SUPPLEMENTATION OF SOW FEED WITH OMEGA 3 FATTY ACIDS TO IMPROVE PERFORMANCE AND HEALTH OF PIGLETS

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Executive Summary

Given the rapid increase in foetal development in the final trimester of pregnancy the use of supplemental salmon oil during gestation, additional to the lactation period, may help piglet viability and survival and subsequent growth performance.

The objectives of this experiment were to .

1. Demonstrate improved pre and post weaning health and mortality of piglets from supplemental salmon oil

2. Demonstrate improved pre and post weaning growth performance of piglets from supplemental dietary salmon oil

3. Demonstrate reduced n-6:n-3 in piglet serum from maternal transfer

4. Confirm the transfer of EPA and DHA from sow feed to colostrum and milk

5. Demonstrate modulated immune function in pigs supplemented with salmon oil

The results of the experiment show that there was no improvement in the health and mortality of piglets when the sow and/or piglet were fed salmon oil at 3g/kg of feed. There was no significant difference in growth performance of the piglets from any treatment of salmon oil.

The transfer of fatty acids was unable to be confirmed by this experiment as analytical procedures were unable to determine with any accuracy, fatty acid levels in the blood of the piglets and immune response was removed from the experiment as there was no significant difference in any performance measure recorded.

The major conclusion from this experiment is that feeding salmon oil at 3g/kg to sows and piglets did not improve the performance of the piglets and it may require higher levels of long-chain omega 3 fatty acids to improve performance of piglets through enhanced immune status.

Animal Welfare considerations

The experiment was conducted under the control of the QAF animal welfare committee. There were no identifiable animal welfare concerns with this experiment.

Background

The majority of the work in omega 3 fatty acid nutrition has been conducted in sows, investigating the effects of supplementing feed with a specific marine oil, on the number of pigs born alive. Initial studies incorporating long-chain omega 3 fatty acids from salmon oil into the diet of lactating sows have shown an improvement in subsequent litter size by 0.7 to 1 pig per litter (Spencer et al., 2004 and Webel et al., 2004). The improvements in born alive from PUFA supplementation are attributed to improved embryo survival. It was hypothesised that birth weight may be reduced by feeding PUFA from salmon oil due to the reduction in arachidonic acid (20:4 n-6)(Cordoba et al., 2000), although Rooke et al., (2001) and Fritsche et al., (1993) recorded no such effect.

Short term feeding of salmon oil and its subsequent fertility effects are recognised although the mode of action is to be fully elucidated. If sows are fed diets supplemented with fish oil, a source of preformed EPA and DHA, it has been demonstrated that the long chain PUFA's are readily transferred into the sow (Rooke et al., 2001) and the transfer to milk and colostrum reflects that fed in the sow diet (Fritsche 1993, Rooke et al., 2001, Arbuckle and Innis 1993). The transfer of DHA to piglets is of significance due to its role in the development of the brain and central nervous system. Fritsche (1993) demonstrated the transfer of PUFA, particularly EPA, from sows and milk to the piglet when fed from day 107 of gestation, while Arbuckle and Innis (1993) recorded increased tissue uptake of DHA in piglets. Rooke et al., (2001) measured maternal transfer of DHA and found the uptake of DHA in specialised tissues is not linear. The weight of the brain was affected quadratically, and the proportions of n-6 PUFA declined linearly with increasing amounts of salmon oil. The optimum dose of salmon oil for transfer of DHA and maximum brain weight specified by Rooke et al., (2001) is 10g of salmon oil per kg of the sow gestation diet. Given the rapid increase in foetal development in the final trimester of pregnancy the use of supplemental salmon oil during gestation, additional to the lactation period, may help piglet viability and survival. While the maternal transfer of PUFA in utero has been recorded, it is thought to be quite specific for fatty acids (Campbell et al. 1998 in Rooke et al., 2001). In order to measure the maternal transfer of EPA and DHA it would have to be measured in piglet serum obtained at birth.

Salmon oil, like most marine oils is rich in n-3 PUFA's docosahexaenoic acid (DHA 22:6, n-3) and eicosapentaenoic acid (EPA 20:5 n-3). Similar to other aspects of nutrition, the total level and balance of fatty acids are critical to health and performance. Like the omega 6 arachidonic acid, both EPA and DHA, which can be synthesised from linolenic acid, are incorporated in large amounts into phospholipid membranes of cells. At the cellular level they modulate fluidity, enzyme activity and membrane receptors (Zamaria 2004). However it has been reported that in the metabolism of prostaglandins, thromboxanes and leukotrienes in eiconosoid metabolism,metabolites derived from arachidonic acid are more inflammatory than metabolites from EPA (James et al, 2000). Supplemenation with long chain omega 3 fatty acids from long chain n-3 PUFA and fish oil is known to reduce tissue and blood levels of arachidonic acids (Smits et al 2007), but the main effect is through substitution of arachidonic acid in the cyclooxygenase and lipoxygenase enzyme complexes in eicosanoid metabolism (James et al, 2000). As well as the effects on reproduction, n-3 PUFA have positive effects on health, immunity and growth. A substantial effect of salmon oil on the immune system is through its anti-inflammatory role via altered eiconsoid metabolism. Liu (2003), investigated the effects of fish oil and its functional constituents (EPA and DHA) on the immune function of weaned pigs. In this experiment EPA and DHA exerted an anti inflammatory effect by suppressing lymphocyte function. In experiments using various species (Barber 2005, Korotkova 2004) following the supplementation of EPA and DHA, the immune response is tested by immunising the subject and the immunological response measured. It is hypothesised that routine vaccinations of piglets, such as the mycoplasma pneumonia vaccine at approximately 2 and 3 weeks of age could be used to measure the effect that DHA and EPA has on the pig's immune response.

Feeding the sow a diet supplemented with salmon oil during the last half of gestation should provide adequate opportunity for the maternal transfer of EPA and DHA. Additionally supplementation of the lactation diet with salmon oil will allow transfer of the long chain n-3 PUFA's to the pig via the colostrum and milk. It is anticipated that the viability, health and performance of piglets, both pre and post weaning, will be improved via the supplementation of salmon oil.

Objectives:

6. Demonstrate improved pre and post weaning health and mortality of piglets from supplemental salmon oil

7. Demonstrate improved pre and post weaning growth performance of piglets from supplemental dietary salmon oil
8. Demonstrate reduced n-6:n-3 in piglet serum from maternal transfer
9. Confirm the transfer of EPA and DHA from sow feed to colostrum and milk
10. Demonstrate modulated immune function in pigs supplemented with salmon oil

Project Hypotheses

That supplementing salmon oil to gestation and lactation diets of sows will allow maternal transfer of long chain n-3 PUFA's

That supplementing salmon oil to gestation and lactation diets of sows will improve health and mortality of pigs, both pre and post weaned, and aid in modulating immune response of pigs.

Materials and Methods

The experiment was designed as a 3 x 2 factorial design. There were three sow treatments and two treatments imposed on the piglets during the weaner phase. The sow treatments were assigned as either; A - supplemented with salmon oil during the last 28 days of gestation (5g/kg of feed) and during lactation (3g/kg of feed), B – Supplementation from entry to the farrowing shed or C - nil supplementation during gestation and lactation periods. At weaning progeny from the three sow treatments were split into two treatments and were fed a common diet plus or minus the addition of salmon oil (3g/kg). The rates were designed to provide a daily level of supplementation of approximately 18 g.

Two hundred and thirty seven sows of mixed parity 4 weeks before farrowing were selected over 10 weeks dependant on available sows in the QAF research and development system. The selection distribution is outlined in Table 1. The selection process began in April 2006 and continued for the 10 weeks. Sows began farrowing in March 2006. Sows were removed from the experiment analysis if they did not complete the lactational period because of misadventure or were culled. The final set of data contained 71 sows in treatment A and 73 sows for each of the treatments B and C. The data was consolidated into parity groups. The parity groups were; Gilts, Parity 1, Parity 2 and Parity 3 and over with 49, 38, 48 and 82 in each parity group respectively.

Sows were housed in individual stalls in a gestation shed after they were allocated to their respective treatments. All sows were given a standard commercial gestation diet up to selection for the experiment 4 weeks before expected farrowing date. The sows assigned to treatment A were given a 1 kg/day of the top dress diet (Appendix 1) and 1.75 kg/day of the standard gestation diet. All other sows were given the gestation diet at 2.75kg/day

Sows were moved to the farrowing shed and into individual farrowing facilities 3-10 days before expected farrowing date where they received their respective lactation diets. Sows allocated to treatment A and B received the Lactation diet with salmon oil whereas the sows on treatment C received the standard Lactation diet without salmon oil supplemementation.

The date of birth, the number born alive, stillbirths and mummified piglets and consequentially the total born were recorded for each sow. The birth weight of each piglet was recorded and a blood sample taken for fatty acid analysis. The piglets were fostered within treatment groups within the first 24 hours after farrowing and the number and weight of individual piglets of the resultant litters was recorded. Any piglet after this period that required fostering was removed from the litter and taken off trial. A milk sample was taken at 48 hours post farrowing for fatty acid analysis and immunoglobulin titres.

Table 1. The number of selected sows by week, treatment and parity

Week	Treatment	Parity								
		0	1	2	3	4	5	6	8	Total
1	A	4		1	1		1			7
	B	4	1		1		1			7
	C	4	1	1	1		1			8
2	A	4		1	1	1			1	8
	B	2			2	1	1	1		7
	C	2	2	2	1		1			8
3	A	1	3			3		1		8
	B		1	2	4		1			8
	C		1	3	2	2				8
4	A	2		2		2		2		8
	B	3	2	2	1		2			10
	C	3	2	1	1		1	1		9
5	A		1	2	3	1		1		8
	B		1	3	3		1			8
	C		1	2	3			1		7
6	A		2	3	1	1	1			8
	B	4	2	2	1					9
	C	5	4	2	1	1	1			14
7	A		1	1	3	2				7
	B	3	2	2	1	3				11
	C	3	1	1	1	2				8
8	A		2	2	2	2				8

Week	Treatment	Parity								
		0	1	2	3	4	5	6	8	Total
	B		2	3	3					8
	C		2	4	2					8
9	A	4	1	1	1	1				8
	B			2	1		1			4
	C		1	1	2					4
10	A	2	2	2	2					8
	B	1	2	2	2					7
	C		2	3	1					6
Total	A	17	12	15	14	13	2	4	1	78
	B	17	13	18	19	4	7	1		79
	C	17	17	20	15	5	4	2		80
Total		51	42	53	48	22	13	7	1	237

Each litter was assessed over a fourteen day period from fostering to 14 days post fostering. The litter was scoured on a scale of 0 to 3 with 0 being no piglets scouring in the litter, 1 being evidence of scouring in the pen, 2 significant scouring in the pen and 3 being all piglets in the pen scouring heavily. The average scour over the 14 days was used to assess the scour score for that litter.

Piglets were given their first vaccination injection for mycoplasma pneumonia at approximately 10 days of age and reweighed. A second vaccination occurred the day prior to weaning which occurred at an average of 26 days of age. The number of piglets weaned per sow and the individual liveweight of each piglet was recorded

At weaning progeny from each sow treatment were split into two dietary treatments and were fed a common diet plus or minus the addition of salmon oil (3g/kg). Pigs will be housed in pen groups of 10 and health and growth performance monitored. Blood samples from a subset of pigs were taken to measure the antibody response to the vaccination 4 weeks post the booster injection at weaning.

Piglets were weighed in groups of 10 at weaning into the QAF Research and Innovation weaner facility. They were subsequently weighed at day 14, 28 and the final day of the weaner experimental period. Feed intake was recorded throughout the weaner experimental period with feed reconciliation recorded on each weigh day. This allows the calculation of average daily rates of gain, average feed intake and feed conversion efficiency. All removals were recorded.

Statistical analysis

All data was analysed using SPSS for Windows Version 10. The sow performance data was grouped by parity (gilts, parity 1, parity 2 and parity 3 and over) to ensure enough numbers were represented in each group. The influence of dietary treatment and sow parity on farrowing performance (number born alive, still born, mummified) were analysed using a multivariate analyses of variance (ANOVA), with the model including the random effect for week farrowed and the fixed effects for dietary treatment and parity. Similar analyses were undertaken to determine the effects of dietary treatment and sow parity on progeny and sow performance pre-weaning, with litter size or lactation length included in the model as covariates where appropriate. The experimental unit for the pre-weaning progeny performance was the litter or individual sow. The influence of sow dietary treatment on litter scour rating, pre-weaning progeny deaths/ removals and sow deaths/removals were determined using chi squared analyses.

