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REGULAR ARTICLES

Incidence and knowledge of bovine brucellosis in Kahuro district, Murang'a County, Kenya

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Abstract Brucellosis in cattle is a zoonosis mainly caused by *Brucella abortus*. In Kenya, the disease is widespread, but its prevalence is largely unknown. The objective of this study was to investigate incidence rates of brucellosis and farmers' knowledge on the disease in Kahuro district, Murang'a County. In this study, 150 pooled milk samples were collected from 75 milk collection centers and tested. Subsequently, 230 milk samples were collected from farmers in 16 collection centers in Wangu and Mugoiri divisions whose pooled samples gave positive results. Five cow owners in each of the 16 collection centers were interviewed using a questionnaire to assess their knowledge levels. Wangu division had the highest incidence rate 19% with positive samples observed from 14 collection centers. Mugoiri division recorded 3% with two collection centers having positive samples, while Murarandia had none. All respondents with no formal education were unaware of the causative agent of brucellosis. There was a significant difference in incidence between Mugoiri and Wangu divisions ($p < 0.05$). Knowledge levels were high in the young and educated farmers compared to the old and uneducated. Frequent screening for brucellosis to identify infected animals should be initiated thus prevent transmission to other animals and humans.

Keywords Brucellosis · Zoonosis · Transmission and incidence

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Introduction

Brucellosis is a highly contagious zoonosis caused by bacteria in the genus *Brucella* and causes a great negative economic effect on cattle farming (Ducrotoy et al. 2014). It is caused by *Brucella abortus* and mainly affects reproductive organs of infected cattle which shed the organism in vaginal discharges following loss of the fetus and/or accouchement and also in the colostrum and milk (Rubach et al. 2013). Initial infection in cattle is normally followed by abortion and subsequent delayed or permanent inability to conceive (Dirar et al. 2015). Within the herd brucellosis is mainly transmitted by ingestion of contaminated material such as feed and water (Roushan and Ebrahimpour 2015). Infection through coitus may occur if the bull is suffering from orchitis or epididymitis (Ducrotoy et al. 2014). Humans are infected by four species of *Brucella* with *B. mellitensis* being more infective and virulent than *B. abortus*, while *B. suis* and *B. canis* have intermediate virulence (Ducrotoy et al. 2015).

Brucellosis manifests as an acute febrile illness characterized by fever, chills, and headache which may continue firmly and progress to a chronically incapacitating disease. Infections in humans occur through transmission incase of cuts or bruises in the skin following unprotected contact with vaginal discharges, blood, tissues, urine, aborted fetuses, or placenta from infected animals (Roushan and Ebrahimpour 2015). Consumption of raw milk, unpasteurized goat milk, and other related dairy products leads to food borne infection (Rubach et al. 2013). Occupational infection is acquired through oral, respiratory, and conjuctival routes due to handling of infected animals and aborted fetuses or placenta (Deshmukh et al. 2015). Though eradicated in many developed countries after years of effort, brucellosis remains a major neglected zoonosis in low-income nations, impacting on human health and livestock production (McDermott et al. 2013). Across the African

continent, brucellosis is poorly documented and under-reported in both human and animal populations (Ducrotoy et al. 2015). In Kenya, scanty data is available on the disease burden estimates (Njeru et al. 2016). According to Murang'a North Veterinary Department records (October 2015), six cases of retained placenta which is a common sign of brucellosis among other livestock diseases were reported. This indicates possibilities of brucellosis prevalence hence need to determine incidence of brucellosis among dairy cattle in the county. In Kahuro district, homes are congested, hygiene standards are low, and also contact of farmers with infected animals is constant. Brucellosis being one of the diseases caused by living standards is one of the common livestock diseases reported (DVO 2015). Determining knowledge levels on brucellosis in the study population is necessary. Study output will guide Kenyan policy makers on areas where brucellosis is prevalent so as to put in control measures and create awareness of brucellosis among dairy farmers so as to put preventive measures to avoid infection.

Materials and methods

Study area and population

Kahuro district within Murang'a County with a total dairy cattle population of 26,823 according to the District Veterinary Office records (DVO records October 2015) was selected for milk sampling because of its settlement setup to determine incidence of brucellosis for a period of 6 months starting December 2015 to May 2016. Target population involved all dairy cattle whose milk was delivered to collection centers in Kahuro district Murang'a County during the study period.

