Dietary Omega-6 to Omega-3 Fatty Acid Ratios Affect Body Fat Mobilization During Lactation

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SUMMARY

An experiment was conducted to determine the effects of altering the omega-6 (n6) to omega-3 (n3) fatty acid (FA) ratio in the diets of high producing sows on whole body metabolism. Results demonstrated that sows consuming diets with an n6:n3 ratio below 5:1 were more likely to be in a state of negative energy balance and body fat mobilization relative to sows with a greater n6:n3 ratio, with potentially negative consequences on reproductive performance and sow longevity. .

INTRODUCTION

Improved genetics and management practices over several years have led to dramatically increased litter sizes. Pre-weaning mortality however, has increased at even greater rates, suggesting that sows may not be able to keep up with the increased energy demands of the litter. At farrowing, sows undergo many metabolic changes associated with milk production which can put them into a negative energy balance. Hypophagia at farrowing contributes to the sows' inability to meet the energy demands for milk production. Over subsequent parities, severe negative energy balance and the loss of body condition have negative impacts on subsequent rebreeding performance and may lead to early culling.

Altering the FA's in adipose tissue can affect lipolytic activity and the ability of the animal to mobilize body fat. Omega-3 FA's alter lipid metabolism, and may also affect feed intake. Moreover, it is possible that the ratio of n3 FA's in relation to n6 FA's will differentially affect body fat mobilization in the sow.

Our overall objective of a series of experiments is to improve the reproductive and productive functions of high producing sows. In this specific experiment, the objective was to determine how altering the n6:n3 FA profile of sow diets affects whole body metabolism and the ability to provide nutrients and energy to her offspring. Milk energy output, piglet growth rate, sow feed intake, plasma leptin and mobilization of fatty acids from sow adipose tissue in response to an epinephrine challenge were measured.

"When included correctly into sow diets, n3 fatty acids may have positive impacts on body condition and longevity"

MATERIALS AND METHODS

The experiment used 5 dietary treatments, each divided into a gestation and lactation ration. Total fat concentration (5% crude fat) was the same among diets, but the ratio of n6 to n3 FA's varied. Treatment groups consisted of a control (tallow), 3 diets with plant oil based n6:n3 ratios (10:1, 5:1, and 1:1) and a 5:1 fish oil diet.

Sows (n=100) farrowing ≥ 11 piglets and nursing ≥ 10 piglets were assigned to 1 of the 5 diets. Piglet growth rate and sow feed intake was determined throughout lactation. Milk samples were collected on d 4 and 16, and the dry matter (DM), N and energy output of milk was estimated based on piglet growth. On d 5 of lactation, 8 sows from each of the 10:1 and 1:1 groups had jugular catheters inserted

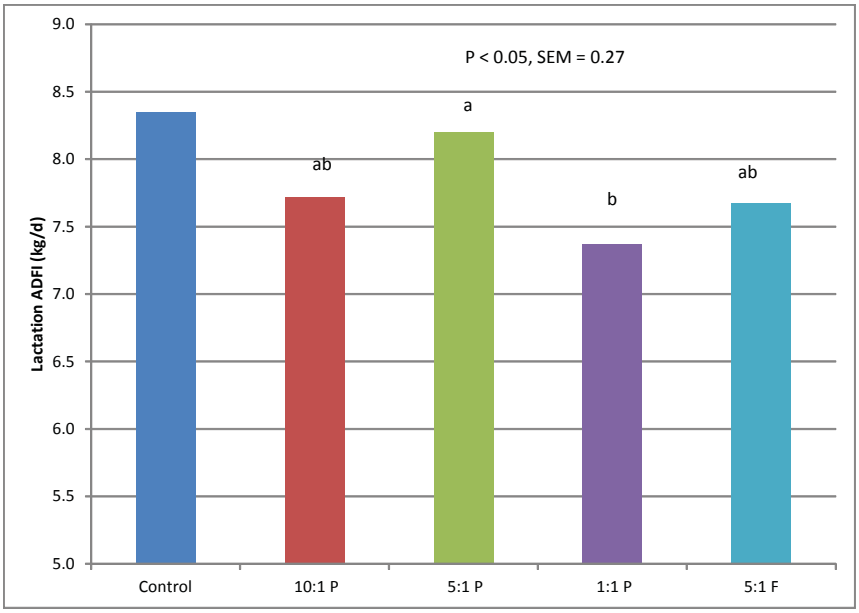

Figure 1: Average daily feed intake of sows consuming diets with varied omega-6 to omega-3 fatty acid ratios during lactation (kg/d)

and were challenged with a single injection of epinephrine (epi) followed by serial blood collections to determine the effect of diet on maximal body fat mobilization. Blood was collected for leptin (a hormone which controls appetite and is negatively correlated with feed intake) analysis on day 5 and 15.

