The effect of dietary fat level on growth rate and efficiency of finisher pigs

2B 101

Pork CRC Project Report

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Summary

Supplemental dietary fat is commonly added to the diets of young pigs to increase energy intake and maximise protein deposition rates. Historically, additional fat has not been included in the diets of older animals due to their propensity to deposit excess energy as fat. In these older (heavier) animals, and in castrates and pigs of poorer genotypes, the relationship between energy intake and protein deposition is linear plateau (Campbell and Taverner 1988a), with maximum protein deposition rates achieved within the limit of feed intake. The selection for leaner, improved genotypes has however resulted in the plateau occurring at higher feed intakes for some animals, or in other cases not at all up to commercial slaughter weights (Dunshea *et al.* 1998; King *et al.* 2004; Rao and McCracken 1992). The use of supplemental fat in finisher diets to increase energy intakes and therefore protein deposition provides Australian producers with an opportunity to improve production efficiencies. There is evidence to suggest that the addition of dietary fat to finisher diets has production benefits above that expected by the increase in energy content alone (Campbell 2005). Further research is however required to confirm this effect under commercial conditions and evaluate the economic impacts of feeding high fat diets to finisher pigs under Australian conditions.

A total of 1296 pigs (Large white x Landrace) were selected at 16 weeks of age at an average weight of 64.0 kg and allocated to a 2 x 6 factorial experiment with the respective factors being sex (entire male and female) and supplemental dietary fat concentration (1 %, 2 %, 3 %, 4 %, 5 % and 6 % added tallow). All pigs were offered the respective diets *ad libitum* from 16 weeks of age through to slaughter at 21 weeks of age. During the initial 14 days, daily gain increased linearly with increasing fat concentration of the diet (P=0.002) as did feed efficiency (P<0.001) with feed intake unaffected by dietary fat concentration. These improvements in daily gain were not maintained during the subsequent 3 weeks, primarily due to a linear reduction in feed intake (P<0.001) of the pigs offered the high fat diets.

Feed efficiency was however still improved with increasing dietary fat concentration. Carcass weight increased linearly (*P*=0.009) with increasing fat concentration as did dressing percentage (*P*=0.009), although there was also an increase in P2 back fat depth (*P*<0.001). Between QAF's target carcass weight of 68 – 72 kg, there were only 15 out of 225 pigs (6.7 %) that had a P2 measurement of 12 mm or greater. The results of this investigation suggest that growth performance and economic returns may be maximised by offering diets containing 3-6 % dietary fat during the finisher period, improving returns by up to $4.17 per pig.

Animal Welfare considerations

A total of 14 pigs died or were removed from this experiment, with the deaths and removals spread across all treatment groups. The breakdown of the number of deaths/removals and their causes are displayed in Table 1.

Table 1. Impact of increasing supplemental fat concentration in finisher diets on mortality and cause of death

	Supplemental fat concentration					
Cause of death	1 %	2 %	3 %	4 %	5 %	6 %
APP	1				1	
Unthrifty	1		1			
Sudden death		1	2	2	2	1
Twisted bowel		1				
Lame	1					

Introduction

In young animals, the relationship between energy intake and protein deposition is linear, with the maximum potential for protein deposition limited by gut capacity. As such, supplemental fat is commonly added to the diets of young pigs to increase the energy density of the diet and hence maximise protein deposition. In older animals, the relationship between energy intake and rate of protein deposition is generally considered linear plateau, such that at high energy intakes the potential for protein deposition may be exceeded and the excess energy is deposited as fat. This relationship is however dependent on the sex, age, genotype and environment of the animal, with recent investigations suggesting that current genotypes have a high capacity for lean tissue growth and that protein deposition rates may continue to increase linearly with increasing energy intakes up to at least 120 kg live weight (King *et al.* 2004). As such, increasing the energy intake of these pigs provides a means of achieving higher slaughter weights within a specified time period or alternatively achieving an ideal weight faster and more efficiently.

The addition of supplemental fat, sourced primarily as tallow in Australia, increases the energy content of the diet and if intake is not reduced increases the pigs total energy intake. Supplemental fat may however have more value in diets for grower and finisher pigs than simply its energy value. Campbell (2005) demonstrated that supplementing corn/ soy diets with fat increased the energy content of the diet by 6.2 %, while efficiency was increased by 12.6 % indicative of its effective energy metabolism. These authors suggest that older pigs may be more responsive to supplemental fat than younger animals, although the mechanisms for this response are not fully understood. More recently, the inclusion of supplemental fat in finisher diets has been shown to increase growth rates, and importantly increase carcass weight without any impact on carcass P2 once the effect of carcass weight is taken into account (Brooke *et al.* 2007). Further research is required to confirm this effect under commercial conditions and evaluate the economic impacts of feeding high fat diets to finisher pigs under Australian conditions.

Project Implications

Increasing the dietary fat content will increase the energy content and the cost of the finisher diet, but feed efficiency may be improved beyond that of the incremental increase in energy content and hence reduce the costs of production

Project Hypotheses

The addition of supplemental fat to finisher diets has nutritional benefits other than the increase in energy density of the diet.

Materials and Methods

Animals and treatments

A total of 1296 pigs (Large white x Landrace) were selected at 16 weeks of age (average 115 days of age) at an average weight of 64.0 kg ± 0.21 kg (mean ± s.e) and allocated to a 2 x 6 factorial experiment with the respective factors being sex (entire male and female) and supplemental dietary fat concentration (1 %, 2 %, 3 %, 4 %, 5 % and 6 % added tallow). Pigs were selected over a twelve week period (54 entire males and 54 females selected per week, starting 3rd October 2006) and housed in group pens of 9 pigs per pen (0.75 m^2/pig). Within week, pens were randomly allocated to dietary treatment. The dietary compositions of the six experimental diets are displayed in Table 2. All other nutrient concentrations remained constant across treatment groups, with the diets formulated to contain 0.53 g of available lysine per MJ digestible energy (DE). All pigs were offered the respective diets *ad libitum* from 16 weeks of age through to slaughter at 21 weeks of age. Experimental diets were pelleted and fed via self feeders. All animals had *ad libitum* access to water via nipple drinkers for the entire experimental period.

Management and measures

Pen weights were recorded at the beginning of the experimental period (day 0) and again at day 14, day 28 and day 35 (prior to slaughter). Pen feed intakes were also recorded over these time periods as measured by feed disappearance and feed conversion efficiency subsequently calculated. All deaths and removals were recorded and taken into account when calculating feed intake and feed efficiency by the adjustment of the number of days that pigs were on trial. Pigs were slaughtered in a commercial abattoir at the conclusion of the 35 day experimental period and hot standard carcass weight (HSCW) and fat depth at the P2 site (65mm from the midline, measured using a Hennessy grading probe) were measured, with dressing percentage calculated from live weight and carcass weight on a pen basis.

A sub-sample of 60 pigs were selected for blood sampling (via jugular venipuncture) for analyses of plasma insulin and glucose concentrations. Five pigs per pen from one replicate (week) were randomly selected and bled prior to the start of the experimental period and again 2 days before the conclusion of the experiment. Plasma samples were collected in EDTA from these pigs following a 12 hour fast and again 24 hours later when in a fed state. Adipose and muscle tissue samples were also obtained at slaughter from these selected animals and immediately frozen for later analyses if required

Statistical analyses

Data were subjected to an analysis of variance for a completely randomized design with the main effects being sex and dietary fat concentration. Replicate was included in the analyses to account for the blocking factor. The responses to increasing dietary fat were tested for linear and quadratic effects using the polynomial function in GenStat for Windows, Version 10. The experimental unit for all analyses was the pen of 9 pigs.

Table 2. Ingredient composition and analysed nutrient profile of each of the experimental finisher diets, % of diet (as fed basis).

