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REGULAR ARTICLES

Risk factors associated with the bovine subclinical mastitis in an Amazon micro-region

Romero Kadran Rodrigues Vieira[1] · Marcos Rodrigues[2] · Patrícia Kaline da Silva Santos[1] · Natalia Bianca Caires Medeiros[1] · Ebson Pereira Cândido[2] · Marilia Danyelle Nunes Rodrigues[1,3]

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Abstract

In this study, we evaluated the main risk factors for the occurrence of bovine mastitis, in the southeastern of Pará, in the Brazilian Amazon. We surveyed 91 dairy farmers to identify management practices and bovine breed characteristics. From each farm, 50 mL of milk sample was collected for microbiological analysis and somatic cell count (SCC). Depending on the management practices and breed, a logit model was used to determine the odds ratio of subclinical mastitis (SCM) occurrence. In irrigated pastures, an SCM-associated risk factor, the occurrence of SCM was 5.03 times higher than that in the non-irrigated pastures. Similarly, in Girolando breed herds, the occurrence of SCM increased by 5.8 times compared to the crossbred herds. Moreover, the occurrence of mastitis was 33 times higher in farms using common cloths for drying teats than in farms using paper towels. Therefore, adoption of better management practices can lead to SCC reduction, milk quality improvement and a guarantee to contain SCC within prescribed Brazilian limits for the Amazon region.

Keywords Logit · Animal production · Subclinical mastitis · Somatic cell counts

Introduction

Mastitis is an inflammation of the mammary gland characterized by pathological changes in the glandular tissue and physicochemical changes in the milk. During milking, cows are managed by the dairy personnel (Radostits et al., 2007), which may cause cross-contamination resulting in an increase in the occurrence of mastitis (Keefe, 2012). Somatic cell count (SCC) is used to detect subclinical mastitis (SCM) (Kehrli and Shuster, 1994). SCC is a parameter widely used to evaluate milk quality and health of mammary glands, as mastitis may lead to economic losses for the dairy farms by compromising milk quality and animal health (Mendes et al., 2010).

Preventive management is effective in reducing the SCM occurrence (Vieira et al., 2021). Extensive research on the production management, prevalence control, clinical cases frequency and causal agent has been done to understand the pathology of this disease (Ribeiro et al., 2006; Olde Riekerink et al., 2008; Martins et al., 2010). Such studies have been helpful in devising strategies to reduce SCM occurrence in dairy farms by unravelling the causes, effects, intensity and susceptibility of pathogens. The risk factors for SCM vary depending on biomes, herds and management

✉ Marilia Danyelle Nunes Rodrigues
nunes.mdnunes@gmail.com

Romero Kadran Rodrigues Vieira
romerokadran@hotmail.com

Marcos Rodrigues
marcos.rodrigues.adm@gmail.com

Patrícia Kaline da Silva Santos
patriciakaline7@gmail.com

Natalia Bianca Caires Medeiros
caires-medeiros@hotmail.com

Ebson Pereira Cândido
ebsonzoo@yahoo.com.br

[1] Postgraduate Program in Animal Production in the Amazon - Campus Parauapebas, Federal Rural University of the Amazon-UFRA, Parauapebas, Pará, Brazil

[2] Capanema Campus, Federal Rural University of the Amazon-UFRA, Capanema, Pará, Brazil

[3] Campus Belém, Federal Rural University of Amazonia-UFRA, Av. Presidente Tancredo Neves 2501, Terra Firme, Belém, Pará, Brazil

practices. Research done in the Northern Brazil (Prestes et al., 2002; Vieira et al., 2021), specifically in the Amazon region, revealed that irrigated pastures and breed of herds could affect the presence of SCM in cows. Therefore, this study aims to evaluate the main risk factors associated with the bovine mastitis due to management practices, in south-eastern Pará state, using a probabilistic model. We hypothesize that dairy farmers having poor management and low zootechnical indexes, consequently, produce inferior quality milk.

Material and methods

Study area and data collection

In this study, we followed a combination of quantitative and qualitative approach. We collected the necessary data from three municipalities in the south-east of Pará: Parauapebas, Curionópolis and Eldorado dos Carajás. Between August 2018 and March 2019, 91 responses from the farms were obtained. To understand the production aspects, the surveys had 30 multiple choice questions enquiring about production characteristics, herd characteristics and milking management (in supplementary material).

