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Lysine Requirement Titration in Female Finisher Pigs from 60 to 105 kg Liveweight

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Executive Summary

Optimising the dietary concentration of available lysine relative to digestible energy, is fundamental to achieving maximum growth and profitability in the finisher pig. The finisher pig accounts for approximately 50% of all progeny feed and hence feed efficiency in this stage is critical. The optimum lysine requirement of the modern Australian finisher pig is poorly defined and believed to be understated.

This series of trials was a part of a co-ordinated project conducted on several sites across Australia (Rivalea, CHM, APFG and Medina) attempting to titrate the optimum lysine requirements of finisher pigs. The titration involved feeding a range of lysine levels in isocaloric diets from 0.40 to 0.76 gm Avail. Lysine/MJ DE in seven steps and monitoring daily gain, FCR and carcass yields to define the most cost effective specification.

The responses in terms of ADG and FCR were remarkably flat cross the range tested, and given the standard errors involved (variance between replicates on the same treatment) it was difficult to achieve a precise definition of requirement. There was considerable difference between the peak of the polynomial regression lines fitted to the data and the lowest point which was not statistically significantly different from the pinnacle value.

Several methods of determining a practical requirement have been discussed, and a considered judgement has been made to arrive at realistic estimates of requirement. The apparent requirement varied across the 3 live weight ranges tested (approximately 60 – 75, 75 – 90, 90 – 105 kg) and best estimates of requirement in each phase for female pigs were nominated to be 0.64, 0.58 and 0.52 gm Avail. Lysine/MJ DE for the respective phases. If a single value has to be nominated for the entire range then this was estimated to be 0.62 gm Avail. Lysine/MJ DE based on ADG, FCR, carcass gain and profitability (IMFC).

If the single diet concept (from 30kg live weight to slaughter) is to have any commercial relevance it must recognise this finisher phase requirement as a basic minimum.

I believe this series of experiments will add considerable knowledge to our understanding of finisher pig requirements.

Introduction

The efficiency of lean tissue deposition in finisher pigs is influenced by the adequacy of the first limit amino acid lysine. Optimising the dietary concentration of available lysine (relative to digestible energy) is fundamental to achieving maximum growth and profitability of the finisher pig. The optimum lysine requirement of the modern Australian finisher pig grown under commercial conditions is poorly defined and believed to be underestimated. A recent lysine requirement study at the Medina Research Station, W.A. (Moore *et al.*, 2012) using PIC stock, concluded that the requirements were approximately 10% higher than current industry recommendations. However, the relevance of these results to commercial operations has been questioned as the conditions at Medina (low numbers, low stocking rate, high health status) may be atypical of the industry at large (as reflected in the extraordinary performance levels recorded).

To validate the Medina results for the commercial industry APL/Pork CRC commissioned a multisite trial involving the three major commercial producers (Rivalea, CHM and APFG) as well as Medina to run a common lysine titration exercise, concurrently using essentially the same base diets to eliminate the potential distortions of season and diet composition.

The results detailed in this report relate to the study conducted at Australian Pork Farms, Brinkley, Research Facility. The hypothesis to be tested was that finisher pigs will respond to increasing levels of available lysine per MJ of digestible energy by demonstrating increased ADG and reduced FCR up to their genetic potential for lean growth beyond which the response will plateau or decline. The breakpoint hence defines the apparent requirement.

Materials and Methods

Ethics approval for this trial was sought and granted from the PIRSA Animal Ethics Committee. A total of 1120 female pigs were drawn from a weekly production batch of commercial PIC pigs from the Wasleys piggery and grown in the test facilities from 30 to 60 kg liveweight, on the normal commercial diet regime until the commencement of the trial.

The pigs were graded at placement into 4 weight categories (Heavy, Medium 1, Medium 2, Small), and each category was started on trial as they reached an approximate live weight of 60 kg. The pigs were housed in 56 pens of 20 pigs. The pens are arranged in pairs sharing a common feeder, and the weight categories were allocated to a block of 7 valves (14 pens) with each of 7 treatments represented randomly within each block. The 7 treatments applied involved a series of lysine concentrations (0.4, 0.46, 0.52, 0.58, 0.64, 0.70 and 0.76 gm Available Lysine / MJ DE) which were derived from the blending of two base diets (Table 1) using a Big Dutchman computerised blending and dispensing system. The blending ratios for each treatment are presented in Table 2, and the analysed amino acid content of the base diet in Table 3. The 4 initial weight categories then represented the 4 replicates of the treatment and commenced the trial in a staggered manner such that each was close to a 60 kg live weight average. The trial was conducted over 3 x 14 day periods which corresponded to approximate live weight of 60 – 75, 75 – 90 and 90 – 105 kg.

Table 1: Composition of the 2 base diets and their basic nutritional specifications

Components %	**Low Lysine(0.4gm Av. Lys/ MJ DE)**	**High Lysine(0.76 gm Av. Lys/ MJ DE)**
Wheat 10%	67.99	46.65
Barley 11%	20.00	20.00
Soybean meal 46%	6.60	28.90
Tallow	2.10	1.10
Salt	0.20	0.20
Limestone	1.40	1.40
Dicalphos	1.20	1.10
Lysine HCl	0.20	0.20
D,L,-Methionine	-	0.13
L- Threonine	0.05	0.12
Choline Chloride – 60	0.06	-
Grower PMX^	0.20	0.20
	100	100
Estimated Analysis		
Digestible Energy MJ/kg	14.0	14.0
Protein %	12.3	20.5
Fat %	3.9	2.9
Fibre %	3.0	3.5

Ca %	0.90	0.92
Av. Phos %	0.32	0.34
Lysine %	0.63	1.20
Gm Av. Lys/ MJ DE	0.40	0.76

^ Premix contained 500FTU of phytase and xylanases.

Table 2: Blending proportions of the 2 base diets to create the 7 treatments

Lysine Concentration Gm Avail. Lysine/ MJ DE	Low Lysine (%)	High Lysine (%)
0.40	100	0
0.46	83.3	16.7
0.52	66.7	33.3
0.58	50.0	50.0
0.64	33.3	66.7
0.70	16.7	83.3
0.76	0	100

The pigs were weighed initially and the after each 14 day period at which time the feed was weighed back and the actual feed consumption for the 14 day period calculated for each pen (on a pig day basis accounting for any pigs removed during the period).

The feed was presented in pellet form, *ad libitum* in wet/dry feeders. Water was available also through independent water points in each pen.

After the final weighing the pigs were transferred to the abattoir and processed the following day. Individual hot standard carcass weights (Trim 1) and P2 fat depth were recorded. Dressing percentage was calculated on a pen basis using average final live weights and average carcass weight. Apparent carcass gain over the 42 day test period was calculated as average carcass weight per pen minus (average initial live weight x 0.75). The data was analysed using one way analysis of variance (ANOVA) using Stats Graphic Plus V 5.1 (Statpoint Technology Inc., Warrenton, Virginia). Statistical analysis of the data was also conducted by Dr Simon Diffey, University of Wollongong, NSW. Graphical presentations of his analysis showing the fitted polynominal curves and their predicted maxima are included in Appendix 1 (Figures 5 – 18).

Additions to the original protocol

This project was unfortunately compromised by health issues (APP) in that it had to be repeated 4 times. The first 3 runs were OK for the first two fortnightly periods but were distorted in the final period by APP breaks resulting in no useful carcass data.

