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Leptin in sow: Influence on the resumption of cycle activity after weaning and on the piglet gain

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ABSTRACT

In sows, a strong relationship exists between body condition and reproductive efficiency and milk yield. Leptin may act as a metabolic gate which permits the activation of reproductive axis: in the sow, serum concentration of leptin was positively correlated with adiposity at farrowing. An interesting aspect useful to clarify the biology of leptin, was the discovery that the placenta expresses the ob gene, the ob receptor gene and it is a site of leptin production, suggesting a possible role of the hormone in fetal growth; after birth, the placenta functions were taken over from milk, especially to the delivery of maternal hormones and growth factors to the neonate. The exact role of maternal leptin in the physiology of neonatal piglets remains to be determined. Our aim was to evaluate if maternal leptin levels at the beginning of lactation and at weaning could predict the resumption of cycle activity and/or the piglet gain. Thirty-eight Large White×Landrace pregnant sows (16 nulliparous and 22 pluriparous) were used. Blood samples were taken from sows and piglets at d 5 and d 21 after farrowing; in the same days, milk samples were taken after oxytocin injection by means of complete manual milking of all mammary glands of one side. On the basis of the blood leptin at d 5, sows were divided into 3 groups (Low: <2.3 ng/ml; Medium: 2.3 to 2.6 ng/ml; High: >2.6 ng/ml). Our results show a correlation at d 5 between backfat thickness and blood leptin ($r=0.342$; $P<0.05$). The resumption of the cyclic activity was faster in sows with a leptin level at d 5 greater than 2.3 ng/ml ($P<0.01$). Milk composition at d 5 and 21 was not affected by parity and leptin. Piglet ADG was significantly ($P<0.05$) influenced by sow leptin groups (0.180 kg day^{-1} for piglets from Low group and 0.224 for High group). Piglets weaned by High group sows have shown a greater blood leptin content at weaning ($P<0.01$) than other groups. In conclusion we have found a significant correlation between leptin and productive and reproductive performances of pigs. This paper underlines the pleiotropic actions exerted by leptin in the productive sow.

1. Introduction

In modern high-producing herds, the maintenance of an optimal body condition of sows is a prerequisite to achieve adequate production levels. In the sow, a strong relationship exists between body condition and reproductive efficiency (Mullan and Williams, 1989; van der Peet-Schwering et al., 1998, Hultén et al., 2002, Maes et al., 2004). Body reserves are also determinants of milk yield. Pulske and Dong (1998) show that the metabolic state of sows during lactation influences the milk dry matter conversion in piglet gain. Sows in good condition produced more milk, energy and protein than thin sows (Klaver et al., 1981). In early lactation, sow body composition affected milk production and only during the progression of lactation the dietary intake of precursors for milk synthesis becomes more important (Revell et al., 1998). Lactation is a complex, and unique physiological state characterized by behavioral and neuroendocrine adaptations which shift the energy balance to milk components synthesis. A

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variety of hormones and metabolic signals modulates the body omeostasis by regulating the food intake/energy balance; in particular, the hypothesis that adipose tissue is the source of hormones controlling metabolism is not new (Kennedy, 1953). The discovery of obese gene and its product, leptin, by Zhang et al. (1994) supported this concept. Leptin is mainly produced by adipocytes and adipose and blood leptin levels are coupled to energy stores. Serum leptin concentrations have been demonstrated to be positively correlated with adiposity of sows at farrowing and inversely related to feed intake during lactation (Estienne et al., 2000). Barb and Kraeling (2004) showed a strong link between leptin, luteinizing hormone (LH) and growth hormone (GH). In sows plasma leptin is associated with backfat depth and the loss of backfat depth during lactation is associated with reproductive performance (De Rensis et al., 2005). However, there is not a direct association between plasma leptin and reproductive performance. An interesting aspect useful to clarify leptin biology, was the discovery that placenta expresses both ob and ob receptor gene and it is a site of leptin production (Smith-Kirwin et al., 1998), thus suggesting a possible role of the hormone in fetal growth; after birth, placenta functions are taken over from milk, especially to deliver maternal hormones and growth factors to the neonate. In the sow, leptin concentrations in whole milk are much greater than blood ones and reflect dietary energy intake during pregnancy (Estienne et al., 2003; Woliński et al., 2003). The presence of leptin in human milk raised the possibility that maternal leptin may exert biological effects on the infant at a time in which both adipose tissue and the appetite regulatory systems are immature (Casabiell et al., 1997).

