ANALYSIS OF METAL IONS AS SOLUBLE SALTS IN DIFFERENT DAIRY PRODUCTS

ANALIZA UNOR IONI METALICI DIN SĂRURI SOLUBILE ÎN DIFERITE PRODUSE LACTATE

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Abstract. *Milk and dairy products are unique combinations of micronutrients with multiple recognized health benefits. The trace elements present in dairy products have an important role in living organisms, among the most important being Fe, Mn and Co.*
Through this work we performed the analysis of the content in soluble salts of some metals in several dairy products on the market regarding the content of nitrites, phosphates, chlorides and ions of iron, manganese and cobalt.
Following the analyzes, a higher iron content was observed in the products Lapte de consum Vreau din România with 3,5% fat (18.36 mg/Kg) and Actimel Danone de căpşuni with 1,5% fat (15.44 mg/Kg), higher values for manganese ions in products Danonino brânzică de zmeură with 2,5% fat (84.56 mg/Kg) and Danonino brânzică de banane with 2,5% fat (96.57 mg/Kg) and higher values for the cobalt content of drinking yogurt products (Iaurt de băut Vreau din România with 2% fat - 0.06097 mg/Kg, Iaurt natural de băut Zuzu with 2% fat - 0.0663 mg/Kg, Iaurt de băut Pilos with 2% fat - 0.07697 mg/Kg).
Key words: milk, dairy products, trace elements, metal ions

Rezumat. *Laptele şi produsele lactate sunt combinaţii unice de micronutrienţi cu beneficii multiple recunoscute pentru sănătate. Oligoelementele prezente în produsele lactate au un rol important în organismele vii, dintre cele mai importante finnd Fe, Mn şi Co.*
Prin intermediul acestei lucrări am realizat analiza conţinutului în săruri solubile ale unor metale în mai multe produse lactate de pe piaţă privind conţinutul de nitriţi, fosfaţi, cloruri şi ioni de fier, mangan şi cobalt.
În urma analizelor s-a observat un conţinut mai mare de fier la produsele Lapte de consum Vreau din România cu 3,5% grăsime (18.36 mg/Kg) şi Actimel Danone de căpşuni cu 1,5% grăsime (15.44 mg/Kg), valori mai ridicate pentru ionii de mangan la produsele Danonino brânzică de zmeură cu 2,5% grăsime (84.56 mg/Kg) şi Danonino brânzică de banane cu 2,5% grăsime (96.57 mg/Kg) şi valori mai mari pentru conţinutul în cobalt la produsele din gama iaurturilor de băut (Iaurt de băut Vreau din România cu 2% grăsime - 0.06097 mg/Kg, Iaurt natural de băut Zuzu cu 2% grăsime - 0.0663 mg/Kg, Iaurt de băut Pilos cu 2% grăsime - 0.07697 mg/Kg).
Cuvinte cheie: lapte, produse lactate, oligoelemente, ioni metalici

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INTRODUCTION

From the nutritional point of view, metals in milk and dairy products can be grouped into essential elements (iron, copper and zinc) at low doses and non essential or toxic ones (lead and cadmium). (Arafa *et al.*, 2014)

The trace element contents of milk and dairy products depends on the stage of lactation, nutritional status of the animal, environmental and genetic factors, characteristic of the manufacturing practices and possible contamination from the equipment during processing (Cashman, 2011).

Iron is essential for the formation of hemoglobin in red blood cells, hemoglobin that binds oxygen and carries it throughout the body. Iron is also an essential component in many enzymatic reactions and plays an important role in the immune system. The total amount of iron found in the body is about 3-5 g, of which most, respectively 75%, is found in the blood, while the rest is in the liver, bone marrow and muscles. (Vasudevan *et al.*,2007)

Iron contents in milk and kareish cheese samples were analyzed by and found in the ranges of 2.9619–45.6198 respectively 1.7633–14.7388 ppm (Arafa *et al.*, 2014).

Another important trace element for the body contained in dairy products is manganese. It is necessary for bone formation and energy metabolism. The optimal level at which manganese should be maintained is 2.5-5 mg / day. Chronic manganese exposure is associated with neurotoxicity and is linked to neurological disorders (Parkinson's disease).

Manganese concentrations are 3 to 10 μg/L in breast milk and 30 to 100 μ/L in cow's milk–based infant formulas (Aschner and Aschner, 2005; Lonnerdal, 1994). Soy-based infant formulas have higher manganese concentrations, 200 to 300 μ/L, than milk-based formulas (Lonnerdal, 1994). Limited research suggests that the absorption rate of manganese from human milk (8.2%) is much higher than that from soy formula (0.7%) and cow's milk formula (3.1%) (Davidsson *et al.*, 1989).

