THE PORK MEAT ENRICHED WITH ORGANIC SELENIUM AND ITS EFFECT ON SELENIUM CONCENTRATION AND TOTAL ANTIOXIDANT STATUS IN HEALTHY VOLUNTEERS

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Abstract: It is known that organic selenium (Sel Plex) supplemented to pig feed mixture is significant for effective transport of essential element selenium to the food chain. It enables to create important body deposits of selenium in skeletal muscles and it also increases selenium transfer in natural metabolic form of selenomethionine into functional food. The intake of feed mixture with increased organic selenium at the dose of 0.3 mg kg⁻¹ probably increases selenium concentration in MSM (musculus semimembranosus) - experimental selenium group 1.293 mg kg⁻¹ and control group 0.513 mg kg⁻¹ and in MLT (musculus longissimus thoracis) - experimental selenium group 1.364 mg kg⁻¹ and control group 0.506 mg kg⁻¹. The aim of this study was to evaluate the selenium and total antioxidant status (TAS) in a selected group of healthy people. Twenty-five volunteers consumed pork meat enriched with organic selenium three times a week during one month (average age in 9 men was 51.2 years, in 16 women 39.06 years, respectively). Daily selenium intake of 110 µg was calculated by Alimenta software, version 4.3 on the basis of nutrition statement. Recommended daily selenium intake of 50 – 200 µg was stated by the World Health Organization (WHO). During the research, the volunteers consumed pork enriched with 35 µg of selenium. At the beginning the mean selenium concentration in blood serum was at 75.41 ± 14.18 µg l⁻¹ in men, 75.21 ± 15.20 µg l⁻¹ in women. After two weeks of consumption pork enriched with selenium, the average selenium concentration in blood serum in men and women increased to 86.69 ± 11.72 µg l⁻¹ and 87.93 ± 16.22 µg l⁻¹ respectively. At the end of the study the average selenium concentration decreased in men and women to 85.75 ± 2.72 µg l⁻¹ to 84.07 ± 15.62 µg l⁻¹ respectively. In the selected group of healthy people the total antioxidant
status increased from 1.68 mmol.l⁻¹ to 1.86 mmol.l⁻¹ after two weeks of consumption of pork enriched with selenium. However, at the end of the research the decrease in TAS was recorded. Improvement in selenium status has positive impact on human health, and thus our results could contribute to the new trends in the production of functional food.

**Key words:** supplementation of pork, organic selenium, selenium status, total antioxidant status

**Introduction**

At present much attention is devoted to the impact of nutrition on health with respect to the antioxidant intake, especially that of vitamins and essential trace elements such as zinc, copper and selenium, which are constituents of antioxidant enzymes. One of the vital nutritional antioxidant element is the trace element selenium (Se). It was found out that its nutritional deficit in people caused cardiomyopathy, degenerative osteoarthropathia and thyroid function disorders. Selenium belongs to the group of antioxidants since it is a co-factor of antioxidant enzyme glutationperoxidaze (GPx) which catalyzes the reduction of organic hydroperoxide and oxygen peroxide protecting cells against damaging. The status of essential microelement selenium is primarily determined by its food intake. The low selenium levels in food chain elements correspond to its low levels in people. Selenium levels in plasm/serum in European countries ranges 63-110 μg l⁻¹ whereas the selenium status in Slovak population is at the bottom of this range (Kadrabová and Maďarič, 1997).

Optimum activity of this antioxidant enzyme is achieved in serum/plasm at Se levels between 90-100 μg/l. It was found out that certain simple nucleotide polymorphisms (SNPs) in seleno-proteine genes can affect the risk of cancer and hence increase the demand on selenium intake by organism (Rayman, 2005). This trace element is included in the overall antioxidant capacity of the organism.

The paper aims at the evaluation of pig feed mixtures supplemented with organic selenium in form of yeast preparations. The main attention was focused on the significant selenium deposits in pig carcass. Moreover, selenium status and overall antioxidant capacity was evaluated in a selected group of people who consumed pork enriched with organic selenium.

**Materials and Methods**

Carcass hybrid pigs were tested in the experimental centre of farm animals at the Department of Special Zootechnics of the Slovak Agricultural University in Nitra. The individual groups of tested pigs were as follows: control group – 16 pigs
The pork meat enriched with organic selenium and experimental group – 17 pigs. The experimental group was fed on standard mixtures OŠ-3 and OŠ-6 supplemented with 0.3 mg kg\(^{-1}\) organic selenium (SelPlex). After disjointing the carcass parameters were analyzed and MLT samples of 700 g weight were also taken for analysis. Some samples were analysed in the Institute of Physiology of Farm Animals (IPFA) of the Slovak Academy of Sciences (SAS) Košice where selenium ratio in meat was estimated by spectrophotometric method.