The fourth run was trouble free, losing only 4 pigs from the total experiment. This report is mainly focused on this final uncompromised run, but to salvage something from the initial 3 studies the data for the first 2 periods in all 4 runs has been combined and subjected to statistical analysis as a complementary reinforcement of the data for the final trial. As this involves a total of 16 replicates (of 40 pigs each) for each treatment it adds more weight to the requirement estimates of the first 2 periods (60 – 75, 75 – 90 kg. L. Wt.)

Results

The amino acid assays of the base diets employed confirmed the theoretical amino acid levels with remarkable precision, for both batches of feed made (Table 3). There was an apparent slight over run in the addition of synthetic methionine and threonine in batch 2 of the high lysine diet but this would not have affected the response to lysine. A summary of the average live weights, ADG, ADFI, FCR and carcass values of each treatment and period are presented in Table 4.

Table 3: Analysed amino acid values for the 2 base diets compared to the theoretical values (%) in the diet

	High Lysine			**Low Lysine**		
Amino Acids*	**Theoretical**	**Batch 1**	**Batch 2**	**Theoretical**	**Batch 1**	**Batch 2**
Lysine	1.20	1.180	1.137	0.63	0.646	0.618
Methionine	0.42	0.414	0.479	0.19	0.197	0.195
Cystine	0.37	0.359	0.342	0.26	0.268	0.265
M + C	0.79	0.773	0.821	0.45	0.465	0.460
Threonine	0.85	0.854	0.957	0.45	0.456	0.459
Isoleucine	0.85	0.868	0.831	0.45	0.466	0.460
Tryptophan	0.26	-	0.269	0.15	0.167	0.179
Arginine	1.32	1.349	1.275	0.68	0.692	0.684
Leucine	1.48	1.519	1.475	0.85	0.889	0.879
Valine	0.95	0.996	0.935	0.56	0.574	0.568
Histidine	0.51	0.491	0.497	0.29	0.300	0.299
Phenylalanine	0.96	1.02	1.000	0.57	0.600	0.600
P + T	1.11	-	-	0.82	-	-
Protein	20.50	21.44	21.10	12.26	13.44	13.34
Added synthetic AA						
L-Lysine	0.156	0.145	0.149	0.156	0.167	0.145
DL-Methionine	0.127	0.120	0.198	NIL	NIL	NIL
L-Threonine	0.118	0.119	0.255	0.05	0.055	0.059
* Analysed by EVONIK SEA PTE LTD, Singapore						

Table 4: Effect of lysine concentration on growth performance and carcass parameters

	Lysine (g Avail. Lys/MJ DE)								
	0.40	**0.46**	**0.52**	**0.58**	**0.64**	**0.70**	**0.76**	**SED**	**P**
Liveweight (kg)									
Day 0	61.12	61.72	61.34	60.29	60.96	61.91	61.56	2.717	0.909
Day 14	71.98	71.38	72.44	71.79	73.29	73.77	73.79	2.881	0.486
Day 28	83.70	83.54	85.54	84.94	87.44	87.63	87.52	3.961	0.129
Day 42	96.55^{a}	95.81^{a}	99.84^{ab}	99.33^{ab}	101.97^{b}	101.84^{b}	101.51^{b}	4.394	0.009
ADG (kg/day)									
D 0 – 14	0.776^{ab}	0.713^{a}	0.792^{abc}	0.821^{bcd}	0.850^{bcd}	0.892^{d}	0.873^{cd}	0.079	0.006
D 14 – 28	0.838	0.869	0.936	0.939	1.011	1.008	0.981	0.114	0.206
D 28 – 42	0.918^{ab}	0.877^{a}	1.022^{c}	1.028^{c}	1.038^{c}	1.002^{bc}	0.999^{bc}	0.078	0.006
D 0 – 42	0.844^{a}	0.820^{a}	0.917^{b}	0.929^{b}	0.967^{b}	0.967^{b}	0.951^{b}	0.065	0.001
ADFI (kg)									
D 0 - 14	2.141	2.038	2.066	2.058	2.112	2.172	2.108	0.84	0.747
D 14 – 28	2.329	2.329	2.314	2.362	2.406	2.493	2.393	0.175	0.838
D 28 – 42	2.695	2.643	2.763	2.761	2.773	2.796	2.715	0.134	0.745
D 0 – 42	2.388	2.337	2.381	2.394	2.430	2.487	2.406	0.103	0.598
FCR									
D 0 – 14	2.763^{bc}	2.907^{c}	2.615^{abc}	2.513^{ab}	2.488^{ab}	2.172^{a}	2.414^{a}	0.242	0.012
D 14 – 28	2.811^{c}	2.688^{bc}	2.476^{ab}	2.522^{ab}	2.392^{a}	2.493^{ab}	2.456^{ab}	0.200	0.017
D 28 – 42	2.937	3.037	2.704	2.694	2.674	2.822	2.718	0.259	0.327
D 0 – 42	2.829^{b}	2.860^{b}	2.597^{a}	2.576^{a}	2.517^{a}	2.571^{a}	2.530^{a}	0.168	0.001
Carcass Characteristics									
HSCW (kg)	72.71^{a}	71.83^{a}	74.69^{b}	73.86^{b}	75.72^{b}	76.03^{b}	75.30^{b}	3.187	0.042
Ap Car Gn (kg)^	26.62^{a}	25.54^{a}	28.68^{b}	28.76^{b}	29.95^{b}	30.06^{b}	29.13^{b}	2.089	0.001
P2 Backfat (mm)	9.93	9.66	9.78	9.41	9.56	9.44	9.53	0.603	0.602
Dressing %	75.06	75.00	74.80	74.34	74.28	74.65	74.23	0.903	0.332

^ Apparent carcass gain, HSCW (Hot Standard Carcass Weight)

Table 5: Effect of lysine concentration on growth and feed efficiency from 60 – 90 kg L. Wt. (Combined data from all 4 experiments for the first 2 x 14 day periods)

	Lysine (g Avail Lys/ MJ DE)								
	0.40	**0.46**	**0.52**	**0.58**	**0.62**	**0.70**	**0.76**	**SED**	**P Value**
Live weight (kg)									
Day 0	60.81	60.77	60.97	60.72	60.60	60.99	61.17	2.611	0.997
Day 14	71.32	72.05	72.98	73.33	73.51	74.24	73.83	3.196	0.125
Day 28	82.61^{a}	84.25^{ab}	84.98^{abc}	86.30^{bc}	86.64^{bc}	87.25^{c}	86.59^{bc}	3.640	0.002
ADG (kg)									
D 0-14	0.736^{a}	0.791^{b}	0.832^{bc}	0.879^{cd}	0.892^{d}	0.922^{d}	0.889^{d}	0.094	0.001
D 14-28	0.814^{a}	0.883^{b}	0.892^{b}	0.941^{bc}	0.965^{c}	0.943^{bc}	0.927^{bc}	0.099	0.001
ADFI (kg)									
D 0-14	2.15	2.19	2.14	2.19	2.14	2.22	2.12	0.143	0.466
D 14-28	2.32	2.43	2.36	2.46	2.40	2.46	2.41	0.172	0.209
FCR									
D 0-14	2.94^{d}	2.79^{c}	2.58^{b}	2.49^{ab}	2.41^{a}	2.42^{a}	2.40^{a}	0.264	0.001
D 14-28	2.87^{c}	2.76^{bc}	2.65^{ab}	2.62^{ab}	2.51^{a}	2.62^{ab}	2.62^{ab}	0.231	0.002

ADG = Average Daily Gain
ADFI = Average Daily Feed Intake
FCR = Feed Conversion Ratio (ADFI/ADG)
Values in the same line having the same line having the same subscript (a,b,c, etc.) are not significantly different $p>0.05$.

