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EFFECT OF DIETARY SELENIUM ON SELENIUM CONTENT AND ANTIOXIDANT STATUS OF TISSUES OF VEAL CALVES

Two experiments (I and II) were carried out on veal calves fed a milk replacer and a starter concentrate with or without supplemental linseed. Control calves received the basal diet containing selenium (Se) at 0.10 - 0.13 mg per kg of solids, other calves the same diet supplemented with Se-enriched yeast to increase Se concentration to 0.50 mg/kg. There was no effect of diets on growth rate, feed intake and chemical composition of meat (M. longissimus thoracis et lumborum). Feeding Se-yeast resulted in two-fold higher concentration of Se in meat (as much as 0.69 mg/kg) and faeces. Hepatic concentration of Se was non-significantly increased by < 20%. Activity of glutathione peroxidase (GSH-Px) was the same in meat of control and treated calves in experiment I, but significantly increased in treated calves in experiment II. Hepatic activity of GSH-Px was significantly higher in Se-supplemented calves both in experiment I and II. The oxidative stability of meat expressed as production of thiobarbituric acid-reactive substances was non-significantly improved by Se-yeast in both experiments. Feeding Se-yeast to calves thus represents a means for improving the nutritive value of veal.

Key words: *calves, meat, selenium, oxidative stability.*

Selenium (Se) has been recognized in fifties as an important essential trace element [1]. More than twenty selenoproteins have been identified in eukaryotic organisms since that time. These include glutathione peroxidases (GSH-Px), thyroid hormone deiodinases, thioredoxin reductases, selenophosphate synthetase and several other enzymes [2]. The four GSH-Px detoxify H_2O_2 and fatty acid derived hydroperoxides, thus are considered important antioxidant selenoenzymes. In areas where soils are low in Se, Se deficiencies can cause health risks for humans [3]. In majority of European countries the recommended Se intake (55 μg per day for adults) is not achieved [4]. Thus, the increased consumption of meat enriched with Se may improve the Se status in humans. Several studies have shown that feeding supplemental organic Se increases Se content in animal tissues [5, 6, 7]. In addition, a correlation exists between the Se concentration and activity of GSH-Px in veal [8], beef and pork [9]. The supplementation of diets of farm animals thus may also increase the oxidative stability of meat. Meat is susceptible to lipid oxidation, which leads to quality deterioration. The oxidation of meat lipids after slaughter can adversely affect the flavour and nutritive value of meat and meat products. In recent years, meat animals are often fed unsaturated lipids (oils and oilseeds) to elevate content of polyunsaturated fatty acids which are beneficial to human health. Lipids containing polyunsaturated fatty acids are particularly prone to attack by oxygen radicals. The presence of various antioxidants

in meat such as GSH-Px, vitamins C, E and ubiquinone provides a great protection against oxidation of lipids [10]. This paper summarizes results of two experiments on veal calves fed a diet with or without supplemental linseed. Calves of experimental groups were fed diets supplemented with Se-enriched yeast.

Materials and Methods. *Animals and diets*. Holstein bulls, 3 to 4 weeks of age at the start of the experiment were fed a milk replacer Telasan V (Bodit Tachov, Czech Rep.) and a starter concentrate Telstar (Zea Sedmihorky, Czech Rep.). The milk replacer was supplied twice a day at 0.4 kg in 3 l of water. The starter was available *ad libitum* and its consumption was measured. Six bulls per a treatment were used. Calves of control groups received the basal diet without a Se supplement. Concentration of Se in the basal diet varied depending on starter intake from 0.10 to 0.13 mg/kg feed solids. Calves of Se-supplemented groups received the basal diet with Se-yeast (Sel-Plex, Alltech) to achieve a final Se concentration of 0.50 mg/kg feed. Two experiments, I and II were carried out. In the latter experiment calves received Telasan V enriched with 4% of linseed, to increase dietary concentration of unsaturated lipids. Water was available *ad libitum*. Animals were slaughtered after 125 and 105 days in experiment I and II, respectively.

Sampling. Faeces were collected for 5 days, 3 weeks before the slaughter. After slaughter, samples of liver were taken and immediately frozen. The carcasses were rapidly chilled and samples of *M. longissimus thoracis et lumborum* (MLT) were obtained 24h postmortem and stored at -40°C. Samples for enzyme assays were stored at -70°C.

