Global Advanced Research Journal of Food Science and Technology (ISSN: 2315-5098) Vol. 3(5) pp. 125-134, October 2014
Available online http://garj.org/garjfst/index.htm

Full Length Research Paper

Effct of Supplementation Diets of Slipery Fish Level Fat on Performance, Milk Yield and Milk Composition of F1 (*Landrace X Yorkshire*) Sows

Pham Khanh Tu[1], Nghia Duyet Hoang[1], Ngoan Le Duc[1], Thuy Nguyen Thi Thanh[2] and Martin Verstegen[3]

[1]Department of Animal Science, Hue University of Agriculture and Forestry, 102 Phung Hung, Hue City, Vietnam
[2]Department of Animal Science , Quang Binh University, Dong Hoi City, VietNam
[3]Animal Nutrition group, Department Animal Sciences, Wageningen University, PO Box 338, NL 6700 AH, Wageningen, The Netherlands.
*Corresponding Author: Pham Khanh Tu, Tel: + 85 54 3525439, Fax: 84 54 3524 923, *E-mail:* p.khanhtu@gmail.com

Accepted 01 October 2014

Twenty five F_1 (Landrace x Yorkshire) sows parity of 2- 4 were used to determine the effect of catfish fat to late-pregnant and lactating sows on sow and their piglets' performance. Sows were fed trial diets from 107 d of gestation until 21 d of lactation. Diets were: control without fish fat; 2% fish fat supplementation; 4% fish fat meal supplementation; 6 % fish fat meal supplementation; and 8 % 4% fish fat meal supplementation. The sow's diet was made from the major ingredients including rice bran, corn meal, cassava meal and soy bean meal. Sows were fed 1.7 kg per day during gestation and 0.25 kg per piglet per day during lactation. Sows were were fed twice a day in the gestation and lactation period with diets containing 14.5 and 17.50 % of CP respectively. Calculated DE concentration in the diets was 13.0 –13.5 MJ per kg. Milk samples were obtained on d 3 and 20 of lactation. Milk from sows fed catfish fat increased n-3 fatty acids on d 3 and 20 of lactation. Results demonstrated that feeding catfish lard has significant effects on sow's milk yield, fatty acid profile and number and weight of weaned piglets.

Keywords: Supplementation Diets, Slipery Fish, Level Fat on Performance, Milk Yield, And Milk Composition of F1 , Sows.

INTRODUCTION

Nutritional and physiological status of pregnant and lactating sows affects foetal and neonatal growth. Genetically improved modern sows are highly prolific and their progeny possesses a great potential for rapid growth. With the current recommended levels of feed allowance for pregnant sows, while the supply of energy and protein for foetal growth is sufficient, some special nutrients like fatty acids may be limited (Ji et al., 2005). Low voluntary feed intake during lactation resulted in a reduced supply of nutrients for milk production (Kim et al., 2004), thereby causing massive maternal tissue mobilization (Dourmad et al., 1994). The maternal catabolic conditions may impair the growth of the fetus and the neonate as well as increase their morbidity and mortality (Wu et al., 2006). Coffey et al. (1982) reported that fat supplementation of sows during late gestation resulted in increased milk yields.

A low viability of piglets at birth may be related to the deficiency in dietary fatty acids especially omega–3 fatty acids (C18:3n-3O). Their potential benefits in improving health and preventing certain diseases have been widely recognized (Rice, 1999). These nutrients are essential not only for normal growth and maintenance of animals but also for the syntheses of many bioactive compounds (Uauy and Castillo, 2003).

Fatty acids with special functions may benefit pregnant and lactating sows with regard to foetal growth, neonatal health, and lactation performance. Perez–Rigau et al. (1995) found that sows whose diets were supplemented with fish oil (rich in C22 6n–3) had increasing rates of foetal survival in the first 30 days of lactation. According to Arbuckle and Innis (1993), Yorkshire pregnant sows fed diets with 2.5 g/100g vegetable oil (Soybean and canola oil, rich in C18: 3n–3) during gestation, 2.5 % in soybean (rich in 18;2and in canola oil (rich in C18: 3n–3) plus 1 % in fish oil (rich in C18:2) 3n–3, and C22 6n–3) to 15 days of lactation have increased their levels of milk, DHA and eicosapentanoic acid from 0.1 to 1.5 % and from 0.2 to 0.4 %, respectively. Baidoo et al., (2003a) reported that feeding flaxseed to pregnant and lactating sows increased piglet growth rate.

Pangasius hypophthamus-fresh water Tra catfish is main comercially farmed fish of Vietnam. Catfish by-product oil is released in the processing of catfish by-product meal with large amount in the Mekong Delta, where catfish production is increasing. According to Da et al (2010), Tra catfish production in the Delta was over 1 million tonnes in 2009, and increased up to 1.5 million tonnes in 2010. Of the abundant residues, about 34% as crude fat (wet weight basis) can be recovered from the by-products. Important feature of catfish fat is that rich of unsaturated fatty acid. The aim of this research was to determine the effect of catfish by-product oil in late gestation and lactation diets on performance of the sows and their piglets.

MATERIAL AND METHODS

Animals

Twenty–five F1(Landrace x Yorkshire) sows with 5 sows per treatment, were used to study the effect of supplying fatty acids in gestation and lactation diets on sow and litter performance. The sow's age was about 2 to 3 years, with the average weight of 115 kg and animals were at least of 2nd parity. Trials were designed, which contain later gestation period (from 107 d of gestation to farrow) and lactation period (from farrow to 21 d of lactation). Sows were divided into five groups: 1) Control (CTRL) sow were fed basal diet without catfish fat; 2) Basal diet supplemented with 2 % catfish fat 3) Basal diet supplemented with 4 % catfish fat ; 4) Basal diet supplemented with 6 % catfish fat; 5) Basal diet supplemented with 8 % catfish fat and. The sows remained in the same pen during pregnancy and lactation. Piglets were weaned at the 21th day age. The experiment was conducted during cool season from September 2013 to March 2014 at the farrowing house at Le Ninh state farm.

