THE EFFECT OF ORGANIC SELENIUM AND THE DURATION OF ITS USE ON SELECTED INDICATORS OF FATTENING CAPACITY AND CARCASS VALUE IN HYBRID PIGS

Stupka R., Čítek J., Šprysl M., Brzobohatý L., Okrouhlá M., Kluzáková E.

Czech University of Life Sciences Prague, Czech Repiublic

Abstract

The aim of this study was to verify the effects of adding the organic selenium to the pigs ration (during different fattening periods) on the selected parameters of the fattening capacity and quantitative and qualitative aspects of the carcass value in 72 hybrid pigs. The animals were divided into 4 groups, 3 experimental (where selenium was administered at different times of the fattening period) and one control group (without the addition of selenium). The process of increasing the selenium amount in pork was done by addition of Sel-Plex at a dose of 1mg of selenium/1kg of complete feed mixture. After reaching average live weight of 109.8 kg, the individuals were slaughtered and subjected to detailed dissection.

Regarding the evaluation of selected fattening capacity parameters, none of the groups showed any impact of the added selenium. Similar results were obtained for quantitative parameters of the carcass value. In assessing the qualitative indicators of the carcass value, it is obvious that experimental animals, compared to the control group, had better color and higher water content.

Key Words: Pig, nutrition, selenium, carcass value, fattening capacity

Selenium has a a specific place among the nutrients in the feed and it is the main component of seleinoproteins participating in regulation of various physiological processes in the body (ŠIMEK, ZEMANOVÁ, 2003).

Organic selenium compounds can also be found in proteins and play important role in various biological processes (BARCELOUX, 1999). The functional form of selenium is seleinoproteins, especially selenomethionine and selenocysteine (HÄRTL et al., 2009).

Basic functions of selenium (together with vitamin E) can be described as protecting cells against the effects of free oxygen radicals via the glutathione peroxidase (GSH-Px). Free oxygen radicals are highly reactive compounds. Selenium also affects certain immune functions of the body, especially the production of antibodies, lymphocyte proliferation and phagocytosis. Selenium affects the thyroid gland, thyroxine production, sperm and thus fertility in both male and female (SURAI, 2003).

YANG et al. (2010) found that feeding the fatted pigs with organic selenium resulted in increased daily gain and improved feed conversion. On the contrary, MATEO et al. (2007), argues that the administration of selenium had no effect on growth rate in fattening pigs.

Many authors agree that selenium has a positive impact on the organoleptic characteristics of meat (meat quality), but also the addition of selenium into the feed increases its content in meat, which can then be used as a „functional food“ (ACDA, 2002; D´SOUZA et al., 2001).The antioxidative selenium effects on pork quality are reflected in limited oxidation of lipids, as well as better color stability of heme pigments. Selenium has a positive effect on reducing water losses and at the same time it improves some of the organoleptic characteristics of meat. Pork meat that is rich in selenium proves to be juicier, more tender and has a better appearance (MUÑOZ et al., 1997; SVOBODA, 2004).

The aim of this study was to verify the effects of organic selenium addition and the duration of its administration in fattening on selected parameters of the fattening capacity and quantitative and qualitative aspects of the carcass value.

Hypothesis

The addition of organic selenium into the feed mixtures for fattening pigs improves the parameters of the fattening capacity (1), the quantitative indicators of the carcass value (2) as well as the qualitative indicators of the carcass value (3).

Materials and Methods

Animals

The experiment included a total of 72 hybrid pigs of (LW_SxPN) x (LW_DxL) genotype. The sex of the pigs was sex balanced, with the age of 60 days from birth and average live weight of 16.32 kg.

The animals were tested in the Test Station Ploskov-Lány. After reaching an average live weight (ALW) of 109.8 kg the pigs were slaughtered in commercial abattoirs.

Nutrition and feeding

The pigs were fed with a complete feeding mixture (CFM) based on wheat, barley, soy and premix. Fattening was carried out in three stages with continuous transition. Nutrient composition shows Table 1.

