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THE INFLUENCE OF NEGATIVE CATION-ANION BALANCE IN COWS ON THE FREQUENCY OF MILK FEVER

Bartosz Kłos, Marta Kaliciak, Katarzyna Walkowiak, Maciej Adamski

Wrocław University of Enviromental and Life Sciences, Poland

Abstract. The experiment was performed on dairy cattle herds from two farms in Opole Province. The animals were in at least 75% Holstein-Friesians. During the dry period the cows were fed negative cation-anion balanced feed. Statistically important differences in frequency of milk fever were noticed between groups of animals fed the feed with and without anionic salts.

Key words: cation–anion balance, DCAD, DCAB, hypocalcaemia, milk fever

INTRODUCTION

The concentration of protein and energy in the feeding ration as well as balancing them are still a topical problem in animal nutrition, especially in nutrition of high yielding dairy cows. The obtainment of high milk yield requires the application of the feeding systems adapted to the respective phases of the production cycle [Łopuszańska-Rusek and Bilik 2007].

Apart from covering the nutritional requirements of cows with regard to energy components and protein, the proper mineral balance is very essential as well. In recent years more and more attention has been paid to the cation-anion balance which is also defined as DCAD (Dietary Cation-Anion Difference) or DCAB (Dietary Cation-Anion Balance) [Heron and Tremblay 2009, Hu and Kung 2009,

Corresponding author: Maciej Adamski, Institute of Animal Breeding, Wrocław University of Enviromental and Life Sciences, Chełmońskiego 38C, 51-630 Wrocław, Poland, e-mail: maciej.adamski@up.wroc.pl

Schonewille 2013, Goff and Liesegang 2014]. This term defines the reciproctal ratio of positively-charged (cations) and negatively-charged (anions) elements [Hu and Kung 2009]. It is about the ratio evaluation of cations (sodium, potassium) to anions (chlorine, sulfur), expressed as milliequivalent (mEq). Depending whether the predominant cations or anions is in feeding ration, the overall balance of minerals may be positive or negative [Mulligan et al. 2006, Patel et al. 2011, Kronqvist et al. 2012].

The animal's organism constantly aims to achieve the state of acid-base balance. Dosing the additives of negative ions (chlorine or sulfur) to the cow's feeding ration during the dry period initiates the acidification of the internal environment of the organism. It mobilizes the cow's organism to transformation aligning the acid-base state. It begins with the physiological mechanism of calcium releasing from the bones [Heron and Tremblay 2009, Goff and Liesegang 2014]. This is particularly important in preparing cows for calving, 3–4 weeks before the expected birth [Patel et al. 2011]. Even the best-balanced feeding ration is not able to cover the calcium requirements at the beginning of lactation, which is connected to the increased excretion of this component with milk [Kowalski 2012, Kronqvist et al. 2012]. However, calcium contained in the fodder along with calcium absorbed from the bones allow the cow for gentle transition through the specific period of increased requirement for this element. Excessively tardy activation of the bone demineralization significantly increases the probability of disorders associated to hypocalcemia, primarily the milk fever [Horst et al. 1997, Lean et al. 2006, Łopuszańska-Rusek and Bilik 2007, Ramos-Nieves and Thering 2009, Kronqvist et al. 2012, Smith 2012, Goff and Liesegang 2014, Martin-Theresa and Wijlen 2014]. This process should take place in the last phase of calving, not in the perinatal period.