Average feed intake was normal or similar across all treatments at around 2.10, 2.35 and 2.70 kg/head/day in the 3 respective time periods.

In the first 14 day period (Approx. 61-73 kg) ADG and FCR improved progressively with increasing lysine concentration peaking at 0.70 g Avail. Lys/MJ DE beyond which the response plateaued or declined (Fig. 1 & 2 arbitrary linear response lines fitted, and Fig. 5 & 9 – fitted polynomial). This break point was also confirmed by the ADG response in the combined result of all 4 trials (Fig. 3, 13, & 15), but the FCR response could be interpreted to turn at 0.64 g Av. Lys/MJ DE in this data set (Fig. 4).

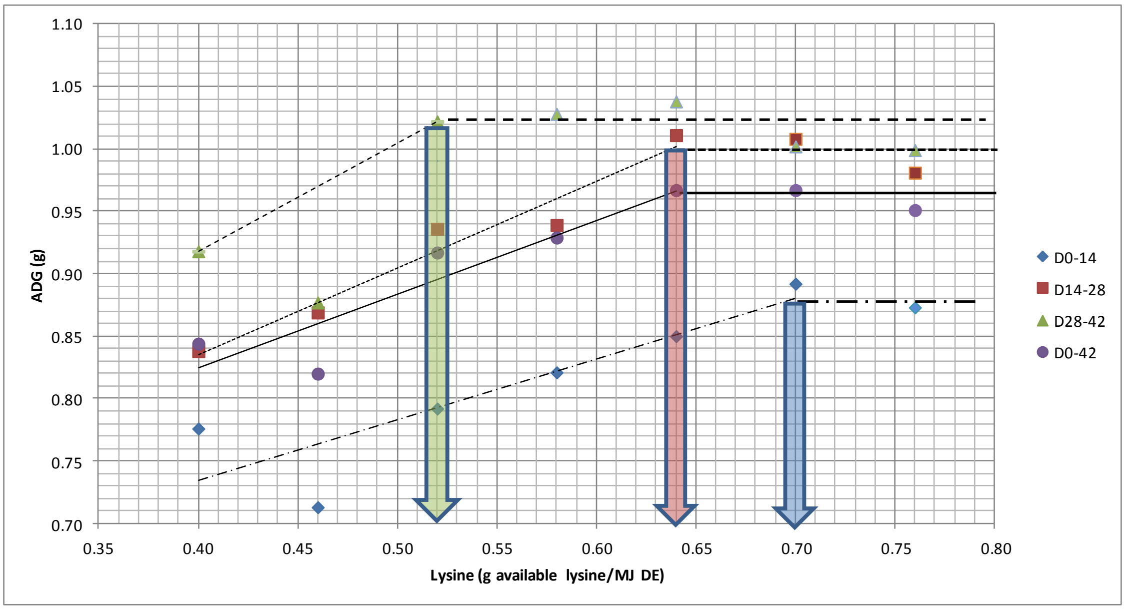

Figure 1: Influence of dietary lysine on average daily gain (Trial 4)

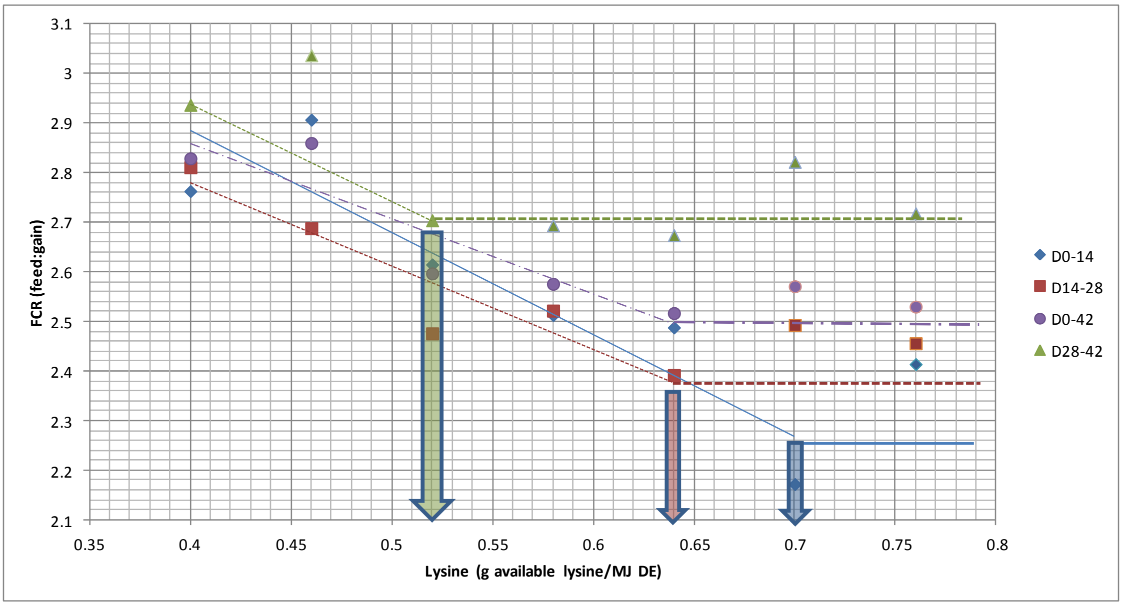

Figure 2: Influence of dietary lysine on feed conversion efficiency (Trial 4)

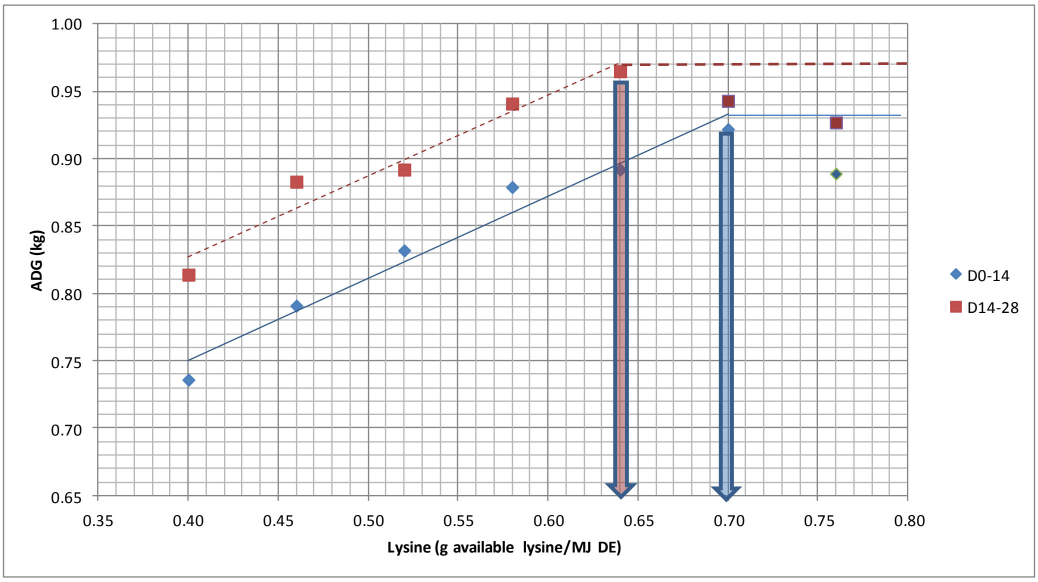

Figure 3: Influence of dietary lysine of average daily gains (four trials combined)

