Selenium content in tissues and meat quality in rabbits fed selenium yeast

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ABSTRACT: Ten weaned rabbits were fed a basal (control) diet containing 0.12 mg Se/kg. In 10 rabbits the basal diet was supplemented with Se-enriched yeast to increase the Se concentration to 0.50 mg/kg. Rabbits were slaughtered at the age of 11 weeks. Samples of meat, liver and hair of 4 rabbits from each group were taken and analyzed. No effect of Se on growth, feed conversion and dressing out percentage was observed. Loin and hindleg meat, liver and hair of control rabbits contained 93, 98, 521 and 267 μg Se/kg, respectively (average values). In treated rabbits the corresponding Se concentrations were 400, 389, 1 414 and 914 μg/kg. Supranutritional Se supply had no effect on the activity of glutathione peroxidase in meat, and oxidative stability of meat expressed as production of thiobarbituric acid-reactive substances in meat stored for 3 and 6 days. Thus, the enrichment of meat with Se is the main benefit of Se supplementation of rabbit diets.

Keywords: rabbits; selenium; meat

Fifty years ago, selenium (Se) was recognized as an important trace element, essential for human and animal health (Schwarz and Foltz, 1957). Se in the form of selenocysteine is the central structural component of various selenoproteins. Selenoproteins with known functions include five glutathione peroxidases (GSH-Px), two deiodinases, thioredoxin reductases and selenophosphate synthetase (Behne and Kyriakopoulos, 2001). The five GSH-Px detoxify H_2O_2 and fatty acid derived hydroperoxides, thus contributing to the antioxidant defence against reactive molecules and free radicals, and complement the effects of vitamin E. Se enters the food chain through plants. Selenomethionine (SeMet) and selenocysteine are the most common organic Se sources in foods. SeMet is incorporated into general proteins by the same codon as that to methionine, thus it is feasible to enrich the meat of animals with Se when excessive SeMet is given to animals.

Adequate intake of Se is needed to decrease the risk of several serious diseases in humans (Hartikainen, 2005). The recommended dietary intake of Se for adults is 55 μg/day. In pregnant and lactating women the estimated value for adequate supply is 60 and 70 μg/day, respectively (Surai, 2006). In many regions of the world including Central Europe the recommended Se intake is not achieved (Rayman, 2004). Consequently, it is desirable to increase the Se content in animal products. The consumption of rabbit meat is not high in the Czech Republic, nevertheless the enrichment of rabbit meat with Se may increase its attractiveness for consumers. Previous studies showed that the feeding of supplemental organic Se increased Se content in animal tissues (Molnár et al., 1998; Pavlata et al., 2001; Leng et al., 2003). In addition, a correlation exists between the Se concentration and the activity of GSH-Px in meat (Scholz et al., 1981; Daun et al., 2001). Therefore, the supplementation

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of diets with Se may also increase the oxidative stability of meat. Information on the effects of dietary Se on Se deposition and meat quality in rabbits is scarce. A study of Erdélyi et al. (2000) was focused on the effect of supranutritional Se on Se concentration in blood and liver, and GSH-Px activity in tissue samples. Thus, the aim of this study was to investigate deposition of Se in meat, and the effect of supplemental Se on meat quality in rabbits fed a diet enriched with organic Se.

MATERIAL AND METHODS

Animals and diets

Ten Hyplus rabbits, weaned at 5 weeks of age, were fed a granulated diet containing 0.12 mg Se/kg. In ten rabbits the basal diet was supplemented with Se-yeast (Sel-Plex, Alltech) to increase the Se concentration to 0.50 mg/kg. Rabbits were housed individually in stainless mesh cages. The environmental temperature was about 16°C and the humidity ca 65%. The rabbits had *ad libitum* access to feed and water. Ingredients and chemical composition of diets are shown in Table 1. Consumption of feeds was recorded individually. Animals were weighed in one-week intervals. No rabbit died in the course of the trial. Rabbits were slaughtered at 11 weeks of age. Hot carcass weight including head, liver, kidney and perirenal fat was measured 15–30 min after slaughter (Blasco and Ouhayoun, 1996). Dressing out percentage was calculated as the proportion of hot carcass weight from live weight.

