

MINERAL CONTENT OF MILK FROM DAIRY SHEEP BREEDS**Tanja Ivanova¹, Nikola Pacinovski², Emilija Raicheva¹, Desislava Abadjieva¹**¹*Institute of Animal Science, Kostinbrod, Bulgaria*²*“Ss. Cyril and Methodius“ University in Skopje, Institute of Animal Science,
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The aim of the present study was to determine the mineral content of milk from three dairy populations of sheep: the synthetic population Bulgarian milk, the East-Friesian and the Awassi breeds. 97 sheep of the Synthetic population Bulgarian milk in the IAS (Institute of Animal Science) – Kostinbrod, Bulgaria, 92 sheep from the East-Friesian breed and 67 sheep from the Awassi breed in the IAS (Institute of Animal Science) – Skopje, Macedonia, were investigated. The milk samples were taken and analyzed on every 20-th day, during a period of 100 days (the Spring inc. both raised indoors and in pasture for the Synthetic population Bulgarian milk and the Awassi, but the East-Friesian breed was raised only indoors). The contents of major elements calcium (Ca) and phosphorus (P) were determined in IAS – Kostinbrod by the colorimetric method with the mixed fuel gauge for calcium and on the base of the reaction to $\text{PO}_4^{(-3)}$ by $(\text{NH}_4)_2\text{MoO}_4$ for phosphorus. The trace elements content – lead (Pb), cadmium (Cd), arsenic (As), copper (Cu), iron (Fe) and manganese (Mn) was determined by the Atom Absorbing System in the Central laboratory of veterinary – Sanitary investigation and ecology, Sofia, Bulgaria. The ratio of calcium and phosphorus was accounted. The data were calculated by variation statistic methods by the computer programme Excel 2003. The contents of calcium and phosphorus in the milk of the sheep of the Synthetic population Bulgarian milk (150 mg/100 g, and 125.78 mg/100 g), the East-Friesian (155.8 mg/100 g and 150.29 mg/100 g) and the Awassi (139.4 mg/100 g and 163.95 mg/100 g) were established. The ratio Ca : P was in the optimum borders for the milk sheep of the Synthetic population Bulgarian milk and the East-Friesian breed (1.19 and 1.05) and it was lower for the Awassi breed (0.85). The established content of trace elements in the milk from the studied breeds is lower than the permissible one for the raw sheep milk. The obtained results for the mineral content of the sheep milk from the three breeds, breeding in the different areas of the Balkan, characterized it as an appropriate raw material for the production of dairy products that are healthful for the human milk products.

Key words: dairy sheep; mineral content; major elements; trace elements**СОДРЖИНА НА МИНЕРАЛИ ВО МЛЕКО ОД МЛЕЧНИ РАСИ ОВЦИ**

Целта на ова истражување беше да се определи содржина на минерали во млекото од три млечни раси овци: бугарска синтетична млечна популација, источнофризиска и аваси. Испитани се вкупно 97 овци од бугарската синтетична млечна популација во Институтот за сточарство во Костинброд, Р. Бугарија, како и 92 овци од источнофризиската раса и 67 овци од расата аваси во Институтот за сточарство во Скопје, Р. Македонија. Примероците на млекото беа собирани и анализирани на секој 20-ти ден во период од 100 дена (одгледувањето на овците од бугарската млечна синтетична популација и расата аваси беше комбинирано: шталски и на пасиште, додека овците од источнофризиската раса се одгледуваа исклучително во затворен простор). Содржината на главните елементи калциум (Ca) и фосфор (P) беше определена во Институтот за сточарство од Костинброд со помош на методот на калориметрија, со пропишана количина измешано гориво за калциум и врз основа на реакцијата на $\text{PO}_4^{(-3)}$ од $(\text{NH}_4)_2\text{MoO}_4$ за фосфор. Содржината на другите елементи: олово (Pb), кадмиум (Cd), арсен (As), бакар (Cu), железо (Fe) и манган (Mn) беше определена со системот за атомска апсорпција во Централната лабораторија за ветеринарно-санитарно испитување и екологија во Софија, Р. Бугарија. Беше пресметан соодносот на калциум и фосфор. Податоците беа пресметани со варијационо-статистички методи преку компјутерската програма Excel 2003. Беше утврдена содржината на калциум и фосфор во млекото од овци од бугарската млечна синтетична популација (150 mg/100 g, и 125,78 mg/100 g), од источнофризиската (155,8 mg/100 g и 150,29 mg/100 g) и од расата аваси (139,4 mg/100 g и