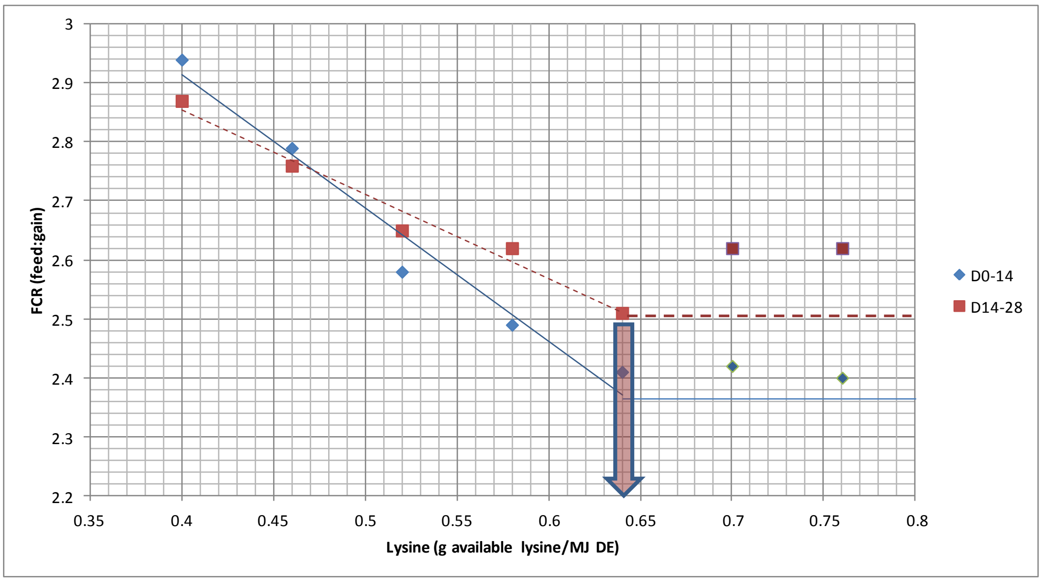

Figure 4: Influence of dietary lysine on feed conversion efficiency (four trials combined.

In the second 14 day period (approx. 73-87 kg) there was again a progressive response to increasing lysine concentration which peaked and turned at around 0.64 g Av. Lys/MJ DE for both ADG and FCR (Fig. 1 & 2, Fig. 6 & 10). This figure was again confirmed in the combined data of all 4 trials for both ADG and FCR (Fig. 3 & 4, Fig. 14 & 16).

In the final 14 day period (approx. 87 – 102 kg) there appeared to be no response in either ADG or FCR above 0.52 g Av. Lys/MJ DE. (Fig. 1 & 2), yet the polynomials for ADG and FCR peaked at 0.66 and 0.65 g Av. Lys/MJ DE respectively (Fig. 7 & Fig. 11).

Over the full 42 day period the indicated requirement was 0.64 g Avail. Lys/MJ DE (Fig. 1 & 2) yet the polynomials peaked at 0.68 and 0.69 g Av. Lys/MJ DE for the ADG and FCR, respectively.

Discussion

The overall performance of the pigs at close to optimal lysine supply was quite respectable for commercial production e.g. 60 – 100 kg L. Wt., ADG = 967 g, FCR = 2.52, P2 backfats = 9.5 mm @ 76 kg Carcass Wt. In fact these values are not far removed from the values recorded in the Medina study of Moore *et al.,* (2012) for female pigs (e.g. 50 – 103 kg L. Wt., ADG = 977 g, FCR=2.41) or those of O'Connell *et al.,* (2006) (e.g. 60 – 90 kg L. Wt., ADG=980 g, FCR = 2.42). This implies the animals were performing close to their genetic potential and should be responsive to the lysine treatments applied. Over the full 42 day period from approximately 60 – 100 kg live weight, performance was optimal at 0.64 g Avail. Lysine/MJ DE which is in close agreement with the estimate of 0.63g/MJ DE made by Moore *et al.,* (2012).

There were however differences in the apparent requirement in each 14 day period. Estimates of requirement (based on the maximal value of the polynomial regression, refer to Figs. 5-8 for ADG, and Figs. 9-12 for FCR) in each phase are outlined in Table 6a.

Table 6a: Apparent Lysine Requirement of female pigs (g Avail. Lys/MJ DE)

Liveweight Range (kg)	Based on ADG	Based on FCR
60 – 75	0.70	0.71
75 – 90	0.70	0.66
90 – 105	0.66	0.65
60 – 105	0.68	0.69

These results were confirmed by the response in the first two test periods (60 – 75 and 75 – 90 kg) of the 4 combined duplicated trials (refer to Fig. 13 & 14 for ADG, and Fig. 15 & 16 for FCR). Estimates of the requirements for the combined trial data are shown in Table 6b.

Table 6b: Apparent lysine requirement (g Avail. Lysine/MJ DE) – 4 trial combined data

Live Weight Range (kg)	Based on ADG	Based on FCR
60 – 75	0.69	0.71
75 – 90	0.66	0.65

The carcass response was also optimised at around 0.64 gm Avail. Lys/MJ DE both in terms of carcass gain and also in profitability (Tables 4 & 7).

Table 7. Economic analysis of the lysine responses, over the full 42 day test period

Treatment g avail. Lys/MJ DE	n	HSCW (kg)	Feed Cost ($/pig)	% Pigs >12mm P2	Revenue $/pig	IMFC*
0.40	144	72.71	39.52	9.7	208.75	169.23
0.46	143	71.83	39.91	6.3	206.94	167.03
0.52	142	74.69	41.84	9.9	214.36	172.52
0.58	143	73.86	43.11	4.2	212.23	170.12
0.64	144	75.72	44.37	7.6	217.85	173.48
0.70	143	76.03	47.61	8.4	218.59	170.98
0.76	144	75.30	47.32	8.3	216.47	169.17
* Income minus feed costs						

HSCW = Hot Standard Carcass Weight

Assumes - Prime pigs @ $2.90/kg and >12 mm @ $2.60/kg. (Column 6)
- Feed costs of $394/tonne for low lysine and $468/tonne for high lysine (Column 4)

One interesting observation from this lysine requirement titration was that the P2 back fat varied very little across the entire range of lysine concentrations. As the feed intake was similar at all lysine levels, and the response to the lower lysine concentrations was reduced growth and poorer FCR, it would be expected that the pigs would be depositing more fat. This was not reflected in P2 depots, so it is likely it was deposited elsewhere.

It is obvious in the graphical representation of the responses to increasing lysine contribution (Fig.5 – 18) that the response lines are relatively flat. This makes the definition of a confident requirement quite difficult. It could be argued that a value somewhat less than the pinnacle of the fitted polynomial may be equally relevant commercially. One method of accommodating this rather flat response curve and its attendant error component is to reduce the pinnacle response by one standard error unit and follow this back until it crosses the actual curve. Based on this approach, the practical requirement indicated for Trial No. 4 might be as follows:

Table 8: Trial 4 - Indicated requirements based on pinnacle responses discounted by one SED

Period	**ADG (kg/day)**	**FCR (Kg feed/kg ADG)**	**Δ Carcass**
0 – 14 d (60 – 75 kg)	0.64	0.63	-
14 - 28 d (75 – 90 kg)	0.58	0.55	-
28 – 42 d (90 – 105 kg)	0.55	0.52	-
0 – 42 d (60 – 105 kg)	0.62	0.60	0.61
Combined Data			
0 – 14 d (60 – 75 kg)	0.62	0.63	-
14 – 28 d (75 – 90 kg)	0.57	0.57	-

Another approach to the interpretation of the response data is to base it on statistically significant differences from the pinnacle value. This yields the following estimates (based on the lowest value not statistically different from the pinnacle value).

