Influence of soyabean lecithin on carcass weight and dressing percentage

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By

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Executive Summary

A number of studies have investigated the use of soya bean lecithin as a dietary means of improving meat tenderness (D'Souza *et al.* 2005; Edmunds *et al.* 2005). A dose-response study was conducted by the Pork CRC during 2009 to assess the impact of lecithin concentration on pork tenderness (0, 4, 20 or 80 g lecithin/kg diet). Diets were fed to individually housed finisher gilts for a period of six weeks prior to slaughter. The results showed an increase in carcass weight and dressing percentage associated the lecithin supplementation. Following slaughter, meat quality assessment found differences in the colour of the loin due to lecithin supplementation. As such, this follow-up study tested the hypothesis that dietary lecithin increases carcass weight and dressing percentage of pigs housed in groups. In addition, a further assessment of meat quality was made.

A total of 256 pigs (Large White x Landrace, PrimeGro™ Genetics) were identified at 17 weeks of age and transferred to finisher accommodation (pens of 8 pigs of the same sex). Pens were randomly allocated to a 2 x 2 factorial experiment with the respective factors being dietary lecithin supplementation (0 or 5 g/kg) and sex (female and Improvac vaccinated male). Diets were pelleted and fed *ad libitum* from 17 weeks of age through to slaughter at 22 weeks of age. Pen weights were recorded at the beginning of the experimental period (day 0, 17 weeks of age) and again at day 14. At day 35 (pre-slaughter), individual live weights were obtained to enable the accurate measurement of dressing percentage on a pen basis. Pen feed intake was measured by feed disappearance and feed conversion efficiency subsequently calculated. Pigs were slaughtered in a commercial abattoir and individual hot standard carcass weight (HSCW) and fat depth at the P2 site measured. Dressing percentage was calculated from the individual live weight and carcass weight measures and analysed on a pen basis. Twenty-four hours after slaughter, a subset of 64 carcasses (2 pigs per pen) were followed through the boning room for collection of the loin (*longissimus dorsi*). Colour (L*, a*, b*), pH and iron content measures were obtained on each of the loins

Over the entire experimental period, pigs offered the lecithin diet utilized feed for weight gain more efficiently than pigs offered the control diet (FCR 2.96 and 2.79 kg/kg respectively for the control and lecithin treatment groups, P=0.006). This improvement was due to a small (non-significant) reduction in feed intake coupled with a similar rate of gain over the entire test period. There was no impact of dietary lecithin supplementation on final live weight, carcass weight, P2 back fat depth or dressing percentage. There was no impact of lecithin supplementation on meat quality. All measures of pH, colour and loin iron content were similar between the control and lecithin treatments.

The results from this study do not support the use of lecithin in the diet of finisher pigs at 5 g/kg to improve carcass weight, dressing percentage, pork colour or iron content of the loin. The results do however suggest that lecithin may be a worthwhile component in finisher diets containing high levels of added fat (tallow) to improve the efficiency of feed utilization.

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1. Introduction

A number of studies have investigated the potential for soya bean lecithin to be utilised as a dietary means of improving meat tenderness (D'Souza *et al.* 2005; Edmunds *et al.* 2005). The main factor contributing to the toughness of meat is intramuscular connective tissue, which consists of cross-linked collagen molecules. As the animal matures the synthesis and turnover of collagen molecules decreases allowing existing fibrillar collagen to progressively cross-link. It is this maturation of collagen that contributes largely to the toughness of meat (Fang *et al.* 1999).

A very important aspect of collagen is its high proportion of proline and hydroxyproline. Without hydroxyproline, cross-linking of collagen molecules cannot occur. The main enzyme responsible for the hydroxylation of proline is prolyl-4-hydroxylase (Bailey and Light 1989). A known inhibitor of this enzyme is polyenylphosphatidylcholine (PPC), which is present in lecithin extracted from soya beans. Several studies have therefore investigated the inclusion of soya bean lecithin in the diet of growing pigs for the purpose of inhibiting the collagen cross-linking and improving meat quality. D'Souza *et al.* (2005) observed reduced hardness and chewiness values in the *semitendinosus* muscle when pigs were fed diets containing 3 g/kg lecithin from 68 days of age through to slaughter at 23 weeks of age. Similar results were reported by Edmunds *et al.* (2005) in the *longissimus thoracis* muscle when up to 75 g/kg lecithin was included in the diet for growing pigs.