We also collected a composite sample from milk bulk tank and/or milk drums on each farm. The milk was homogenized before sample collection. In bulk tanks, milk was homogenized in drums using a mechanical stirrer for 10 s. The samples were then collected using a milk dipper and incubated between 1 and 7 °C for 72 h, while being transported to the Milk Quality Laboratory, Food Research Centre, School of Veterinary and Zootechnics of the Federal University of Goiás in Goiânia, Brazil. For SCC analysis, 50 mL of milk was transferred to appropriate containers containing bronopol (2-bromo-2-nitro-1,3-propanediol).

Data analysis

After collecting data, a logistic regression model (logit model) was used to determine a mathematical model for the prediction of the occurrence of bovine mastitis in dairy farms (in supplementary material). As per the SCC, the farms were classified into two groups (Olechnowicz & Jaškowski, 2012). SCM was present (Y = 1) when the group had SCC > 200×10^3 SC/mL and SCM was absent (Y = 0) when group had SCC ≤ 200×10^3 SC/mL, followed by calculating the odds ratio, which was inversed when lower than 1.

The variables selected for the study were—the irrigation production system (IPS), Girolando breed (RCG), strip cup test (SCT), if the teats were washed before milking then use of paper towels (TWP) or plain cloth (PC) for drying—to ascertain the material used for drying, or if the teats were not dried and the treatment of dry cows suffering with mastitis (Table 1). We performed Pearson's chi-square test to validate the estimated model. All statistical analyses were performed using R version 3.6.0, GLM function, Stats package.

Results and discussion

Of the 91 dairy farms, 32.97% used irrigated pastures and 70% of the irrigated pastures had SCC values > 200×10^3 SC/mL. A total of 0.22% farm herds were crossbred (i.e., with no defined pedigree) and 19.78% were Girolando (Holstein Frisian × Gir with different blood lines); 79.12% of the farms preferred manual milking method while remaining used mechanical milking method; 82.42% of the farm herds

Table 1 Descriptive statistics of variables in logit model

Variable	Class	% of farms	SCC (SC/mL)	
			≤ 200×10^3	> 200×10^3
IPS	Pasture without irrigation	67.03	39.34	60.66
	Irrigated pasture	32.97	30.00	70.00
RCG	Girolando	19.78	27.78	72.22
	Crossbred animals	80.22	38.36	61.64
SCT	Yes	40.66	48.65	31.85
	No	59.34	27.78	39.66
TWP	Yes	5.49	80.00	15.40
PC	Yes	28.57	69.23	21.88
DPW	TWP = PC = 0	65.93	18.33	42.63
TD	No	13.19	33.33	37.76
	Yes	86.81	36.71	36.55

IPS, irrigated production system; *RCG*, breed girolando; *SCT*, strip cup test; if teats were washed before milking (TW); drying of teats with paper towels (TWP); drying of teats with plain cloth (PC); the treatment of dry cows (TD).

were milked in an open shed, and 17.58% in the milking parlour. On 92.31% of the farms, 60% of the cows in the herd were until the third lactation. On 93.41% farms, 30% of the cows were lactating and on 29.67% farms; 20% of the cows were in the dry period; 81.32% of the farms produced less than 100 L of milk/day. Pearson's chi-square test rejected the hypothesis that the logit model was not well adjusted (p-value = 0.551). The significant variables were IPS, RCG, TWP and PC (Table 2).

According to the model, cows in IPS were five times more likely to develop SCM than those in the non-IPS, possibly because the high humidity and temperature in IPS favoured proliferation of mastitis-causing microorganisms (Pinho Manzi et al., 2012; Santos and Fonseca, 2007). Additionally, 97.80% farm animals were not fed during or after milking but they went to humid and dirty pastures after milking. Such an environment favoured the teat canal infection, thus increasing the probability of mastitis occurrence (Oliveira et al., 2012). Therefore, SCM occurrence can be attributed to herd management. The high SCC levels and its relationship with wet pasture is subject to future research. Following milking, the teat canal may remain dilated for 0.5 to 2 h (Prestes et al., 2002); therefore, it is safe to feed the animal after milking and not let them wander until teat canal is dilated. Therefore, feeding animals during milking protects them from environmental pathogens and this strategy can decrease the likelihood of infection (Costa et al., 1998). Although none of the studies has reported breeding in irrigated pasture systems as a risk for the occurrence of mastitis, Anderson and Walker (1988) isolated *Prototheca zopfii* in the pastures and water. During dry periods, Costa et al. (1997) isolated *Prototheca zopfii* from the water and grazing animals and observed outbreaks of bovine mastitis. Increased waste, humidity and organic matter in the pastures encouraged the transmission of mastitis-causing microorganisms. Though we identified irrigation systems as a risk factor, it improved the animal feed's nutritional value and maintained productivity in periods of drought.

