ASSOCIATION BETWEEN BLOOD VARIABLES AND MILK SOMATIC CELLS COUNT IN DAIRY COWS

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Abstract

This study evaluated the association between blood variables and milk somatic cells count in dairy cows. Other possible effects of breed and age at calving on blood profiles were also investigated. It is known that greater concentrations of both non-esterified fatty acid (NEFA) and β-hydroxybutyrate (BHBA) have been associated with impaired immune functions and mastitis in dairy cows. Somatic cell count were considered as effective tools for mastitis control in dairy. Farmer get big losses were found due to mastitis, therefore the control of mastitis is needed. Many factors including health variables were investigated whether those health variables (plasma or serum) were associated with occurrence of high SCC or mastitis. The results showed that not only BHBA and NEFA, but also glucose, urea, insulin, protein, globulin, α-tocopherol direct and indirectly were associated with SCC and mastitis. Moreover, the concentration of antibodies (IgG) were associated with increasing levels of SCC. It seems that cows with improved energy balance indicated with high plasma glucose levels, low NEFA concentration had better immune profiles. This study suggest, immune profiles not only affected with SCC levels in milk but also energy status of the cows in early lactation.

Key words: Somatic Cell Counts (SCC), Plasma Glucose, Natural Antibodies (NAbs), dairy cows

INTRODUCTION

A dairy cow's mammary gland is especially susceptible to infection at lactation cessation and at the start of the next lactation. During transition period, high-yielding dairy cows often experienced severe negative energy balance, has high risk of metabolic disorders and infection diseases, oxidative stress, inflammation status and low immune status in early lactation [1, 2]. Therefore, there is extrapolation that infection diseases like mastitis are related with the consequences of negative energy balance, metabolic disorder, oxidative stress and low immune status. It is known that excessive lipolysis of the adipose tissue during negative energy balance results in high concentrations of non-esterified fatty acid (NEFA), which in turn induces oxidative stress and increased secretion of ketone bodies (e.g. β-hydroxybutyrate/BHBH) and thus suppresses immune and inflammatory responses[3].Many studies evaluated the associations between metabolic variables and immunological status during transition period, and udder health status measured as somatic cell counts (SCC) in milk [4].

Mastitis, is a major disease of dairy cattle caused by bacterial infection of the mammary gland. The greatest risks of intramammary infection occur at the end of lactation and at the initiation of the next lactation when the cow calves. Mastitis indicated by high SCC, affect the productive performance of dairy farms and it's a big problems for the farmers.

Sarikaya et al. (2006) suggested that the most important methods for assessing infection of bovine mammary glands are microbiological and SCC testing in milk. Somatic cell count offers a fast and reliable analytical tool. Heifers may have specific risk factors for high SCC compared with multiparous cows with respect to dry period, production level, and nutrition before calving [5]. Therefore, heifer mastitis may differ than mastitis in multiparous cows. Other studies reported that primiparous cows have a lower

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incidence of mastitis than older cows, but in early lactation they have higher risk of mastitis than older cows[4, 6].

It is known that the relationship between metabolic changes in early lactation, immune functions and infectious diseases like mastitis is not clear yet. A study reported that there were few associations among metabolites, immunological variables, and udder health of primiparous cows, but also that these variables differed between breeds and ages at first calving[4]. The objective of this study were to evaluated the potential blood variables related to metabolic and immunological status around calving, and its association with udder health measured as milk somatic cell counts (SCC).

MATERIAL AND METHODS

This study used secondary data from published articles. Literature study was conducted by searching literature using electronic database of Google Scholar (www.scholar.google.com). The database was chosen because it has high coverage rates of journals. Scientific articles were all written in English and Bahasa Indonesia. The search terms metabolic, dairy cows, SCC, mastitis, glucose, NEFA, immune status and parity. The keywords were typed on the advanced search or keywords were type in between two quotation mark (“). The word AND was used to combine the search. The search has not limited the year of publication, place of publication, and publisher.

RESULTS AND DISCUSSION

Maintenance of mammary gland health and activation of immune response requires energy and nutrients [7]. A previous study showed a negative relationship between BHBA plasma concentration before calving and SCC before calving [8]. This relationship may seem surprising, as higher concentrations of BHBA are usually thought to be associated with impaired immune functions and metabolic stress. This study speculated that this association were related with other factors, since the cows showed mild subclinical ketosis [8]. In the same study, we found a negative correlation between glucose and SCC. Low availability of glucose affect energy status which contribute to immune response. Glucose is the preferred substrate for lymphocytes, monocytes and neutrophils[9].

Beside glucose and BHBH, it has been shown that elevated NEFA concentrations were associated with high SCC. In immune perspective, the increase of NEFA concentrations were activate Toll-like receptors and their regulated signalling pathways involved in immune response[10]. Reduced intake of feed during mastitis raises metabolic load with an associated negative effect on the immune system [8].

Polymorphonuclear neutrophils (PMN) mainly reflect the increased SCC throughout mastitis [5]. PMNact as the firstline of immune-mediated defense against intramammary infection because this immune components can kill opsonized and nonopsonized bacteria usingbactericidal enzymes and oxygen derived free radicals. Thus, PMN also known as the most active phagocytic cell in milk[11].The increased percentage of macrophages and PMN in quarters with higher SCC is also reflected by high cytokine mRNA expression.