Housing

From artificial insemination until 108 days of gestation, the sows were individually housed in trial 1, and were either individually housed or group-housed (six or 13 sows per pen) in trial 2. From 108 days of gestation until weaning, the sows were kept individually in two farrowing rooms with 12 farrowing pens each. The sows were housed individually in 2.0 m length and 1.75 m width cages separated. The floor consists of solid concrete almost throughout the cage, except for the part of the gutter (0.25 m width × 1.50 m length × 0.40 m depth) which was protected with an iron lattice–covered floor at the back of the cage. Each cage was equipped with a feeder and water drinker for the sows and an infrared heating lamp to provide the piglets with supplemental heat. Bedding material was not used. The farrowing house is open so that the inside temperatures is about similar to the outside ambient temperature. Sows were kept in the same environmental conditions from gestation to farrowing and room temperature varied from 20° to 26°C.

Feeding

The basal diets were formulated to provide a dietary level of 14.5 % CP according to nutrient requirement recommended by NRC (1998) and NIAH (2001) for pregnant sows from the initiation of pregnancy until the 110th day of pregnancy.

Daily feed allowance in lactation was formulated according to protein and energy requirement proposed by Pettigrew and Young (1987). A supplement of 0.5 % vitamin premix, 0.5 % mineral premix used by trace vitamin–mineral premixes, 0.5 % lysine and 0.5 % sodium was added.

The experimental diets offered to the (Landrace x Yorkshire) sows during late pregnancy and lactation differed in their catfish fat supplementation. The fat used to form each experimental treatment were catfish fat (CFF) as source of C18: 3n–3 (α-linolenic acid (ω3)) and C22: 6n–3 (docosahexapentaenoic acid) as a source of C18: 3n–3 α-linolenic acid (ω3) (Table 2). The control diet was without fish fat added.

Feed allowance in the gestation diet (from day 0 to day

Table 1. Calculated and analyzed composition of the 6 experimental diets					
Ingedients	**Catfish fat levels**				
	0%	2%	4%	6%	8%
Maize bran	47.85	43.00	40.53	34.60	31.00
Rice bran	3.60	6.80	7.00	11.11	15.80
Cassava meal	11.20	10.60	7.60	7.20	3.60
Soy bean[1]	9.60	9.00	6.00	6.00	5.00
Soybean cake	14.35	15.00	16.40	16.60	17.20
Wheal bran	7.44	7.60	12.40	12.49	13.50
Fish meal [1] (50% CP)	2.40	2.40	2.40	2.40	2.40
Catfish fat	0.00	2.00	4.00	6.00	8.00
Lysin[3]	0.5	0.5	0.5	0.5	0.5
Vitamine -meneral mix [3]	3.10	3.10	3.10	3.10	3.10
ME (MJ/kg)	12.98	13.22	13.45	13.66	13.79
CP(%)	17.51	17.50	17.5	17.50	17.50

[1] Soy bean meal and fish meal was supplied by Cargill, Minneapolis, MN, USA.
[2] Lysine HCL, manufactured by CJ CHEILJEDANG Cooperation, Seoul, Korea.
[3] Vitamine : Supplied per kg diet: diet 0.24 mg folic acid, 840 IU Vitamin A, 1 mg Vitamin B_1, 80 IU Vitamin D_3, 0.5 mg vitamin E, 0.05mg Vitamin K.
[3] Mineral : Supplied per kg diet: 52 mg Zn (as $ZnSO_4$), 47 mg Fe(as $Fe_2SO_45H_2O$), 60 mg Mn (as $MnSO_41H_2O$), 3.4 mg Cu (as $CuSO_45H_2O$), 0.96 mg I, 0.11 mg Co (as $CoSO_47H_2O$), 0.07 mg Se (as Na_2SeO_3), 2 g calcium phosphate (as $CaHPO_42H_2O$).
Calculated using digestibility values of individual ingredients from the NIAH (2001).

Table 2. Faty acid profile of experiment sow diet					
Name of fatty acid	**Catfish fat levels**				
	0%	2%	4%	6%	8%
C12:0 (Lauric acid)	0.002	0.004	0.009	0.009	0.011
C14:0(Myristic acid)	0.035	0.036	0.081	0.122	0.133
C15:0 (Pentadecanoic)	0.003	0.004	0.005	0.008	0.007
C16:1 (Palmitoleic)	0.022	0.054	0.085	0.149	0.175
C16:0 (Palmitic)	0.763	1.07	1.37	1.56	2.36
C17:1 (Heptadecenoic)	0.002	0.004	0.005	0.009	0.009
C17:0 (Heptadecanoic)	0.006	0.008	0.011	0.019	0.018
C20:1 n9 (Eicosenoic)	0.008	0.017	0.025	0.042	0.048
C20:3n(Eicosatrienoic)	0.001	0.003	0.005	0.008	0.096
C20:0 (Arachidic)	0.017	0.019	0.022	0.035	0.041
C22:6n3 (Docosahexaenoic)	0.016	0.021	0.023	0.064	0.027
C22:1n9 (Erucic)	0.002	0.002	0.002	0.004	0.003
C22:0 (Behenic)	0.007	0.008	0.008	0.013	0.013
C23:0 (Tricosanoic)	0.001	0.001	0.001	0.002	0.002
C24:0 (Lignoceric acid)	0.007	0.009	0.009	0.016	0.016
Total saturated fatty acids	1.06	1.47	2.09	2.50	3.45
Total unsaturated fatty acids	4.15	5.20	5.68	6.02	8.57

114) was formulated using maintenance requirement estimated according Pettigrew and Young (1987) and NIAH (2001). Daily feed allowance in lactation was formulated according to protein and energy requirement estimates proposed by Pettigrew and Young (1987). Pregnant sows were offered the same gestation diet containing 14.5 % CP at a rate of 1.7 kg/d until day 110. After farrowing sows were fed limited for three days at 2.0, 2.5 and 3kg per day. After the third day of farrowing , sows were fed *ad litbitum* the lactation diets which contained 17.5 % CP. The calculated digestible energy content lactation diets was 13.1 MJ DE, respectively (Table 1).

The control diet was offered to the control group both during gestation and lactation. Pregnant sows were offered a gestation diet of 1.7 kg per day, two times daily at 8 AM and 4 PM. After that, farrowing sows were fed 2.5 kg of the lactation diets until the sows had a good appetite. Then sows were fed *ad libitum* during lactation This was based on Pettigrew and Young's formulation (1987). Water was supplied to allow the sow to drink ad libitum during lactation to maintain the feed intake and milk production.

