study revealed that bovine brucellosis is prevalent in Yankari Game Reserve area of Bauchi state, Nigeria, with a herd-level prevalence of 47.7% (Table 1). This result is lower than 63% herd-level prevalence reported by Muma *et al.* (2007b) in the livestock-wildlife interface areas of Zambia. Higher prevalence than the present study was also reported by Mai *et al.* (2012) 77.5% in three states of northern Nigeria and 63.6% by Haileselassie *et al.* (2010) in Ethiopia under semi-intensive production system. However, the result of the present study was higher than 26.1% herd-level prevalence reported by Megersa *et al.* (2011) in Ethiopia under traditional cattle husbandry. The variation in the herd-level seroprevalence may be attributed to the variation in the herd husbandry and management practices and herd sizes as reported by the various authors mentioned above. Table 2 presents an overall animal-level seroprevalence of 4.1%, which was lower than 26.3% and 21.3% obtained by Mai *et al.* (2012) and Zubairu *et al.* (2014) in Nigeria. This could be attributed to the seasonal migration of the livestock and the wild animals in the study area. Differences in sample size and the serological tests employed would further accentuate these variations. However, the result is comparable with 6% and 3.5% reported by Mellau *et al.* (2009) and Megersa *et al.* (2011) in a livestock-wildlife interface area and traditional livestock husbandry studies in Tanzania and Ethiopia respectively. The result obtained from the influence of breed, sex and age on seroprevalence of bovine brucellosis in this study is consistent with the reports by Junaidu *et al.* (2011) and Mai *et al.* (2012). This difference between breeds may be attributed to the effect of genetic variation in conferring resistance or tolerance of cattle breeds to *Brucella* infections (Martinez *et al.*, 2010). The overall animal-level seroprevalence of

brucellosis in the present study was the same between females (4.1%) and males (4.1%). This is consistent with observations by Bayemi *et al.* (2009) who reported a similar result, indicating no differences between sexes. However, this finding is contrary to the assertion by Junaidu *et al.* (2008) who reported a higher prevalence in females than males, also, Chimana *et al.* (2010) and Mai *et al.* (2012) observed higher prevalences in male than female cattle. Cows are kept longer and in large proportion in a herd than bulls; this is particularly true in the pastoral farming system where cows are kept for breeding purpose. This may explain the variations recorded in the prevalence of brucellosis in relation to sex. In the present study, the prevalence of brucellosis in relation to age did not follow a definite pattern. There was higher prevalence (4.9%) in the older (9 years and above) animals followed by the younger (3-5 years) (4.4%), then the middle age (6-8 years) (3.6%), although the differences were not significant. The result is contrary to that of Junaidu *et al.* (2011); Matope *et al.* (2011) and Mai *et al.* (2012). Brucellosis is endemic in all the different age groups alike, although there was report that indicated older cattle may not exhibit detectable antibody titres possibly due to latency, which is common in chronic brucellosis (Cadmus *et al.*, 2008; Matope *et al.*, 2011). Risks of *Brucella* infections linked to husbandry/management practices, farming system and membership in a cooperative/association were observed as shown in Table 4. The prevalence of brucellosis in herds that belong to a cooperative society or association in this study was significantly higher (7.3%) ($p=0.042$) than in herds that do not (3.6%). Membership in a cooperative society/association is closely associated with access to veterinary services, which is also associated with high odds of herd brucellosis. These two factors allowed

herdsmen to get access to information, and animals to congregate at dipping sites and during vaccination campaigns and could probably explain the increased risk (Muma *et al.*, 2007b). The result obtained from herds that have only one animal species is contrary to the reports by Omer *et al.* (2000) and Muma *et al.* (2007b). This may be attributed to the fact that as the organisms find a population of their preferred hosts, they tend to build up and remain endemic therein. Although not statistically significant ($p=0.551$), the prevalence of brucellosis was lower in herds that purchased their replacement stock from the market (2.0%) than those that raised them from within the herd (4.3%) and across the herd (4.5%). Farmers that purchase their initial stock from the market mostly practice quarantine and therefore have low prevalence, this is contrary to those that inherit their initial stock, who mostly does not practice quarantine and therefore have higher risk of infections. There was significant difference between pastoral 13(3.8%) and agro-pastoral 28(4.3%) farming systems ($p=0.051$). Mai *et al.* (2012) reported a higher prevalence amongst pastoral herds than agro-pastoral herds. They attributed the high prevalence of brucellosis in a pastoral management system partly to the long distance movement of cattle in search of pasture and water and comingling in communal grazing areas and at watering points particularly during the dry season. There is no statistically significant difference ($P<0.073$) in the prevalence of brucellosis between farms that owned multiple herds 3(1.7%) and those that owned single herd 38(4.6%).

