Domestic Animal Endocrinology 53 (2015) 35–41

Contents lists available at ScienceDirect

Domestic Animal Endocrinology

journal homepage: www.domesticanimalendo.com

Relative prolactin-to-progesterone concentrations around farrowing influence colostrum yield in primiparous sows

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ARTICLE INFO

Article history:
Received 3 February 2015
Received in revised form 26 March 2015
Accepted 19 April 2015

Keywords:
Colostrum yield
Colostrum composition
Peripartum
Progesterone
Prolactin
Sow

ABSTRACT

In swine, colostrum production is induced by the drop of progesterone (P4) concentrations which leads to the prepartum peak of prolactin (PRL). PRL regulates mammary cell turnover and stimulates lacteal nutrient synthesis. P4 inhibits PRL secretion and downregulates the PRL receptor in the mammary gland. The aim of the present study was to determine if the relative prepartum concentrations of P4 and PRL (PRL/P4 ratio) influence sow colostrum production. The performance of 29 Landrace × Large White primiparous sows was analyzed. Colostrum yield was estimated during 24 h starting at the onset of parturition (T0) using litter weight gains. Colostrum was collected at T0 and 24 h later (T24). Repeated jugular blood samples were collected during the peripartum period, that is, from −72 to +24 h related to farrowing and were assayed for P4 and PRL. Sows were retrospectively categorized in 2 groups according to their PRL/P4 ratio 24 h before farrowing being either <2 (low PRL/P4, n = 16) or >3 (high PRL/P4, n = 13). During the peripartum period, the circulating concentrations of P4 were lower ($P < 0.05$) and those of PRL tended to be greater ($P < 0.10$) in high PRL/P4 compared with low PRL/P4 sows. Colostrum yield was greater in high PRL/P4 compared with low PRL/P4 sows (4.11 vs 3.48 kg [root mean square error = 0.69], $P < 0.05$). Colostrum composition (dry matter, energy, protein, lipid, and lactose contents) and IgG and IgA concentrations did not differ between the 2 groups of sows ($P > 0.10$). The Na/K ratio in colostrum 24 h after the onset of farrowing was lower in high PRL/P4 compared with low PRL/P4 sows ($P < 0.05$). Piglet mortality between birth and T24 averaged 10.0% in low PRL/P4 litters and 7.0% in high PRL/P4 litters ($P = 0.29$). In conclusion, a greater PRL/P4 ratio 24 h prepartum, characterized by lower P4 concentrations and a trend for greater PRL concentrations peripartum, led to increased colostrum yield in primiparous sows.

1. Introduction

Colostrum intake by piglets plays an essential role for their early survival and performances during lactation, mainly by providing energy and immunoglobulins [1,2]. The amount of colostrum ingested by piglets depends greatly on the ability of piglets to extract the colostrum from the teats, but it also depends on the capacity of the sow to produce colostrum [3]. Colostrum yield and composition are highly variable between sows, even when sows are of the same genotype and parity and are reared in similar conditions. In swine, as in other species, lactogenesis is controlled hormonally. It is initiated by the prepartum peak of prolactin (PRL) which is induced by the drop of progesterone (P4) concentrations [4,5]. PRL stimulates mammary growth and

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http://dx.doi.org/10.1016/j.domaniend.2015.04.005

lacteal nutrient synthesis in swine [5,6]. P4, on the other hand, inhibits in rodents PRL secretion and downregulates the expression of the PRL receptor in the mammary gland [7,8]. Recently, Foisnet et al [9] suggested that a severely impaired production of colostrum is related to a delay in the decrease in P4 concentrations and in the increase in PRL concentrations during the prepartum period. The aim of the present study was to determine if the relative concentrations of P4 and PRL (PRL/P4 ratio) before farrowing influence colostrum yield and composition and piglet performances during lactation.

2. Materials and methods

The studies were conducted at INRA, Saint-Gilles, France. Animals were cared for according to the French regulations for the humane care and use of animals in research. The experimental protocols were approved by the Local Ethics Committee in Animal Experiment of Rennes, France.

2.1. Animals

Thirty-five Landrace × Large White sows in their first reproductive cycle were used. Data originated from 2 studies (study 1, n = 23, 5 replicates from October 2011 to January 2012; study 2, n = 12, 5 replicates from September to December 2012) during which sows were subjected to similar rearing conditions except for the feeding strategy during late pregnancy. At approximately 285 d of age, gilts were inseminated with semen from Piétrain boars. After insemination, gilts were housed in groups of 6. They were moved to the farrowing room on day 105 of pregnancy and were kept in individual farrowing crates thereafter. Gilts were fed 2.5 to 2.6 kg/d of a conventional gestation diet containing 5.3% crude fiber (standard diet, Table 1) from day 1 to 105 of pregnancy (day 0 being the day of the first insemination). Then, from day 106 of pregnancy until the day of farrowing, gilts were fed 2.6 kg/d of a diet containing 3.3% crude fiber (low-fiber diet, Table 1) or 2.9 kg/d of a diet containing 7.9% crude fiber (high-fiber diet, Table 1) in study 1 and 2.5 kg/d of the standard diet in study 2 (Table 1). On day 1 of lactation (day 0 of lactation being the day of farrowing), all sows were fed a conventional lactation diet providing 9.52 MJ of net energy (NE)/kg, 17.5% crude protein, 0.9% lysine, and 4.3% crude fiber (as fed basis). Feed allowance was 2.5 kg on day 1 of lactation and increased thereafter by 1 kg/d until ad libitum feeding. For all sows, feed was provided in 2 equal meals during pregnancy and lactation, and water was freely available.