The animals were divided according to the nutriet composition and the selenium addition into 4 groups.

- *1st group* - G1 (n=10), was fed with the addition of organic selenium (commercial product Selplex) at a dose of 1 mg per 1 kg of CFM throughout the fattening period,
- *2nd group* - G2 (n=10), was fed with the addition of organic selenium (commercial product Selplex) at a dose of 1 mg per 1 kg of CFM during the 1st half of the fattening period, during the 2nd half of the fattening period the pigs were fed with no added selenium,
- *3th group* - G3 (n=10), was fed without the addition of selenium during the 1st half of the fattening period and during the 2nd half of the fattening period pigs were fed with the addition of organic selenium (commercial product Selplex) at a dose of 1 mg per 1 kg of CFM,
- *4th group - G4* (n=42), pigs were fed with no added selenium in CFM throughout the whole fattening period.

Monitoring indicators

In assessing the fattening capacity the following indicators were monitored:

- daily feed intake (DFI1-kg/day) - the 1st half of the fattening period (i.e. week 1-7),
- daily feed intake (DFI2-kg/day) - the 2nd half of the fattening period (i.e. week 8-15),
- daily feed intake (DFI-kg/day) throughout the whole fattening period,
- average daily gain (ADG1-g/day) - the 1st half of the fattening period,
- average daily gain (ADG2-g/day) - the 2nd half of the fattening period,
- average daily gain (ADG-g/day) throughout the whole fattening period,
- feed convertion ratio (FCR1-kg) - the 1st half of the fattening period,
- feed convertion ratio (FCR2-kg) - the 2nd half of the fattening period,
- feed convertion ratio (FCR-kg) throughout the whole fattening period.

Concerning the quantitative indicators of carcass value, the following were observed:

- carcass weight (DW-kg),
- backfat thickness 1 (BFT1) - over the 1st thoracic vertebra (mm),
- backfat thickness 2 (BFT2) - over the last thoracic vertebra (mm)
- backfat thickness 3 (BFT3) - over the 1st sacrum vertebra (mm),
- lean meat share (LMP - %),
- main meat part weight (MMPW -kg) and share (MMPP -%)

Concerning the qualitative indicators of carcass value, the following were observed:

- meat colour L-lightness, colour LAB determined with the use of spectrofotometer Minolta CM-700d, Osaka, Japan,
- colour a* (redness),
- colour b* (yellowness),
- drip loss (%) - determined gravimetrically,
- electrical conductivity (EC in μS, determined by LATKA 1980 instrument) of the
- ham (*m.semimebranosus* - MS),
- loin (*m.longissimus lumborum and thoracis* - MLLT),
- MS and MLLT pH $_{45}$,
- Warner-Bratzler texture (WBT - power cut in N) determined by Instron 3342, Norwood, MA, US).

Method, model

All phenotypical data obtained from the fattening test was processed by employing regular mathematical and statistical methods, then visualised in tabular array. To determine the influence of individual factors a statistical analysis was performed using GLM procedures of SAS version 9.1. The following model was used:

$$Y_i = \mu + V_i + e_i$$ where

Y_i - observed value of the carcass parameter as a dependent variable,

μ - average value of dependent variable,

V_i - fixed effects of nutrition (CG, EG),

e_i - residual mistakes (random error).

Table 1. Nutrient composition of the CFM in dependence on live weight

Pig category	N- substances(%)	MEp (MJ)	Lysine (g/kg)
up to 35 kg ALW	19.6	13.2	12.2
35 - 65 kg ALW	18.75	13.1	10.4
over 65 kg ALW	16.7	13.0	8.4

Results and Discussion

Table 2. presents the selected monitored parameters characterizing fattening capacity in pigs based on the duration of the selenium administration. From the results it is evident that the type of the treatment period did not affect the achieved fattening capacity parameters. The study also showed that the selenium addition does not improve fattening capacity in pigs. These findings do not correspond with NIU et al. (2009) and YANG et al. (2010), who found a positive effect of selenium addition on feed conversion ratio. On the contrary, the works of DENIZ et al. (2005) and FERNANDES et al. (2008) did not confirm the effects of selenium on feed intake, weight and growth.