Postnatal paralysis is a common problem in the dairy cattle herds worldwide, including Poland [Mulligan et al. 2006, Łopuszańska-Rusek and Bilik 2007, Ramos-Nieves and Thering 2009, Patel et al. 2011, Schonewille 2013, Martin-Theresa and Wijlen 2014]. It is a metabolic disorder of the cows occurring in the period of 10 hours before up to 24–72 hours after a parturition [Patel et al. 2011]. The etiology is not adequately understood yet. It is considered that the main cause of this disorder is an incorrect feeding of cows during their dry period [Łopuszańska-Rusek and Bilik 2007, Kowalski 2012, Kronqvist et al. 2012] as well as an increased requirement for calcium as a result of initiated lactation [Hu and Kung 2009, Ramos-Nieves and Thering 2009, Patel et al. 2011, Kronqvist et al. 2012 Oetzel and Miller 2012, Smith 2012, Zebeli et al. 2013]. As a result of mineral metabolism dysfunction, the disease might also be accompanied by: retained fetal membranes, displacement of abomasum, ketosis, or mastitis [Mulligan et al. 2006, Łopuszańska-Rusek and Bilik 2007, Patel et al. 2011, Kowalski 2012, Kronqvist et al. 2012]. This sort of situation is a consequence of the constantly increasing performance of cows in large-scale herds.

The required value of DCAD balance depends on the phase of the production cycle. During lactation, it is recommended to keep a positive balance at a low level, and slightly negative during the dry period [Mulligan et al. 2006, Kronqvist et al. 2012]. The presented study focuses only on the DCAD balance during the dry period as well as its impact on the occurrence of milk fever of cows from two farms.

MATERIAL AND METHODS

The experiment was performed on dairy cows herds from two farms in Opole Province. The animals had at least 75% genes of the Holstein-Friesian breed. Farm I managed a herd of 100 cows with an average yield of 10,000 kg of milk. In this herd the level of culling was 30%. Farm II kept 60 dairy cows with an average yield of 8000 kg of milk. The level of culling in this herd was 35%.

In either farm, the animals were divided in two groups – fed with rations including the addition of the salt anion and without them (Tables 1 and 2). For three weeks before calving cows were given fodder with a negative cation-anion balance. This balance was achieved by the addition of anionic salts (Blattin DCAB) adapted to the feeding rations used in the farms I and II. The preparation of the feeding ration and its appliance were prefixed by the calculations of current cation-anion balance. During the perinatal period, the animals were monitored.

In order to determine statistical differences between the groups of animals receiving fodder supplemented with anionic salt additives and fodder without them, we used Pearson's chi2 statistical test. The statistical test was performed by using the R-Project® software package.

RESULTS AND DISCUSSION

Statistically significant differences ($P \leq 0.05$) were observed between the two groups of animals fed with rations supplemented with anionic salts and without this additive. These differences were observed on the farm I as well as farm II (Table 3). In the farm I there were no cases of milk fever observed in a subgroup of cows fed with fodder containing the addition of anionic salts. Among the cows fed with ration not containing the salt additives the percentage of incidence was 48%. In case of farm II the percentage of cows suffering from this disorder was 5% in a subgroup of cows fed with fodder containing the anionic salt (with a negative cation-anion balance). However, in the subgroup of cows fed with fodder without salt addition (with a positive value of balance) rate was 65%.

Table 1. The feeding ration applied in farm I during the transitional period

Tabela1. Dawka pokarmowa stosowana w gospodarstwie I podczas okresu przejściowego

Component Komponent	Quantity, kg Ilość, kg	Cation–anion balance, mEq Bilans kationowo-anionowy, mEq
Corn silage Kiszonka z kukurydzy	15	1050
Haylage Sianokiszonka	8	1232
Beet–pulp Wysłodki	4	200
Grains Młóto	3	–50
Straw Słoma	2.5	300
Barley Jęczmień	2	–40
Rape seed extracted Śruta rzepakowa	1	–600
Sum – control group (N = 50) Suma – grupa kontrolna	35.5 (14.7 d.m.)	2092
DCAB (bitter salt) DCAB (sole gorzkie)	0.2	–2200
Sum – experimental group (N = 50) Suma – grupa eksperymentalna	37.7 (14.9 d.m.)	–108

Table 2. The feeding ration applied in farm II during the transitional period

Tabela 2. Dawka pokarmowa stosowana w gospodarstwie II podczas okresu przejściowego