Table 9: Indicated requirements based on statistical differences

	Time Period	Liveweight	ADG (g/d)	FCR (kg feed/kg ADG)	Δ Carcass
Trial 4	D 0-14	60-75kg	0.58	0.52	-
	D 14-28	75-90kg	NS	0.52	-
	D 28-42	90-105kg	0.52	NS	-
	D 0-42	60-105kg	0.52	0.52	0.52
Combined	D 0-14	60-75kg	0.58	0.58	-
	D 14-28	75-90kg	0.58	0.52	-

Δ Carcass = Apparent Carcass Gain

Given the limited replication and the variance between replicates on the same treatment, this statistically significant difference approach probably underestimates the practical requirement.

So at some point all these differing estimates of requirement need to be reconciled and condensed into a practical recommendation. Table 9 collates the various estimates presented in this report, and arrives at the author's preferred estimate of requirement in each phase and across the full finishing period from 60 – 105 kg live weight.

Table 10: Summary of various lysine (g Avail. Lys/MJ DE) requirement estimates

Period	**LWT (kg)**	**Response**	**Maximum Lysine Response**	**SED Corrected**	**Statistical Significance**	**Author's Preferred Estimate**
D 0 – 14	60 – 75	ADG	0.70 (0.69)*	0.64 (0.62)	0.58 (0.58)	0.64
		FCR	0.70 (0.71)	0.63 (0.63)	0.52 (0.58)	
D 14 – 28	75 – 90	ADG	0.64 (0.66)	0.58 (0.57)	NS (0.58)	0.58
		FCR	0.62 (0.65)	0.55 (0.57)	0.52 (0.52)	
D 28 – 42	90 – 105	ADG	0.66	0.55	0.52	0.52
		FCR	0.52	0.52	(NS)	
D 0 – 42	60 – 105	ADG	0.68	0.62	0.52	0.62
		FCR	0.69	0.60	0.52	
Δ Carcass			0.68	0.61	0.52	0.62
I.M.F.C.			0.64			0.62
	* Figures in brackets relative to the 4 trial – combined data					

Conclusions

There is no doubt that female finishing pigs respond to increasing available lysine/DE ratios in the range from 0.4 – 0.76 g Avail. Lys/MJ DE. Defining an unambiguous, clear requirement for all pigs, consistent with maximum commercial returns, however has proved complicated. Not only are there questions of interpretation of this data set but no doubt there will be further anomalies to resolve as the data from the other sites is collated.

One part that is clear is that the apparent requirement for finishing female pigs is substantially higher than that which has been proposed and adopted commercially to date. Further to this the requirement declines between 60 and 100+ kg live weight and so setting a single value for this period will involve some considerable judgement, particularly with regard to the actual live weight end point.

There has been considerable interest in the use of a single diet from 30 kg to slaughter. Preliminary evaluations at Medina and APFG were compromised by the specification set for the commercial step down reference programme. These studies used an Avail. Lysine: DE specification of only 0.50 – 0.52 g Avail Lysine/MJ DE in the finisher phase, and this current study demonstrates how inadequate that was. A re-run of the single diet experiment using data from this current trial and other sources should ensure the step down reference programme meets the needs of the stock in the finishing phase and hence gives a more creditable evaluation of the single diet concept.

References

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O'Connell, M.K., Lynch, P.B., and O'Doherty, J.V. (2006) Determination of the optimum dietary lysine concentration for boars and gilts penned in pairs and in groups in the weight range 60 to 100kg. *Animal Science.* Vol. 82, pp.65-73

Appendix 1.

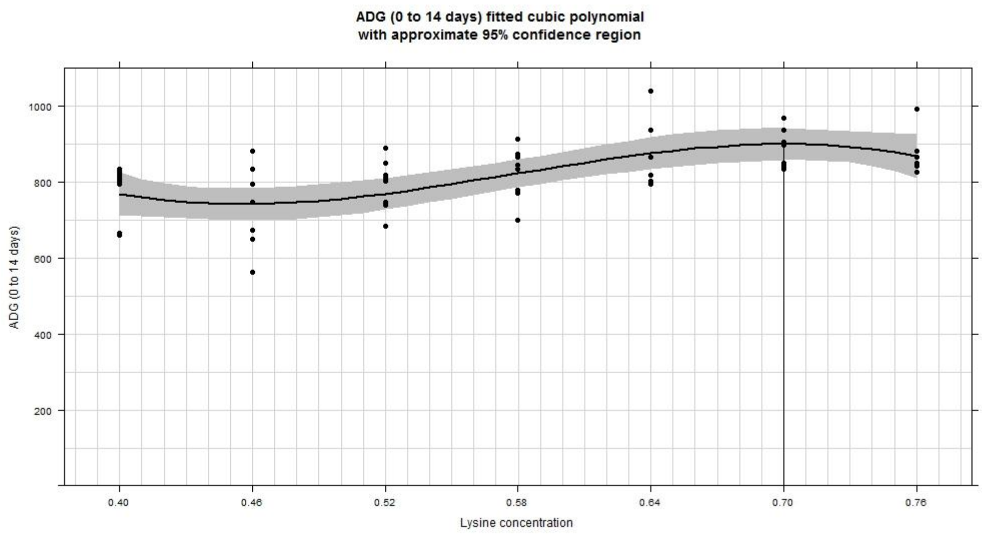

Figure 5: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D0-14 (Trial 4)

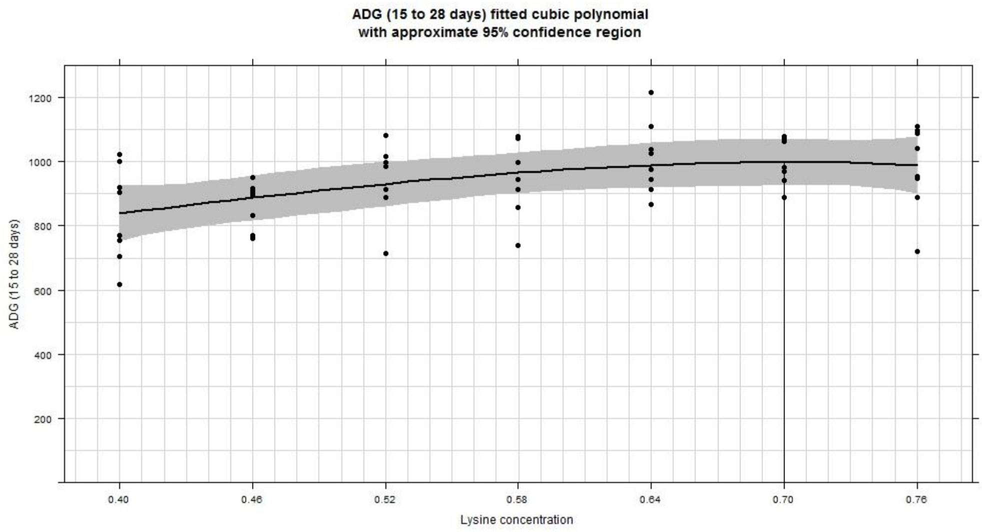

Figure 6: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D15-28 (Trial 4)