The basal diet was prepared with rice bran, cassava meal, soybean and fish meal. Every morning, feed refusals were collected and weighed, and new feed was

Table 3. Effect of catfish fat level supplementation on sow's weight and milk yield.

Criteria	0%*	2%*	4%*	6%*	8%*	P
Sow weight at farrowing (kg)	135.00	131.5	134.50	142.50	137.00	0.210
Sow weight at weaning (kg)	126.50[a]	127,75	124,75[a]	130.75	130.50[b]	0.046
Sow weight at loss (kg)	-10.00 [a]	-9.00[b]	-8.75[b]	-8.50[b]	-7.00[c]	0.008
Milk yield at 4 day (kg)	4,37	5,09	4,58	4,55	5.13	0.232
Milk yield at 11 day (kg)	3.89[a]	5,24[b]	5.86 [b]	5,95[c]	6.02[c]	0.002
Milk yield at 18 day (kg)	4.43[a]	5,12[b]	5.14 [b]	6,66[b]	7.00[c]	0.001
Reustrus interval (day)	7,75 [a]	7,50[a]	5.50 [b]	5,00[b]	5.25 [b]	0.026

* Percentage of dietary catfish fat in the diets
[abc] Means within rows for catfish fat level with different superscripts differ

Table 4. Effect of catfish oil by product on performance of sows and piglets

Criteria	0%*	2%*	4%*	6%*	8%*	P
Number of piglet born	9.50	9.25	10.25	10.25	9.75	0.898
Number of piglet alive	9.25	9.0	10.25	9.75	9.75	0.826
Number of weaned piglet	8.00	8.50	8.50	9.25	9.75	0.037
Average birth weight (kg)	1.43	1.52	1.39	1.37	1.41	0.940
Total litter birth weight (kg)	13.61	14.6	13.96	14,04	13.72	0.980
Average 7day weight (kg)	2.59	2.87	2.60	2.61	2.57	0.705
Total litter 7day weight (kg)	20.89	27,37	22.84	24,04	24.95	0.155
Average 14 day weight (kg)	3.68	3.65	3.66	4.13	3.80	0.738
Total litter 14day weight (kg)	29.85	36.25	31.52	38.07	37.04	0.229
Average weaned weight (kg)	4.15 [a]	4.98	5.19 [b]	5.63	5.38 [b]	0.002
Total litter weaned weight (kg)	33.19[a]	42.13B	43.94[b]	53.49[C]	52.45[C]	0.001
Growth rate during lactation (g/d)	130	165	181	202	189	0.01
Survial rate from birth to wean (%)	90.10	94.44	91.00	94.87	100.00	0.290

* Percentage of dietary catfish fat in the diets
[abc] Means within rows for catfish fat level with different superscripts differ
[abc] Means within rows for catfish fat level with different superscripts differ

immediately distributed. Feed consumption was determined by the difference between feed allowance and the refusals collected the next morning based on DM.

Milk sampling

Representative milk samples were obtained from sows on d 18 of lactation by collecting milk from 3 glands on each side of the udder after an intravenous injection of 1.0 mL of oxytocin (20 IU/mL, Victoriaville, Canada) was given. Pigs were separated from their dam for 45 min before oxytocin was injected. Collected milk was immediately frozen at –20°C until fatty acid concentrations were determined.

Chemical acid analysis

The chemical commposition of sows feed was determined according to the AOAC (1995) proce- dures (16.032). Total lipids were measured according to the Roese-Gottlieb method (16.052; AOAC, 1995). Crude proteins were estimated to be Kjeldahl N × 6.38. The fatty acid composition of the feed and milk was analyzed by gas chromatography using the method of Javadi et al. (2004).

Fatty acid analysis

Fatty acids composition of milk (10mL), diets (1g), were analyzed by gas chromatography. Fatty acid methyl ester

Table 5. Fatty acid composition of milk of treament sow goups (g/100g fatty acid)					
Fatty acid name	0% *	2%*	4%*	6%*	8%*
C14:0 (Myristic)	0.249	0.231	0.211	0.247	0.237
C15:0 (Pentadecanoic)	0.006	0.005	0.005	0.006	0.005
C16:1(Palmitoleic)	0.856	0.918	0.644	0.727	0.544
C16:0 (Palmitic)	1.82	1.91	1.68	1.93	1.60
C17:1 (Heptadecenoic)	0.012	0.008	0.008	0.011	0.008
C17:0(Heptadecanoic)	0.009	0.006	0.008	0.010	0.007
C18:3n6 (gamma-Linolenic)	0.003	0.002	0.003	0.005	0.003
C18:2n6 (Linolelaidic)	1.08	0.984	1.15	1.34	1.24
C18:1n9 (Oleic)	1.36	1.43	1.60	1.78	1.74
C18:3n3 (Linolenic)	0.158	0.161	0.178	0.199	0.193
C18:2n6 (Linoleic)	1.02	1.04	1.19	1.35	1.29
C18:1n9 (Elaidic)	0.171	0.173	0.218	0.280	0.232
C18:0 (Stearic)	0.312	0.249	0.285	0.345	0.266
C20:4n6 (Arachidonic)	0.026	0.022	0.028	0.038	0.028
C20:5n3(Eicosanpentaenoic)	0.002	0.002	0.002	0.003	0.002
C20:3n(cis-Eicosatrienoic)	0.003	0.003	0.003	0.005	0.004
C20:2n(Eicosadienoic)	0.009	0.010	0.011	0.017	0.014
C20:1 (Eicosenoic)	0.005	0.008	0.010	0.012	0.012
C20:3n (Eicosatrienoic)	0.002	0.002	0.003	0.004	0.003
C20:0 (Arachidic)	0.004	0.004	0.004	0.005	0.004
C22:6n (Docosahexaenoic)	0.008	0.006	0.01	0.012	0.008
Total saturated fatty acids	2.396	2.401	2.189	2.543	2.119
Total unsaturated fatty acids	4.715	4.769	5.068	5.783	5.321
* Percentage of dietary catfish fat in the diets					

was prepared for gas chromatography determination using KOH/methanol (0.4mol/L).

