Original article

Heavy Metals from Donkey (*Equus asinus*) Milk

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Received 27 October 2019; received and revised form 11 November 2019; accepted 16 December 2019
Available online 30 December 2019

Abstract

Donkey milk is a complex food, beneficial to the human body. It is widely used in the treatment of food allergies and in the nutrition of children suffering from various diseases. Donkey milk was analyzed to assess the level of heavy metals under the influence of lactation. Lactation has influenced the amount of heavy metals. Heavy metals were present in the highest quantities in lactation 4 and the lowest in lactation 1. The following heavy metals in donkey milk were analyzed: Cu, Pb, Fe, Zn, Na, Mg, Al and Cu. The analyzed heavy metals show the highest average values in lactation 4: Fe (1.98 ± 0.03), (Zn 2.03 ± 0.01), Na (192 ± 1.91), Mg (44.72 ± 0.71), Al (5.49 ± 0.20) and Mg (44.72 ± 0.71).

Keywords: donkey, lactation, heavy metals, Cu, Pb, Fe, Zn.

1. Introduction

Milk is one of the most complete foods because it contains proteins, essential fatty acids, lactose, vitamins, minerals, all in a very well established proportion.

Donkey milk contains a number of antimicrobial factors, especially proteins, which play an important role in the immune-modulating system of milk. The high content of antimicrobial factors in donkey milk highlights the beneficial impact on the health of the gastrointestinal system in people with low immune system [4, 10, 11, 12].

Milk by its specific, promising composition is indicated as an alternative source of protein and an intolerance treatment.

Moreover, recently, donkey milk has been proposed as nutritional food, due to bioactive compounds, not only in the diet of infants, but also in patients with osteogenesis deficiencies, premature senescence, coronary heart disease or atherosclerosis therapy and in hypocholesterolemic diets.

These properties give milk the role of a successful surrogate of breast milk, to the detriment of cow's milk, which can cause intolerance by decreasing the health of the baby [1, 2, 3, 4]. The biggest problem is that it can very easily become contaminated and pose a risk to human health. Heavy metals exist in the atmospheric air due to industrial activities, their presence in animal feed, due to their presence in water and soil.

Research on heavy metal residues is diverse and covers very large fields of research. A study on heavy metal residues in milk and dairy products was conducted in Italy, and this study looked at the presence of heavy metals in both milk and dairy products and in the feed administered to sheep.

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Milk and dairy products are an extremely rich and suitable nutritional source for all ages, because of this there are a large number of studies on the influence of heavy metals, especially lead, cadmium, copper, zinc and iron, on the human body [3, 5, 6, 7, 9]. The purpose of this study was the analysis of heavy metals in donkey milk according to lactation.

Material and Method

Donkey milk samples were collected from donkeys in lactation 1-IV (a total of ten samples for each lactation). Donkeys come from small capacity farms in Sălaj and Cluj area. They are exploited in the traditional system. The analysis of heavy metals in donkey milk was analyzed by inductive coupled plasma mass spectrometry or ICP-MS used to identify and quantify the elements Pb, Cd, Cu and Zn at a concentration level of ng/l- μ g /L. 1 mL of milk was used and digested with 8 mL of 65% HNO₃ and 2 ml of 30% H₂O₂.

After cooling to ambient temperature, the milk sample is diluted with 25 ml of ultrapure water, then filtered through a 0.45 μ m cellulose membrane filter. The concentrations of the elements in traces of the mineralized solutions were determined through ICP-MS.

3. Results and Discussions

Tables 1-4 shows the average values, variability and minimum and maximum values for the heavy metals analyzed from donkey milk. The level of Cu in donkey milk varied in the range (0.14 ± 0.01), in lactation 1 and (0.75 ± 0.04), in lactation 4. Lead is in the lowest quantity in lactation 1 and 2 and increases in lactation 3 and 4 (Tables 1 - 4). Fe content in donkey milk varied thus (1.41 ± 0.14) in lactation 1 and (1.98 ± 0.03) in lactation 4. Zn behaves similarly to Fe, in that it is present in the first two lactations in small quantities and increases with the number of lactates.