Analyses. The drip loss was estimated during the period 24-48h after slaughter, by weighing the drip collected from 100 g of the MLT during hanging in a plastic bag at 4°C. Feeds and samples of MLT were air-dried at 105°C to determine the dry matter content. Crude protein and fat were determined using Kjeltec AUTO 1030 Analyzer and Soxtec 1043 instruments (Tecator Comp., Sweden), respectively. Petrol ether was used for fat extraction. Content of fibre in feeds was determined using Fibertec 2010 from the same firm. Feeds, tissues and faeces were mineralized employing 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 procedure was validated by the analysis of a certified reference material RM 8414 Bovine Muscle (NIST).

Table 1

Composition of feeds of calves (per 1 kg)

	Milk replacer[1]	Starter concentrate[2]
Dry matter (g)	930	860
Crude protein (g)	220	200
Fat (g)	190	29
Fibre (g)	13	42
Ash (g)	70	62
Se (mg)	0.034	0.15

[1]Telasan V contained milk, plant oils, oilseeds, yeast, soyabean meal, cereal products, vitamin and mineral supplements. In experiment II Telasan V was enriched with 4% of linseed.

[2]Telstar contained cereals, cereal by-products, oilseed cake, by-products of the sugar industry, antioxidant, vitamin and mineral supplements. Calves of Se-supplemented groups received Telstar enriched with Se-yeast.

The activity of GSH-Px in tissues was assayed with tert-butyl hydroperoxide as a substrate by recording the oxidation of NADPH at 340 nm. This activity was expressed as μmol NADPH oxidised per minute per g of tissue [11]. Stability of lipids in minced MLT was measured by the thiobarbituric acid method [12] and results were expressed as thiobarbituric acid-reactive substances (TBARS) in mg of malondialdehyde per kg muscle.

The *t*-test was used to assess the significance of differences between groups.

Results and Discussion. Calves fed the control diet and diet supplemented with Se gained on average 924 and 947, and 1098 and 1130 g per day in experiment I and II, respectively (Table 2). Effect of Se on weight gain was not statistically significant. No effect of Se supplementation on quality traits of meat was observed (Table 3). In both experiments, the supplementation of diets with Se-yeast significantly increased Se concentration in MLT and faeces. Hepatic concentrations of Se in treated calves were non-significantly increased by 19.1% and 16.7% in the I^{st} and the II^{nd} experiment, respectively (Table 4). Activity of GSH-Px was the same in MLT of control and treated calves in experiment I, but significantly increased in treated calves in experiment II. In both experiments hepatic activity of GSH-Px was significantly higher in Se-supplemented animals (Table 5). The oxidative stability of meat expressed as production of TBARS was non-significantly improved by Se-supplementation, both in experiment I and II.

The effect of supplemental Se on feed intake and performance of calves was marginal, probably because the Se concentration in the control diet satisfied the nutritional requirement of calves for this element (0.10 mg Se per kg of feed dry matter), as set by NRC [13, 14].

Table 2

Performance and feed intake in calves[1] fed control diets and diets supplemented with Se-yeast

	Experiment I			Experiment II	
	Control	Se- yeast		Control	Se- yeast
Exp. duration (days)	125	125		105	105
Initial weight (kg)	57.5 ± 5.7	58.6 ± 6.1		48.2 ± 5.7	48.1 ± 6.0
Final weight (kg)	173.0 ± 15.0	177.0 ± 13.9		163.5 ± 19.8	166.7 ± 23.5
Intake (kg):					
Milk replacer	100	100		84	84
Starter	233 ± 22	245 ± 24		234 ± 128	204 ± 131

Means ± S.D. [1]Six calves per group

Table 3

Quality parameters of M. longissimus thoracis et lumborum (MLT) of calves[1] fed control diets and diets supplemented with Se-yeast

	Experiment I			Experiment II	
	Control	Se- yeast		Control	Se- yeast
pH_{24h}	5.5 ± 0.1	5.6 ± 0.3		5.6 ± 0.2	5.7 ± 0.2
Drip $loss_{24h}$ (%)	1.9 ± 0.7	1.2 ± 0.2		1.4 ± 0.2	1.4 ± 0.5
Dry matter (g/kg)	228 ± 3	227 ± 7		229 ± 13	228 ± 6
Protein (g/kg)	200 ± 3	202 ± 4		202 ± 9	203 ± 4
Fat (g/kg)	5.1 ± 1.6	5.7 ± 2.2		5.5 ± 1.6	6.6 ± 2.4

Means ± S.D. [1]Six calves per group

Supplementation of diets with Se doubled the Se concentrations in MLT without affecting other meat quality parameters. Comparable Se concentrations have been reported in meat of lambs fed a Se-supplemented diet [5]. O´Grady et al. [15] suggested that dietary Se had limited potential for increasing the oxidative stability of meat. Our results neither support nor deny this opinion. In both experiments, the oxidative stability of meat was improved in treated calves, the effect of Se-yeast, however, was not statistically significant due to high variability of findings. The elevation of Se content in meat of treated calves was accompanied by a significantly higher activity of GSH-Px in experiment II, but not in experiment I.

