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ORIGINAL RESEARCH

Brucellosis seroprevalence in livestock in Uganda from 1998 to 2008: a retrospective study

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Abstract A total of 17,359 samples were analysed serologically, of which 1,061, 15,758 and 585 samples were from Makerere, Entebbe and Tororo laboratories, respectively, were used to determine the seroprevalence of brucellosis. The overall seroprevalence of brucellosis was 10% while from individual laboratories was 38%, 32% and 7% for Makerere, Entebbe and Tororo laboratories, respectively. Majority of these positive brucellosis test results were in the cattle corridor with *P* value=0.399. There were significant differences in brucellosis seroprevalence among species (*P* value=0.014). The trends of brucellosis seroprevalence among the different species were decreasing with time but were highest in bovine species (*P* value=0.043). Brucellosis seroprevalence had a bimodal monthly pattern corresponding with rainfall. The study showed that brucellosis was prevalent, though the trend of the disease has declined over years. It was recommended that regular disease surveillance, control programmes and further studies be carried out in the country.

Keywords Brucellosis · Seroprevalence · Host species · Retrospective

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Introduction

Brucellosis is a major zoonotic disease of public health importance worldwide in domestic animals, wild animals and humans (OIE 2009). It is one of the endemic neglected zoonotic diseases with little attention paid to it and often persists in the poorest and most vulnerable populations (FAO 2009). The disease mainly occurs in Mediterranean basin, Middle East, Western and Central Asia, Latin America, Africa and India (Maurin 2008). It has been eradicated in most developed countries that have implemented a tight eradication programme. In the Sub-Saharan Africa, the average seroprevalence of *Brucella* infections in cattle populations varied from 10% to 16% (Mangen et al. 2002; Makita et al. 2008).

In Uganda, earlier studies indicated presence of the disease in some parts of the country. It was found out that brucellosis in humans resulted from consumption of raw milk (Makita et al. 2008). In animals, specifically in cattle population in central and southern Uganda, the individual animal seroprevalence ranged from 8% to 75.9%, while in goats, prevalence between 4% and 10% by various serological tests have been reported (Oloffs et al. 1998; Nakavuma et al. 1999; Kabagambe et al. 2001; Faye et al. 2005; Magona et al. 2009). Herd prevalence ranging from 0% to 100% has been reported by various researchers (Nakavuma et al. 1999; Faye et al. 2005; Sheik 2005; Magona et al. 2009). Kalema-Zikusoka et al. (2005) found out that 2% of buffaloes were exposed to brucellosis. Magona et al. (2009) also noted that the risk of natural *Brucella abortus* infection was higher among older cattle and dry cows in the pastoral system and in calves aged 0 to 6 months in the zero grazing system.

Brucellosis results in decreased milk production, loss of young calves, infertility and lameness. The disease in

domestic animals is associated with the reproductive system causing abortion, retained placenta, dead foetuses and infertility problems (CABI 2007; Merck's 2008; OIE 2009). The epidemiological risk factors for transmission of brucellosis include food habits, method of processing milk and dairy products, social customs, animal husbandry practices, socioeconomic status and environmental hygiene (Merck's 2008). The disease can be controlled by good sanitation practices, good replacement programme, regular surveillance, vaccination and treatment of infected human beings (Merck's 2008). The major challenges faced with brucellosis include the expanding wildlife reservoir for the disease, the emergence of *Brucella melitensis* infection in cattle and the emergence of the disease in marine mammals (Maurin 2008). The control of brucellosis in animal reservoirs has a corresponding and significant decline in humans (Mohamed et al. 2010). Brucellosis seroprevalence varies very widely among different animal species and humans, in equine (0.24–37.50%), bovine (0.58–35.9%), caprine (0.40–33.3%), ovine (0.28–16.7%) and humans (0.89–4.10%) (Gul and Khan 2007). However, for the camelidae, it is not known since they have a strange immunoglobulin.

Materials and methods

A retrospective study was undertaken on data obtained from laboratories (Makerere University, Entebbe and Tororo) between the periods of 1998 to 2008. These laboratories were selected because they are the biggest referral laboratories handling samples from the different districts. Hence, the information obtained is almost reflective of the disease situation in the country. The microbiology diagnostic laboratory in the Faculty of Veterinary Medicine, Makerere University and Entebbe epidemiological diagnostic laboratory which belongs to the Ministry of Agriculture, Animal industry and Fisheries are found in the central region of the country and handle samples from both individual farmers and veterinarians in the field from different parts of the country. Tororo diagnostic laboratory mainly handles cases from the eastern and at times other parts of the country. Information was obtained from records for the samples submitted, specifically for brucellosis diagnosis, to the selected laboratories from 1998 to 2008. Information collected included the date of analysis, source of the samples (location), type of samples and host species.

