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INFLUENCE OF FEEDING SYSTEM ON MINERAL PROFILE OF CHAROLAISE BREED COWS BLOOD

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Abstract. The aim of the study was an assessment of macro- and microelements level in blood serum of Charolaise breed cows with a change of feeding system from organic to indoor one, when supplementary mixtures (mineral-vitamin) were introduced. Thirty two cows of Charolaise breed were selected for the experiment. The study included 2 periods taking into account final period of organic feeding system (1st period) and 6 months of indoor feeding with mineral supplements (2nd period). Blood for laboratory analysis was collected at the end of organic system feeding and after 6 months where mineral additives were used. Comparing both research periods, small decrease in Na and K content was noted in the 2nd period when compared to the beginning of the study. An increase in Fe concentration was observed in 2nd period of the study when compared to the 1st one. The differences between research period were not confirmed statistically. Also slight increase in Cl, Ca, Mg and P concentration was noted in the 2nd period of the study compared to the 1st period.

Key words: blood serum, Charolaise, feeding, mineral elements

INTRODUCTION

Monitoring of herd health status is of a large significance in prevention of diseases and contributes to an improvement in economic indices in cows breeding [Mordak and Nicpoń 2006]. Laboratory examinations are an important part of this monitoring, and occurring deviations may prove disorders of homeostatic equilibrium in an organism. In problematic herds they are sometimes the only tool for detection of metabolic disorders of subclinical course. They are also a help in an assessment of an effectiveness of introduced reconstructive changes. Determining particular

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blood parameters in clinically healthy animals, taking into account their breed, physiological status, production yield and feeding system, it is possible to obtain important information useful in interpretation of the results of animals exhibiting disease symptoms [Kupczyński et al. 2008]. Metabolic profile of blood may be also used in an assessment of nutrition correctness [Kowalski 2008].

Nutritional mistakes are a reason of organism homeostasis disorders, lead to metabolic diseases and diseases connected to deficiency or excess of given elements, decrease milk yield and cause reproductive disorders [Barszcz et al. 2009]. Full coverage of nutritional requirements of cows is a condition not only of high production level, but good health status as well. In this aspect, mineral-vitamin balance is equally important as energy-protein balance.

Mineral deficiencies and metabolic disorders occurring in cow herds are recognized based on the whole set of diagnostic examinations. Performance of laboratory examinations in the range of mineral elements determination in cow blood is not common practice, especially in the range of trace elements [Mordak 2008]. Levels of particular parameters in blood serum depends on numerous factors such as: species, breed, gender, age, maintenance conditions, as well as physiological state and nutrition system.

Determination of mineral elements content in blood faces a large interest from breeders, veterinarians, fodder companies side. However, large part of mineral components contained in blood are subject to a considerable degree of homeostasis processes [Saba et al. 2000]. An example may be Ca, which level in blood depends on hormonal management, and also on an influence of cationic-anionic balance of a dose.

The aim of the study was an assessment of an influence of a change of feeding system from organic (end of pasture season) to intense one with an introduction of mineral supplements (indoor) on a level of macro- and microelements in blood serum of Charolaise breed cows.

MATERIAL AND METHODS

The study was conducted in Research – Didactic Station in Radomierz belonging to Wroclaw University of Environmental and Life Sciences, where a herd of 110 cows of Charolaise breed is maintained. In an organic breeding during pasture feeding (1st period of the study) the animals had an access to Lysal licks containing only sodium and chlorine, they were provided in amount of 5 pcs (10 kg each) for the whole period of this system maintenance. The cows used natural water courses. Pastures were not fertilized with minerals for a period of 15 years. In winter period (2nd stage of the study) when the animals stayed in a cowshed they were fed with silage originating from meadows belonging to the farm and R–277–PB433 X supplementary mixture (Provimi Poland). The cows had a constant access to water in drinkers. Universal supplementary mixture Crysta Lyx Standard (Blattin) and mineral supplements Lysal and Multi Lysal Se were also introduced from the moment of animals moving to the cowshed. Mineral supplements were used up to the moment of end of indoor feeding. Composition of mineral supplements used in both periods of feeding (organic and indoor) are presented in Tables 1, 2 and 3.

