Effects of mastitis on milk production and composition in dairy cows

by Dian Wahyu Harjanti

PAPER • OPEN ACCESS

Effects of mastitis on milk production and composition in dairy cows

To cite this article: Dian Wahyu Harjanti and Priyo Sambodho 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **518** 012032

Effects of mastitis on milk production and composition in dairy cows

Dian Wahyu Harjanti[1] and Priyo Sambodho

[1] Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia.

E-mail: harjantidian@gmail.com

Abstract. Mastitis is the biggest economic problem in dairy industry. Mastitis also causes animal welfare problem and it is a thread to food safety and security. A baseline survey involving small-holder dairy farms was conducted to identify the correlation between mastitis (mammary inflammation) and cow's productivity. The performance of cows, in terms of milk production, milk composition, as well as mammary inflammation levels were observed. The research was conducted in Central Java, Indonesia. A total of 103 lactating cows in the 2nd to 3rd month of lactation and parity were used. California Mastitis Test was used to analyse the inflammation level of mammary gland. Milk protein, fat and lactose contents were determined with Lactoscan Milk Analyzer. Milk production was recorded daily at morning and evening milking. The result shows statistically negative correlation ($P<0.0001$) between the level of mammary inflammation and milk production ($r = -0.59$) as well as milk protein ($r = -0.55$), lactose ($r = -0.51$), and fat contents ($r = -0.46$). It is concluded that, when the mammary infection in cows increased, milk production and milk components will be decreased.

1. Introduction

Mastitis is an inflammatory reaction of the mammary gland which is mainly caused by bacterial infection. Mastitis is the most prevalent production disease in dairy herds worldwide and well documented as a heavy burden disease in dairy farms. The values for losses of milk production were proposed at 5% of total milk production in lactation period and at 0.5 kg milk per-2-forld increase of inflammatory cells of a cow [1]. Biosynthesis of milk components occurs in secretory cell of mammary alveoli. The function and structure are going hand-in-hand. At the level of mammary alveoli, milk production and its components secretion are depending on the biochemical and structure of the cell. It is belief that the bacterial infection in mastitis cases is related to the disruption of alveolar cell-integrity, sloughing of cells, induced apoptosis, and increased of poorly differentiated cells [2]. The sub-subclinical mastitis cases also associated with the increases of somatic cell counts [3] [4]. Somatic cell is useful predictor of intramammary infection that includes 75% leucocytes, i.e. neutrophils, macrophages, lymphocytes, erythrocytes and 25% of epithelial cells [5]. The elevated leucocytes migration from vascular into mammary cells evoked to fight the inflammation. Threshold limits of 4.0×10^5 somatic cell counts/ml have been fixed for milk quality and udder health monitoring in Indonesia [6]. The ability of ruminant mammary gland to produce milk is determined by the number of cells secreting milk and their level of activity [7]. Hence, the amount of milk produced and the concentrations of protein, lactose and fat in milk are might be affected by the level inflammation in mammary gland. Milk produced by local farmer must comply with National Milk Quality Standard.

The milk that does not meet the standards will be rejected by the milk processing industry, thus causes economic losses to farmers. The California Mastitis Test (CMT) is a practical, inexpensive, cow-side test used to estimate the number of inflammatory cell (somatic cell) in the milk with the higher scores being associated with an increased probability and severity of mastitis. This research aimed to evaluate the relationship between the mammary inflammation level (somatic cell counts) and milk production as well as milk components (protein, lactose, fat). The CMT was used to examine the inflammation level of mammary gland.

2. Materials and Methods

2.1. Animal and Sampling

An observational study was conducted in local farms of Central Java Indonesia. A total of 103 lactating cows in the 2nd to 3rd month of lactation and parity from 40 local farmers were used. In the study, the cows were screened for mastitis using California Mastitis Test, udder palpation and visual examination of milk. Reproduction recording also was used to determine the lactation stage of the cow. While the cows were restrained in a standing position, quarter milk samples were collected after discarding the first few milliliters of milk. Udder and teat were cleaned with warm water and left to dry, and then wiped with cotton soaked in 70% alcohol, after which of 100 ml of milk sample for milk component analysis was aseptically collected in sterile bottle keep refrigerated at 4°C. Milk components were analyzed with Lactoscan Milk Analyzer (Bulgaria). The milk components analysis was carried out in duplicate. The assessment includes lactose, fat and protein. The inflammation level of mammary gland was determined by total score of all four quarters.

2.2. Statistical Analysis

SCC values were transformed to log10 prior to statistical analysis. Pearson correlation coefficients and linear regression were used to investigate the relationship between SCC levels and various milk components.

