SHORT COMMUNICATION

The effects of age and reproductive status on blood parameters of carbohydrate and lipid metabolism in Iberian obese sows

Laura Torres-Rovira², Pilar Pallares², Pedro Gonzalez-Añover³, Maria L. Perez-Solana², Antonio Gonzalez-Bulnes¹,²
²Animal Reproduction Department, INIA, Madrid; ³NUTEGA Madrid, Spain

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SUMMARY
The effects of age and reproductive status on carbohydrate and lipid metabolism of Iberian sows reared in an intensive management system were examined. These animals, with age, are predisposed to hyperglycaemia and dyslipidemia which may develop in response to nutritional challenges during lactation. At weaning, high levels of glucose, triglycerides and low-density lipoproteins cholesterol (LDL-c) with low high-density lipoproteins cholesterol (HDL-c) are indicative of insulin resistance. Reproductive Biology 2011 11 2: 165-171.

Key words: Iberian-swine, leptin-resistance, glucose, lipids

INTRODUCTION
The Iberian pig, similar to other Mediterranean breeds, has been extensively reared for centuries and, thus, has developed a “thrifty genotype” i.e. an adaptive mechanism to seasonal cycles of feasting and famine characterized by accumulating fat when food is in excess [8]. The abundance of fat causes high secretion of leptin as compared to lean swine breeds [1]. However, the Iberian pig has a gene polymorphism of the leptin receptor which increases food intake, body

¹Corresponding author: Animal Reproduction Department, INIA, Avda. Puerta de Hierro s/n. 28040-Madrid, Spain; e-mail: bulnes@inia.es
weight and fat deposition [10], hence, the animals may become obese. The failure to suppress feeding and, consequently, to lose body weight in obese individuals (including humans) with elevated leptin level is called “leptin resistance” [5, 7].

Currently, the traditional extensive management of the Iberian pig and other Mediterranean breeds is being changed to more intensive systems by directly adapting strategies from lean commercial breeds. In lean genotypes, the effects of nutritional management and metabolic status on reproductive features are well established. However, such information in Iberian pigs is scarce. The current management ignores the breed characteristics of obesity, leptin resistance and high sensitivity to changes in nutritional balance [15]. Therefore, the objective of the current study was to evaluate the possible effects of age (nulliparous vs. multiparous non-pregnant females) and reproductive status (cycling vs. weaned multiparous sows) on plasma concentrations of glucose, fructosamine and lipids in Iberian sows.

**MATERIALS AND METHODS**

Thirty Iberian purebred sows with no previous evidence of health problems and adequate pathogen-monitoring reports (all animals were negative to brucellosis, classical and African pests and Aujeszky and vesicular diseases) were used in the study in agreement with the local, national and European requirements for scientific procedures and animal establishments. For evaluating the effect of age, ten young (8 month-old) cycling nulliparous females were compared to 10 adult (18-30 months-old) cycling multiparous females. For evaluating the effects of reproductive status, these 10 adult females were compared to 10 weaned sows (after 28 days of lactation).

All animals were housed (12 h light: dark, 20 to 24°C, 50 to 70% relative humidity) indoors in individual pens (5.49 m²/animal) in a passively ventilated common ward with concrete slatted floors. Animals had *ad libitum* access to water and grain-based food (Nutega, Coslada, Madrid, Spain) that contained 89.6% of dry matter, 13.0% of protein, 83.3% of carbohydrates and 3.7% of fat. Mean food intake was estimated to be 2 kg/animal/day in nulliparous females and 3.5 kg/animal/day in multiparous sows, without differences between cyclic and weaned dams. The sows were weighed during blood sampling. Body weight averaged 121.7 kg and 174.2 kg in young and
adult females, respectively, without differences between cyclic and weaned sows.

All animals were fasted overnight (approximately 18 h) with free access to water. Blood samples were collected on the following day by jugular venopuncture using 5 ml sterile blood vacuum tubes with heparin (Vacutainer™ Systems Europe; Becton Dickinson, Meylan Cedex, France). Immediately after collection, the blood was centrifuged at 4°C at 1500×g for 15 min and plasma was stored at -20°C until assayed.