Table 1. Composition of Lysal and Multi Lysal Se mineral supplements

Tabela 1. Skład dodatków mineralnych Lysal i Multi Lysal Se

Mineral compounds – Związki mineralne	Lysal	Multi Lysal Se
Sodium – Sód (Na)	374 g · kg^{-1}	370 g · kg^{-1}
Chlorine – Chlor (Cl)	576 g · kg^{-1}	570 g · kg^{-1}
Magnesium – Magnez (Mg)	–	2 g · kg^{-1}
Copper – Miedź (Cu)	–	–
Cobalt – Kobalt (Co)	–	18 mg · kg^{-1}
Zinc – Cynk (Zn)	–	0.8 g · kg^{-1}
Manganese – Mangan (Mn)	–	0.8 g · kg^{-1}
Iodine – Jod (J)	–	10 mg · kg^{-1}
Selenium – Selen (Se)	–	13 mg · kg^{-1}

Table 2. Composition and energetic value of Crysta Lyx Standard supplement

Tabela 2. Skład i wartość energetyczna dodatku Crysta Lyx Standard

Specification – Wyszczególnienie	Content – Zawartość
Raw protein – Białko surowe	3.00%
Fibre – Włókno	0.00%
Fat – Tłuszcz	2.50%
Ash – Popiół	40.00%
Calcium – Wapń	3.50%
Phosphorus – Fosfor	1.50%
Sodium – Sód	4.50%
Magnesium – Magnez	5.00%
Manganese (manganese oxide) – Mangan (tlenek manganu)	3.000 mg
Zinc (zinc oxide) – Cynk (tlenek cynku)	3.000 mg
Copper (copper sulfate, pentahydrate) – Miedź (siarczan miedziowy, pentahydrat)	1.000 mg
Iodine (calcium iodide) – Jod (jodek wapnia)	300 mg
Cobalt (cobalt carbonate monohydrate) – Kobalt (jednowodorowy węglan kobaltu)	30 mg
Sodium selenite – Selenit sodowy	20 mg
Vitamin A – Witamina A	75.000 I.E · kg^{-1}
Vitamin D_3 – Witamina D_3	7.500 I.E · kg^{-1}
Alpha-tocopheryl acetate (Vit. E) – Alpha, Tocopherolacctat (wit. E)	600 mg · kg^{-1}
NEL – NEL	5.80 MJ · kg^{-1}
ME – ME	9.00 MJ · kg^{-1}

The strict experiment included 32 cows with a division onto 2 periods: cows in their final period of feeding with organic system (1st period of the study) and cows in analogical age and physiological state after 6 months of indoor feeding with an addition of mineral supplements (2nd period of the study). The animals were randomly selected for the study. Half of the individuals were primiparous, and the rest multiparous cows (from 3rd to 5th lactation). The animals did not exhibit any disease symptoms nor clinical changes pointing mineral management disturbances.

Table 3. Composition and nutritional value of R–277–PB433 X supplementary mixture for cows and young cattle

Tabela 3. Skład w wartość pokarmową mieszanki uzupełniającej dla krów i młodzieży hodowlanej R–277–PB433 X

Specification – Wyszczególnienie	Content, % – Zawartość, %
Calculated crude protein – Białko ogólne kalkulowane	6.00
Guaranteed crude protein – Białko ogólne gwarantowane	15.00
Raw fibre – Włókno surowe	9.00
Raw ash – Popiół surowy	5.7–7.7
Raw fat – Tłuszcz surowy	2–4
Ca	0.70
P	0.50
Na	0.40
Mg	0.50
JPM	0.86
BTJP	3.60
BTJN	10.20
BTJE	8.90

JPM – unit of milk production – jednostka produkcji mleka.
BTJP – protein reaching small intestine – białko docierające do jelita cienkiego.
BTJN – protein digested in small intestine (nitrogen in rumen is a limit) – białko trawione w jelicie cienkim (limitem jest azot w żwaczu).
BTJE – protein digested in small intestine (energy in rumen is a limit) – białko trawione w jelicie cienkim (limitem jest energia w żwaczu).

