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## Fatty acid composition of the porcine conceptus in response to maternal omega-3 fatty acid supplementation

### Abstract

Marine and plant sources of omega-3 fatty acids have been evaluated for their effects on reproductive and other traits. Therefore we evaluated the effects of two sources of polyunsaturated fatty acids on the composition of the pig endometrium and conceptus. Treatments were Control, a corn-soybean meal diet; Flax, Control diet plus ground flax (3.75% of the diet); and PFA, Control plus a protected marine source of polyunsaturated omega-3 fatty acids (Fertilium<sup>®</sup>, 1.5% of diet). Supplements replaced equal parts of corn and soybean meal in the PFA and Flax diets. Dietary treatments did not affect linoleic acid, linolenic, and arachidonic acid concentrations in conceptuses, but Flax increased ( $P = 0.055$ ) eicosapentanoic acid (EPA) 78.8% and docosapentanoic acid (DPA) 32% ( $P < 0.05$ ) in the fetus. Gilts receiving PFA had 16% more ( $P < 0.006$ ) docosahexanoic acid (DHA) in their fetuses than fetuses in Controls had. Both Flax and PFA diets increased ( $P < 0.05$ ) DHA in the chorioallantois. In the endometrium, both EPA and DPA were increased ( $P < 0.02$ ) by the Flax diet, whereas the gilts receiving PFA had increased DHA ( $P < 0.0001$ ). In summary, initiating fatty acid supplementation approximately 40 d before breeding with these omega-3 supplements affected conceptus and endometrial composition early in the fetal period of pregnancy. Further, plant and marine sources affected fatty acid composition differently. These differences may have implications for the physiological responses reported in the literature.; Swine Day, 2005, Kansas State University, Manhattan, KS, 2005

### Keywords

Swine day, 2005; Summary Publication of Report of Progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 964; Kansas Agricultural Experiment Station contribution; no. 06-63-S; Embryo; Pigs; Omega-3 fatty acids; Swine

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## FATTY ACID COMPOSITION OF THE PORCINE CONCEPTUS IN RESPONSE TO MATERNAL OMEGA-3 FATTY ACID SUPPLEMENTATION

A. B. Brazle, B. J. Johnson, E. C. Titgemeyer,  
S. K. Webel<sup>1</sup>, and D. L. Davis

### Summary

Marine and plant sources of omega-3 fatty acids have been evaluated for their effects on reproductive and other traits. Therefore we evaluated the effects of two sources of polyunsaturated fatty acids on the composition of the pig endometrium and conceptus. Treatments were Control, a corn-soybean meal diet; Flax, Control diet plus ground flax (3.75% of the diet); and PFA, Control plus a protected marine source of polyunsaturated omega-3 fatty acids (Fertilium<sup>®</sup>, 1.5% of diet). Supplements replaced equal parts of corn and soybean meal in the PFA and Flax diets.

Dietary treatments did not affect linoleic acid, linolenic, and arachidonic acid concentrations in conceptuses, but Flax increased ( $P = 0.055$ ) eicosapentanoic acid (EPA) 78.8% and docosapentanoic acid (DPA) 32% ( $P < 0.05$ ) in the fetus. Gilts receiving PFA had 16% more ( $P < 0.006$ ) docosahexanoic acid (DHA) in their fetuses than fetuses in Controls had. Both Flax and PFA diets increased ( $P < 0.05$ ) DHA in the chorioallantois. In the endometrium, both EPA and DPA were increased ( $P < 0.02$ ) by the Flax diet, whereas the gilts receiving PFA had increased DHA ( $P < 0.0001$ ).

In summary, initiating fatty acid supplementation approximately 40 d before breeding with these omega-3 supplements affected conceptus and endometrial composition early in the fetal period of pregnancy. Further, plant and marine sources affected fatty acid composition differently. These differences may have implications for the physiological responses reported in the literature.