163,95 mg/100 g). Соодносот Ca : P беше во оптимални граници за овците од бугарската млечна синтетична популација и источнофризиската раса (1,19 и 1,05) и понизок кај овците од расата аваси (0,85). Утврдената содржина на другите елементи во млекото од проучуваните раси е пониска од дозволената за необработено овчо млеко. Добиените резултати за содржината на минерали во млекото кај трите раси овци, одгледувани во различни области на Балканот, го карактеризираат млекото како соодветен материјал за производство на здрави млечни производи наменети за хумана исхрана.

Клучни зборови: млечни раси овци; содржина на минерали; главни елементи; елементи во траги

1. INTRODUCTION

The mineral content of the sheep milk is closely related to the production of healthful dairy products for the consumers and it was an object of studies in different aspects (Epstein, 1985; Polychroniadou and Vafopoulou, 1985; Sawaya et al., 1985; Voutsinas et al., 1988; Mehaia, 1994; Sahan et al., 2005; Yanchev, 2006; Slavov, 2007).

The variation of major elements in the sheep milk was more limited in comparison with the cow milk (Polychroniadou and Vafopoulou, 1985). On the one hand the quantity of the calcium and the phosphorus and their ratio has an importance to milk quality as a raw and on the other hand – as food for lambs.

The study of the level of the trace elements in sheep milk from different breeds adds the milk characteristic of its mineral content. The production of the qualitative and safe dairy products for human health is related to the lack of the heavy metals in the raw materials. Their presence in the sheep milk in an amount over the permissible norms is an indicator for the contamination of the environment.

The aim of the present study was to determine the mineral content of milk from three dairy populations of sheep: the Synthetic population Bulgarian milk, the East-Friesian and the Awassi breeds.

2. MATERIAL AND METHODS

The mineral content of milk from three dairy populations of sheep – the Synthetic population Bulgarian milk, the East-Friesian and the Awassi breeds, reared in different agroecological areas of the Balkan was studied. The mixed milk samples from 97 ewes of the Synthetic population Bulgarian milk in IAS (Institute of Animal Science) – Kostinbrod, Bulgaria, 92 ewes from the East-Friesian breed and 67 ewes from the Awassi breed in IAS (Institute of Animal Science) – Skopje, Macedonia, were investigated. The mixed milk

samples at five numbers from each breed were analyzed. The samples were taken on every 20-th day, during a period of 100 days (the Spring inc. both raised indoors and in pasture for the Synthetic population Bulgarian milk and the Awassi, but the East-Friesian breed was raised only indoors).

The contents of the major elements calcium (Ca) and phosphorus (P) were determined according to the method of Peichevski et al., 1982, and Alekseeva et al., 1986, in the biochemistry laboratory in IAS – Kostinbrod. The colorimetric method was used with the mixed fuel gauge for calcium and on the base of the reaction to $\text{PO}_4^{(-3)}$ by $(\text{NH}_4)_2\text{MoO}_4$ for phosphorus.

The trace elements content – lead (Pb), cadmium (Cd), arsenic (As), copper (Cu), iron (Fe) and manganese (Mn) was determined by the Atom Absorbing System in the Central Laboratory of the Veterinary-Sanitary Investigation and Ecology, Sofia, Bulgaria. The ratio of calcium and phosphorus was accounted. The data were calculated by variation statistic methods by the computer programme Excel 2003.