Sampling and analyses

Loin and hindleg meat, liver and hair of four rabbits selected by random from each group were analyzed. Samples of liver and meat were taken 24 h *post mortem* and stored at –40°C. Meat samples for GSH-Px assay were stored at –70°C. Feed and meat dry matter (DM) was determined by oven drying at 105°C, and fat by extraction with petroleum ether in Soxtec 1045 apparatus (Tecator Comp., Sweden). Contents of feed protein and fibre were determined employing instruments Kjeltec Auto 1030 Analyser and Fibertec 2010 from the same firm; ash after burning at 550°C. To determine Se, feeds, tissues, and hair were mineralized using the microwave digestion technique in a closed system (Milestone Ethos TC, Italy), in the presence of HNO_3 and H_2O_2. Se in processed samples was measured by the atomic absorption spectrometry (Solaar M-6 instrument, TJA Solutions, U.K.). The analytical procedure was validated by the analysis of a certified reference material RM 8414 Bovine Muscle (NIST).

Table 1. Ingredients and determined chemical composition of the basal[1] rabbit diet

Ingredients (%)		Chemical composition (g/kg)	
Lucerne meal	30	dry matter	906
Wheat bran	26	crude protein	166
Barley	14.5	crude fibre	161
Oat	6	fat	41
Sugar beet pulp	4	ash	73
Sunflower meal (extracted)	13	Se	1.2×10^{-4}
Soybean meal (extracted)	2		
Rapeseed oil	1.5		
Mineral supplement[2]	2		
Supplement of vitamins and trace elements [3]	1		

[1]Experimental diet was supplemented with Se at 0.38 mg/kg

[2]limestone, dicalcium phosphate, and salt

[3]per 1 kg: vitamin A 1 200 000 IU, vitamin D_3 20 000 IU, alpha-tocopherol 5 g, vitamin K_3 200 mg, vitamin B_1 300 mg, vitamin B_2 700 mg, vitamin B_6 400 mg, vitamin B_{12} 2 mg, niacin amide 5 g; calcium pantothenate 2 g, biotin 20 mg, folic acid 170 mg, choline 60 g, DL-methionine 100 g, L-lysine HCL 20 g, sodium salinomycinate 2 250 mg, cobalt 100 mg, copper 2 g, iron 5 g, iodine 120 mg, manganese 4.7 g, zinc 5 g, selenium 15 mg, antioxidant 10 g

Table 2. Growth, feed intake, feed conversion and carcass yield in rabbits[1] fed a basal diet and diet supplemented with Se-yeast (mean values ± SD)

	Control	Se
Initial weight (g)	1 015 ± 19	1 016 ± 25
Final weight (g)	2 944 ± 319	2 801 ± 302
Weight gain (g)	1 929 ± 320	1 785 ± 305
Feed intake (kg)	6.21 ± 0.96	5.56 ± 0.68
Feed/gain (kg/kg)	3.22 ± 0.14	3.11 ± 0.29
Carcass yield (%)	60.1 ± 1.3	60.0 ± 2.0

[1]10 rabbits/group

Table 3. Dry matter (DM), fat and Se concentration in loin and hindleg meat of rabbits[1] fed a basal diet and diet supplemented with Se-yeast (mean values ± SD)

	Loin		Hindleg	
	control	Se	control	Se
DM (g/kg)	250 ± 4	250 ± 4	267 ± 12	266 ± 11
Fat (g/kg)	10.6 ± 1.5	8.7 ± 2.5	44.8 ± 13.8	37.7 ± 11.5
Se (µg/kg)	93 ± 3	400 ± 26*	98 ± 13	389 ± 34*

[1]meat of 4 rabbits per group was analyzed

*significant effect of Se supplementation ($P < 0.05$)

The activity of GSH-Px was measured with tert-butyl hydroperoxide as a substrate by a coupled assay, recording the oxidation of NADPH by the decrease in absorbance at 340 nm. The activity was expressed as µmol NADPH oxidized min/g meat or liver tissue (DeVore and Greene, 1982). Lipid oxidation in minced meat samples was measured by the thiobarbituric acid method of Piette and Raymond (1999) and results were expressed s thiobarbituric acid-reactive substances (TBARS) in mg of malondialdehyde per kg muscle.

