Iraqi Journal of Veterinary Sciences

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Prevalence and risk factors associated with subclinical mastitis in peri-urban bovine dairy farms of Ouagadougou and Bobo Dioulasso in Burkina Faso, West Africa

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Article information

Article history:
Received September 3, 2022
Accepted May 11, 2023
Available online September 9, 2023

Keywords:
Dairy cattle
Subclinical mastitis
California mastitis test
Risk factors analysis

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Abstract

Subclinical mastitis is an insidious infection of the mammary gland that results in an inflammation of one or more quarters of the udder, generally due to a bacterial infection, a physiological disorder, or local trauma. They have a negative impact on dairy cow production. The current study aimed to determine the prevalence and associated risk factors of subclinical mastitis in peri-urban farms in Ouagadougou and Bobo Dioulasso (Burkina Faso). In total, 305 lactating cows, including 150 from the peri-urban area of Ouagadougou and 155 from Bobo Dioulasso, were tested using the California Mastitis Test. Also, a questionnaire survey has been carried out to collect data about farm management and selected animals. The overall prevalence was 42.9%, with 45.3% and 40.6%, respectively, in farms in the peri-urban area of Ouagadougou and Bobo Dioulasso. The biostatistical analysis identified the breed, former cases of mastitis on the farm, and diarrhea as risk factors associated with subclinical mastitis. In conclusion, this study demonstrates evidence of mastitis in peri-urban farms in Burkina Faso. Further investigations are needed to identify pathogens associated with these infections to select better control actions.

DOI: 10.33899/ijvs.2023.135679.2501,

Introduction

Livestock is one of the leading agricultural activities in Burkina Faso. It is practiced by nearly 86% of the country's active population and accounts for about 10-20% of the gross domestic product (GDP). Livestock is the second largest contributor to agricultural value added after cotton and gold. In Burkina Faso, the contribution of the livestock sector to the agricultural gross domestic product is 15 % (1). Milk is an essential source of protein for the populations of West Africa. Milk and dairy products such as cheese, yogurt, cream, and fermented milk are part of the dietary habits of the Burkinabe population, especially in pastoral or agropastoral areas. It is also a source of income for livestock farmers. According to production systems, milk volume sold has been estimated to range between 349 to 2140 liters/TLU per year, and the annual consumption of about 20 liters of milk per capita (2,3). In 2018, this annual per capita milk consumption increased from 20 to 30 liters, which remains low compared to the West African average. Burkina Faso has more than 9 million cattle, primarily local breeds. Despite this numerical importance, the demand for milk and dairy products is not met due to the high population growth, the low milk potential of local breeds, and some diseases such as mastitis. Although the trade balance is in surplus for meat, Burkina Faso invests enormous resources to meet its milk

and dairy product's needs. Every year, Burkina Faso imports milk powder to supply mainly urban areas and milk powder is the main imported dairy product (4). Local milk production faces certain sanitary constraints, and improving the health and hygiene conditions of dairy farms could improve the production level and the competitiveness of the more competitive local sector. The constraints include mastitis, which affects the quantity and quality of milk, especially its chemical composition (5). Depending on the severity, there are two types of mastitis: clinical mastitis, characterized by severe inflammation of the udder, reduced milk production, and changes in milk composition, and subclinical mastitis, characterized by moderate inflammation with no visible signs in the cow, udder or milk. Diagnosing clinical mastitis remains easy and is associated with clinical signs in animals. However, subclinical mastitis is challenging to diagnose as few clinical signs are noted in sick animals. Sign animals are identified mainly after the implementation of in-field or laboratory analysis. Different tests are available for mastitis diagnosis in the field, and on-farm tests used traditionally are somatic cell count, California mastitis test, and Surf field mastitis test (6). Nevertheless, none of those mentioned above methods indicate either the causative agent or mastitis level of severity (7). Other tests like Microbial culturing methods, PCR-based methods, probe-based assay, and protein-based diagnostics are implemented for mastitis pathogens identification (6). Mastitis, especially subclinical mastitis, can lead to a decrease in milk production (8). Furthermore, cows with clinical mastitis or subclinical mastitis had longer calving to first service interval to conception interval and a lower rate of getting pregnant (9). They are the most outstanding health and economic concern for dairy farms worldwide (10).