First blood samples were collected at the end of feeding with organic system (1st period of the study). The second sampling was conducted from cows after 6 months during which mineral additives were used (2nd period of the study). Blood for the analysis was collected from the cows from external jugular vein. After serum centrifugation, the material was frozen at –20°C up to the time of laboratory analysis. Examinations were performed using Pentra 400 analyzer (Horiba ABX). The following parameters were examined in blood serum:

- Ca using photometric method with ortho-cresolphthalein complexone application (Ca Cat. No. A11A01633),
- inorganic P using UV method with phosphomolybdate (Cat. No. A11A01665),

- Mg using photometric method with an application of xylidyl blue (Cat. No. A11A01646),
- Fe using photometric method with pherene (Cat. No. A11A01637),
- Na, K and Cl using ISE; three ionoselective electrodes with separate membranes were used.

The obtained results of laboratory examinations were analyzed statistically taking into account means and standard deviations using Statistica 8.0 software. Differences between means for particular parameters in both periods were examined based on linear model:

$$Y_{ijklm} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij}$$

where: μ – general mean for a given feature,
α_i – feeding period,
β_j – age of cows (primiparous, multiparous),
$\alpha\beta_{ij}$ – random residual effect.

Significance of differences between the means was determined with Duncan's test.

RESULTS AND DISCUSSION

The results of analysis of particular elements content in blood serum of examined cows are presented in Table 4.

Analyzing the results of the study from the 1st period it was observed that concentrations of Na (140.49 mmol $\cdot$ l^{-1}), K (4.33 mmol $\cdot$ l^{-1}), Cl (107.16 mmol $\cdot$ l^{-1}), Mg (0.84 mmol $\cdot$ l^{-1}), P (1.93 mmol $\cdot$ l^{-1}) were within the limits of proper values [Winnicka 2004]. In case of Ca concentration, its mean value was 2.06 mmol $\cdot$ l^{-1}, so it was below a lower limit of physiological value for adult cattle, which is 2.25–3.03 mmol $\cdot$ l^{-1} [Winnicka 2004]. Fe concentration in animals at the 1st period of the study reached a value of 18.91µmol $\cdot$ l^{-1} and was considerably below reference values (21.50–38.50 µmol $\cdot$ l^{-1}) [Winnicka 2004]. Low level of Fe was particularly visible in primiparous cows (17.6 µmo $\cdot$ l^{-1}).

In the 2nd period of the study after change of pasture feeding on silage with an addition of supplementary fodders and mineral additives, a small decrease in a concentration of Na (137.23 mmol $\cdot$ l^{-1}) and K (4.29 mmol $\cdot$ l^{-1}) was noted when compared to the 1st period of the study. Despite decrease in both elements concentration, the results obtained were within the reference values limits [Winnicka 2004]. The level of Cl reached a value of 109.16 mmol $\cdot$ l^{-1}, which exceeded reference value described in the standards (93.10–107.20 mmol · l^{-1}) [Winnicka 2004]. Small increase when compared to the 1st period of the study was noted when analyzing concentration of Mg (0.96 mmol · l^{-1}) and P (1.99 mmol · l^{-1}). In case of Ca (2.10 mmol · l^{-1}) and Fe (21.07 µmol · l^{-1}), also an increase in these elements content was noted with respect to the 1st period of the study. Despite observed increase in both elements concentration, the values obtained were below physiological standards [Winnicka 2004]. In spite of some fluctuations in examined elements concentration in both periods of the study, the differences were not confirmed statistically.