From our point of view the hypothesis(1) relating to the fact that the addition of organic selenium in feed mixtures for fattening pigs improves parameters of the fattening capacity, was not confirmed.

Table 3. evaluates the selected quantitative indicators of the carcass value in pigs. In this case most of the parameters of the pig production performance were also not affected by the duration of the selenium administration.

The only statistically significant difference was observed in the backfat thickness 1 parameter, where the group in which the selenium was administered during the whole course of the fattening period showed a marked increase in backfat thickness 1 as opposed to the group without any selenium addition.

As it is evident, the hypothesis (2), relating to the fact that the addition of organic selenium in feed mixtures for fattening pigs improves quantitative indicators of the carcass value, was not confirmed.

Table 2. The effects of selenium administration on selected parameters of fattening capacity in pigs

Indicator	G1 (n=10)		G2 (n=10)		G3 (n=10)		G4 (n=42)		Significance*
	x	s_x	x	s_x	X	s_x	x	s_x	
DFI1 (kg/day)	1,58	0,23	1,63	0,19	1,49	0,54	1,71	0,32	NS
DFI2 (kg/day)	2,72	0,34	2,72	0,52	2,75	0,13	2,81	0,31	NS
DFI (kg/day)	2,17	0,24	2,19	0,36	2,14	0,24	2,28	0,28	NS
ADG1 (g/day)	829	136,40	836	123,61	807	99,43	811	145,15	NS
ADG2 (g/day)	922	95,19	943	137,89	926	115,02	942	106,77	NS
ADG (g/day)	873	87,15	906	121,04	871	84,57	890	90,26	NS
FCR1(kg)	2,35	0,39	2,38	0,26	2,23	0,78	2,56	0,34	NS
FCR2 (kg)	3,01	0,32	2,84	0,35	3,01	0,27	2,98	0,31	NS
FCR (kg)	2,56	0,14	2,49	0,26	2,52	0,33	2,63	0,20	NS

* NS: no signifiant

Table 3. The effects of selenium administration on selected parameters of carcass value in pigs

Indicator	G1 (n=10)		G2 (n=10)		G3 (n=10)		G4 (n=42)		Significance
	x	s_x	x	s_x	X	s_x	x	s_x	
DW (kg)	83,24	5,99	84,61	10,21	83,12	6,03	85,67	10,56	NS
BFT1(mm)	33,42	6,59	34,07	7,58	38,25	5,37	38,88	7,59	1-4 0,043
BFT2 (mm)	22,62	5,20	21,67	6,02	22,75	2,64	22,94	5,18	NS
BFT3 (mm)	17,02	3,90	16,81	5,69	18,26	4,14	16,74	5,10	NS
LMP (%)	55,66	2,43	56,57	2,70	56,01	1,50	55,36	2,84	NS
MMPW (kg)	21,91	1,89	22,31	2,32	21,63	1,99	23,09	2,29	NS
MMPP (%)	53,40	4,15	53,87	2,76	53,33	2,09	52,60	3,12	NS

* NS: no signifiant

Table 4. presents the obtained selected qualitative indicators of the carcass value. There were significant differences between groups in the following indicators: L-meat color, b-color, drip loss and pH_{45} *MLLT*. As shown, the impact of added selenium on the meat color between the groups without the selenium addition and other groups has been demonstrated. However the effect of the duration of selenium administration has not been confirmed. Meat with added selenium attained lighter color. The same conclusion was reached by MAHAN (1996) and ŠIMEK et al. (2002), who claim that the antioxidative effects of selenium on the quality of pork meat may be represented in reduced lipid oxidation and therefore in better color stability of heme pigments.