Genetic traits of animals determined their resistance to diseases, as farms with RCG were 5.8 times more susceptible to SCM than the crossbred animals. The results indicated that crossbred animals (80.22% of the herds on the studied farms comprised crossbred animals, without a complete pedigree) had greater rusticity and resistance to diseases (Madruga et al., 2016). A lack of selection criteria favoured genetic variability in crossbred herds by influencing SCC variations. Conversely, genetic selection done to increase milk production increased animal's susceptibility to intramammary infections (Prestes et al., 2002). Oliveira et al. (2012) studied risk factors for bovine mastitis and observed that crossbred animals were less susceptible to mastitis compared to other breeds. Udder morphology has moderate to high heritability and can influence SCC variations. The majority of animals was crossbred, whose genetic variability was greater than that of the Girolando breed (Bishop and Woolliams, 2010).

The discretion to wash/no washing and dry/no drying did not impact the mastitis occurrence. However, farms that do not wash or dry were more susceptible to SCM than the washing and drying farms. In case of washing and drying the teats with a PC or TWP, negative coefficients indicated that these variables reduced susceptibility to bovine mastitis. In case of TWP usage, the inversed odds ratio indicated that the chance of having subclinical mastitis was 111 times more than the case where teats were not dried. Moreover, when drying with a PC, the odds ratio of SCM non-occurring was 33 times lower (Dohoo et al., 2009). Therefore, using TWC lowers the risk to mastitis compared to a PC.

The SCT was not statistically significant. Using the SCT, producers observed visible changes in the milk and udder morphology. The obtained information influenced cow selection for disposal and SCC levels by adopting appropriate management techniques.

Knowledge of bovine mastitis risk factors allowed producers and public assistance agencies to improve disease prevention and control programs. This led to reduced incidence of the disease, improved animal productivity and a profitable milk production system. Thus, the three risk factors for an increased SCC in milk were irrigated pasture systems, herds comprising Girolando breed and the non-drying of the teats before milking and the drying of the teats after washing with paper towels.

Table 2 Final logit model with the somatic cell count values of cow's milk above or below 200×10^3 CS/mL as the dependent variable

Variable	Coefficient	Odds ratio (ODS)
(Intercept)	1.026[a]	-
IPS	1.616[a]	5.030
RCG	1.756[a]	5.789
SCT	−0.459 [ns]	-
TWP	−4.713[a]	0.009
PC	−3.513[a]	0.030
TD	1.377 [ns]	-

[a]significance the 0.05 ($p < 0.05$); [ns]not significant; *IPS*, irrigated production system; *RCG*, breed Girolando; *SCT*, strip cup test; *TWP*: drying of teats with paper towels; *PC*, drying of teats with plain cloth; *TD*, treatment of cows with no milk; *WND*, washes but does not dry variable occurs when TWP = PC = 0. Pseudo-McFadden R^2: 0.34.

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Author contribution All authors contributed to the study conception and design. RKR Vieira: conceptualization, methodology, data curation, writing—original draft preparation, visualization, investigation, validation, review and editing. M Rodrigues: methodology, data curation, software, writing—original draft preparation, review and editing. PKS Santos: writing—original draft preparation, visualization, investigation, validation, review and editing. NBC Medeiros: conceptualization, methodology, data curation. EP Cândido: conceptualization, methodology, visualization, investigation, validation. MD Nunes-Rodrigues: conceptualization, methodology, data curation, writing—original draft preparation, investigation, validation, review and editing, supervision.

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Data availability Data are publicly and available in the Mendeley Data Repository: (https://doi.org/10.176032/xbk6x9rrnb.1)

Declarations

Ethics approval The Federal Rural University of the Amazon-UFRA Research Ethics Committee has confirmed that no ethical approval is required.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Competing interests The authors declare no competing interests.

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