

SWINE SPECIES: SWINE SPECIES REPRODUCTION AND MANAGEMENT

1937 (M383) Dietary supplementation with organic or inorganic selenium and pyridoxine in gilts on gene expression in the porcine expanded blastocysts in vivo. D. Bueno Dalto^{*1,2}, S. Tsoi³, I. Audet¹, M. Dyck³ and J. J. Matte¹, ¹*Agriculture & Agri-Food Canada, Sherbrooke, QC, Canada*, ²*Department of Animal Science, Universidade Estadual de Londrina, Londrina, Brazil*, ³*Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada*

This study aimed to determine the effect of dietary selenium (Se) and pyridoxine supplementation, in gilts, on gene expression in the porcine expanded blastocyst (PEB). Eighteen gilts were randomly assigned to one of the 3 experimental diets: 1) basal diet (natural Se content of 0.2 mg/kg) without supplemental Se or pyridoxine (CONT, $n = 6$); 2) basal diet + 0.3 mg/kg of feed of sodium selenite, and 10 mg/kg of feed of hydrochloride pyridoxine (MSeB₆10, $n = 6$); and 3) basal diet + 0.3 mg/kg of feed of Se-enriched yeast, and 10 mg/kg of feed of hydrochloride pyridoxine (OSeB₆10, $n = 6$). All gilts were inseminated at their fifth estrus, and sacrificed 5 d after. Both uterine horns were flushed for embryo harvesting. Expanded blastocysts were selected for the porcine embryo-specific microarray: direct comparisons were done for MSeB₆10 vs. CONT and OSeB₆10 vs. CONT, whereas a reference design comparison were used for OSeB₆10 vs. MSeB₆10. Data were analyzed according to a randomized arrangement of treatments in blocks with the 3 dietary treatments as the main independent variables. Microarray data were analyzed using FlexArray, with threshold fold change ≥ 1.7 and P -value ≤ 0.05 . CONT had lower blood Se concentration than Se-supplemented gilts ($P < 0.01$), but no differences were found between Se sources ($P = 0.38$). CONT had lower pyridoxine concentrations than B₆10 gilts ($P < 0.05$). Plasma glutathione peroxidase (GSH-Px) activity tended to increase during the experimental period ($P < 0.06$), but no treatment effect was detected ($P = 0.57$). MSeB₆10 vs. CONT and OSeB₆10 vs. CONT respectively showed 24 and 446 differentially expressed genes, whereas the corresponding number was 190 for OSeB₆10 vs. MSeB₆10. No specific biological processes were affected using Gorilla gene list analysis in MSeB₆10, however OSeB₆10 stimulated protein folding but not selenoprotein synthesis. Although all associated genes for GSH-Px and other selenoprotein synthesis were found, none of them were differentially expressed in any comparison. Antioxidant genes such as glutaredoxin-3 (GLRX3), peroxiredoxin-4 (PRDX4) and coenzyme Q6 monooxygenase (COQ6) were up-regulated in OSeB₆10 vs. CONT, and thioredoxin and thioredoxin domain containing 17 were downregulated in

OSeB₆10 vs. CONT and OSeB₆10 vs. MSeB₆10, respectively. GLRX3, PRDX4 and COQ6 expression were validated by real-time PCR. In conclusion, OSeB₆10 affects PEB metabolism more markedly than MSeB₆10. Although supplements of both Se sources and pyridoxine did not influence GSH-Px-related genes expression in the PEB, they are involved with other antioxidant enzymes regulating antioxidant defense and cell proliferation, at this stage.

Key Words: porcine embryo, selenium, gene expression

1938 (M384) Comparing the growth curves of females and immuno castrated males in commercial conditions. S. López-Vergé^{*1}, G. Ibanez² and J. Gasa¹, ¹*Animal Nutrition and Welfare Service, Department of Animal and Food Sciences, Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Globosuínos Agropecuária S/A, Paraná, Brazil*