Table 1. Mean value and variability for Cu and Pb in donkey milk according to lactation

Lactation	n	Cu			Pb		
		X $\pm$ sx	V%	min-max	X $\pm$ sx	V%	min-max
Lactation 1	10	0.14 ± 0.01	20.01	0.11-0.18	0.04 ± 0.01	22.26	0.028-0.046
Lactation 2	10	0.22 ± 0.02	20.83	0.15-0.27	0.07 ± 0.01	20.18	0.048-0.081
Lactation 3	10	0.43 ± 0.04	19.73	0.37-0.54	0.08 ± 0.01	15.57	0.061-0.093
Lactation 4	10	0.75 ± 0.04	13.23	0.58-0.83	0.085 ± 0.01	21.31	0.054-0.098

X – mean value; n- number of lactation specimens taken in the study; min, max - minimum and maximum value; V – variability.

Table 2. Mean value and variability for Fe and Zn in donkey milk according to lactation

Lactation	n	Fe			Zn		
		X $\pm$ sx	V%	min-max	X $\pm$ sx	V%	min-max
Lactation 1	10	1.41 ± 0.14	21.67	0.97-1.67	1.62 ± 0.05	6.68	1.49-1.77
Lactation 2	10	1.87 ± 0.04	4.76	1.76-1.96	1.96 ± 0.02	2.73	1.88-2.01
Lactation 3	10	1.96 ± 0.05	5.37	1.78-2.04	2.01 ± 0.02	1.82	1.97-2.05
Lactation 4	10	1.98 ± 0.03	3.47	1.88-2.05	2.03 ± 0.01	1.23	1.99-2.05

X - mean value; n- number of lactation specimens taken in the study; min, max - minimum and maximum value; V – variability.

Table 3. The mean value and variability for Na and Mg in donkey milk according to lactation

Lactation	n	Na			Mg		
		X $\pm$ sx	V%	min-max	X $\pm$ sx	V%	min-max
Lactation 1	10	119.76 ± 2.72	5.08	111.7-128.4	34.1 ± 1.65	10.80	30.5-38.7
Lactation 2	10	152.06 ± 6.58	9.68	134.7-170.5	40.24 ± 0.81	4.50	37.8-41.4
Lactation 3	10	188.12 ± 4.33	5.15	175.8-198.5	42.06 ± 0.56	2.95	40.3-43.6
Lactation 4	10	192 ± 1.91	2.23	188.5-198.6	44.72 ± 0.71	3.53	42.1-46.1

X - mean value; n- number of lactation specimens taken in the study; min, max - minimum and maximum value; V – variability.

The Na content of donkey milk showed the highest average values in lactation 3 and 4, respectively (188.12 ± 4.33) and (192 ± 1.91) (Table 3). The same can be observed in the case of Mg. Because milk and dairy products are mandatory products in the daily diet, studies of toxic compounds

present or possible contaminants of milk are of real interest; milk and dairy products with a heavy metal content represent a technological problem, a risk on the image of the product, that is a product management problem, but, most importantly, a risk on human health.

Table 4. The mean value and variability for Al and Cr in donkey milk according to lactation

Lactation	n	Al			Cr		
		X±sx	V%	min-max	X±sx	V%	min-max
Lactation 1	10	3.38±0.09	6.04	3.2-3.70	0.42±0.03	17.36	0.32-0.51
Lactation 2	10	4.22±0.09	4.78	4.02-4.56	0.48±0.03	13.18	0.38-0.55
Lactation 3	10	5.03±0.16	7.15	4.62-5.57	0.51±0.02	10.74	0.43-0.57
Lactation 4	10	5.49±0.20	8.05	4.98-6.01	0.68±0.04	14.49	0.58-0.81

X - mean value; n- number of lactation specimens taken in the study; min, max - minimum and maximum value; V – variability.

In lactation 1, the average aluminum content was (3.38 ± 0.09) and (5.49 ± 0.20), in lactation 4. The Cr content varied between (0.42 ± 0.03) in lactation 1 and (0.68 ± 0.04) in lactation 4 (Table 4).

It can be observed that the metals analyzed in milk are in a small quantity in the first two lactations and their quantity increases with the increase of the number of lactations. We can say that lactation influences the assimilation of heavy metals into milk. The data obtained for heavy metals are similar to those obtained in other studies: [1, 2, 5, 8].

4. Conclusions

The heavy metals in donkey milk fall within the maximum allowed limits. Lactation influences the content of heavy metals in donkey milk. They are present in higher quantities in lactations 3 and 4. The heavy metals studied have the lowest content in lactation 1.

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