3. RESULTS AND DISCUSSION

Major elements

The mean, minimal and maximal values of the major elements, calcium and phosphorus, in the raw sheep milk from the Synthetic population Bulgarian milk are shown in Table 1. The mean content of Ca (150 mg/100 g) was higher from that of P (125.78 mg/100 g). The ratio between them was optimal (1.19). The dynamics of a variation of the two major elements during the researched period showed a tendency to a higher calcium value (Fig. 1).

In the milk of the ewes from the East-Friesian breed there was a small difference in the amount of Ca (155.8 mg/100 g) and P (150.29 mg/100 g). It was read ratio 1:1 between the two elements (Tab. 2). In the beginning of the study, the content

of calcium was with a tendency for a lower value in comparison with the phosphorus, but for the subsequent periods a reverse tendency was observed (Fig. 2, Tab. 2).

Table 1

Content of major- and trace elements in the milk of Synthetic population Bulgarian milk

	min	$X \pm Sx$	max
Major elements, $n = 5$			
Calcium, mg/100 g	140	150 ± 3.332	156
Phosphorus, mg/100 g	122.48	125.78 ± 1.347	130.65
Ratio Ca : P	1.07	1.19 ± 0.033	1.25
Trace elements, $n = 5$			
Lead, mg/kg	0.01	0.013 ± 0.001	0.016
Cadmium, mg/kg	0.00026	0.00042 ± 0.001	0.00049
Arsenic, mg/kg	0.019	0.026 ± 0.002	0.034
Copper, mg/kg	0.035	0.056 ± 0.007	0.073
Iron, mg/kg	0.0023	0.0071 ± 0.001	0.0094
Manganese, mg/kg	0.00089	0.00098 ± 0.001	0.0011

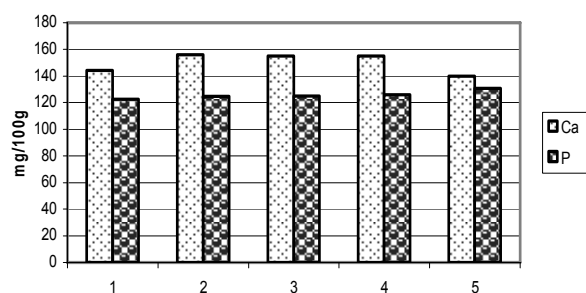


Fig. 1. The dynamics of the content of calcium and phosphorus during the experimental period at SPBM

Table 2

Content of major- and trace elements in the milk of East-Friesian breed

	min	$X \pm Sx$	max
Major elements, $n = 5$			
Calcium, mg/100 g	143	155.8 ± 3.3527	164
Phosphorus, mg/100 g	120.11	150.29 ± 7.834	163.05
Ratio Ca : P	0.88	1.05 ± 0.081	1.36
Trace elements, $n = 5$			
Lead, mg/kg	0.0093	0.0131 ± 0.001	0.0170
Cadmium, mg/kg	0.00031	0.0005 ± 0.001	0.001
Arsenic, mg/kg	0.023	0.025 ± 0.002	0.031
Copper, mg/kg	0.054	0.075 ± 0.008	0.099
Iron, mg/kg	0.00086	0.0021 ± 0.001	0.0045
Manganese, mg/kg	0.00079	0.00085 ± 0.001	0.0009

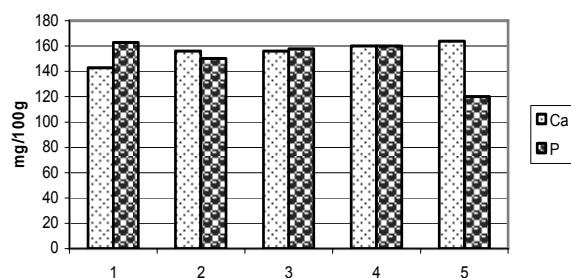


Fig. 2. The dynamics of the content of calcium and phosphorus during the experimental period at IF breed

The average values of the content of calcium (139.4 mg/100 g) and phosphorus (163.95 mg/100 g) of the Awassi ewes showed a tendency for a higher level of the phosphorus. The ratio Ca : P was lower up 1.0 (Tab. 3). For the whole studied period, the milk content of calcium was with a tendency for lower values than these of phosphorus (Fig. 3).