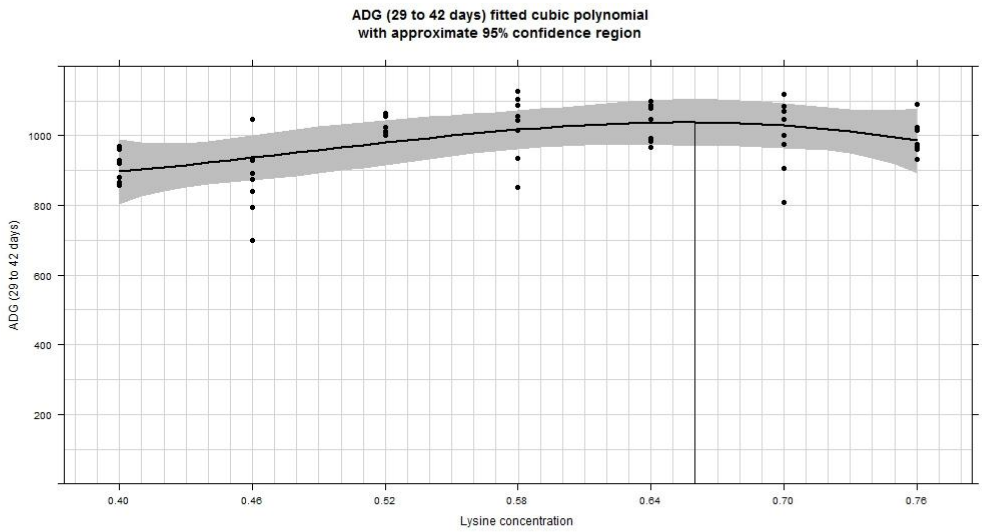

Figure 7: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D29-42 (Trial 4)

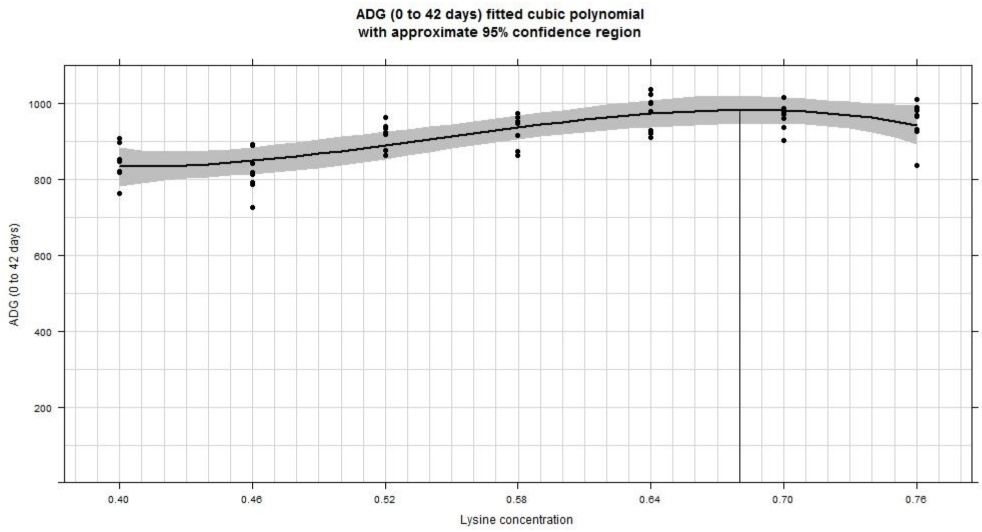

Figure 8: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D0-42 (Trial 4)

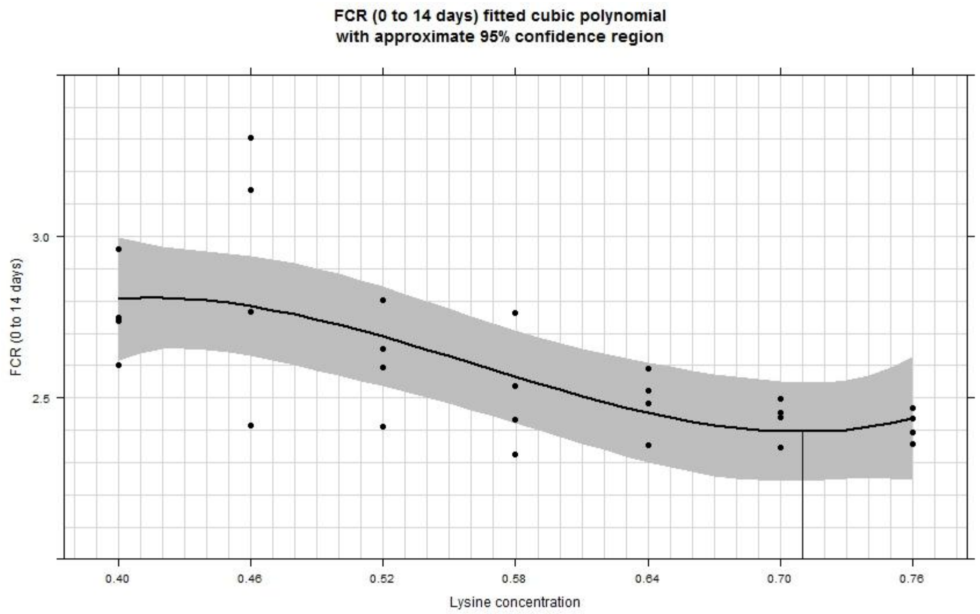

Figure 9: Influence of lysine (g available lysine/MJ DE) on FCR from D0-14 (Trial 4).

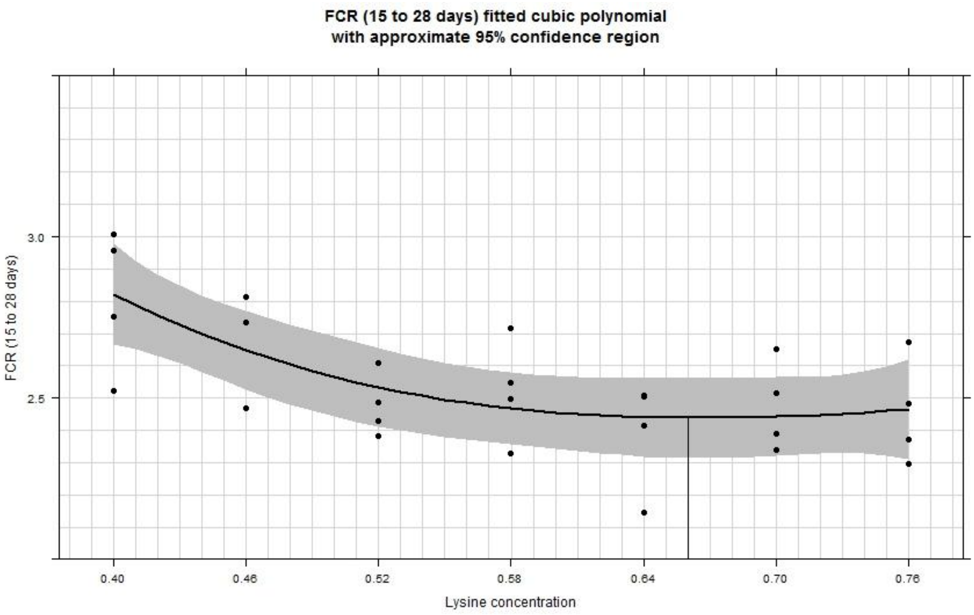

Figure 10: Influence of lysine (g available lysine/MJ DE) on FCR from D15-28 (Trial 4)