Post weaning progeny performance was analysed using an ANOVA with the fixed effects of sow dietary treatment, weaner dietary treatment and progeny sex and the random effect of week weaned. The experimental unit for these post weaning analyses were the pen of animals. Subsequent sow reproductive performance was also analysed using an ANOVA with the model including the fixed effects for dietary treatment and parity and the random effect of week farrowed.

Results

The performance of the sows at farrowing from the control treatment or the salmon oil during the last 28 days of gestation and during lactation, or the Salmon oil during lactation period only is shown in Table 2. There was no effect of the treatment regime on the number of piglets born alive, as stillbirths or as mummified piglets and consequently no effect on the number of piglets born in total. There was a significant increase in number of total pigs born and those pigs born alive across parities with sows of parity 2 or over having a higher number than those of gilts or parity 1. There was no interaction between the parity group or the treatment regime for any of these traits.

Table 3 highlights that there was no significant difference in piglet birth weight or fostered weight due to any treatment effect but do show a significant effect of parity group. Piglets from gilts had the lowest birth weight with piglets from Parity 1 and 2 with the highest birth weight. Older parity sows tended to have piglets of a lower birth weight than the prime parity 1 and 2 sows. There was no interaction between treatment regime and parity for birth weight or litter weight.

The performance of the sows and litters during lactation and up to weaning is shown in Table 4. There was no significant effect of any treatment on average litter weight, number of piglets, or average weight of the piglets at weaning. Litters from gilts tended to be smaller and significantly lighter than litters from older parity sows. There were no significant differences in lactation length between treatments or between the parity groups, however this parameter does affect the results of the other statistics and further analysis of all results was carried out using the lactation length as a co-variant. Gilts did tend to have a longer lactation length by 1 day compared to older parity sows in the study. Although there was a trend towards a numerical treatment difference in average piglet birth weight (Table 3), the response is not consistent in favour of the salmon oil treatment, especially in gilt litters. Sows allocated to Salmon oil offered during lactation only were supplemented prior to farrowing for an average of only three days.

The pre-weaning growth rate of the piglets was not affected by the dietary treatment of the sows (Table 4). Piglets from gilt litters had a significantly lower growth rate than piglets from older sows. The average piglet growth performance for all sow treatments was within expectations for day 1 to 26 days of age. The growth performance is an indicator of the milk yield from the sow and thus we can suggest that there was no difference due to the dietary treatments on milk yield although not directly measured

The average daily feed intake of the sow from farrowing to weaning was not influenced by the dietary treatments and there was no interaction between the parity and the treatment. Gilts did eat less than older parity sows but the level of intake recorded was at or above commercial expectations.

Table 2. The performance of sows at farrowing given a commercial control gestation and lactation ration, supplemented with salmon oil during the last 28 days of gestation and lactation or a lactation diet 3 days before farrowing and during lactation.

		Gilts	Parity 1	Parity 2	Parity 3 and over	All Parities	SEM	Statistics (p=)	
Number of piglets Born Alive per litter	Control	11.2	10.8	12.6	13.0	12.1	0.31	Treatment	0.378
	Salmon Oil Gestation/ Lactation	11.1	12.2	12.9	12.4	12.2	0.33	**Parity Group**	**0.001**
	Salmon oil Lactation only	10.6	10.3	12.0	13.0	11.8	0.31	Interaction	0.521
Number of still birth piglets per litter	Control	0.8	0.2	0.7	0.8	0.7	0.10	Treatment	0.977
	Salmon Oil Gestation/ Lactation	0.5	0.8	0.6	0.8	0.7	0.10	Parity Group	0.560
	Salmon oil Lactation only	0.6	0.7	0.6	0.8	0.7	0.11	Interaction	0.658
Number of Mummified piglets per litter	Control	0.4	0.1	0.3	0.1	0.2	0.06	Treatment	0.930
	Salmon Oil Gestation/ Lactation	0.1	0.3	0.2	0.3	0.2	0.06	Parity Group	0.975
	Salmon oil Lactation only	0.3	0.2	0.1	0.3	0.2	0.06	Interaction	0.560
Total number of piglets born per litter	Control	12.5	11.1	13.6	13.9	13.0	0.31	Treatment	0.392
	Salmon Oil Gestation/ Lactation	11.7	13.2	13.7	13.4	13.1	0.35	**Parity Group**	**0.001**
	Salmon oil Lactation only	11.5	11.2	12.7	14.0	12.7	0.33	Interaction	0.285

Table 3. **The performance of sows and piglets during lactation given a commercial control gestation and lactation ration, supplemented with salmon oil during the last 28 days of gestation and lactation or a lactation diet 3 days before farrowing and during lactation.**

		Gilts	Parity 1	Parity 2	Parity 3 and over	All Parities	SEM	Statistics (p=)		Corrected for Litter size
Average Piglet Birth Weight (kg)	Control	1.32	1.65	1.56	1.52	1.51	0.03	Treatment	0.216	0.100
	Salmon Oil Gestation/ Lactation	1.49	1.62	1.62	1.58	1.58	0.03	**Parity Group**	**0.001**	0.001
	Salmon oil Lactation only	1.49	1.62	1.62	1.50	1.54	0.03	Interaction	0.487	0.692
Number of piglets per sow after fostering	Control	10.1	10.3	11.0	11.3	10.7	0.14	Treatment	0.234	
	Salmon Oil Gestation/ Lactation	10.5	11.5	10.9	11.1	11.0	0.12	**Parity Group**	**0.014**	
	Salmon oil Lactation only	10.7	10.6	10.9	11.0	10.8	0.13	Interaction	0.164	
Average weight of fostered piglets (kg)	Control	1.38	1.63	1.64	1.54	1.55	0.026	Treatment	0.384	0.161
	Salmon Oil Gestation/ Lactation	1.57	1.54	1.66	1.63	1.61	0.029	**Parity Group**	**0.017**	0.006
	Salmon oil Lactation only	1.51	1.64	1.59	1.56	1.57	0.025	Interaction	0.265	0.479

Table 4. **The performance of sows and piglets at weaning from sows given a commercial control gestation and lactation ration, supplemented with salmon oil during the last 28 days of gestation and Lactation or a lactation diet 3 days before farrowing and during lactation.**

		Gilts	Parity 1	Parity 2	Parity 3 and over	All Parities	SEM	Statistics (p=)		Corrected for Lactation length
Average Litter weaning Weight (kg)	Control	56.6	75.1	71.1	76.4	70.2	2.10	Treatment	0.599	0.703
	Salmon Oil Gestation/ Lactation	58.5	74.1	78.8	69.8	69.8	1.96	**Parity Group**	**0.001**	0.001
	Salmon oil Lactation only	68.3	73.9	78.2	68.9	71.5	1.69	Interaction	0.091	0.149
Number of piglets Weaned per sow	Control	8.6	9.3	9.2	9.4	9.2	0.19	Treatment	0.524	
	Salmon Oil Gestation/ Lactation	8.7	9.8	9.9	8.6	9.1	0.19	Parity Group	0.097	
	Salmon oil Lactation only	9.5	9.7	9.5	9.0	9.3	0.16	Interaction	0.202	
Average weight of weaned piglets (kg)	Control	6.5	8.1	7.8	8.1	7.7	0.165	Treatment	0.749	0.859
	Salmon Oil Gestation/ Lactation	6.6	7.5	8.0	8.1	7.7	0.140	**Parity Group**	**0.001**	0.001
	Salmon oil Lactation only	7.3	7.6	8.2	7.7	7.7	0.139	Interaction	0.168	0.183
Average Lactation length (days)	Control	26.4	26.9	26.7	26.6	26.6	0.24	Treatment	0.168	
	Salmon Oil Gestation/ Lactation	27.0	26.3	25.6	25.5	25.9	0.24	Parity Group	0.079	
	Salmon oil Lactation only	27.7	26.2	26.7	26.2	26.7	0.26	Interaction	0.351	
Average rate of gain of piglets (g/day)	Control	194	239	232	251	230	5.7	Treatment	0.967	0.923
	Salmon Oil Gestation/ Lactation	185	227	246	257	235	5.2	**Parity Group**	**0.001**	0.001
	Salmon oil Lactation only	208	232	249	234	230	5.1	Interaction	0.149	0.130
Average Sow daily feed intake (kg/day)	Control	6.44	6.86	6.74	6.80	6.71	0.075	Treatment	0.463	0.241
	Salmon Oil Gestation/ Lactation	6.22	6.66	6.75	6.66	6.59	0.080	**Parity Group**	**0.004**	0.024
	Salmon oil Lactation only	6.42	6.74	6.99	6.61	6.67	0.079	Interaction	0.795	0.752

A summary of the results of the scour scoring system are shown in Table 5. The piglets on the salmon oil diets tended to have a higher level of scouring than the control pigs although the difference was not significant at the 5% level.

Table 5. The Scour rating of piglets from sows given a commercial control gestation and lactation ration, supplemented with salmon oil during the last 28 days of gestation and Lactation or a lactation diet 3 days before farrowing and during lactation.

	no scours	scour rating 1	scour rating 2	scour rating 3	Average Rating
Control	37	30	12	3	0.179
Salmon Oil Gestation/ Lactation	30	22	18	1	0.217
Salmon oil Lactation only	28	20	20	1	0.247
Chi square	2.21				P=0.282
P value	*0.331*				

Table 6. The number of piglet removals from sows given a commercial control gestation and lactation ration, supplemented with salmon oil during the last 28 days of gestation and lactation or a lactation diet 3 days before farrowing and during lactation.

	Total number born	Total number weaned	Removals and losses	% Removals and losses
Control	859	677	182	21.2%
Salmon Oil Gestation/ Lactation	831	671	160	19.3%
Salmon oil Lactation only	855	692	163	19.1%
Chi square		1.48		
P value		*0.476*		

Approximately 20% of the piglets were removed from the experiment before weaning but there was no significant difference between any treatments on the number of piglets removed (Table 6).

Table 7. The subsequent reproductive performance of sows given a commercial control gestation and lactation ration, supplemented with salmon Oil during the last 28 days of gestation and Lactation or a lactation diet 3 days before farrowing and during lactation.

		Gilts	Parity 1	Parity 2	Parity 3 and over	All Parities	SEM	Statistics (p=)	
Remating Interval (days)	Control	6.7	8.1	8.6	8.5	8.0	0.77	Treatment	0.454
	Salmon Oil Gestation/ Lactation	5.6	10.0	9.8	6.5	7.7	0.63	Parity Group	0.446
	Salmon oil Lactation only	7.7	7.0	7.4	6.3	7.0	0.93	Interaction	0.930
Subsequent Number of piglets Born Alive per litter	Control	11.8	12.4	10.6	11.7	11.6	0.51	Treatment	0.732
	Salmon Oil Gestation/ Lactation	10.8	12.7	12.5	11.4	11.8	0.41	Parity Group	0.445
	Salmon oil Lactation only	10.8	11.9	11.9	10.8	11.3	0.37	Interaction	0.742
Subsequent Number of still birth piglets per litter	Control	0.7	0.5	0.6	0.8	0.7	0.13	**Treatment**	**0.036**
	Salmon Oil Gestation/ Lactation	1.5	2.3	1.1	1.2	1.5	0.30	Parity Group	0.958
	Salmon oil Lactation only	1.1	0.5	1.0	1.2	1.0	0.21	Interaction	0.649
Subsequent Number of Mummified piglets per litter	Control	0.3	0.1	0.2	0.3	0.2	0.07	Treatment	0.254
	Salmon Oil Gestation/ Lactation	0.6	0.6	0.2	0.2	0.4	0.10	Parity Group	0.401
	Salmon oil Lactation only	0.2	0.4	0.5	0.2	0.3	0.08	Interaction	0.278
Subsequent Total number of piglets born per litter	Control	12.5	12.9	11.2	12.4	12.2	0.55	Treatment	0.143
	Salmon Oil Gestation/ Lactation	12.4	14.9	13.5	12.6	13.2	0.38	Parity Group	0.433
	Salmon oil Lactation only	11.9	12.4	12.9	12.0	12.3	0.36	Interaction	0.616

After the piglets were weaned the sows from all treatments were returned to normal commercial production and mated on their first post-weaning oestrus. The reproductive performance was recorded through to the next farrowing of those sows to examine if there was any residual effect of the treatments on the reproductive capacity of the sows. The results of this extended period of the experiment are shown in Table 7. There was no significant difference of sow dietary treatment on weaning to re-mating interval or subsequent litter size. There was a significant increase in the average number of stillbirth piglets in the subsequent parity although further in-depth analysis does not support this difference when the number of litters that had stillbirths is corrected for. It is very unlikely that a feeding treatment period 16 weeks prior to farrowing would have an influence on the level of still births produced by the sow at farrowing. There was a trend for the sows that had the longest duration of feeding with salmon oil in the diet to have the highest total born and while this was not significant it is in line with field expectations of increases in total born.