Table 4. Content of macro- and microelements in blood serum at the 1st and 2nd period of the study

Tabela 4. Zawartość makro- i mikroelementów w surowicy krwi w I i II okresie badań

Groups Grupy		Calcium Wapń mmol · l^{-1}	Magnesium Magnez mmol · l^{-1}	Phosphorus Fosfor mmol · l^{-1}	Sodium Sód mmol · l^{-1}	Potassium Potas mmol · l^{-1}	Chlorine Chlor mmol · l^{-1}	Iron Żelazo mmol · l^{-1}
I – W	$\bar{x}$	2.07	0.89	1.91	140.78	4.27	107.84	20.19
	SD	0.13	0.06	0.25	1.57	0.26	2.01	5.76
I – M	$\bar{x}$	2.05	0.79	1.95	140.20	4.40	106.5	17.6
	SD	0.10	0.06	0.35	1.85	0.51	2.66	5.02
In total		2.06	0.84	1.93	140.49	4.33	107.16	18.91
Razem		0.12	0.08	0.30	1.70	0.40	2.40	5.42
II – W	$\bar{x}$	2.11	0.98	1.90	139.7	4.44	111.02	20.42
	SD	0.27	0.082	0.31	4.69	0.59	3.46	4.47
II M	$\bar{x}$	2.09	0.95	2.08	134.75	4.13	107.3	21.72
	SD	0.27	0.10	0.37	7.48	0.40	7.67	6.75
In total		2.10	0.96	1.99	137.23	4.29	109.16	21.07
Razem		0.26	0.09	0.34	6.49	0.51	6.00	5.50

1st period of the study – end of pasture feeding (organic system), 2nd period of the study – end of indoor feeding with introduction of supplements. D – multiparous cows (2–5 lactations), M – primiparous cows.
I okres badań – koniec żywienia pastwiskowego (system ekologiczny), II okres badań – koniec żywienia alkierzowego, w którym wprowadzono dodatki uzupełniające. D – krowy wieloródki (2–5 laktacji), M – pierwiastki.

In the study of Brucka-Jastrzębska et al. [2007] conducted on a group of pregnant cows of Simmental breed, the level of electrolytes (Na, K and Cl) in blood was within the standard limits determined for cattle [Winnicka 2004], on a similar level like in the present study. Proper level of electrolytes in body fluids ensures suitable osmotic pressure, regulates water management and affects reactivity of tissues. Occurrence of electrolytes deficiency in blood of pregnant cows is the most often a reason of perinatal disorders and may affect an increase in a number of dead born calves [Brucka-Jastrzębska et al. 2007]. Based on the study conducted by Martyna et al. [2006] on cows of black-white breed with various contribution of Holstein-Friesian genes, the level of Na in an experimental group from farm A was 140.6 mmol · l^{-1}, while in the experimental group from farm

B it was 148.3 mmol $\cdot$ l^{-1}. K level was as follows: farm A 4.39 mmol $\cdot$ $l^{-1}$and farm B 4.48 mmol $\cdot$ l^{-1}. Experimental factor in the cited study was mineral mixtures. In the present study, an application of an increased supply of macro- and microelements did not influence distinctly electrolytes management in cows.

In the study of Kurek and Stec [2005] conducted on a group of cows of PBW, HF breeds and their crossbreds aged from 2.5 to 10 years, the level of Na in the whole experimental period was within the standard limit, while concentration of K was in a lower limit of a standard or slightly exceeded it. Lower values were noted in younger animals. Similar relationships were noted in the second period of the present study. Other study points that electrolyte management depends to a high degree on lactation phase [Mordak and Nicpoń 2006].