Component Komponent	Quantity, kg Ilość, kg	Cation–anion balance, mEq Bilans kationowo-anionowy, mEq
Corn silage Kiszonka z kukurydzy	16	1120
Haylage Sianokiszonka	12	1848
Beet–pulp Wysłodki	5	250
Straw Słoma	2	240
Barley Jęczmień	1	–20
Rape seed extracted Śruta rzepakowa	0.5	–300
Sum – control group (N = 50) Suma – grupa kontrolna	36.5 (14.4 d.m.)	3138
DCAB (bitter salt) DCAB (sole gorzkie)	0.3	–3300
Sum – experimental group (N = 50) Suma – grupa eksperymentalna	36.9 (14.7 d.m.)	–162

Table 3. The frequency of incidence of milk fever in dependance of cation–anion balance

Tabela 3. Częstotliwość występowania zalegania poporodowego w zależności od bilansu kationowo-anionowego

Farm Gospodarstwo	Sort of feeding ration Rodzaj dawki pokarmowej	Value of cation–anion balance, mEq Wartość bilansu kationowo-anionowego, mEq	Frequency of milk fever, % Częstotliwość występowania zalegania poporodowego, %
I	Without anionic–salts Bez soli anionowych	2092	48 [A]
	With anionic–salts Z solami anionowymi	–108	0 [B]
II	Without anionic–salts Bez soli anionowych	3138	65 [A]
	With anionic–salts Z solami anionowymi	–162	5 [B]

A, B – statistically significant differences ($P \leq 0.05$).
A, B – różnice statystycznie istotne ($P \leq 0,05$).

The experiment confirmed the results obtained by Lean et al. [2006] as well as Goff et al. [2014]. It denoted that the negative cation-anion balance during the dry period positively effects the decrease of incidence of postpartum retention. The increased amount of accessible calcium before lactation, present in the animal's organism, largely prevents the cows against the occurrence of milk fever. DCAD balance during the cow's dry period should reach the range of –100 up to –200 $mEq \cdot kg^{-1}$ of dry matter feed [Mulligan et al. 2006].

Negative DCAB might be achieved by using a feeding additive in the form of the anionic salt, such as magnesium sulfate, calcium sulfate, ammonium sulfate, calcium chloride, magnesium chloride, ammonium chloride [Łopuszańska-Rusek and Bilik 2007, Patel et al. 2011]. It is the most effective way to achieve the negative cation-anion balance of the feeding ration. There is also the concept of reducing the percentage of incidence of postpartum retention in dairy cowsherds by decreasing the supply of potassium in the feeding ration, while negative DCAB [Mulligan et al. 2006]. The increasing of the potassium concentration in the fodder may result in an increase of incidence of hypocalcemia [Patel et al. 2011].

CONCLUSIONS

The increased amount of calcium in a blood during the calving prevents postpartum retention. It is one of the most expensive metabolic diseases of the cows. The cows receiving the feeding rations with a negative cation-anion balance in the final period of their dry have a high level of calcium in the blood. This affects both the health status of the animals and the high yielding results. The use of an appropriate dairy cows feeding systems on particular stages of the production cycle affects the animals' productivity and farm's economy. In balancing rations for dairy cows there should paid a special attention to the mineral mixture taking into account the cation-anion balance.

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WPŁYW UJEMNEGO BILANSU KATIONOWO-ANIONOWEGO U KRÓW NA CZĘSTOTLIWOŚĆ WYSTĘPOWANIA ZALEGANIA POPORODOWEGO

Streszczenie. Doświadczenie przeprowadzono u krów mlecznych w stadach pochodzących z dwóch gospodarstw na terenie Opolszczyzny. Badane zwierzęta charakteryzowały się co najmniej 75% udziałem genów rasy holsztyńsko-fryzyjskiej. Krowom w okresie zasuszenia podawano pasze o ujemnym bilansie kationowo-anionowym. Stwierdzono istotne różnice w częstości występowania porażenia poporodowego pomiędzy grupami zwierząt żywionymi paszami z dodatkiem soli anionowych oraz bez nich.

Słowa kluczowe: bilans kationowo-anionowy, DCAD, DCAB, hipokalcemia, porażenie poporodowe.

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