Table 8 shows the number of sows that began the experiment that progressed through weaning, re-mating and farrowing. The number of sows on the experiment did not allow any conclusive analysis of the data from a statistical point of view but the results are consistent with field observations that sows that are fed salmon oil for a period longer than 28 days during their reproductive period have a better farrowing rate and larger total litter size. In this experiment the sows fed the salmon oil over 28 days during gestation as well as lactation had a better farrowing rate (12%) and a higher total born (1 pig/litter) in the subsequent litter.

Table 8 . The number of sows that were recorded at each interval on each treatment during the experiment.

	Control	Salmon Oil Gestation/ Latation	Salmon oil Lactation only
Number of Sows Start trial	80	78	79
Number of Sows Weaned	75	74	75
Number of Sows Remated	70	68	69
Number of Sows Farrowed	53	60	52
Subsequent Farrowing rate	75.7%	88.2%	75.4%
		Chi square	**4.55, P=0.103**

The piglets from each of the three sow treatments were divided into two dietary treatments. The first treatment was a standard commercial weaner diet regime with the addition of 3g/kg of salmon oil. The second treatment was a standard commercial weaner diet regime.

The growth performance of the piglets for 0-14 days, 14-28 days, 28-40 days and throughout the weaner period 0-40 days is shown in Tables 9, 10, 11, 12 respectively.

The growth performance of the piglets during the first 14 days was at a commercially acceptable level for this period. There was no significant effect of the sow treatment on the weight at 14 days, the rate of gain or feed intake over that period and subsequent feed conversion due to the dietary treatments imposed upon the sows of those piglets in the experiment. In contrast to the hypothesis, there was a significant reduction in feed intake and growth rate of the piglets fed diets containing the salmon oil treatments. There was no detectable difference between the performance of the male and female pigs during the first 14 days of the weaner period. There were no statistical interactions between any of the parameters measured.

The performance during the second two weeks of the weaner phase of the experiment indicated no differences in performance between any of the treatment variables and no interactions between the variables (Table 10). The performance was within commercial expectations and there was no significant difference between the sexes during the period of the weaner phase.

The final two weeks of the weaner phase of the experiment indicated no difference in any of the treatment variables with good levels of commercial performance. Males had significantly better feed conversion efficiency during this period indicating the sex differences that are expected after 10 weeks of age there was however, no significant difference in growth rate or feed intake between the sexes.

The overall piglet performance during the weaner phase was not influenced by sow dietary treatment (Table 12). There was, however, a tendency for piglets fed the salmon oil diets to exhibit a lower growth rate as a result of the lower intake over the early period of the post-weaning period and deterioration in feed conversion ratio. Male pigs had a significantly better feed conversion ratio than female pigs over the entire period.

Table 13 indicates the deaths and removals from the weaner phase of the experiment. There were no treatment effects on the deaths or removals from the experiment for any time period in the weaner.

Table 9. The 0-14 day performance of weaner pigs from sows on the salmon oil treatments and then split into two salmon oil weaner dietary treatments (0 and 3 kg/t).

			Sow Salmon Oil								
	Weaner	Sex	Control	Gestation/ Latation	Lactation only	Total	SEM	Main effects		Interactions	
Start Weight (Kg)	Salmon Oil	Female	7.8	7.7	7.7	7.7	0.10	Sow (Sw)	0.881	Sw x W	0.977
		Male	7.8	7.7	7.9	7.8		Weaner (W)	0.785	Sw x S	0.775
	Control	Female	7.9	7.6	7.6	7.7		Sex (S)	0.819	W x S	0.952
		Male	7.7	7.6	7.9	7.7				Sw x W xS	0.977
14 day Weight (Kg)	Salmon Oil	Female	10.1	10.0	9.9	10.0	0.11	Sow (Sw)	0.955	Sw x W	0.812
		Male	9.8	10.0	10.2	10.0		Weaner (W)	0.376	Sw x S	0.575
	Control	Female	10.5	10.2	9.9	10.2		Sex (S)	0.951	W x S	0.962
		Male	10.2	10.2	10.2	10.2				Sw x W x S	0.971
Rate Of Gain (Kg/d)	Salmon Oil	Female	0.166	0.171	0.166	0.168	0.003	Sow (Sw)	0.495	Sw x W	0.360
		Male	0.152	0.164	0.167	0.161		**Weaner (W)**	**0.004**	Sw x S	0.572
	Control	Female	0.194	0.191	0.171	0.185		Sex (S)	0.441	W x S	0.822
		Male	0.179	0.191	0.175	0.182				Sw x W x S	0.976
Feed Conversion	Salmon Oil	Female	1.374	1.407	1.337	1.372	0.019	Sow (Sw)	0.984	Sw x W	0.552
		Male	1.375	1.328	1.303	1.335		Weaner (W)	0.225	Sw x S	0.848
	Control	Female	1.263	1.295	1.324	1.294		Sex (S)	0.873	W x S	0.414
		Male	1.310	1.312	1.337	1.320				Sw x W x S	0.953
Average Daily Intake (kg/d)	Salmon Oil	Female	0.218	0.231	0.210	0.219	0.003	Sow (Sw)	0.137	Sw x W	0.570
		Male	0.203	0.213	0.215	0.210		**Weaner (W)**	**0.003**	Sw x S	0.359
	Control	Female	0.243	0.245	0.218	0.235		Sex (S)	0.336	W x S	0.601
		Male	0.229	0.243	0.226	0.233				Sw x W x S	0.859

Table 10. The 14-28 day performance of weaner pigs from sows on the salmon oil treatments and then split into two salmon oil weaner dietary treatments (0 and 3 kg/t).

			Salmon Oil								
	Weaner	Sex	Control	Gestation/ Latation	Lactation only	Total	SEM	Main effects		Interactions	
14 day Weight (Kg)	Salmon Oil	Female	10.1	10.0	9.9	10.0	0.11	Sow (Sw)	0.955	Sw x W	0.812
		Male	9.8	10.0	10.2	10.0		Weaner (W)	0.376	Sw x S	0.575
	Control	Female	10.5	10.2	9.9	10.2		Sex (S)	0.951	W x S	0.962
		Male	10.2	10.2	10.2	10.2				Sw x W x S	0.971
28 day Weight (Kg)	Salmon Oil	Female	16.7	16.4	16.1	16.4	0.16	Sow (Sw)	0.765	Sw x W	0.988
		Male	16.4	16.7	16.6	16.6		Weaner (W)	0.308	Sw x S	0.431
	Control	Female	17.1	16.9	16.3	16.8		Sex (S)	0.654	W x S	0.893
		Male	16.6	17.1	16.9	16.9				Sw x W x S	0.980
Rate Of Gain (Kg/d)	Salmon Oil	Female	0.494	0.470	0.457	0.474	0.005	Sow (Sw)	0.425	Sw x W	0.587
		Male	0.486	0.508	0.481	0.492		Weaner (W)	0.370	Sw x S	0.432
	Control	Female	0.488	0.503	0.478	0.489		Sex (S)	0.269	W x S	0.583
		Male	0.481	0.506	0.499	0.495				Sw x W x S	0.759
Feed Conversion	Salmon Oil	Female	1.430	1.440	1.442	1.437	0.010	Sow (Sw)	0.672	Sw x W	0.253
		Male	1.355	1.367	1.405	1.376		Weaner (W)	0.610	Sw x S	0.984
	Control	Female	1.437	1.379	1.398	1.405		Sex (S)	0.059	W x S	0.296
		Male	1.425	1.369	1.366	1.387				Sw x W x S	0.797
Average Daily Intake (kg/d)	Salmon Oil	Female	0.703	0.672	0.656	0.677	0.007	Sow (Sw)	0.491	Sw x W	0.997
		Male	0.653	0.690	0.666	0.670		Weaner (W)	0.416	Sw x S	0.332
	Control	Female	0.698	0.692	0.668	0.686		Sex (S)	0.712	W x S	0.880
		Male	0.680	0.690	0.679	0.683				Sw x W x S	0.738

Table 11 The 28-40day performance of weaner pigs from sows on the salmon oil treatments and then split into two salmon oil weaner dietary treatments (0 and 3 kg/t).

			Salmon Oil								
	Weaner	Sex	Control	Gestation/ Latation	Lactation only	Total	SEM	Main effects		Interactions	
28 day Weight (Kg)	Salmon Oil	Female	16.7	16.4	16.1	16.4	0.16	Sow (Sw)	0.765	Sw x W	0.988
		Male	16.4	16.7	16.6	16.6		Weaner (W)	0.308	Sw x S	0.431
	Control	Female	17.1	16.9	16.3	16.8		Sex (S)	0.654	W x S	0.893
		Male	16.6	17.1	16.9	16.9				Sw x W x S	0.980
40 day Weight (Kg)	Salmon Oil	Female	24.9	24.6	24.4	24.7	0.2	Sow (Sw)	0.784	Sw x W	0.860
		Male	24.8	24.9	25.0	24.9		Weaner (W)	0.346	Sw x S	0.600
	Control	Female	25.6	25.0	24.5	25.1		Sex (S)	0.554	W x S	0.961
		Male	25.0	25.7	25.1	25.3				Sw x W x S	0.897
Rate Of Gain (Kg/d)	Salmon Oil	Female	0.636	0.643	0.649	0.643	0.006	Sow (Sw)	0.809	Sw x W	0.531
		Male	0.653	0.631	0.652	0.645		Weaner (W)	0.675	Sw x S	0.800
	Control	Female	0.660	0.625	0.638	0.641		Sex (S)	0.460	W x S	0.640
		Male	0.654	0.674	0.636	0.655				Sw x W x S	0.300
Feed Conversion	Salmon Oil	Female	1.662	1.604	1.599	1.622	0.009	Sow (Sw)	0.092	Sw x W	0.250
		Male	1.576	1.667	1.604	1.617		Weaner (W)	0.441	Sw x S	0.245
	Control	Female	1.601	1.685	1.642	1.643		**Sex (S)**	**0.014**	**W x S**	**0.045**
		Male	1.538	1.592	1.587	1.572				Sw x W x S	0.088
Average Daily Intake (Kg/d)	Salmon Oil	Female	1.055	1.034	1.032	1.041	0.009	Sow (Sw)	0.582	Sw x W	0.660
		Male	1.027	1.047	1.039	1.038		Weaner (W)	0.973	Sw x S	0.392
	Control	Female	1.056	1.051	1.046	1.051		Sex (S)	0.415	W x S	0.503
		Male	0.998	1.070	1.007	1.025				Sw x W x S	0.823

Table 12 The overall 0-40day performance of weaner pigs from sows on the salmon oil treatments and then split into two salmon oil weaner dietary treatments (0 and 3 kg/t).

