

Evaluation of selenium status in pure bred duroc sows and their progeny

Tomas BANOCH, Zdenek FAJT, Svetlana ODEHNALOVA, Josef DRABEK, Martin SVOBODA

Clinic of Pig Diseases, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic.

Correspondence to: Doc. MVDr. Martin Svoboda, Ph.D., Clinic of Pig Diseases, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic Palackého 1/3, 612 42, Brno, Czech Republic.
PHONE: +420 541 562 433, E-MAIL: svobodama@vfu.cz

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Abstract

OBJECTIVES: The aim of this trial was to determine selenium status in pure bred duroc sows and their progeny and to compare it to Czech Large White x Landrace breed.

DESIGN: The pregnant duroc sows (n=12) and pregnant Czech Large White x Landrace sows (n=12) were fed identical diets supplemented with sodium selenite.

RESULTS: During lactation significantly higher serum Se concentrations (p<0.001) were found in duroc piglets. Also significantly higher serum GSH-Px activities (p<0.001) were found in duroc sows and piglets. No differences in concentrations of Se in colostrums and milk were found between the two breeds.

CONCLUSION: Our findings support the hypothesis that there may be breed differences in indices of selenium status in pigs.

INTRODUCTION

Selenium is considered as an important microelement for swine. Being an essential component of enzyme glutathione peroxidase it protects organism against oxidative stress (Tappel, 1974; Bujalska & Gumulka, 2008) like other antioxidants, e.g. melatonin (Wiktorska *et al.* 2007). Selenium deficiency causes several pathological conditions in pigs described as mulberry heart disease, dietetic hepatitis and nutritional muscular dystrophy (Jensen *et al.* 1979). The deficiency is usually manifested clinically by sudden death of weaned pigs due to heart failure.

Selenium is principally available to the young pig from both placental and mammary transfer (Mahan *et al.* 1977). An adequate selenium status of sow is thus an important prerequisite for normal development of piglets. The selenium status of sow

can be influenced by the provided Se source and its concentration in the diet (Mahan *et al.* 1974; Mahan, 2000; Mahan & Peters 2004). Mahan and Kim (1996) found that Se content in newborn piglets' tissues was higher when organic vs. inorganic Se was fed.

It has been suggested by Mahan and Newton (1995) that Se status in sows can be negatively influenced by their increasing reproductive performance. However the effect of different genotypes on Se requirements of pigs has not yet been firmly established, although possible genetic differences in Se utilization in pigs have been proposed by several authors (Stowe & Miller, 1985; Kim & Mahan, 2001).

The aim of our study was to evaluate selenium status in pure bred duroc sows and their progeny and to compare it to Czech Large White x Landrace breed.

MATERIAL AND METHODS

Experimental design. Altogether 12 pregnant duroc sows (group Du) and 12 pregnant Czech Large White x Landrace sows (group LCWxL) were used in our study. The sows of both groups were fed identical gestation and lactation diets composed of basal diet and a mineral supplement. The feed mixture was supplemented with sodium selenite at the dose of 0.26 mg/kg of Se for the gestation diet and 0.33 mg/kg of Se for the lactation diet.

The gestation diet was proved at 2.5 kg daily during gestation period. The sows were fed ad libitum during the lactation period. The composition of gestation and lactation diets is presented in **Table 1.** and **Table 2.**

At the age of 3 days the piglets were injected i.m. with 200 mg of Fe (as iron dextran, Ferridextran 10 % ad us. vet.). The piglets were weaned at the age of 28 days.

Sampling blood, tissues (liver, heart, gluteal muscles), colostrum and milk. Sows were bled from vena cava on days 25 and 65 of gestation, after parturition and on day 25 of lactation. The blood from 6 piglets within each litter was taken from vena cava cranialis on day 25 of lactation. The blood was centrifuged and serum collected and frozen until it was analysed for GSH-Px (glutathione peroxidase) activity and Se concentration. Twelve stillborn piglets from group Du and 12 stillborn piglets from group LCWxL during the whole trial were used for the determination of Se content in tissues (heart, liver, gluteal muscles). Colostrum was collected by hand expression from several glands. Milk was obtained on day 25 of lactation after i.v. injection of oxytocin (5 i.u.). The collected colostrums and milk was frozen and stored for later determination of Se content.

Analysis of samples. Concentrations of Se in serum pigs tissues (heart, liver, gluteal muscles), colostrum and milk were measured using the following steps: samples of serum were mineralised in a closed system using a

microwave (MLS-1200, Milestone, Italy) digestion technique with HNO₃ and H₂O₂. Samples were evaporated and the mineral residue was dissolved in water to which 20% HCl was added. Selenium was then determined with Solar 939 AA Spectrometer (Unicam, UK) using a hydride AAS technique with detection limit of 0.762 µg.kg⁻¹ and determination error (4.6-15%).