The research variables were mainly sero-reactivity in relation to the year, source of the samples (location), type of samples and host species. The data were sorted out according to the year, month, district, type of samples and animal host species. The data were entered into the computer using the Excel package. Thereafter, cross tabulation and chi-square test were done to determine whether there was any significant relationship between the presence of brucellosis and the variables mentioned above. The data were analysed using the SPSS and Excel computer packages.

Results

A total of 17,359 samples were submitted to the laboratories for brucellosis testing. The sample types submitted to the laboratories included sera alone (17,331), sera and milk from the same animal (6), and sera and foetal tissues (60). The seroprevalence among these specimens were 10%, 83% and 60% for sera, sera and milk, and sera and foetal tissues, respectively. The proportions of samples submitted to each laboratory are presented in Fig. 1 below. Majority of the samples (15,758) were submitted to Entebbe laboratory, followed by Makerere (1,016) and lastly Tororo (585). The brucellosis seroprevalence in samples tested from the different laboratories is also presented in Fig. 1 below as 38% for Makerere, 7% for Entebbe and 32% for Tororo. The overall prevalence over the 10-year period was 10%. The implication of all these findings is that samples tested at Makerere and Tororo laboratories had brucellosis seroprevalence above the overall brucellosis seroprevalence while samples tested at Entebbe laboratory had brucellosis seroprevalence lower below the overall brucellosis seroprevalence.

Figure 2 below presents the prevalence of brucellosis in samples from different animal species. Samples where the host species was not indicated had the highest brucellosis seroprevalence (57%), while human and bovine species had a seroprevalence of 16% and 12%, respectively. Other species had a seroprevalence of 5% to 9%, but the canine had 0% seroprevalence.

The number of samples that were submitted annually for brucellosis analysis and the number of positive samples that were encountered from 1998 to 2008 are presented in Figs. 3

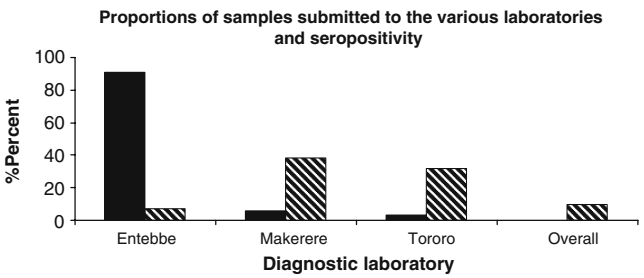

Fig. 1 Proportion of samples submitted to the various laboratories and brucellosis seropositivity

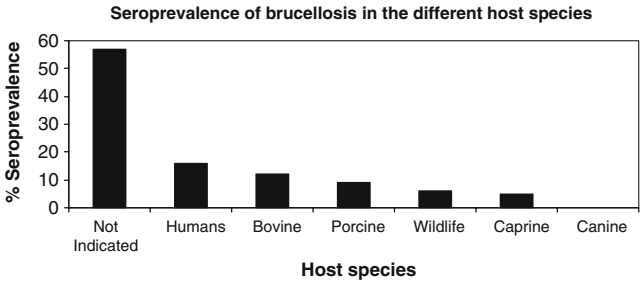

Fig. 2 Seroprevalence of brucellosis in the different host species

and 4, respectively, while Fig. 5 presents the annual seroprevalence of brucellosis. The annual seroprevalence ranged from 4% to 65% with the lowest occurring during 2006 while the highest was in 2001. In 1998, the seroprevalence was 6% (n=3,608); in 1999, 13% (n=678); in 2000, 21% (n=269); in 2001, 65% (n=289); in 2002, 21% (n=768); in 2003, 11% (n=1,837); in 2004, 11% (n=668); in 2005, 6% (n=3,210); in 2006, 4% (n=3,683); in 2007, 16% (n=859) and in 2008, 16% (n=1,490).

Seroprevalence of brucellosis for the different months during the study periods are shown in Fig. 6 below. Apart from the 'not indicated' category, which had the highest brucellosis seroprevalence of 44%, April had a seroprevalence of 14%, followed by September (12%), then October (10%) and January had the lowest of 4%.

