

Fluorine in Milk

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Abstract

This experiment was conducted in order to determine the concentration of fluorine in cow's milk and human breast milk. Milk samples were tested for fluoride concentration. After fractioning, free fluorine and protein-bound fluorine were tested using an ion-selective electrode. It was determined that concentration of fluorine in tested human breast milk was higher than in cow's milk. The fluorine appeared mainly in free form and only a small fraction was bound to proteins. Complete concentration of fluorine was higher in human breast milk than in cow's milk.

Keywords: fluorine, milk, cow's milk, human breast milk

Introduction

Fluorine, as a trace element with a significant biological role, is necessary in small amounts for proper development of the body. Excess fluorine accumulates and can cause various metabolic disturbances [1, 2]. Fluorine is introduced to the body mainly through food and water, but it can also be inhaled. Increasing fluorine concentration in nature is associated with industrial activity. Excess fluorine in an environment is a threat to plants and animals living there. Fluorine, a very active element upon entering the body, takes part in many metabolic processes, mainly by influencing enzyme activity [3, 4]. An interesting problem is fluorine secretion in mammals' milk. The purpose of this study was to determine the concentration of free and bound fluorine in cow's milk and comparing it to concentrations in human breast milk.

Material and Methods

Our studies were conducted on ten commercially available samples of cow's milk from the Lublin area and on human breast milk, which came from ten women hospitalized in the Perinatology and Obstetrics Clinic of Medical University in Lublin. Samples of human breast milk were collected a moment before the first morning's sucking. They were collected from different women primiparas aged

20-28 years. Samples of milk were collected in polyethylene containers and frozen for 24 hours. After thawing, to 3 ml of milk an equal volume of 1 M HClO₄ was added and left at +4°C for 20 minutes. Next, the samples were centrifuged 5000/min. for 15 min. obtaining supernatant and sediment. After neutralizing the pH of the supernatant by adding 1M NaOH, fluoride ion concentration (free fluoride) was tested [5]. The sediment was transferred to a quartz container and was mineralized at a temperature of 450°C. Next, the ash was dissolved in 50% HClO₄ and neutralized with 30% NaOH and a concentration of fluoride ion (bound fluoride) was tested. All measures of fluoride ion concentration were done using ion-selective electrode's of Orion Company, type 9609 BN and a microcomputer milivolt-meter pH meter CP-531 of the Elmetron Company [6]. In order to attain sufficient ion energy and optimal pH for electrode function, TISAB buffer was added to the standard solutions as well as the tested samples in a constant ratio of 1:1. TISAB buffer consisted 1 M NaCl, 0.001 M NaNO₃, 0.25 M CH₃COOH, 0.75 M CH₃COONa, ionic strength 1.75 mol/L. The calibration curve was obtained by appropriate dilution of 100 ppm NaF standard solution (Orion Co, USA). All measures were conducted at room temperature constantly mixed by a magnetic mixer of Teleko type N5893. Fluoride ion concentration based on measurement voltage was read from the standard curve. The measures were repeated three times. The results were subjected to statistical analysis by Cochran Cox test.

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Table 1. Fluorine concentration in milk (ppm).

	Cow's milk			Human breast milk		
	Ratio value	Average	SD	Ratio value	Average	SD
Free fluorine	0.220 – 0.400	0.293	0.050	0.440 – 0.610*	0.492	0.056
Bound fluorine	0.015 – 0.025	0.019	0.003	0.018 – 0.026	0.021	0.003
Total fluorine	0.262 – 0.422	0.313	0.050	0.454 – 0.628*	0.513	0.055
Ratio of bound to free fluorine	0.05 – 0.09	0.07	0.014	0.03 – 0.06	0.04	0.009

Significant differences in comparison to cow's milk: * - $p < 0.001$

Results

Fluorine concentration in tested samples of milk is presented in Table 1.

In all samples, the significantly higher free fluorine concentration in relation to bound fluorine is obvious. Comparing average values, it can be noticed that only approximately 6% of total fluorine in cow's milk is bound fluorine. Bound fluorine in the case of human breast milk is only 4% of total fluorine. The ratio of bound fluorine to free fluorine is 0.04 and is smaller than in cow's milk (0.07). The comparison of fluorine concentration in cow's milk and human breast milk is illustrated in Figure 1.

Higher concentrations of total fluorine in human breast milk as well as free fluorine is observed. The differences are statistically significant. The values of bound fluorine are similar in tested samples of milk but statistically non-significant.

Discussion

The necessity of tracing fluorine concentrations in the environment is related to its influence on living organisms [7]. Fluorine is a very active element and easily enters into reactions with other compounds [8, 9, 10]. Fluorine assimilation by the human organism takes place mainly in diet, and milk is a major item in nutrition [11]. Studies have shown that fluorine appears mainly as a free fluoride ion and only a small portion is bound to protein. These results are similar to those of other authors [12]. The concentrations of fluorine in cow's milk are lower in comparison to concentration in human breast milk. Slightly higher concentrations of fluorine in human breast milk may be connected with the necessity of providing the organism of the

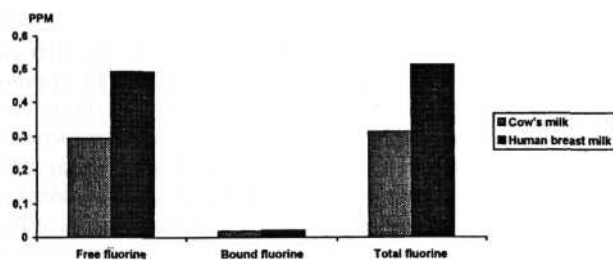


Fig. 1 The comparison of average fluorine concentrations in cow's milk and human breast milk.

new-born an appropriate dose of this element. The body of a pregnant woman can regulate the availability of fluorine to the foetus by uptaking and storing this element [13, 14]. Higher concentrations of fluorine can be the result of increased introduction of this element of fluorine in human breast milk, and may vary according to the age of the baby. According to our results, a significant fraction of the fluorine is in free form. This may be connected with the possibility that the fluoride reacts with other compounds and influences metabolism.

Conclusions

1. Fluorine concentration in human breast milk was higher than in samples of cow's milk.
2. In the tested samples of milk, fluorine appeared mainly in free form and only a small portion was bound to proteins.

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