The *t*-test was used to evaluate the effects of Se supplementation.

RESULTS

No effect of Se on growth, feed conversion and dressing out percentage was observed (Table 2). Loin and hindleg meat of rabbits fed the Se-supplemented diet contained four times more Se than meat of control rabbits. The content of DM and fat in meat was not significantly influenced (Table 3). Concentrations of Se in the liver and hair exceeded those in meat. Supplementation with Se significantly increased Se concentration in liver and hair by 171 and 242%, respectively.

Table 4. Concentration of Se in liver, hair, and activity of GSH-Px in loin meat of rabbits[1] fed a basal diet and diet supplemented with Se-yeast (mean values ± SD)

	Control	Se
Se in liver (µg/kg)	521 ± 58	1 414 ± 48*
Se in hair (µg/kg)	267 ± 33	914 ± 142*
GSH-Px in meat (U/g)[2]	1.29 ± 0.48	1.49 ± 0.50

[1]meat of 4 rabbits per group was analyzed

[2]expressed as µmol NADPH oxidized min/g meat

*significant effect of Se supplementation ($P < 0.05$)

Table 5. Production of thiobarbituric acid-reactive substances (TBARS, mg MDA/kg) in loin and hindleg meat of rabbits[1] fed a basal diet and diet supplemented with Se (mean values ± SD)

	Loin		Hindleg	
	control	Se	control	Se
Day 0	0.94 ± 0.04	0.80 ± 0.14	0.83 ± 0.20	0.95 ± 0.22
Day 3	1.13 ± 0.26	1.13 ± 0.25	1.14 ± 0.17	1.73 ± 0.40
Day 6	1.70 ± 0.46	1.59 ± 0.32	1.86 ± 0.44	2.28 ± 1.10

[1]samples from 4 rabbits per group were analyzed
MDA, malondialdehyde

There was no treatment effect on GSH-Px activity in loin meat (Table 4). Dietary Se did not influence the formation of TBARS in meat stored for 3 and 6 days at 4°C (Table 5).

DISCUSSION

The nutritional requirement of rabbits for Se is low, only 0.08 mg per kg of feed (NRC, 1977). Thus, it is not surprising that the Se supplementation did not significantly influence the rate of growth, feed efficiency and carcass yield. Se was well deposited in all tissues examined. Rabbits did not differ in this respect from other animals. The supplement of Se increased Se concentration in meat of broiler chickens (Ševčíková et al., 2006), pigs (Goehring et al., 1984), calves (Pavlata et al., 2001), and in eggs (Skřivan et al., 2006). One hundred and forty g of meat of Se-fed rabbits would cover the recommended Se daily intake for adults (Rayman, 2004). High Se exposure could be detrimental. However, it should be mentioned that toxic Se doses are more than 10 times higher than the physiological requirement (Surai, 2006).There was no treatment effect on DM and fat content of meat.

Erdélyi et al. (2000) did not observe a relationship between the Se status and the GSH-Px activity in femoral muscles of rabbits. On the other hand, several authors reported a correlation between GSH-Px activity and Se content of tissues of poultry (Daun and Åkesson, 2004), pigs (Daun et al., 2001) and cattle (Scholz et al., 1981; Gatellier et al., 2004). This relationship was not observed in our experiment with rabbits. According to Lee et al. (1979) rabbit liver and kidney contain a sufficient level of non Se-dependent GSH-Px, whereas lungs, heart, spleen, erythrocytes and plasma have only the Se-dependent GSH-Px activity. This makes rabbits poorly responsive to dietary Se deficiency. The increase in the dietary Se level from 0.12 to 0.50 mg/kg did not decrease oxidation of lipids expressed as production of TBARS. Therefore, in rabbits the supranutritional Se supply has a limited potential for increasing the oxidative stability of meat. It can be concluded that the enrichment of meat with Se is the main benefit of Se supplementation of rabbit diets.

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