Unfortunately, in Burkina Faso, few investigations are available on mastitis's prevalence and risk factors in peri-urban dairy farms. This study was implemented in the peri-urban areas of Ouagadougou and Bobo Dioulasso in Burkina Faso to determine the prevalence and factors associated with subclinical mastitis.

Materials and methods

Ethical approval

Ethical approval was obtained from the Research Ethics Committee of Joseph KI ZERBO University (agreement reference CE-UJKZ/2020-03). In addition, before each milk collection, animal keepers were informed of the context and purpose of the study, emphasizing that participation was voluntary and that the data collected would remain confidential. Therefore, only animal keepers who gave oral consent to participate in the study were included.

Study areas and period

The present study took place in the provinces of Kadiogo and Houet from March to December 2021. The study focused on farms in the peri-urban areas of the main towns of these provinces. In the Province of Kadiogo, the study was carried out around Ouagadougou city, and in the Province of Houet, it took place in the peri-urban area of Bobo Dioulasso (Figure 1). In Ouagadougou peri-urban area, farms in Koubri, Zagtouly, Boassa, Komsilga, Kamboinse, and Boulbi were visited. At the same time, in Bobo Dioulasso, the study has been implemented in the villages of Bama, Saouleni, Nasso, Colma, Yeguere, Pola, Leguema, Dofiguisso, Kimidougou, Kiri. All these villages host modern and semi-modern dairy farms. Ouagadougou, the administrative capital and largest city of Burkina Faso, is located in the center of the country in the province of Kadiogo. It is located at 12°20' 00" North and 1°30' 00" West with an estimated population of about 2.6 million inhabitants in 2015 and a surface area of 2,805 Km^2 with a tropical and hot climate all year round (11). However, the extensive system is the most practiced. In addition to cattle, poultry, goats, sheep, and pigs are also raised in this area (Figure 1). Bobo Dioulasso, the economic capital and second largest city in Burkina Faso, is located southwest of Burkina Faso in the Hauts-Bassins region. It is located at 11° 11' 00" North and 4° 17' 00" West. This city has a population of approximately 887,000 and an area of 136.78 km^2. It has a warm tropical climate all year round (11). All three livestock systems present in Burkina are encountered, but the extensive livestock system is more practiced, particularly the sedentary agropastoral system comprising various animal species (Figure 1).

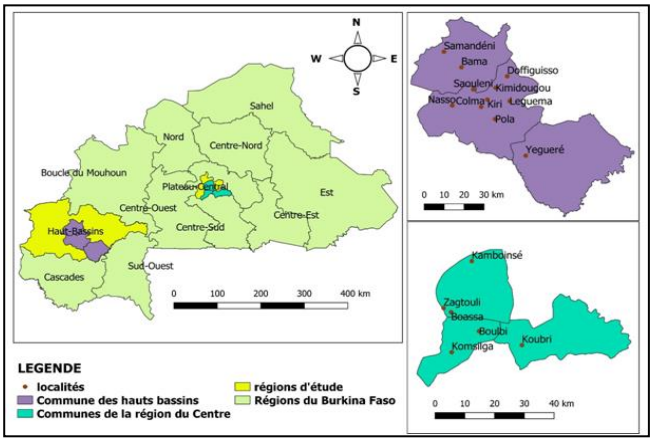

Figure 1: Location of the study area in Burkina Faso.

Sampling design

A cross-sectional study was conducted to determine the prevalence and factors associated with mastitis in dairy cows in a peri-urban area of Ouagadougou and Bobo Dioulasso in Burkina Faso. The sample size was calculated based on the

formula of Thrusfield (12) with 6% absolute precision and an expected prevalence of 43,25% (13). Using this data, the minimum sampling size was 262. The sample consisted of 305 cows tested on 31 farms, including 12 farms in Ouagadougou with 150 cows and 19 farms in Bobo Dioulasso with 155 cows. In each farm, animals have been selected at random. All the different farming systems (extensive, semi-intensive, and intensive) were concerned.