			Salmon Oil								
	Weaner	Sex	Control	Gestation/ Latation	Lactation only	Total	SEM	Main effects		Interactions	
Start Weight (Kg)	Salmon Oil	Female	7.8	7.7	7.7	7.7	0.10	Sow (Sw)	0.881	Sw x W	0.977
		Male	7.8	7.7	7.9	7.8		Weaner (W)	0.785	Sw x S	0.775
	Control	Female	7.9	7.6	7.6	7.7		Sex (S)	0.819	W x S	0.952
		Male	7.7	7.6	7.9	7.7				Sw x W xS	0.977
40 day Weight (Kg)	Salmon Oil	Female	24.9	24.6	24.4	24.7	0.2	Sow (Sw)	0.784	Sw x W	0.860
		Male	24.8	24.9	25.0	24.9		Weaner (W)	0.346	Sw x S	0.600
	Control	Female	25.6	25.0	24.5	25.1		Sex (S)	0.554	W x S	0.961
		Male	25.0	25.7	25.1	25.3				Sw x W x S	0.897
Rate Of Gain (Kg/d)	Salmon Oil	Female	0.428	0.424	0.420	0.424	0.003	Sow (Sw)	0.494	Sw x W	0.682
		Male	0.427	0.430	0.429	0.429		Weaner (W)	0.104	Sw x S	0.552
	Control	Female	0.444	0.437	0.425	0.435		Sex (S)	0.467	W x S	0.982
		Male	0.433	0.453	0.433	0.440				Sw x W x S	0.864
Feed Conversion	Salmon Oil	Female	1.511	1.496	1.480	1.496	0.005	Sow (Sw)	0.567	Sw x W	0.760
		Male	1.446	1.483	1.458	1.463		Weaner (W)	0.101	Sw x S	0.593
	Control	Female	1.474	1.489	1.483	1.482		**Sex (S)**	**0.001**	W x S	0.772
		Male	1.437	1.447	1.441	1.442				Sw x W x S	0.543
Average Daily Intake (Kg/d)	Salmon Oil	Female	0.647	0.634	0.622	0.634	0.005	Sow (Sw)	0.359	Sw x W	0.861
		Male	0.617	0.637	0.625	0.627		Weaner (W)	0.387	Sw x S	0.379
	Control	Female	0.654	0.651	0.630	0.645		Sex (S)	0.409	W x S	0.910
		Male	0.623	0.655	0.625	0.635				Sw x W x S	0.984

Table 13. The losses and removals of pigs during the weaner phase of the experiment.

			0-28 days			0-40 days		
Sow treatment	Weaner treatment	Number of pigs at weaning	DEATHS	OFF TRIAL	TOTAL REMOVALS	DEATHS	OFF TRIAL	TOTAL REMOVALS
Salmon Oil gestation/lactation	Salmon oil	308	1	6	7	4	10	14
	Control	339	0	6	6	4	13	17
Salmon Oil lactation	Salmon oil	327	2	7	9	5	13	18
	Control	335	0	8	8	2	12	14
Control	Salmon oil	315	0	7	7	3	13	16
	Control	333	2	6	8	3	12	15
Chi Squared					0.76			0.83
Significance (p=)					0.980			0.975

Discussion

The initial work into the incorporation of long-chain omega 3 fatty acids from fish oil into lactating sow rations showed substantial increases in litter size in the following farrowing (Spencer et al. 2004 and Webel et al. 2004). Webel et al (2004) reported that this improvement in fecundity was due to an increase in embryo survival, with no observed difference in ovulation rate between supplemented and un-supplemented sows during a 35 day period of feeding for a short interval before farrowing and continued through lactation. An increase in subsequent litter size could explain the decline in piglet birth weight in the subsequent litter where uterine crowding or placental efficiency is limiting (Cordoba et al., 2000). The transfer of the long chain polyunsaturated fatty acids (PUFA) to the piglet has been shown in utero (Rooke, 2001) and in milk (Fritsche, 1993, Rooke et al. 2001, Arbuckle and Innis 1993). The effect of this transfer of long chain PUFA's on the piglet performance is as yet not established.

This experiment indicated that there was no benefit of feeding salmon oil during the last 28 days of gestation on the number of piglets that were born alive or total born to the sow. Therefore any uptake of the long chain PUFA's by the sow and transferred into the piglet during the last third of gestation does not confer any direct benefit to the piglet in respect to its survival at farrowing. There is very little loss of piglets during the last 28 days of pregnancy in normal production systems so it was not expected that there would be any difference between the treatments in respect to total number of piglets born. Still borns or mummies were not affected by dietary treatment as a result of late gestation supplementation. The lack of any difference in the amount of still birth piglets indicates that there is little effect of the long chain PUFA's on the birthing process itself. There was no difference in birth weight between the sow gestation treatments indicating no increase in tissue deposition that influences survival or weight at birth.

There was no influence of feeding salmon oil during the last 28 days of gestation and/or throughout the lactation period on the performance of the piglets in respect to growth rate or the ability of the sow to wean the piglets including her average daily feed intake. This tends to indicate that any increase in consumption of long chain PUFA's did not translate into any improvement in commercial performance of the piglets or sows up to the point of weaning. This experiment did not examine the response of the piglets during the first 2 days after farrowing and may have biased any conclusion due to the use of fostering. It is thought that the addition of the PUFA during gestation and absorbed by the foetus will aid in the cognitive ability of the piglet immediately after birth (R. Newman pers comm.).

There were no significant differences in the survivability of the piglets through the production system as shown by Table 6 but there is a tendency for a higher average scour score for piglets from a dam that received the salmon oil in the lactation diet. This does tend to suggest that there is some transfer of fatty acids through the milk to the piglet causing some reaction in the piglets. Blood analysis for fatty acid levels was inconclusive as the amount of blood and milk collected was insufficient to get reliable levels of long-chain omega 3 or omega 6 concentrations. The few pigs where blood volumes were sufficient for analysis suggested that there was a higher concentration of omega 3 in the blood of piglets from dams feed the diets containing fish oil. We know from other studies that supplementation at 3 g/kg results in a physiological increase in plasma fatty acid levels of EPA and DHA in the pubertal gilt (Smits et al, 2007).

The reduction in feed intake and growth rate during the first two weeks after weaning when the piglets were fed 3kg/t of salmon oil in their diet suggests that there was a palatability factor associated with the addition of the salmon oil which the piglets became adjusted to after the first two week period. The lack of difference during the weaner phase with the addition of Salmon oil to the diet suggests that there is no response to this dietary treatment at 3kg/t inclusion rate. It is possible that the addition rate is too low to achieve a physiological response transferring into a physical performance increase.

The lack of response to the addition of the salmon oil to the sow diet in piglet performance either during the pre-weaning period or post weaning period indicates that the level of inclusion of the salmon oil is too low to illicit the desired effects on performance although there still maybe underlying physiological changes occurring as seen in other work at higher inclusion rates (J. A. Rooke 2001). The levels chosen for this experiment were based on commercially accepted levels for increasing the subsequent litter performance of the sows. It is uncertain if there is a minimum period of supplementation at 3g/kg in sow diets required to observe increases in reproductive performance. Webel et al. (2004) reported that a better response to supplementation when their protected polyunsaturated fish oil product was offered for late gestation (last 8 days) and lactation, compared to lactation supplementation only. However, we have recently found that plasma levels of fatty acids respond quite quickly, within a week, to supplementation in pubertal gilts (Smits, unpublished). It appears from this experiment that possibly the level of inclusion at 3 g/kg was insufficient to cause a response to long-chain EPA and DHA. Other studies

(Rooke, 2001, Leskanish and Noble, 1999; Newman unpublished) reported piglet responses in growth and development at levels of supplementation of between 10-50 g/kg. We adopted the lower level due to a sow reproductive response we have observed commercially. However, from a piglet health viewpoint, a response at a high level of supplementation as reported elsewhere (see review by Leskanish and Noble, 1999) cannot be ruled out. Based on their review, Leskanish and Noble recommend a daily dietary intake of 2.9 g EPA+DHA/day. At 3 g/kg of salmon oil added to a breeder diet, we have analysed the dietary level of EPA and DHA to be 0.54 g/100 g. Therefore a weaned piglet consuming 250 g/day would have a daily intake of only 0.14 g/day. The dietary inclusion of EPA and DHA as recommended by Leskanish and Noble would need to be much higher, at the level of 7.7 g/100 g total fatty acids. Given that the supplementation levels of 3 g/kg contains 0.54 g EPA+DHA/100 g, the amount of fish oil to be included would need to be 43 g/kg.

The conclusion from this experiment is that the use of 3g/kg of salmon oil into the diets of sows and piglets is not sufficient enough to increase the growth performance of the neonatal and post-weaned piglet. The subtle effects on physiology of the piglets were not under investigation in this experiment and may need further investigation with higher levels of salmon oil addition.

Implications

Benefits

There is no expectation that the feeding of salmon oil at 3 g/kg will improve the performance of piglets from before or after weaning. Thus when examining the cost effectiveness of addition of salmon oil to sow diets at 3g/kg then the cost effectiveness should only consider the improvement in the sow performance. The study provided further evidence that subsequent litter size and farrowing rate can be commercially improved through the supplementation of long-chain omega 3 fatty acids when salmon oil is included at low levels (3g/kg) in the diet.

There was no identifiable intellectual property developed from the project although further work at higher levels may lead to a commercially significant development.

Conclusion

The major conclusion from this experiment is that feeding salmon oil at 3g/kg to sows and piglets did not improve the performance of the piglets and it will require higher levels of salmon oil to improve performance of piglets. It is estimated that this may need to be as high as 40-50 g/kg salmon oil.

Extension Opportunities

Further work should examine the use of the salmon oil at higher levels in the diets of both sows and piglets. This work is expected to be part of the Pork CRC.

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APPENDICES

- Protocol

- Experimental Diets

Supplementation of sow feed with omega 3 fatty acids to improve performance and health of piglets

Internal

Introduction

The majority of the work in omega 3 fatty acid nutrition has been conducted in sows, investigating the effects of supplementing feed with a specific marine oil, on the number of pigs born alive. Initial studies incorporating salmon oil into the diet of lactating sows have shown an improvement in subsequent litter size by 0.7 to 1 pig per litter (Spencer et al., 2004 and Webel et al., 2004). The improvements in born alive from PUFA supplementation are attributed to improved embryo survival. If sows are fed diets supplemented with fish oil, a source of preformed EPA and DHA, it has been demonstrated that the long chain PUFA's are readily transferred into the sow (Rooke et al., 2001) and the transfer to milk and colostrum reflects that fed in the sow diet (Fritsche 1993, Rooke et al., 2001, Arbuckle and Innis 1993).

Salmon Oil is rich in n-3 PUFA's Docosahexaenoic acid (DHA 22:6, n-3) and Eicosapentaenoic acid (EPA 20:5 n-3). Similar to other aspects of nutrition, the total level and balance of fatty acids are critical to health and performance. Like arachidonic acid both EPA and DHA, which can be sythentised from linolenic acid, are incorporated in large amounts into phospholipid membranes of cells. At the cellular level they modulate fluidity, enzyme activity and membrane receptors (Zamaria 2004). Metabolites of arachidonic acid are more inflammatory than metabolites from long chain n-3 PUFA and fish oil is known to reduce tissue and blood levels of arachidonic acid (Ballard, unpublished). As well as the effects on reproduction, n-3 PUFA have positive effects on health, immunity and growth.

Feeding the sow a diet supplemented with salmon oil during the last half of gestation should provide adequate opportunity for the maternal transfer of EPA and DHA. Additionally supplementation of the lactation diet with salmon oil will allow transfer of the long chain n-3 PUFA's to the pig via the colostrum and milk. It is anticipated that the viability, health and performance of piglets, both pre and post weaning, will be improved via the supplementation of salmon oil.

Project Implications

Decreased pre and post weaning mortality potentially will permit, firstly, an increased number of pigs to be sold or, secondly, a reduction in the required sow stocks. Additionally, post weaning performance, mortality and subsequent growth or improved reproductive efficiency from gestational feeding may be improved further increasing herd efficiencies

Project Hypotheses

That supplementing salmon oil to gestation and lactation diets of sows will allow maternal transfer of long chain n-3 PUFA's

That supplementing salmon oil to gestation and lactation diets of sows will improve health and mortality of pigs, both pre and post weaned, and aid in modulating immune response of pigs.