The fatty acids were identified by comparing the retention times of the peaks with those of known standards (Sigma Chemical Co., St. Louis, Mo). Response factors for the fatty acids were calculated using the same standard mixtures plus an internal standard. Fatty acid results are presented as g/100g fatty acids.

Saturated fatty acids (SFA) are the sum of C14:0, C16:0, and C18:0. The monounsaturated fatty acids (MUFA) are the sum of C16:1 (n-7) and C18:1 (n-9). The polyunsaturated fatty acid (PUFA n-3) are the sum of C18:3 (n-3), C20:5(n-3),C22:5 (n-3),and C22:6(n-3).The polyunsaturated fatty acid (PUFA n-6) are the sum of C18:2(n-6) and C20:4(n-6).The sum of the PUFA was calculated as the sum of (n-3) PUFA and (n-6) PUFA. The fatty acid composition of fish oil and linseed oil is given in Table 2.

Measurements

Sows were weighed at serving day, the 110th day of pregnancy, within 24h after farrowing, at the 21st day of lactation and at weaning.

Within 24 hours of farrowing, the number of live born, stillborn and mummified piglets as well as piglet weights were recorded. The piglets were treated with a routine management practice that included umbilical cord treatment, teeth clipping, ear notching and subcutaneous iron dextrin injection (200 ml/pig) within 24 hours of parturition. Piglets were marked individually with an ear tattoo on the first day after farrowing (day 1 postpartum). At day 7, male piglets were castrated and piglets were weighted individually on successive days of 7, 14 and 21 postpartum and at weaning. The accuracy of scale used for weighing piglets was 0.1g.

During the lactation period, piglets had no access to the sow feed (no piglet diets were fed to piglets) but water was available through a low–pressure nipple drinker. Weaning occurred on day 21 ± 2 postpartum. At weaning, piglets were moved to the nursery of the farm, and the sows were moved to a breeding facility and checked twice daily for signs of oestrus i.e. coming into heat with a mature boar. Oestrus was recorded when sows stood to be mounted by the boar.

Statistical analysis

Effects of oil types on dependent variables such as sow weight, sow back–fat measurements, litter size, piglet weight were analyzed by the ANOVA procedure using GLM–multivariate analysis of SPSS software (Version 18.0). The residual variance of the model is reported as the square root of the residuals (RR), which is analogous to the root mean square error in the GLM procedure of SPSS. Differences between means were tested by the Student–Newman–Keuls *t* test. Differences were considered significant at *P*<0.05.

RESULTS

Performance of treatment sows are presented in Table 3. Dietary fat supplementation had not effect on milk yield of sows at three day laction (P>0.05) but had significant differences on sow's milk yield at 11 and 18 day restatively. Overall, sows lost weight during lactation, ranging from 4.25 to 10kg and statistical differences between treatments were found (P<0.05). The type of dietary supplementation had effect on milk yield and milk composition.

No significant differences were noted among treatments with respect to the total number of piglets born, piglets born alive. (Table 4). Similarly, piglet birth weights, did not differ among treatment groups. There were no significant differences between the number of piglets born alive and the number of piglets at the 7th day (Table 4).

Piglet birth weight and litter weight based did not differ among treatments. Variation in birth weights within a litter, based on either total piglets born or piglets born alive showed no difference among treatment groups. There were no significant differences between the number of piglets born , piglets born alive , number of piglets at the 7th and 14th day (Table 4).

The addition of fish fat to the diet of (Landrace x Yorkshire) sows during the last week of pregnancy and two weeks postpartum resulted in more piglets at 21 days of age. The number of weaned piglets was higher in sows fed 6% fat was higher than other sows. The sows fed the diet without additional catfish fat had a lower number of piglets at weaning compared to the sows fed diets with catfish fat supplementation (Table 4)

Results showed no differences in litter weight among treatment groups at 14 days of lactation. Sows fed 6% and 8% fish fat had higher litter weight and average piglet weight at days 14 and at weaning (day 21) compared to piglets born from sows fed control diet without catfish fat. Among treatment group, the sows fed the diets of 6% fish fat had greater piglet weights at weaning compared to sows 2 and 4% and 8% of catfish fat.

Fatty acid profiles in milk of different trial sow groups are shown in Tables 5 . The relative amount of linolenic acid, Eicosadienoic acid, Docosahexaenoic increased and that of arachidonic acid decreased in 4% FF and 8% CFF compared with control sows. Values for SFA, MUFA, and PUFA were affected by treatment with values being less in 2% CFF and 4% CFF compared with control diets. There were more n-3 fatty acids and a decreased n-6/n-3 ratio in milk from 6% CFF and 8% CFF compared with that from other diet and control sows on 18 days of lactation, whereas n-6 content was unaffected .

Values for SFA, MUFA, and PUFA were affected by treatment values being less SFA and MUFA contents and greater for PUFA content. There were more n-3 fatty acids and a decreased n-6/n-3 ratio in milk from trial sows compared with that from sows fed diet without catfish fat.

DISCUSSION

The study's main objective is to test sows and piglets' responses to supplying additional catfish fat. There were close relationships between level of catfish fat and loss of live weight during lactation and days to first estrus. Feeding the catfish fat reduced the weight loss during lactation and decreased the interval from weaning to first estrus. Sows that lost less weight in lactation had shorter interval to first oestrrus after weaning.

During lactation it is normal for sows to lose weight as their body reserves are moblized for milk production (Trottier and Johnston 2001). According to Hardy (2003), sows often lose 10-12 kg in a 21 day lactation with no detriment to subsequent performance. In contrast with our findings, Schoenherr et al (1989) showed that subsequent estrus activity of the sow was not altered by dietary energy source as no difference was observed in the number of days from weaning to first estrus.

In the present study, weight loss during lactation was higher in the Control sows compared to those receiving supplements. Moreover, weigh loss was similar for all experimental groups, with the exception of sows fed 2% and 4% catfish fat. These sows lost considerably more weight during lactation, which may, in part, be due to the fact that they put on less weight over the first part of gestation compared to the other groups. Previously Averette et al. (1999) observed no difference in weight loss between control and fat supplemented animals, but our results indicate that the type of fat supplement may have a role to play when supplements are provided, particularly in sows fed of 6 and 8% CFF supplementation.