Our aim was to evaluate if maternal leptin levels, determined 5 d after farrowing and at weaning could predict the resumption of cycle activity and/or the piglet gain. We chose to take the first blood and milk sample 5 days after the delivery to reduce the effects of hormonal changes at the farrowing on leptin levels and because at 5 d, the colostrum secretion was replaced by milk secretion.

2. Materials and methods

2.1. Experimental groups

Thirty-eight Large White × Landrace sows (16 nulliparous and 22 pluriparous) were randomly selected from the herd effective in the same reproduction status during two months. Mean (± SD) parity order of pluriparous sows was: 3.22 ± 0.75. All sows received, from d 7 to d 35 of gestation, a complete feed (13.95% crude protein, 2803 kcal ME/kg, 0.65% lys as-fed basis) in different amounts to obtain a final BCS value of 3.5. The amount of the same complete feed was 2.8 kg $head^{-1}$ d^{-1} from d 36 of gestation to farrowing. During lactation feed (15.60% crude protein, 2832 kcal ME/kg, 0.92% lys as-fed basis) was offered ad libitum; the mean intake during lactation was 4.7 kg $head^{-1}$ d^{-1}. During both gestation and lactation free access to water was provided.

At d 110 of gestation sows entered the farrowing room; they were evaluated for fat thickness at P2 level using an a-mode ultrasound (Lean-meater, Renco Corporation, Minneapolis, MN, USA); the measurement was repeated at the end of lactation (21 d). After weaning, the sows were kept in individual cages until successive pregnancy control.

Blood samples from jugular vein were taken from sows and piglets 5 (+5 d) and 21 d (+21 d) after farrowing; in the same days, milk samples were taken after oxytocin injection (30 IU in auricular vein) by means of complete manual milking of all mammary glands of one side. On the basis percentile frequency (33%) of blood leptin concentrations 5 d after farrowing, sows were divided into 3 groups (Low: <2.3 ng/ml — parity 2.50 ± 1.29; Medium: 2.3 to 2.6 ng/ml — parity 2.50 ± 1.29; High: >2.6 ng/ml — parity 2.17 ± 1.34). In Low group (*n*.13) 36% were nulliparous and 64% pluriparous, as in Medium (*n*.13) and High (*n*.12) the ratio was 50/50 and 42/58, respectively. The number of piglets born alive, stillborn and weaned was recorded, as well as their weight at litter balancing (within 24 h from farrowing) and at weaning. Litter balancing was carried out by assigning 9–10 piglets to each nulliparous and 10–11 to pluriparous. Milk production was estimated on the basis of litter growth, according to the equation proposed by Noblet and Etienne (1989). The weaning-to-estrus interval (WOI) and number of service per conception were recorded.

2.2. Analytical methods

Serum samples were obtained by centrifugation at 536 *g* for 10 min and were kept at −20 °C until analysis; milk samples were treated as suggested by Estienne et al. (2000). In particular, skimmed milk was obtained by heating whole milk until 40 °C for 10 min, then centrifuged at 1489 *g* for 10 min; fat was removed by a vacuum pump.

Leptin content in blood and milk was determined by a commercial kit (Multi species Leptin RIA — Linco Research, St. Louis, MO), previously validated in swine for serum (Qian

Table 1
Full cream milk composition.

Item	Parity		Leptin group[a]		
	Nulliparous (no. 16)	Pluriparous (no. 22)	Low (no. 13)	Medium (no. 13)	High (no. 12)
Milk composition at d 5					
Fat	9.67 ± 0.48	10.26 ± 0.39	9.73 ± 0.57	9.87 ± 0.49	10.28 ± 0.53
Protein	5.42 ± 0.18	5.55 ± 0.14	5.58 ± 0.21	5.40 ± 0.18	5.48 ± 0.20
Lactose	4.56 ± 0.13	4.52 ± 0.11	4.63 ± 0.16	4.47 ± 0.14	4.52 ± 0.15
Milk composition at d 21					
Fat	8.41 ± 0.65	9.36 ± 0.53	8.78 ± 0.78	8.76 ± 0.67	9.12 ± 0.73
Protein	4.84 ± 0.18	5.05 ± 0.14	4.85 ± 0.21	4.93 ± 0.18	5.05 ± 0.20
Lactose	4.57 ± 0.17	4.65 ± 0.14	4.60 ± 0.21	4.72 ± 0.18	4.52 ± 0.19

Least squares means ± SE, g/100 g.
[a] Low: <2.3 ng/ml; Medium: 2.3 to 2.6 ng/ml; High: >2.6 ng/ml.