	Supplemental dietary fat (%)					
Ingredient, %	1	2	3	4	5	6
Wheat	62.61	57.80	53.03	48.30	43.46	38.69
Barley	20.00	21.40	22.8	24.2	25.60	27.00
Millmix	2.80	4.63	6.47	8.30	10.17	12.00
Canola meal	5.77	6.23	6.70	7.17	7.67	8.13
Soyabean meal	3.90	3.97	4.03	4.10	4.17	4.23
Water	1.00	1.00	1.00	1.00	1.00	1.00
Natuphos 5000	0.01	0.01	0.01	0.01	0.01	0.01
Porzyme 9310	0.02	0.02	0.02	0.02	0.02	0.02
Tallow	1.00	2.00	3.00	4.00	5.00	6.00
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Limestone	1.63	1.67	1.70	1.67	1.70	1.70
Dicalcium phosphate	0.50	0.50	0.47	0.47	0.43	0.43
Lysine HCL	0.30	0.30	0.30	0.30	0.30	0.30
Dl-methionine	0.01	0.01	0.01	0.02	0.02	0.02
Threonine	0.08	0.09	0.09	0.09	0.09	0.10
Copper premix	0.10	0.10	0.10	0.10	0.10	0.10
QAF finisher premix	0.07	0.07	0.07	0.07	0.07	0.07
Elancoban G	0.10	0.10	0.10	0.10	0.10	0.10
*Estimated nutrient composition, %**						
DE, MJ/kg	13.58	13.69	13.81	13.94	14.05	14.17
Crude protein	14.22	14.28	14.34	14.41	14.48	14.54
Crude fat	2.92	3.93	4.93	5.94	6.95	7.95
Crude fibre	3.76	3.94	4.12	4.31	4.49	4.68
Total Lysine	0.76	0.78	0.79	0.80	0.82	0.83
Available lysine	0.71	0.72	0.73	0.73	0.74	0.74
Available lysine: DE ratio g/MJ DE	0.53	0.53	0.53	0.53	0.53	0.53
Methionine	0.23	0.23	0.24	0.24	0.25	0.25
Threonine	0.54	0.54	0.55	0.56	0.57	0.58
Tryptophan	0.18	0.18	0.18	0.18	0.19	0.19
Measured nutrient composition, %						
Moisture	12.8	12.4	11.8	11.8	11.5	11.6
Crude protein	13.8	13.4	13.7	14.1	14.2	14.0
Crude fat	3.1	4.0	5.0	5.6	6.6	7.1

* Estimated from composition of ingredients (SCA 1987)

Results

Growth performance

The effect of supplemental dietary fat on finisher growth performance over the initial 14 days of the experimental period is displayed in Table 3. Daily gain increased linearly with increasing fat concentration of the finisher diet (*P*=0.002). In contrast, feed intake was unaffected by dietary treatment, resulting in a linear improvement in feed efficiency during this initial feeding period ($P<0.001$) with increasing fat concentration. Figure 1 displays the growth response to increasing dietary fat during the initial 14 days of the finisher period. The male pigs were heavier than the females at the start of the experimental period (65.4 and 62.6 kg respectively $P<0.001$) and maintained this weight difference to day 14 (78.4 and 75.0 kg respectively, $P<0.001$).

The improvement in daily gain observed during the initial growth period with increasing supplemental dietary fat was not maintained during the subsequent 3 weeks (Table 4, Figure 2). This was primarily due to a linear reduction in feed intake ($P<0.001$) during this time of the pigs offered the high fat diets. Feed efficiency was however still improved with increasing dietary fat concentration. The breakdown of the growth performance from 14 to 28 days and 28 to 35 days are displayed in Table 5. Similar reductions in feed intake and growth rates were observed during both of these time periods, indicating that the reduction in growth performance was not solely during the final week of the investigation. The males continued to gain weight faster (1012 and 900 g/d respectively for the male and female pigs, $P<0.001$) and were more feed efficient (FCR: 2.48 and 2.73 respectively, $P<0.001$) than the females during this final growth period.

The effects of increasing dietary fat on growth performance over the entire finisher period are displayed in Table 6. Over the five week experimental period, feed intake reduced linearly with increasing supplemental fat in the diet (*P*=0.009). However, there was still a tendency for growth rates to improve linearly with increasing fat content (*P*=0.063), while feed efficiency was also improved

(*P*<0.001). Despite this, there were no treatment effects on live weight at the end of the finisher period (day 35, *P*=0.253). Carcass weights did however differ due to dietary treatment, with a linear increase in carcass weight (*P*=0.009) and dressing percentage (P=0.009) with increasing fat concentration of the finisher diet (Table 7). Back fat depth at the P2 site increased with increasing dietary fat concentration, regardless of whether carcass weight was included as a covariant in the analyses or not. Furthermore, the percentage of animals with a P2 measurement greater than 12 mm also increased with increasing fat concentration in the diet. Between QAF's target carcass weight of 68 – 72 kg, there were only 15 out of 225 pigs (6.7 %) that had a P2 measurement of 12mm or greater.

Table 3. Effect of supplemental fat concentration in finisher diets on growth performance from 0 to 14 days (16 to 18 weeks of age).

	Fat (%)	Start weight (kg)	Weight day 14 (kg)	Daily gain (g/day)	Feed intake (kg/d)	Feed:gain
Males	1	65.3	77.3	858	2.16	2.55
	2	65.2	78.4	938	2.17	2.33
	3	65.4	78.7	941	2.26	2.43
	4	65.4	77.9	885	2.17	2.47
	5	65.5	78.6	933	2.18	2.36
	6	65.3	79.1	976	2.16	2.23
Females	1	62.6	74.3	830	2.11	2.60
	2	62.6	74.8	865	2.13	2.51
	3	62.6	75.0	877	2.20	2.52
	4	62.6	75.2	892	2.23	2.52
	5	62.6	75.5	912	2.16	2.39
	6	62.6	75.4	908	2.18	2.42
SED[a]		0.29	0.61	28.0	0.048	0.060
SED[b]		0.23	0.35	16.2	0.028	0.034
				Significance		
Fat		0.999	0.246	0.018	0.411	0.001
Sex		<0.001	<0.001	0.012	0.579	0.004
Fat*Sex		0.999	0.947	0.660	0.795	0.642
Linear		0.777	0.024	0.002	0.410	<0.001
Quadratic		0.796	0.623	0.642	0.102	0.657

[a]Standard error of the difference for the effect of treatment

[b]Standard error of the difference for the effect of sex

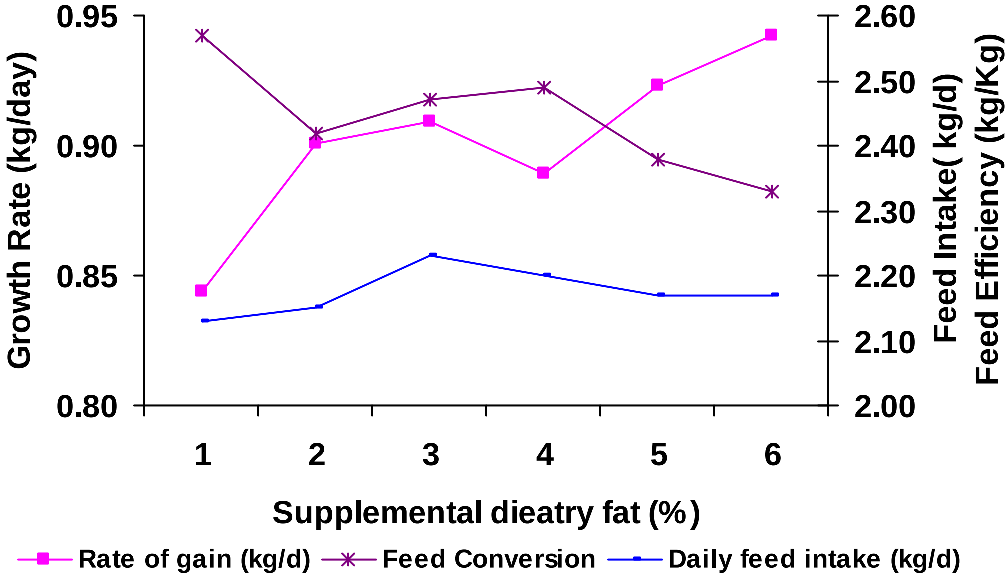

Figure 1: Growth performance of finisher pigs during the first 14 days of pigs fed graded levels of supplemental fat in the diet