3. Results and Discussion

The final data set included 103 lactating cows (412 quarters). Based on the CMT examination, 296 (71.84%) of the quarters were experiencing intramammary infection (Table 1). Mastitis is clinical or subclinical in nature. We found 98% subclinical and only 2% clinical mastitis by physical examination and CMT test. Clinical mastitis is readily detected during physical examination and results in visible abnormalities in milk. There are three categories of clinical mastitis according to Kandeel et al. [7] : (1) abnormal secretion with visible abnormalities in milk; (2) abnormal secretion and mammary gland (clinical evidence of udder inflammation, including the presence of heat, redness, swelling, pain);(3) abnormal secretion, gland and cow (clinical evidence of systemic illness, including fever, decreased appetite and rumen fill). Subclinical mastitis is not detectable during physical examination and there were no visible abnormalities in milk. Subclinical mastitis cases are usually identified by examining the mastitis pathogens in milk and detecting the presence of inflammatory biomarkers.

The average of milk production was 12.08(±0.4) liter/d. Milk composition results were as follow: 3.36% (±0.05) lactose, 3.45% (±0.06) fat and 2.97% (±0.05) protein. The mixed-model linear regression analysis showed negative correlation ($P<0.001$) between the level of mammary inflammation and total milk production and milk composition (lactose, fat, protein) (Figure 1). The inflammation level of mammary gland was determined by total score of all four quarters. It has recently been reported that an increase in mammary inflammation in dairy animals are associated with a decrease in milk production [7]. In clinical mastitis cases, the decrease in milk production of a cow was observed at least 1 week before it is diagnosed [8]. The time lag was probably due to the fact that mastitis is subclinical before the onset of clinical symptoms. Previous publication suggested that the effect of mastitis on milk production are indeed more severe when the mastitis developed in early lactation or before the peak of milk production [1,5]. In cows, milk production losses vary with the species of bacteria pathogen as a causative agent. Le Maréchal et al. [9] suggested that *S. aureus,* *Arcanobacterium pyogenes, E. coli, Klebsiella spp*. caused the greatest losses among the primipara, whereas *Streptococcus spp., S. aureus, A. pyogenes, E. coli, and Klebsiella spp*. caused the most significant losses among the multipara. Observation on the gram positive and negative bacteria showed that the gram-negative cases in clinical mastitis had more severe milk loss compared with the gram-positive cases. This has also been described in dairy goat where the milk production decreases during subclinical mastitis. The milk production of healthy goat was 0.98 kg/ milking, whereas the mastitis ones was 0.69 kg/ milking [10]. Data concerning the impact of mastitis on milk protein, fat and lactose in present study also showed negative correlation with the mammary inflammation. A decrease in fat concentration during mastitis can be expected due to a reduced synthetic and secretory capacity of the mammary gland. This may be explain by the alteration of milk globule membrane by leucocyte lipases or by plasmin through the hydrolysis of lipoproteins, both of which may enhance lipolysis [9]. Regarding to the protein content, it seems that mastitis affected the casein concentration and casein composition. Protein content was decreased as increasing inflammation level of mammary gland in present study. Lactose contents also decrease with a rise in inflammation level. Similarly, Coulon et al. [11] also noticed a decrease in lactose content (-2.1 g/kg) and casein/protein ratio (-2 %) during *S. aureus* subclinical mastitis. The use of mastitis milk in processing can affect the quality of milk products. The *S. aureus* and *E. coli* enhance the production of urokinase, a plasminogen activator in bovine epithelial cells which in turn induce an increase in plasmin concentration. Plasmin influences the quality of dairy product, notably by hydrolyzing casein which may influences milk coagulation properties, cheese yields and cheese ripening. Plasmin also known to have ability in surviving with the heat treatment. Even after UHT treatment, 30% to 40% plasmin activity can be detected in milk [12]. However, the impact of mastitis on milk production milk components are seems to be depend on the species of ruminant and the species of mastitis pathogens. Subclinical mastitis caused by coagulase-negative staphylococci increases mammary inflammation but has no effect on milk production and composition [13]. It also has recently been reported that no changes in goat milk composition when the somatic cell counts increased as the result of increasing inflammation in the mammary gland [8]. Prevention of both clinical and subclinical mastitis in the dairy farm can be done by implementing the biosecurity practices. Consideration should be given to the routine application of biosecurity during milking process, including cleaning the barn and mammary gland, using clean towel to dry the quarters (1 towel for 1 cow), stripping off quarters into a bucket rather than onto the floor to check the milk before milking, hand milking for mastitis cows, milking twice a day, use of portable milking machine with disinfection of cluster between cows, using antiseptic for post-milking teat sanitation, and thorough hand washing after milking a cow.

Table 1. The CMT result of each quarter and mastitis prevalence

	CMT score					n
	0	1	2	3	4	
The number of positive quarters	116	172	92	26	6	412
Percent (%)	28.2 %	41.7%	22.3%	6.3%	1.5%	Positive: 71.8% Negative: 28.2%
Clinical mastitis *	2%					
Subclinal mastitis*	98%					

