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Short communication

Influence of season and breed on serum mineral levels in sheep

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Abstract

The main objective of this study was to assess the concentration of various minerals (Ca, P, Mg, Cu, Zn, Fe) in the blood of sheep, followed by biochemical analysis in order to reveal possible associations of season and breed. The study was conducted by sampling four herds: Suffolk (n=20), Merino (n=20), Lithuanian blackhead (n=20) and Charolaise (n=7). The first blood collection was conducted in April and the last one was performed in February. The highest level of Ca was estimated in Suffolk ewes, lowest (12.61%) in Merino breed; the highest Mg content was found in Lithuanian blackhead breed, lowest (5.26%) in Charolaise; highest P content was determined in Merino, lowest (24.18%) in Suffolk breed ($p<0.05$). Evaluation of the biochemical parameters during different seasons showed a possible environmental effect on the health of the animals. The difference among minerals content showed the highest level in Ca, Mg, Fe in the autumn, P - in the summer, Cu and Zn - in the winter. The lowest differences between seasons were observed in content of Mg (1.24-4.03% from total average of all seasons) and Ca (0.59-8.18%), the highest – in Cu (2.52-18.36 %) and Zn (4.33-24.33%) ($p<0.05$). The significance of this work is the possible use of the data in the prevention of metabolic and production diseases.

Keywords: sheep, breed, minerals, biochemistry, season

Introduction

Mineral needs of animals are different in the period of physiological degrees, season and breed. It is an important variable in the assessment of adaptive and productive capacity of breeds under unfavorable environmental conditions (Bezerra et al. 2017). According Macías-Cruz et al. (2015) in warm and dry summer seasons with temperatures ≥40°C with little rainfall, the remaining seasons are generally thermo neutral (i.e., autumn, spring) or slightly cold (i.e., winter). Thus, the heat stress conditions prevailing during summer becomes a key factor that usually leads to low productivity of sheep flocks. Earlier investigation has found that there are sheep breeds more adapted than others to hot conditions and has demonstrated

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the ability to grow and reproduce in any season in arid climates (Marai et al. 2007). Determination of blood parameters profile is used for evaluating the individual health conditions and monitoring the nutritional and metabolic conditions of the animals (Kaneko et al. 2008). Metabolic profiles have been used to predict postpartum metabolic problems, and for the diagnosis of metabolic diseases and the assessment of nutritional status of animals (Gwaze et al. 2012). According Kovacik et al. (2017) season and environment can affect concentrations of minerals. Establishment of mineral variations in different seasons would be helpful in interpretation of mineral concentrations for various sheep breed. Therefore the aim of this study was to determine blood serum mineral parameters and possible differences between sheep breeds and seasons.

Materials and Methods

The experiment was conducted from 2018 April until 2019 February in four regions of Lithuania. The present study used 67 adult (3 years), not pregnant, clinical healthy sheep (an average rectal temperature of +38.5°C, rumen motility four–five times per two minutes, without signs of any diseases) of four different breeds: Suffolk (n=20), Merino (n=20), Lithuanian blackhead (n=20) and Charolaise (n=7), keeping in similar conditions. This work was carried out under two different feeding systems which are stable-diet (indoors) and grazing (outdoors). Grazing season starts at April until October. Pastures were predominantly grasses, legumes, tree leaves. In addition, all sheep on the farms had the same access at all time to a free choice complete mineral mixture. During the winter, the ewes were kept in stables and fed diets formulated to cover their nutrient requirements. All sheep got the same feeding ration. Average temperature during experimental year was 10.5±1ºC, relative humidity 77.6±2 %. The climate of the country is transitional between the maritime type of Western Europe and characterized by warm, dry summers and fairly severe winters. Blood samples were collected at 7:00h to 8:00h after overnight fasting by jugular venipuncture, using vacuum tubes without the anticoagulant. Blood samples were taken one time per month from the same animals. Blood biochemical parameters calcium (Ca), phosphorus (P), magnesium (Mg), copper (Cu), zinc (Zn), iron (Fe) were determined by using specific commercial kits and automatic analyzer Selectra Junior (Netherlands, 2006). In the present study, the blood parameters of the tested animals were analysed using IBM SPSS Statistics (version 20.0, IBM, Munich, Germany). Distributions of the continuous traits were assessed according to the Kolmogorov-Smirnov test. The descriptive statistics for blood parameters was presented as mean ± standard error (M ± SE). The results were considered to be reliable under p level <0.05. This work followed all ethics principles involving animals in the research. Study approval number – PK014606.

