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Responses in colostrum production and immunoglobulin concentrations to conjugated linoleic acid fed to multiparous sows during late gestation

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ABSTRACT

This study was conducted to determine whether supplemental conjugated linoleic acid (CLA) fed during late gestation affects reproductive performance, colostrum production and colostral immunoglobulin (Ig) levels of multiparous sows. Forty-eight, pregnant, Landrace × Large White, multiparous sows were allotted to four dietary treatments ($n = 12$), control (CTR, no CLA addition) and 7.5, 15.0, or 22.5 g/kg CLA supplementation from d 85 of gestation until farrowing. The CLA was added at the expense of soybean oil. All sows were fed the same commercial lactation diet postpartum. Blood samples were collected from sows on d 85, 100 and 112 of gestation while blood samples were obtained from neonatal piglets 24 h postpartum. Colostrum was collected immediately after farrowing and its production was estimated for 24 h starting with the birth of the first piglet. Neither the body weight nor backfat thickness of sows were altered by dietary CLA. Reproductive performance, piglet growth and calculated colostrum production were also unaffected. Compared with the CTR diet, dietary CLA supplementation during late gestation decreased ($P < 0.01$) the colostral fat, and increased ($P < 0.01$) the concentrations of IgG, IgA, and IgM in colostrum ($P < 0.01$). The concentrations of serum Ig and interleukin-2 on d 112 of gestation were increased ($P < 0.01$) in sows receiving CLA, although those factors did not differ among different levels of CLA supplementation. Serum IgG, IgA, and IgM concentrations in piglets from sows fed diets containing CLA were increased ($P < 0.05$) 24 h postpartum. This study indicates that dietary CLA has potential immunomodulatory effects in gestating sows and neonatal piglets, whereas there were no differences within the CLA treatments.

1. Introduction

Colostrum, the first secretion of the mammary gland after parturition, plays an important role in the survival, growth and development of piglets (Rooke and Bland, 2002; Le Dividich et al., 2005; Theil et al., 2014). Colostrum consumption, which depends both on the ability of the sow to produce colostrum and the ability of piglets to reach and suckle teats (Devillers et al., 2004), determines the total amount of energy and nutrients supplied to the neonatal piglet. Therefore, both

Abbreviations: CLA, conjugated linoleic acid; CTR, control treatment; Ig, immunoglobulin; BW, body weight; SEM, the standard error of the mean.

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an improvement in colostrum production and composition, especially maternal antibodies in the form of IgG, IgA and IgM, will have a benefit for the piglets (Rooke and Bland, 2002; Le Dividich et al., 2005).

Conjugated linoleic acid (CLA) refers to a class of positional and structural isomers of linoleic acid containing conjugated double bonds (Bontempo et al., 2004), which has been reported to have many beneficial biological functions as reviewed by Belury (2002). Bee (2000a) reported that consumption of CLA during gestation and lactation could increase the concentration of CLA isomers in sow colostrum and milk, and then transferred to piglets resulting in some potential benefits (Bee, 2000b). In addition, dietary CLA supplementation during the last week of gestation may affect sow colostrum production and could also increase immunoglobulin (Ig) concentrations of sows (Krogh et al., 2012; Bontempo et al., 2004; Corino et al., 2009). Although the supplemental level of dietary CLA to gestation sows varied widely, data on the effects of different levels of dietary supplementation of CLA to sows on colostrum production and Ig concentrations are scarce.

In swine, the synthesis of colostrum secreted during lactation and the appearance of specific milk secretory products in mammary tissue, such as β-casein and β-lactoglobulin, were reported to take place in approximately one month pre-partum (Theil et al., 2012; Lee et al., 1993; Dodd et al., 1994). Therefore, the objective of the present study was to determine whether different levels of dietary supplemental CLA to sows from d 85 of gestation till parturition affected reproductive performance and colostrum production, as well as serum and colostrum Ig concentrations in sows and piglets.

2. Materials and methods

All procedures involving animals were approved by the China Agricultural University Animal Care and Use Committee (Beijing, China).

2.1. Animals and diets

Forty-eight, pregnant, Landrace × Large White, multiparous sows were allotted to four dietary treatments based on parity (mean 5.5 ± 0.1) and body weight (BW) (mean 258 ± 2 kg) ($n = 12$), control (CTR, 0 g/kg CLA) and 7.5, 15.0, or 22.5 g/kg CLA supplementation from d 85 of gestation until farrowing. The CLA was added at the expense of soybean oil. A commercially available CLA containing 30.9% *cis*-9, *trans*-11 and 28.2% *trans*-10, *cis*-12 CLA isomers (Qingdao Auhai Biotechnology Company, Qingdao, China) was used.

During gestation, the sows were fed twice a day at 0800 and 1600 h and had free access to water through drinking nipples. The total daily ration varied from 3.0 to 3.5 kg with the amount actually fed adjusted according to the body condition of the sow. The chemical composition of the gestation diets and the fatty acid profile of the lipid content of the diets are shown in Tables 1 and 2.

Table 1
Ingredient and nutrient composition of sow gestation diets (g/kg as-fed basis).

	CTR	Dietary CLA, g/kg		
		7.5	15.0	22.5
Ingredient composition				
Corn	602.5	602.5	602.5	602.5
Soybean meal	175.0	175.0	175.0	175.0
Wheat bran	160.0	160.0	160.0	160.0
Vitamin-mineral premix[a]	40.0	40.0	40.0	40.0
Soybean oil	22.5	15.0	7.5	0.0
CLA[b]	0.0	7.5	15.0	22.5
Energy and nutrient levels[c]				
Digestible energy, MJ/kg	13.4	13.4	13.4	13.4
Crude protein (N × 6.25)	149	151	150	150
Lysine	7.6	7.5	7.8	7.5
Methionine	2.3	2.4	2.3	2.5
Methionine and cysteine	4.8	4.7	4.6	4.8
Threonine	5.5	5.5	5.6	5.5
Tryptophan	1.8	1.8	1.7	1.9
Calcium	8.9	8.5	9.1	8.9
Total phosphorus	5.0	4.9	5.2	5.1

CTR, control treatment; CLA, conjugated linoleic acid.

[a] Premix provided per kg of complete feed: 6000 IU of vitamin A, 3000 IU of vitamin D_3, 20 IU of vitamin E, 1.8 mg of vitamin K_3, 2.0 mg of thiamine, 6.0 mg of riboflavin, 4.0 mg of pyridoxine, 3000 mg of choline, 0.02 mg of vitamin B_{12}, 26.0 mg of niacin, 18.0 mg of pantothenic acid, 3.2 mg of folic acid, 0.4 mg of biotin, 400 mg of Fe as $FeSO_4 \cdot H_2O$, 20 mg of Cu as $CuSO_4 \cdot 5H_2O$, 100 mg of Zn as $ZnSO_4 \cdot H_2O$, 50 mg of Mn as $MnSO_4 \cdot H_2O$, 1.2 mg of I as KI, 0.30 mg of Se as Na_2SeO_3, 8.0 g of Ca, 0.8 g of P, 5.6 g of sodium chloride, and 0.05% of lysine.

[b] The fatty acid composition of the CLA-enriched oil provided (g/100 g of total fatty acids): myristic acid, 0.6; palmitic acid, 13.8; stearic acid, 3.3; palmitoleic acid, 0.4; oleic acid, 20.6; linoleic acid, 1.9; CLA *cis*-9, *trans*-11, 30.9, and CLA *trans*-10, *cis*-12, 28.2 (Qingdao Auhai Biotechnology Company, Qingdao, China).

[c] All values except the digestible energy were analyzed.