The difference observed in the seroprevalence of bovine brucellosis among herd sizes in the study area agreed with the findings of Jergefa *et al.* (2009), who reported that animals from smaller and medium sized herds were at greater risk of

acquiring brucellosis. This could be related to the close contacts between the animals in smaller herds which will increase the transmission of the disease. Also, among farmers with small herds, lack of owned bulls for breeding may compel them to strategically graze their animals in close proximity with those who had bulls of their preferred breed choice. This was to facilitate easy straying of the bulls in their herds leading to multiple herd contacts which is another brucellosis risk factor (Muma *et al.*, 2007b). Quarantine practice is closely related to sharing of breeding bulls and purchasing of breeding bulls from the market as most farmers that practice quarantine are aware of the risk of introducing infection in to their herd. Therefore, the lack of defined clinical sign for brucellosis in bulls coupled with the chronic nature of the disease may inform the higher prevalence obtained in the herds that practice quarantine (25.0%) than those that do not (3.9%) in the present study. The results of the questionnaire showed that there is lack of hygienic practices in the study area, such as the use of a separate parturition pen and proper disposal of aborted materials. Similar finding has been reported by Jergefa *et al.* (2009), suggesting that little attention has been given to prevention of brucellosis and that this, in turn, contributes to the spread and transmission of the infection in the area, although the result of the present study showed no statistically significant difference ($p=0.924$). Considering the contagious nature of *Brucella* species, sharing grazing land and drinking water between livestock and wild animals is likely to facilitate transmission of the disease (Jiwa *et al.*, 1996; Reviriego *et al.*, 2000). Contact with wild animals was assumed when a farmer confirmed spotting wild animals in their grazing area and watering points (indirect contact) which was the case with most of the herdsmen in

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the study area that is bordering the Game Reserve (Muma *et al.*, 2007b). Herds that had contact with wild animals showed a higher prevalence of brucellosis (4.4%) than those that do not (0%), although not statistically significant ($p=0.073$). Cattle with no history of abortion and other reproductive disorders recorded a statistically higher prevalence than those that had history of abortion. This finding is in consonance with reports by Haileselassie *et al.* (2010) who stated that farmers who cull animals with fertility problem (3.1%) had statistically lower ($p=0.001$) prevalence of brucellosis than those who retain such animals (32.9%) in the herd. Also, there are reports indicating that about 20% of infected pregnant animals do not abort, while 80% of the animals that abort as a result of *Brucella abortus* infection, do so only once and thereafter will usually carry the pregnancy to full-term and appear healthy (Anon., 1986). Furthermore, herds that have chronic brucellosis, very few or no abortions occur, and the disease is almost impossible to recognize clinically (Crawford *et al.*, 1990), which may explain the reason for high prevalence in herds with no history of abortion. Although not statistically significant ($p=0.316$), there was a higher prevalence (4.2%) of brucellosis in herds that have access to veterinary services than those that did not. This finding is consistent with report by Muma *et al.* (2007b), in that, access to veterinary services has higher prevalence than having no access. Access to veterinary services mostly allows the animals to congregate at dipping sites, during large scale disease control processes and during vaccination campaigns and could probably explain the increased risk. Herd health management factors such as, grazing site, watering point and disposal of aborted fetuses or foetal membranes have been incriminated to contribute in the brucellosis' prevalence

(Jiwa *et al.*, 1996; Muma *et al.*, 2007b; Haileselassie *et al.*, 2010). These agree with the present study where higher prevalence was recorded in herds with improper method of disposal of aborted materials (4.3%) than those that dispose them properly (2.0%). The differences were, however, not significant ($p=0.279$).

Conclusion

The finding of this study revealed that bovine brucellosis is endemic in the livestock, wildlife and human interface area of Yankari Game Reserve, with about half of the herds sampled infected. Breed, sex and age were found to influence the prevalence of the disease in the area, although not statistically significant. Some husbandry, management and reproductive factors were found to be important risk factors associated with *Brucella* seropositivity.

Recommendation

There is need for more extensive studies in specific areas in Nigeria as there is paucity of information on the prevalence of brucellosis in specific areas in the country particularly wildlife-livestock-human interface.

Also, improvements are needed in awareness on hygienic practices, provision of veterinary/technical personnel, proper husbandry and management practices and organized ranch farming system which will reduce the effect of the potential risk factors in the transmission of the disease.

Conflict of Interest

The authors declare that they have no conflict of interest whatsoever.

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Received: 7th September, 2019

Accepted: 19th December, 2019