Dietary Omega-6 to Omega-3 Fatty Acid Ratios Affect Colostrum, Sow and Piglet Plasma Fatty Acid Profiles

Eastwood L., P. Leterme, and A. D. Beaulieu
Prairie Swine Centre, Box 21057-2105, 8th Street East, Saskatoon, SK, S7H 5N9


Pascal Leterme


Denise Beaulieu

SUMMARY

An experiment was conducted to determine the effects of altering the omega-6 (n-6) to omega-3 (n-3) fatty acid (FA) ratio in sow diets on the FA profile of colostrum, and sow and piglet plasma. A reduction in the n-6:n-3 ratio improved circulating levels of eicosapentaenoic acid (EPA) and α-linolenic acid (ALA) in both sows and piglets, indicating that the FA ratio is an important factor for increasing conversion of ALA into its longer chain counterparts.

INTRODUCTION

Polyunsaturated fatty acids (PUFA) are precursors for many important hormones and molecules within the body. Omega-3 PUFA's have proven health benefits. In general, their biological activity is opposite of the n-6 PUFA's. They are considered to be anti-inflammatory, and can affect reproduction by changing the circulating profile of prostaglandins. Within the body, direct competition occurs between the n-3 and n-6 FA's and thus the ratio may be important in maximizing the benefits of including n-3 FA's into sow diets. The type of n-3 FA may also be important, as the biological activity of ALA (found in plant sources such as flaxseed) differs from EPA and docosahexaenoic acid (DHA) which are both found in fish oils.

Our objective was to determine if feeding different n-6:n-3 FA ratios would alter the circulating FA profiles in sow and piglet plasma, specifically elongation to the longer chain fatty acids. We also wanted to determine if feeding plant based n-3's would increase circulating levels of EPA and DHA in pigs.

MATERIALS AND METHODS

This experiment used five dietary treatments, each divided into a gestation and lactation ration. The diets were formulated to have a constant total fat concentration (5% crude fat), but varied in the ratio of n-6 to n-3 FA's. The treatment groups consisted of a control (tallow), 3 diets with plant oil based n-6:n-3 ratios (10:1, 5:1, and 1:1) as well as a 5:1 fish oil diet.

Sows (n=150) were randomly assigned to one of five diets on d 80 of gestation. The sows remained on their diets through a first farrowing to weaning period (referred to as Cycle 1), followed by a subsequent breeding, gestation and farrowing to weaning period (referred to as Cycle 2). Blood was collected from sows (n=12/diet) on d 110 of gestation during Cycle 1. During Cycle 2, colostrum was collected from 12 sows per diet at the time of farrowing, and blood was collected from 2 piglets/sow (one pre-suckle and one 1 d post-farrowing).

"Increasing the intake of plant based n-3 fatty acids in a 1:1 (n-6:n-3) ratio increased circulating levels of EPA in addition to ALA in both sows and piglets."

RESULTS AND DISCUSSION

The FA profiles of sow plasma, pre- and post-suckle piglet plasma and colostrum are shown in Table 1. Total plasma n-3 FA's were greater in sows ($P < 0.0001$) and post-suckle piglets ($P = 0.004$) consuming the 1:1 and fish diets. The ALA content was highest in the 1:1 group whereas EPA and DHA were highest in the fish group. In pre-suckle piglet plasma, ALA and DHA did not differ among treatment groups ($P > 0.05$). Relative to the control piglets, EPA was 2.5 times greater in the 1:1 group and 4 times greater in the fish group ($P < 0.0001$) prior to suckling. In post-suckle samples, ALA was highest in piglets from the 1:1 diet group ($P < 0.005$), and EPA and DHA were highest in piglets from the fish based sows ($P < 0.0001$) which was expected based on the colostrum FA profile.

The FA profile of pre-suckle piglet plasma indicates that the conversion of ALA into EPA can be increased by reducing the dietary n-6:n-3 FA ratio of their mothers. It is possible that reduced competition for the enzymes responsible for the desaturation and elongation occurs, allowing for increased selection of the n-3 FA's by these enzymes and thus improving conversion efficiency.