Increasing the proportion of energy supplied by fat in the lactation diet was associated in the present study with a higher dietary net energy content. Such results indicate that the extra energy intake supplied by lipids is of little interest for the sow itself as most fatty acids are transferred to the mammary glands and incorporated in milk lipids (Jones et al ., 2002).

The data showed that when feeding catfish fat by-product litter size at 21 days and at weaning (0.50 to 1.75 pigs/litter) as well as the growth rate are improved when sows are provided diets that contained (3n–3 and 6n–3) fatty acids supplements.

Webel et al. (2003) found that the inclusion of n–3 FA's in sow's diets during lactation increased the weaning litter size by 0.6 piglet in comparison with the control group. Spencer et al. (2004) reported an increase in litter size when sows were fed diets supplemented with n–3 FA between d 30 pre–partum and farrowing. However, the increase in litter size was associated with piglet birth weight's decrease without changes in the distribution of low–birth–weight piglets. Consistent with this finding, Rooke et al. (2001c) reported that sows fed diets supplemented with salmon oil produced lighter pigs at birth but these piglets had a higher pre–weaning survival rate than the control group. The mechanism for the beneficial effect of n–3 FA,s supplementation with to sow's diets on piglets involves an increase in embryonic survival (Webel et al., 2003). Alpha-liolenic acid and liolenic acid are member of omega-6 and omega-3 family of fatty acid (3OFA) respectively, and are considered essential nutrients. These fatty acids are the precursors for synthesis of different types of ecosanoid as prostaglandin, thromboxanes and leukotrienes, all of which play important roles in regulation both immune and reproductive functions (Muskiet et al., 2004). Embryo survival is the key to all reproductive success. The result of Wamsley (2005) in ruminants recorded that the survival embryo is related to the content of prostaglandin hormone. Prostaglandin is a hormone that destabilizes the uterus, resulting in auto–abortion. Omega –3 fatty acid has been proven to decrease prostaglandin production resulting in higher embryo survival (Wamsley, 2005). More embryo survival means more healthy litters.

In our study, fatty acid from catfish fat supply had an influence on piglet performance. Piglets reared by the sows offered CFF were heavier at the 14th day and at weaning (the 21th day) than those offered the diet without CFF. The mechanism for differences in piglets growth are not known but it may be related to the anti–inflammatory property of 3n–3 fatty acid (Turek et al.1996). Fritsche et al. (1993a) have demonstrated that inclusion of fish oil in sow's diets resulted in elevated levels of O3FA in milk as well as both maternal and neonatal plasma. The balance between O3FA and O6FA may determine the type of eicosanoids produced, and therefore the response of animals.

Rooke et al. (2001a) reported that fish oil supplementation during either late gestation or lactation resulted in heavier piglets at all stages of lactation compared with sows fed the control diet throughout the study.

Present study showed sow fed catfish fat had greater piglet weights at 21 days compared to sow fed without fish fat. Bazinet et al. (2003) reported that high maternal intake linseed oil increased both ALA and DHA content in sow milk and neonatal tissue. ALA and DHA are essential fatty acids that had important roles on the growth of piglets. The authors suggested that the increase in growth was due to improved piglet status (i.e. brain fatty acid composition; Rooke et al., 2001b) and vigor at birth (Rooke et al., 2001a, b). Fritsche et al. (1993b) reported that substituting menhaden fish oil as a source of fat in sow's diets during late gestation and lactation resulted in high concentrations of omega–3 fatty acids (O3FA) (i.e. EPA) in immune cells of nursing pigs. Compelling evidence shows highly beneficial effects of O3FA on improving the sow's immunity under a number of inflammatory conditions (Papadopoulos et al., 2008).

In lactating sows, the growth of the nursing litter is determined by total milk production and by the amounts of different nutrients secreted into the milk relative to the nutrient needs of the piglet. Previous studies (Lori et al., 1999; Tilton et al., 1999) have examined the manipulation of sow milk composition through the supplementation of lactating sow diets with dietary fat to increase the milk fat content and therefore increase the energy intake of piglets.

In the milk of sows that had received the catfish fat diet the concentration of docosapentaenoic (22:5 n−3) and docosahexaenoic (22:6 n−3) acid was much higher than in that of other animals, supporting the work of Rooke et al. (2001b) and Lauridsen and Danielsen (2004). The particularly high content of long chain n–3 polyunsaturated fatty acids, in the colostrum of sows, suggests that there may be a mechanism by which they are selectively stored in adipose tissue for release during lactation.

Changes in milk composition reported by Baidoo et al. (2003b) also agree with the present findings, indicating an increase unsaturated and n-3 fatty acids and a decrease SFA in milk from sows fed dietary flaxseed.

The fatty acid profile of milk is known to alter with fat supplementation of sow diets (Coffey et al.,1982; Rooke et al., 2001b). The fatty acid profiles of the lipid fraction of the milk, in the current study, differed both with stage of lactation and between treatment groups. Independently of the diet received, the concentration of myristic acid (14:O) and palmitic acid (16:O) increased with advancing lactation as fatty acid synthesis by the mammary gland increases (Bazer et al., 2001). In contrast, stearic and (18:O) and oleic (18:1) acid decrease as lactation advances indicating that fatty acid synthesis becomes increasingly important as lactation progresses, relative to the importation of fatty acids from the maternal circulation.

In controlled studies, guinea pigs were protected against metabolic acidosis and death from endotoxine administration when they had been fed a fish oil–supplemented diet for 6 weeks (Teo et al., 1991). The study of Cordoba et al. (2000) recorded that neonatal mortality is reduced by feeding sow marine oil and suggested that there may be a requirement for preformed of C22: 6n–3 (the form into a shape resembling the final 6n–3) during pregnancy for optimum function of the new born piglet.

Our result showed that, both number of weaned piglet and piglet weight with sows supplemented catfish fat groups tended to be greater than that of the control group

(P<0.05). The higher number of piglets and weaning weight of piglets in sows that were fed CFF diet indicated that the source of unsaturated fatty acid can effect young animals' survival (Shackelford et al., 1989).

