Environmental Risk Factors Associated With Bovine Mastitis in an Amazon Micro-region

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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. In this research we gathered data from 91 dairy farmers through structured questionnaires to identify management practices and breed characteristics. Along with the questionnaire, a sample of 50 mL of milk was collected from each property for microbiological analysis using somatic cell counts (SCC). A logit model was used to determine the probability of subclinical mastitis occurrence, depending on management practices and breed. One risk factor associated with mastitis was irrigated pastures, where the chances of mastitis was 5.03 times higher than in non-irrigated pastures. Herds comprising the Girolando breed increased the chances of mastitis by 5.8 times over those comprising crossbred cows. In production systems where common cloth are used to teat drying the chances of occurrence were 33 times greater compared to drying them using paper towels. The adoption of better management practices in dairy farmers could lead to reduce SCC, increasing both milk quality and guarrating that farmers keep SCC at Brazilian legal limits for Amazon region.

Introduction

Mastitis occurs when cow's mammary glands provide a suitable environment for microorganism's development (Lopes et al., 2017). During the milking process, cows are managed with equipments and the hands of dairy personnel (Radotits et al., 2007), which may cause cross-contamination between animals and increase the occurrence of mastistis (Keefe, 2012). The sum of somatic milk cells (SCC) is used as an indicator to detect subclinical mastitis (Kehrli and Shuster, 1994). It is an important mean of monitoring milk quality and the health of mammary glands, since the presence of mastistis in herd may lead to economic losses for dairy farms (Mendes et al., 2010).

Preventive management is important to reduce the occurrence of subclinical mastitis (Vieira et al., 2021). Many researches already dealt with the different aspects of the pathology of this disease, such as the incidence of somatic cells, milk's bacterias, production management, disposal of affected cows, control of prevalence, incidence and frequency of clinical cases, and discovery of agents that cause it (Ribeiro et al., 2006; Olde Riekerink et al., 2008; Martins et al., 2010).

Such studies are relevant to understand the causes, effects, intensity, susceptibility of pathogens, and to provide basis for strategies to reduce mastitis occurrence in dairy farms. However, risk factors for mastitis can change between producing regions, considering different biomes, herd characteristics and management. Few researches have been carried out in the Northern region of Brazil, especially in the Amazon region, where irrigated pastures and breed factors could affect the presence of subclinical mastitis in cows. Therefore, this study aims to evaluate, through a probabilistic model, the main risk factors associated with management practices for the occurrence of bovine mastitis in dairy herds in southeastern of Pará state. Our hypothesis is that dairy farmers have poor management and low zootechnical indices of dairy activity, consequently, impacting the milk quality in most of these farms.

Material & Methods

Study area and data collection

This study is analytical with a quantitative and qualitative approach. We performed an investigation in three municipalities in the south-east of Pará: Parauapebas, Curionópolis, and Eldorado dos Carajás. We visited farms and collected the necessary data using questionnaires. A total of 91 farmers answered the questionnaires from August 2018 to March 2019. To understand the production aspects, these questionnaires had thirty closed questions (multiple choice) subdivided into three blocks: characteristics of production, herd characteristics, and milking management.

We also collected a composite sample from expansion tanks and/or milk drums on each property. Fifty millilitres of milk were transferred to appropriate containers containing bronopol (2-bromo-2-nitro-1,3-propanediol) for later SCC analysis. The milk was homogenised before samples were collected. For milk from expansion tanks, homogenisation was performed in drums using a mechanical stirrer, immersing it in the milk for 10 s. The samples were then collected using stainless steel shells. The collected samples were kept at temperatures between 1 and 7°C for 72 h during transportation to the Milk Quality Laboratory of the Food Research Centre of the School of Veterinary and Zootechnics of the Federal University of Goiás in Goiânia, Brazil.

Data analysis

With the collected data, a logistic regression model was employed to determine a mathematical model to predict the occurrence of bovine mastitis in dairy farms (Supplementary Material). As model-dependent variable, we classified farms into two groups according to the SCC. For dairy farms with herd SCC greater than 200×10^3 SC/ml, Y = 1 (presence of subclinical mastitis); for SCCs less than or equal to 200×10^3 SC/ml, Y = 0 (no subclinical mastitis).

The independent (Table 1) variables selected are the irrigated production system (IPS); race girolando (RCG); strip cup test (SCT); if teats were washed before milking: drying of teats with paper towels (TWP) or drying of teats with plain cloth (PC), whether the producer dries teats after washing and what material was used to dry them, otherwise, the farm washes but does not dry (WND); treatment of dry cows (TD), whether the producer treated dry cows suffering from mastitis. All statistical analyses were performed using R version 3.6.0 (R Core Team, 2019), GLM function, Stats package.

Table 1
Descriptive statistics of variables in Logit Model.

Variable	Class	% of farms	SCC (SC/ml)	
			≤ 200.000	> 200.000
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

Note: Irrigated production system (IPS); race girolando (RCG); strip cup test (SCT); 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).

Results And Discussion

Of the 91 milk-producing units, 32.97% of the properties use irrigated pastures. Of these, 70% had SCC values above 200 × 10^3 ^{s}cc mL^{-1}. Regarding to the breed of herds present on the properties, 80.22% were crossbred animals (without complete blood lines), 19.78% were of the Girolando breed, (Holandez × Gir with different blood lines). Regarding milking processes, 79.12% used manual milking processes and the rest used mechanical milking processes. On most properties (82.42%), milking was performed in an open shed, and only 17.58% had a milking parlour. On 92.31% of the studied properties, 60% of the cows in the herd were until the third lactation. On 93.41% of the properties, 30% of the cows were in lactation and 29.67% of the farms had 20% of the cows in the dry period of their lactation cycle. Most properties (81.32%) produced less than 100 L of milk per day.

