THE EFFECT OF INORGANIC SELENIUM ON PRODUCTIVITY AND MEAT QUALITY OF FATTENING PIGS

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Abstract. The aim of this study was to determine the effect of higher amount of inorganic selenium (Na_2SeO_3) on productivity parameters and meat quality of pigs for fattening. Sixty 62-d-old pigs (Landrace x Yorkshire (mother) and Pietrain x Duroc (father)) for fattening which were individually weighed and were randomly assigned to 2 dietary treatments with 2 replicate stalls of 15 pigs each. The pigs were fed for 13 weeks *ad libitum* with a standard wheat-barley-soybean meal compound diet supplemented with 0.3 mg/kg Na_2SeO_3 and 75 mg/kg vit. E (Control group) and with 0.5 mg/kg Na_2SeO_3 and 75 mg/kg vit. E (Experimental group). Meat traits in live pigs were measured by ultrasonic equipment Piglog 105. The samples for the analysis of selenium were taken from the *M. longissimus dorsi* between 12 and last rib and from the liver. Chemical composition of breast meat was being determined by standard methods. The results of conducted trial showed, that the addition of 0.5 mg/g of sodium selenite in the diets of fattening pigs didn‘t affect productivity parameters, chemical meat composition, accumulation of selenium in the meat tissue, but significant improved the muscularity of pigs.

Keywords: fattening pigs, inorganic selenium, productivity, meat quality

Introduction

Selenium (Se) is an antioxidant trace element whose presence in the body is essential for the proper growth and development of humans and animals. An optimum concentration of Se is necessary for the normal function of selenoproteins which play a key role in numerous metabolic processes. Selenium is incorporated as selenocysteine at the active site of a wide range of selenoproteins. The four glutathione peroxidase enzymes (classical GPx1, gastrointestinal GPx2, plasma GPx3, phospholipid hydroperoxide GPx4)) which represent a major class of functionally important selenoproteins, were the first to be characterised (Brown et al., 2001). These enzymes are present in many types of cells in the body and are involved in processes of defense against free radicals and their detoxification (Rayman, 2000; Lener et al., 2012). According Joksimović Todorović et al., (2012), the effect of adding selenium into chick's diet is associated mostly with its participation in preserving antioxidative system of cells. Research suggests that as an antioxidant Se may reduce the risk and course of many diseases (Saxena and Jaiswal, 2007; Fairweather-Tait et al., 2011). Food products are also characterized by a great diversity in Se content. In natural products, an important determinant of the nutritional quality of meat is the presence of nutrients that are beneficial to the health and well-being of consumers (Janz et al., 2008). Higher Se levels are observed in humans who regularly eat fish and pork (Sager, 1993). Intake of meat fortified with Se, especially animal organs, may, therefore, improve the levels of Se within the body, especially in Se-deficient populations.

As pork is consumed in large quantities throughout the world it could be an important selenium source. The most commonly used form of selenium for fattening pigs is inorganic sodium selenite. The sodium selenite has prooxidative potential (Spallholz, 1994) and its use has been associated with impaired meat quality (Mahan et al., 1999).

So the objective of this study was to determine the effect of higher amount of inorganic selenium (Na_2SeO_3) on productivity parameters and meat quality of pigs for fattening.

Materials and Methods

The trial with pigs for fattening were conducted following the regulations of the Republic of Lithuania (01-01-2013 new edit of 1997-11-06) for animal welfare and handling (Valstybės žinios, 2012, No. 122 - 6126) and by the State Food and Veterinary Service of Lithuanian Republic Ditector order regarding the animals used for experiments, research, storage, maintenance and operating requirements (2015-09-24, No. B1-872 change by order 2012-10-31, No. B1-866). The trial was performed in accordance with EU Directive 2010/63/EEC and the EC recommendation 2007/526 EC for Animal use and storage for experiments and other purposes. The pigs for fattening were kept in the stalls and its keeping condition was accorded with the Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs.

The feeding trial was performed with sixty 62-d-old Landrace x Yorkshire (mother) and Pietrain x Duroc (father) pigs for fattening which were individually weighed and were randomly assigned to 2 dietary treatments with 2 replicate stalls of 15 pigs each. The pigs were fed for 13 weeks *ad libitum* with a standard wheat-barley-soybean meal compound diet (18.51% crude protein, 12.85 MJ/kg metabolizable energy, 1.11% lysine, 0.73% threonine and 0.67%

methionine/cysteine) supplemented with 0.3 mg/kg Na_2SeO_3 (Control group) and with 0.5 mg/kg Na_2SeO_3 (Experimental group). The diet was formulated to meet the nutrient and energy requirements for fattening pigs (NRC, 2012).

The sodium selenite is soluble in water white powders (solubility 46.3%) contain 45% of active substances, the trace of heavy metals, a melting temperature - 710 °C, the heat of vaporization - 26.32 kJ/mol and covalent radius - 116 pm, in contact with skin burns.

The data recorded during the feeding phase were live weight (LW) at 62, 90, 118 and 150 day from the start of the study, average daily gains (ADG) and feed: gain ratio (F:G) during the periods 62-90 days, 91-118 days, 119-150 days and during all experimental period (62–150 days).

Before pigs slaughtering, fat thickness and muscularity (two measurements of fat thickness and thickness of the *M. longissimus dorsi*) was measured by ultrasound equipment „Piglog-105"(SFK Technology, 1991).

At the end of the trial (150 days) from each group 8 pigs for fattening (8 pigs x 2 groups = total of 16 pigs) were selected and slaughtered according to standard procedures. The samples for the analysis of selenium were taken from the *M. longissimus dorsi* between 12 and last rib and from liver. The content of selenium in the feed and accumulation of Se in the meat and liver were determined with the atomic absorption spectrometric method (Neugebauer et al., 2000).