Study design and sampling

Pooled milk samples and individual farmer's milk samples were collected for 6 months from milk collection centers and analyzed at Kabete Veterinary Laboratory for *Brucella* antibodies using milk ring test to establish incidence rates in the district. Questionnaires were given out to test the knowledge levels of the farmers about the disease. To get the desired sample size, sample proportion formula by Ryan (2013) was used.

$$n = \frac{z^2.p.q.N}{e^2(N-1) + z^2.p.q}$$

where

N = size of the population

n = size of the sample

e = acceptable error; the estimate should be within 2% of the true value

z = value of standard variate at 2.005 confidence level, worked out from table

p = prevalence of disease in Kenya 4% (Ogola et al. 2014)

q = 1−p

$$n = \frac{(2.005)^2.(0.04).(0.96).26863}{(0.02)^2.(26863-1) + (2.005)^2.(0.04).(0.96)} = 380$$

The sample size used in this study was 380 milk samples. Simple random sampling was used to collect two pooled milk samples from each of the 75 milk collection centers in Kahuro district. Two hundred thirty individual farmers were also purposively selected using systematic sampling from 16 collection centers whose pooled samples gave positive results. Farmers were numbered, and every second farmer selected giving a total of 14 farmers in each collection center. Extra six farmers were sampled proportionately from Mukangu collection center which had a higher population of farmers (40) compared with the other centers which had approximately 29 farmers. Cattle owners were identified to be approximately 22 in each of the 16 collection centers, using systematic sampling every fourth cow owner was selected and interviewed using a questionnaire giving a total of 80 questionnaires.

Analysis of milk samples by milk ring test

At the veterinary laboratories, small sterile measuring cylinders were used to take 8 ml of milk from each sample and place it in sterile test tubes which were then labeled using the sample codes correspondingly. Milk samples were tested for *Brucella* antibodies according to the procedure described by Mohamand et al. (2014). To ensure proper mixing of antigen with the milk, milk samples were allowed to stand for a minute after placing them on small test tube racks. They were then incubated at 37 °C, and results read after 1 h and then after 24 h. Formation of a dark blue ring in the cream layer above a white milk column indicated a strong positive reaction. However, negative reaction was considered if the color intensity in the milk portion was more than or equal to that in cream layer. There was inclusion of both positive and negative controls for each test.

Data management and analysis

Data obtained from analysis of milk samples were analyzed by one way ANOVA with divisions as the independent variable and positive cases as the dependent variable to determine whether incidence of brucellosis differed significantly from one division to another within Kahuro district Murang'a

County. In questionnaires data analysis, computed percentages of different variables were compared.

Results

Incidences of brucellosis in Kahuro district Murang'a County for the period December 2015 to May 2016

Out of 150 pooled milk samples analyzed in Kahuro district, 32 samples representing 16 collection centers tested positive for brucellosis. Wangu division with a higher number of collection centers with positive samples (14) recorded the highest infection rate (19%) followed by Mugoiri division (3%) with two collection centers giving positive results. Murarandia division was found to have none, because there were no positive cases out of the 56 milk samples that were analyzed (Table 1).

Out of 230 individual milk samples analyzed in Murang'a County, 55 (24%) samples tested positive for brucellosis. Wangu division with a higher number of positives (51) recorded a higher incidence rate of 22%, whereas Mugoiri division with four positive samples recorded 2% (Table 2).

Taking into consideration both pooled and individual milk samples analyzed in Mugoiri and Wangu divisions, independent *t* test showed that Wangu division recorded a significantly high mean percentage incidence of brucellosis compared to Mugoiri division ($p = 0.009$, $\alpha = 0.05$) (Table 3).

Knowledge levels of farmers on bovine brucellosis in Kahuro district

Sociodemographic information of the study subjects

The majority of respondents (70%) were female, indicating that women generally undertake domestic chores, while men look for pasture or are involved in selling cattle. The majority (70%) of the farmers were between 40 and 59 years of age. Regarding level of education attained by the farmers, 60% had attended secondary school, but 24% reported no formal education. Almost all respondents (95%) stated that livestock rearing was their main occupation.

Table 1 Pooled milk samples analyzed for brucellosis per division in Murang'a County

Division	Number of collection centers	Number of samples analyzed	Positive samples	% incidence
Wangu	25	50	28	19
Mugoiri	22	44	4	3
Murarandia	28	56	0	0
Total	75	150	32	22

Table 2 Individual farmers' samples analyzed for brucellosis in Wangu and Mugoiri division

Division	Number of samples analyzed	Positive samples	% incidence
Mugoiri	28	4	2
Wangu	202	51	22
Total	230	55	24

Respondents knowledge on causative agent of brucellosis in livestock

Majority respondents (83%) had heard about brucellosis. However, most of them (82%) had no idea on the causative agent, but a few of them (18%) said it was caused by bacteria (Fig. 1). There was a significant association between education levels and knowledge on causative agent of brucellosis in livestock ($x^2 = 45$, $df = 79$, $P < 0.001$) and also in the age ($x^2 = 35$, $df = 79$, $P < 0.004$). All respondents with post secondary education knew brucellosis is caused by bacteria, while (41%) with secondary education and all with primary and those with no formal education had no idea on the causative agent. All respondents in the age bracket 19–39 knew it was caused by bacteria, while (13%) in the age bracket 40–59 and all with over 60 years had no idea on the causative agent.