Our data indicate that a higher growth rates of piglets from sows treated with catfish fat during the suckling period compared to those of piglets from control sows may be due more available nutrients in the milk. But it is unlikely that milk has more energy because than sows would have lost more condition According to Jorgensen et al. (1992, 1993) unsaturated fatty acid have a higher digestibility than saturated acid. Fritsche et al. (1993a) have demonstrated that inclusion of fish oil in sow's diets resulted in elevated levels of O3FA in milk as well as both maternal and neonatal plasma. Rooke et al. (2001b) found that piglets from sows fed diets containing tuna oil had a more active suckling behavior immediately after birth, which may help to enhance growth . As a result the effect of sows fed fish fat on growth of the piglets may be due to more available energy provided to piglets.

In some studies a higher milk fat content was found (Xiao et al. 2008). On the other hand neonatal pigs may have enhanced immunity function with increase in milk O3FA. Liu et al. (2003) fed 3.5 –7 % fish oil to sows and reported that EPA level in milk were more than six times that of sow's fed lard as main fat supplement, with more than half of the effect occurring in the first week of treatment.

Our studies showed that using catfish fat did not affect sow body weight during lactation nor the number of pigs at birth and at the 7days. This finding is in agreement with Harrell et al., (2002) that sow body weight and backfat losses were not altered by dietary fatty acid. Babinszky et al. (1992) reported that there were no treatment differences in body condition at farrowing or at weaning between sows fed diets containing either 7.5 or 12.5 % fat compared to control sows

The data showed that when feeding catfish fat litter size at weaning (0.50 to 1.75 pigs/litter) as well as the growth rate are improved when sows are provided diets that contained (3n–3 and 6n–3) fatty acids supplements.

In lactating sows, the growth of the nursing litter is determined by total milk production and by the amounts of different nutrients secreted into the milk relative to the nutrient needs of the piglet. Previous studies (Tilton et al., 1999) have examined the manipulation of sow milk composition through the supplementation of lactating sow diets with dietary fat to increase the milk fat content and therefore increase the energy intake of piglets.

Webel et al. (2003) found that the inclusion of n–3 FA's in sow's diets during lactation increased the weaning litter size by 0.6 piglet in comparison with the control group. Spencer et al. (2004) reported an increase in litter size when sows were fed diets supplemented with n–3 FA between d 30 pre–partum and farrowing. However, the increase in litter size was associated with piglet birth weight's decrease without changes in the distribution of low–birth–weight piglets. Consistent with this finding, Rooke et al. (2001c) reported that sows fed diets supplemented with salmon oil produced lighter pigs at birth but these piglets had a higher pre–weaning survival rate than the control group. The mechanism for the beneficial effect of n–3 FA,s supplementation with to sow's diets on piglets involves an increase in embryonic survival (Webel et al., 2003). Alpha-liolenic acid and liolenic acid are member of omega-6 and omega-3 family of fatty acid (3OFA) respectively, and are considered essential nutrients. These fatty acids are the precursors for synthesis of different types of ecosanoid as prostaglandin, thromboxanes and leukotrienes, all of which play important roles in regulation both immune and reproductive functions (Muskiet et al., 2004). Embryo survival is the key to all reproductive success. The result of Wamsley (2005) in ruminants recorded that the survival embryo is related to the content of prostaglandin hormone. Prostaglandin is a hormone that destabilizes the uterus, resulting in auto–abortion. Omega –3 fatty acid has been proven to decrease prostaglandin production resulting in higher embryo survival (Wamsley, 2005). More embryo survival means more healthy litters.

In our study, fatty acid supply had an influence on piglet performance. Piglets reared by the sows offered CFF were heavier at the 14 st day and at weaning (the 21th day) than those offered the diet without CFF. The mechanism for differences in piglets growth are not known but it may be related to the anti–inflammatory property of 3n–3 fatty acid (Turek et al.1996). Fritsche et al. (1993a) have demonstrated that inclusion of fish oil in sow's diets resulted in elevated levels of O3FA in milk as well as both maternal and neonatal plasma. The balance between O3FA and O6FA may determine the type of eicosanoids produced, and therefore the response of animals.

Rooke et al. (2001a) reported that fish oil supplementation during either late gestation or lactation resulted in heavier piglets at all stages of lactation compared with sows fed the control diet throughout the study.

Present study showed sow fed catfish fat had greater piglet weights at 21 days and at weaning compared to sow fed diet without fish fat. Bazinet et al. (2003) reported that high maternal intake linseed oil increased both ALA and DHA content in sow milk and neonatal tissue. ALA and DHA are essential fatty acids that had important roles on the growth of piglets. Curent result in agreement with Schoenherr et al . (1989), and Van den Brand et al. (2000) that milk lipid content was higher in sows fed the high fat diets compaired to sow fed diet without fat or lower fat contents.

The authors suggested that the increase in growth was due to improved piglet status (i.e. brain fatty acid composition; Rooke et al., 2001b) and vigor at birth (Rooke et al., 2001a, b). Fritsche et al. (1993b) reported that substituting menhaden fish oil as a source of fat in sow's diets during late gestation and lactation resulted in high concentrations of omega–3 fatty acids (O3FA) (i.e. EPA) in immune cells of nursing pigs. Compelling evidence shows highly beneficial effects of O3FA on improving the sow's immunity under a number of inflammatory conditions (Papadopoulos et al., 2008).

The study of Cordoba et al. (2000) recorded that neonatal mortality is reduced by feeding sow marine oil and suggested that there may be a requirement for preformed of C22: 6n–3 (the form into a shape resembling the final 6n–3) during pregnancy for optimum function of the new born piglet. The higher number of piglets and weaning weight of piglets in sows that were fed CFF indicated that the source of unsaturated fatty acid can effect young animals' survival (Shackelford et al., 1989).

Curent results showed that, both number of weaned piglet and piglet weight with sows supplemented catfish fat tended to be greater than that of the control group (<0.001). Compared with the control group, piglet body weight at weaning and body weight gain in treatment groups were higher than those of piglets of sows fed diet without catfish fat.