(Key Words: Embryo, Pigs, Omega-3 Fatty Acids.)

### Introduction

Published research indicates that supplementing sow diets with a marine source of omega-3 fatty acids increases litter size and that adding salmon oil to the maternal diet increased both the omega-3 content of the brain and postnatal survival in pigs.

Omega-3 fatty acid supplements may be of either plant or marine origin. Plant sources contain significant amounts of linolenic acid, whereas marine sources contain appreciable eicosapentanoic acid (EPA) and docosahexanoic acid (DHA). Here we report the effects of ground flax seed and a marine source of polyunsaturated fatty acids (PUFA) on the fatty acid composition of the pig endometrium and conceptus.

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<sup>1</sup>United Feeds, Sheriden, IN.

## Procedures

At 170 days of age, twenty-four gilts (PIC C22 × 280; BW = 260 lb) were assigned randomly to dietary treatments. Gilts were injected with PG600<sup>®</sup> to induce puberty, and dietary treatments were initiated. Control gilts were fed a corn-soybean meal diet. Gilts assigned to Flax were fed the control diet containing 3.75% added ground flax, and the diet for PFA gilts contained a protected fatty acid (PFA) product (Fertilium<sup>®</sup>) containing 1.5% marine products to provide approximately equal amounts of EPA and DHA. Flax and PFA supplements replaced equal parts of corn and soybean meal from the control diet.

On d 20 of the experiment, a 14-d treatment of Matrix<sup>®</sup> was applied to synchronize estrus. Estrous detection was initiated 4 d after the last Matrix<sup>®</sup> treatment, and gilts were artificially inseminated the first and second days of estrus with semen from PIC 280 boars. Dietary treatments continued until d 40 to 43 of gestation, when gilts were slaughtered and reproductive tracts were removed for sample collection.

Gilts were penned in groups of 7 and fed *ad libitum*, except during Matrix treatment and until after artificial insemination, when gilts were penned individually in gestation stalls and fed 3.2 kg/day. After insemination, gilts returned to group pens and were fed *ad libitum*.

Samples were lyophilized and ground, and fatty acid composition was analyzed by using gas chromatography. Chromatography used a capillary column (SUPELCO SP<sup>TM</sup>-2560, 0.25 mm × 100 m, film thickness 0.25  $\mu$ m) equipped with a flame ionization detector. The carrier gas was helium, with a run time of sixty-five minutes. The column temperature was increased from 140 to 240°C at 4°C/minute and then held at 240°C. The focus

of the fatty acid analysis included linoleic acid, linolenic acid, arachidonic acid, EPA, docosopentanoic acid (DPA), and DHA.

Data are expressed as mg/g of lyophilized tissue and were analyzed by using the MIXED procedure of SAS, with gilt as the experimental unit.

## Results and Discussion

Analysis of some dietary PUFA is in Table 1. Dietary treatments did not affect arachidonic or linoleic acid in the fetus, chorioallantois, or endometrial samples.

**Table 1. Diet Fatty Acid Composition<sup>a</sup>**

	Control	Flax	PFA
Linoleic	1.91	2.60	2.25
Linolenic	0.21	1.21	0.13
EPA	0.00	0.00	0.02
DHA	0.00	0.00	0.02

<sup>a</sup>Percentage of diet as fed.

The Flax treatment increased concentrations of fetal EPA and DPA, compared with those of Control and PFA. Fetuses from gilts receiving the Flax treatment contained 78% more ( $P = 0.055$ ) EPA/g and 32% more ( $P < 0.05$ ) DPA/g than did fetuses in Control gilts (Figure 1). Gilts fed PFA had fetuses with 16% more ( $P < 0.01$ ) DHA than Control fetuses had. It is of interest that fetuses in all treatments contained approximately seven times more DHA than EPA.