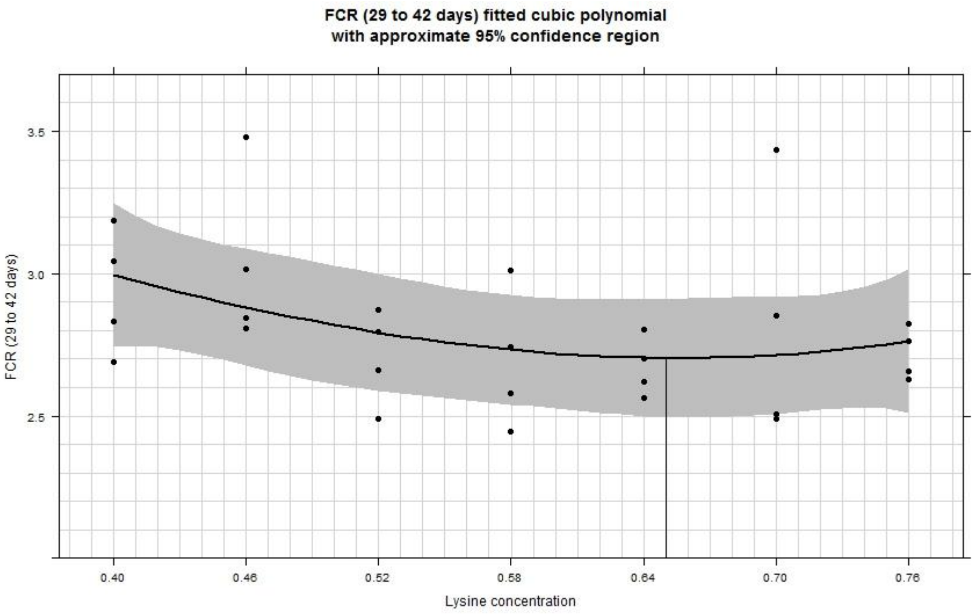

Figure 11: Influence of lysine (g available lysine/MJ DE) on FCR from D29-42

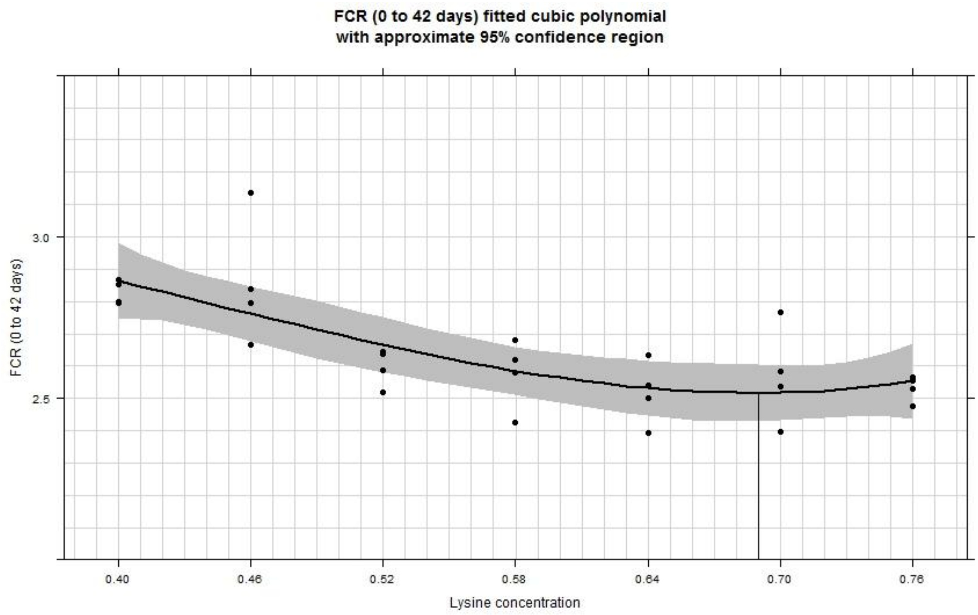

Figure 12: Influence of Lysine (g available lysine/MJ DE) on FCR from D0-42 (Trial 4)

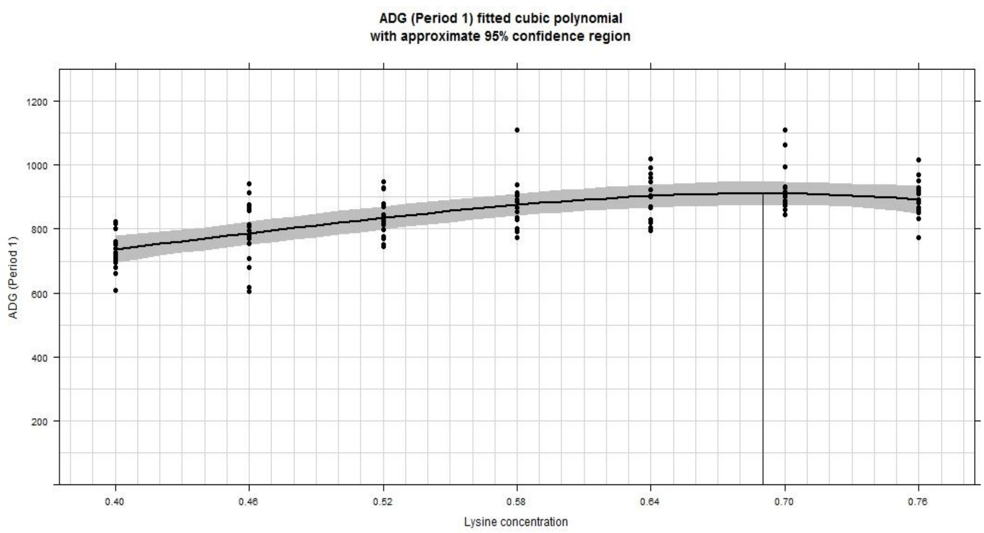

Figure 13: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D0-14 (four trials combined)

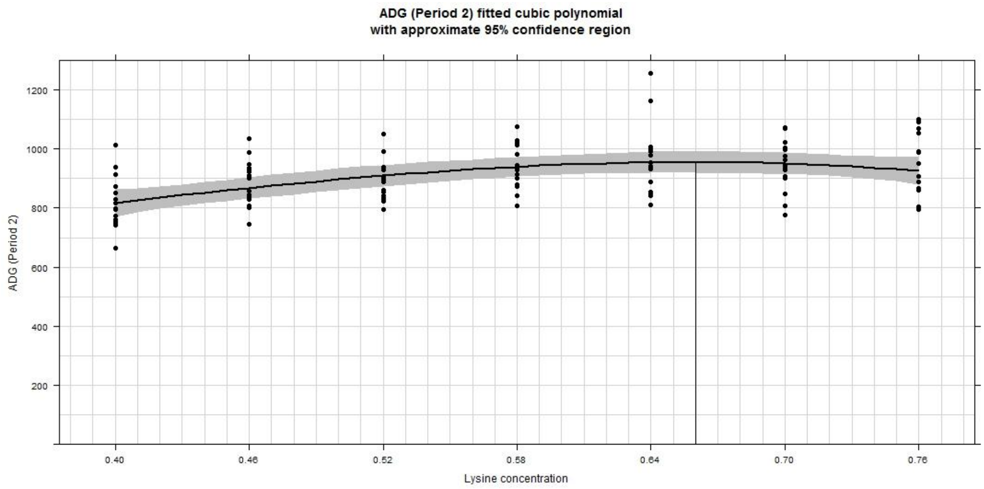

Figure 14: Influence of lysine (g available lysine/MJ DE) on ADG of pigs D15-28 (four trials combined)