The drip loss is considered to be perhaps the most damning indicator of the quality of meat gained from the animals supplemented with selenium. This is mentioned in number of works, such as studies published by authors COMBS (1981), MAHAN (1996), ŠIMEK et al. (2002), MUÑOZ et al. (1997), SVOBODA (2004), D´SOUZA et al. (2001), VERNER et al. (2007). However while monitoring this parameter in our study we did not reach the same conclusions. The most favorable results (only 2.82%) were reached in the 3rd group. In contrast, the second group tested the worst of all with a value of 5.23%. It can be stated that a significant effect on the water binding capacity of meat was demonstrated when the selenium addition is administered in the 2nd half of the fattening period.

Another observed indicator was the texture of the meat, that is, the power required to cut the muscle fiber by WB-knife. Measurements were conducted on uncooked meat so it is important to mention that the meat tenderness may be different after subjecting to cooking process.

The lowest (however statistically insignificant) values were achieved in the 1st group, where the selenium was being added throughout the whole fattening period. Again, a significant effect of the selenium administration period duration was not confirmed, however there was a certain trend observed. The positive effects of selenium use on the qualitative indicators of the carcass value were observed in the works of D´SOUZA et al. (2001) and VERNER et al. (2007). On the contrary works of SVOBODA et al. (2011) did not confirm positive effects on the quality of porcine meat.

As it is evident, the hypothesis (3), relating to the fact that the addition of organic selenium in feed mixtures for fattening pigs improves qualitative indicators of the carcass value, was partially confirmed.

Based on the obtained results the addition of selenium supplements can be recommended to administer during the second half of the fattening period.

Table 4. The effects of selenium administration on selected qualitative parameters of the carcass value in pigs

Indicator	G1 (n=10)		G2 (n=10)		G3 (n=10)		G4 (n=42)		Significance
	x	s_x	x	s_x	x	s_x	x	s_x	
L - meat colour	51,24	1,70	52,83	4,18	50,8	2,90	47,66	4,91	1-4 (0,03); 2-4 (0,003)
a - colour	-0,90	0,67	-0,90	1,44	-0,93	0,46	-1,08	0,90	NS
b - colour	8,24	1,02	8,89	2,13	8,24	0,85	7,62	1,67	2-4 (0,04)
Driploss (%)	4,77	1,87	5,23	2,54	2,82	0,94	5,14	2,69	2-3 (0,03)
EC MLLT (µS)	3,66	1,29	3,34	0,32	2,96	0,44	3,60	0,99	NS
EC MS (µS)	3,41	0,66	3,15	0,33	3,30	0,58	3,35	0,69	NS
pH_{45} MLLT	5,95	0,43	6,19	0,34	6,47	0,23	6,28	0,31	1-3 (0,001); 1-4 (0,007)
pH_{45} MS	6,37	0,27	6,60	0,20	6,52	0,23	6,48	0,27	NS
WBT (N)	33,88	10,13	37,64	13,65	42,83	9,14	38,14	13,23	NS

* NS: no signifiant

Conclusion

The influence of additive selenium supplements and the duration of their administration on the fattening capacity parameters and quantitative indicators of the carcass value in pigs was not confirmed. With regards to the qualitative indicator of the carcass value we observed a partially positive effect of selenium administration. In order to achieve more favourable qualitative parameters of the carcass value the administration of organic selenium during the second half of the fattening period only seems to be sufficient enough.

References

ACDA, S. P., CHAE, B. J. (2002): A review on the application of organic trace minerals in pig nutrition, Pakistan Journal of Nutrition, 1 (1), 25-30. ISSN 1680-5194.

BARCELOUX, D. G. (1999): Selenium. Clinical toxicology, 37 (2), 145-172.