Data collection

Data was collected using a questionnaire administered by an interview with the farm owner or herder. The interview was conducted in the French or local languages, and data collected included farm identification, herd structure, herd management, milking practices and techniques, floor hygiene, and cow health. In addition, information on herd size, breed, and age of cows, parity, teat size, and body condition of each selected cow was collected. Exotic breeds found in the study area were Holstein, Montbeliarde, and Brune des Alpes.

Characteristics of the selected farms

Most of the sampled farms were managed by men 93%. The owners of farms surveyed were aged from 35 to 69 years. Animals were acquired by purchase 82% and by inheritance 18%. The semi-intensive system was dominant 80%. In this study, 96.4% of the animals were exotic breeds. The cows concerned were at least 3 years old for exotic breeds and 5 years old for local breeds.

California mastitis test measurements

The California Mastitis Test (CMT) was applied to the milk of each functional quarter of the selected cows. The CMT test is based on using a surface-active detergent (Teepol solution) on the milk. This detergent will cause lysis of the cells present in the milk. The destruction of the cell walls releases the cell DNA, which forms a network that traps fat globules and other particles, increasing the viscosity of the milk or producing a flocculate, the size and consistency of which depends on the cell content of the milk sample. The color indicator in the detergent (bromocresol purple) accelerates the green color change to violet (14,15).

In practice, the selected cow should be restrained, and the teats cleaned before the test is carried out. After cleaning, each quarter is allocated a cell in the cup, and after removing the first few streams of milk from each teat, a small amount of milk of about 2 ml from each quarter is taken from the cell allocated to that quarter. After adding 2 ml of Teepol to each quarter, a circular motion is made on the tray for a few seconds to mix the milk with the Teepol. Finally, the presence or absence of mastitis is noted by observation according to the appearance of the flocculation. The CMT was read and interpreted according to the manufacturer's recommendations (UKAL elevage, Eschbach, France). The animal has been considered positive for each selected animal when doubtful results were obtained for some quarters of the udder with a positive reaction in one quarter. No animals have been found during all analyses, with doubtful results in the quarter.

Statistical analysis

Statistical analyses were performed using R 3.5.2 and STATA version 13. A cow was considered positive if at least one udder quarter tested positive. The 95% Confidence Interval (CI) was calculated for each prevalence value. First, a statistical analysis of the association between mastitis status and the explanatory variables was performed using the chi-square test or Fisher's exact test. For the identification of factors associated with mastitis, odds ratios were calculated using STATA 13 software. The cow's health status regarding mastitis was considered the dependent variable, and the variables collected through the interview were independent. Univariate logistic regression was performed to determine the unadjusted odds ratios. Following this analysis, variables for which the univariate logistic regression provided a p-value less than or equal to 0.20 were used in a multivariate analysis by a logistic regression model. Factors associated with mastitis were identified by analyzing odds ratios, confidence intervals, and the p values associated. For all statistical analyses, the significance level was set at 0.05.

Results

Prevalence and risk factors associated with subclinical mastitis

A total of 131 cows tested positive, giving an overall prevalence of subclinical mastitis was 42.9% (95% CI: 37.3%-48.4%). Of the 31 farms visited, 28 had at least one positive animal, giving a prevalence of 90.3% (95% CI: 79.8%-100%) in the herd at Kadiogo and Houet provinces. The variation in subclinical mastitis prevalence is attributed to several variables. According to provinces, the highest prevalence was observed in the province of Kadiogo (45.3%), but the variation was not significant (P>0.05). A significant variation in prevalence was noted between types of farming, and prevalence was significantly higher in intensive farms compared to other types (P<0.05). Additional significant variation was noted according to the types and hygiene of floors, types of milking, breed, and presence of diarrhea, parity, and past cases of mastitis in the herd (Table 1).