Concerning pigs, intact males grow faster than females; inversely, surgically castrated males perform worse than females. Immuno castration appears as an alternative to surgical castration in pigs, since it features less detrimental effects on growth and guarantees the full preservation of animal welfare conditions. The objective was to compare the growth curve parameters obtained from females and immuno castrated males, reared in commercial conditions. The experiment lasted 105 d and 168 piglets from 6 commercial white genetic lines (28 piglets each) were selected at the end of the nursery period ($24.8 \text{ kg} \pm 5.10 \text{ kg BW}$). Animals were allocated to a growing-finishing facility and segregated by sex (males and females). Pigs were fed with up to 6 consecutive different corn-soybean diets in a controlled ad libitum way and ractopamine (10 ppm) was added as a feed additive 28 d before slaughtering. A total of 166 animals finished the experiment ($124.4 \text{ kg} \pm 6.20 \text{ kg BW}$). Males were immuno castrated by giving them 2 doses of vaccine Vivax (Zoetis) around 56 and 28 d before slaughtering. Pigs were weighed weekly individually (up to 15 times) and data was adjusted using the double exponential Gompertz model ($\text{Live Weight} = A \cdot \exp(-\exp(b - (c \cdot t)))$); the resulting growth parameters were statistically analyzed by ANOVA. Immuno castrated males had greater ADG (mean values of 1070 vs. 997 g/d, $P < 0.001$) and tended to have a better G:F (441 vs. 428 g of growth/kg feed, $P = 0.076$) than females. Immuno castrated males, compared with females, had greater values for mature live weight (A) ($334.3 \text{ vs. } 272.9 \text{ kg}$; $P < 0.001$), and also maximum growth rate ($(A \cdot c)/e$) ($1249 \text{ vs. } 1099 \text{ g/d}$, $P < 0.001$), age ((b/c)) ($155 \text{ vs. } 141 \text{ d}$, $P < 0.001$) and live weight ($118.5 \text{ vs. } 103.6 \text{ kg}$, $P < 0.001$) at the inflection point (which corresponds to the maximum growth rate with age). In contrast, specific growth rate (c) was higher for females ($0.0111 \text{ vs. } 0.0105$, $P < 0.025$) compared to immuno castrated males. It is concluded that Gompertz model was a useful tool to

demonstrate that Immuno castrated male pigs grow faster and more efficiently than females.

Key Words: immuno castrated pigs, growth curve, Gompertz approach

1939 (M385) Growth performance of Sarda purebred suckling piglets reared in smallholder farms.

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The Sarda pig has been recently included in the Italian register of swine native breeds to preserve its genetic diversity and typical productions. Sarda piglets are usually raised on small farms. The most important product is the suckling piglet slaughtered at about 8–10 kg of body weight, used for the preparation of traditional dishes. In this study, a survey was performed to assess growth performances of purebred Sarda piglets during suckling period in smallholder farms. Twenty sows located in two farms, were housed in individual pens before farrowing. Stillbirths, born live, and birth weights for all litters were recorded. All piglets were ear-tagged and weekly weighed until weaning. Animals were grouped according to litter size: medium-small (5 to 8 pigs born alive), and medium-large (9 to 12 piglets). Effects of farm, litter size group and sex on individual average daily gain (ADG) were tested with an ANOVA model. A multiple linear regression model was used to evaluate the influence of age, litter size and sex on body weight. Birth weight of piglets did not differ between farm and litter size category, whereas, males were heavier ($P = 0.039$) than females (1556 vs. 1458 g, respectively). The ADG of the piglets during the suckling time did not differ for sex and farm. Piglets of medium-large litters had a slower growth than medium-small litters (ADG was 108 vs. 124 g, respectively). Results of regression analysis ($R\text{-Sq} = 0.75$) indicate a significant influence of age and litter size ($P < 0.01$) on body weight. Growth performances of suckling pigs were less than that of pigs of most conventional swine breeds. However, profitability of this breed seems strongly linked to the consumers preference for its meat as a key component of originally regional dishes.

Key Words: growth, suckling piglets, Sarda pig breed

1940 (M386) Piglet body weight at weaning: A key success factor for post-weaning performance?

