Pork CRC Preliminary Results

Determining the lysine to energy requirement of female pigs from the Australian Pig Improvement Company (PIC) genotype when fed a diet containing ractopamine

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Introduction

Ractopamine (Paylean) is a β-agonist that is supplied as an in-feed supplement to the diet of finisher pigs for up to four weeks pre-slaughter, most commonly at the inclusion rate of 5ppm. It is absorbed into the blood and binds to specific beta receptors on the cell membrane of muscles, where the primary response is to increase the size of muscle fibres (Dunshea *et al.* 2005). As a consequence, a major effect is to increase protein deposition and growth rate, and hence improve feed efficiency and lean meat yield, with only a small effect on reducing fat deposition (Dunshea, 1993). Since a major effect of ractopamine is to increase protein deposition, it is therefore important that the supply of essential amino acids in the diet is sufficient to meet this additional requirement.

Pigs have a nutritional requirement for energy (digestible energy or DE) and amino acids, as well as minerals and vitamins. The requirement for each of the essential amino acids follows a concept referred to as ideal protein, where the ratio of each amino acid is expressed relative to lysine (e.g. ratio of methionine to lysine of 0.30). Lysine is the first limiting amino acid, in other words the amino acid that is most likely to be deficient when we feed a mix of typical ingredients to growing pigs. It is therefore common to have to include synthetic lysine in the diet of pigs to meet their requirement. In addition, we discuss the requirement in terms of available lysine (Av Lys) rather than total lysine, since this accounts for the actual amount of lysine that the pig can digest, absorb and deposit as protein.

Despite ractopamine having been registered for use in Australia since December 2003, there have been relatively few experiments conducted to determine the requirement for lysine. Results from research in the USA, where ractopamine was registered for use several years prior to in Australia, may not be entirely relevant to local conditions because of differences in genotype (pigs in the USA are typically fatter at the same live weight (LW) than those in Australia) and the higher slaughter weights that are common in the USA (e.g. 130 vs 100 kg LW). Nevertheless, it is common for lysine levels in the USA to be increased 25 to 30% for pigs fed diets containing ractopamine (Campbell, personal communication). Original studies in Australia by Dunshea et al (1993) were conducted almost 20 years ago using much higher levels of ractopamine (20 ppm for four weeks pre-slaughter) than is used commercially (5 ppm) and also with genotypes quite different to what are now common in Australia.

The most recent research in Australia to determine lysine requirements for pigs fed diets containing ractopamine has been conducted by Rickard-Bell (2009) at the Rivalea research facility in NSW. The data in this study suggests that 0.56 g available lysine / MJ DE is optimal for maximising average daily gain (ADG), feed conversion ratio (FCR) and carcass traits in boars and gilts between 65 and approximately 90 kg LW. This is an increase of about 10% on what they would normally be fed. However, in this research the response to ractopamine was highest when a diet was deficient in lysine and this result is counterintuitive to what we would expect, and as a result there is some concern amongst the Australian industry that there may have been other factors (e.g. health status) involved that affected the result. While commercial nutritionists in Australia most commonly recommend a level of 0.55 g Av Lys/MJ DE (Tony Edwards, personal communication) which is approximately 5 to 10 % higher than what pigs would normally be fed at this stage of production, there is still some uncertainty especially when compared to the levels being used in the USA. The pigs to be used in the proposed experiment are the same genotype that is used by an estimated 60% of commercial producers in Australia (D'Souza, pers com), whereas the genotype used in the research conducted at Rivalea is almost entirely specific for that commercial unit. Therefore the results from the proposed research at Medina will be highly relevant to the Australian pig industry.

To determine the lysine requirements for a growing pig, it is necessary to feed pigs a range of diets that vary in the level of Av Lys/MJ DE, from levels that we expect to be deficient to those that exceed the animal's requirements. As the ratio of Av Lys/MJ DE increases, pigs will increase their growth rate (i.e. average daily gain) and reduce the feed conversion ratio. In this way we can determine a response curve and thus determine the point at which maximum protein gain is achieved. If we exceed the supply of amino acids, the pig will not grow any faster or efficiently, but instead it will mean an increase in cost of production (i.e. feed costs increase) and the excess protein will have to be excreted. Because ractopamine increases protein deposition, we would therefore expect the requirement for lysine to be greater when pigs are fed a diet containing ractopamine than when they are fed a standard diet.