Materials and Methods

Design:	3 x 2: with factors being 3 sow salmon oil levels and 2 weaner salmon oil levels
Site:	R&D
Animals Required:	216 sows and their progeny (approximately 700)
Age:	Balanced structure per treatment, comprising 25% gilts
Treatments:	Sow feeding A. Salmon oil in last 28 days of gestation (5 L/tonne) and salmon oil in lactation (3 L/tonne) B. Salmon oil in lactation only (3 L/tonne) C. Nil salmon oil supplementation **NOTE: ALL WEANERS WILL STAY IN THEIR RESPECTIVE SOW TREATMENT GROUPS (A., B., OR C.) AFTER WEANING AND WILL THEN BE SPLIT INTO 2 WEANER TREATMENTS:** Weaners will be fed one of two diet treatments: A. Salmon oil (3 L/tonne) supplemented weaner program

	B. Nil supplementation weaner program NOTE: Piglets will receive an ear notch in the farrowing house to identify their treatment. NOTE: Gilt progeny will receive an ear punch to identify them from other progeny
Start Date:	19/5/06
Duration:	8 sows per treatment for 9 weeks and approximately 240 progeny from the same litters
Feed Required:	15 tonne of gestation feed (5 tonne per treatment) Note: will need a salmon oil top dress diet, gestation feeding rates may need to be 3kg per sow to accommodate this 42 tonne of lactation feed (14 tonne per treatment) 18 tonne of 1st stage weaner feed (6 tonne per treatment) 36 tonne of 2nd stage weaner feed (12 tonne per treatment)
Laboratory Analyses: (To include all analyses required by Mill Laboratory)	
Medication:	Gestation: 1kg of Elancoban Lactation: 1kg of Elancoban 1st stage weaner: 1kg Anzamoxil 20% & 1kg of Tiamulin 20% 2nd stage weaner: 1 kg DMZ 20% Water medication as per QI 128
Measurements:	*Sows* Total born and born alive Still births Average daily lactation intake (including measured feed wastage) Days to remating Conception rate Subsequent farrowing rate and born alive

	Piglets Piglet Birth weight, foster weight and weaning weight (fostering should be within treatments only) Scour score, number of scouring piglets and intensity of scour Mortality and cause of death Group weights at point of mycoplasma vaccination (approximately 14 and 25 days of age) and 14 days post vaccination or. *Blood* Piglet Serum at birth for n-6, n-3 and consequently n-6:n-3 (2 piglets per litter for subset of 10 litters per treatment: Total 20 piglets per treatment) Mycoplasma vaccination immune response. Blood samples taken 4 to 6 weeks following booster vaccination, at approximately 8 weeks of age. Measure mycoplasma titres and white blood cell counts (30 per treatment) *Milk(48-72 hours post-farrowing)* Fatty acid profile (subset of 10 sows per treatment) n-6, n-3 and consequently n6:n-3 ratio. 48 hour IgG (subset of 10 sows per treatment) *Progeny post wean performance* Measurements are taken at the start of the experiment, day 14, 28 and on the final day of the experimental period (day 49). *Live weights:* Pen weights measured and average pig live weight calculated on the outlined days of measurement *Average daily gain (ADG):* Calculated per pig for the outlined time periods and the experimental period based on pen live weights *Average Daily Intake (ADI):* Feed disappearance will be measured and ADI calculated per pig for the outlined time periods and the experimental period *Feed Conversion Efficiency (FCR):* Calculated from determined ADG and ADI

	Feed Determinations Crude Protein Total Fat Fatty acid profile Dry Matter
Data Safety Sheets/ Information: (must be attached for new products/additives)	
Ethical Considerations: (is Ethics Committee approval required?)	
QA Documentation	
Production Considerations	
Processing Considerations:	
Co-ordinator (as FTE if this is a CRC Project)	0.2 Manager 0.2 Researcher
Technical Assistant(s) (as FTE if this is a CRC Project)	0.3 TA
Monitor	

Please complete the relevant costings table of the two tables shown below.

Project Costings (for internal or other contract trials):

Items	**$ (AUD)**	
Labour ($27.50 / hr)		
Diet Costs		
Animal charge		
Data Collection and Analysis		
Technical Services and Management		
Chemical Analysis		
Contract Fee Chargeable		
Total	**$ 0**	***GST exclusive***

<u>**OR**</u>

Project Costings (For CRC projects):

Items	**$ (AUD)**	**(FTE)**	
Principle investigator			
Trial Coordinator			
Research Assistant			
Diet Costs			
Animal charge			
Chemical Analysis			
Total			***GST exclusive***
CRC Cash Requested			
CRC Staff Inkind			
CRC Non Staff Inkind	**$ 0**		

Business Agreement

1. QAF Meat Industries undertakes to conduct the experiment outlined in the protocol on behalf of Name of Company for a total cost of $AUD

2. QAF Meat Industries to provide a detailed report on the results and implications of the completed experiment within six weeks of the completion date of the experimental work.

3. Name of Companyagrees to pay QAF Meat Industries $AUD on receipt of the final report.

Signed by:

.... Date ....
on behalf of Name of Company

.... Date ....
on behalf of QAF Meat Industries

PROTOCOL AMENDMENT / DEVIATION

Protocol Number: 06N022

Protocol Title: Supplementation of sow feed with omega 3 fatty acids to improve performance and health of piglets

Amendment or Deviation (circle one): Amendment / ~~Deviation No~~:

Description of Amendment / ~~Deviation~~:

Bleeding of weaners post Mycoplasma booster to be taken three weeks after the booster injection instead of 4 weeks after booster

Reasons for Amendment / ~~Deviation~~:

Peak antibody levels more likely to be achieved in this time frame

Impact of Amendment / ~~Deviation~~:

Move bleeding one week earlier. First group bled 17/8/06

Effective Date:

10/8/06

Investigator:	**Client: CRC**
Date: 14/05/2012	**Date: 14/05/2012**

EXPERIMENTAL DIETS

QAF Meat Industries (4124)

Rchive (RA) * Corowa * {8} AUGUST 2007 ALL DATA 13:48 21/08/07 0001

27-October-2006/643.5r (1) Plant=1 David

Recipe Basic Data

Code : 2090.2006050001 Name : GESTATION

Cost : 172.003 Valid from: 31/05/06 Version : 2003040024

Raw Material	Available	%	[Kg]	Tonnes	% Cost
1 WHEAT	[X]	44.906667	1347.2	305.365333	80.935
12 BARLEY 10%	[X]	12.033333	361.0	81.826667	20.848
200 MILLMIX	[X]	12.0	360.0	81.6	18.488
207 PIG ONLY MILLMIX	[X]	10.0	300.0	68.0	15.407
225 WHEAT PROTEIN EXTRACT	[X]	3.0	90.0	20.4	4.273
230 HOMINY	[X]	12.0	360.0	81.6	16.674
500 WATER	[X]	1.0	30.0	6.8	0.0
502 NATUPHOS 5000	[X]	0.01	0.3	0.068	1.058
510 MOLASSES	[X]	1.0	30.0	6.8	1.32
520 TALLOW-MIXER	[X]	1.0	30.0	6.8	3.43
551 SALT BIN ADD	[X]	0.3	9.0	2.04	0.286
560 LIMESTONE	[X]	1.466667	44.0	9.973333	0.725
576 DICALPHOS BIN ADD	[X]	0.833333	25.0	5.666667	2.495
600 LYSINE-HCL	[X]	0.203333	6.1	1.382667	2.246
610 THREONINE	[X]	0.016667	0.5	0.113333	0.291
708 QAF BREEDER PMX	[X]	0.13	3.9	0.884	3.93
709 QAF LAC SOW PLUS	[X]	0.1	3.0	0.68	4.349
		100.0	3000.0	680.0	

Analysis

[VOLUME] :	100.0	PHENYLAL :	0.535072	CHLORIDE :	0.343302
[DRYMAT] :	88.7925	P+T :	0.827577	MAGNES :	0.177188
DE_PIG :	12.962886	ARGININE :	0.671247	NA+K_CL :	119.08986
NE4G :	9.587749	TYROSINE :	0.337049	CHOLINE :	1176.3819
#ALY/NE4G :	0.05383	T:EAA :	4.449343	LACTOSE :	0.0
DEENZYME :	13.24362	#LYS/DE_ :	0.043595	N:D:F: :	20.6348
PROTEIN :	12.212217	#ALY/DE_ :	0.039814	LINOLEIC :	1.527603
FAT :	4.0958	#MET/LYS :	0.324765	A:D:F: :	6.644027
STARCH :	41.654	#M+C/LYS :	0.748869	RUMIN:ME :	11.79114
FIBRE :	4.729333	#THR/LYS :	0.698837	LAYER:ME :	2575.50833
ASH :	5.226817	#ISO/LYS :	0.706477	COPPER :	32.546887
CALCIUM :	0.899237	#TRY/LYS :	0.27267	COBALT :	0.05694
T:PHOS :	0.649907	#VAL/LYS :	0.976615	MANGANES :	97.424733
AV:PHOS :	0.446877	AMETH :	0.169983	ZINC :	130.067453
ENZAVPHOS :	0.489594	AM+C :	0.395109	IRON :	170.6342
CAL:PHOS :	1.38364	ATHREO :	0.367561	#AME/ALY :	0.329354
CAL:AVPHOS:	2.01227	AISOLEUC :	0.349925	#ACY/ALY :	0.427169
P:PHOS :	0.368378	ATRYPTO :	0.088158	#AM+/ALY :	0.76555
CAL:ENZAVP:	1.8367	AVALINE :	0.42991	#ATH/ALY :	0.712175
LYSINE :	0.565119	ACYSTINE :	0.220466	#AIS/ALY :	0.678004
ALYSINE :	0.516111	AP+T :	0.687923	#ATR/ALY :	0.170813
METHION :	0.183531	APHENYL :	0.420646	#AVA/ALY :	0.832981
M+C :	0.4232	ALEUCINE :	0.625477	#ATH/DE_ :	0.028355
THREO :	0.394926	AHISTID :	0.239306	ATYROSIN :	0.299758
ISOLEUC :	0.399243	AARGININ :	0.535581	LNAA :	15.010168
TRYPTO :	0.154091	SALT :	0.40344	#TRY/LNA :	0.026311
CYSTINE :	0.262925	%LEGUMES :	3.0	BULKDENS :	55.829433
VALINE :	0.551903	ABC :	684.302	IONOPHORE :	0.0
HISTIDIN :	0.296219	SODIUM :	0.151034	DURABIL :	79.092
LEUCINE :	0.781343	POTASS :	0.629488		

Formula basic data

Code	:	9897	Name	: 06N022 TOP DRESS	
Cost	:	216.838	Created	: 18/05/06	Version : 2003040024

Analysis

[VOLUME]	%	:	100.0	PHENYLAL	%	:	0.545501	CHLORIDE	%	:	0.317359
[DRYMAT]	%	:	88.942578	P+T	%	:	0.846523	MAGNES	%	:	0.17416
DE_PIG	MJ/KG	:	12.971884	ARGININE	%	:	0.679926	NA+K_CL	MEQ/KG	:	118.511235
NE4G	MJ/KG	:	9.602773	TYROSINE	%	:	0.345666	CHOLINE	MG/KG	:	1233.02824
#ALY/NE4G	GM/MJ	:	0.053973	T:EAA	%	:	4.55208	LACTOSE	%	:	0.0
DEENZYME	MJ/KG	:	12.747401	#LYS/DE_	GM/MJ	:	0.044021	N:D:F:	%	:	20.551213
PROTEIN	%	:	12.467498	#ALY/DE_	GM/MJ	:	0.039955	LINOLEIC	%	:	1.458227
FAT	%	:	4.323274	#MET/LYS	G/G	:	0.330896	A:D:F:	%	:	6.769928
STARCH	%	:	41.925671	#M+C/LYS	G/G	:	0.769104	RUMIN:ME	MJ/KG	:	11.788614
FIBRE	%	:	4.823558	#THR/LYS	G/G	:	0.699905	LAYER:ME	KCALS/KG	:	2599.054803
ASH	%	:	5.436625	#ISO/LYS	G/G	:	0.717484	COPPER	PPM	:	32.902009
CALCIUM	%	:	0.963111	#TRY/LYS	G/G	:	0.277135	COBALT	PPM	:	0.058774
T:PHOS	%	:	0.652949	#VAL/LYS	G/G	:	0.990973	MANGANES	PPM	:	98.77897
AV:PHOS	%	:	0.448604	AMETH	%	:	0.173845	ZINC	PPM	:	133.303049
ENZAVPHOS	%	:	0.494844	AM+C	%	:	0.406673	IRON	PPM	:	174.546422
CAL:PHOS	G/G	:	1.475016	ATHREO	%	:	0.367711	#AME/ALY	G/G	:	0.335419
CAL:AVPHOS	G/G	:	2.146905	AISOLEUC	%	:	0.356568	#ACY/ALY	G/G	:	0.438458
P:PHOS	%	:	0.371884	ATRYPTO	%	:	0.091105	#AM+/ALY	G/G	:	0.784643
CAL:ENZAVP	G/G	:	1.946291	AVALINE	%	:	0.438639	#ATH/ALY	G/G	:	0.709469
LYSINE	%	:	0.571035	ACYSTINE	%	:	0.227248	#AIS/ALY	G/G	:	0.687971
ALYSINE	%	:	0.51829	AP+T	%	:	0.702775	#ATR/ALY	G/G	:	0.17578
METHION	%	:	0.188953	APHENYL	%	:	0.428133	#AVA/ALY	G/G	:	0.846319
M+C	%	:	0.439185	ALEUCINE	%	:	0.634188	#ATH/DE_	GM/MJ	:	0.028347
THREO	%	:	0.39967	AHISTID	%	:	0.242693	ATYROSIN	%	:	0.316288
ISOLEUC	%	:	0.409708	AARGININ	%	:	0.544566	LNAA	GM	:	16.154845
TRYPTO	%	:	0.158254	SALT	%	:	0.399164	#TRY/LNA	G/G	:	0.02474
CYSTINE	%	:	0.272959	%LEGUMES	%	:	4.028814	BULKDENS	KG/HL	:	55.758603
VALINE	%	:	0.56588	ABC	MEQ/KG	:	719.457615	IONOPHORE	PPM	:	99.700897
HISTIDIN	%	:	0.301418	SODIUM	%	:	0.147294	DURABIL	%	:	77.998534
LEUCINE	%	:	0.794728	POTASS	%	:	0.60497				