RESULTS AND DISCUSSION

There was no effect of treatment on the number of piglets born or weaned. Piglets raised by sows consuming the 5:1 plant diet had higher birth and weaning weights, while those nursing sows on the fish based diet had the lowest ($P < 0.05$). Control and 5:1 plant fed sows consumed the most feed, while the 1:1 and fish diet sows consumed the smallest amount ($P = 0.05$; Figure 1). Sow body weight was unaffected by dietary treatment; however, sows consuming the 1:1 diet had greater amounts of backfat when compared to the sows consuming the other diets ($P < 0.05$; Figure 2). Piglet growth rates were unaffected.

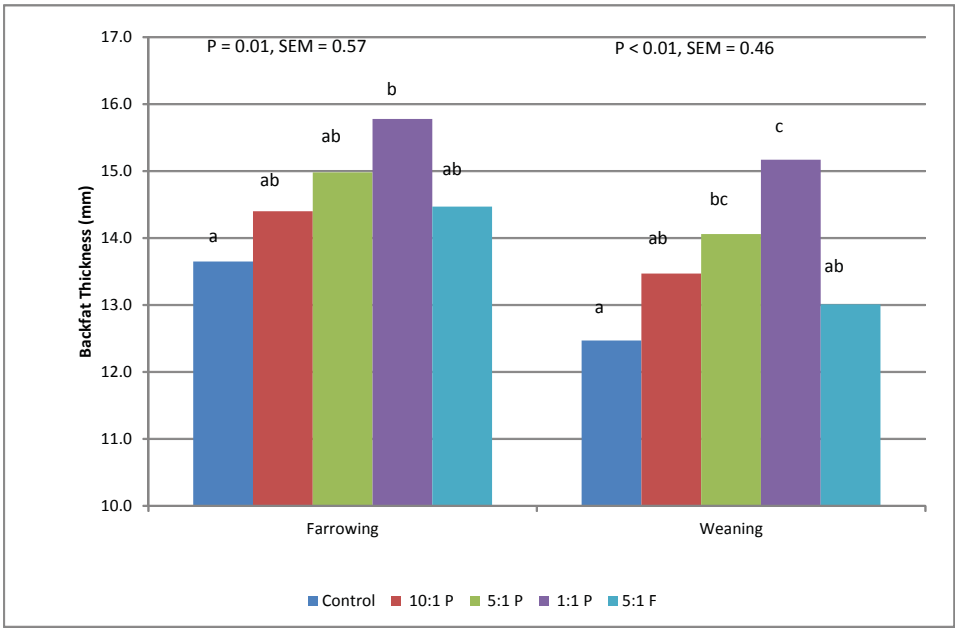

Figure 2: Backfat thickness (mm) of sows consuming diets with varied omega-6 to omega-3 fatty acid ratios at farrowing and weaning

Altering the n6:n3 FA ratio in sow diets did not affect milk composition or output, suggesting that sows will compensate for changes in feed intake through body fat mobilization. Prior to any form of metabolic challenge, sows consuming the 1:1 ratio diet appeared to be in a state of body fat mobilization when compared to those consuming the 10:1 ratio (Table 1). Both NEFA and glycerol concentrations (indicators of body fat breakdown) were more than doubled in sows fed the 1:1 diet relative to those fed the 10:1 diet, however the variability associated with this determination was very high and thus significance was not reached. Leptin levels were also elevated in mid lactation in the 1:1 diet sows, which had reduced feed intakes relative to the 5:1 and control diet sows.

When sows were submitted to a metabolic challenge with exogenous epi, we found that the sows consuming a ratio of 10:1 had a greater response, indicated by a lower area under the response curve for glucose ($P < 0.05$) and tendencies for higher area under the curve responses for NEFA and glycerol concentrations. We hypothesize that since the 1:1 ratio sows were mobilizing more body fat prior to the challenge, they were less sensitive to a dose of exogenous epi. than the 10:1 ratio sows.

Table 1: Pre-challenge NEFA and glycerol concentrations in sow plasma in early lactation

	Diet		Statistics	
	10:1 P	1:1 P	SEM	P Value
NEFA, uM	93.27	240.02	74.15	0.16
Glycerol, mg/dl	0.4	0.81	0.21	0.2

CONCLUSIONS

Reducing the n6:n3 FA ratio below 5:1 put sows into a state of increased body fat mobilization, which may have negative impacts on body condition and longevity. In order to ensure producers are not increasing their cull rates and cost of production due to body condition loss, diet formulations including n3 FA's should be formulated relative to n6 FA's. With the costs of raising replacements increasing, sow longevity is a key factor for producers to maximize profits. Producers can keep their most productive sows in the herd longer, and reduce the costs of raising replacements. When included correctly into diets, n3 FA's may help reduce the severity of the negative energy balance which occurs in early lactation.

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