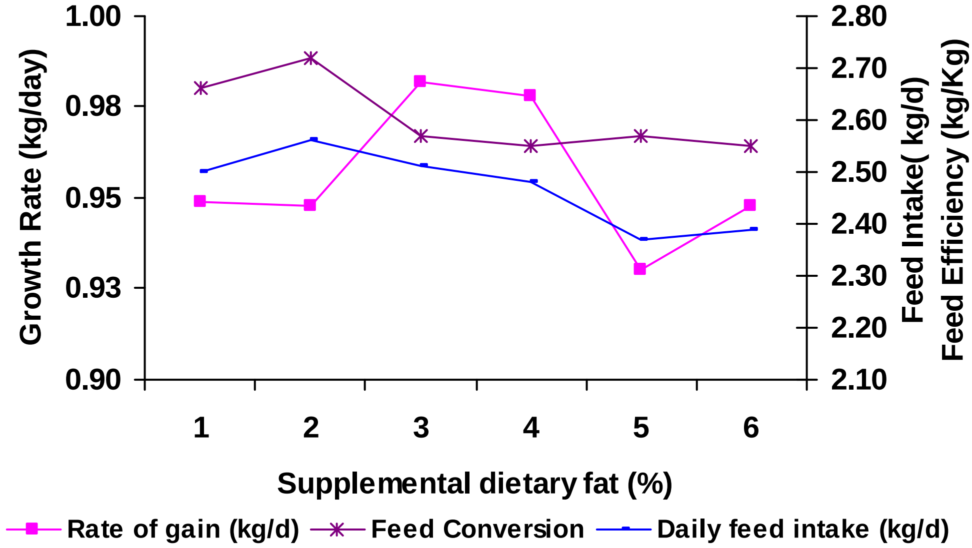

Figure 2: Growth performance of pigs fed graded levels of supplemental dietary fat during the final 21 days of the finisher period

Table 4. Effect of supplemental fat concentration in finisher diets on growth performance from 14 to 35 days (18 to 21 weeks of age).

	Fat (%)	Weight day 14 (kg)	Weight day 35 (kg)	Daily gain (g/day)	Feed intake (kg/d)	Feed:gain
Males	1	77.3	97.3	987	2.52	2.57
	2	78.4	98.9	1014	2.62	2.58
	3	78.7	99.8	1043	2.56	2.46
	4	77.9	98.8	1030	2.48	2.41
	5	78.6	98.5	980	2.41	2.48
	6	79.1	99.7	1015	2.40	2.37
Females	1	74.3	92.7	911	2.48	2.76
	2	74.8	92.6	882	2.51	2.85
	3	75.0	93.6	921	2.46	2.68
	4	75.2	93.9	926	2.49	2.70
	5	75.5	93.3	881	2.32	2.67
	6	75.4	93.2	881	2.37	2.72
SED[a]		0.61	0.75	23.0	0.045	0.056
SED[b]		0.35	0.43	13.3	0.026	0.032
				Significance		
Fat		0.246	0.253	0.188	<0.001	0.011
Sex		<0.001	<0.001	<0.001	0.023	<0.001
Fat*Sex		0.947	0.684	0.785	0.775	0.687
Linear		0.024	0.108	0.642	<0.001	0.002
Quadratic		0.623	0.165	0.118	0.103	0.481

[a]Standard error of the difference for the effect of treatment
[b]Standard error of the difference for the effect of sex

Table 5. Effect of supplemental fat concentration in finisher diets on growth performance from 14 to 28 days and 28 to 35 days.

		Daily gain (g/day)		Feed intake (kg/d)		Feed: Gain	
	Fat (%)	14 to 28 days	28 to 35 days	14 to 28 days	28 to 35 days	14 to 28 days	28 to 35 days
Males	1	980	1005	2.50	2.56	2.57	2.68
	2	1032	978	2.58	2.70	2.51	2.83
	3	1034	1076	2.53	2.63	2.47	2.53
	4	1034	1032	2.46	2.54	2.39	2.50
	5	994	949	2.38	2.47	2.41	2.74
	6	1030	980	2.38	2.46	2.32	2.53
Females	1	889	967	2.44	2.56	2.78	2.84
	2	850	964	2.47	2.57	2.94	2.75
	3	907	955	2.41	2.59	2.67	2.75
	4	911	958	2.45	2.58	2.70	2.75
	5	882	876	2.33	2.32	2.67	2.71
	6	889	861	2.34	2.44	2.67	2.90
SED[a]		22.9	48.9	0.049	0.057	0.065	0.126
SED[b]		13.2	28.2	0.028	0.033	0.037	0.073
				Significance			
Fat		0.370	0.211	0.003	<0.001	0.004	0.762
Sex		<0.001	0.011	0.021	0.126	<0.001	0.046
Fat*Sex		0.487	0.864	0.856	0.513	0.409	0.457
Linear		0.402	0.073	<0.001	<0.001	<0.001	0.578
Quadratic		0.219	0.217	0.179	0.092	0.741	0.328

[a]Standard error of the difference for the effect of treatment
[b]Standard error of the difference for the effect of sex

Table 6. Effect of supplemental fat concentration in finisher diets on growth performance from 0 to 35 days (16 to 21 weeks of age).

	Fat (%)	Start weight day 0 (kg)	Weight day 35 (kg)	Daily gain (g/day)	Feed intake (kg/d)	Feed:gain
Males	1	65.3	97.3	933	2.37	2.55
	2	65.2	98.9	998	2.43	2.48
	3	65.4	99.8	1001	2.44	2.43
	4	65.4	98.8	971	2.35	2.42
	5	65.5	98.5	961	2.31	2.41
	6	65.3	99.7	999	2.30	2.31
Females	1	62.6	92.7	877	2.32	2.65
	2	62.6	92.6	875	2.35	2.69
	3	62.6	93.6	902	2.35	2.61
	4	62.6	93.9	912	2.38	2.61
	5	62.6	93.3	894	2.26	2.53
	6	62.6	93.2	892	2.29	2.58
SED[a]		0.29	0.75	16.9	0.037	0.032
SED[b]		0.23	0.43	9.7	0.021	0.018
				Significance		
Fat		0.999	0.253	0.090	0.011	<0.001
Sex		<0.001	<0.001	<0.001	0.051	<0.001
Fat*Sex		0.999	0.684	0.387	0.623	0.087
Linear		0.777	0.108	0.063	0.009	<0.001
Quadratic		0.796	0.165	0.116	0.042	0.936

[a]Standard error of the difference for the effect of treatment
[b]Standard error of the difference for the effect of sex

Table 7. The effects of dietary fat concentration in finisher diets on carcass parameters

	Fat (%)	HSCW (kg)	Carcass P2 (mm)	Carcass P2 (mm)**	% pigs with carcass P2 above 12 mm	Dressing %
Males	1	74.9	8.68	8.70	5.56	77.03
	2	76.9	9.15	8.95	10.19	77.74
	3	77	9.23	9.01	13.22	77.13
	4	75.9	9.28	9.20	11.34	76.82
	5	76.4	9.12	8.97	7.52	77.57
	6	77.3	9.31	9.06	14.86	77.58
Females	1	73.4	8.66	8.87	7.52	79.07
	2	72.8	8.43	8.70	3.70	78.49
	3	73.7	9.03	9.20	14.77	78.75
	4	74.8	9.47	9.50	19.68	79.61
	5	74.4	9.23	9.31	13.72	79.72
	6	74.3	9.26	9.35	17.59	79.73
SED[a]		0.64	0.196	0.183	5.68	0.313
SED[b]		0.37	0.113	0.124	3.27	0.181
				Significance		
Fat		0.144	0.002	0.013	0.001	0.091
Sex		<0.001	0.310	0.115	0.153	<0.001
Fat*Sex		0.155	0.235	0.632	0.172	0.041
Linear		0.009	<0.001	0.002	<0.001	0.009
Quadratic		0.434	0.082	0.113	0.245	0.286