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	44.95	1348.5	332.63
12 BARLEY	[X]	14.0	420.0	103.6
200 MILLMIX	[X]	17.0	510.0	125.8
207 PIG ONLY MILLMIX	[X]	5.0	150.0	37.0
225 DDGS	[X]	3.0	90.0	22.2
230 HOMINY	[X]	9.371043	281.131	69.345721
300 CANOLA MEAL 36%	[X]	1.0409	31.227	7.702663
500 WATER	[X]	1.0	30.0	7.4
502 NATUPHOS 5000	[X]	0.01	0.3	0.074
518 SALMATE	[X]	1.4	42.0	10.36
551 SALT BIN ADD	[X]	0.3	9.0	2.22
560 LIMESTONE	[X]	1.652514	49.575	12.228606
576 DICALPHOS BIN ADD	[X]	0.842746	25.282	6.236323
600 LYSINE-HCL	[X]	0.191553	5.747	1.417493
610 THREONINE	[X]	0.011242	0.337	0.083194
708 QAF BREEDER PMX	[X]	0.13	3.9	0.962
709 QAF LAC SOW PLUS	[X]	0.1	3.0	0.74
879 BMD 100	[X]	0.1	3.0	0.74
912 ELANCOBAN G	[X]	0.1	3.0	0.74
1050 BIOFIX	[X]	0.1	3.0	0.74
		100.3	3009.0	742.22

Formula basic data

Code	:	9917	Name	: 06N022 C LACTATION			
Cost	:	282.169	Created	: 20/06/06	Version	: 2004030054	

Analysis

[VOLUME]	%	:	100.0	PHENYLAL	%	:	0.785883	CHLORIDE	%	:	0.561336
[DRYMAT]	%	:	89.694634	P+T	%	:	1.269625	MAGNES	%	:	0.147636
DE_PIG	MJ/KG	:	13.973214	ARGININE	%	:	1.19786	NA+K_CL	MEQ/KG	:	121.896613
NE4G	MJ/KG	:	10.10046	TYROSINE	%	:	0.520022	CHOLINE	MG/KG	:	1774.308852
#ALY/NE4G	GM/MJ	:	0.079277	T:EAA	%	:	6.265146	LACTOSE	%	:	0.0
DEENZYME	MJ/KG	:	14.206127	#LYS/DE_	GM/MJ	:	0.064984	N:D:F:	%	:	13.86121
PROTEIN	%	:	18.672025	#ALY/DE_	GM/MJ	:	0.057305	LINOLEIC	%	:	1.160276
FAT	%	:	5.819682	#MET/LYS	G/G	:	0.315848	A:D:F:	%	:	5.673365
STARCH	%	:	40.478833	#M+C/LYS	G/G	:	0.678039	RUMIN:ME	MJ/KG	:	12.234164
FIBRE	%	:	3.656268	#THR/LYS	G/G	:	0.701872	LAYER:ME	KCALS/KG	:	2842.082175
ASH	%	:	5.549532	#ISO/LYS	G/G	:	0.676969	COPPER	PPM	:	31.783433
CALCIUM	%	:	0.898931	#TRY/LYS	G/G	:	0.227064	COBALT	PPM	:	0.06486
T:PHOS	%	:	0.54826	#VAL/LYS	G/G	:	0.955844	MANGANES	PPM	:	96.757078
AV:PHOS	%	:	0.44917	AMETH	%	:	0.237457	ZINC	PPM	:	126.4127
ENZAVPHOS	%	:	0.440923	AM+C	%	:	0.541842	IRON	PPM	:	176.361439
CAL:PHOS	G/G	:	1.639607	ATHREO	%	:	0.558498	#AME/ALY	G/G	:	0.296548
CAL:AVPHOS	G/G	:	2.001315	AISOLEUC	%	:	0.542342	#ACY/ALY	G/G	:	0.365655
P:PHOS	%	:	0.249924	ATRYPTO	%	:	0.160741	#AM+/ALY	G/G	:	0.676679
CAL:ENZAVP	G/G	:	2.038747	AVALINE	%	:	0.717487	#ATH/ALY	G/G	:	0.697481
LYSINE	%	:	0.90804	ACYSTINE	%	:	0.292793	#AIS/ALY	G/G	:	0.677305
ALYSINE	%	:	0.800736	AP+T	%	:	1.125494	#ATR/ALY	G/G	:	0.200742
METHION	%	:	0.286802	APHENYL	%	:	0.650984	#AVA/ALY	G/G	:	0.896034
M+C	%	:	0.615686	ALEUCINE	%	:	1.058546	#ATH/DE_	GM/MJ	:	0.039969
THREO	%	:	0.637327	AHISTID	%	:	0.382368	ATYROSIN	%	:	0.538514
ISOLEUC	%	:	0.614714	AARGININ	%	:	0.978997	LNAA	GM	:	38.465241
TRYPTO	%	:	0.206183	SALT	%	:	0.55996	#TRY/LNA	G/G	:	0.016569
CYSTINE	%	:	0.350531	%LEGUMES	%	:	14.308294	BULKDENS	KG/HL	:	63.361575
VALINE	%	:	0.867944	ABC	MEQ/KG	:	705.144672	IONOPHORE	PPM	:	99.825306
HISTIDIN	%	:	0.485888	SODIUM	%	:	0.208183	DURABIL	%	:	78.404793
LEUCINE	%	:	1.257109	POTASS	%	:	0.741174				

	Raw material	Available	%	[Kg]	Tonnes
1	WHEAT	[X]	49.97334	1499.2	134.928018
12	BARLEY	[X]	15.0	450.0	40.5
110	LUPIN KERNELS 33%	[X]	9.333333	280.0	25.2
200	MILLMIX	[X]	6.7	201.0	18.09
300	CANOLA MEAL 36%	[X]	5.0	150.0	13.5
400	MEATMEAL	[X]	5.933333	178.0	16.02
410	FISHMEAL 64%	[X]	1.0	30.0	2.7
420	BLOODMEAL	[X]	1.1	33.0	2.97
500	WATER	[X]	1.0	30.0	2.7
502	NATUPHOS 5000	[X]	0.01	0.3	0.027
503	PORZYME 9310	[X]	0.02	0.6	0.054
520	TALLOW-MIXER	[X]	2.8	84.0	7.56
551	SALT BIN ADD	[X]	0.366667	11.0	0.99
560	LIMESTONE	[X]	0.9	27.0	2.43
600	LYSINE-HCL	[X]	0.096667	2.9	0.261
679	POTASSIUM CHLORIDE	[X]	0.41666	12.5	1.124982
708	QAF BREEDER PMX	[X]	0.13	3.9	0.351
709	QAF LAC SOW PLUS	[X]	0.1	3.0	0.27
770	ENDOX	[X]	0.02	0.6	0.054
912	ELANCOBAN G	[X]	0.1	3.0	0.27
990	BETAINE	[X]	0.1	3.0	0.27
1080	RAVICOL FIDO (RED)	[ ]	0.075	2.25	0.2025
			100.175	3005.25	270.4725

Formula basic data

Code : 9740 Name : 02N022 Lactation Salmon oil

Cost : 282.169 Created : 11/05/06 Version : 2004030054

Analysis

[VOLUME]	%	:	100.0	PHENYLAL	%	:	0.785687	CHLORIDE	%	:	0.561196
[DRYMAT]	%	:	89.672255	P+T	%	:	1.269308	MAGNES	%	:	0.147599
DE_PIG	MJ/KG	:	13.969728	ARGININE	%	:	1.197562	NA+K_CL	MEQ/KG	:	121.866199
NE4G	MJ/KG	:	10.097939	TYROSINE	%	:	0.519892	CHOLINE	MG/KG	:	1773.86616
#ALY/NE4G	GM/MJ	:	0.079277	T:EAA	%	:	6.263583	LACTOSE	%	:	0.0
DEENZYME	MJ/KG	:	14.094798	#LYS/DE_	GM/MJ	:	0.064984	N:D:F:	%	:	13.857752
PROTEIN	%	:	18.677945	#ALY/DE_	GM/MJ	:	0.057305	LINOLEIC	%	:	1.159987
FAT	%	:	5.81823	#MET/LYS	G/G	:	0.315848	A:D:F:	%	:	5.67195
STARCH	%	:	40.468733	#M+C/LYS	G/G	:	0.678039	RUMIN:ME	MJ/KG	:	12.231112
FIBRE	%	:	3.655356	#THR/LYS	G/G	:	0.701872	LAYER:ME	KCALS/KG	:	2841.373072
ASH	%	:	5.64695	#ISO/LYS	G/G	:	0.676969	COPPER	PPM	:	31.775503
CALCIUM	%	:	0.898707	#TRY/LYS	G/G	:	0.227064	COBALT	PPM	:	0.064844
T:PHOS	%	:	0.548123	#VAL/LYS	G/G	:	0.955844	MANGANES	PPM	:	96.732937
AV:PHOS	%	:	0.449058	AMETH	%	:	0.237397	ZINC	PPM	:	126.38116
ENZAVPHOS	%	:	0.440813	AM+C	%	:	0.541706	IRON	PPM	:	176.317436
CAL:PHOS	G/G	:	1.639607	ATHREO	%	:	0.558359	#AME/ALY	G/G	:	0.296548
CAL:AVPHOS	G/G	:	2.001315	AISOLEUC	%	:	0.542207	#ACY/ALY	G/G	:	0.365655
P:PHOS	%	:	0.249862	ATRYPTO	%	:	0.160701	#AM+/ALY	G/G	:	0.676679
CAL:ENZAVP	G/G	:	2.038747	AVALINE	%	:	0.717308	#ATH/ALY	G/G	:	0.697481
LYSINE	%	:	0.907813	ACYSTINE	%	:	0.29272	#AIS/ALY	G/G	:	0.677305
ALYSINE	%	:	0.800536	AP+T	%	:	1.125214	#ATR/ALY	G/G	:	0.200742
METHION	%	:	0.286731	APHENYL	%	:	0.650821	#AVA/ALY	G/G	:	0.896034
M+C	%	:	0.615532	ALEUCINE	%	:	1.058282	#ATH/DE_	GM/MJ	:	0.039969
THREO	%	:	0.637168	AHISTID	%	:	0.382272	ATYROSIN	%	:	0.538379
ISOLEUC	%	:	0.614561	AARGININ	%	:	0.978753	LNAA	GM	:	38.455644
TRYPTO	%	:	0.206132	SALT	%	:	0.55982	#TRY/LNA	G/G	:	0.016569
CYSTINE	%	:	0.350444	%LEGUMES	%	:	14.304724	BULKDENS	KG/HL	:	63.345766
VALINE	%	:	0.867728	ABC	MEQ/KG	:	704.968738	IONOPHORE	PPM	:	99.800399
HISTIDIN	%	:	0.485767	SODIUM	%	:	0.208131	DURABIL	%	:	78.460081
LEUCINE	%	:	1.256796	POTASS	%	:	0.740989				