Risk factors associated with subclinical mastitis

In univariate analysis, cows in the semi-intensive system were more susceptible to subclinical mastitis infection than those in the other two systems (OR = 5.11; 95% CI: 2.02 - 13.96) (Table 2). According to the milking techniques, manually milked cows were more susceptible to infection than those milked by machine (OR = 4.02; 95% CI: 1.92-8.44). Regarding breed, the analysis showed that exotic cows

were more likely to infection than other breeds (OR = 3.31; 95% CI: 2.01-5.41). Cows with at least 2 lactations were more likely to be infected than others (OR = 2.5; 95% CI: 1.14-3.66) (Table 2).

Table 1: Variation in the prevalence of subclinical mastitis in urban and peri-urban farms in Ouagadougou and Bobo Dioulasso

Variables	Modalities	No. tested	No. Positives	Prevalence and 95% CI	P value
Provinces	Kadiogo	150	68	45.3 (37.3-53.2)	0,408
	Houet	155	63	40.6 (32.9-48.3)	
Past cases of mastitis	Yes	202	103	51.0 (44.1-57.9)	0,00007
	No	103	28	27.2 (18.6-35.8)	
Type of breeding	Extensive	35	18	51.4 (34.8-67.9)	0,0004
	Semi-intensive	244	93	38.1 (32.0-44,2)	
	Intensive	26	20	76.9 (60.7-93.1)	
Cattle shed floor	With straw	120	38	31.7 (23.4-40.0)	0,0013
	Without straw	185	93	50.3 (43.1-57.5)	
Floor hygiene	Clean	24	4	16.7 (1.7-31.6)	0,002
	Medium	181	73	40.3 (33.1-47.4)	
	Dirty	100	54	54 (44.2-63.7)	
Type of milking	Mechanical	39	28	71.8 (57.7-85.9)	0,0097
	Manual	266	103	38.7 (32.8-44.5)	
Breed	Exotic	183	99	54.1 (46.8-61.3)	0,06
	Mixed	26	20	76.9 (60.7-93.1)	
	Local	96	12	12.5 (5.8-19.1)	
Existence of diarrhea	Yes	12	11	91.6 (75.9-100)	0,0011
	No	293	121	41.3 (35.6-46.9)	
Teat size	Short	82	28	34.1 (23.8-44.4)	0,06
	Long	223	103	46.2 (39.6-52.7)	
Teat cleaning	Some of the time	143	59	41.3 (33.2-49.4)	0,574
	Always	162	72	44.4 (36.7-52.1)	
Parity	1st	77	26	33.8 (23.2-44.4)	0,030
	2nd	93	36	38.7 (28.8-48.6)	
	More than 2	135	69	51.1 (42.6-59.9)	

Table 2: Univariate logistic regression of subclinical mastitis infection with different variables

Variables	Modalities	Odds ratio and 95% CI	P value
Province	Kadiogo	1.21 (0.77-1.90)	0,408
	Houet	Ref	
Teat size	Long	1.65 (0.98-2.80)	0.061
	Short	Ref	
Parity	1st	Ref	0.50
	2nd	1.23 (0.66-2.33)	
	More than 2	2.05 (1.14-3.66)	
Breed	Exotic	3.31 (2.01-5.45)	0.000
	Local	Ref	
Teat cleaning	Always	Ref	0.57
	Some of the time	0.88 (0.56-1.38)	
Diarrhea	Yes	14.3 (1.8-113.15)	0.012
	No	Ref	
Past occurrence of mastitis	Yes	2.78(1.66-4.66)	0.000
	No	Ref	
Breeding system	Extensive	1.71 (0.84-3.50)	0.136
	Intensive	5.11 (2.02-13.96)	
	Semi-intensive	Ref	
Cattle shed floor	Without straw	2.18 (1.34-3.52)	0.001
	With straw	Ref	
Floor hygiene	Dirty	1.95 (1.20-3.16)	0.007
	Satisfying	Ref	
Type of milking	Manual	Ref	0.000
	Mechanical	4.02 (1.92-8.44)	

The multivariate logistic regression results showed that diarrhea in the cow was a risk factor for subclinical mastitis (OR=18.03; 95% CI: 2.2- 14.08) (Table 3). The breed was also found to be a risk factor for infection, as cows of mixed breeds were 3.17 (95% CI: 3.71-5.84) more likely to be infected than cows of other breeds. The existence of previous mastitis was also a risk factor for mastitis occurrence (OR=1.97; 95% CI: 1.01-3.84) (Table 3).