[a]Standard error of the difference for the effect of treatment
[b]Standard error of the difference for the effect of sex
** HSCW used as covariate in analysis

Discussion

Supplemental dietary fat is commonly added to the diets of young pigs to increase energy intake and maximise protein deposition rates. Historically, additional fat has not been included in the diets of older animals due to their propensity to deposit excess energy as adipose tissue. In these older (heavier) animals, and in castrates and pigs of poorer genotypes, the relationship between energy intake and protein deposition is linear plateau (Campbell and Taverner 1988a), with maximum protein deposition rates achieved within the limit of feed intake. The selection for leaner, improved genotypes has however resulted in the plateau occurring at higher feed intakes for some animals, or in other cases not at all with protein deposition rates increasing linearly with energy intake up to commercial slaughter weights (Dunshea *et al.* 1998; King *et al.* 2004; Rao and McCracken 1992). Investigations by King *et al.* (2004) indicated that current genotypes may not have an intrinsic limit to protein deposition up to 120 kg live weight with protein deposition rates increasing with increasing energy intakes during this time.

The use of supplemental fat in finisher diets to increase energy intake and therefore protein deposition rates is increasing in popularity, particularly in the USA, and provides Australian producers with an opportunity to improve production efficiencies. There is evidence to suggest that the addition of dietary fat to finisher diets has benefits in terms of growth performance and feed efficiency above that expected by the increase in energy content alone (Campbell 2005). Adding 5 % fat to corn/ soy diets has been shown to increase growth rates of castrated male pigs (initial weight 91 kg) by 10.2 % and improve feed efficiency by 11.2 % despite only increasing digestible energy content by 6.2 % (Campbell 2005). It is unclear however, whether the improved growth response is simply due to the increase in digestible energy component of the diet, or whether it is the inclusion of fat per se that has benefits beyond that of the increased energy. Campbell (2005) suggesting that possible explanations for the improved efficiency may include the ability of the finisher pig to utilise fat more efficiently for lipogenesis compared to carbohydrate sources, a possible effect of fat on the rate of dietary passage and nutrient availability, or simply a reduction in dust and bacterial particles in the air through the incorporation of fat in the diet and hence a reduction in the production of pro-inflammatory cytokines in the pig. The daily energy intakes of each of the experimental diets in this investigation are displayed in Table 8, as are daily lysine intakes. Although dietary DE increased in the experimental diets with increasing fat concentration, daily energy intakes were relatively similar due to the reduction in feed intake at the higher fat concentrations. However, there did appear to be a slight increase in total lysine intake with increasing fat in the diet, and as such this cannot be ruled out as contributing to the improved growth performance. The QAF genotype is known to maximise protein deposition at an energy intake of approximately 38 MJ DE per day. The finishers in this investigation were only consuming approximately 32 MJ DE/d, inside the potential for protein deposition. As this investigation began in October, the results may differ if undertaken when feed intakes are higher, such as during winter or in a higher health status herd. This may also change the profitability of the feeding strategy in terms of the number of animals with a P2 greater than 12 mm.

Table 8. Effect of dietary treatment on daily digestible energy and lysine intakes

Supplemental dietary fat (%)	1	2	3	4	5	6
DE, MJ/kg diet	13.58	13.69	13.81	13.94	14.05	14.17
Total dietary lysine (%)	0.76	0.78	0.79	0.8	0.82	0.83
Daily intake (kg/d)	2.300	2.339	2.349	2.326	2.262	2.265
Total energy intake (MJ DE/d)	31.23	32.02	32.44	32.42	31.78	32.10
Total lysine intake (g/d)	17.48	18.24	18.56	18.61	18.55	18.80

Growth performance in this current investigation suggests that the feeding of high fat diets has the greatest impact during the initial 14 days of feeding. During this time there was a substantial increase in growth performance and an improvement in feed efficiency with the higher concentrations of dietary fat. These outcomes were primarily the result of increasing energy intake as feed intake was not influenced by dietary treatments. Similar observations have been reported in other studies, with the feeding of 5 % choice white grease or beef tallow to finisher pigs (59 – 111 kg) reported to improve feed efficiency, particularly during the initial 14 days of feeding, with the response reduced during weeks 2 – 6 (Weber *et al.* 2006). Interestingly though, these authors did observe an improvement again in feed efficiency during the final 14 days of the experimental period (weeks 6 to 8). In this current investigation, the benefits associated with feeding the higher concentrations of supplemental fat diminished with time, to the extent that feeding above 3 – 4 % supplemental fat during the final three weeks of the finisher period had a detrimental impact on growth performance. This outcome was primarily the result of pigs offered the high fat diets reducing feed intake during the later part of the experiment. The reduction in feed intake of pigs offered the high fat diets may be associated with a reduction in pellet quality, with pellet durability reducing from 95.2 % (1 % added fat), to 77.3 % (6 % added fat). The reduction in growth performance with the continued feeding of diets containing supplemental fat has also been reported by Brooke *et al.* (2007). In this investigation, the growth performance benefits of feeding high fat finisher diets were reduced when the pigs were also offered grower diets containing supplemental fat during the preceding five weeks. Importantly though, offering supplemental fat during the grower period and then removing it in the finisher period had a more pronounced negative effect on carcass weight than if supplemental fat had remained in the diet. This suggests that if supplemental fat is included in the diets of younger pigs it should remain in their diets through to slaughter weights. Campbell (2005) suggests that this is due to the effect supplemental fat has on feed intake, with pigs offered high fat diets often reducing feed intake to some degree. If these animals are subsequently offered diets lower in energy they may continue to consume the same amount of feed during the latter period, thereby reducing energy intake and growth performance, with the carryover effects of supplemental fat on energy metabolism lasting for up to seven weeks (Campbell 2005).

As anticipated, carcass weight was increased with increasing dietary fat in the current investigation, as was carcass back fat measured at the P2 site and the percentage of animals displaying a P2 above 12 mm. Similar observations have been observed by other researchers, with Weber *et al.* (2006) reporting that the addition of 5 % fat to pig diets from 58 to 111 kg resulted in an increase in carcass weight, loin eye area and back fat depth at the 10th rib and last rib, while dressing percentage and lean percentage were unaffected. Campbell (2005) suggests that the addition of fat to finisher diets in the USA has little impact on carcass fat given the lean genotypes used in this country, but rather that the increase in dietary fat actually increases loin depth and the percentage of lean tissue at slaughter. The use of intact males in Australia proves an opportunity to utilise high fat diets while minimising the propensity of the pigs to deposit excess back fat. In addition, there may be an opportunity to utilise other technologies such as pST in conjunction with high fat diets in order to minimise any price penalties for increased back fat and enable the full benefits from the increased carcass weight to be realised for Australian producers.

Economic analysis

Increasing the supplemental fat concentration in finisher diets from 1 % to 6 % increases the cost of the diet by approximately $6.70 per tonne based on 2006 feed prices. This increase in the cost of the diet is however offset by the reduced feed intake required to achieve similar or greater live weight gain (Tables 9 and 10). Under these circumstances, increasing the supplemental fat inclusion rates from 1 % to 5 or 6 % in commercial finisher diets can achieve reductions in the costs of production and increase the net return per pig by $4.17 (6 % inclusion) for the males and $1.47 (5 % inclusion) for the females. Brooke (2007) suggests that the most economic strategy for maximum growth performance in terms of dietary energy might be to refrain from supplementing grower diets with additional fat (30 to 60 kg live weight) and including 4 % dietary fat in the finisher period. These results together with those from the current investigation indicate that growth performance and economic returns may be maximised by offering diets without supplemental fat in the grower period followed by finisher diets containing dietary fat between 3 and 6 %.

Table 9. Cost Analysis of increasing supplemental dietary fat concentration for male finisher pigs over a 35 day period.