Table 4

Concentration of Se (mg/kg) in M. longissimus thoracis et lumborum (MLT), liver and faeces of calves[1] fed control diets and diets supplemented with Se-yeast

	Experiment I			Experiment II	
	Control	Se-yeast		Control	Se- yeast
MLT	0.35 ± 0.08	0.69 ± 0.10*		0.21 ± 0.04	0.43 ± 0.05*
Liver	1.57 ± 0.68	1.87 ± 0.46		1.50 ± 0.08	1.75 ± 0.10
Faeces	0.94 ± 0.28	2.13 ± 0.69*		0.67 ± 0.13	1.29 ± 0.34*

Means ± S.D.[1]Six calves per group*Significantly different from the control value ($P < 0.05$)

Table 5

Activity of glutathione peroxidase (GSH-Px) in meat and liver, and production of thiobarbituric acid-reactive substances (TBARS) in M. longissimus thoracis et lumborum (MLT) of calves[1] fed control diets and diets supplemented with Se-yeast

	Experiment I			Experiment II	
	Control	Se- yeast		Control	Se- yeast
GSH-Px in MLT[2]	0.41 ± 0.13	0.42 ± 0.11		0.32 ± 0.05	0.50 ± 0.06*
GSH-Px in liver	2.89 ± 0.33	5.61 ± 0.63*		2.77 ± 0.72	4.63 ± 0.31*
TBARS[3]					
Day 0	0.07 ± 0.04	0.09 ± 0.05		0.07 ± 0.02	0.06 ± 0.01
Day 3	0.38 ± 0.24	0.18 ± 0.06		0.83 ± 0.20	0.75 ± 0.38
Day 6	0.95 ± 0.59	0.41 ± 0.21		2.22 ± 0.59	1.82 ± 0.74

Means ± S.D.[1]Six calves per group[2]Expressed as μmol NADPH oxidised min^{-1} g^{-1} meat or liver tissue[3]Expressed in mg malondialdehyde per kg *Significantly different from the control value ($P < 0.05$)

In accordance with other studies [8, 16] the hepatic activity of GSH-Px responded well to dietary Se supplementation. Contrary to our expectation, the hepatic Se concentration was only slightly increased in calves on Se-supplemented diets.

Conclusions

Thus, it can be concluded that the enrichment of meat with Se is the main benefit of supplementation of diets of veal calves with Se-yeast. Consumption of meat of veal calves fed a Se-supplemented diet would provide a means for improving the Se status in humans

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Резюме

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ВПЛИВ ХАРЧОВОГО Se НА ЙОГО ВМІСТ І ОКСИДАНТНИЙ СТАТУС ТКАНИН ВІДГОДІВЕЛЬНИХ ТЕЛЯТ

Два експерименти (I і II) проводилися на відгодівельних телятах, яким згодовували замінник молока і стартерні концентрати із зернольоновою добавкою або без неї. Контрольні телята утримувалися на основному раціоні, який містив Se 0,1 до 0,13 мг/кг сухої речовини, інші тварини утримувалися на такому ж раціоні, додатково отримуючи Se- збагачену дріжджову добавку, з метою підвищення концентрації селену до 0,5 мг/кг. Не спостерігалося впливу раціону на прирости живої маси, споживання кормів і хімічний склад мяса (M. longissimus thoracis et lumborum). Згодовування дріжджового селену сприяло двократному зростанню концентрації Se в м'ясі (до 0,69 мг/кг) і фекаліях. У печінці концентрація не вірогідно збільшувалася на < 20 %. Активність глютатіонпероксидази (GSH-Px) була такою ж в м'ясі контрольних і дослідних телят в експерименті I, але вірогідно зростала у телят за експерименту II. Гепатична активність GSH-Px вірогідно була вищою у телят, яким згодовували Se-вмісну добавку у двох експериментах I і II . Окиснювальна стабільність м'яса, що виражалася продукцією активних речовин тіобарбітурової кислоти не вірогідно покращувалася дріжджовим селеном у обох експериментах. Отже, згодовування дріжджового селену телятам сприяє покращенню поживної цінності м'яса відгодівельних телят.

Ключові слова: *телята, м'ясо, селен, окиснювальна стабільність.*