After a fast of 12 h, sows were weighed on days 2 and 21 of lactation. On those same days, backfat thickness was measured ultrasonically (Vetko plus, Noveko, Boucherville, QC, Canada) at the level of the 10th rib on each side, 65 mm from the midline.

Parturition was induced on day 113 of pregnancy (day 0 being the day of first insemination) by an intramuscular injection of 2 mL of alfaprostol (Alfabédyl, Céva Santé Animale, Libourne, France). In the present herd and for similar females (Landrace × Large White gilts), such inductions on day 113 did not significantly shorten pregnancy duration (113.9 d, n = 36, and 114.6 d, n = 56, with and without induction, respectively; unpublished data) and did not alter milk yield or plasma profiles of P4, PRL, cortisol, and estradiol-17β around farrowing [10]. Farrowings in the present study were attended. Oxytocin (2 mL of a 10 IU/mL solution; Ocytocem, Céva Santé Animale) was injected intramuscularly to one sow because the interval between 2 births exceeded 1 h. Time elapsed between birth and the first suckling was recorded for each piglet. During the first 24 h postpartum, the original litter was kept with the sow. Beyond 24 h, litters were standardized to 12 ± 1 piglets. Piglets were weighed at birth, 24 h after birth of the first piglet, and at 7 and 21 d of age. Piglets had free access to water throughout lactation but had no access to creep feed. They were weaned at 21 d.

Table 1
Composition of the experimental diets containing 3.3% (low fiber), 7.9% (high fiber), or 5.3% (standard) crude fiber, which were given to sows from day 106 of pregnancy until the day of farrowing.

Item	Low fiber	High fiber	Standard
Ingredient, % (as fed basis)			
Barley	41.69	31.31	31.54
Wheat	41.69	31.31	22.00
Corn	—	—	10.00
Soybean meal	11.50	1.45	9.00
Soybean hulls	—	8.00	—
Wheat bran	—	8.00	18.00
Sunflower meal (undecorticated)	—	8.00	—
Sugar beet pulp	—	8.00	5.00
Rapeseed oil	2.00	1.45	2.00
L-Lys HCl	0.05	0.16	—
L-Thr	—	0.05	—
Calcium carbonate	0.72	0.23	1.10
Dicalcium phosphate	1.40	1.20	0.30
Salt	0.45	0.34	0.45
Vitamin and mineral premix[a]	0.50	0.50	0.50
Chemical analysis[b]			
Crude fiber, %	3.3	7.9	5.3
NDF, %	13.1	20.3	20.2
ADF, %	4.2	9.4	6.6
ADL, %	0.6	1.3	1.4
CP, %	13.8	13.0	13.3
Lipids, %	3.4	3.2	4.2
Starch, %	46.1	36.3	40.1
Ash, %	4.6	4.6	5.2
DM, %	87.5	87.5	87.6
GE, MJ/kg	16.1	16.1	16.2
Nutritional value[c]			
NE, MJ/kg	9.94	8.81	9.43
Lys, %	0.63	0.60	0.60
Daily allowance, MJ NE/d	25.8	25.5	23.6

Abbreviations: ADF, acid detergent fiber; ADL, acid detergent lignin; CP, crude protein; DM, dry matter; GE, gross energy; Lys, lysine; L-Lys HCl, L-Lys monohydrochloride; NDF, neutral detergent fiber; NE, net energy; Thr, threonine.

[a] Supplied the following amounts per kilogram of diet: vitamin A, 10,000 IU; vitamin D3, 1,500 IU; vitamin E, 45 mg; vitamin K3, 2 mg; thiamine, 2 mg; riboflavin, 4 mg; nicotinic acid, 15 mg; D-pantothenic acid, 10 mg; niacin, 0.02 mg; pyridoxine, 3 mg; D-biotin, 0.2 mg; folic acid, 3 mg; vitamin B12, 0.02 mg; choline, 500 mg; Fe, 80 mg as ferrous sulfate and ferrous carbonate; Cu, 10 mg as copper sulfate; Mn, 40 mg as manganous oxide; Zn, 100 mg as zinc oxide; Co, 0.1 mg as cobalt carbonate; I, 0.6 mg as potassium iodide; and Se, 0.25 mg as sodium selenite.

[b] Analyzed values except for soluble fiber content.

[c] Calculated from INRA-AFZ (2004) tables.

2.2. Surgery and sampling

2.2.1. Surgery

On day 105 of pregnancy, a catheter (2.16-mm outside diameter and 1.02-mm inside diameter; Silastic Dow