

## MINERAL COMPOSITION OF FRESH COW'S MILK AND THE IMPORTANCE OF MINERALS IN THE HUMAN DIET

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### Abstract

Minerals in particular macro-minerals play a very important role in human health, a very large part of them comes from milk and milk products in our diet, so their importance is quite large. This research aimed to evaluate which feed influences fresh cow milk mineral (Ca, K, P, Na, and Mg) composition.

The two model farms monitored for 6 months January - June 2023 were included in this research. Milk samples for analysis were taken in a sterile container at a temperature of 5 °C directly from the lactofreezer, while all minerals from the feed and concentrates were analyzed with microwave plasma atomic emission spectroscopy (MP-AES).

From the experimental results, we can see that farm 2, which uses mixed feed and concentrate for dairy cows, has significantly higher values of minerals in fresh milk compared to the results obtained by farm 1. In farm 2, fresh cow's milk contains Ca on average 1268.20 mg/L, K - 1409.33 mg/L, P - 1537.53 mg/L, and Mg - 83.36 mg/L, while in farm 1 fresh cow's milk on average has Ca was 1038.31 mg/L, K - 1406.16 mg/L, P - 1232.86 mg/L, and Mg - 65.67 mg/L.

From the experimental analyses in this research, it is observed that the use of mixed feed by dairy cows consisting of many components such as silage of grass, corn, alfalfa, dry grass, high-protein concentrate, various supplements with mineral composition, etc. are positive indicators of increasing mineral values in fresh cow's milk.

**Key words:** Analysis, Mineral elements, Physicochemical parameters, Cow's milk.

### 1. Introduction

Milk is a very ancient food that has been used for centuries by different peoples around the world (Velten [25]). Milk and milk products are widely recognized as nutrient-rich foods, which is why it is one of the most consumed products by humans, especially infants and children (Park [11]). Throughout history, people have used the milk produced by ruminants such as cows, goats, sheep, buffaloes, camels, etc., to meet their nutritional needs (Griffiths [5]). Dairy cows make up about 1/5 of all domestic animals in the world and thus contribute to milk production (Marth and Steele [9]). Usually, the moderate human diet provides milk and milk products with about 30% of proteins and lipids, as well as about 80% of calcium for daily dietary needs (Smit [17]). Milk has a rather complex physico-chemical composition, where the components are in a rather fragile balance, as a result of breaking the balance over the years, people have acquired many milk products (Griffiths [5]). In addition to proteins, lipids, and calcium, milk also contains many other components such as lactose, vitamins, minerals, enzymes, etc. (Tamime [19]). Milk is also a very rich source of minerals, especially calcium (Ca) and phosphorus (P) and other macro minerals such as Na, K, etc. (Smit [17]). Even in our country, milk, and milk products are used quite a lot, even though some research has been done on different food products, it is necessary to continue to have research on food products (Elshani *et al.*, [3]; Pehlivani *et al.*, [12]; Loshi *et al.*, [8]).

Having all of this in mind, this research aimed to evaluate which feed influences fresh cow milk mineral (Ca, K, P, Na, and Mg) composition.

## 2. Materials and Methods

The study includes 2 model farms for the production of Simmental breed cows' fresh milk, with 30 dairy cows on each farm. Farm 1, uses mainly dry food and grass silage without animal concentrates in the rations, and farm 2 uses complete rations containing dry food, different types of silage as well as different concentrates. Fresh milk samples were taken in two model farms in 500 mL sterile plastic bottles, while samples of mixed animal feed were taken in sterile plastic bags weighing 1 kg. For the determination of minerals in fresh cow's milk, the following devices were used: microwave Ethos UP-Microwave digestion system, and the Microwave Plasma Atomic Emission Spectroscopy (MP-AES) Agilent Technologies 4200 for determining the level of elements [1]. With an automatic pipette, 1 mL of sample was taken and placed in the Teflon tube, and then 6 mL of nitric acid  $\text{HNO}_3$  (67% to 69%) and 1 mL of hydrochloric acid  $\text{HCl}$  (32% to 36%) were added. After that, the Teflon tube was closed with care and placed in the microwave for about 50 minutes at a temperature of 240 °C. In the mixed animal feed, we took 0.18 - 0.5 g of finely grounded dry food sample and then added 7 mL  $\text{HNO}_3$  and 1 mL  $\text{H}_2\text{O}_2$ . After removing the tubes from the microwave, the samples were diluted with deionized water in a 50 mL beaker. The ready samples were analyzed with the MP-AES apparatus.