Pearson's chi-square test resulted in a rejection of the hypothesis that the logit model was not well adjusted (p-value = 0.551). The selected variables that showed significance were RC, RS, TW, and TWP (Table 2).

Table 2
Final logistic regression model with the somatic cell count values of cow's milk above or below 200 x 103 cs / ml as the dependent variable.

Variable	Coefficient	Probability ratio
(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]	-

Note: [a]: significance the 0.05 ($p<0.05$); [ns]: not significant; IPS: irrigated production system; RCG: race 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.

According to the model, cows in irrigated pasture production systems are 5.0 times more likely to develop subclinical mastitis than the non-irrigated pasture production system. This is possibly because the microorganisms that cause mastitis benefit from the increase in humidity and high temperature (Pinho Manzi et al., 2012) during the season when irrigation systems are in operation, favouring their development (Santos and Fonseca, 2007).

The higher probability of occurrence of subclinical mastitis in irrigated systems is supported by the fact that, in almost all properties (97.80%), the animals are not fed during or after milking. This approach favours the occurrence of mastitis. Animals in the present study went to pasture immediately after milking and were subjected to environments with high humidity, dirt, and organic matter; animals lying down or moving about in the pasture favour the penetration of microorganisms into the udders epidermis, increasing the chances of infection (Oliveira et al., 2012). Even though irrigated pastures increase cases of subclinical mastitis, and therefore higher SCC are observable, the probabilist model does not account that the irrigated pastures consequently increase SCC.

Feeding animals during milking protects them from environmental pathogens, as soon after milking, the nipple ducts expand and remain this way for approximately 30 to 120 min (Prestes et al., 2002). Thus, to decrease the likelihood of infection, it is advisable to provide food after milking, encouraging the animals to remain standing until the nipple ducts close (Costa et al., 1998).

There are no studies in the literature reporting on breeding in irrigated pasture systems as a risk factor for the occurrence of mastitis. However, Anderson & Walker (1988) reported the isolation of Prototheca zopfii in pasture and water. Costa et al. (1997) observed outbreaks of bovine mastitis when isolating Prototheca zopfii from water and grazing animals during dry periods. Elevated levels of waste, humidity, and organic matter in these systems, encourage the transmission of microorganisms which cause mastitis.

Irrigation systems should not be a problem for producers, even though we identified as a risk factor due to the development of microorganisms that cause subclinical mastitis. Irrigation is a tool that improves the nutritional value of plants in the animals' diet and makes it possible to maintain productivity levels in periods of drought.

Regarding to the racial characteristics of herds, properties with animals of the Girolando breed (Holandez × Gir animals with different degrees of pedigree) were 5.8 times more likely to experience subclinical mastitis compared to properties in which the herd comprises crossbred animals (without defined pedigrees). This result is related to the genetic characteristics of these animals, as 80.22% of the herds on the studied properties comprised crossbred animals (without a complete pedigree), which have greater rusticity and resistance to diseases.

The lack of selection criteria by producers favours genetic variability of the animals, influencing variations in SCCs in crossbred herds. Conversely, genetic selection with the objective of increasing milk production is accompanied by an increased susceptibility to intramammary infections (Prestes et al., 2002). Oliveira et al (2012) studied risk factors for bovine mastitis and observed that crossbred animals had a lower frequency of mastitis compared to other breeds.

The morphological characteristics of udders have moderate to high heritability and can influence variations in SCC values in herds (Bishop and Woolliams, 2010). The animals on the properties, however, are predominantly composed of crossbred animals (80.22%), and the genetic variability of these animals is greater than that of the Girolando breed.

Regarding the washing of teats before milking, the properties that do not wash or wash, but do not dry, did not differ, having the same chance of mastitis occurring as result of both procedures. However, they are more likely to face subclinical mastitis in relation to washing and drying properties.

For properties that wash and dry the nipples after washing with a common cloth or paper towel, negative coefficients show that these variables contribute to reducing the probability of occurrence of bovine mastitis. For those dairy farms that wash and dry with paper towels, the chance of not having subclinical mastitis is 111 times less than properties that do not wash or wash but do not dry, while drying with a soft cloth reduces this likelihood to 33 times. Therefore, drying the teats with paper towels is less likely to cause mastitis compared to drying with a regular cloth.

The strip cup test did not result in statistically significant rates. Using the test, producers check for visible changes in the milk and udder characteristics and will have information that influences decision making

regarding which cows to select for disposal and keep herd with low SCC levels adopting correctly management techniques.

Knowledge of risk factors for bovine mastitis in the region allows for the elaboration and improvement of disease prevention and control programs of producers and public assistance agencies, allowing a lower incidence of the disease, improving the productivity of animals, and the profitability of the system of milk production. Thus, the risk factors for the increase in milk SCC, indicating cases of subclinical mastitis in the Parauapebas microregion, were irrigated pasture systems, herds comprising Girolando animals, the non-drying of the teats before milking, and the drying of the teats after washing with paper towels.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

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, Inves- tigation, Validation, Review and editing, Supervision.

Data Availability

Data are publicly and available in the Mendeley Data Repository: (doi:10.17632/xbk6x9rrnb.1).

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.

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