Supplemental dietary fat (%)	1	2	3	4	5	6
ADI (kg/d)	2.37	2.43	2.44	2.35	2.31	2.3
Feed costs ($/t)	316.43	317.73	318.96	320.43	321.75	323.12
Total feed intake (kg)	82.95	85.05	85.4	82.25	80.85	80.5
Feed costs ($/pig)	26.25	27.02	27.24	26.36	26.01	26.01
Live weight in (kg)	65.3	65.2	65.4	65.4	65.5	65.3
Live weight final (kg)	97.27	98.94	99.82	98.77	98.5	99.65
Live weight gain (kg)	31.97	33.74	34.42	33.37	33.00	34.35
Cost/kg gain ($/kg)	0.821	0.801	0.791	0.790	0.788	0.757
Cost saving (cents/kg)		2.00	2.96	3.12	3.27	6.38
Carcass weight	74.9	76.9	77.0	75.9	76.4	77.3
Return on carcass weight ($2.40/kg)	179.76	184.56	184.8	182.16	183.36	185.52
% pigs above 12mm back fat	5.56	10.19	13.22	11.34	7.52	14.86
Discount for P2	1.04	1.96	2.54	2.15	1.43	2.87
Income per pig	178.72	182.60	182.26	180.01	181.92	182.65
Net return	152.47	155.58	155.02	153.65	155.91	156.64

Table 10. Cost Analysis of increasing supplemental dietary fat concentration for female finisher pigs over a 35 day period.

Supplemental dietary fat (%)	1	2	3	4	5	6
ADI (kg/d)	2.32	2.35	2.35	2.38	2.26	2.29
Feed costs ($/t)	316.43	317.73	318.96	320.43	321.75	323.12
Total feed intake (kg)	81.2	82.25	82.25	83.3	79.1	80.15
Feed costs ($/pig)	25.69	26.13	26.23	26.69	25.45	25.90
Live weight in (kg)	62.6	62.6	62.6	62.6	62.6	62.6
Live weight final (kg)	92.74	92.64	93.6	93.94	93.31	93.22
Live weight gain (kg)	30.14	30.04	31	31.34	30.71	30.62
Cost/kg gain($/kg)	0.852	0.870	0.846	0.852	0.829	0.846
Cost saving (cents/kg)		-1.754	0.622	0.081	2.376	0.670
Carcass weight	73.4	72.8	73.7	74.8	74.4	74.3
Return on carcass weight ($2.40/kg)	176.16	174.72	176.88	179.52	178.56	178.32
% pigs above 12mm back fat	7.52	3.70	14.77	19.68	13.72	17.59
Discount for P2	1.38	0.67	2.72	3.68	2.55	3.27
Income per pig	174.78	174.05	174.16	175.84	176.01	175.05
Net return	149.09	147.91	147.92	149.15	150.56	149.15

Implications

The improvements in growth performance with increasing fat concentrations of the finisher diet provide an opportunity for producers in Australia to reduce their costs of production by either producing pigs to greater carcass weights or reducing the time and costs to produce pigs to a specific market weight. The economic benefits of increasing dietary fat concentration are greater in males than females, with females incurring a greater price penalty for the percentage of pigs above 12 mm back fat. Further research is required to determine the mechanisms responsible for the enhanced performance observed by incorporating fat into finisher diets, and is the subject of a further CRC project being undertaken by Gabby Brooke.

There may also be the opportunity to increase growth performance and efficiency of finisher pigs through the combined effects of high neutral detergent fibre (NDF) and fat in finisher diets. The use of mill mix in finisher diets to increase the concentration of NDF has been shown to improve feed conversion and increase growth rate (particularly during the initial 14 days of feeding) (A. Philpotts, unpublished). This increase in growth performance followed through as a numerical increase in live weight at the end of the experimental period and produced a carcass of similar weight but reduced back fat (measured at the P2 site) compared to the control animals. It is possible that the combined benefits of including high NDF and high fat concentrations in finisher diets may be greater than the benefits of either of these nutrients on their own. Further research is required in this area to determine the economic benefits of such a feeding strategy during the finisher period.

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APPENDICES

(APPROVED 21.03.06)

PROTOCOL 06N021 **SCOTT JOHNSTON** April 2, 2009

Effect of Dietary Fat Level on Growth Rate and Efficiency of Finisher Pigs

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Pork CRC Project 2B-101-0506: Experiment 1

Introduction

Sourced primarily as tallow, fat is a commonly used material in Australian pigs diets. It is used primarily in least cost formulations due to its energy density and cost. Increasing the fat content of a diet increases the energy density of the feed and if feed intake is not substantially reduced, overall energy intake is increased. Therefore, given the capacity of the genotype, undesirable carcass characteristics are unlikely to occur. It is thought that fat has more value than simply it's energy content, as demonstrated by Campbell (2005). Supplementing corn soy diets with fat increased the energy content of the diet by 6.2% while efficiency of was increased by 12.6%, which is indicated of its effective energy metabolism. This was also demonstrated by Murphy et al. (2005) in weaner pigs, where the growth rate and feed conversion efficiency was improved, by 12% and 8%, with the addition of fat to isoenergetic diets.

This project will attempt to evaluate the effect of varying levels of dietary fat on the endocrinology and physical performance of finisher pigs.

Project Implications

Increasing the fat content of the diet will increase the energy content and the cost, however feed efficiency may be improved beyond that of the incremental increase in energy content.

Project Hypotheses

Fat has nutritional properties other than their chemical composition and digestible energy that enhance growth performance and efficiency in progeny.

Materials and Methods

Design:	2 x 6 Sex (male/female) and fat (1%,2%, 3%,4%, 5%,6% added to the diet) as factors.
Site:	Commercial Finisher
Animals Required:	1188 pigs (99 male and 99 female per treatment) at average 60kg (±2.5 kg) live weight 2 pens of 9 pigs (108) per treatment per week for 11 weeks
Age:	16 weeks
Treatments:	Assigned as per level of added dietary fat in the form of tallow A. Phase 1 finisher plus 1% tallow B. Phase 1 finisher plus 2% tallow C. Phase 1 finisher plus 3% tallow D. Phase 1 finisher plus 4% tallow E. Phase 1 finisher plus 5% tallow F. Phase 1 finisher plus 6% tallow
Start Date:	16/5/06
Duration:	6 weeks (42 days) feeding period 11 weeks of replication
Feed Required:	20 tonnes per treatment All feed to be formulated at 0.52 g of available lysine/MJ and 15% NDF All feeds to contain a coloured microgrit marker

Laboratory Analyses: (To include all analyses required by Mill Laboratory)	
Medication:	As per script 1kg/tonne Elancoban Water medications as per QI 128

Measurements:	o Start weights and weights at 14 day intervals (0,14,28,42 days) o Average daily intake o Feed conversion o Deaths, removals and reason for death or removal o Final pen live weight o Carcass weight o HC grading P2 o Eye muscle depth o *4x Blood samples will be required for insulin sensitivity/glucose tolerance test.* *Blood samples taken as per SOP 036 Blood sampling collection* A total of 60 pigs (5 pigs per pen) from one week of production, will be subject to the following procedure twice. The first occasion will be one week prior to the start of the experiment and the second will be 2 days before the conclusion of the experiment. Pigs will need to be fasted for 12 hours and then a blood sample will be taken from each of the selected pigs at the end of the fasted period. Immediately following the first blood sample, the pigs will be returned to feed with unrestricted access. 24 hours after being returned to feed another blood sample will be taken. The blood samples should be collected in EDTA in case other analyses on the plasma are required. EDTA is the is the most versatile anticoagulant . o *Feed samples need to be retained and should be analysed for GE, Fat, CP, NDF, ADF and CF* o Faecal samples GE
Data Safety Sheets/ Information: (must be attached for new products/additives)	N/A