Respondents knowledge on signs and symptoms of brucellosis in livestock

Multiple responses were given as signs and symptoms of infection. Among the commonest responses given were abortion and miscarriage (50%) and infertility and sterility (25%); other responses included premature calf birth, reduced milk production, swollen udders, and testicles as indicated by 10, 6, 5,and 4%, respectively. However, for measurement of knowledge, an appropriate scale was established where one correct response on signs and symptoms indicates lack of knowledge, two correct responses meaning little knowledge, three correct responses showing average knowledge, and four or more correct responses indicating high level of knowledge (Table 4). There was a significant association between education levels and knowledge on signs and symptoms of brucellosis ($x^2 = 47$, $df = 79$, $P < 0.05$).

Table 3 Occurrence of brucellosis in Mugoiri and Wangu divisions

Division	*n*	Mean ± SE
Mugoiri	72	0.61 ± 0.21
Wangu	252	2.52 ± 0.61
p value		0.009

n = number of samples analyzed, $p < 0.05$

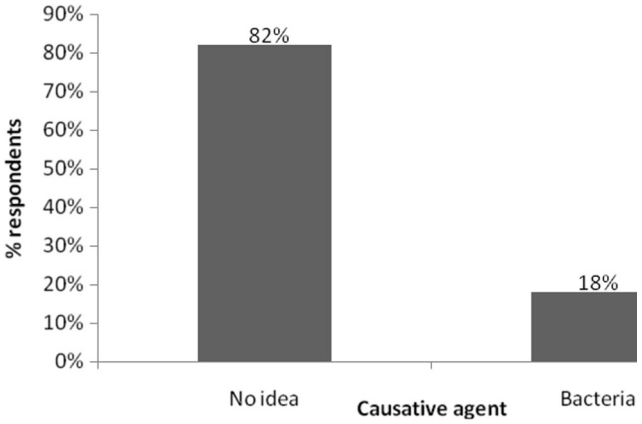

Fig. 1 Respondents knowledge on brucellosis causative agent

Assessment on Brucella transmission from one cow to another

Majority respondents (65%) gave eating placentas of an aborting cow and (20%) gave use of pooled colostrums (when feeding newborn calves) whereas heredity had the lowest (5%). Artificial insemination was given as the main method of servicing the cows when on heat 60% however (40%) of the respondents used the local bulls. The majority (60%) of the respondents stated that they had experienced abortions in their cattle though unaware of the cause. In case of abortions, 85% of the respondents gave burying as the main method of disposing placentas and stillborns, while 15% gave the carcasses to dogs.

Practice of conducting physical operations to assist the animal during delivery

Results revealed that all respondents assisted their animals during delivery. Among the precautions taken to prevent infection during delivery, majority of the respondents (45%) said that they wiped their hands with a piece of cloth after delivery, 30% said that they rinsed hands with soap and water, 15% rinsed hands with water only whereas, and 10% wore plastic paper as gloves during delivery.

Home visits by Ministry of Livestock officials for educative seminars and testing

It was found that 70% of the respondents had visits by officials from the Ministry of Livestock who helped in the assessment of disease burden in livestock on quarterly basis. However, 30% of the respondents said they never had visits or educative seminars by officials from Ministry of Livestock for the purpose of creating awareness about the disease.

Discussion and conclusions

Discussion

Infected animals milk lead to spread of many disease causing organisms including *Brucellae* which can be detected in milk and milk products occasionally (Ducrotoy et al. 2015). In this study, random sampling from three administrative divisions in Kahuro district showed that the disease is prevalent in Murang'a County. Disease incidence in Wangu and Mugoiri divisions was attributed to the fact that homesteads were built closely together with each having at least one cow. In addition, feeding materials and drinking water were sourced from the same areas which potentially increased the rate of infection. *Brucella* organisms have the ability to survive and remain infective for long periods in various environments; thus, when infected animals shed *Brucella* organisms into the environment, this becomes a source of human and animal infection (Bayemi et al. 2015). Disease incidence may also be attributed to rearing of cattle together with other animals; this is because different *Brucella* species can be transmitted among the hosts (Ducrotoy et al. 2014).