It may be concluded from the present study (2nd feeding period) that despite an application of feed and mineral supplements rich in Ca, its concentration pointed a deficiency of this macroelement in blood was 2.10 mmol $\cdot$ l^{-1}, while proper values demonstrated higher Ca content (2.25–3.03 mmol $\cdot$ l^{-1}), [Winnicka 2004]. Lowering in total Ca and P level in extracellular fluids is a direct reason of hypocalcemia development. The risk of hypocalcemia occurrence depends on breed of cows and subsequent lactation. It results from the present study, that small increase in the content of Mg (0.96 mmol $\cdot$ l^{-1}) and P (1.99 mmol $\cdot$ l^{-1}) was noted after mineral supplements application. Also in the study of Brzóska et al. [1996] concentration of Mg, Ca and P in blood serum of Polish red-white breed cows increased after supplementation with magnesium oxide and dolomite. However, no significant influence of chemical form of magnesium on the level of magnesium and other mineral elements in blood serum was noted with this kind of supplementation.

Fe deficiency in adult ruminants occurs very rarely and in practice concerns only pathological states [Kupczyński et al. 2009]. Roughage used in ruminants feeding are abundant in iron. Supplementation used in the present study caused an increase in Fe concentration in blood serum of primiparous cows, in which the content of this element in blood was very low at the 1st period of the study. An occurrence of sideropenia, and resulting from it anemia, should be taken into account in a course of long-lasting inflammatory states [Ganz 2003]. However, the animals in the present study were clinically healthy. An increase in iron demand is observed physiologically between 5th and 7th month of pregnancy [Underwood and Shuttle 1999].

Iron requirement of a calf is 100 mg $\cdot$ kg^{-1} DM, and in beef cattle and cows about 50–70 mg $\cdot$ kg^{-1} DM (oilseed plants meals contain it 100–200 mg $\cdot$ kg^{-1} DM). About 100 mg $\cdot$ kg^{-1} DM of iron is contained in barley and maize grain, and 140 mg $\cdot$ kg^{-1} DM in wheat [Underwood and Shuttle 1999]. The content of

Fe in pasture grass may reach 260 mg · kg^{-1} DM and 350 mg · kg^{-1} DM in herbs. However, the content of this element in grasslands may be very variable (from moderate to very high). Such a situation occurred probably in the present study.

CONCULUSIONS

1. Observed in the present study differences in the range of concentration of selected macro- and microelements in blood serum between pasture period (organic system) and indoor one (mineral supplements introduction) were not confirmed statistically.
2. Utilization of mountain pasture by the cattle enables maintenance of blood electrolyte homeostasis.
3. After the end of pasture feeding, Na and K concentration in blood serum in primiparous cows was more even when compared to indorr period.
4. An application of Cysta Lyx and Lysal mineral mixture in feeding of Charolaise breed cows caused a slight increase in Ca, Mg, P, Fe concentration in blood serum. An application of supplementation profitably influenced Fe content in blood serum of primiparous cows.

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WPŁYW ZMIANY SYSTEMU ŻYWIENIA NA PROFIL MINERALNY KRWI KRÓW RASY CHAROLAISE

Streszczenie. Celem badań była ocena kształtowania się poziomów makro- i mikroelementów w surowicy krwi krów rasy Charolaise przy zmianie systemu żywienia z ekologicznego na alkierzowy, podczas którego wprowadzono mieszanki uzupełniające (mineralno-witaminowe). Do doświadczenia wybrano 32 krowy rasy Charolaise. Badaniami objęto 2 okresy, biorąc pod uwagę końcowy okres żywienia systemem ekologicznym (I okres) oraz po 6 miesiącach żywienia alkierzowego z dodatkami mineralnymi (II okres). Krew do analiz laboratoryjnych została pobrana pod koniec okresu żywienia systemem ekologicznym oraz po 6 miesiącach, podczas których stosowane były dodatki mineralne. Porównując oba okresy badań stwierdzono w II okresie niewielki spadek w zawartości Na i K w porównaniu z początkiem badań. W II okresie badań odnotowano wzrost stężenia Fe w porównaniu z i okresem. Różnice pomiędzy okresami badań nie były potwierdzone statystycznie. W II okresie badań zaobserwowano także niewielki wzrost stężenia Cl, Ca, Mg i P w porównaniu z okresem I.

Słowa kluczowe: Charolaise, surowica krwi, związki mineralne, żywienie

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