D´SOUZA, D. N., WARNER, R. D., LEURY, B. J., DUNSHERA, F. R. (2001): Dietary nutrient supplement improve meat quality. Science and Technology in the Feed Industry, Proceeding of Alltech´s 17th Anual Symposium, Nottingham University Press, Nottingham, UK, 305-317.

DENIZ, G., GEZEN, S. S., TURKMEN, I. I. (2005): Effects of two supplemental dietary selenium sources (mineral and organic) on broiler performance and driploss, Rev. Med. Vet. 156, 423 – 425.

FERNANDES, J. I. M., MURAKAMI, A. E., SAKAMOTO, M. I., SOUZA, L. M. G., MALAGUIDO, A., MARTINS, E. N. (2008): Ef fects of organic and mineral dietary supplementation on production performance and egg quality of white layers, Braz. J. Poult. Sci. 10, 59 – 65.

HÄRTLOVÁ, H., FUČÍKOVÁ, A., SEDMÍKOVÁ, M., CHMELÍKOVÁ, E., KREJČÍ, M., ČTRNÁCTÁ A., ŠKOPEK, J., MATĚCHOVÁ, L., VACKOVÁ K. (2009): Fyziologiea hygiena výživy a alimentární onemocnění hospodářských zvířat. ČZU, Praha, s. 214, ISBN 978-80-213-1885-4.

JANG, Y. D., CHOI, H. B. DUROSOY, S., SCHLEGELL, P., CHOI, B. R., KIM, Y. Y. (2010): Comparison of Bioavailability of Organic Selenium Sourcesin Finishing Pigs. Asian-Aust. J. Anim. Sci., 23 (7), 931 – 936.

MAHAN, D. C. (1996): How organic selenium may help reduce drip loss, Misset World Poultry, 12, 19-21. ISSN 0926-924X.

MATEO, R. D., SPALLHOLZ, J. E., ELDER, R., YOON, I., KIM, S.W. (2007): Efficacy of dietary selenium sources on growth and carcass characteristics of growing-finishing pigs fed diets containing high endogenous selenium. J. Anim. Sci. 85, 1177-1183.

MUÑOZ, A., GARINDO, M. D., GRANADOS, M. V. (1997): Effect of selenium yeast and vitamins C and E on pork exudation (cited by T. P. Lyons in: Biotechnology in the Feed Industry, 14th Annual Symposium, s. 1).

NIU, Z., LIU, F., YAN, Q., LI, L. (2009): Effects of different levels of selenium on growth performance and immunocompetence of broilers under heat stress. Arch. Anim. Nutr. 63, 56 – 65.

SURAI, P. F. (2003): Selenium-vitamin E interactions: does 1 + 1 equal more than 2?, Nutritional Biotechnology in the Feed and Food Industries, Proceeding of Alltech´s 19th Anual Symposium, Nottingham University Press, Nottingham, UK, 59-76.

SVOBODA, M. (2004): Metabolické poruchy u prasat. Farmář, č. 12, 35-36.

SVOBODA, M., FAJT, Z., BAŇOCH, T., SALÁKOVÁ, A., DRÁBEK, J. (2011): The effects of soybean selenium proteinate on tissue selenium and meat quality trans in finishing pigs. Polish Journal of Veterinary Sciences, 14 (1), 147-148.

ŠIMEK L., ZEMANOVÁ, D. (2003): Výživa vysokoprodukčních dojnic, Zemědělec, č. 48, 10-11.

ŠIMEK J., CHLÁDEK, G., KOUTNÍK, V. STEINHAUSER, L. (2002): Selenium content od beef and its effecton drip and fluid losses. Animal Science Papers and Reports, 20 (1), 49-53. ISSN 0860-4037.

VERNEROVÁ J., PIPEK P., SKLENÁŘOVÁ M. (2007): [online], Kvalita vepřového masa obohaceného selenem, 7 s., <http://www.vepaspol.cz/soubory/s1.pdf>.

This study was supported by an S-grant of the Ministry of Education, Youth and Sports of the Czech Republic and project no. MSM 6046070901