A follow up dose response study was conducted in late 2009 (Pork CRC project 3A-109) to assess the impact of increasing dietary lecithin concentration on pork tenderness (0, 4, 20 or 80 g lecithin/kg diet). Diets were fed to individually housed finisher pigs for a period of six weeks prior to slaughter (12 female pigs per treatment, start weight 63 kg). Diets were based on summer specifications (DE 14.2 MJ/kg, 0.52 g available lysine/ MJ DE) and contained high levels of added fat (4.5 % added tallow). Of interest, the growth performance results from this study showed an increase in carcass weight and dressing percentage associated the lecithin supplementation. Following slaughter, meat quality assessment found no impact of dietary lecithin on muscle pH, drip loss, cooking loss or shear force. Interestingly, there were however differences in the colour of the loin due to lecithin supplementation. Loins from pigs offered the lecithin diets were found to have lower lightness (L*) and higher redness (a*) values. It has been hypothesised that these changes in loin colour may indicate an increase in iron content of the meat (H. Akit personal communication).

Further investigation is warranted to assess the impact of low dose dietary lecithin supplementation on growth performance and carcass characteristics of group housed finisher pigs. Further investigation is also required to define the impact of lecithin supplementation during the finisher period on additional aspects of meat quality including the iron content of pork. As such, this study tested the hypothesis that the inclusion of dietary lecithin can increase carcass weight and dressing percentage of female and Improvac vaccinated male pigs when pigs are housed in groups. In addition, this study tested the hypothesis that dietary lecithin supplementation increases the iron content of pork.

2. Methodology

Animals and treatments

A total of 256 pigs (Large White x Landrace, PrimeGro™ Genetics) were identified at 17 weeks of age and transferred to finisher accommodation (pens of 8 pigs of the same sex, 0.84 m2/pig). Pigs were selected over a 2 week period commencing May 2011. Pen weights were recorded at entry to the finisher pens (average pig weight 66.2 kg ± 0.61 kg) and pens randomly allocated to a 2 x 2 factorial experiment with the respective factors being dietary lecithin supplementation (0 or 5 g/kg) and sex (female and Improvac vaccinated male). The composition of the two test diets are displayed in Table 1. All diets were formulated to contain 0.52 g available lysine/ MJ DE and 13.8 MJ DE/kg. Diets were pelleted and fed ad libitum from 17 weeks of age through to slaughter at 22 weeks of age. All animals had ad libitum access to water via nipple drinkers for the entire experimental period. All procedures outlined in this investigation were approved by the Rivalea Animal Care and Use Committee.

Management and measures

The priming Improvac vaccination was administered at 13 weeks of age and the second vaccination at 17 weeks of age. Pen weights were recorded at the beginning of the experimental period (day 0, 17 weeks of age) and again at day 14. At day 35 (pre-slaughter), individual live weights were obtained to enable the accurate measurement of dressing percentage on a pen basis. Pen feed intake was recorded day 0-14 and day 14-35 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 individual hot standard carcass weight (HSCW) and fat depth at the P2 site (65mm from the midline, measured using a PorkScan ultrasound system) were measured. Dressing percentage was calculated from the individual live weight and carcass weight measures and analysed on a pen basis.

Twenty-four hours after slaughter, a subset of 64 carcasses (2 pigs per pen) were followed through the boning room for collection of the loin (*longissimus dorsi*) from one side of the carcass. Colour (L*, a*, b*) measures were obtained on each of the loins as was pH (45mins and 24 hrs post slaughter). A sub sample of each loin was analysed for iron content (Regional Laboratory Services, Benalla VIC).

Statistical analyses

Differences in growth performance and carcass characteristics due to the main effects of dietary lecithin supplementation and sex were analysed using an analysis of variance for a randomized design. Replicate was included in the model as a blocking factor. The experimental unit for all analyses was the pen of pigs.

Differences in loin colour, pH and iron content from the subset of animals were determined using analyses of variance. Replicate was again included in the model as the blocking factor. All analyses were performed using Genstat 8th Edition (Payne *et al.* 2005).

Table 1 - Ingredient composition and analysed nutrient profile of each of the experimental finisher diets, % of diet (as fed basis).

	Control	Lecithin
Wheat	59.9	59.9
Barley	8.0	8.0
Millmix	13.6	13.6
Canola meal	7.0	7.0
Meat meal	3.8	3.8
Water	1.0	1.0
Natuphos 5000	0.01	0.01
Porzyme	0.02	0.02
Tallow	4.6	4.6
Salt	0.2	0.2
Limestone	1.3	1.3
Lysine HCL	0.36	0.36
DL-Methionine	0.03	0.03
Threonine	0.12	0.12
Copper premix	0.10	0.10
Rivalea finisher premix	0.07	0.07
Rumensin	0.08	0.08
Lecithin		0.5
Estimated nutrient composition, %*		
DE, MJ/kg	14.2	14.2
Crude protein	15.2	15.2
Crude fat	6.3	6.3
Crude fibre	4.1	4.1
Total Lysine	0.87	0.87
Available lysine: DE ratio g/MJ DE	0.52	0.52

*Estimated from Rivalea Australia Pty Ltd composition data

3. Outcomes

There were no negative effects of lecithin supplementation on animal welfare during this study. There were no deaths or removals during the 35 day test period. One animal that had been offered the lecithin diet died in lairage prior to slaughter (cause undetermined). As such the final live weight (day 35) of this animal was removed from the pen calculations for dressing percentage.