Curent data indicate that a higher growth rates of piglets from sows treated with catfish fat during the suckling period compared to those of piglets from control sows may be due more available nutrients in the milk. But it is unlikely that milk has more energy because than sows would have lost more condition. According to Jorgensen et al. (1992, 1993) unsaturated fatty acid have a higher digestibility than saturated acid. Fritsche et al.(1993) have demonstrated that inclusion of fish oil in sow's diets resulted in elevated levels of O3FA in milk as well as both maternal and neonatal plasma. Rooke et al. (2001b) found that piglets from sows fed diets containing tuna oil had a more active suckling behavior immediately after birth, which may help to enhance growth. As a result the effect of sows fed fish fat on growth of the piglets may be due to more available energy provided to piglets.

In some studies a higher milk fat content was found (Xiao et al. 2008). On the other hand neonatal pigs may have enhanced immunity function with increase in milk O3FA. Liu et al. (2003) fed 3.5 –7 % fish oil to sows and reported that EPA level in milk were more than six times that of sow's fed lard as main fat supplement, with more than half of the effect occurring in the first week of treatment.

In conclusion, adding Tra catfish fish fat to sow diets during late gestation and lactation improve the performance of piglets. Results of this study have shown that supplying 6 % of fish oil uring the last week of pregnancy and three weeks of postpartum to obtain increasing of number of weaned and weaning weight of piglets. This study underlines the practical importance of an adequate supply and balance of fatty acid (Alpha Linolenic Acid (ω3) EPA and Docosahexapentaenoic Acid DHA) during gestation and lactation. To compensate for fat in dietary sow diet, catfish fat can be used.

ACKNOWLEDGEMENTS

The authors would like to thank the Programme of New Rural Developpement of Hue University for financial support and special thanks the staffs of Le Ninh farm for their assistances during implementing study.

REFERENCES

AOAC. 1995. Official Methods of Analysis. 16th ed. Assoc. Off. Anal. Chem., Washington, DC.

Averette, L.A., Odle, J., Monaco, M.H., Donovan, S.M., 1999. Dietary fat during pregnancy and lactation increases milk fat and insulin-like growth factor I concentrations and improves neonatal growth rates in swine. J. Nutr. 129: 2123–2129.

Arbruckle, L. D and S. M. Innis. 1993. Docoshahexaenoic acid is transferred through maternal diet to milk and tissues of natural milk–fed piglets. J. Nutr. 123:1668–1675.

Baidoo, S. K., G. Azunaya, and A. Fallad-Rad. 2003a. Effects of feeding flaxseeds on the production traits of sows. J. Anim. Sci. 81(Suppl. 1):320. (Abstr.)

Baidoo, S. K., A. Fallad-Rad, and Q. M. Yang. 2003b. Dietary ef- fects of flaxseed and vitamin E on lipid profiles of sows. J. Anim. Sci. 81(Suppl. 1):320–321. (Abstr.)

Babinszky, L., M.W.A. Verstegen, L. A. den Hartog, T. Zandstra, P. L. van der Togt, and J.T.P. van Dam. 1992. Effect of dietary fat and a-tocopherol level in the lactation diet on the performance of primiparous sows and their piglets. Anim. Prod. 55:233–240

Bazer, F.W., Ford, J.J., Kensinger, R.S., 2001. Reproductive physiology. In: Pond, W.G., Mersmann, H.J. (Eds.), Biology of the Domestic Pig. Cornell University Press, New York, pp:15O–224.

Bazinet, R. P., E. G. McMillan and S. C. Cunnane. 2003. Dietary alpha-linolenic acid increases the n-3 PUFA content of sows milk and the tissue of the suckling piglet. Lipids 38:1045-1049.

Coffey, M. T., R.W., Mabry, J. W., 1982. The effect of source of supply mental dietary energy on sow milk yield, milk composition and litter performance. J. Anim. Sci.55: 1389-1394.

Cordoba R., S. Pkiyach, J. A. Rooke, A. S. Eswards, P. C. Penny and I. Pike. 2000. The effect of feeding salmon oil during pregnant on cause of piglet deaths prior to weaning. Proceeding of Bristish Society of Animal Sciences. p.105 (Abstr.).

Da C T and Thanh B. X., 2010. Current situation analysis and environmental impacts of Striped Catfish (*Pangasianodom hypophthalmus*) farming practices in the vicinity of the Mekong Delta, Vietnam: a review. AUN/SEED-Net, Asean Foundation, 2nd Regional Conference on Global Environment.

Dourmad, J. Y., M. Etienne, A. Prunier and J. Noblet. 1994. The effect of energy and protein intake of sows on their longevity: In a review, Livest. Prod. Sci. 40:87–97.

Fritsche, K. L., S. C. Huang and N. A. Cassity. 1993a. Enrichment of omega–3 fatty acids in suckling pigs by maternal dietary fish oil supplementation. J. Anim. Sci. 71:1841–1847.

Hardy B 2003. Factors affecting lactation feed intake of the sow. NutriVision Inc (Australia), Nottingham Nutrition International.

Harrell, R. J., O. Phillips, D. L. Jerome, R. D. Boyd, D. A. Dwyer and D. E. Bauman. 2000. Effects of conjugated linoleic acid on milk composition and baby pig growth in lactating sows. J. Anim. Sci. 77(suppl. 1):137–138.

Javadi, M., H. Everts, R. Hovenier, S. Kocsis, A. E. Lankhorst, A. Javadi, M., H. Everts, R. Hovenier, S. Kocsis, A. E. Lankhorst, A. G. Lemmens, J. T. Schonewille, A. H. Terpstra and A. C. Beynen. 2004. The effect of six different C18 fatty acids on body fat and energy