Natural antibodies (NAb) is also part of innate immune system. NAb has polyreactive antibodies that are present in non-immunized individuals which found to be associated with the occurrence of high SCC and mastitis[6]. SCC, is a very sensitive biomarker of mammary gland inflammation. Variations in SCC depend mainly on the recruitment of leukocytes from blood to tissue and finally to milk, most often in response to an inflammatory reaction elicited in the mammary tissue by the intrusion of bacteria into the mammary gland [12].

Increased proteins and globulin demonstrate an activation of immune response after mammary gland infection. Such proteins are mainly serum albumin and immunoglobulins involved in pathways of udder defense. In host immunity and inflammation, immunoglobulin plays an important role, and there is a link between total serum protein and the count of somatic cells in milk [13].

Factors that has also been shown to be significant for udder health is breed and age [4]. Other factors such as geography, bedding materials, and season are also affect the control of mastitis incidence.

Table 1 Association between plasma metabolites, immunological variables with somatic cell count

Reference	N	Variables	Relationship with SCC
Nyman et al. (2008)[4]	20 Swedish herd	BHBA	Negatif
		Glucose	Negatif
		A-tocopherol	Negatif
		NEFA	Positif
Gross et al. (2020)[8]	15 Holstein cows	BHBA	Negatif
		Glucose	Negatif
Mayasari et al. (2016)[14]	206 Holstein cows	Plasma IgG	Negatif
Matei (2010) [15]	120 Holstein cows	Serum Protein	Positif
		Globulin	Positif

CONCLUSION

In conclusion, concentrations of BHBA, NEFA, glucose, urea, insulin, protein, globulin, α-tocopherol are potential blood parameter to diagnose SCC and mastitis. Moreover, the concentration of antibodies (IgG) and PMN are health variables are important factors due to they regulate the levels of SCC. Cows with better energy balance and better immune profiles had less risk of incidence of high SCC and mastitis. Factors like age, breed, geography, material bedding are other important aspect to be considered in mastitis control.

REFERENCES

[1]. Sordillo, L.M., G.A. Contreras, and S.L. Aitken, Metabolic factors affecting the inflammatory response of periparturient dairy cows. Animal health research reviews, 2009. 10(1): p. 53.
[2]. Mayasari, N., et al., Effects of dry period length and dietary energy source on inflammatory biomarkers and oxidative stress in dairy cows. Journal of Dairy Science, 2017. 100(6): p. 4961-4975.
[3]. Suriyasathaporn, W., et al., β-Hydroxybutyrate levels in peripheral blood and ketone bodies supplemented in culture media affect the in vitro chemotaxis of bovine leukocytes. Veterinary Immunology and Immunopathology, 1999. 68(2-4): p. 177-186.
[4]. Nyman, A.K., et al., Metabolites and Immune Variables Associated with Somatic Cell Counts of Primiparous Dairy Cows. Journal of Dairy Science, 2008. 91(8): p. 2996-3009.
[5]. Santman-Berends, I.M.G.A., et al., Incidence of subclinical mastitis in Dutch dairy heifers in the first 100 days in lactation and associated risk factors. Journal of Dairy Science, 2012. 95(5): p. 2476-2484.
[6]. Barkema, H.W., et al., Incidence of Clinical Mastitis in Dairy Herds Grouped in Three Categories by Bulk Milk Somatic Cell Counts. Journal of Dairy Science, 1998. 81(2): p. 411-419.
[7]. Ingvartsen, K.L. and K. Moyes, Nutrition, immune function and health of dairy cattle. animal, 2013. 7(Supplements1): p. 112-122.
[8]. Gross, J.J., et al., Metabolic status is associated with the recovery of milk somatic cell count and milk secretion after lipopolysaccharide-induced mastitis in dairy cows. Journal of Dairy Science, 2020. 103(6): p. 5604-5615.
[9]. Pithon-Curi, T.C., M.P. De Melo, and R. Curi, Glucose and glutamine utilization by rat lymphocytes, monocytes and neutrophils in culture: a comparative study. Cell Biochemistry and Function: Cellular biochemistry and its modulation by active agents or disease, 2004. 22(5): p. 321-326.
[10]. Lee, J.Y., et al., Differential modulation of Toll-like receptors by fatty acids preferential inhibition by n-3 polyunsaturated fatty acids. Journal of lipid research, 2003. 44(3): p. 479-486.
[11]. Kimura, K., et al., Activation of immune cells in bovine mammary gland secretions by zymosan-treated bovine serum. Journal of dairy science, 2008. 91(5): p. 1852-1864.
[12]. Rainard, P., et al., Invited review: Low milk somatic cell count and susceptibility to mastitis. Journal of Dairy Science, 2018. 101(8): p. 6703-6714.
[13]. Pandey, P., V. Pandey, and J. Singh, Somatic cell count (scc) in relation to milk production, milk composition and subclinical mastitis: A review. International Journal of Cow Science, 2005. 1(1): p. 27-32.
[14]. Mayasari, N., et al., The effects of dry period length and dietary energy source on natural antibody titers and mammary health in dairy cows. Preventive Veterinary Medicine, 2016. 127: p. 1-9.
[15]. Matei, S.T., Serum metabolic parameters in healthy and subclinical mastitis cows. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Veterinary Medicine, 2010. 67(1).