Table 1 presents the seroprevalence of brucellosis in samples tested from the different districts. Results showed that Manafa and Mayuge districts had the highest average brucellosis seroprevalence at 100% followed by Sembabule District at 51%, and Kibale had the least average brucellosis seroprevalence at 1%. Twenty-two districts had a seroprevalence of 11% to 47%, nine districts had a seroprevalence of 1% to 10% and 11 districts had a 0% seroprevalence. Arua, Amuro, Bundibugyo, Fortportal, Ibanda, Kabarole, Kasese, Mubende and Nakapiripiriti Districts had zero brucellosis seroprevalence. There were no significant differences in brucellosis seroprevalence across the districts in samples tested from 1998 to 2008 (P value=0.399).

Discussion

The overall seroprevalence of 10% in all samples handled in the different laboratories agrees with what Nakavuma et al. (1999), Mangen et al. (2002) and Weinhaupl et al. (2000) found out. This was in the range of what Gul and Khan (2007) found out being the seroprevalence of the disease for most species of animals. The high seroprevalence of brucellosis (38%) obtained from Makerere laboratory when compared to the other laboratories was attributed to the fact that at Makerere, samples are submitted by farmers and veterinarians after tentative diagnosis is made based on symptoms of the disease such as abortions, still births and retained placentas in the field. Therefore, there were high chances of obtaining positive results as compared to the rest of other laboratories that handle research samples and surveillance samples.

Brucellosis seroprevalence in samples tested in 2001 were higher (65%) than samples tested in other years, and this could be linked to high positive samples that were submitted to different laboratories and probably reflects the period when brucellosis disease was highest in the country. This finding was associated with laxity in the brucellosis control in the country which later on was revisited followed by active control of the disease through increased awareness of the disease and massive vaccination in the different parts of the country.

The seroprevalence of brucellosis across the different districts was highest during the period of 2006 with highest seroprevalence of 100% in Manafa and Mayuge Districts compared to the 11% to 47% in most of other districts. The high prevalence in these two districts [Manafa (n=3) and Mayuge (n=4)] was most likely because of the few samples that were screened and probably were purposively selected because the disease was suspected in the herds or animals. A larger sample set would have given a clearer picture of the district. Secondly, these two districts are found in the Eastern part of the country where most of the animals kept there are indigenous cattle, most of them kept under

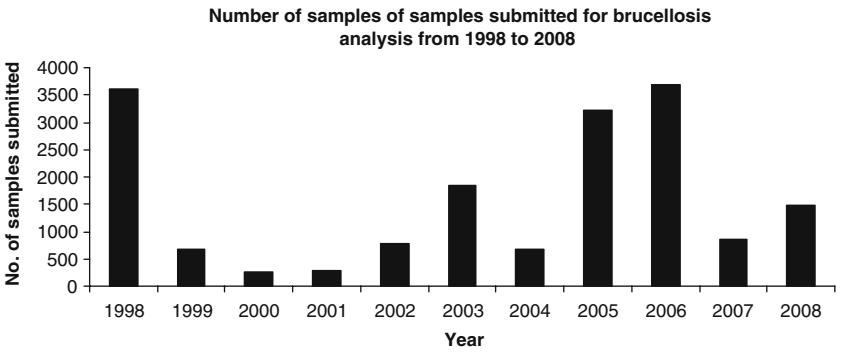

Fig. 3 The number of samples submitted for brucellosis analysis from 1998 to 2008

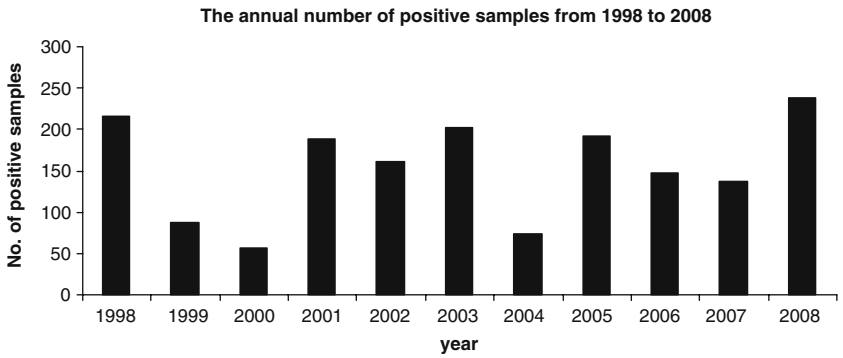

Fig. 4 The annual number of positive samples from 1998 to 2008

indigenous methods of animal husbandry. There are also chances that samples from these districts were picked from suspected herds where the possibility of getting positive seroprevalence was high. In Uganda, currently there is a trend of creating new districts from splitting of earlier large ones (Elliott 2008), so probably the disease control systems were not yet properly instituted in such areas.