Humans absorb only about 1% to 5% of dietary manganese. Infants and children tend to absorb greater amounts of manganese than adults (Chen *et al.*, 2018). In addition, manganese absorption efficiency increases with low manganese intakes and decreases with higher intakes, but little is known about the mechanisms that control absorption (Buchman, 2014).

Dietary iron intakes and iron status (measured by serum ferritin concentration) appear to be inversely associated with manganese absorption (Finley and Davis, 1999). The mechanism for this effect is unknown, but the shared transporter of iron and manganese in the intestine might play a role. Infants absorb higher proportions of manganese than adults; limited research shows that formula-fed infants retain about 20% of the manganese they consume (Aschner and Aschner, 2005).

The third most important microelement in living organisms is cobalt. It induces erythropoiesis and blocks the absorption of iodine by the thyroid. Bacteria in the stomachs of ruminant animals transform cobalt into cobalamin – the form of cobalt needed by animals and humans. Cobalamin is more commonly known as vitamin B_{12}.

Humans and all non-ruminant animals need cobalamin "ready-made" in their diet. Cobalamin is needed for blood cell formation, and consequently one of the main deficiency effects is anaemia with a decrease in red blood cells. Cobalamin is also essential for healthy brain and nervous system function, as well as in DNA synthesis, fatty acid synthesis and energy metabolism.

Top groups for cobalt in the human diet are: milk and dairy products, which account for approximately 32% of the total cobalt intake; fish and shellfish, which account for approximately 20%, and condiments, sugar and oils, which account for about 16%. Milk contains 0.0036 mg/Kg, unpasteurised dairy products - 0.0042 mg/Kg and cheese - 0.0153 mg/Kg (Nguyen *et al.*, 2004) .

However, a diet that is based only on milk for a long time is not indicated because, due to the low content of manganese, iron, copper, cobalt, vitamin C and vitamin D, anaemia can occur, especially in young children.

.MATERIAL AND METHOD

The following samples were analyzed, for metal ions and anions content:
P 1 – Lapte de consum Vreau din România with 3,5% fat;
P 2 – Lapte de consum integral Fulga with 3,5% fat;
P 3 – Lapte UHT Sim puternic românesc with 3,5% fat;
P 4 – Iaurt de băut Vreau din România with 2% fat;
P 5 – Iaurt natural de băut Zuzu with 2% fat;
P 6 – Iaurt de băut Pilos with 2% fat;
P 7 – Actimel Danone de căpș uni with 1,5% fat;
P 8 – Danonino brânzică de zmeură with 2,5% fat;
P 9 – Danonino brânzică de banane with 2,5% fat;

The milk and dairy products were purchased a day before the analysis and kept in refrigeration conditions. The nitrites content was determined using the Griess colorimetric method, the phosphates using the phosphomolybdenic solution method and a Spekol 1100 spectrophotometer and the chlorides using the titrimetric method with silver nitrate standard solution. The iron, manganese and cobalt ions were also determined using colorimetric methods and the Spekol 1100 spectrophotometer.

RESULTS AND DISCUSSIONS

As regards the moisture and dry matter of the analyzed samples, the values are shown in table 1. They were determined in order to properly express the specific ions content in samples.

Table 1

Humidity and dry matter values for the analyzed fruit and vegetable samples

Sample	Humidity (%)	Dry matter (%)
P 1	87.26131	12.73869
P 2	85.41103	14.58897
P 3	88.50102	11.49898
P 4	88.64461	11.35539

P 5	89.81385	10.18615
P 6	90.32568	9.674321
P 7	81.34402	18.65598
P 8	77.98126	22.01874
P 9	77.83108	22.16892

According to Griess method, we prepared a series of known concentration solution and draw a calibration curve, based on which we determined the nitrite content of the samples, as presented in figure 1:

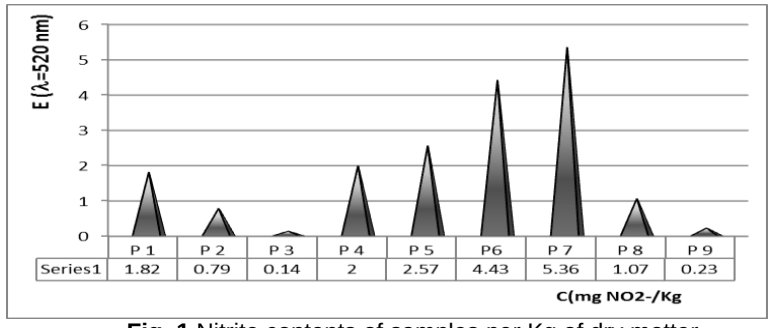

Fig. 1 Nitrite contents of samples per Kg of dry matter

As shown in figure 1, in what regards the milk and dairy samples, the highest value for nitrite content was registered for Actimel Danone de căpşuni (P_7) and the lowest for Lapte UHT Sim puternic românesc (P_3).