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	49.97334	1499.2	134.928018
12 BARLEY	[X]	15.0	450.0	40.5
110 LUPIN KERNELS 33%	[X]	9.333333	280.0	25.2
200 MILLMIX	[X]	6.7	201.0	18.09
300 CANOLA MEAL 36%	[X]	5.0	150.0	13.5
400 MEATMEAL	[X]	5.933333	178.0	16.02
410 FISHMEAL 64%	[X]	1.0	30.0	2.7
420 BLOODMEAL	[X]	1.1	33.0	2.97
500 WATER	[X]	1.0	30.0	2.7
502 NATUPHOS 5000	[X]	0.01	0.3	0.027
503 PORZYME 9310	[X]	0.02	0.6	0.054
517 FISH OIL	[X]	0.3	9.0	0.81
520 TALLOW-MIXER	[X]	2.5	75.0	6.75
551 SALT BIN ADD	[X]	0.366667	11.0	0.99
560 LIMESTONE	[X]	0.9	27.0	2.43
600 LYSINE-HCL	[X]	0.096667	2.9	0.261
679 POTASSIUM CHLORIDE	[X]	0.41666	12.5	1.124982
708 QAF BREEDER PMX	[X]	0.13	3.9	0.351
709 QAF LAC SOW PLUS	[X]	0.1	3.0	0.27
770 ENDOX	[X]	0.02	0.6	0.054
912 ELANCOBAN G	[X]	0.1	3.0	0.27
950 RED MICRO-GRITS	[X]	0.1	3.0	0.27
990 BETAINE	[X]	0.1	3.0	0.27
		100.2	3006.0	270.54

Formula basic data

Code	: 9918	Name	: 06N022 WEAN 1 CONTROL		
Cost	: 477.159	Created	: 22/09/06	Version	: 2005120169

Analysis

[VOLUME]	%	100.0	GLYCINE	%	1.218591	N:D:F:	%	7.526421
[DRYMAT]	%	90.858757	GLUTAMIC	%	3.520503	LINOLEIC	%	0.848936
DE_PIG	MJ/KG	14.661805	SERINE	%	0.909953	A:D:F:	%	2.838088
NE4G	MJ/KG	10.28307	GLUTAMIN	%	3.431552	RUMIN:ME	MJ/KG	12.223952
#ALY/NE4G	GM/MJ	0.125491	PROLINE	%	0.996311	LAYER:ME	KCALS/KG	2925.566947
DEENZYME	MJ/KG	14.857195	OH_PROLI	%	0.277946	SULPHUR	%	0.298455
PROTEIN	%	22.512562	ASPARAG	%	1.663606	COPPER	PPM	47.08056
FAT	%	5.294115	#LYS/DE_	GM/MJ	0.099931	COBALT	PPM	0.050133
STARCH	%	31.602276	#ALY/DE_	GM/MJ	0.088013	MANGANES	PPM	104.340675
FIBRE	%	1.85607	#MET/LYS	G/G	0.299092	ZINC	PPM	2549.45188
ASH	%	5.949403	#M+C/LYS	G/G	0.558249	IRON	PPM	244.912595
CALCIUM	%	0.83378	#THR/LYS	G/G	0.650049	IODINE	PPM	1.332172
T:PHOS	%	0.635055	#ISO/LYS	G/G	0.550833	SELENIUM	PPM	0.583235
AV:PHOS	%	0.609485	#TRY/LYS	G/G	0.189184	#AME/ALY	G/G	0.306688
ENZAVPHOS	%	0.549057	#VAL/LYS	G/G	0.760977	#ACY/ALY	G/G	0.32461
CAL:PHOS	G/G	1.312927	AMETH	%	0.39576	#AM+/ALY	G/G	0.550654
CAL:AVPHOS	G/G	1.368008	AM+C	%	0.710581	#ATH/ALY	G/G	0.643232
P:PHOS	%	0.149973	ATHREO	%	0.830047	#AIS/ALY	G/G	0.550103
CAL:ENZAVP	G/G	1.518568	AISOLEUC	%	0.70987	#ATR/ALY	G/G	0.164602
LYSINE	%	1.465171	ATRYPTO	%	0.212407	#AVA/ALY	G/G	0.734545
ALYSINE	%	1.290431	AVALINE	%	0.947879	#ATH/DE_	GM/MJ	0.056613
METHION	%	0.438222	ACYSTINE	%	0.418886	ATYROSIN	%	0.560441
M+C	%	0.81793	AP+T	%	1.34778	AALANINE	%	0.909786
THREO	%	0.952433	APHENYL	%	0.816028	AASPARTI	%	1.403263
ISOLEUC	%	0.807065	ALEUCINE	%	1.448081	AASPARAG	%	1.446619
TRYPTO	%	0.277187	AHISTID	%	0.493271	AGLUTAMI	%	3.412499
CYSTINE	%	0.382428	AARGININ	%	1.133779	AGLUT:IN	%	3.457693
VALINE	%	1.114962	SALT	%	0.82423	AGLYCINE	%	1.062828
HISTIDIN	%	0.60083	%LEGUMES	%	14.955135	ASERINE	%	0.806993
LEUCINE	%	1.677969	ABC	MEQ/KG	707.147455	APROLINE	%	0.966362
PHENYLAL	%	0.974226	SODIUM	%	0.340422	LNAA	GM	23.738891
P+T	%	1.689875	POTASS	%	0.672212	#TRY/LNA	G/G	0.040121
ARGININE	%	1.373405	CHLORIDE	%	0.524439	BULKDENS	KG/HL	62.564808
TYROSINE	%	0.674067	MAGNES	%	0.132994	IONOPHORE	PPM	99.700897
T:EAA	%	8.996476	NA+K_CL	MEQ/KG	173.099169	DURABIL	%	81.32893
ALANINE	%	1.039957	CHOLINE	MG/KG	1684.706029			
ASPARTIC	%	1.608411	LACTOSE	%	10.667996			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	50.283333	1508.5	75.424999
110 LUPIN KERNELS 33%	[X]	7.0	210.0	10.5
325 SOYABEANMEAL-48%	[X]	8.0	240.0	12.0
400 MEATMEAL	[X]	8.766667	263.0	13.15
420 BLOODMEAL	[X]	3.0	90.0	4.5
450 WHEY POWDER 11%	[X]	17.833333	535.0	26.75
500 WATER	[X]	1.0	30.0	1.5
502 NATUPHOS 5000	[X]	0.01	0.3	0.015
520 TALLOW-MIXER	[X]	2.566667	77.0	3.85
551 SALT BIN ADD	[X]	0.2	6.0	0.3
600 LYSINE-HCL	[X]	0.35	10.5	0.525
605 DL-METHIONINE	[X]	0.143333	4.3	0.215
610 THREONINE	[X]	0.133333	4.0	0.2
615 ISOLEUCINE H/A	[X]	0.056667	1.7	0.085
620 TRYPTOPHAN H/A	[X]	0.04	1.2	0.06
650 ZINC OXIDE	[X]	0.3	9.0	0.45
700 QAF CREEP PMX	[X]	0.166667	5.0	0.250001
770 ENDOX	[X]	0.02	0.6	0.03
856 ANZAMOXYL 20%	[X]	0.1	3.0	0.15
912 ELANCOBAN G	[X]	0.1	3.0	0.15
937 ACID LAC DRY	[X]	0.1	3.0	0.15
950 RED MICRO-GRITS	[X]	0.1	3.0	0.15
989 RONOZYME	[X]	0.03	0.9	0.045
		100.3	3009.0	150.45

Formula basic data

Code	:	9919	Name	: 06N022 WEAN 1 SALMON OIL	
Cost	:	477.159	Created	: 22/09/06	Version : 2005120169

Analysis

[VOLUME]	%	:	100.0	GLYCINE	%	:	1.218591	N:D:F:	%	:	7.526421
[DRYMAT]	%	:	90.858757	GLUTAMIC	%	:	3.520503	LINOLEIC	%	:	0.848936
DE_PIG	MJ/KG	:	14.661805	SERINE	%	:	0.909953	A:D:F:	%	:	2.838088
NE4G	MJ/KG	:	10.28307	GLUTAMIN	%	:	3.431552	RUMIN:ME	MJ/KG	:	12.223952
#ALY/NE4G	GM/MJ	:	0.125491	PROLINE	%	:	0.996311	LAYER:ME	KCALS/KG	:	2925.566961
DEENZYME	MJ/KG	:	14.749518	OH_PROLI	%	:	0.277946	SULPHUR	%	:	0.298455
PROTEIN	%	:	22.512562	ASPARAG	%	:	1.663606	COPPER	PPM	:	47.08056
FAT	%	:	5.294115	#LYS/DE_	GM/MJ	:	0.099931	COBALT	PPM	:	0.050133
STARCH	%	:	31.602276	#ALY/DE_	GM/MJ	:	0.088013	MANGANES	PPM	:	104.340675
FIBRE	%	:	1.85607	#MET/LYS	G/G	:	0.299092	ZINC	PPM	:	2549.451872
ASH	%	:	5.949403	#M+C/LYS	G/G	:	0.558249	IRON	PPM	:	244.912595
CALCIUM	%	:	0.83378	#THR/LYS	G/G	:	0.650049	IODINE	PPM	:	1.332172
T:PHOS	%	:	0.635055	#ISO/LYS	G/G	:	0.550833	SELENIUM	PPM	:	0.583235
AV:PHOS	%	:	0.609485	#TRY/LYS	G/G	:	0.189184	#AME/ALY	G/G	:	0.306688
ENZAVPHOS	%	:	0.549057	#VAL/LYS	G/G	:	0.760977	#ACY/ALY	G/G	:	0.32461
CAL:PHOS	G/G	:	1.312927	AMETH	%	:	0.39576	#AM+/ALY	G/G	:	0.550654
CAL:AVPHOS	G/G	:	1.368008	AM+C	%	:	0.710581	#ATH/ALY	G/G	:	0.643232
P:PHOS	%	:	0.149973	ATHREO	%	:	0.830047	#AIS/ALY	G/G	:	0.550103
CAL:ENZAVP	G/G	:	1.518568	AISOLEUC	%	:	0.70987	#ATR/ALY	G/G	:	0.164602
LYSINE	%	:	1.465171	ATRYPTO	%	:	0.212407	#AVA/ALY	G/G	:	0.734545
ALYSINE	%	:	1.290431	AVALINE	%	:	0.947879	#ATH/DE_	GM/MJ	:	0.056613
METHION	%	:	0.438222	ACYSTINE	%	:	0.418886	ATYROSIN	%	:	0.560441
M+C	%	:	0.81793	AP+T	%	:	1.34778	AALANINE	%	:	0.909786
THREO	%	:	0.952433	APHENYL	%	:	0.816028	AASPARTI	%	:	1.403263
ISOLEUC	%	:	0.807065	ALEUCINE	%	:	1.448081	AASPARAG	%	:	1.446619
TRYPTO	%	:	0.277187	AHISTID	%	:	0.493271	AGLUTAMI	%	:	3.412499
CYSTINE	%	:	0.382428	AARGININ	%	:	1.133779	AGLUT:IN	%	:	3.457693
VALINE	%	:	1.114962	SALT	%	:	0.82423	AGLYCINE	%	:	1.062828
HISTIDIN	%	:	0.60083	%LEGUMES	%	:	14.955135	ASERINE	%	:	0.806993
LEUCINE	%	:	1.677969	ABC	MEQ/KG	:	707.147453	APROLINE	%	:	0.966362
PHENYLAL	%	:	0.974226	SODIUM	%	:	0.340422	LNAA	GM	:	23.738891
P+T	%	:	1.689875	POTASS	%	:	0.672212	#TRY/LNA	G/G	:	0.040121
ARGININE	%	:	1.373405	CHLORIDE	%	:	0.524439	BULKDENS	KG/HL	:	62.564808
TYROSINE	%	:	0.674067	MAGNES	%	:	0.132994	IONOPHORE	PPM	:	99.700897
T:EAA	%	:	8.996476	NA+K_CL	MEQ/KG	:	173.099168	DURABIL	%	:	81.32893
ALANINE	%	:	1.039957	CHOLINE	MG/KG	:	1684.706024				
ASPARTIC	%	:	1.608411	LACTOSE	%	:	10.667996				

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	50.283333	1508.5	75.424999
110 LUPIN KERNELS 33%	[X]	7.0	210.0	10.5
325 SOYABEANMEAL-48%	[X]	8.0	240.0	12.0
400 MEATMEAL	[X]	8.766667	263.0	13.15
420 BLOODMEAL	[X]	3.0	90.0	4.5
450 WHEY POWDER 11%	[X]	17.833333	535.0	26.75
500 WATER	[X]	1.0	30.0	1.5
502 NATUPHOS 5000	[X]	0.01	0.3	0.015
518 SALMATE	[X]	0.3	9.0	0.45
520 TALLOW-MIXER	[X]	2.266667	68.0	3.4
551 SALT BIN ADD	[X]	0.2	6.0	0.3
600 LYSINE-HCL	[X]	0.35	10.5	0.525
605 DL-METHIONINE	[X]	0.143333	4.3	0.215
610 THREONINE	[X]	0.133333	4.0	0.2
615 ISOLEUCINE H/A	[X]	0.056667	1.7	0.085
620 TRYPTOPHAN H/A	[X]	0.04	1.2	0.06
650 ZINC OXIDE	[X]	0.3	9.0	0.45
700 QAF CREEP PMX	[X]	0.166667	5.0	0.250001
770 ENDOX	[X]	0.02	0.6	0.03
856 ANZAMOXYL 20%	[X]	0.1	3.0	0.15
912 ELANCOBAN G	[X]	0.1	3.0	0.15
937 ACID LAC DRY	[X]	0.1	3.0	0.15
951 BLUE MICRO-GRITS	[X]	0.1	3.0	0.15
989 RONOZYME	[X]	0.03	0.9	0.045
		100.3	3009.0	150.45