Table 3: Multivariate logistic regression of subclinical mastitis

Variables	Modalities	Odds ratio and 95% CI	P value
Past cases of mastitis	Yes	1.97 (1.01-3.84)	0.04
	No	Ref	
Type of breeding	Extensive	0.87 (0.31-2.47)	0.80
	Intensive	1.21 (0.29-5.03)	
	Semi-intensive	Ref	
Cattle shed floor	No straw	1.74 (0.22-3.27)	0.08
	With straw	Ref	
Floor hygiene	Dirty	1.98 (0.93-4.22)	0.07
	Satisfying	Ref	
Type of milking	Manual	1.08 (0.36-3.25)	0.89
	Mechanical	Ref	
Diarrhea	No	Ref	0.007
	Yes	18.03 (2.2-147.8)	
Cow breed	Exotic	3.17 (1.71-5.84	0.000
	Local	Ref	
Parity	Second	1.27 (0.63-2.55)	0.49
	More than 2	1.63 (0.84-3.15)	
	First	Ref	
Teat size	Long	1.39 (0.74-2.62)	0.31
	Short	Ref	

Discussion

The present study was carried out to contribute to improving local milk production in Burkina Faso. Identifying the dairy farm's constraints, such as subclinical mastitis prevalence and risk factors, is essential for better managing dairy farms. The prevalence of bovine subclinical mastitis was 45.3% in cows from the province of Kadiogo and 40.6% in cows from the province of Houet, with an overall prevalence of 42.9%. This prevalence is higher than the overall prevalence of mastitis in African countries, which is evaluated at 30% (16). A previous study conducted in a restricted area in urban Ouagadougou revealed the presence of mastitis in an urban area (17) but has not assessed the prevalence. Similar findings have been made in Nigeria, with a prevalence of 40.4% (18). Recent studies in Senegal revealed a lower prevalence of 11.9% (19). These differences in mastitis prevalence could be explained by several factors related to breeding systems, milking techniques and hygiene, and the study periods (20). The season influences the occurrence of mastitis with the periods when mastitis germs are likely to multiply.

Among the risk factors selected for inclusion in the regression model in multivariate analysis, three variables were statistically significant in the present study and therefore considered risk factors for subclinical mastitis occurrence. Indeed, the breed of the cow, diarrhea and past mastitis on the farm were identified as risk factors for infection. Exotic cows were more likely to be infected than local breeds. The prevalence of subclinical mastitis in local cows was very low 12.5% compared to 54.1% in exotic breeds. These results are similar to recent data in Ethiopia (21,22) and Senegal (19). This difference in prevalence between these two cattle breeds could be because the local breeds are hardy, have low milk production, and are resistant to climatic conditions, while the crossbred breeds are high milk producers and are not resistant enough to local climatic conditions and pathogens. Due to the fragility of these breeds, they are more susceptible to infections. In addition, the exotic breeds known for their high milk-producing character have larger teat channels, which could facilitate the passage of pathogens during milking. Also, animals with diarrhea were more likely to be infected than those without diarrhea. Diarrhea is sometimes caused by bacteria that can cause mastitis. *Escherichia coli* is a persistent bacterium in the cow's stomach, and case diarrhea could contaminate the living area of a cow with a substantial risk of penetration into the teat. Studies implemented in Iraq have identified *Escherichia coli* as a frequent pathogen associated with mastitis in cow and cow milk (23,24). Moreover, Alsanjary and Sheet (25) have noted *that Escherichia coli* is frequently isolated in cow feces in dairy farms in Iraq.

Furthermore, animals with former cases of subclinical mastitis were also more likely to be infected. Similar observations have been made by previous studies (26,27). Most of the time in the study area, farmers do not treat

subclinical mastitis. In this case, the pathogen could persist in the herd and cause new infections.