Samples whose species were unidentified gave highest brucellosis seroprevalence of 57%, and probably these samples are for bovine species since these were the major samples handled by these laboratories. On rare occasions, Makerere University laboratory gets human samples and whoever comes to such laboratory is suspecting brucellosis infection basing on whether one is in a risky occupation or the physician's laboratory request. Canine samples are the least handled in these laboratories. This is because majority of our people do not take dogs as very important to them, hence, apart from vaccinating against rabies and deworming, their health is not taken care of. Moreover, these samples are likely to have been obtained from small animal clinics, and clients who take their animals to such establishment usually have them confined at home and are not in contact with other animals, hence the chances of them being infected are low. Also, the smooth antigen is likely to have been employed in screening the sera of these animals, whereas the *Brucella* spp. (*Brucella canis*) with predilection to dogs is a rough strain and there is no information as to whether the organism exists in Uganda. The majority of the sample types submitted to the laboratories, and where positive reactors were detected, included sera and milk. This is because these samples are easily obtained, the serological tests are almost solely employed for brucellosis detection and the laboratories do not have the facilities that would enable them to isolate the organisms (they are generally of biosafety level 1 and 2). The high seroprevalence of brucellosis (83%) in sera and milk samples was because sera and milk are universally used to screen herds for brucellosis (OIE 2009).

In Uganda, one would expect births of livestock, especially cattle, to occur around the months of March, April, May and then during September, October and November. Usually samples are submitted after abortion or delivery of a dead foetus, and many samples were submitted during the month of May (2,569), October (2,615) and December (2,844) with corresponding seroprevalence of 9%, 10% and 7%, respectively. The months of April, September and October correspond with the bimodal rainfall pattern associated with high rainfall peaks, hence there is a possibility of brucellosis disease to be more prevalent during high rainfall season. These findings agree with FAO (1993) which pointed out that season has a dramatic effect on breeding of livestock and milk production in the case of cattle with 70% of births occurring during the rain season and 17% during the short rains. This implies that during the rainfall season, a lot of *Brucella*

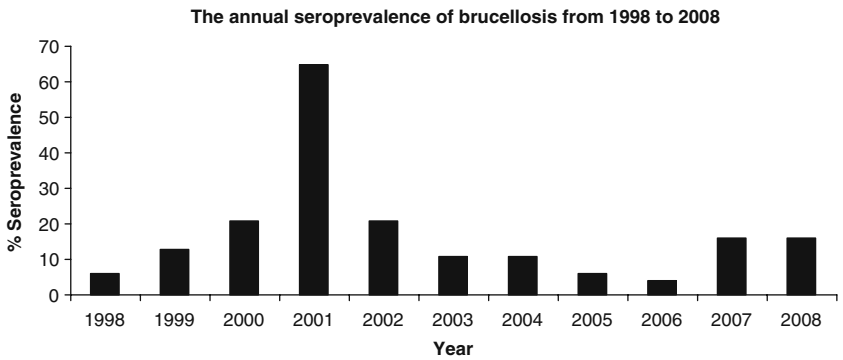

Fig. 5 The annual seroprevalence of brucellosis from 1998 to 2008

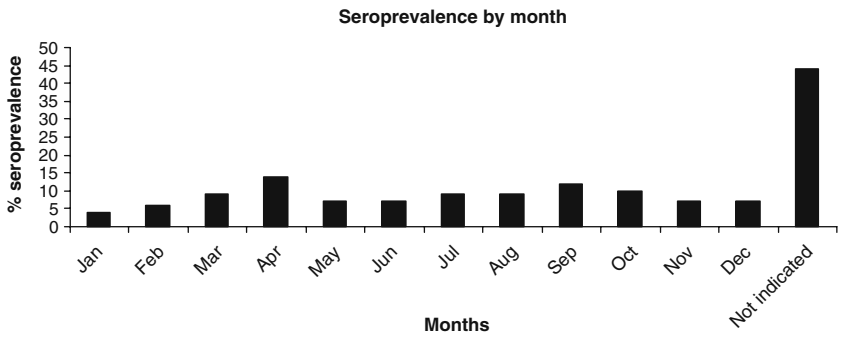

Fig. 6 Seroprevalence of brucellosis by months from 1998 to 2008

organisms are shed at parturition and lactation periods and decreases with dry season or short rains, hence the bimodal distribution of the organisms.

