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DYNAMICAL CHANGES IN THE TRACE ELEMENT COMPOSITION OF FRESH AND LYOPHILIZED EWE'S MILK

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Abstract

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The present study aims to investigate the trace element composition of fresh and lyophilized ewe's milk from sheep of the Karakachan breed raised in the region of the Middle Rhodopes. The analysis of trace elements in the native and lyophilized ewe's milk was made after ashing with atomic-absorption photometer AES-ICP "Varian-Liberty II". In the course of lactation a decrease of the content of the trace elements boron, barium, chromium, copper, iron, zinc, selenium and iodine and a good availability of manganese was observed in the native and freeze-dried milk.

Key words: fresh sheep's milk, trace elements, lyophilized ewe's milk

Introduction

The ewe's milk is an important source of nutritive substances in the diet of growing up animals and man. The element composition of the milk is well studied and it is affected by the lactation phase, the applied nutritional regime, especially the introduction of mineral additives in the rations, the environmental conditions. It is considered that milk is a bioindicator of industrial pollution (Kashamov et al., 2005). The problem of providing of the animals with protein, energy, macro and trace elements is of substantial importance for modern stock-breeding. During the recent years an extremely great importance has been rendered to the correct balancing of the feeding of ruminants. In the case of pasture sheep breeding in the mountain regions conditions are created for unfixed mineral supply to the organism due to the lack of balanced providing of the basic macro elements – calcium and phosphorus and trace elements – selenium, iodine, copper, zinc, cobalt in the pasture plants after reaching of a certain vegetation period. The reasons for the natural deficit are the geological characteristics of the region, the botanical composition of the pastures and the above sea level (Todorova et al, 1996; Angelov, 1998; Petrova et al., 2001,). The trace elements have a significant physiological importance for the young animals and participate in the forming of enzymes, vitamins and hormones of vital importance. Without them the assimilation of the nutritional substances by the organism is impossible (Peichevski et al., 1990). The prolongation of the shelf-life of milk and diary products has been of extraordinary interest to science during the recent decades. Freeze-drying is a relatively sparing method for preservation of short-lived products due to the fact that their initial qualities remain unchanged (Georgieva et al., 2007).

The objective of the present work is to assess the concentration of trace elements in fresh and lyophilized ewe's milk from sheep of the Karakachan breed, raised on pastures.

Material and Methods

The investigation was carried out with ten sheep of the Karakachan breed, raised in the region of the Middle Rhodopes, at second lactation.

The milk samples were gathered individually during the evening milking and were investigated for content of microelements in the months April, May and June. The individual ewe's milk samples were lyophilized at the following parameters: freezing temperature: -35°C, drying temperature: 35°C, thickness of the layer: 1 cm and duration of the lyophilization process – 24h.

The mineral composition of the raw and lyophilized ewe's milk was determined by dry ashing of the sample and its mineralization in a muffle furnace at 450°C for 72 hours. The ash residue was dissolved with 6n HCl and was diluted with bidistilled water to a certain volume. The analysis of trace elements is made on atomic-emission photometer - AES-ICP "Varian- Liberty II".

The obtained data were processed variation-statistically with software Statistica for Windows.

Results and Discussion

The trace element boron participates in the forming of the bone structures of the organism, stimulates the brain by improving its ability to draw energy from the decomposition of fats and carbohydrates. The recommended daily intake of boron with foods is 3-5 mg. The content of the microelement boron increases in the course of lactation from 0.13 mg/L in April to 0.16 mg/L in June, i.e. its total quantity increases for the period by 23%. After lyophilization as a result of over concentration the content of the trace element boron increases 5,6 times and varies from 0.74 (April) to 0.85 (June) mg/kg (Table 1). Mathematically justified differences for the analyzed fresh and lyophilized ewe's milks were not established.

Table 1

Content of boron in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk,mg/L	0.13	0.04	0.05-0.18	0.14	0.03	0.05-0.17	0.16	0.07	0.03-0.28
Lyophilized milk, mg/kg	0.74	0.29	0.30-1.29	0.77	0.21	0.29-1.13	0.85	0.35	0.15-1.44

Table 2

Content of barium in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	0.57	0.18	0.41-0.98	0.53	0.03	0.25-0.88	0.67	0.07	0.37-0.92
Lyophilized milk, mg/kg	3.22	0.75	2.46-4.88	3.01	0.21	1.46-4.68	3,60	0.35	2.33-4.76

Table 3

Content of chromium in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	0.06	0.02	0.02-0.09	0.05	0.02	0.02-0.07	0.05	0.02	0.02-0.08
Lyophilized milk, mg/kg	0.35	0.1	0.14-0.47	0.3	0.11	0.14-0.36	0.27	0.13	0.04-0.42

Table 4

Content of copper in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	0.24	0.07	0.13-0.37	0.24	0.29	0.12-1.06	0.34	0.19	0.17-0.80
Lyophilized milk, mg/kg	1.37	0.39	0.77-2.07	1.40	1.67	0.51-6.36	1.83	0.95	0.96-4.16

Table 5

Content of iron in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	1.00	0.18	0.55-1.17	0.82	0.24	0.53-1.27	1.29	0.35	0.86-1.83
Lyophilized milk, mg/kg	5.85	1.30	3.09-8.04	4.68	1.35	3.01-7.21	7.12	2.47	4.28-11.56

According to literature data the medium content of boron in milk is 0.18 mg/L (Peichevski et al., 1990). Therefore the fresh and lyophilized ewe's milks are characterized with a relatively good concentration of the element boron and practically don't have a negative effect on human health.