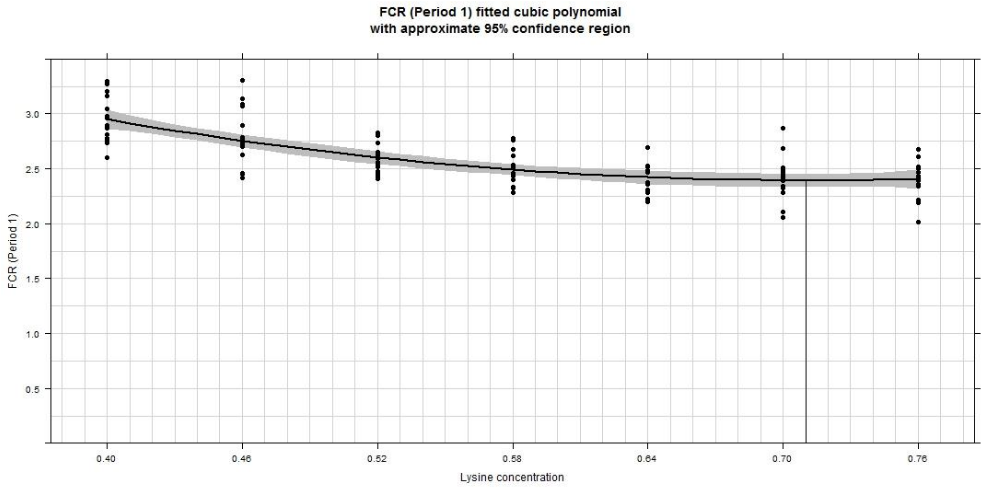

Figure 15: Influence of lysine (g available lysine/MJ DE) on FCR of pigs D0-14 (four trials combined)

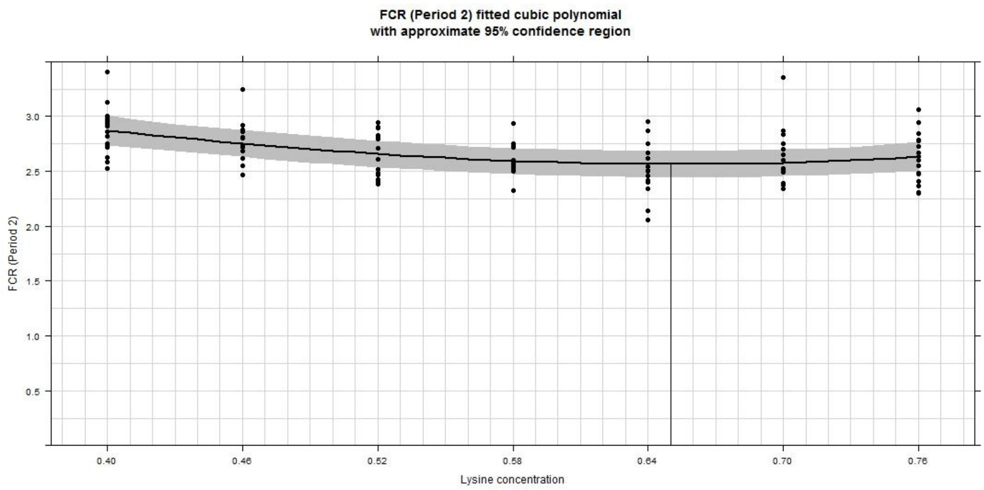

Figure 16: Influence of lysine (g available lysine/MJ DE) on FCR of pigs D14-28 (four trials combined)

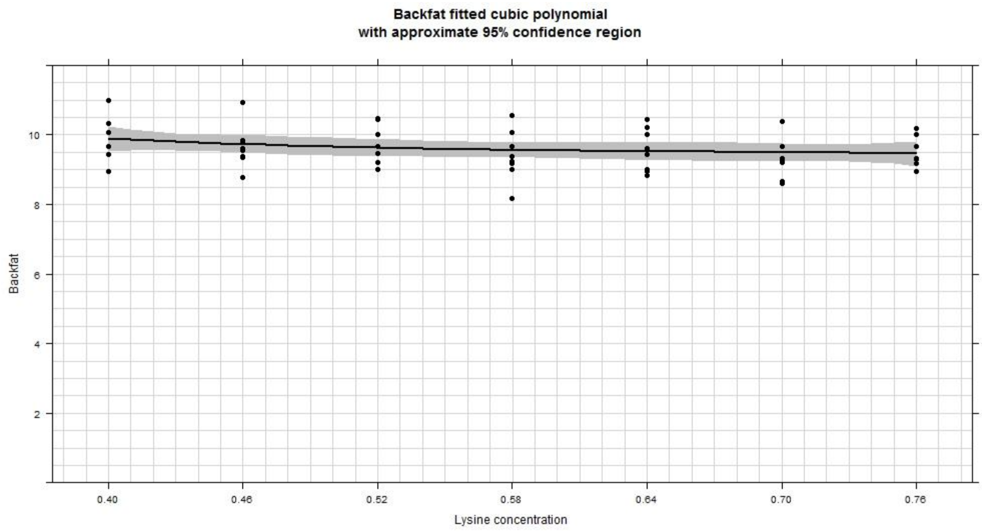

Figure 17: Influence of lysine (g available lysine/MJ DE) on backfat thickness at slaughter

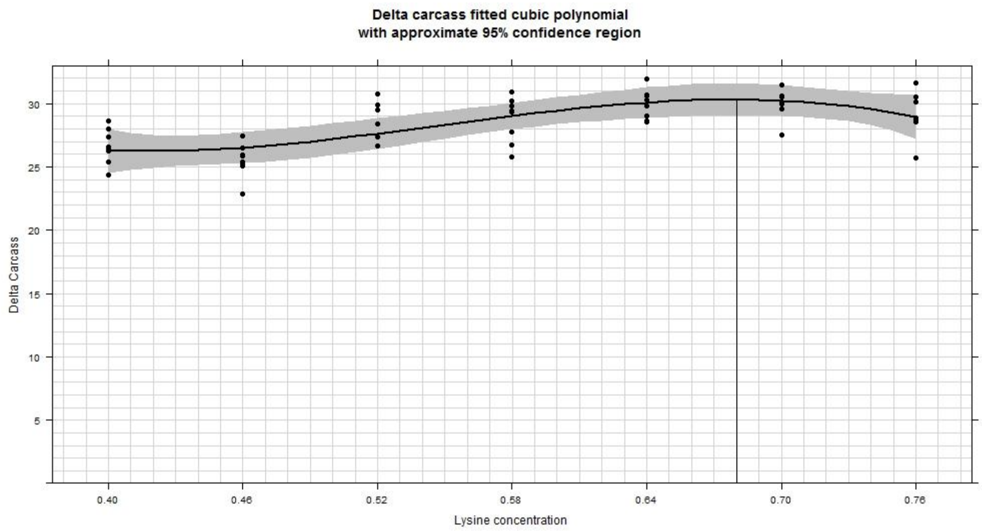

Figure 18: Influence of lysine (g available lysine/MJ DE) on carcass gain from D0-42