After the meat having been analysed, the heat processed pork supplemented with organic selenium was served to volunteers as dinner menu (all volunteers were healthy people without any pathological changes concerning the basic hematological and biochemical parameters). Twenty-five persons participating in the experiment were represented by 9 men at the average age 51.2 years and 16 women at the average age 39.06 years. All the volunteers consumed meat enriched with selenium three times a week during one month (in total 450 g/week). After the volunteers having filled out the nutritional protocol, the daily intake of selenium in men and women was evaluated by means of Alimenta software, version 4.3. The experimental group of people was taken blood samples in the following intervals: at the beginning, after two weeks and after the finishing of consumption. The concentration of selenium in blood serum was estimated by means of spectrophotometric method in IPFA SAS in Košice. The overall antioxidant status of heparined plasma was estimated by means of a diagnostic device (TAS\(^{\circledR}\), fy Randox) in biochemical analyser LISA 200 (BIOCODE-HYCEL) at the University of Agriculture in Nitra. The achieved results were statistically processed and evaluated by Anova programme, Tukey test.

Results and Discussion

Selenium concentration in meat dry matter was found higher in the experimental group SE where in MSM (musculus semimembranosus) represented 1.293 mg kg\(^{-1}\) and in MLT (musculus longissimus thoracis) 1.364 mg kg\(^{-1}\) compared with the control group where the values were lower, namely in MSM 0.513 mg kg\(^{-1}\) and MLT 0.506 mg kg\(^{-1}\) respectively. These differences were also confirmed by Anova and Tukey test at significance \(P< 0.001\) in the experimental group with organic selenium (Table 1).

Higher manifestation of selenium in meat with higher selenium supplement into feed mixture was also confirmed by Mahan et al. (1999), Lahuč ký et al. (2001) and Vernerová et al. (2008) who claimed that organic selenium supplement into feed mixture during pig fattening increased selenium content in pork meat.
Table 1. Characteristics of selenium concentration in pork dry matter MSM and MLT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\bar{x})</td>
<td>s</td>
</tr>
<tr>
<td>Selenium in meat dry matter MSM</td>
<td>0.513</td>
<td>0.041</td>
</tr>
<tr>
<td>(mg kg(^{-1}))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium in meat dry matter MLT</td>
<td>0.506</td>
<td>0.036</td>
</tr>
<tr>
<td>(mg kg(^{-1}))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the second stage of our research the heat processed pork meat enriched with selenium was integrated in the menu of a selected group of people. Before consumption the concentration of selenium in blood serum on average 75.41 ± 14.18 µg l\(^{-1}\) in men and 75.21 ± 15.20 µg l\(^{-1}\) in women was set up. After the consumption of the average selenium for two weeks, the concentration in blood serum in men and women increased to 86.69 ± 11.72 µg l\(^{-1}\) and 87.93 ± 16.22 µg l\(^{-1}\) respectively. At the end of the study the mean selenium concentration decreased in men and women to 85.75 ± 2.72 µg l\(^{-1}\) and 84.07 ± 15.62 µg l\(^{-1}\) respectively (Table 2; Graph 1). In the tested group of people significantly increased concentration of selenium at P< 0.01 (after the second blood taking) was found in the blood serum after the consumption of pork enriched with selenium for two weeks. The difference between the initial and after consumption blood samples was also significant at P<0.05. Clinical and experimental studies confirmed the relation between selenium and oncological or cardiovascular diseases. Critical Se level in blood serum was reported at 45 µg l\(^{-1}\). Our research has not recorded Se values in serum lower than the reported critical level. The concentration of selenium in plasm lower than 60 µg l\(^{-1}\) was reported by Hač (2001). In his study Hač reported the concentration of selenium 60 µg l\(^{-1}\) in 22 % examined individuals and the level of selenium in blood serum lower than 60 µg l\(^{-1}\) in 12 % examined individuals. Kadrabová and Maďarič (1997) reported the results of clinical studies which included 1056 tested people coming from various regions of Slovakia where the concentrations of selenium in plasm ranged within 45.8-76.9 µg l\(^{-1}\). Comparing the results it was found out that at the first blood sample the concentration of selenium ranged from 50.42 to 114.65 µg l\(^{-1}\) whereas at the second blood sample the concentration increased ranging from 69.05-139.5 µg l\(^{-1}\). These results indicate that the higher concentration of selenium in blood serum is conditioned by the intake of this element in food.

According to the filled out nutritional protocol before the consumption of supplemented pork the average daily intake in men and women was 110 µg. During the consumption of pork enriched with selenium there was an increase by
110 µg. Recommended daily selenium intake stated by the World Health Organization (WHO) is 50-200 µg.