The impact of dietary lecithin supplementation on feed intake and growth performance during the finisher period is displayed in Table 2. During the initial 14 day period the response to lecithin supplementation differed between the sexes. While there were no main effects of lecithin supplementation on feed intake and weight gain during this time, feed intake was higher in the gilts offered the lecithin diets, while the opposite was true for the Improvac vaccinated males. Reflecting the response in feed intake, rate of gain was greater in the females when offered the lecithin diet, while lecithin supplementation appeared to reduce growth rate of the Improvac vaccinated males. The enhanced feed intake and rate of gain of the female finishes offered the lecithin diets resulted in an improvement in feed efficiency during this time. In contrast, there was little difference in the efficiency of feed utilization between the Improvac males offered the control or lecithin diets.

During the subsequent period from 14 to 35 days pigs that were offered the lecithin diet consumed approximately 4 % less feed (ADFI 3.15 and 3.02 kg/d

respectively for the control and lecithin treatment groups, P=0.13) and displayed a small improvement in rate of gain. These minor changes resulted in a strong trend for improved feed utilisation during this time (FCR: 3.12 and 2.95 kg feed/kg gain for the control and lecithin treatments respectively, P=0.051).

Over the entire experimental period, pigs offered the lecithin diet utilized feed for weight gain more efficiently than pigs offered the control diet (FCR 2.96 and 2.79 kg/kg respectively for the control and lecithin treatment groups, P=0.006). This improvement was due to a small (non-significant) reduction in feed intake (2.91 and 2.81 kg/d respectively) coupled with a similar rate of gain over the entire test period (0.99 and 1.01 kg/d respectively). There was no impact of dietary lecithin supplementation on final live weight, carcass weight, P2 back fat depth or dressing percentage (Table 2).

Growth performance did differ between the sexes, with the Improvac vaccinated males consuming more feed, gaining weight faster and utilizing feed for weight gain more efficiently than the females over the entire test period. While the Improvac vaccinated males were heavier at slaughter, P2 back fat depth was similar between the sexes when corrected for carcass weight. Dressing percentage was lower in the Improvac males (78.5 and 76.0 % respectively for the females and Improvac vaccinated males, P<0.001).

There was no impact of lecithin supplementation on meat quality (Table 3). All measures of pH, colour and loin iron content were similar between the control and lecithin treatments. There was also no impact of sex on any of these meat quality measures.

Table 2 - Influence of lecithin on feed intake, growth rate and carcass characteristics of gilts and Improvac vaccinated males.

	Female		**Improvac Male**			**Significance**		
	Control	**Lecithin**	**Control**	**Lecithin**	**SED**	**Sex**	**Diet**	**Sex x Diet**
Live weight								
Day 0	65.1	65.1	67.3	67.3	0.70	<0.001	1.00	0.98
Day 35*	96.8	98.5	105.3	104.7	1.31	<0.001	0.53	0.18
0-14 days								
ADG (kg/d)	0.83	0.95	1.09	1.00	0.042	<0.001	0.65	0.002
ADFI (kg/d)	2.48	2.53	2.61	2.45	0.066	0.60	0.26	0.028
FCR (kg/kg)	3.04	2.68	2.40	2.46	0.114	<0.001	0.068	0.015
14-35 days								
ADG (kg/d)	0.87	0.87	1.17	1.20	0.048	<0.001	0.64	0.66
ADFI (kg/d)	2.76	2.64	3.54	3.39	0.120	<0.001	0.13	0.87
FCR (kg/kg)	3.22	3.07	3.02	2.82	0.121	0.015	0.051	0.75
0-35 days								
ADG (kg/d)	0.85	0.90	1.14	1.12	0.037	<0.001	0.56	0.21
ADFI (kg/d)	2.65	2.60	3.17	3.02	0.091	<0.001	0.12	0.43
FCR (kg/kg)	3.13	2.90	2.78	2.69	0.078	<0.001	0.006	0.21
Carcass characteristics								
Carcass weight (kg)*	75.5	76.8	80.3	80.1	1.04	<0.001	0.39	0.29
Carcass P2 (mm)^	10.8	10.2	10.5	10.8	0.40	0.49	0.40	0.067
Dressing %	78.4	78.5	75.9	76.1	0.47	<0.001	0.70	0.79