Ethical Considerations: (is Ethics Committee approval required?)	Yes, 60 pigs will require repeated blood samples (total 4 per pig)
QA Documentation	
Production Considerations	Pigs will need to be fed for the full six weeks of the trial which may compromise their ability to meet QT weight specification
Processing Considerations:	o Carcass weight o HC grading P2 o Eye muscle depth
Co-Ordinator (as FTE if this is a CRC Project)	Scott Johnston 0.15 manager 0.2 Researcher
Technical Assistant(s) (as FTE if this is a CRC Project)	0.5 for duration of experiment
Monitor	Peter Wynn

Formula basic data

Code	: 9900	Name	: 06N021 A		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	100
Cost :	0.0	Created	: 02/06/06	Version :	

Analysis

[VOLUME]	%	100.0	ISOLEUC	%	0.49619	LAYER:ME	KCALS/KG	2837.714167
[DRYMAT]	%	89.20343	TRYPTO	%	0.182769	COPPER	PPM	8.020997
DE_PIG	MJ/KG	13.577566	#LYS/DE_	GM/MJ	0.056289	MANGANES	PPM	30.212163
NE4G	MJ/KG	9.984529	#ALY/DE_	GM/MJ	0.052583	ZINC	PPM	34.323624
#ALY/NE4G	GM/MJ	0.071505	#MET/LYS	G/G	0.305433	IRON	PPM	71.01938
DEENZYME	MJ/KG	13.840613	#M+C/LYS	G/G	0.690746	#AME/ALY	G/G	0.297849
PROTEIN	%	14.224426	#THR/LYS	G/G	0.701076	#ACY/ALY	G/G	0.439668
FAT	%	2.924391	#ISO/LYS	G/G	0.649237	#AM+/ALY	G/G	0.676691
STARCH	%	50.281385	#TRY/LYS	G/G	0.239143	#ATH/ALY	G/G	0.685164
FIBRE	%	3.755727	#VAL/LYS	G/G	0.824317	#AIS/ALY	G/G	0.585551
ASH	%	4.543149	SALT	%	0.292452	#ATR/ALY	G/G	0.187193
CALCIUM	%	0.893187	%LEGUMES	%	9.65701	#AVA/ALY	G/G	0.674241
T:PHOS	%	0.463393	ABC	MEQ/KG	619.519147	#ATH/DE_	GM/MJ	0.036028
AV:PHOS	%	0.348218	SODIUM	%	0.087694	BULKDENS	KG/HL	63.078223
ENZAVPHOS	%	0.344775	POTASS	%	0.503762	IONOPHORE	PPM	99.9001
CAL:PHOS	G/G	1.927492	CHLORIDE	%	0.267855	W6 FA	%	0.0
CAL:AVPHOS	G/G	2.565024	MAGNES	%	0.14406	W3 FA	%	0.0
P:PHOS	%	0.261144	NA+K_CL	MEQ/KG	91.489837	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.59064	CHOLINE	MG/KG	1292.880451	SAT FA	%	0.0
LYSINE	%	0.764267	LACTOSE	%	0.0	MONO FA	%	0.0
ALYSINE	%	0.713946	N:D:F:	%	13.970829	POLY FA	%	0.0
METHION	%	0.233432	LINOLEIC	%	1.019104	ENDF	%	4.126247
M+C	%	0.527914	A:D:F:	%	5.80452			
THREO	%	0.535809	RUMIN:ME	MJ/KG	11.883124			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	62.606666	1878.2	0.0
12 BARLEY	[X]	20.0	600.0	0.0
200 MILLMIX	[X]	2.8	84.0	0.0
300 CANOLA MEAL 36%	[X]	5.766667	173.0	0.0
325 SOYABEANMEAL-48%	[X]	3.9	117.0	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.01	0.3	0.0
503 PORZYME 9310	[X]	0.02	0.6	0.0
520 TALLOW-MIXER	[X]	1.0	30.0	0.0
551 SALT BIN ADD	[X]	0.2	6.0	0.0
560 LIMESTONE	[X]	1.633333	49.0	0.0
575 DICALPHOS	[ ]	0.5	15.0	0.0
600 LYSINE-HCL	[X]	0.3	9.0	0.0
605 DL-METHIONINE	[X]	0.013333	0.4	0.0
610 THREONINE	[X]	0.083333	2.5	0.0
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.0
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.0
912 ELANCOBAN G	[X]	0.1	3.0	0.0
		100.1	3003.0	0.0

Formula basic data

Code : 9901 Name : 06N021 B

Sell price: 0.0 Batch [Kg]: 3000.0 Group code: 120

Cost : 0.0 Created : 09/10/02 Version :

Analysis

[VOLUME] %	:	100.0	ISOLEUC %	:	0.498894	LAYER:ME KCALS/KG	:	2844.836149
[DRYMAT] %	:	89.249191	TRYPTO %	:	0.183321	COPPER PPM	:	7.982356
DE_PIG MJ/KG	:	13.691992	#LYS/DE_ GM/MJ	:	0.056736	MANGANES PPM	:	29.621306
NE4G MJ/KG	:	10.091581	#ALY/DE_ GM/MJ	:	0.052569	ZINC PPM	:	34.367595
#ALY/NE4G GM/MJ	:	0.071325	#MET/LYS G/G	:	0.302234	IRON PPM	:	71.9059
DEENZYME MJ/KG	:	13.947014	#M+C/LYS G/G	:	0.68234	#AME/ALY G/G	:	0.295596
PROTEIN %	:	14.28092	#THR/LYS G/G	:	0.701469	#ACY/ALY G/G	:	0.436738
FAT %	:	3.928975	#ISO/LYS G/G	:	0.642221	#AM+/ALY G/G	:	0.669534
STARCH %	:	48.373216	#TRY/LYS G/G	:	0.235987	#ATH/ALY G/G	:	0.685915
FIBRE %	:	3.938102	#VAL/LYS G/G	:	0.82051	#AIS/ALY G/G	:	0.583015
ASH %	:	4.667264	SALT %	:	0.291548	#ATR/ALY G/G	:	0.183245
CALCIUM %	:	0.907311	%LEGUMES %	:	10.18981	#AVA/ALY G/G	:	0.67665
T:PHOS %	:	0.47691	ABC MEQ/KG	:	641.187231	#ATH/DE_ GM/MJ	:	0.036058
AV:PHOS %	:	0.352695	SODIUM %	:	0.088343	BULKDENS KG/HL	:	62.556162
ENZAVPHOS %	:	0.357162	POTASS %	:	0.521517	IONOPHORE PPM	:	99.9001
CAL:PHOS G/G	:	1.902479	CHLORIDE %	:	0.268108	W6 FA %	:	0.0
CAL:AVPHOS G/G	:	2.572508	MAGNES %	:	0.147294	W3 FA %	:	0.0
P:PHOS %	:	0.272718	NA+K_CL MEQ/KG	:	96.010776	W6:W3 G/G	:	0.0
CAL:ENZAVP G/G	:	2.540332	CHOLINE MG/KG	:	1314.950575	SAT FA %	:	0.0
LYSINE %	:	0.776827	LACTOSE %	:	0.0	MONO FA %	:	0.0
ALYSINE %	:	0.719781	N:D:F: %	:	14.533201	POLY FA %	:	0.0
METHION %	:	0.234783	LINOLEIC %	:	1.046069	ENDF %	:	4.008501
M+C %	:	0.53006	A:D:F: %	:	6.052572			
THREO %	:	0.54492	RUMIN:ME MJ/KG	:	11.99701			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	57.803342	1734.1	0.0
12 BARLEY	[X]	21.4	642.0	0.0
200 MILLMIX	[X]	4.633333	139.0	0.0
300 CANOLA MEAL 36%	[X]	6.233333	187.0	0.0
325 SOYABEANMEAL-48%	[X]	3.966667	119.0	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.009997	0.3	0.0
503 PORZYME 9310	[X]	0.019994	0.6	0.0
520 TALLOW-MIXER	[X]	2.0	60.0	0.0
551 SALT BIN ADD	[X]	0.2	6.0	0.0
560 LIMESTONE	[X]	1.666667	50.0	0.0
575 DICALPHOS	[ ]	0.5	15.0	0.0
600 LYSINE-HCL	[X]	0.3	9.0	0.0
605 DL-METHIONINE	[X]	0.013333	0.4	0.0
610 THREONINE	[X]	0.086667	2.6	0.0
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.0
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.0
912 ELANCOBAN G	[X]	0.1	3.0	0.0
		100.1	3003.0	0.0