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The aim of the study was to evaluate the importance of piglet BW at weaning (WBW) on post-weaning performance and mortality. A total of 4320 male and female crossbreed piglets

[Pietrain x (Landrace x Large White)] were used. All the animals were individually weighted at weaning (28 d-old). The selected animals (240 per batch without those corresponding to the percentile 10 and 90) were distributed into 3 BW categories: Low (L; BW < 6.5 kg, $n = 92$); Middle (M; 6.5 kg < BW < 8.5 kg, $n = 216$) and High (H; BW > 8.5 kg, $n = 94$) and allocated in groups of 10 piglets. The same commercial pre-starter diet formulated to contain 10.35 MJ/kg NE, 17.9% CP and 1.32% Lys was offered ad libitum. Feed intake (FI), BW and mortality rate (MR) were weekly monitored to calculate FI and ADG (0 to 14 d post-weaning). Performance data were analyzed with ANOVA by using the GLM procedure of SAS taking into account the WBW category. The initial differences between WBW categories were maintained along the pre-starter period ($P < 0.01$). Lower ADG ($P < 0.01$) but not FI ($P > 0.10$) was observed between WBW categories for the first week post-weaning (H = 99^b g/d; M = 115^a g/d and L = 122^a g/d; $P < 0.01$). For the second week post-weaning, higher ADG and FI was observed for H compared to M and L groups ($P < 0.01$). Overall, higher FI was observed for H than M and L (H = 325^a g/d; M = 293^b g/d and L = 265^c g/d; $P < 0.01$), however, no difference in ADG was achieved (H = 207 g/d; M = 203 g/d and L = 192 g/d; $P > 0.05$). Moreover, higher MR was observed for H than for M and L during the pre-starter period (1.98 vs. 0.2 and 0.3%; $P < 0.05$). The H animals failed to meet the energy requirements during the first week after weaning probably due to a longer anorexia period. After that, H animals start suddenly to eat high amounts of solid feed, following digestive and malabsorptive problems which may explain the higher MR, causing important losses. These results confirmed that in large suckling periods (28 d) the early contact with solid feed may optimize performance and reduce mortality after weaning in pigs with high BW.

Key Words: performance, mortality, weaning, piglet

1941 (M387) Comparison of fecal microbiota among healthy piglets during the weaning transition using barcoded 16S rDNA pyrosequencing.

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The objective of this study is to investigate change in the fecal microbiota of healthy piglets during the weaning transition using barcoded pyrosequencing of the prokaryotic 16S rRNA gene. It is believed that the gastrointestinal microbiome changes over time beginning from birth until adulthood in response to changes in diet, environmental stress and diseases. In particular, the weaning process results in reduced metabolic activity, malabsorption of nutrients, and susceptibility to enteric diseases as a consequence of abrupt separation from the sow before joining other litters in a different environment. Fifteen crossbred piglets weaned on the Day 28 were used in the study. Fecal samples were obtained immediately before

weaning (4 wk of age) and after weaning (6 wk of age), and were subjected to genomic DNA extraction for pyrosequencing analysis. As the piglets underwent the weaning transition a trend toward increased bacterial diversity was observed, based on species abundance as measured by the Shannon-Weaver index. *Firmicutes* (54.0%) and *Bacteroidetes* (59.6%) were the most dominant phyla during pre-weaning and post-weaning, respectively. During the weaning transition a distinct shift from *Bacteroides* sp. to *Prevotella* sp. as the most abundant genus was observed. Additionally, we detected a number of abundant species in the piglet gastrointestinal tract that have not been reported previously. *Clostridium rectum*, *C. clostridioforme*, *C. lactatifermentans* and *Butyrivimonas virosa* were uniquely detected before weaning while *Roseburia cecicola* and *Blautia wexlerae* were detected during the post-weaning period only.

Key Words: bacterial diversity, piglets, weaning

1942 (M388) Piglets' early body weight and milk consumption partially explain post-weaning performance.