Serum GSH-Px activities were determined according to the method of Paglia and Valentine (1967) using the test kit RANSEL (Randox Laboratories, Ltd., United Kingdom).

Statistical analysis. Sample frequency distributions were examined prior to statistical analyses and standard robust summary statistics were used to describe distribution patterns in the data (median, 5th - 95th percentile range). Non-parametric tests were applied for comparisons of two groups of sow and piglet Du and LCWxL in each time (Mann-Whitney test).

Non-parametric tests were applied for comparisons of days within groups of sow (Kruskal – Walis test). Differences among days were found by Multiple comparisons of mean ranks for all groups (STATISTICA Electronic Manual).

All statistical analyses were performed using STATISTICA 8.0 and SPSS 16.0 for Windows.

RESULTS

The results are presented as median and 5% and 95% percentile of each index in **Tables 3-5** and **Figs. 1,2.**

Selenium status of the sows. The serum selenium concentrations of the sows are presented in Figure 1. No differences in serum Se concentrations were found between the two experimental groups on day 25 and 65 of gestation. Statistically comparable serum Se concentrations were found also after parturition and on day 25 of lactation.

Table 1. Percentage composition of the gestation diet.

Ingredient	Percentage (%)
Corn	53.10
Barley	27.00
Oat	8.00
Rape	4.00
Sunflower oil	4.20
Trace mineral and vitamin premix ^a	4.70

^aSupplied per kilogram diet: 0.26 mg of Se, 88 mg of Zn, 40 mg of Mn, 0.8 mg of I, 128 mg of Fe, 12 mg of Cu, 0.48 mg of Co, 10560 I.U. of vit. A, 1760 I.U. of vit. D3, 48 mg of vit. E, 2 mg of vit. K3, 1.6 mg of vit. B1, 3.6 mg of vit. B2, 2.8 mg of vit. B6, 20 µg of vit. B12, 16 mg of niacin, 20 mg of panthotenic acid, 0.32 mg of biotin, 0.4 mg of folic acid, 520 mg of cholin

Table 2. Percentage composition of the lactation diet.

Ingredient	Percentage (%)
Corn	54.20
Barley	27.00
Soyabean pollard	10.20
Dried blood	2.80
Press wheaten gemmules	2.00
Soyabean oil	0.20
Trace mineral and vitamin premix ^a	4.80

^aSupplied per kilogram diet: 0.33 mg of Se, 110 mg of Zn, 50 mg of Mn, 1.0 mg of I, 160 mg of Fe, 15 mg of Cu, 0.60 mg of Co, 13200 I.U. of vit. A, 2200 I.U. of vit. D3, 60 mg of vit. E, 2.50 mg of vit. K3, 2 mg of vit. B1, 4.5 mg of vit. B2, 3.50 mg of vit. B6, 25 µg of vit. B12, 20 mg of niacin, 25 mg of panthotenic acid, 0.40 mg of biotin, 0.5 mg of folic acid, 650 mg of cholin



Figure 1. Distribution of concentration of sow serum Se for groups LCWxL and Du in time. Above each couple there is a statistical significance of difference (p-value, Mann-Whitney U test).

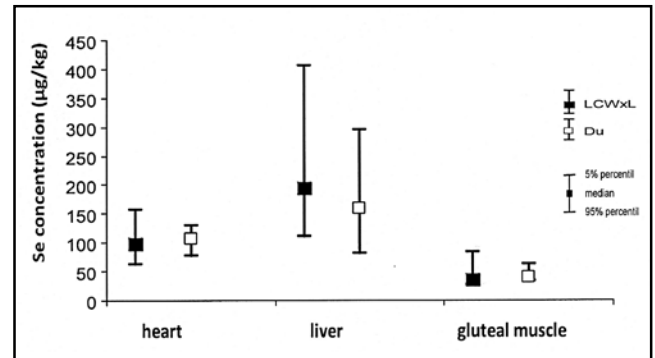


Figure 2. Comparison of parameter Se heart, liver and gluteal muscle for piglet LCWxL and Du. Above each couple there is a statistical significance of difference (p-value, Mann-Whitney U test).

Table 3. Selenium status of sows and piglets on day 25 of lactation

Parameter	CLWxL		Du		p ¹
	Median	5 th / 95 th perc.	Median	5 th / 95 th perc.	
Sow serum Se (µg/l)	156.10	144.10 / 174.50	176.80	133.80 / 288.40	0.044
Sow serum GSH-Px (µkat/l) (µkat/l)	37.67	30.97 / 52.08	151.15	45.60 / 154.80	<0.001*
Piglets serum Se (µg/l)	56.70	48.00 / 73.00	71.80	63.30 / 84.40	<0.001*
Piglets serum GSH-Px (µkat/l) (µkat/l)	20.00	11.20 / 30.80	94.50	79.80 / 118.20	<0.001*

¹ Mann – Whitney U test, $\alpha=0.05$

* Statistically significant difference

Table 4. Concentration of Se in colostrum and milk (µg/l)