metabolism in mice. Br. J. Nutr. 92:391-399.
Ji, F., G. Wu, J. R. Blanton and S. W. Kim. 2005. Weight and compositional changes in pregnant gilts and its implication to nutrition. J. Anim. Sci. 83:366–375.
Jones GM, Edwards SA, Sinclair AG, Gebbie FE, Rooke JA, Jagger S and Hoste S 2002. The effect of maize starch or soya-bean oil as energy sources in lactation on sow and piglet performance in association with sow metabolic state around peak lactation. Animal Science 75, 57–66.
Jørgensen, H., K. Jakobsen, and B. O. Eggum. 1992. The influence of different protein, fat and mineral levels on the digestibility of fat and fatty acids measured at the terminal ileum and in feces of growing pigs. Acta. Agric. Scand. Sect. A. Anim. Sci. 1992. 42:177-184.
Jørgensen, H., K. Jakobsen and B. O. Eggum. 1993. Determination of endogenous fat and fatty acids at the terminal ileum and in faeces in growing pigs. Acta. Agric. Scand. Sect. A. Anim. Sci. 43:101-106.
Kim, S. W., R. L. McPherson and G. Wu. 2004. Dietary arginine supplementation enhances the growth of milk–fed young piglets. J. Nutr. 134:625–630.
Lauridsen, C., Danielsen, V., 2004. Lactational dietary fat levels and sources influences milk composition and performance of sows and their progeny. Livest. Prod. Sci. 91, 95–1O5.
Liu, Y. L., D. F. Li, L. M. Gong, G. F. Yi, A. M. Gaines and J. A. Carroll. 2003. Effect of fish oil supplementation on performance as well as immunological, adrenal, and somatotrophic response of weaned pig after Escherichia coli lipopolysaccharide challenge. J. Anim. Sci. 81:2758–2765.
Muskiet F. A. J., M. R. Fokkema, A. Schaafsma, E. R. Boersma and M. A. Crawford. 2004. Is decahexneoic acid (DHA) essential?: Lession from DHA status regulation our ancient diet and edpidemiology and randomized controlled trials. J. Nutr. 134:183-186.
NIAH (National Institute for Animal Husbandry) 2001. Composition and Nutritive Value of Animal Feedstuffs in Vietnam. Publishing house Agriculture, Hanoi, Vietnam.
NRC. 1998. Nutrient Requirements of Swine. 10th ed. Natl. Acad. Press, Washington, DC.
Papadopoulos, G. A., D. G. D. Maes, S. Van Weyenberg, T. A. T. G. van Kempen, J. Buyse and P. J. G. Janssens. 2008. Peripartal feeding strategy with different *n*–6:*n*–3 ratios in sows: effects on sows' performance, inflammatory and periparturient metabolic parameters. Br. J. Nutr. Jul.10:1–10.
Perez–Rigau, A., M. D**.** Lindemann, E. T. Kornegay, A. F. Harper and B. A. Watkins. 1995. Role of dietary lipids on foetal tissue fatty acid composition and foetal survival in swine at 42 days of gestation. J. Anim. Sci. 73:1372–1380.
Pettigrew, J. E and H. Young. 1987. Protein nutrition of gestation sows. J. Anim. Sci. 75: 2723–2730.
Rice, R. 1999. Focus on omega–3. Ingred. Health Nutr. 2:11–15.
Rooke, J. A., A. G. Sinclair and S. A. Edwards. 2001a. Feeding tuna oil to the sow at different times during pregnancy has different effects on piglet long–chain polyunsaturated fatty acid composition at birth and subsequent growth. Br. J. Nutr. 86:21–30.
Rooke, J. A., A. G. Sinclair and M. Ewen. 2001b. Changes in piglet tissue composition at birth in response to increasing maternal intake of long –chain *n*–3 polyunsaturated fatty acids are non–linear. Br. J. Nutr. 86:461–470.
Rooke, J. A., A. G. Sinclair, and M. Ewen. 2001c. Changes in piglet composition at birth in response to increasing maternal intake of long chain n-3 polyunsaturated fatty acids are non-linear. Br. J. Nutr. 86:461–470.
Skackelford, S. D., J. O. Reagan, K. D. Haydon and M. F. Miller. 1989. Effect of feeding elevated level monounsaturated fats to growing–finishing swine on acceptability of boneless hams. J. Food Sci. 55:1485–1517.
Schoenherr W. D., Stahly T. S., and Cromwell G. L 1989. The effect of dietary fat or fiber addition on yield and composition of milk from sows housed in a warm or hot temperature. J. Anim. Sci.67: 482–495.
Tilton, S. L., P. S. Miller, A. J. Lewis, D. E. Reese and P. M. Ermer. 1999. Addition of fat to the diets of lactating sows: I. Effects on milk production and composition and carcass composition of the litter at weaning. J. Anim. Sci.77:2491–2500.
Trottier N L and Johnston L J 2001 Feeding gilts during development and sows during gestation and lactation. In: Lewis, A.J Southern, L.L (Editors). Swine Nutrition, 2nd edition, CRC Press, Boca Raton, pp.725-769".
Turek, J. J., I. A. Schoenlein, B. A. Watkins, W. G. van Alstine, L. K. Clark and K. Knox. 1996. Dietary polyunsaturated fatty acids modulate responses of pigs to Mycoplasma hyopneumonia infection. J. Nutr. 126:1541–1548.
Uauy, R. and C. Castillo. 2003. Lipid requirement of infants: Implications for nutrient composition of fortified complementary foods. J. Nutr. 133:2962S–2972S.
Van den Brand H, Heetkamp MJW, Soede NM, Schrama JW and Kemp B 2000. Energy balance of lactating primiparous sows as affected by feeding level and dietary energy source. Journal of Animal Science 78, 1520–1528.
Xiao, C. L, C. Z. Tian, F-R. Huang, J. Fei, J. Luo and J. Peng. 2008. Effect of feeding sows fish oil on fatty acids in milk and growth performance of piglets. Chinese J. Anim. Ntr. 20:1-7. http://www.chinajan.com/oa/arcticle.asp.
Wamsley, N. E., P. D. Burns, T. E. Engle, and R. M. Enns. 2005. Fish meal supplementation alter uterine prostaglandin F2α synthesis in beef heifer with low–luteal phase progesterone. J. Anim. Sci. 83:1832–1838.
Webel, S. K., E. R. Otto, D. M. Webel, R. L. Moser, J. D. Spencer, and D. E. Orr. 2003. Effect of protected n–3 polyunsaturated fatty acids (Fertilium™) on litter size in sows. J. Anim. Sci. 81 (Suppl. 1):18 (Abstr.).
Wu, G., F. W. Bazer, J. M. Wallace and T. E. Spencer. 2006. Intrauterine growth redaction: Implication for the animal sciences. J. Anim. Sci. 84:2316–2337.