Recent research conducted at Medina by Moore *et al.* (2010), using the PIC genotype, found that at 80kg LW there was no difference in the lysine requirement of entire males and females (0.50 g Av. Lys/MJ DE). Since females make up the majority of pigs in Australia (males are either castrated or left entire), then it is proposed to use only females in this experiment to increase the likelihood of obtaining a statistically significant result. Determining the lysine requirements of pigs fed diets containing ractopamine will provide valuable information to commercial nutritionists that will subsequently mean more efficient use of feed and a reduction in the cost of production by the Australian pig industry.

Hypothesis:

1. That female finisher pigs will respond to the addition of ractopamine in their diet by having an increase in growth rate and a lower feed conversion ratio.
2. That female finisher pigs will respond to increasing levels of Av Lys/MJ DE by having an increased growth rate and reduced feed conversion ratio, until a plateau is reached corresponding to their genetic potential.

3. That the inclusion of ractopamine in the diet will increase the level of lysine (Av. Lys/MJ DE) that is required for optimal ADG and FCR.

Aims and Objectives:

1. To determine the response in female finisher pigs to the inclusion of 7.5ppm ractopamine in the diet,
2. Determine the optimal Av. Lys/MJ DE ratio for female pigs fed either a control (0ppm ractopamine) or a supplemented diet (7.5ppm ractopamine).

Methods

A total of four hundred and twenty Large White x Landrace x Duroc female pigs were used in this experiment. The experiment was a 2 x 5 factorial with the main treatments being:
i) treatment (0 vs 7.5 ppm ractopamine) and;
ii) available lysine to MJ digestible energy (Av Lys/MJ DE) ratio (0.42, 0.48, 0.56, 0.64 and 0.72 g Av Lys/MJ DE).

Four hundred and twenty female pigs were sourced from a high health status commercial herd and transported to Medina Research Station 52.7 kg LW. Upon arrival all pigs were identified with a unique ear tag, weighed and randomly allocated to treatment on their LW. Upon arrival the pigs were fed a standard commercial finisher diet (14.0 MJ DE/kg and 0.75 g av Lys/MJ DE) until they reached the required LW to start the experiment. Diets were manufactured by a commercial feedmill (Wesfeeds).

All pigs were weighed weekly and feed disappearance recorded daily by the Feedlogic system. Ultrasound back fat was measured on day 0 and 28 of the experiment using real time ultrasound (Renco Lean-Meter). Four weeks after the experimental diets commence (approximately 100 kg LW as per normal commercial practice) the pigs were transported to a commercial abattoir and subjected to normal abattoir processing procedures. Feeders were shut down on the day that pigs are to be sent to slaughter so as to comply with the 12 hour withholding period for ractopamine. Carcass weight and depth of backfat was measured on the hot carcass by abattoir staff as per normal commercial practice.

The experimental diets were fed for four weeks from approximately 72 kg LW until slaughter. The composition of the diets and the ratios used to attain the blended diets using the Feedlogic system are given in Tables 1 and 2, respectively.

Table 1: The composition of the diets for the two extreme lysine levels.

Diet	Diet 1 (Low)	Diet 2 (High)
Ingredients (g/kg)		
Wheat	395	350
Barley	356	308
Lupins	100	100
Soyabean meal	30	126
Canola meal	30	40
Meat meal	46.0	35.5
Tallow	24	17
Limestone	9.0	11.0
Dical Phosphorus	2.5	2.0
Salt	2.40	1.85
L-Lysine HCL	0.0	3.0
Threonine	1.00	1.48
Alimet	2.00	1.60
Choline Chloride	0.13	0.13
Mineral Vitamin	2.50	2.50
Nutrient composition[a]		
DE (MJ/kg)	13.5	13.6
Crude protein (%)	15.5	19.1
Available lysine:DE (MJ/kg)	0.40	0.72

[a] Calculated composition.