Parameter	CLWxL		Du		p ¹
	Median	5 th / 95 th perc	Median	5 th / 95 th perc	
Day 1 (Lactation)	104.00	36.30 / 177.50	94.60	33.90 / 120.50	0.204
Day 25 (Lactation)	21.00	15.10 / 41.10	31.25	24.30 / 37.00	0.125

¹ Mann – Whitney U test, $\alpha=0.05$

* Statistically significant difference

In both groups we have found a significant decrease ($p<0.001$) in Se serum concentrations from the beginning of the trial till parturition. From parturition till weaning Se serum concentrations increased significantly ($p<0.001$) in both experimental groups. A significantly higher GSH-Px activity in serum was found on 25 day of lactation in sows of duroc breed (**Table 3**).

Selenium status of the piglets. The results of selenium status of the piglets are presented in Table 3 and Figure 2. The concentrations of Se in neonatal tissues (heart, liver, gluteal muscles) were statistically comparable between the two experimental groups. Significantly higher ($p<0.001$) serum Se concentrations were found on day 25 of lactation in duroc piglets. Also GSH-Px activity in serum was significantly higher ($p<0.001$) in piglets of duroc breed.

Colostrum and milk selenium. No differences in concentrations of Se in colostrum and milk were found between the two breeds. Selenium concentrations in colostrum and milk in **Table 4**.

Reproductive performance. Reproductive data are summarized in Table 5. Higher number of live born piglets was found in CLWxL breed as compared to Du breed. Also significantly higher ($p<0.001$) birth weights and significantly higher ($p<0.001$) weights of piglets at weaning were found in CLWxL breed.

DISCUSSION

The goal of this study was to evaluate and compare indices of selenium status in pure bred duroc breed and Czech Large White x Landrace breed. The possible

Table 5. Characteristic of piglets in CLWxL and Du groups and their comparison.

Parameter	CLWxL		Du		p ¹
	Median	5 th / 95 th perc.	Median	5 th / 95 th perc.	
Birth weights (kg)	1.90	1.50 / 2.20	1.50	1.30 / 1.80	<0.001*
Weights (kg)(day25)	7.55	6.20 / 8.65	5.20	4.10 / 6.40	<0.001*
Total piglets born	12.00	8.00 / 15.00	9.50	5.00 / 15.00	0.154
Live piglets born	11.00	8.00 / 15.00	8.50	4.00 / 13.00	0.010
Stillborn piglets	0.00	0.00 / 3.00	1.00	0.00 / 5.00	0.107

¹ Mann - Whitney U test, $\alpha=0.05$

* Statistically significant difference

genetic influence on selenium indices has been suggested by several authors.

Stowe and Miller (1985) found that relative high or low serum Se concentrations in pigs can be passed on their progeny. This supports hypothesis of genetically influenced ability to utilize dietary Se in pigs.

Moreover Kim and Mahan (2001) reported that white-haired pigs exhibit selenosis more rapidly than red or black-haired pigs. The authors suggest that Se deposition in tissues in breeds that are more muscular may differ, since muscles retains Se. Mahan and Newton (1995) also suggest that depletion of Se reserves is exacerbated with increasing reproductive performance of sows.

As far as GSH-Px activity is concerned there is now evidence that the expression of human plasma GSH-Px activity is under genetic control (Yoshimura *et al.* 1991; Johnson, 2002; Iwata *et al.* 2006). A possible genetic influence on GSH-Px in pigs was suggested by Jorgensen *et al.* (1977). This is consistent with observations of Tucker *et al.* (1980) and Atroshi & Sankari (1981) who found a genetic influence on GSH-Px activity in sheep.

It has been also demonstrated that GSH-Px activity shows variability from species to species (Toyda *et al.* 1989; Johnson, 2002) and differ among breeds of horses (Kirschvink *et al.* 2006). In a study conducted on horses, Kirschvink *et al.* (2006) demonstrated higher values of GSH-Px in thoroughbred horses than in standard breeds. The possible breed differences in indices of Se status in pigs needs to be elucidated.

No differences between the two groups of sows were found in the dynamic of serum Se values. A significant decrease in serum Se from the beginning of the trial till parturition is in agreement with Mahan and Peters (2004) and indicates an increased utilization of Se by developing fetuses. Our results are however contradictory to findings of Vrzgula *et al.* (1980) who found a decline of serum Se from day 30-70 of gestation.

The two breeds did not differ in Se concentrations in colostrums and milk and in neonatal tissues. This is in agreement with Stowe and Miller (1985) who did not

find differences in tissue selenium between pigs predisposed to hypo and hyperselenemia.

Significantly higher serum GSH-Px activities in duroc sows and duroc piglets found during lactation indicate possible effect of the breed on serum GSH-Px activity.

The results of our study support the hypothesis there may be breed differences in indices of selenium status in pigs.

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