In what regards the phosphate content (figure 2), we determined the highest value for sample Actimel Danone de căpşuni (P_7) – 80.46 mg/Kg, the rest of the samples having close values in the 33 – 42 mgP/Kg range.

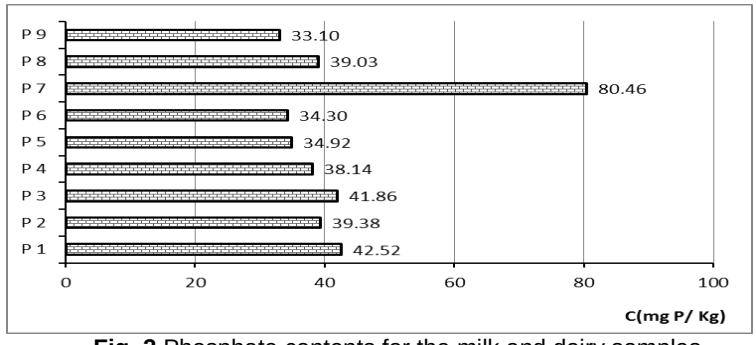

Fig. 2 Phosphate contents for the milk and dairy samples

The biggest level of chlorides was registered in samples P_8 and P_9 – the fruity Danonino products, with values double than the rest of the samples, as shown in figure 3.

Based on the calibration curves we made for the metal ions according to each specific colorimetric method, we determined the concentration of the samples in iron, manganese and cobalt ions, as shown in figures 4, 5 and 6.