* Weight day 0 included as a covariate in the analysis

^ Carcass weight included as a covariate in the analysis

Table 3 - Influence of lecithin supplementation during the finisher period on measures of meat quality (n= 32 per treatment)

	Sex		SED	Diet		SED	Significance		
	Female	Improvac	Sex	Control	Lecithin	Diet	Sex	Diet	Sex x Diet
pH									
pH(45 mins)	6.4	6.4	0.08	6.4	6.4	0.08	0.93	0.41	0.58
pH (24 hrs)	5.8	5.8	0.05	5.8	5.8	0.05	0.47	0.81	0.99
Colour									
L*	49.00	48.83	0.420	48.96	48.88	0.420	0.68	0.85	0.085
a*	5.85	5.89	0.217	5.74	6.00	0.217	0.85	0.22	0.63
b*	2.01	2.16	0.166	2.10	2.08	0.166	0.37	0.91	0.41
Iron content (mmol/kg)	0.053	0.053	0.0014	0.053	0.054	0.0014	0.86	0.22	0.86

4. Application of Research

The results from this study do not support the hypothesis that the inclusion of lecithin in the diet of finisher pigs improves carcass weight and/or dressing percentage. The measure of live weight pre-slaughter on an individual basis enabled an accurate assessment of dressing percentage on a large number of animals, with the results failing to support the findings from the pilot study (Pork CRC project 3A-109).

The results of this study do however provide evidence for enhanced feed efficiency when lecithin is incorporated into diets containing high levels of added fat (tallow). In this study, the diets contained 4.6 % added tallow, with total dietary fat around 6.3 %. It is likely that this improvement in efficiency is a product of the emulsifying properties of lecithin in these high fat diets. As such, the use of lecithin to improve finisher feed efficiency may best be suited to the summer period where the level of added fat in the diet is typically much higher than at other times of the year. Numerous studies have investigated the impact of lecithin addition in the diet of weaner pigs to improve fat digestibility and growth performance (Jones *et al.* 1992; Overland *et al.* 1993; Reis de Souza *et al.* 1995). While the results from these studies did vary, Jones *et al.* (1992) reported that the source of dietary fat had a major impact on the response to added lecithin. Lecithin improved the apparent digestibility of total fat from 80.9 % to 88.4 % when lecithin was incorporated into weaner diets containing tallow as the predominant fat source. On the other hand, the addition of lecithin to diets utilizing soybean oil or coconut oil as the dietary fat source did not show the same level of improvement. It is likely that the source of dietary fat will also impact on the response of finisher pigs to lecithin supplementation.

The meat quality assessment found no significant effects of dietary lecithin supplementation on pH, colour or iron content of the loin. These results are in contrast to those observed in the pilot CRC study (3A-109), where loins from pigs offered the lecithin diets were found to have lower lightness (L*) and higher redness (a*) values (Akit *et al.* 2010). The results do however agree with those of Edmunds *et al.* (2005) where the supplementation of grower and finisher diets with up to 75 g/kg lecithin had no impact on 24 hr pH or colour of the *longissimus thoracis* muscle 24 hrs after slaughter. In addition, it was hypothesised that the changes in loin colour observed in the CRC pilot study may indicate an increase in iron content of the meat (H. Akit personal communication). The results from the analyses of the loins do not support this hypothesis.

5. Conclusion

The results from this study do not support the use of lecithin in the diet of finisher pigs at 5 g/kg to improve carcass weight, dressing percentage, pork colour or iron content of the loin. The results do however suggest that lecithin may be a worthwhile component in finisher diets containing high levels of added fat (tallow) to improve the efficiency of feed utilization.

6. Limitations/Risks

The improvement in the efficiency of feed utilization with dietary lecithin is likely to be dependent on the use of high levels of added fat to the diet and may vary with dietary fat source. The response is likely to be reduced in diets containing a lower concentration of added fat, and in diets in which the source of added fat is predominately of vegetable origin.

7. Recommendations

As a result of the outcomes in this study the following recommendations have been made:

- The supplementation of finisher diets with 5 g/kg lecithin to improve carcass weight or dressing percentage is not supported at this time.
- The supplementation of finisher diets with 5 g/kg lecithin to influence colour and/or iron content of the loin is not supported at this time.
- The addition of lecithin to diets high in added fat (tallow) to improve feed efficiency is worthy of further consideration.

8. References

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