Table 2: The blend ratios of the two basal diets to produce the five dietary treatments.

Treatment	Diet 1	Diet 2	MJ DE/kg	Av. Lys/MJ DE
1	100	0	13.5	0.40
2	75	25	13.5	0.48
3	50	50	13.5	0.56
4	25	75	13.5	0.64
5	0	100	13.5	0.72

Results

Table 3: Growth performance and carcass characteristics for female pigs fed varying levels of Av Lys/MJ DE (Level) with or without Ractopamine (Treat) (n=6).

	Lysine level (g Av Lys/MJ DE)					SEM[a]	P-value		
	0.40	0.48	0.56	0.64	0.72		Level	Treat	LxT
Initial LW (kg)									
Control	72.7	73.4	74.3	73.2	73.7		0.435	0.874	0.827
Ractopamine	73.5	73.4	73.8	72.9	73.4				
Final LW (kg)									
Control	96.9	98.4	100.2	99.0	99.5		0.003	0.004	0.757
Ractopamine	97.3	101.0	102.2	101.4	102.6				
ADG wk 1-2 (g)									
Control	900	896	962	942	961		0.001	0.001	0.001
Ractopamine	900	976	1036	1076	1102				
ADG wk 1- 4 (g)									
Control	861	892	920	923	915		0.001	0.001	0.001
Ractopamine	851	980	995	1018	1050				
VFI wk 1 (kg/d)									
Control	2.31	2.37	2.31	2.38	2.21		0.057	0.013	0.892
Ractopamine	2.40	2.45	2.47	2.42	2.30				
VFI wk 1-4 (kg/d)									
Control	2.43	2.46	2.36	2.50	2.32		0.194	0.679	0.216
Ractopamine	2.34	2.46	2.53	2.44	2.38				
DW (kg)									
Control	67.0	68.1	69.2	68.0	67.6		0.028	0.001	0.402
Ractopamine	67.7	69.8	70.1	69.9	71.1				
DP (kg)									
Control	69.1	69.1	69.0	68.7	68.1		0.106	0.005	0.704
Ractopamine	69.9	69.1	69.3	69.0	69.1				
P2 (mm)									
Control	11.4	12.8	11.4	12.4	10.7		0.027	0.249	0.213
Ractopamine	10.9	11.3	12.1	11.8	10.9				
FCR wk 1									
Control	2.65	2.51	2.40	2.66	2.49		0.219	0.025	0.315
Ractopamine	2.56	2.49	2.36	2.19	2.12				
FCR wk 1to 2									
Control	2.65	2.72	2.45	2.56	2.40		0.001	0.002	0.062
Ractopamine	2.69	2.53	2.43	2.31	2.12				
FCR wk 1 to 4									
Control	2.81	2.76	2.56	2.73	2.52		0.001	0.001	0.043
Ractopamine	2.76	2.50	2.50	2.40	2.29				

References:

Dunshea FR, King RH, Campbell RG, Sainz RD, Kim YS (1993) Interrelationships Between Sex and Ractopamine on Protein and Lipid Deposition in Rapidly Growing Pig. *Journal of Animal Science.* 71, 2919-2930.

Dunshea, F.R., Rikard-Bell, C., Curtis, M.A., Edwards, A.C., Gannon, N.J., Henman, D.J., Mullan, B.P. and van Barneveld, R.J. (2005). A step-up ractopamine (Paylean) program increases lean tissue in all sexes and decreases fat tissue in boars and immunocastrates. In "Manipulating Pig Production X". (Ed JA Paterson). Pp. 152. (Australasian Pig Science Association: Werribee)

Moore, K.L. and Mullan, B.P. (2010), Lysine requirements of pigs from 20 to 100 kg live weight. Final report prepared for the Co-Operative Research Centre for an Internationally Competitive Pork Industry.

Rikard-Bell, C. (2009) The rate of tissue deposition in finisher pigs fed 5 levels of available lysine and 3 dosage levels of ractopamine. Final Study Report to the Pork CRC, T4VAL0801