The findings showed high brucellosis seroprevalence in the districts of Luwero, Mbarara, Mpigi, Mukono, Nakasongola, Sembabule and part of Wakiso. This agrees with the fact that such districts are found in the cattle corridor where cattle are predominantly raised under pastoral management system. This kind of management system is characterised by large herds on free range, gazette livestock markets, collective drinking place (valley dam or tank as a source of water) and disease control that is moderate or neglected especially brucellosis (FAO 2009). This therefore accounts for high brucellosis seroprevalence rates in these areas, a fact consistent with the findings of Magona et al. (2009) who found high seroprevalence of *Brucella* in the pastoral system.

In all the species of animal whose samples were analysed for brucellosis over the period of 10 years, the trends show a decrease in the seroprevalence of the disease since 1998 to 2008. This was attributed to a number of factors such as the improved disease management and control which is coming up and this is in line with Mohamed et al. (2010) who suggested that control of brucellosis in animal reservoirs has a corresponding decline in other animals. Also, the increased farming initiatives through government programmes such as the National Agricultural Advisory Services, Plan for Modernisation of Agriculture and empowerment of the disadvantaged groups have contributed to the decline of the disease. The high brucellosis seroprevalence in the porcine species contradicts the findings of Ssedyabane-Nsubuga (2005) who got no reactors from abattoirs around Kampala and attributed it to pigs not feeding together with other animals, lack of porcine semen importation and rampant outbreaks of swine fever, hence no reservoirs for swine brucellosis in addition to early slaughter age of pigs. However, this study considered retrospective data over a 10-year period countrywide, hence encompassing all the different production systems of livestock such as intensive and extensive system and the pastoral and rural communities where there are high levels of interaction but with different host species.

The positive seroprevalence among the species were more pronounced in bovines (12%) followed by caprine species (5%). This was attributed to the causative agents *B. abortus* and *B. melitensis* most found in the bovines and caprine species as suggested by Godfroid and Kasbohrer (2002) and Merck's (2008). Bovine species tested positive throughout the period simply because farmers have more interest in cattle, and whenever any disease condition is suspected, they have to act quickly and call a vet or take blood or milk sample for analysis so as to confirm the disease and treat it. This study confirmed earlier studies by Gul and Khan (2007) that there are significant differences

Table 1 Seroprevalence of brucellosis in samples tested from different districts

District	% Seroprevalence (*n*)
Manafa	100 (3)
Mayuge	100 (4)
Adjuman	47 (253)
Kayunga	45 (33)
Mpigi	45 (143)
Mbale	44 (9)
Hoima	35 (88)
Mityana	27 (60)
Tororo	26 (34)
Soroti	25 (122)
Iganga	23 (272)
Ntungamo	22 (9)
Masaka	21 (28)
Kiruhura	20 (138)
Nakasongola	17 (1,048)
Kotido	16 (37)
Kampala	15 (363)
Kamuli	14 (28)
Mukono	14 (423)
Rakai	14 (221)
Busia	13 (23)
Lyantonde	13 (144)
Luwero	11 (604)

Table 1 (continued)

District	% Seroprevalence (*n*)
Lira	8 (311)
Kumi	7 (694)
Mbarara	7 (694)
Wakiso	6 (1,842)
Masindi	5 (44)
Sembabule	5 (629)
Apac	4 (342)
Kabale	4 (348)
Kibale	1 (80)
Amuro	0 (25)
Arua	0 (1)
Bundibugyo	0 (10)
Fortportal	0 (16)
Ibanda	0 (94)
Kabarole	0 (208)
Kasese	0 (47)
Kiboga	0 (524)
Mubende	0 (411)
Nakapiripiriti	0 (300)
Rwanda	0 (12)
Not indicated	21 (847)

in brucellosis seroprevalence among species. This could also be explained by the different *Brucella* organisms that affect the different species (Godfroid and Kasbohrer 2002).

The retrospective nature of the study posed a danger of misplacing and losing the records. This could explain why not all information was available. In addition, the formats of recording data were not uniform. For example, some left out important information such as breed of animal, age and stage of lactation, and this explains why some analysis indicated no data and not applicable, which could have compromised the data analysis.

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