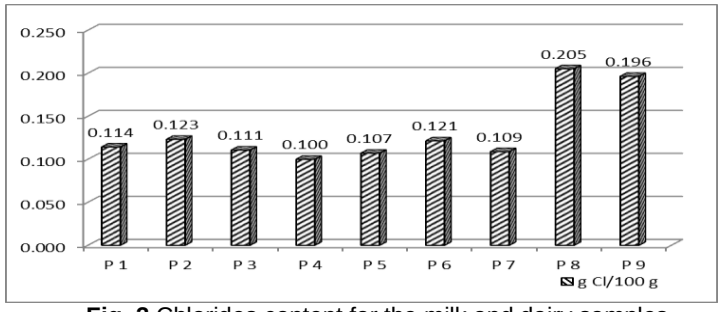

Fig. 3 Chlorides content for the milk and dairy samples

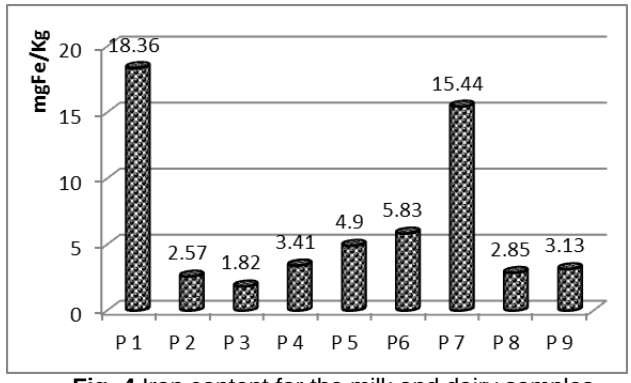

Fig. 4 Iron content for the milk and dairy samples

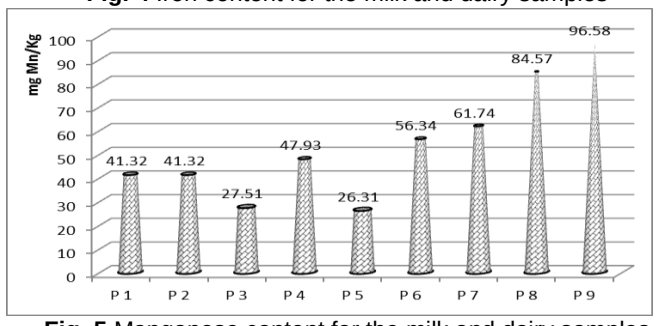

Fig. 5 Manganese content for the milk and dairy samples

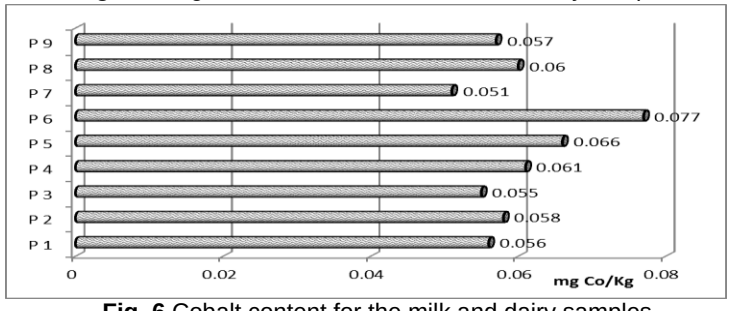

Fig. 6 Cobalt content for the milk and dairy samples

P_1 – Lapte de consum Vreau din România and P_7 – Actimel Danone de căpşuni had the highest contents in iron, while both Danonino fruity cheese

samples gave bigger values for manganese content than all the other samples. All three yoghourt samples ranged highest in what regards the cobalt content, compared to the other milk and dairy considered products.

CONCLUSIONS

1. In the analyzed samples, the highest content in nitrites in dry matter was registered for Actimel Danone de căpşuni (P_7) – 15.36 mg/Kg, which also registered the highest value for phosphate ions – 80.46 mg/Kg;

2. The biggest level of chlorides was registered in samples P_8 (Danonino brânzică de zmeură) – 0.205 g Cl/100 g and P_9 (Danonino brânzică de banane) – 0.196 g Cl/100 g;

3. P_1 – Lapte de consum Vreau din România and P_7 – Actimel Danone de căpşuni had the highest contents in iron, of 18.36, respectively 15.44 mg Fe/Kg;

4. Manganese values were highest in the samples P_8 (Danonino brânzică de zmeură) – 84.57 mg Mn/Kg and P_9 (Danonino brânzică de banane) – 96.58 mg Mn/Kg;

5. The yoghourt samples ranged highest for the cobalt content, with the following values: P_4 (Iaurt de băut Vreau din România) – 0.061 mg Co/Kg; P_5 (Iaurt natural de băut Zuzu) – 0.066 mg Co/Kg and P_6 (Iaurt de băut Pilos) – 0.77 mg Co/Kg.

REFERENCES

1. **Arafa M. S. Meshref, Walaa A. Moselhy & Nour El-Houda Y. Hassan, 2014** - *Heavy metals and trace elements levels in milk and milk products*, Journal of Food Measurement and Characterization 8, pp 381–388;
2. **Aschner J.L., Aschner M., 2005** - *Nutritional aspects of manganese homeostasis*. Mol Aspects Med., 26, pp.353-362.;
3. **Buchman A.R., 2014** - *Manganese*. In: A. Catharine Ross BC, Robert J. Cousins, Katherine L. Tucker, Thomas R. Ziegler ed. Modern Nutrition in Health and Disease. 11th ed. Baltimore, MD: Lippincott Williams & Wilkins, pp.238-244;
4. **Cashman K.D., 2011** - *Trace elements, nutritional significance*. In Encyclopedia of dairy science, 2nd edition, Vol. 3, ed. by J.W. Fuquay, P.F. Fox, P.L.H. McSweeney (Academic press,), pp. 933-940;
5. **Chen P., Bornhorst J., Aschner M., 2018** - *Manganese metabolism in humans*. Front Biosci (Landmark Ed), 23, pp. 1655-1679;
6. **Davidsson L., Cederblad A., Lonnerdal B., Sandstrom B., 1989** - *Manganese absorption from human milk, cow's milk, and infant formulas in humans*. Am J Dis Child.,143, pp.823-827;
7. **Finley J.W., Davis C.D., 1999** - *Manganese deficiency and toxicity: are high or low dietary amounts of manganese cause for concern?* BioFactors (Oxford, England),10, pp.15-24;
8. **Lonnerdal B., 1994** - *Nutritional aspects of soy formula*. Acta Paediatr Suppl., 402, pp.105-108;
9. **Nguyen H.L., Leermakers M., Elskens M., De Ridder F., Doan T.H., Baeyens W., 2004** - *Correlations, partitioning and bioaccumulation of heavy metals between different compartments of Lake Balaton*, Sci Total Environ., 341 (1-3), pp. 211-226.;
10. **Vasudevan Dm., Sreekumari S., 2007** - *Text Book of Biochemistry for Medical Students*, 5th Ed. New Delhi: Jaypee Publication.