Milk ring test (MRT) is a consistent way of identifying possible presence of *Brucella* organisms in cattle herds (Mohamand et al. 2014). However, in this study, it is unclear if this had an effect on the results particularly Murarandia division which gave no positive results, because concentration of antibodies in milk could be reduced to undetectable levels by pooling of milk from clean and *Brucella* infected herds.

Table 4 Respondents knowledge on signs and symptoms of brucellosis in livestock

Knowledge on signs and symptoms	Frequency	Percentage of farmers (%)	Education levels			
			None	Primary	Secondary	Tertiary
Lack knowledge	6	7	4	2	16	1
Low knowledge	38	48	15	6	30	1
Average knowledge	31	39			2	3
High knowledge	5	6				
Total	80	100	19	8	48	5

Knowledge levels on brucellosis among the respondents were high in the young farmers compared to the old farmers. This was attributed to the fact that majority had secondary level education. The old and non-educated had no idea on what causes brucellosis. This concurs with a study by Lindahl et al. (2015) in an urban and peri-urban area of Tajikistan who documented that knowledge of brucellosis was poor among the dairy farmers. Majority of the respondents gave abortion and miscarriage as the main signs of *Brucella* infection in livestock which concurs with the idea of Singh et al. (2015) who documented that *Brucella* infection of the pregnant female reproductive tract results in abortion, because the organisms have a special predilection for the embryonic tissues of the maternal and fetal placenta where they cause loosening of the membranes resulting to stoppage of blood which provides nourishment to the fetus.

All interviewed respondents said they assisted their animals during delivery by physically handling the newborns, afterbirths, or even stillborns with only a small proportion taking adequate measures such as wearing gloves and using disinfectants to avoid infection. These practices potentially predisposed them to infections. Lindahl et al. (2015) documented that transmission from animals to human occurred when manipulating infected aborted fetuses or healthy calves that are born to infected animals through breaks in the skin. Safeguards to human infection include wearing of appropriate clothing by animal handlers when dealing with infected animals (Rubach et al. 2013).

Majority of the respondents who had experienced abortions in their cattle gave burying as their method of disposing carcasses which makes it impossible for cattle to feed on these products. Bayemi et al. (2015) documented that placenta of an infected animal and products of abortion contains large number of *Brucella* organisms, and transmission occurs by oral ingestion or after exposure to fetal tissues, vaginal discharges, aborted fetuses, and placenta containing high concentration of organisms, because cattle tend to pass their tongue over the aborted carcasses and vaginal discharge of an aborting cow. However, poor disposal of aborted carcasses by some of the farmers who fed them on dogs may have contributed to increased spread of the disease in Kahuro district. According to Hegazy et al. (2015), dogs play a role in mechanical transmission of the infection when they drag aborted material across the ground. Therefore, farmers should be educated on proper disposal ways.

Majority of the farmers indicated that ministry of livestock personnel's had paid them visits. However, some of the farmers noted that they had no visits, and so to ensure that all farmers are visited, there is a need for introduction of an intensive program for testing and vaccinating all livestock in the area. Such program should be initiated by the Ministry of Agriculture, Livestock and Fisheries in collaboration with the local non-governmental organizations which have programs on animal health. Njeru et al. (2016) documented that the greatest challenge for control program in Kenya is lack of public and veterinary health services due to both decreased governmental resources and the lack of interest by the private sector to support it.

Conclusions

Knowledge level of brucellosis among dairy farmers in Murang'a County was low. This was attributed to the poor education levels and older age of most respondents. In contrast, younger farmers with secondary and tertiary education were more knowledgeable about brucellosis causes, signs and symptoms, mode of transmission to other animals and to humans, and prevention measures. Wangu division in Kahuro district recorded a higher incidence of brucellosis than Mugoiri, and Murarandia recorded none. Further studies are recommended involving culture and enzyme-linked immunosorbent assay (ELISA) testing concurrently with the MRT to establish disease status including collection centers where *Brucella* antibodies were not detected by MRT. In addition, countrywide high quality disease surveillance involving both human health and veterinary services should be initiated to generate reliable estimates of disease incidence, transmission dynamics, and effective control strategies.

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Compliance with ethical standards

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

Ethical clearance Approval of the study was obtained from Graduate School Kenyatta University. To ensure confidentiality, code names instead of farmer's names were used. The farmers were informed on the study purpose prior to commencement of the research through questionnaire preliminaries.

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