Effect of vitamin e and selenium supplementation on the antioxidant content of milk and dairy products in dairy cows

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SUMMARY

In 2007, the aim of the Ányos Jedlik program and the call for tenders was to support application-oriented, strategic research and development projects, which can increase the competitiveness of the Hungarian economy. In the framework of our project, we intended to examine whether non-protected antioxidants - in this case: vitamin E and selenium – used as feed-additives can increase the antioxidant content of milk. The milk with an increased level of vitamin E and selenium content can be used for producing functional foods which will represent competitive products on the current market of milk products. Our results show that the use of vitamin E and selenium as feed-additives can significantly increase the amount of vitamin E and selenium in the milk and also in the diary products.

LITERATURE

Damage of the redox homeostasis in animals and the human body - as the latest research justify – could be the starting point of many diseases. The importance of antioxidant compounds comes from the fact that during the operation of the immune system, there are many highly reactive compounds generated, e.g. nitrogen and oxygen-free radicals. The organism as a whole - including the immune system itself - should be protected from the harmful effects of free radicals and this requirement is partly responsible for the need for antioxidant vitamins (Katner, 1998). We can see in the Hungarian population through mortality statistics that poor diet and lifestyle are responsible for morbidity and mortality. Nowadays, increasingly more people are being diagnosed with civilization-determined diseases: cardiovascular disease, osteoporosis, and unfortunately, cancer develop regardless of age (Jónás, 2001). To prevent and cure such diseases, functional foods could be used. The goal in the development of functional foods is to significantly enrich food with beneficial compounds which are proven to be beneficial for the body (Prokisch, 2008). To develop functional food, milk is suitable as a basic material, which is a valuable food itself. For this reason, we performed our antioxidant feeding experiments on dairy cattle. We used vitamin E and selenium among of the antioxidants. Experiments showed that antioxidant supplementation has also a significant effect in meat quality. Research results show that for 3 weeks before slaughter, feeding of 275 IU vitamin E increased the vitamin E content of turkey tissues from 1.6 mg/kg to 5 mg/kg (Sheldon, 1984). The addition of organic selenium increased selenium content in eggs and poultry meat significantly (Honey, 2004). In Japanese quail feeding experiments, it was also found that feeding inorganic selenium significantly increased the selenium content of eggs (Poland et al, 2004). Studies on the uptake of selenium in poultry found, that from sodium selenite the utilization of selenium was better than that of seleno-methionine (Lawson et al, 1986; Sarudi et al, 2004). Sarudi et al (2004) also performed poultry feeding experiments with sodium selenite and organic selenium, and there were no significant differences between the selenium contents of the eggs. In addition, selenium and vitamin E are synergistic. It has been showed that selenium intake helps to decrease the absence of vitamin E (Gavrilovic and Matesic, 1984). Others examined the effectiveness of selenium therapy against "white muscle disease" in lambs, calves and foals, and the prevention of hepatitis in pigs. (Pais, 1980). A daily requirement of vitamin E for an adult person - according to the WHO - is 12 mg, and 0.12 mg from selenium. This quantity can be supplied into the body with adequate nutrition.

OBJECTIVE

In our experiment, we were looking for the answer as to with which non-protected antioxidants – in our case with vitamin E and selenium – could we increase the antioxidant contents of milk and dairy products. We investigated the following aspects.

Studies on milk:

- the effect of different doses of vitamin E on the antioxidant content of milk
- the effect of organic and inorganic selenium on the antioxidant content of milk
- the effect of Vitamin E and organic or inorganic selenium on the antioxidant content of milk

Studies on dairy products:

- the antioxidant content of dairy products, which were made from high antioxidant content milk

MATERIALS AND METHODS

We did our feeding experiments between 15-29 September 2010. at the Körös-Maros Biofarm Ltd. We used Holstein-Friesian dairy cattles. The vitamin E and organic selenium (Sel-Plex 2300) from the Agrofeed Ltd., the organic selenium (Se 1%) from Alltech Hungary Ltd were obtained. We applied individual feeding, once a day for 14 days. We constructed 7 groups. Every group contained 5 animals. The groups were homogeneous about stages of lactation and production records.

Groups:
-1. group, vitamin E supplement, 800 mg/individual/day
-2. group, vitamin E supplement, 1 900 mg/individual/day
-3. group, vitamin E supplement, 3 800 mg/individual/day
-4. group, organic Se supplement, 10 mg/individual/day
-5. group, organic Se 10 mg/individual/day and 1 900 mg vitamin E/individual/day supplement
-6. group, inorganic Se supplement, 10 mg/individual/day
-7. group, inorganic Se 10 mg /individual/day and 1 900 mg vitamin E/individual/day supplement

During cheese processing we used 10 liters milk for 1 kg of 30% fat cheese and 3 liters milk for 1 kg of 3% fat yoghurt. Milk and milk products (cheese, yoghurt) were frozen until the laboratory tests. The Food-Analitika Szolgáltató és Innovációs Ltd. made the laboratory analysis. For the statistical analysis we used SPSS 13.0 and the testing of results paired t test was applied.