Plasma concentrations of glucose and fructosamine as well as triglycerides, total cholesterol, high-density lipoproteins cholesterol (HDL-c) and low-density lipoproteins cholesterol (LDL-c) were measured by a clinical chemistry analyzer (Screen Point, Hospitex Diagnostics, Sesto Fiorentino, Italia). Plasma HDL-c ratio and LDL-c ratio were calculated by dividing HDL-c and LDL-c concentrations, respectively, by total cholesterol. Plasma LDL-c/HDL-c ratio was obtained by dividing the concentration of LDL-c by HDL-c.

Effects of age and reproductive status on plasma metabolic parameters were estimated by one-way ANOVA or Kruskall-Wallis test when Levene’s test showed non-homogeneous variances. Relationships between selected parameters were assessed by Pearson correlation analysis and linear regression procedures. Results were expressed as the mean±SEM and statistical significance was accepted from p<0.05.

RESULTS AND DISCUSSION
Plasma concentrations of glucose, fructosamine and triglycerides were higher in adult sows than in young cycling sows (p<0.05; figs 1 and 2). HDL-c was lower (p<0.05) in adult sows than in young sows, while LDL-c did not differ between the two groups of sows. The age-related differences in glucose, fructosamine and lipids are in agreement with previous studies on other swine breeds [4, 13].

There was also a clear effect of reproductive status on metabolism of carbohydrates and lipids. Weaned sows showed higher plasma concentration of glucose (p<0.05) compared to cycling sows, while differences in fructosamine were not statistically significant. These results indicate an acute increase in nutritional balance since plasma glucose levels indicate acute glycaemia, while fructosamine levels indicate glycaemia during the 2-3 previous weeks.
Figure 1. Plasma concentrations of glucose (A) and fructosamine (B; mean±SEM) in nulliparous (young cyclic) and multiparous (adult cyclic and adult weaned) Iberian sows. Different superscripts denote statistically significant differences (p<0.05).

Figure 2. Plasma concentrations of triglycerides (A), total cholesterol (B), low-density lipoproteins cholesterol (LDL-c; C), high-density lipoproteins cholesterol (HDL-c; D); LDL-c/HDL-c ratio (E; mean±SEM) in nulliparous Iberian sows (young group) and in nulliparous (young cyclic) and multiparous (adult cyclic and adult weaned) Iberian sows. Different superscripts denote statistically significant differences (p<0.05).
This acute increase in nutritional balance may be related to the cessation of lactation and, thus, an acute decrease in glucose uptake by the mammary gland at weaning as it has been reported previously with lean sows [11, 12].

Moreover, weaned sows in comparison to cycling sows, developed a dyslipidemic profile showing significantly higher plasma triglycerides, total cholesterol, LDL-c and LDL-c/HDL-c ratio (p<0.05) with no differences in HDL-c. In the weaned sows, HDL-c was inversely related to triglyceridemia (p<0.01) and total cholesterinemia (p<0.05). These features resemble hyperlipidemia type 2 (increased total cholesterol and LDL-c) and the so-called “lipid triad” (elevated triglycerides, elevated LDL-c and low HDL-c) in human medicine [9, 14]. Elevations of cholesterol caused by elevations of LDL-c may occur both in type-1 and type-2 diabetic patients; however, low HDL-c levels are indicative of obese individuals with type-2 diabetes [2]. A possible explanation for the dyslipidemic profile in the weaned sows may be related to their high plasma glucose and fructosamine levels; hyperglycaemia increases mobilization of body reserves by favouring lipolysis [6].

Therefore, high triglyceride and low HDL-c levels, concurrent with high glucose suggest insulin resistance, which in humans has been shown to be central to the metabolic syndrome and type-2 diabetes [9]. In the sows of our study, the abnormalities found in the lipoprotein profile would indicate an asymptomatic diabetic prodrome [3], since later stages of diabetes are characterized by a really high hyperglycaemia.

In conclusion, the current results indicate that the Iberian sow manifests changes in indexes of glucose and lipid metabolism with age. These changes may be dramatic in response to challenges in nutritional balance like lactation, leading to insulin resistance and diabetic prodrome that may affect reproductive features of Iberian sows after weaning.

REFERENCES
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