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It's well known that piglets' BW at birth is an important factor determining their subsequent performance. Furthermore, equally important is trying to maximize milk intake during the suckling period. The objective was to assess the influence of the piglets' BW at birth and BW at weaning on pig performance over time. A total of 305 crossbreed piglets [Pietrain x (Landrace x Large White)] from 30 litters were used. All the animals were individually weighed at Day 2 (CF; cross fostering), 27 (weaning), 41 (14 d post-weaning), 62 (35 d post-weaning), 98 (growing) and 173 (slaughter). Piglets were fed ad libitum the same commercial pre-starter, starter, growing and finishing diets. The relationship between the BW at CF and BW at weaning with the BW at the different productive steps until slaughter was analyzed using the CORR procedure of SAS. BW at CF was related with BW at weaning ($P = 0.002$). Considering the Pearson correlation coefficient (r), showed that the BW at weaning was highly related to the BW at 14 d post-weaning [41 d-old ($r = 0.80$, $P < 0.001$)] but its influence was progressively reduced on Days 62 ($r = 0.51$, $P < 0.001$), 98 ($r = 0.19$, $P < 0.001$) and 173 ($r = 0.18$, $P < 0.001$), respectively. The strong relationship between BW at weaning and at 14 d post-weaning resulted in a huge BW difference between the 30% heavier and 30% lighter piglets (at weaning: 8.52 kg vs. 6.43 kg, $P < 0.001$; 14 d post-weaning: 12.17 kg vs. 10.63 kg, $P < 0.001$); difference which were reduced from 32.5% at weaning to 14.5% 2 wk later. The BW at CF also had an effect, but not as strong as BW at weaning, having the best correlation at 14 d post-weaning ($r = 0.40$, $P < 0.001$). Thus, we observed an attenuated effect on Day 27 ($r = 0.36$, $P < 0.001$), 62 ($r = 0.33$, $P < 0.001$), and 173 ($r = 0.27$, $P <$

0.001), respectively. It is concluded that both BW at CF and at weaning, play a significant role on pig BW performance and variability along the productive cycle. However these effects are gradually replaced over time, indicating that new factors become more important explaining BW variability. A higher effect of the BW at weaning was observed at the beginning of the nursing period, but it was diluted later on.

Key Words: performance, correlation, piglet

1943 (M389) Effects of parity and selection for uterine capacity on sow litter performance traits.

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Selection for 11 generations for uterine capacity (UC) was previously reported to increase litter size in gilts by 1.6 more fully formed pigs at birth compared to an unselected control line (CO) despite averaging 1 less ova shed. Our objective was to characterize litter performance traits in each line from subsequent sow parities following a shift in management scheme to a continuous flow farrowing system that more closely resembles industry conditions. Gilts entered into the system and were farrowed in contemporary groups of a maximum of 19 litters and maintained in this system through four parities if successfully mated in that contemporary group. A total of 203 litters (90 CO, 103 UC; 101 Parity 1, 49 Parity 2, 33 Parity 3; and 20 Parity 4) were analyzed. A mixed model analysis of variance was conducted. Fixed effects of farrowing group, line, parity (1–4), and two-way interactions involving line were fitted. The random effect of sire ($n = 75$) of the litter within farrowing group and line was included in the model. UC line averaged 1.3 ± 0.38 greater ($P < 0.01$) pigs born alive with 0.5 ± 0.14 fewer ($P < 0.01$) stillbirths than CO. Average pig birth weight was similar ($P = 0.99$) between lines, thus the UC line exceeded ($P < 0.05$) the CO line by 1.1 ± 0.38 kg in litter birth weight. UC line averaged 1.6 ± 0.32 greater ($P < 0.001$) pigs weaned than CO. Average pig wean weight was similar ($P = 0.64$) between lines, thus the UC line exceeded ($P < 0.05$) the CO line by 6.0 ± 2.07 kg in litter wean weight. Parity effects were observed as expected from first through fourth parities and no interactions of parity effects were observed with line. Improved reproductive performance of the UC line was maintained in sow litters similar to those previously measured in gilts. Selection for uterine capacity improved fetal survival resulting in increased number born alive with a similar average birth weight. This resulted in an increase in total weaning weight of sows through four parities. USDA is an equal opportunity provider and employer.

Key Words: pigs, selection, uterine capacity

1944 (M390) Gene expression profiles in muscle of black Iberian pigs supplemented with organic selenium compared with sodium selenite in finishing diets.