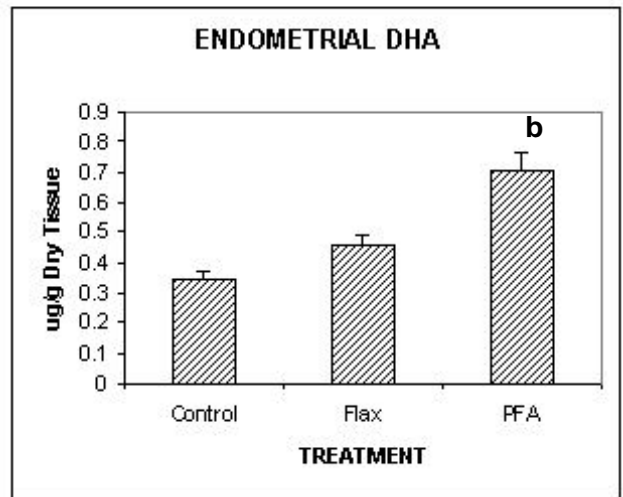
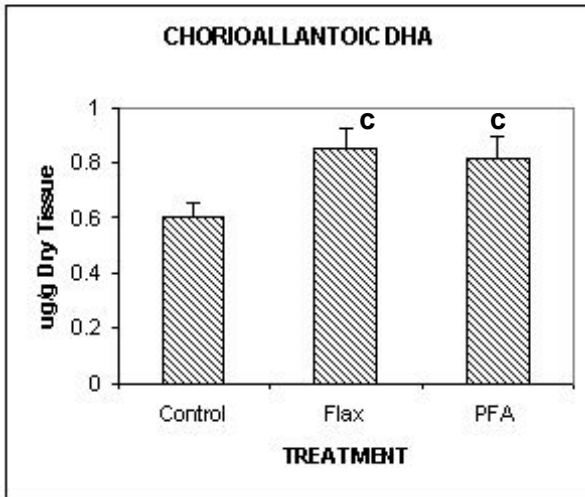
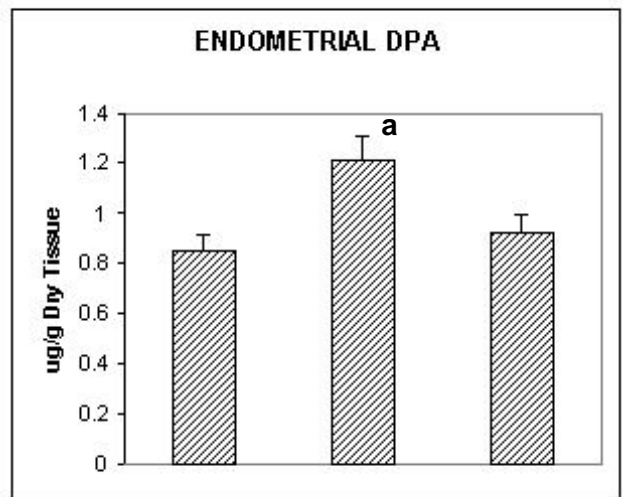
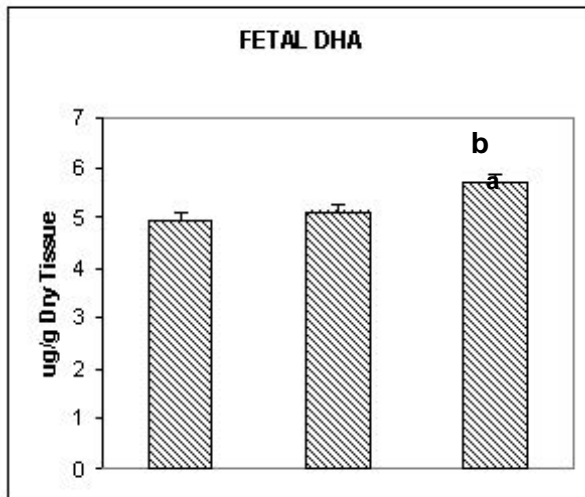
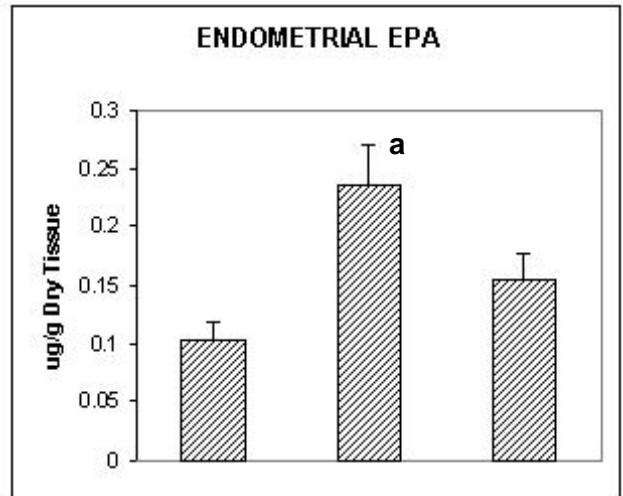
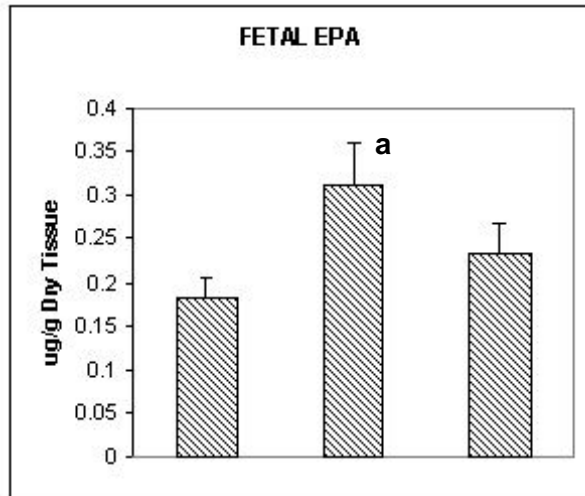
Dietary treatments did not affect EPA concentrations in the chorioallantois, but both Flax and PFA increased concentrations of DHA ( $P < 0.05$ ) in this placental tissue. Concentrations of DPA in the chorioallantois were unaffected by dietary treatments.