Formula basic data

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[DRYMAT]	%	:	89.291948	TRYPTO	%	:	0.183926	COPPER	PPM	:	7.946145
DE_PIG	MJ/KG	:	13.811211	#LYS/DE_	GM/MJ	:	0.057163	MANGANES	PPM	:	29.042434
NE4G	MJ/KG	:	10.202249	#ALY/DE_	GM/MJ	:	0.052546	ZINC	PPM	:	34.424149
#ALY/NE4G	GM/MJ	:	0.071134	#MET/LYS	G/G	:	0.299173	IRON	PPM	:	72.814392
DEENZYME	MJ/KG	:	14.058343	#M+C/LYS	G/G	:	0.674297	#AME/ALY	G/G	:	0.293415
PROTEIN	%	:	14.34141	#THR/LYS	G/G	:	0.701895	#ACY/ALY	G/G	:	0.433899
FAT	%	:	4.934226	#ISO/LYS	G/G	:	0.635508	#AM+/ALY	G/G	:	0.66259
STARCH	%	:	46.485853	#TRY/LYS	G/G	:	0.232966	#ATH/ALY	G/G	:	0.686704
FIBRE	%	:	4.12131	#VAL/LYS	G/G	:	0.816921	#AIS/ALY	G/G	:	0.580588
ASH	%	:	4.760243	SALT	%	:	0.290676	#ATR/ALY	G/G	:	0.179386
CALCIUM	%	:	0.913157	%LEGUMES	%	:	10.722611	#AVA/ALY	G/G	:	0.679087
T:PHOS	%	:	0.483866	ABC	MEQ/KG	:	659.568591	#ATH/DE_	GM/MJ	:	0.036084
AV:PHOS	%	:	0.350916	SODIUM	%	:	0.088995	BULKDENS	KG/HL	:	62.02324
ENZAVPHOS	%	:	0.36315	POTASS	%	:	0.539395	IONOPHORE	PPM	:	99.9001
CAL:PHOS	G/G	:	1.88721	CHLORIDE	%	:	0.268387	W6 FA	%	:	0.0
CAL:AVPHOS	G/G	:	2.602207	MAGNES	%	:	0.150568	W3 FA	%	:	0.0
P:PHOS	%	:	0.284099	NA+K_CL	MEQ/KG	:	100.55715	W6:W3	G/G	:	0.0
CAL:ENZAVP	G/G	:	2.514545	CHOLINE	MG/KG	:	1337.316987	SAT FA	%	:	0.0
LYSINE	%	:	0.789497	LACTOSE	%	:	0.0	MONO FA	%	:	0.0
ALYSINE	%	:	0.72573	N:D:F:	%	:	15.099568	POLY FA	%	:	0.0
METHION	%	:	0.236196	LINOLEIC	%	:	1.073384	ENDF	%	:	3.892354
M+C	%	:	0.532355	A:D:F:	%	:	6.301923				
THREO	%	:	0.554143	RUMIN:ME	MJ/KG	:	12.115091				

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	53.033342	1591.0	0.0
12 BARLEY	[X]	22.8	684.0	0.0
200 MILLMIX	[X]	6.466667	194.0	0.0
300 CANOLA MEAL 36%	[X]	6.7	201.0	0.0
325 SOYABEANMEAL-48%	[X]	4.033333	121.0	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.009997	0.3	0.0
503 PORZYME 9310	[X]	0.019994	0.6	0.0
520 TALLOW-MIXER	[X]	3.0	90.0	0.0
551 SALT BIN ADD	[X]	0.2	6.0	0.0
560 LIMESTONE	[X]	1.7	51.0	0.0
575 DICALPHOS	[ ]	0.466667	14.0	0.0
600 LYSINE-HCL	[X]	0.3	9.0	0.0
605 DL-METHIONINE	[X]	0.013333	0.4	0.0
610 THREONINE	[X]	0.09	2.7	0.0
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.0
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.0
912 ELANCOBAN G	[X]	0.1	3.0	0.0
		100.1	3003.0	0.0

Formula basic data

Code :	9903	Name	: 06N021 D
Sell price:	0.0	Batch [Kg]: 3000.0	Group code: 120
Cost :	0.0	Created : 02/06/06	Version :

Analysis

[VOLUME]	%	100.0	ISOLEUC	%	0.504702	LAYER:ME	KCALS/KG	2862.349068
[DRYMAT]	%	89.331708	TRYPTO	%	0.184585	COPPER	PPM	7.912365
DE_PIG	MJ/KG	13.935225	#LYS/DE_	GM/MJ	0.057572	MANGANES	PPM	28.47555
NE4G	MJ/KG	10.316601	#ALY/DE_	GM/MJ	0.052513	ZINC	PPM	34.493291
#ALY/NE4G	GM/MJ	0.070932	#MET/LYS	G/G	0.300354	IRON	PPM	73.744861
DEENZYME	MJ/KG	14.1746	#M+C/LYS	G/G	0.670712	#AME/ALY	G/G	0.295764
PROTEIN	%	14.405879	#THR/LYS	G/G	0.698285	#ACY/ALY	G/G	0.43115
FAT	%	5.940142	#ISO/LYS	G/G	0.629087	#AM+/ALY	G/G	0.660314
STARCH	%	44.619303	#TRY/LYS	G/G	0.230076	#ATH/ALY	G/G	0.683068
FIBRE	%	4.30535	#VAL/LYS	G/G	0.813542	#AIS/ALY	G/G	0.57827
ASH	%	4.819429	SALT	%	0.289838	#ATR/ALY	G/G	0.175615
CALCIUM	%	0.903635	%LEGUMES	%	11.255411	#AVA/ALY	G/G	0.68156
T:PHOS	%	0.497582	ABC	MEQ/KG	668.00323	#ATH/DE_	GM/MJ	0.03587
AV:PHOS	%	0.355498	SODIUM	%	0.08965	BULKDENS	KG/HL	61.461213
ENZAVPHOS	%	0.375658	POTASS	%	0.557397	IONOPHORE	PPM	99.9001
CAL:PHOS	G/G	1.81605	CHLORIDE	%	0.268694	W6 FA	%	0.0
CAL:AVPHOS	G/G	2.541886	MAGNES	%	0.153882	W3 FA	%	0.0
P:PHOS	%	0.29582	NA+K_CL	MEQ/KG	105.128965	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.405474	CHOLINE	MG/KG	1359.979768	SAT FA	%	0.0
LYSINE	%	0.802276	LACTOSE	%	0.0	MONO FA	%	0.0
ALYSINE	%	0.731782	N:D:F:	%	15.669931	POLY FA	%	0.0
METHION	%	0.240967	LINOLEIC	%	1.101049	ENDF	%	3.777805
M+C	%	0.538097	A:D:F:	%	6.552572			
THREO	%	0.560217	RUMIN:ME	MJ/KG	12.237367			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	48.296676	1448.9	0.0
12 BARLEY	[X]	24.2	726.0	0.0
200 MILLMIX	[X]	8.3	249.0	0.0
300 CANOLA MEAL 36%	[X]	7.166667	215.0	0.0
325 SOYABEANMEAL-48%	[X]	4.1	123.0	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.009997	0.3	0.0
503 PORZYME 9310	[X]	0.019994	0.6	0.0
520 TALLOW-MIXER	[X]	4.0	120.0	0.0
551 SALT BIN ADD	[X]	0.2	6.0	0.0
560 LIMESTONE	[X]	1.666667	50.0	0.0
575 DICALPHOS	[ ]	0.466667	14.0	0.0
600 LYSINE-HCL	[X]	0.3	9.0	0.0
605 DL-METHIONINE	[X]	0.016667	0.5	0.0
610 THREONINE	[X]	0.09	2.7	0.0
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.0
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.0
912 ELANCOBAN G	[X]	0.1	3.0	0.0
		100.1	3003.0	0.0