Gained data were analyzed by using the Statistical Package for the Social Sciences (SPSS) (Loshi *et al.*, [8]; Agilent Technologies, [1]).

## 3. Results and Discussion

From Table 1, it can be seen that in farm 1, the average values composition of minerals in fresh cow's milk are: Ca - 1038.31, K - 1406.16, P - 1232.86, Mg - 65.67, and Na - 539.03, while in mixed animal feed are as follows: Ca - 3973.13, K - 13680.12, P - 5062.73, Mg - 1651.90, and Na - 2901.97.

From Table 2 it can be seen that in farm 2, the average values composition of minerals in fresh cow's milk are: Ca - 1268.20, K - 1409.33, P - 1537.53, Mg - 83.36, and Na - 563.26 it can be seen that in farm 1, the average values composition of minerals in fresh cow's milk are: Ca - 7971.22, K - 8237.62, P - 7285.16, Mg - 2288.26, and Na - 3980.15.

From the average values for both farms, we see that farm 2 has higher values for all the elements obtained in the research - both in fresh milk and also in mixed animal feed. Farm 1 mainly uses dry fodder and grass silage and does not use concentrate as feed for dairy cows, while farm 2 uses dry fodder, grass silage, corn silage, concentrate, and other mineral and vitamin

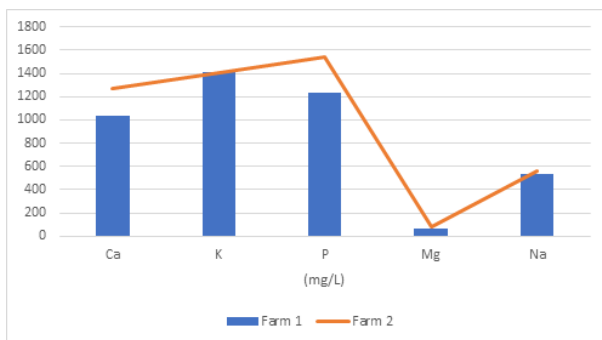
**Table 1. Mineral composition of fresh cow's milk and mixed animal feed on farm 1**

Elements	Ca		K		P		Mg		Na	
	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)
Sample 1	859.54	4312.19	1430.4	19398.61	1190.3	3946.82	63.47	2087.89	380.1	3060.22
Sample 2	949.01	2028.40	1449.8	7712.97	1265.7	4273.98	65.51	1195.88	561.6	2955.44
Sample 3	1306.4	5578.80	1338.3	13928.78	1242.6	6967.40	68.04	1671.94	675.4	2690.26
x	1038.31	3973.13	1406.16	13680.12	1232.86	5062.73	65.67	1651.90	539.03	2901.97
σ	236.43	1799.32	59.56	5846.78	38.63	1657.58	2.28	446.34	148.93	190.68
Min.	859.54	2028.40	1338.30	7712.97	1190.30	3946.82	63.47	1195.88	380.10	2690.26
Max.	1306.40	5578.80	1449.80	19398.61	1265.70	6967.40	68.04	2087.89	675.40	3060.22

**Table 2. Mineral composition of fresh cow's milk and mixed animal feed on farm 2**

Elements	Ca		K		P		Mg		Na	
	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)	Fresh milk (mg/L)	Mixed animal feed (mg/kg)
Sample 1	1212.8	9782.24	1421.6	8601.20	1253.9	8392.81	71.68	2847.40	459.4	4697.11
Sample 2	1229.3	7670.79	1477.3	8050.55	1663.9	6522.34	92.43	1961.77	443.8	3730.77
Sample 3	1362.5	6460.65	1329.1	8061.11	1694.8	6940.33	85.97	2055.62	786.6	3512.58
x	1268.20	7971.22	1409.33	8237.62	1537.53	7285.16	83.36	2288.26	563.26	3980.15
σ	82.08	1681.05	74.85	314.91	246.11	981.75	10.61	486.49	193.56	630.41
Min.	1212.80	6460.65	1329.10	8050.55	1253.90	6522.34	71.68	1961.77	443.80	3512.58
Max.	1362.50	9782.24	1477.30	8601.20	1694.80	8392.81	92.43	2847.40	786.60	4697.11

supplements as feed for dairy cows. Figure 1 shows the values for macro-minerals in fresh milk in the two farms.



**Figure 1. Difference of macro-minerals in cow's milk in farms 1 and 2**

Table 3 shows the data obtained from the research against the recommendations from FAO [29], and the values obtained in other research in different countries.