The fatty acid analysis of endometrial tissue revealed that the Flax treatment increased ( $P<0.05$ ) concentrations of EPA and DPA and the PFA treatment increased concentrations of DHA in the endometrial tissue ( $P<0.01$ ).

Supplemental flax, a rich source of  $\alpha$ -linolenic acid, in the diet of pregnant gilts increased concentrations of EPA and DPA, but not DHA, in the fetus and endometrium. In comparison, supplementation with a marine source of EPA and DHA (PFA diet) increased DHA but not the other omega-3 fatty acids. This differential enrichment of tissues in the gravid uterus is consistent with literature reports describing other tissues in animals re-

ceiving similar supplements. It seems that  $\alpha$ -linolenic acid is used as a substrate to synthesize EPA but is not effective for increasing DHA in the fetus and endometrium. Therefore, flax is not effective for increasing DHA in the pig fetus.

The chorioallantois provided an exceptional pattern in that both flax and marine oils resulted in higher concentrations of DHA. This observation may result from the physiological processes exchanging fatty acids between the mother, placenta, and fetuses. A better understanding of these processes in the pig may be useful for understanding prenatal fatty acid nutrition in this species.



**Figure 1. Fatty Acid Composition of the Porcine Conceptus.** PFA = protected source of polyunsaturated fatty acids from marine sources. Superscripts indicate differences from other treatments, <sup>a</sup>P = 0.055; <sup>b</sup>P<0.05; <sup>c</sup>P<0.006.

**Figure 2. Fatty Acid Composition of the Porcine Endometrium.** Superscripts indicate differences from other treatments, <sup>a</sup>P<0.05; <sup>b</sup>P<0.0001.