Table 3

Content of major- and trace elements in the milk of Awassi breed

	min	$X \pm Sx$	max
Major elements, $n = 5$			
Calcium, mg/100 g	130	139.4 ± 3.600	152
Phosphorus, mg/100 g	160.02	163.95 ± 1.079	166.44
Ratio Ca : P	0.78	0.85 ± 0.028	0.95
Trace elements, $n = 5$			
Lead, mg/kg	0.01	0.014 ± 0.001	0.017
Cadmium, mg/kg	0.00026	0.00079 ± 0.001	0.0024
Arsenic, mg/kg	0.02	0.024 ± 0.001	0.026
Copper, mg/kg	0.025	0.054 ± 0.014	0.108
Manganese, mg/kg	0.0012	0.00084 ± 0.001	0.00061

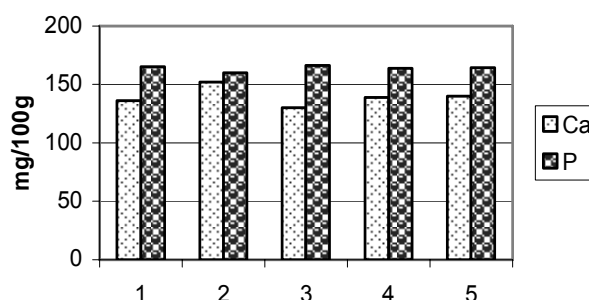


Fig. 3. The dynamics of the content of calcium and phosphorus during the experimental period at Awassi breed

The obtain results at the study were in agreement with the received requirements for calcium (140–200 mg/100 g) and phosphorus (82–183 mg/100 g) content in the sheep milk (Peichevski et al., 1982; Alekseeva et al., 1986; Moniello et al., 2005; Sahan et al., 2005).

The mean value of the calcium in our investigation is similar to the results from Epstein, 1985; Voutsinas et al., 1988; Mehaia, 1994; Янчев, 2006, but considerably lower than these reported by Sahan et al., 2005; Slavov, 2007. The amount of Ca in the milk samples from the East-Friesian breed was lower than the results of Kuchtik et al, 2008 (200 mg/100 g) at the same breed. Celki and Ozdemir, 2003, established higher values of Ca (171.69 mg/100 g) in comparison to ours at the Awassi breed.

The quantity of the phosphorus registered in the samples of the present study corresponded with the results of Polychroniadov and Vafopoulou, 1985, Voutsinas et al., 1988; Sahan et al., 2005, and Slavov, 2007, and was higher than this was announced by Sawaya et al., 1985, and Mehaia, 1994; Celki and Ozdemir, 2003, obtained lower values of P (120.04 mg/100 g) in comparison to ours at the Awassi breed. The determined amount of P at the Awassi breed agreed with those reported by Mutassim et al., 2002 (165 mg/100 g).

The optimal ratio Ca : P of the sheep milk is 1:1 or 2:1 according to Moniello et al., 2005. The results obtained from us about this ratio in the sheep milk from the Synthetic population Bulgarian milk and the East-Friesian breed were included in optimal levels, but they were lower than those of Polychroniadov and Vafopoulou, 1985, and Gerchevetal, 2006; Sahan et al., 2005, reported a value of ratio Ca : P lower in comparison to the optimal level and to our results, too (0.73).

Trace elements

The values for the content of the trace elements (lead, cadmium, arsenic, copper, iron and manganese) in studied milk samples shown in Tables 1, 2 and 3.

The amount of the above – mentioned trace elements in the milk from the Synthetic population Bulgarian milk were in allowable limits (Pb – 0.02 mg/kg, As – 0.05 mg/kg, Cu – 0.056 mg/kg). This content characterized the milk as an appropriate raw for the production of dairy products (Tab. 1).