Parity has not been identified as a risk factor of subclinical mastitis, even if a significant association was found during the Chi-square test analysis. Similar findings have been made in India (28). However, other authors found that parity is significantly associated with subclinical mastitis (22,29). Breeding system and floor hygiene are associated with infection but have not been identified as risk factors after multivariable regression analysis. According to the breeding system, this study reported that prevalence was higher in the intensive system than in the semi-intensive, extensive system. This could be attributed to the variation in the hygienic standards of intensive farm environments. In most dairy farms, cows are kept in an intensive system maintained in a dirty and wet area which could favor the proliferation and transmission of mastitis-causing organisms. This is true as a higher prevalence has been found in dirty floors compared to the cleaned floor in the present study. The same observations have been made in Kenya by Mbindyo *et al.* (30) and Biffa et al., Sarba, and Tola in Ethiopia (31,32). On the other hand, Iraguha *et al.* (33) found in Rwanda that subclinical mastitis was significantly associated with the production system, and they found a higher prevalence in the extensive system compared to semi-intensive systems.

Regarding Floor hygiene, the highest prevalence was found on dirty floors. A similar observation was made in Ethiopia, where a muddy floor was associated with a higher prevalence of mastitis (34). This study revealed the prevalence of subclinical mastitis in dairy farms located in the peri-urban area of Ouagadougou and Bobo Dioulasso. Several control and research activities are needed to control these infections better.

Conclusion

Our findings revealed the presence of subclinical mastitis in farms. It has also been noted that animals with diarrhea, exotic breed cow, and cow which experienced mastitis infection were more likely to be infected. The presence of mastitis in farms would affect the farms' productivity with significant economic losses through reduced productivity and the low quality of milk. In addition, depending on the germs present, consuming mastitis milk may constitute a public health risk. It is essential to implement future investigations to identify pathogens associated with subclinical mastitis in Burkina Faso for perspective control of this infection in the country.

Competing interest

The authors declare no conflicts of interest regarding this manuscript's publication and/or funding.

Acknowledgments

We thank field technicians in the study area for their helpful assistance during data collection. We would also like to thank Dr. Sayouba Ouedraogo for his helpful support in identifying farmers in the peri-urban area of Ouagadougou.

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عوامل الانتشار والخطورة المرتبطة بالتهاب الضرع تحت السريري في مزارع أبقار إنتاج الحليب شبه الحضرية في واغادوغو وبوبو ديولاسو في بوركينا فاسو، غرب أفريقيا

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الخلاصة

التهاب الضرع تحت السريري هو عدوى خبيثة تصيب الغدة الثديية وتؤدي إلى التهاب ربع أو أكثر من الضرع، وعادةً ما يكون ذلك بسبب عدوى بكتيرية، أو اضطراب فسيولوجي، أو صدمة موضعية تسبب تأثير سلبي على إنتاج بقرة الألبان. تهدف الدراسة الحالية إلى تحديد مدى انتشار التهاب الضرع تحت السريري وعوامل الخطورة المرتبطة بها في المزارع شبه الحضرية في واغادوغو وبوبو ديولاسو (بوركينا فاسو). في المجمل، تم اختبار ٣٠٥ بقرة مرضعة، بما في ذلك ١٥٠ من منطقة واغادوغو شبه الحضرية و١٥٥ من بوبو ديولاسو، باستخدام اختبار كاليفورنيا لالتهاب الضرع. كما تم إجراء جمع لجمع البيانات حول إدارة المزرعة والحيوانات المختارة. بلغ معدل الانتشار الإجمالي ٤٢,٩، ٤٥,٣ و ٤٠,٦٪ على التوالي، في المزارع الواقعة في المناطق المحيطة بالمناطق الحضرية في واغادوغو وبوبو ديولاسو. أشارت نتائج التحليل الإحصائي الحياتي الى أن السلالة، والحالات السابقة لالتهاب الضرع في المزرعة، والإسهال كعوامل خطورة مرتبطة بالتهاب الضرع تحت السريري. في الختام، توضح هذه الدراسة دليلاً على وجود التهاب الضرع في المزارع المحيطة بالمدن في بوركينا فاسو مع وجود حاجة إلى مزيد من التحقيقات لتحديد مسببات الأمراض المرتبطة بهذه العدوى لتحديد إجراءات السيطرة الأفضل.