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=============================================== QAF Meat Industries  (4124) ===============================================
:                                                                                                                          :
:     Single-Mix        (FM)       * Corowa *        {8} AUGUST 2007              ALL DATA              13:26 21/08/07  0005 :
: 27-October-2006/643.5r           (    1)  Plant=1       David                                                            :
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Formula basic data

Code	: 9923	Name	: 06N022 WEAN 2 CONTROL		
Cost	: 310.906	Created	: 22/09/06	Version	: 2006050056

Analysis

[VOLUME]	%	:	100.0	T:EAA	%	:	8.944182	A:D:F:	%	:	3.852459
[DRYMAT]	%	:	89.957385	#LYS/DE_	GM/MJ	:	0.089249	RUMIN:ME	MJ/KG	:	12.063707
DE_PIG	MJ/KG	:	14.170939	#ALY/DE_	GM/MJ	:	0.079081	LAYER:ME	KCALS/KG	:	2959.952169
NE4G	MJ/KG	:	10.165018	#MET/LYS	G/G	:	0.305179	COPPER	PPM	:	23.512472
#ALY/NE4G	GM/MJ	:	0.110246	#M+C/LYS	G/G	:	0.599739	COBALT	PPM	:	0.074684
DEENZYME	MJ/KG	:	14.440253	#THR/LYS	G/G	:	0.669764	MANGANES	PPM	:	53.600198
PROTEIN	%	:	21.27653	#ISO/LYS	G/G	:	0.560055	ZINC	PPM	:	2226.301133
FAT	%	:	3.795474	#TRY/LYS	G/G	:	0.18916	IRON	PPM	:	142.305389
STARCH	%	:	46.916999	#VAL/LYS	G/G	:	0.829155	#AME/ALY	G/G	:	0.306169
FIBRE	%	:	2.614271	AMETH	%	:	0.343108	#ACY/ALY	G/G	:	0.339013
ASH	%	:	4.926532	AM+C	%	:	0.657405	#AM+/ALY	G/G	:	0.586628
CALCIUM	%	:	0.854934	ATHREO	%	:	0.751993	#ATH/ALY	G/G	:	0.671033
T:PHOS	%	:	0.570931	AISOLEUC	%	:	0.599067	#AIS/ALY	G/G	:	0.534571
AV:PHOS	%	:	0.501194	ATRYPTO	%	:	0.178265	#ATR/ALY	G/G	:	0.159073
ENZAVPHOS	%	:	0.462915	AVALINE	%	:	0.85378	#AVA/ALY	G/G	:	0.761861
CAL:PHOS	G/G	:	1.497439	ACYSTINE	%	:	0.379915	#ATH/DE_	GM/MJ	:	0.053066
CAL:AVPHOS	G/G	:	1.705796	AP+T	%	:	1.223339	ATYROSIN	%	:	0.549684
P:PHOS	%	:	0.203526	APHENYL	%	:	0.780067	LNAA	GM	:	15.172621
CAL:ENZAVP	G/G	:	1.846849	ALEUCINE	%	:	1.269275	#TRY/LNA	G/G	:	0.05583
LYSINE	%	:	1.264745	AHISTID	%	:	0.474842	BULKDENS	KG/HL	:	64.412045
ALYSINE	%	:	1.12065	AARGININ	%	:	0.989677	IONOPHORE	PPM	:	99.800399
METHION	%	:	0.385974	SALT	%	:	0.45273	W6 FA	%	:	0.0
M+C	%	:	0.758517	%LEGUMES	%	:	8.982036	W3 FA	%	:	0.0
THREO	%	:	0.847081	ABC	MEQ/KG	:	685.043246	W6:W3	G/G	:	0.0
ISOLEUC	%	:	0.708327	SODIUM	%	:	0.166067	SAT FA	%	:	0.0
TRYPTO	%	:	0.239239	POTASS	%	:	0.484383	MONO FA	%	:	0.0
CYSTINE	%	:	0.376337	CHLORIDE	%	:	0.305782	POLY FA	%	:	0.0
VALINE	%	:	1.048669	MAGNES	%	:	0.138852	PELL QUAL		:	6.947438
HISTIDIN	%	:	0.576744	NA+K_CL	MEQ/KG	:	110.664604	PRESS CAP		:	5.979707
LEUCINE	%	:	1.508252	CHOLINE	MG/KG	:	1249.376915	ABRASIV		:	3.021956
PHENYLAL	%	:	0.948599	LACTOSE	%	:	0.0	DURABIL	%	:	82.279607
ARGININE	%	:	1.177309	N:D:F:	%	:	10.159681				
TYROSINE	%	:	0.573598	LINOLEIC	%	:	0.934314				

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	74.833333	2245.0	213.275
300 CANOLA MEAL 36%	[X]	3.0	90.0	8.55
325 SOYABEANMEAL-48%	[X]	6.0	180.0	17.1
400 MEATMEAL	[X]	9.0	270.0	25.65
420 BLOODMEAL	[X]	3.1	93.0	8.835
500 WATER	[X]	1.0	30.0	2.85
502 NATUPHOS 5000	[X]	0.01	0.3	0.0285
503 PORZYME 9310	[X]	0.02	0.6	0.057
520 TALLOW-MIXER	[X]	1.166667	35.0	3.325
551 SALT BIN ADD	[X]	0.2	6.0	0.57
560 LIMESTONE	[X]	0.433333	13.0	1.235
600 LYSINE-HCL	[X]	0.326667	9.8	0.931
605 DL-METHIONINE	[X]	0.076667	2.3	0.2185
610 THREONINE	[X]	0.116667	3.5	0.3325
615 ISOLEUCINE H/A	[X]	0.06	1.8	0.171
650 ZINC OXIDE	[X]	0.266667	8.0	0.76
702 QAF WEANER PMX	[X]	0.08	2.4	0.228
770 ENDOX	[X]	0.01	0.3	0.0285
912 ELANCOBAN G	[X]	0.1	3.0	0.285
937 ACID LAC DRY	[X]	0.3	9.0	0.855
950 RED MICRO-GRITS	[X]	0.1	3.0	0.285
		100.2	3006.0	285.57

== QAF Meat Industries (4124) ==

: Single-Mix (FM) * Corowa * {8} AUGUST 2007 ALL DATA 13:26 21/08/07 0006 :

: 27-October-2006/643.5r (1) Plant=1 David :

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Formula basic data

Code	: 9924	Name	: 06N022 WEAN 2 SALMON OIL
Cost	: 310.906	Created	: 22/09/06 Version : 2006050056

Analysis

[VOLUME]	%	100.0	T:EAA	%	8.944182	A:D:F:	%	3.852459
[DRYMAT]	%	89.957385	#LYS/DE_	GM/MJ	0.089249	RUMIN:ME	MJ/KG	12.063707
DE_PIG	MJ/KG	14.170939	#ALY/DE_	GM/MJ	0.079081	LAYER:ME	KCALS/KG	2959.952169
NE4G	MJ/KG	10.165018	#MET/LYS	G/G	0.305179	COPPER	PPM	23.512472
#ALY/NE4G	GM/MJ	0.110246	#M+C/LYS	G/G	0.599739	COBALT	PPM	0.074684
DEENZYME	MJ/KG	14.332468	#THR/LYS	G/G	0.669764	MANGANES	PPM	53.600198
PROTEIN	%	21.27653	#ISO/LYS	G/G	0.560055	ZINC	PPM	2226.301133
FAT	%	3.795474	#TRY/LYS	G/G	0.18916	IRON	PPM	142.305389
STARCH	%	46.916999	#VAL/LYS	G/G	0.829155	#AME/ALY	G/G	0.306169
FIBRE	%	2.614271	AMETH	%	0.343108	#ACY/ALY	G/G	0.339013
ASH	%	4.926532	AM+C	%	0.657405	#AM+/ALY	G/G	0.586628
CALCIUM	%	0.854934	ATHREO	%	0.751993	#ATH/ALY	G/G	0.671033
T:PHOS	%	0.570931	AISOLEUC	%	0.599067	#AIS/ALY	G/G	0.534571
AV:PHOS	%	0.501194	ATRYPTO	%	0.178265	#ATR/ALY	G/G	0.159073
ENZAVPHOS	%	0.462915	AVALINE	%	0.85378	#AVA/ALY	G/G	0.761861
CAL:PHOS	G/G	1.497439	ACYSTINE	%	0.379915	#ATH/DE_	GM/MJ	0.053066
CAL:AVPHOS	G/G	1.705796	AP+T	%	1.223339	ATYROSIN	%	0.549684
P:PHOS	%	0.203526	APHENYL	%	0.780067	LNAA	GM	15.172621
CAL:ENZAVP	G/G	1.846849	ALEUCINE	%	1.269275	#TRY/LNA	G/G	0.05583
LYSINE	%	1.264745	AHISTID	%	0.474842	BULKDENS	KG/HL	64.412045
ALYSINE	%	1.12065	AARGININ	%	0.989677	IONOPHORE	PPM	99.800399
METHION	%	0.385974	SALT	%	0.45273	W6 FA	%	0.0
M+C	%	0.758517	%LEGUMES	%	8.982036	W3 FA	%	0.0
THREO	%	0.847081	ABC	MEQ/KG	685.043246	W6:W3	G/G	0.0
ISOLEUC	%	0.708327	SODIUM	%	0.166067	SAT FA	%	0.0
TRYPTO	%	0.239239	POTASS	%	0.484383	MONO FA	%	0.0
CYSTINE	%	0.376337	CHLORIDE	%	0.305782	POLY FA	%	0.0
VALINE	%	1.048669	MAGNES	%	0.138852	PELL QUAL		6.947438
HISTIDIN	%	0.576744	NA+K_CL	MEQ/KG	110.664604	PRESS CAP		5.979707
LEUCINE	%	1.508252	CHOLINE	MG/KG	1249.376915	ABRASIV		3.021956
PHENYLAL	%	0.948599	LACTOSE	%	0.0	DURABIL	%	82.279607
ARGININE	%	1.177309	N:D:F:	%	10.159681			
TYROSINE	%	0.573598	LINOLEIC	%	0.934314			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	74.833333	2245.0	213.275
300 CANOLA MEAL 36%	[X]	3.0	90.0	8.55
325 SOYABEANMEAL-48%	[X]	6.0	180.0	17.1
400 MEATMEAL	[X]	9.0	270.0	25.65
420 BLOODMEAL	[X]	3.1	93.0	8.835
500 WATER	[X]	1.0	30.0	2.85
502 NATUPHOS 5000	[X]	0.01	0.3	0.0285
503 PORZYME 9310	[X]	0.02	0.6	0.057
518 SALMATE	[X]	0.3	9.0	0.855
520 TALLOW-MIXER	[X]	0.866667	26.0	2.47
551 SALT BIN ADD	[X]	0.2	6.0	0.57
560 LIMESTONE	[X]	0.433333	13.0	1.235
600 LYSINE-HCL	[X]	0.326667	9.8	0.931
605 DL-METHIONINE	[X]	0.076667	2.3	0.2185
610 THREONINE	[X]	0.116667	3.5	0.3325
615 ISOLEUCINE H/A	[X]	0.06	1.8	0.171
650 ZINC OXIDE	[X]	0.266667	8.0	0.76
702 QAF WEANER PMX	[X]	0.08	2.4	0.228
770 ENDOX	[X]	0.01	0.3	0.0285
912 ELANCOBAN G	[X]	0.1	3.0	0.285
937 ACID LAC DRY	[X]	0.3	9.0	0.855
951 BLUE MICRO-GRITS	[X]	0.1	3.0	0.285
		100.2	3006.0	285.57

References

J. A. Rooke, A. G. S., S. A. Edwards (2001). "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." British Journal of Nutrition 86(1): 21-30.