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Effects of peripartal energy supply and nicotinic acid supplementation on functional activity and gene expression of blood leukocytes and on anti-oxidative enzyme activity in serum of periparturient dairy cows

Effekte der peripartalen Energieversorgung und einer Nikotinsäureergänzung auf die funktionelle Aktivität und Genexpression von Blutleukozyten und auf antioxidative Enzymaktivität im Serum von peripartalen Milchkühen

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The periparturient dairy cow is challenged with severe metabolic and immunological changes during the transition from late gestation into early lactation. This transition is accompanied by an immunosuppression that renders the animal more susceptible to infections and metabolic disorders. Non-esterified fatty acids (NEFA) and beta-hydroxybutyrate (BHB), which peak shortly after parturition due to lipolysis, are known to impair immune cell functions. The well-known anti-lipolytic activity of niacin may have the ability to ameliorate this situation. In addition, niacin shows also anti-inflammatory and anti-oxidative effects that may be beneficial to the immune status of the cow. The study was conducted to examine the influence of peripartal differing energy levels and nicotinic acid supplementation on the functional activity of blood immune cells and their effect on the expression of oxidative stress-related genes in these cells, as well as on anti-oxidative enzyme activities in the serum.

Methods: Four feeding groups were established with a total of 47 German Holstein cows (29 multi-parous and 18 primiparous). They were fed either with a ration with a high concentrate proportion of 60% (HC) or a low concentrate proportion of 30% (LC). After parturition both concentrate levels were reduced to 30% and increased again to 50% either within 16 days (LC-group) or within 24 days (HC-group) to trigger cow groups differing in postpartum predisposition for developing lipolysis related metabolic disorders. Half of the animals received either 24 grams per day of nicotinic acid (LC-NA, HC-NA) or none for the control groups (LC-CON, HC-CON). Supplementation was applied from 42 days prepartum until 24 days postpartum. The trial period started 42 days before expected parturition and ended at 100 days in milk. Oxidative burst activity of polymorphonuclear leukocytes (PMN) and phagocytic activity of PMN and peripheral blood mononuclear cells (PBMC) were examined with flow cytometry. Oxidative stress related genes glutathione peroxidase 1 (GPX1), superoxide dismutase 2 (SOD2), and xanthine dehydrogenase (XDH) were analyzed with quantitative real time PCR on total RNA from blood leukocytes. Additionally GPX and SOD activities were examined photometrically in serum. Statistical evaluation was done using the MIXED procedure of SAS.

Results: For all measured variables a time dependency was observed which was mainly related to parturition ($p<0.030$). Parity influenced all measured variables except of PMN phagocytosis. Gene expression levels for GPX1, SOD2 and XDH were higher in cows than in heifers ($p<0.020$). Oxidative burst stimulation was higher in heifers than in cows ($p=0.036$). Serum activity of GPX was higher in cows ($p=0.012$) and serum activity of SOD was higher in heifers ($p<0.000$). The percentage of phagocytizing PBMC was higher in cows ($p=0.041$). A concentrate effect was found for GPX serum activity ($p=0.029$) meaning the HC group showed increased GPX activity compared to the LC group. Nicotinic acid supplementation tended to increase PMN and PBMC phagocytosis ($p<0.100$).

Conclusion: We could confirm that parturition is a period of multifold changes with considerable impact on immune cell functional activity and gene expression as well as on anti-oxidative enzyme activity in the serum. Parity in this context plays an important role, since animals differing in age had different prerequisites and functional abilities to respond to the stressful period of parturition. In terms of feeding effects we observed some concentrate level effects on anti-oxidative enzyme activities and a tendency for increased phagocytosis of blood leukocytes with nicotinic acid supplementation. This nicotinic acid effect however showed no interaction with the concentrate level.

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