The content of barium in the fresh milks varies from 0.57 to 0.67 mg/L. An increase of the barium quantity in the milks obtained during the studied period is observed. In the course of lactation its concentration increases by 18% (Table 2). For the lyophilized milks an increase of the concentration from 3.22 to 3.60 mg/kg is observed. The toxicological effect of barium or its compounds penetrated in the human organism cause changes of the mucosa, the ion balance is disturbed which results in a decrease of the potassium content in the myocardial cells, the nervous system and the cross muscles (Pasheva et al., 1988).

The quantity of chromium in the native and lyophilized ewe's milk is relatively constant and is in very low concentrations. For the native sheep's milk it is in the range from 0.6 to 0.5 mg/L (Table 3). For the lyophilized milk the concentration of chromium is from 0.35 to 0.27 mg/kg. A trend towards decrease of the concentration during milking is observed.

According to literature data the content of copper in milk varies from 0.27 – 0.30 mg/L. The concentration of copper in the native product during the period range from 0.24 (April) to 0.34 (June) mg/L, i.e. there is a trend towards increases in June by 41% (Table 4). For the analyzed milks a content of copper above the admissible concentration was established. The content of copper varies from 1.37 to 1.83 mg/kg.

The content of iron in the raw milk in the course of lactation is with variable values. In April its quantity is 1.00 mg/L, in May its concentration decreases to 0.82 mg/L and in June the values of the concentration reach up to 1.29 mg/L. The level of the iron in the lyophilized milk is relatively low and is in the range from 4.68 to 7.12 mg/kg (Table 5). Peichevski (1990) established values of the iron from 2.25 to 77.19 mg/kg.

Manganese is an important microelement which participates in the metabolism of carbohydrates, lipids and proteins. Its quantity in the native milk is relatively constant – 0.07 mg/L (Table 6). The lyophilized product is also characterized by a

Table 6
Content of manganese in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	0.07	0.04	0.04-0.15	0,06	0,02	0.03-0.09	0.07	0.04	0.04-0.13
Lyophilized milk, mg/kg	0.39	0.16	0.23-0.72	0,32	0,15	0.19-0.63	0.40	0.19	0.22-0.78

Table 7
Content of zinc in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, mg/L	3.81	0.85	2.08-4.69	3.98	1.30	1.93-6.17	4.42	1.11	2.47-5.80
Lyophilized milk, mg/kg	22.27	5.26	12.38-30.12	22.49	6.72	12.38-32.26	23.80	5.10	12.88-30.12

Table 8
Content of selenium in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, μg/L	25.5	7.5	12.7-38.6	18.3*	4,9	12.5-25.0	17.5*	2.8	13.4-21.7
Lyophilized milk, μg/kg	146.1	34.9	71.8-191.7	104.5*	30,9	70.5-166.0	95.6*	17.6	80.3-135.0

*P<0.001

Table 9
Content of iodine in fresh and lyophilized milk

	30 April			30 May			30 June		
	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max	$\overline{X}$	SD	min- max
Fresh milk, μg/L	25.7	2.54	22.0-30.0	17.8	2.3	13.0-22.0	14.1	1.9	11.0-17.0
Lyophilized milk, μg/kg	148.8	10.9	137.1-169.6	101.8	19.2	73.3-139.6	76.3	8.7	64.4-88.5

*P<0.001

relatively constant concentration. According to literature data the content of manganese is from 0.116 to 0.65 mg/kg, i.e. the obtained milks are with a very good availability of manganese.

According to literature data the content of zinc in the dry milk varies from 7.74 to 22.5 mg/kg (Dimitrov et al., 2008). In the course of lactation the concentration increases from 3.81 to 4.42 mg/L in the fresh milk. In the lyophilized milk the content of zinc varies in the range from 22.27 to 23.80 mg/kg (Table 7). A trend towards increasing its concentration during lactation is observed.

In the course of lactation the selenium in the fresh milk decreased from 25.5% at the beginning to 17.5% at the end, i.e. its content decreased by 45.7% for the studied period. The case after lyophilization is analogous. Considerable variations of the content of selenium were observed in April in the native milk (from 12.7 to 38.6 μg/L and also in the lyophilized sheep's milk (from 71.8 to 191.7 μg/L.Inconsiderable changes in selenium values were established in June: from 13.4 to 21.7 μg/L for the fresh milk and from 80.3 to 135 μg/kg for the lyophilizate (Table 8). A mathematical authenticity between the analyzed samples for selenium for the different months was established as follows: April-May (P<0.001), April-June (P<0.001) for both the native and the lyophilized milk.

The iodine in the fresh milk decreases during lactation from 25.7 μg/L at the beginning to 14.1 μg/L at the end, i.e. its content in the milk decreases considerably (by 82%) for the period (Table 9) As a result of the technological processing the iodine content increases due to over concentration, but the trend towards decrease (by 95%) of its quantity in the lyophilized milk remains during the period. Considerable variations of the iodine concentration in the fresh and lyophilized milks are not observed but the differences between the results obtained for April-May (P<0.001) and April-June (P<0.001) for the native and also for the freeze dried milk are statistically authentic.

Conclusions

On the basis of the carried out investigations the following conclusions can be made.

Freeze drying is an appropriate method for obtaining of dairy products with high content of trace elements due to over concentration of the source raw material.

The availability of trace elements in the milk during lactation is extremely low, i.e. the animals are bred under conditions of deficit. The content of manganese makes an exception.

The microelements are extremely important components of milk, necessary for the vital activity of the growing up animals and for human nutrition, as well as for the next technological processing for obtaining of diary products.

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