Results and Discussion

Dietary mineral concentrations are often quantified but do not equate directly to animal status (Ademi et al. 2017). Total plasma Ca is affected by total plasma protein concentration. Approximately 45–50% of the total plasma Ca is bound to plasma proteins (Srikandakumar et al. 2003). It was similar in our study results. The highest level of Ca was estimated in Suffolk ewes, lowest (12.61%) - in Merino breed. The highest Mg content was in Lithuanian blackhead breed, lowest (5.26%) in Charolaise. Highest P content in Merino, lowest (24.18%) – in Suffolk breed ($p<0.05$). According to McDowell (1992), P average concentrations are depending on the breed and age of the animals, and P plasma concentrations are influenced by the Ca levels. The average Fe level varied from the lowest in Suffolk breed (135.48±3.405 µg/dl) to 10.27% highest in Merino breed. A significant difference between breeds was found analyzing Cu level in blood serum. Cu content varied from 116.35±5.271 µg/dl in Charolaise ewes to 30.22 % highest in Merino breed ($p<0.05$). Differences in Cu accumulation have often been described in other breeds (Ortolani et al. 2011). The Cu concentrations were closely correlated with Zn levels in the liver. Cu deficiency was found in animals exposed to high dietary levels of Zn (Minervino et al. 2018). The present study showed a 22.76% higher rate of Zn content in native Lithuanian blackhead breed compared to Merino breed ($p<0.05$) (Table 1); it can be a reason that Merino breed have the highest level of Cu. Another study was conducted on the mineral status of sheep in three different regions of Jordan. Results indicated that Cu plasma level in sheep was normal in the three regions. On the other hand, Zn plasma level at Al-Khanasry and Madaba regions was marginal, in spite of the fact that feedstuffs introduced or grazed by the animals in these areas had high Zn level (White et al. 1995). The study showed significant and consistent seasonal variations in blood serum levels of minerals (Table 2). The lowest differences between seasons were observed in content of Mg (1.24-4.03%) and Ca (0.59-8.18%), the highest – in Cu (2.52-18.36 %) and Zn (4.33-24.33%) ($p<0.05$). P level was found to be significantly higher in summer (1.79) and significantly lower in winter (1.65). The results of serum P level are in agreement that found by Yokus et al. (2005), who reported

Table 1. Blood minerals in sheep by breed.

Breed		Ca mmol/l	Mg mmol/l	P mmol/l	Fe µg/dl	Cu µg/dl	Zn µg/dl
Lithuanian blackhead	M	2.63^{a}	0.80^{a}	1.87^{a}	144.87^{ab}	116.81^{a}	200.95^{a}
	SE	0.032	0.009	0.037	3.511	3.381	12.994
Merino	M	2.38^{b}	0.78^{ab}	1.90^{ab}	149.39^{a}	151.51^{b}	163.70^{b}
	SE	0.028	0.009	0.054	3.932	14.319	3.409
Suffolk	M	2.68^{ac}	0.79^{ab}	1.53^{c}	135.48^{b}	122.40^{a}	174.76^{b}
	SE	0.027	0.007	0.026	3.405	2.627	2.360
Charolaise	M	2.56^{ad}	0.76^{b}	1.72^{d}	136.98^{ab}	116.35^{a}	187.98^{ab}
	SE	0.037	0.010	0.055	5.070	5.271	2.878
Total	M	2.57	0.79	1.74	141.86	127.43	181.07
	SE	0.016	0.004	0.022	1.937	3.967	3.905

^{a,b,c,d} Values within a column with different superscripts differ significantly at $p<0.05$. Ca – Calcium; P – phosphorus; Mg – magnesium; Cu – copper; Zn – zinc; Fe – iron.

Table 2. Serum minerals content in sheep by season.

Season		Ca mmol/l	Mg mmol/l	P mmol/l	Fe µg/dl	Cu µg/dl	Zn µg/dl
Winter	M	2.55^{a}	0.80^{a}	1.65^{a}	149.88^{a}	145.49^{a}	225.12^{a}
	SE	0.029	0.011	0.046	6.642	4.429	32.476
Spring	M	2.36^{b}	0.76^{b}	1.69^{a}	129.03^{b}	104.04^{b}	159.11^{b}
	SE	0.030	0.011	0.043	3.266	3.442	2.300
Summer	M	2.64^{a}	0.77^{b}	1.79^{a}	137.61^{ab}	141.07^{a}	173.02^{bc}
	SE	0.032	0.007	0.041	2.972	9.505	2.814
Autumn	M	2.66^{a}	0.81^{a}	1.77^{a}	151.79^{c}	124.22^{ab}	188.91^{c}
	SE	0.025	0.007	0.040	3.706	6.666	2.147

^{a,b,c} Values within a column with different superscripts differ significantly at $p<0.05$. Ca – Calcium; P – phosphorus; Mg – magnesium; Cu – copper; Zn – zinc; Fe – iron.

the seasonal variation in serum inorganic phosphate level, with higher values obtained in September than in March. The increased inorganic phosphate concentration is probably due to the increased intake and increased absorption in the gastrointestinal tract (Devgun et al. 1981). The results of serum Ca, Mg, Fe were significantly higher in autumn. However, seasonal effect on blood Ca was reported with the lowest level observed in summer in sheep (Yokus et al. 2005). According to this study serum levels of the minerals in sheep showed significant and consistent seasonal and breed variations.

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