Table 1. Fatty acid profiles of sow and piglet plasma as well as colostrum (mg FA/ml)

	Dietary Treatment					Statistics	
Fatty Acid (mg/ml)	Control	10:1P	5:1P	1:1P	5:1F	SEM	P-Value
Sow Plasma							
Linoleic Acid (18:2 n-6)	1.20	1.56	1.39	1.12	1.18	0.211	0.599
α-Linolenic Acid (18:3 n-3)	0.06a	0.09a	0.17a	0.39b	0.10a	0.042	<0.001
Arachidonic Acid (20:4 n-6)	0.20a	0.19a	0.14ab	0.09b	0.11b	0.023	0.006
Eicosapentaenoic Acid (20:5 n-3)	0.02ab	0.02a	0.03ab	0.06b	0.26c	0.015	<0.001
Docosahexaenoic Acid (22:6 n-3)	0.02a	0.02a	0.02a	0.02a	010b	0.015	<0.001
Total n-3	0.12a	0.15a	0.25a	0.51b	0.55b	0.050	<0.001
Total n-6	1.44	1.82	1.63	1.41	1.33	0.202	0.462
Pre-Suckle Piglet Plasma							
Linoleic Acid (18:2 n-6)	0.11	0.10	0.20	0.09	0.10	0.039	0.229
α-Linolenic Acid (18:3 n-3)	0.01	0.01	0.02	0.01	0.01	0.006	0.507
Arachidonic Acid (20:4 n-6)	0.24a	0.23a	0.21a	0.13b	0.12b	0.021	<0.001
Eicosapentaenoic Acid (20:5 n-3)	0.01a	0.01a	0.02a	0.04b	0.06b	0.003	<0.001
Docosahexaenoic Acid (22:6 n-3)	0.15	0.08	0.11	0.12	0.16	0.022	0.078
Total n-3	0.21ab	0.14a	0.21ab	0.23bc	0.31c	0.029	0.004
Total n-6	0.26	0.18	0.32	0.21	0.26	0.049	0.331
Post Suckle Piglet Plasm							
Linoleic Acid (18:2 n-6)	0.57a	1.36b	1.24b	0.61a	0.53a	0.204	0.007
α-Linolenic Acid (18:3 n-3)	0.03a	0.11ab	0.16bc	0.22c	0.04a	0.037	0.004
Arachidonic Acid (20:4 n-6)	0.20a	0.30b	0.27b	0.14a	0.15a	0.023	<0.001
Eicosapentaenoic Acid (20:5 n-3)	0.01a	0.02a	0.03a	0.05a	0.16b	0.014	<0.001
Docosahexaenoic Acid (22:6 n-3)	0.09a	0.07a	0.10a	0.09a	0.18b	0.014	<0.001
Total n-3	0.18a	0.36ab	0.51bc	0.61c	0.59bc	0.088	0.003
Total n-6	0.60a	0.143b	1.34b	0.70a	0.70a	0.207	0.010
Colostrum							
Linoleic Acid (18:2 n-6)	44.90a	96.47c	81.88bc	70.04b	28.4a	8.474	<0.001
α-Linolenic Acid (18:3 n-3)	4.54a	16.43a	17.31a	50.38b	4.85a	4.683	<0.001
Arachidonic Acid (20:4 n-6)	1.18ab	1.57a	0.88bc	1.07bc	0.59c	0.163	0.003
Eicosapentaenoic Acid (20:5 n-3)	0.71a	0.80a	0.75a	1.93b	1.86b	0.304	0.006
Docosahexaenoic Acid (22:6 n-3)	0.53a	0.45a	0.38a	0.68a	5.33b	0.346	<0.001
Total n-3	7.29a	19.53a	19.89a	55.01b	12.83a	4.959	<0.001
Total n-6	47.24a	100.08b	84.54bc	72.85c	32.49a	8.805	<0.001

CONCLUSION

Increasing the intake of plant based n-3 FA's in a 1:1 (n-6:n-3) ratio increased circulating levels of EPA in addition to ALA in both sows and piglets. This indicates that flaxseed may be a viable option for reducing the n-6:n-3 ratio and increasing the n-3 content in sow diets, and thus the benefits of including n-3 FA's into swine rations can potentially be achieved using a locally grown crop.

ACKNOWLEDGEMENTS

Strategic program funding was provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Specific funding for this project was provided by Vandeputte s. a., Belgium.