*evaluated by physical examination and the presence of abnormalities in milk

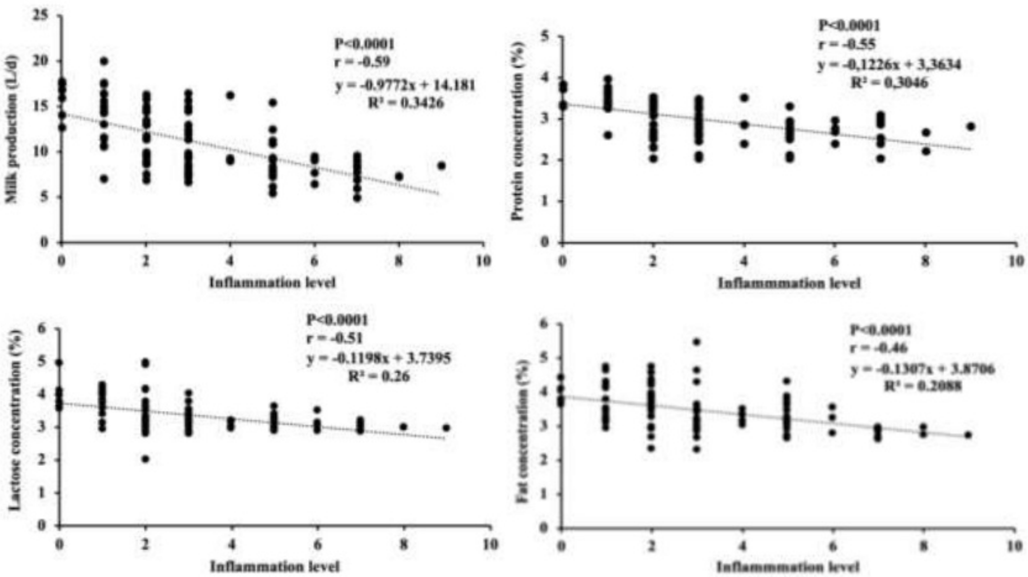

Figure 1. Correlation between milk production and milk components

4. Conclusion

It is concluded that, when the mammary infection in cows was increased, milk production and milk components would be decreased.

Acknowledgments

This research is supported by the Diponegoro University research grant 2019.

References

[1] Seegers H, Fourichon C, and Beaudeau F 2003 *Vet. Res.* 34(5):475-491.
[2] Akers RM and Nickerson SC 2011 *J. Mammary Gland Biol. Neoplasia* 16(4):275-289.
[3] Boutinaud M, Flament JG, and Jammes H 2004 *Reprod. Nutr. Dev.* 44:499-508.
[4] Nyman AK, Weller KP, Bennedsgaard TW, Larsen T, Emanuelson U 2013 *J. Dairy Sci.* 97:5459-5473.
[5] Sharma N, Singh NK, and Bhadwal MS 2011 *J. Anim. Sci.* 24(3):429-438.
[6] Harjanti DW, Ciptaningtyas R, Wahyono F, and Setiatin ET 2018 *IOP Conf. Ser:Earth Environ. Sci.* 102 012076
[7] Kandeel SA, Morin DE, Calloway CD, and Constable PD 2018 *J. Vet. Internal Med.* 32:497-505.
[8] Wilson DJ, Gonzalez RN, Hertl J, Schulte HF, Bennett GJ, Schukken YH, and Grohn YT 2004 *J. Dairy Sci.* 87:2073–2084
[9] Le Maréchal, Thiéry, Vautor, and Le Loir 2011 *Dairy Sci. Technol.* 91(3):247- 282.
[10]Leitner G, Merin U, and Silanikove N 2004b *J. Dairy Sci.* 87:1719–1726.
[11] Coulon JB, Gasqui P, Barnouin J, Ollier A, Pradel P, and Pomies D 2002 *Anim. Res.* 51:383–393.
[12] Ma Y, Ryan C, Barbano DM, Galton DM, Rudan MA, and Boor KJ 2000 *J. Dairy Sci.* 83:264–274.
[13] Tomazi T, Goncalves JL, Barreiro JR, Arcari MA, and dos Santos MV 2015 J. Dairy Sci. 98:3071-3078.

Effects of mastitis on milk production and composition in dairy cows

ORIGINALITY REPORT

10%	9%	10%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	synapse.koreamed.org Internet Source	5%
2	hal.cirad.fr Internet Source	1%
3	N. Sharma, N. K. Singh, M. S. Bhadwal. "Relationship of Somatic Cell Count and Mastitis: An Overview", Asian-Australasian Journal of Animal Sciences, 2011 Publication	1%
4	ousar.lib.okayama-u.ac.jp Internet Source	1%
5	Alex Bach, Martí Dinarés, Maria Devant, Xavier Carré. "Associations between lameness and production, feeding and milking attendance of Holstein cows milked with an automatic milking system", Journal of Dairy Research, 2006 Publication	1%
6	tel.archives-ouvertes.fr Internet Source	<1%

7	Liu, G.. "Canonical correlation of milk immunoglobulins, lactoferrin concentration and Dairy Herd Improvement data of Chinese Holstein cows", Livestock Science, 201003 Publication	<1%
8	portal.research.lu.se Internet Source	<1%
9	Henry Ogola, Anakalo Shitandi, Jackin Nanua. "Effect of mastitis on raw milk compositional quality", Journal of Veterinary Science, 2007 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		

Effects of mastitis on milk production and composition in dairy cows

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5