RESULTS AND DISCUSSION

Results of the milk analysis

Vitamin E, organic and inorganic selenium feeding experiment results

The first three lines of the *Table 1* contain the three different doses of vitamin E supplement group results. In groups 1 and 3, we can statistically prove, that the amount of vitamin E changed significantly in milk ($p = 0.005$ and $p = 0.022$). In group 2, significant increase in the volume of the vitamin was not detected ($p = 0.062$). The last two rows of the table you can see the results of those two groups, which were given pure (organic and inorganic) selenium supplement. The amount of selenium in the milk increased significantly ($p = 0.008$ and $p = 0.007$) in both groups. We can calculate from the data, that while the organic selenium increased 100%, the inorganic selenium increased 255%. Thus inorganic selenium increases the selenium content of milk more effectively than organic selenium.

Table 1

The change of vitamin E and selenium content in milk (µg/kg)

Groups (supplementation mg/nap)	Before treatment	After treatment	Increase
1. group (vitamin E 800 mg/day)	588 a	1 125 b	537
2. group (vitamin E 1 900 mg/day)	698 a	1 142 a	444
3. group (vitamin E 3 800 mg/day)	533 a	1 544 b	1 011
4. group (organic Se10 mg/day)	46 a	92 b	46
6. group (inorganic Se10 mg/day)	22 a	78 b	56

The combined vitamin E and selenium feeding experiment results

Table 2 contains the results of those two groups which groups received selenium and vitamin E supplementation at the same time. Group 5 got organic selenium and group 7 received inorganic selenium. We found significant differences in both groups in vitamin E and selenium levels. The results show that these groups, which got half the amount of vitamin E compared to group 3 (see *Table 1*), produced the same amount of vitamin in the presence of inorganic selenium.

Table 2

The co-change of vitamin E and selenium content of milk

Groups (1 900 mg vitamin E + 10 mg Se supplement / day)	Vitamin E (µg/kg)			Selenium (µg/kg)		
	Before treatment	After treatment	Increase	Before treatment	After treatment	Increase
5. group (organic Se)	751 a	1221 b	470	40 c	138 d	98
7. group (inorganic Se)	693 a	1485 b	739	38 c	136 d	98

Results of the dairy products analysis

Vitamin E and selenium test results

The results in *Table 3* show that the vitamin E contents of the control milk and cheese were similar to those for the experimental milk and cheese. The amount of vitamin E in the experimental yoghurt is just half that compared to the control product. We did not find any significant difference in the antioxidant level between the control and with the organic and inorganic selenium enriched milk. In contrast, we could detect significant differences between the products. The selenium residue of the control cheese was 67% and 23% of the yoghurt. The cheese, which was made from the organic selenium enriched milk contained 87% selenium residue, and the yoghurt contained 49%. The cheese, which was made from the inorganic selenium enriched milk, had selenium residues in 100% and 53% of the yoghurt. It can be concluded that the most significant change was achieved by using the inorganic selenium.

Table 3

The change of vitamin E and selenium content of dairy products (µg/ kg)

Product	E-vitamin content		Selenium content		
	Control	After vitamin E treatment	Control	After organic Se treatment	After inorganic Se treatment
Milk	760	1 640	260	330	320
Cheese	3 950	8 900	1 750	2 880	3 200
Yoghurt	390	450	180	490	510

The combined vitamin E and selenium results

Table 4 shows us the results of those products which were made from the increased vitamin E and selenium content milk. As we see, there is dynamic increase in the antioxidant content, just as is shown in *Table 3*. It can be stated that we got the best results when vitamin E and the inorganic selenium were used together.

Table 4

The co-change of vitamin E and selenium content of dairy products (µg/ kg)

Product	Vitamin E content			Selenium content		
	Control	Before treatment with vitamin E + organic Se	After treatment with vitamin E + organic Se	Control	Before treatment with vitamin E + organic Se	After treatment with vitamin E + organic Se
Milk	760	1 390	1 170	260	290	290
Cheese	3 950	7 120	6 450	1 750	3 470	3 640
Yoghurt	390	1 040	1 170	180	580	630

CONCLUSIONS

Our experiments were designed to show how feed supplementation - in our cease vitamin E and selenium – in dairy cows can increase the antioxidant content of milk. Our results show that use of vitamin E and selenium as feed-additives can significantly increase the amount of vitamin E and selenium in milk, and in the diary products. We gave three different doses of vitamin E for three groups. Two groups had significant increases in the amount of vitamin. Both organic and inorganic selenium has increased significantly the selenium content of milk. The inorganic selenium increased more the selenium content of milk than did organic selenium. It was also found that we could achieve the best results when vitamin E and inorganic selenium are combined. We made dairy products from the milk, which was enriched with vitamin E. We could not find any differences about the antioxidant content between the control and the experimental products. However, using vitamin E with organic or inorganic selenium, we achieved massive change in the antioxidant levels. In case of selenium in the products, selenium requires further research. Based on these results, we can say that we are able to develop dairy products, which can expand the range of functional products. With consumption of 20 g of "Vitamin E Cheese", we can cover 12% of our daily vitamin E needs.

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