From Table 3 we can see that approximate values for minerals such as Ca, K, P, Mg, and Na in fresh cow's milk gained in our research are similar to some research done for Macedonia (Limani and Karapetkovska-Hristova [7], and Vllasaku, *et al.*, [26]), while in some researches done in Croatia (Sikirić *et al.*, [16]<sup>c</sup>, and Vahcic, *et al.*, [24]), the values for macro-minerals in of fresh milk are higher when compared to our and the researches in Macedonia. From the FAO [29] recommendations for macro-minerals in fresh milk, we see that in Farm 1 we gained 81.69 mg/L of Ca less than these recommendations, while Farm 2 had 148.2 mg/L more Ca when compared to the recommendations. Various scientific studies on the lack of Ca intake in the diet show that it can cause problems in human health. Some of the consequences of the lack of calcium in the body are osteoporosis, rickets, and osteomalacia (U.S. Department of Health and Human Services [21], Zhang *et al.*, [28]; Tandoğan and Ullusu [20]).

For K in farm 1, we have less than 43.84 mg/L, while in farm 2 we have about 40.67 mg/L, less K than the recommendations from FAO. Mainly, the health problems from potassium are very rare because many foods contain potassium. However in cases where there is a lack of potassium in the body, and moderate potassium deficiencies may appear, the presence of potassium in larger amounts in the body has resulted in a protective effect for the organism (Lanham-New *et al.*, [6]; Pohl *et al.*, [14]; Palmer and Clegg [10]; Baryshnikova *et al.*, [2]).

When discussing P, in farm 1 we have more 322.86 mg/L, while in farm 2 we have more 627.53 mg/L P compared to recommendations from FAO [29]. In our study, P is present in abundant values. When discussing P in human health, in cases where it may be lacking in the human diet, several disorders may appear such as anemia, lack of appetite, bone pain, muscle weakness, soft and deformed bones, etc. (U.S. Department of Health and Human Service [22]; Takeda *et al.*, [18]; Penido and Alon [13]).

Regarding the Mg in the researched farms, we can say that in farm 1 we have less than 44.33 mg/L, while in farm 2, 26.64 mg/L less Mg than the recommendations from FAO [29]. Mg is a very important chemical element for many functions in the body, starting from its function in muscles and nerves, the level of sugar in the blood, the production of bones, DNA, etc. The lack of magnesium in the diet causes symptoms such as vomiting, lack of appetite, weakness, muscle cramps, abnormal heart rhythm, etc. (U.S. Department of Health and Human Service [23]; Glasdam *et al.*, [4]; Rude [15]).

Last but not least, for Na in farm 1, we measured more than 119.03 mg/L, and in farm 2 143.26 mg/L more Na than the recommendations from FAO [29]. Sodium plays a very important role in maintaining the balance of blood pressure, taking in higher amounts of salt than

**Table 3. Values for mineral elements in fresh milk in our research and different countries of the world**

Elements (mg/L)	Macedonia	Croatia	FAO	Changes (mg/L) of elements according to (FAO) and our research (Farm 1)	Changes (mg/L) of elements according to (FAO) and our research (Farm 2)
<b>Ca</b>	1122	1 403.94	1120	- 81.69	+ 148.2
<b>K</b>	1174	1582.1	1450	- 43.84	- 40.67
<b>P</b>	786	1053.2	910	+ 322.86	+ 627.53
<b>Mg</b>	80.8	165.01	110	- 44.33	- 26.64
<b>Na</b>	489	490.1	420	+ 119.03	+ 143.26
<b>References</b>	Limani and Karapetkovska-Hristova [7], Vllasaku, <i>et al.</i> , [26]	Sikirić <i>et al.</i> , [16], Vahcic, <i>et al.</i> , [24]	FAO [29]	From this research	From this research

Legend: (-) negative value to the recommendation; (+) positive value on the recommendation.

normal has resulted in increased blood pressure and various cardiovascular diseases (Polychronopoulou *et al.*, [30]; Wilck *et al.*, [27]).

#### 4. Conclusions

- From the experimental results but also the scientific literature, we can conclude that the use of a wide variety of mixed feed for dairy cows (when the breed of cows is the same), the use of other additives in the animal ration such as ready granule concentrates, macro and micro mineral supplements, as well as other supplements in different forms (hard or stone form), have a good impact on the presence of macro minerals in fresh cow's milk. Of course, the impact is also on the human diet, since many age groups are daily users of milk and milk products.

- This research has included two model farms, so it is necessary that other researchers expand with a larger number of farms in our country, and in this way, the research are more complete.

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