**Table 2. Evaluation of selenium concentration in human blood serum**

<table>
<thead>
<tr>
<th>Sex</th>
<th>1.sample µg l⁻¹</th>
<th>2. sample µg l⁻¹</th>
<th>3. sample µg l⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>s</td>
<td>min-max</td>
</tr>
<tr>
<td>Men (n=9)</td>
<td>75,41</td>
<td>14,18</td>
<td>51,23 -97,15</td>
</tr>
<tr>
<td>Women (n=16)</td>
<td>75,21</td>
<td>15,20</td>
<td>50,42 -114,65</td>
</tr>
<tr>
<td>Total (n=25)</td>
<td>75,28</td>
<td>14,54</td>
<td>50,42 -114,65</td>
</tr>
</tbody>
</table>

**Graph 1. Selenium status of individuals in a selected group of people**

The estimation of antioxidant substances is based on the radical of a well-known concentration, which eliminates antioxidants of the assessed sample to the extent proportional to its content (Béderová, 1997). Total antioxidant status was estimated in heparined plasma in the first blood sample averaged at 1.68 ± 0.12 mmol.l⁻¹, in the second blood sample at 1.86 ± 0.09 mmol.l⁻¹ and in the last blood sample at 1.67 ± 0.14 mmol.l⁻¹. The total antioxidant status increased proportionally to the selenium status during a two-week consumption of pork enriched with selenium. The experiment having been finished, the values in a selected group of people decreased to those measured at the beginning of the experiment.
In the evaluation of total antioxidant capacity a significant increase $P<0.001$ was found after the second sample. The experiment having been finished, the overall antioxidant status decreased again to the initial level. The difference between initial sample and after consumption sample was statistically insignificant.

**Conclusion**

The research results provided the evidence that the addition of selenium supplement (SEL PLEX) into the feed mixtures of carcass hybrid pigs significantly contributed to the effective transport of essential microelement-selenium into the food chain. The achieved results pointed out to the main advantages of organic selenium application in carcass pigs, namely to the selenium retention in muscles and tissues of carcass body. Supplemented pork in human nutrition leads to increased selenium status and hence to protection of immune system cells against the damaging caused by oxidation stress.

**Acknowledgment**

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Svinjsko meso obogaćeno organskim selenom i njegov uticaj na koncentraciju selena i status ukupnih oksidanata kod zdravih ljudi

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Rezime

Poznato je da je organski selen (Sel Plex) dodat mešavini stočne hrane za svinje značajan za efektivan transport esencijalnog elementa selena u lancu ishrane. On omogućava stvaranje značajnih telesnih rezervi selena u skeletnim mišićima i takođe povećava prelazak selena iz prirodne metaboličke forme selen-metionina u funkcionalnu hranu. Unos mešavine stočne hrane sa većim sadržajem organskog selena od 0,3 mg kg⁻¹ verovatno povećava koncentraciju selena u MSM (musculus semimembranosus) - ekperimentalna selen grupa 1,293 mg kg⁻¹ i kontrolna grupa 0,513 mg kg⁻¹ i u MLT (musculus longissimus thoracis) – eksperimentalna selen grupa 1,364 mg kg⁻¹ i kontrolna grupa 0,506 mg kg⁻¹. Cilj ovog istraživanja bio je da se oceni selenijum i ukupni antioksidativni status (TAS) u izabranoj grupi zdravih ljudi. Dvadeset pet volontera konzumiralo je svinjsko meso obogaćeno organskim selenom tri puta nedjeljo tokom mesec dana (prosečna starost 9 muškaraca bila je 51,2 godine a 16 žena 39,06 godina respektivno). Dnevni unos selena od 110 µg obračunat je putem Alimenta software, verzija 4.3 na bazi nutritivnog izveštaja. Svetska zdravstvena organizacija (WHO) navela je preporučeni dnevni unos selena od 50 – 200 µg. Tokom istraživanja, volonteri su konzumirali svinjetinu obogaćenu sa 35 µg of selenium. Na početku je prosečna koncentracija selena u krvnom serumu bila 75,41 ± 14,18µg l⁻¹ kod muškaraca i 75,21 ± 15,20µg l⁻¹ kod žena. Nakon dve nedelje konzumacije svinjetine obogaćene selenom prosečna koncentracija selena u krvnom serumu muškaraca i žena povećana je na 86,69 ± 11,72 µg l⁻¹ i 87,93 ± 16,22 µg l⁻¹ respektivno. Na kraju istraživanja prosečna koncentracija selena smanjena je kod muškaraca i žena na 85,75 ± 2,72 µg l⁻¹ to 84,07 ± 15,62 µg l⁻¹ respektivno. U odabranoj grupi zdravih ljudi ukupni atioksidativni status povećao se od 1,68 mmol.l⁻¹ na 1,86 mmol.L⁻¹ nakon dve nedelje konzumacije svinjetine obogaćene selenom. Ipak, na kraju istraživanja utvrđeno je smanjenje TAS-a. Poboljšanje statusa selena ima pozitivan uticaj na ljudsko zdravlje zbog čega naši rezultati mogu doprinuti novim trendovima u proizvodnji funkcionalne hrane.
References


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