Formula basic data

Code :	9904	Name	: 06N021 E		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	120
Cost :	0.0	Created	: 02/06/06	Version :	

Analysis

[VOLUME]	%	100.0	ISOLEUC	%	0.507885	LAYER:ME	KCALS/KG	2869.88073
[DRYMAT]	%	89.373666	TRYPTO	%	0.185311	COPPER	PPM	7.875911
DE_PIG	MJ/KG	14.052567	#LYS/DE_	GM/MJ	0.058038	MANGANES	PPM	27.898476
NE4G	MJ/KG	10.42493	#ALY/DE_	GM/MJ	0.052528	ZINC	PPM	34.5692
#ALY/NE4G	GM/MJ	0.070806	#MET/LYS	G/G	0.301455	IRON	PPM	74.710429
DEENZYME	MJ/KG	14.283971	#M+C/LYS	G/G	0.667126	#AME/ALY	G/G	0.298056
PROTEIN	%	14.478489	#THR/LYS	G/G	0.698734	#ACY/ALY	G/G	0.42834
FAT	%	6.945992	#ISO/LYS	G/G	0.622723	#AM+/ALY	G/G	0.657974
STARCH	%	42.69556	#TRY/LYS	G/G	0.227212	#ATH/ALY	G/G	0.683836
FIBRE	%	4.494468	#VAL/LYS	G/G	0.810181	#AIS/ALY	G/G	0.575924
ASH	%	4.915362	SALT	%	0.288964	#ATR/ALY	G/G	0.171839
CALCIUM	%	0.909672	%LEGUMES	%	11.821512	#AVA/ALY	G/G	0.684038
T:PHOS	%	0.505015	ABC	MEQ/KG	686.863111	#ATH/DE_	GM/MJ	0.03592
AV:PHOS	%	0.3539	SODIUM	%	0.090315	BULKDENS	KG/HL	60.914138
ENZAVPHOS	%	0.382062	POTASS	%	0.575889	IONOPHORE	PPM	99.9001
CAL:PHOS	G/G	1.801277	CHLORIDE	%	0.268967	W6 FA	%	0.0
CAL:AVPHOS	G/G	2.570419	MAGNES	%	0.157319	W3 FA	%	0.0
P:PHOS	%	0.307544	NA+K_CL	MEQ/KG	109.835232	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.380951	CHOLINE	MG/KG	1384.197995	SAT FA	%	0.0
LYSINE	%	0.815588	LACTOSE	%	0.0	MONO FA	%	0.0
ALYSINE	%	0.73815	N:D:F:	%	16.249885	POLY FA	%	0.0
METHION	%	0.245863	LINOLEIC	%	1.128729	ENDF	%	3.663042
M+C	%	0.5441	A:D:F:	%	6.81035			
THREO	%	0.569879	RUMIN:ME	MJ/KG	12.354129			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	43.456676	1303.7	0.0
12 BARLEY	[X]	25.6	768.0	0.0
200 MILLMIX	[X]	10.166667	305.0	0.0
300 CANOLA MEAL 36%	[X]	7.666667	230.0	0.0
325 SOYABEANMEAL-48%	[X]	4.166667	125.0	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.009997	0.3	0.0
503 PORZYME 9310	[X]	0.019994	0.6	0.0
520 TALLOW-MIXER	[X]	5.0	150.0	0.0
551 SALT BIN ADD	[X]	0.2	6.0	0.0
560 LIMESTONE	[X]	1.7	51.0	0.0
575 DICALPHOS	[ ]	0.433333	13.0	0.0
600 LYSINE-HCL	[X]	0.3	9.0	0.0
605 DL-METHIONINE	[X]	0.02	0.6	0.0
610 THREONINE	[X]	0.093333	2.8	0.0
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.0
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.0
912 ELANCOBAN G	[X]	0.1	3.0	0.0
		100.1	3003.0	0.0

Formula basic data

Code	: 9905	Name	: 06N021 F		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	120
Cost	: 366.53	Created	: 02/06/06	Version	: 2002020090

Analysis

[VOLUME]	%	100.0	ISOLEUC	%	0.510723	LAYER:ME	KCALS/KG	2878.036289
[DRYMAT]	%	89.416417	TRYPTO	%	0.185917	COPPER	PPM	7.8397
DE_PIG	MJ/KG	14.171785	#LYS/DE_	GM/MJ	0.058444	MANGANES	PPM	27.3196
NE4G	MJ/KG	10.535597	#ALY/DE_	GM/MJ	0.052506	ZINC	PPM	34.625751
#ALY/NE4G	GM/MJ	0.070628	#MET/LYS	G/G	0.298549	IRON	PPM	75.618914
DEENZYME	MJ/KG	14.395298	#M+C/LYS	G/G	0.659692	#AME/ALY	G/G	0.295911
PROTEIN	%	14.538978	#THR/LYS	G/G	0.699182	#ACY/ALY	G/G	0.425639
FAT	%	7.951242	#ISO/LYS	G/G	0.616623	#AM+/ALY	G/G	0.651297
STARCH	%	40.808192	#TRY/LYS	G/G	0.224467	#ATH/ALY	G/G	0.684624
FIBRE	%	4.677676	#VAL/LYS	G/G	0.806918	#AIS/ALY	G/G	0.573611
ASH	%	5.007009	SALT	%	0.288092	#ATR/ALY	G/G	0.168167
CALCIUM	%	0.912018	%LEGUMES	%	12.354312	#AVA/ALY	G/G	0.686346
T:PHOS	%	0.518631	ABC	MEQ/KG	701.914455	#ATH/DE_	GM/MJ	0.035947
AV:PHOS	%	0.358486	SODIUM	%	0.090967	BULKDENS	KG/HL	60.372085
ENZAVPHOS	%	0.39451	POTASS	%	0.593767	IONOPHORE	PPM	99.9001
CAL:PHOS	G/G	1.758509	CHLORIDE	%	0.269247	W6 FA	%	0.0
CAL:AVPHOS	G/G	2.544084	MAGNES	%	0.160593	W3 FA	%	0.0
P:PHOS	%	0.319191	NA+K_CL	MEQ/KG	114.381598	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.311773	CHOLINE	MG/KG	1406.564323	SAT FA	%	0.0
LYSINE	%	0.828258	LACTOSE	%	0.0	MONO FA	%	0.0
ALYSINE	%	0.74411	N:D:F:	%	16.81625	POLY FA	%	0.0
METHION	%	0.247276	LINOLEIC	%	1.156044	ENDF	%	3.546894
M+C	%	0.546395	A:D:F:	%	7.0597			
THREO	%	0.579103	RUMIN:ME	MJ/KG	12.472208			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	38.686666	1160.6	61.898666
12 BARLEY	[X]	27.0	810.0	43.2
200 MILLMIX	[X]	12.0	360.0	19.2
300 CANOLA MEAL 36%	[X]	8.133333	244.0	13.013333
325 SOYABEANMEAL-48%	[X]	4.233333	127.0	6.773333
500 WATER	[X]	1.0	30.0	1.6
502 NATUPHOS 5000	[X]	0.01	0.3	0.016
503 PORZYME 9310	[X]	0.02	0.6	0.032
520 TALLOW-MIXER	[X]	6.0	180.0	9.6
551 SALT BIN ADD	[X]	0.2	6.0	0.32
560 LIMESTONE	[X]	1.7	51.0	2.72
575 DICALPHOS	[ ]	0.433333	13.0	0.693333
600 LYSINE-HCL	[X]	0.3	9.0	0.48
605 DL-METHIONINE	[X]	0.02	0.6	0.032
610 THREONINE	[X]	0.096667	2.9	0.154667
642 AVAILA-COPPER PREMIX	[ ]	0.1	3.0	0.16
706 QAF FINISHER 2KG	[X]	0.066667	2.0	0.106667
912 ELANCOBAN G	[X]	0.1	3.0	0.16
		100.1	3003.0	160.