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Supplementation with organic Se provides positive benefits through increased bioavailability and absorption compared with inorganic Se. The objective of this study was to evaluate the effect of different sources of Se on muscle gene expression in finishing black Iberian pigs. The finishing experimental period started when the animals reached 80 kg and ended at slaughter at approximately 120 kg. The treatments consisted of a standard finishing diet supplemented with organic Se (0.2 ppm Se as Sel-Plex; SP, Alltech Inc) or inorganic Se (0.2 ppm as sodium selenite; SS). Skeletal muscle samples were obtained at slaughter and stored in RNA later until analysis. Total RNA was isolated from samples ($n = 5/\text{trt}$) using standard methods and was hybridized to the Affymetrix Porcine Genome array. Expression data were statistically analyzed using the GeneSpring GX 10.0 software in which SP. was directly compared to SS using a t test. Statistical differences were declared at $P < 0.05$ without considering a fold change cut-off. Genes differentially expressed were imported into Ingenuity for biological function analysis. Results indicated that 1205 genes (757 up- and 448 downregulated) were differentially expressed ($P < 0.05$) in SP. relative to SS. The biological function analysis resulted in several enriched functions related to muscle development. Among these, positive activation of lipid metabolism, cellular and tissue development (Z score > 2) were the most relevant to the study. Further analysis of the biological functions identified specific genes associated with the regulation of β -oxidation and overall energy metabolism including *CPT1C*, *SCD5*, *MYO1B* and *CAST* among others. In addition, upstream molecule analysis indicated that more than 30 genes were controlled by *TGF β 1* (Transforming growth factor β 1), which is closely related to Se in the regulation of oxidative stress. In conclusion, this study shows evidence of multiple molecular mechanisms affected by SP. in skeletal muscle of black Iberian pigs that relate to performance and meat quality.

Key Words: Se, swine, gene expression, microarray, muscle

1945 (M391) Neither photoperiod in the farrowing room nor time of weaning affect nursery performance.

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Weaning may result in anorexia and reduced growth in pigs especially during the initial 24 to 48 h in the nursery. This study was designed to determine if altering the photoperiod in the farrowing room and/or if weaning at the end of the light

or dark cycle would affect performance post-weaning. Twelve farrowing rooms, 13 sows/room, were assigned to one of four treatments approximately one wk before farrowing. Treatments, arranged as a 2×2 factorial included 2 farrowing room photoperiods; 16 h light:8 h dark (16L:8D) or 8L:16D, and 2 weaning times; end of the dark or end of the light cycle. Pigs were weaned at $25 (\pm 1)$ d of age into nurseries maintained on a 16L:8D regime at time 0 of the dark cycle. Pigs were fed standard commercial diets, in a 2 phase feeding program in the nursery. The phase 1 nursery diet was spiked with ferric oxide pellets for 24 h post-weaning and anal swabs taken at 48 h post-weaning allowed pigs to be designated as “eaters” or “non-eaters”. Neither farrowing room photoperiod nor weaning time affected ADG ($P > 0.10$) in the farrowing room (236 g/d; birth to weaning) or nursery (437 g/d, weaning to 54 d of age). On d 0 to 7 post-weaning, there was a tendency for a photoperiod by weaning time interaction for ADFI ($P = 0.06$). The lowest intakes (123 g/d) were observed for pigs who had been on the 16L:8D lighting regime and weaned at the end of the dark cycle. ADFI was similar among the other treatments and averaged 157 g/d. Neither photoperiod nor time of weaning affected the percentage of pigs (34%) identified as “eaters” during the initial 24 h in the nursery ($P > 0.10$). Pigs identified as “eaters” were lighter at weaning (7.26 vs. 7.62 kg BW; $P < 0.01$), but showed improved ADG from d 0 to 7 post-weaning relative to “non-eaters” (187 vs. 141 g/d; $P < 0.01$). Nursery exit weights were similar between “eaters” (19.6 kg) and “non-eaters” (21.0 kg; $P > 0.10$). Farrowing room photoperiod and/or weaning at the end of the dark or light cycle did not affect nursery performance. Pigs exhibiting evidence of phase 1 feed consumption immediately post-weaning were lighter; however they had higher ADG immediately post-weaning than those identified as non-eaters.

Key Words: swine, weaning, photoperiod

1946 (M392) Behavior traits and growth characteristics of newly weaned piglets.