Chemical composition of breast meat was being determined by standard methods (AOAC, 1990).

Statistical analysis. Data were analyzed using one-way analysis of variance (ANOVA) with Statistica software package version 8.0 (StatSoft Inc., 2007). Means were compared with a PLSD Fisher's test. The differences between the control and experimental groups were considered to be statistically significant for $P<0.05$.

Results and discussion

By analysing the growing performance parameters of pigs (Table 1) there were determined, that the insertion of 0.5 mg/kg of inorganic selenium in the feed the average body weight at 90 and 118 days of age incresed by 1.38 and 1.49 kg in comparison to the Control group, but the results were insignificant. The same tendency were observed by analysing the average daily gain results and feed: gain ratio, when this parameter were improved by the higher inorganic selenium supplementation, but results were insignificant. ADG and feed: gain ratio during the all experimental period (62-150 days) was the same between groups.

Table 1. **Growth performance of pigs for fattening fed diets with different amount of inorganic selenium and vitamin E (kg)**

Items	Control group		Experimental group	
Age, days	BW, kg			
62	26.67 ± 0.57		26.25 ± 0.98	
90	55.10 ± 0.93		56.48 ± 0.78	
118	82.19 ± 1.11		83.68 ± 1.09	
150	116.30 ± 1.29		116.35 ± 1.49	
Feeding period	**ADG**	**F:G**	**ADG**	**F:G**
I (62 – 90 days)	1.02	2.08	1.08	2.03
II (91 – 118 days)	0.97	2.75	0,97	2.64
III (119 – 150 days)	1.03	3.13	0,99	3.13
I- III (62 – 150 days)	1.01	2.65	1.01	2.60

Our results are in agreement with Mateo et al. (2007), who didn't find influence on the performance parameters in the experiment with growing-finishing pigs fed diets with organic and inorganic selenium. Contrarily Payne and Southern (2005) and Upton et al. (2009) determined, that the use of inorganic selenium in poultry diet increased the weight of broiler chickens in comparison with control group. In our study, the lack of difference among dietary treatments on growth performance indicates that pigs in the control and experimental diets different inorganic Se amount utilized the same. The rather high dietary vitamin E level (75 mg/kg) might also explain the absence of response to supplementary Se on growth performance (Li et al., 2011).

Table 2. **The influence of different inorganic selenium level on pigs' fattening muscularity (independent by pigs' sex)[1]**

Group	Age in days	Weight, kg	Fat thickness, mm		Mouscles thickness, mm	Muscularity, %
			1 point	2 point		
Control	150	110.4±1.38	14.7±0.94[a]	14.6±0.95[a]	53.9±2.85[a]	56.79±0.91[a]
Experimental	150	104.1±2.46	13.7±0.76[b]	13.3±0.84[b]	59.3±0,94[b]	58.56±1,01[b]

[1] From each group selected 8 pigs for fattening (for the measurement with „Piglog-105" is selected pigs from 85-110 kg); a, b for each column, mean values with the same subscripts are not significantly different, $P<0.05$

By measuring the fattening pigs' thickness of muscle (*M. longissimus dorsi*) and fat (Table 2) were determine statisticaly positive effect of higher inorganic selenium on the analysed parameters: fat thickness in 1st and 2nd points of measurement were by 1 and 1.3 mm respectively lower and mouscle thickness - by 5.4 mm hiher in comparison to the Control group (P<0.05). By calculating the percentage of muscularity, there were determined, that higher amount of inorganic selenium and vitamin E had significant effect on the muscularity of fattening pigs. Our results are in agreement with Lisiak et al. (2014) who also did not confirm the negative effect of sodium selenite on the indices of meat quality.

Table 3. **The influence of different inorganic selenium level on pigs' meat chemical composition**

Items	Group	
	Control	Experimental
Dry matter (%)	29.06 ± 0.73	28.86 ± 0.90
Pure protein (%)	23.73 ± 0.76	22.59 ± 0.56
Fat (%)	4.39 ± 1.15	5.27 ± 1.37
Ash (%)	0.86 ± 0.09	0.90 ± 0.09

No differences in meat chemical composition between the groups were found in our study. Our results are in agreement with Wolter et al. (1999), Zhan et al. (2007) and Lisiak (2014) who also did not find the effect of sodium selenite on the indices of meat chemical composition.

Table 4. **The influence of different inorganic selenium level on the accumulation of selenium in the meat and liver of pigs for fattening**

Group	Selenium μg/g DM (95%)	
	Meat	Liver
Control	0.68±0.13	2.38±0.69
Experimental	0,66±0.12	2.49±0.52

Se concentrations in *M. longissimus dorsi* and liver of fattening pigs (expressed per DM) are summarized in Table 4. No effect of higher sodium selenite amount on selenium accumulation in *M. longissimus dorsi* muscle and liver were observed (P>0.05). Our results is in contrary to previous research, which indicated that a lower proportion of Se was retained in muscle when inorganic Se source was fed to pigs (Mahan et al., 1999).

According results get by Joksimović Todorović et al. (2006) in pigs fed different levels of organic selenium - 0, 0.3 and 0.6 mg/kg diet, the content of selenium in liver was about 3-4 times higher in comparison to the selenium content found in dorsal musculature.

Conclusions

The inclusion on 0.5 mg/g of sodium selenite in the diets of fattening pigs didn't affect productivity parameters, chemical meat composition, accumulation of selenium in the meat tissue, but significant effect on the fat thickness and muscularity.

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