In the period to investigation, the lead, arsenic and copper changed their own values in normal frameworks. The content variation of cadmium, manganese and iron was in lower degree (Fig. 4).

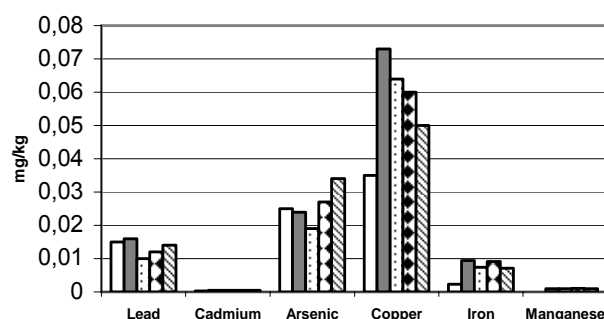


Fig. 4. The dynamics of the content of trace elements during the experimental period at SPBM

The content of trace elements in the sheep milk from the East-Friesian breed was lower from permissible limits (Tab. 2). The change of lead, arsenic and copper content for the period of the investigation was in permissible borders, too (Fig. 5).

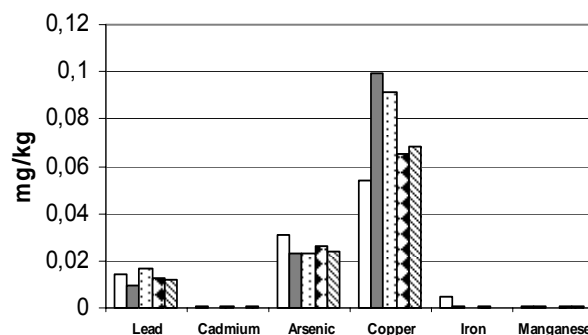


Fig. 5. The dynamics of the content of trace elements during the experimental period at IF breed

The average values for the content of trace elements in the milk of the sheep from the Awassi breed are shown in Table 3. The heavy metals were in admissible amount in these samples. With the exception of the copper, the rest of trace elements were characterized with small changes in the studied period (Fig. 6).

In studies of the mineral content of the sheep milk Al-Wabel, 2008, Yanchev, 2006, and Slavov,

2007, reported the higher values for the content of Mn, Cu и Fe of those who were received in the present investigation. The mentioned norms from Moniello et al., 2005, for the concentration of Mn, Cu и Fe are higher.

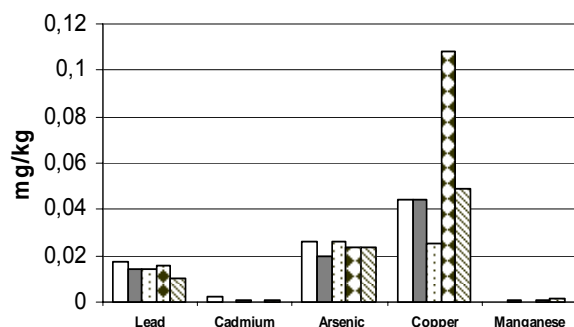


Fig. 6. The dynamics of the content of trace elements during the experimental period at Aw breed

Anastasio et al., 2006, detected higher values for the content of Cd and Pb in comparison to our research and those reported in the literature.

4. CONCLUSIONS

It was established the content of calcium and phosphorus in the milk of sheep of the Synthetic population Bulgarian milk (150 mg/100 g and 125.78 mg/100 g), the East-Friesian (155.8 mg/100 g and 150.29 mg/100 g) and the Awassi (139.4 mg/100 g and 163.95 mg/100 g).

The ratio Ca : P was in the optimal levels for the sheep milk from the Synthetic population Bulgarian milk and the East-Friesian breed (1.19 and 1.05) and it was lower for Awassi ewes (0.85).

The established content of trace elements in the milk from studied breeds was lower to the utmost permissible levels for the raw sheep milk.

The obtained results for the mineral content of the sheep milk from the three breeds, raised in different agroecological areas of the Balkan Peninsula, characterized it as an appropriate raw material for the production of healthful and safety foods for human consumption.

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