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Four litters of newly weaned piglets ($n = 37$; 7.01 kg BW) were used to evaluate the potential correlations between weight of the piglet, behavioral traits, and growth rate in the first 7 d following weaning. Piglets were weaned at an average of 27 d-of-age and moved into an environmentally controlled nursery facility. Littermate piglets were penned together and allowed ad libitum access to feed and water. Room temperature was maintained between 26 and 32°C. Above each pen a video camera connected to a data storage unit recorded all piglet behaviors. Feed and water disappearance and piglet weight were recorded daily. Video files of piglet behavior were evaluated for frequency (FREQ) and amount of time (TIME) involved in the following behaviors: mobile/active, aggression, eating, and drinking. Piglet weaning weight in wk

1 was negatively correlated ($r = -0.47$) to weight change as heavier piglets tended to lose more or gain less weight than their lighter weight contemporaries. The daily correlation of weaning weight to weight change was numerically the least ($r = -0.25$) on d 1, and the greatest on d 4 ($r = -0.48$). Using pen averages, feed intake increased linearly ($P < 0.05$) from d 0 to 7, while water intake increased numerically each day. As expected, *FREQ* and *TIME* spent eating and drinking increased linearly ($P < 0.05$) during the first week post-weaning. On d 1, *FREQ* of eating behavior was not correlated ($r = +0.15$) to piglet weight change, while *FREQ* of drinking and aggression were negatively correlated ($r = -0.58$ and -0.73 , respectively) to piglet weight change. On d 2, *FREQ* of eating and drinking were positively correlated ($r = +0.44$ and $r = +0.72$, respectively) to weight change and *FREQ* of aggression was not correlated ($r = +0.25$) to piglet weight change. These correlations seem to show that piglets that lost more weight tended to exhibit less inclination towards eating and exhibited more instances of drinking or fighting on d 1. By d 2 to 7, *FREQ* of eating behavior was positively correlated ($r = +0.50$) to *FREQ* of watering behavior and was positively correlated ($r = +0.75$) to weight change. Data from this study supports previous work where larger piglets tended to lose more weight than smaller piglets post-weaning, which may be due to increased frequency of aggression and water intake on the first day away from the sow.

Key Words: piglet, growth, behavior

1947 (M393) Oxidative stress is higher in replacement gilts than in multiparous sows. J. Lapointe*, C. Roy and M. Lavoie, *Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada*

The recent success obtained in term of increasing the litter size of sows has not correlated with a reduction of replacement rate. There is thus an increased economic demand for gilts with optimal reproductive potential and longevity. Unfortunately, replacement gilts are known to be more susceptible to diseases and less productive than multiparous sows. While it is straightforward to identify the physiological failure which

leads to the removal of a gilts from the herd, identification of the underlying molecular reasons for the occurrence of these events continues to be more challenging. Interestingly, reproductive performance, resistance to diseases and longevity could all be largely affected by oxidative stress. To investigate if oxidative stress conditions could account for the poor performance and longevity observed in replacement gilts in comparison to older multiparous sows. Three distinct groups of 15 F1 conventional Yorkshire x Landrace sows were formed based on their similar age and parity. These groups were primiparous gilts (group 1), third parity sows (group 2) and fifth parity sows (group 3). All animals were slaughtered during the post-ovulatory period of the estrous cycle and blood as well as tissues samples were collected and frozen at -80°C . Principal biomarkers of oxidative damage to proteins (Carbonyls) were analyzed in plasma and liver samples using ELISA procedures. Specific mRNA expressions of the major antioxidants glutathione peroxidases 1 and 4 (GPx1, GPx4) as well as superoxide dismutases 1 and 2 (Sod1, Sod2) were monitored in liver and kidney samples by quantitative RT-PCR. Specific enzymatic activities of glutathione peroxydases and superoxide dismutases were measured by spectrophotometric assays. The plasmatic concentrations of protein carbonyls were significantly different between the three groups with the higher concentrations being observed in gilts ($P \leq 0.001$). The mRNA expression levels of GPx1 and GPx4 were also significantly increased in the liver of primiparous gilts when compared to multiparous sows ($P \leq 0.05$) while no differences were observed in kidneys ($P > 0.10$). Sod2 enzymatic activity was found to be higher in the liver of primiparous gilts than fifth parity sows ($P \leq 0.05$). It is well established that the expression and activity of antioxidants increase in response to oxidative stress. Taken together, our results indicate that replacement gilts sustain significantly higher oxidative conditions than multiparous sows. Current findings may contribute to the design of nutritional regimens that will increase the productivity of gilts by counteracting oxidative stress.

Key Words: oxidative stress, gilts, longevity.