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Dietary lecithin improves dressing percentage and decreases chewiness in the *longissimus* muscle in finisher gilts

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ABSTRACT

The influence of dietary lecithin at doses of 0, 4, 20 or 80 g/kg fed to finisher gilts for six weeks prior to slaughter on growth performance, carcass quality and pork quality was investigated. *M. longissimus lumborum* (loin) was removed from 36 pig carcasses at 24 h post-mortem for Warner–Bratzler shear force, compression, collagen content and colour analyses. Dietary lecithin increased dressing percentage ($P = 0.009$). Pork chewiness and collagen content were decreased by dietary lecithin ($P < 0.05$, respectively), suggesting that improved chewiness may be due to decreased collagen content. However, dietary lecithin had no effect on shear force, cohesiveness or hardness ($P > 0.05$, respectively). Dietary lecithin reduced loin muscle L* values and increased a* values ($P < 0.05$, respectively) but no changes on b* values ($P = 0.56$). The data showed that dietary lecithin improved dressing percentage and resulted in less chewy and less pale pork.

1. Introduction

Tenderness is regarded as one of the most important eating quality characteristics, with tough meat being considered unacceptable to consumers (Channon, Kerr, & Walker, 2004; Wood et al., 1999). Thus, improvement of pork tenderness is particularly important to increase consumer satisfaction. The myofibrillar proteins and intramuscular connective tissue collagen are components of muscle that are known to affect meat tenderness. The myofibrillar component is primarily associated with post-mortem conditions prior to, during, and following the onset of rigor mortis whereas, the collagen component is primarily related to factors inherent to the animal and during cooking (Jeremiah, Dugan, Aalhus, & Gibson, 2003). The amount of collagen, the extent of collagen cross-linking and the types of collagen could influence meat texture (Purslow, 2005). During cooking several of the collagen characteristics are modified where some characteristics that contributed to the mechanical strength of raw meat have minimal or no effect on cooked meat strength. When meat is heated, the interactions between muscle fibres and collagen contribute further to the complexity of cooked meat texture (Lepetit, 2008).

Lecithin has anti-fibrogenic effects as it reduces hepatic collagen accumulation in liver fibrosis (Aleynik, Leo, Ma, Aleynik, & Lieber, 1997; Ma, Zhao, & Lieber, 1996). Dietary lecithin at 3 kg/g fed to gilts for 14 weeks prior to slaughter reduced pork chewiness and hardness (D'Souza, Mullan, Pethick, Pluske, & Dunshea, 2012). These improvements were suggested to be associated with decreased collagen content and extent of cross-linking, although these parameters were not measured. Hence, it was hypothesised that dietary lecithin could decrease pork chewiness and hardness through reducing muscle collagen content. Lecithin is also an emulsifier and it increased pork polyunsaturated fatty acid content (Kim, Shinde, & Chae, 2008). However, little is known about the effect of dietary lecithin on other aspects of carcass and meat quality. The aim of this study was to investigate the effects of varying levels of dietary lecithin (higher than the lecithin levels used in the previous reports) on growth performance, carcass quality, meat quality and muscle collagen content.

2. Materials and methods

2.1. Animals and experimental procedure

The experiment was conducted at Rivalea (Australia), Corowa, NSW and all procedures outlined in this investigation were approved by the Rivalea Animal Care and Ethics Committee. Thirty six Large White × Landrace finisher (PrimeGro™ Genetics, Rivalea Pty Ltd, NSW, Australia) gilts were randomly allocated into individual pens at entry to the facility at 15 weeks of age with an average weight of 55.9 ± 2.22 kg (mean ± SD). During a one-week acclimatisation period, the pigs were fed the control diet (commercial finisher diet) at 80% ad libitum. After the acclimatisation period, the pigs were split

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into three blocks (three replications) and started on the test diets over three days (to facilitate sell out and carcass data collection over three days). The test diets were randomly allocated within each of the block that included (i) control diet; (ii) soybean lecithin (ADM Australia Pty Ltd, NSW, Australia) at 4 g/kg of commercial finisher diet; (iii) soybean lecithin at 20 g/kg of commercial finisher diet; and (iv) soybean lecithin at 80 g/kg of commercial finisher diet. The composition of the four test diets is displayed in Table 1. All diets were formulated to contain 0.6 g available lysine/MJ of digestible energy (DE) and 14.2 MJ DE/kg. Diets were pelleted and fed to the pigs starting from 17 weeks old through to slaughter at 23 weeks old. All pigs had ad libitum access to feed and water via nipple drinker for six weeks prior to reaching an average final slaughter live weight of 103.9 ± 6.40 kg (mean ± SD).

2.2. Growth performance and carcass quality assessment

Individual live weights were recorded at the beginning of the experimental period Day 0 (17 weeks of age) and again at Day 21 and Day 42. Feed intake was recorded weekly as measured by feed disappearance. The pigs were slaughtered in a commercial abattoir at the conclusion of the 42 day experimental period. The pigs were stunned using a carbon dioxide Dip-lift stunner (Butina®, Sjelland, Denmark) set at 85% CO_2 and exposed for 1.8 min. Exsanguinations, scalding, dehairing and evisceration were performed according to the standard procedures practised in commercial abattoirs. The carcasses were split before entering the chillers (air temperature 5 °C to −2 °C cycle; air speed 4 m/s). The individual hot standard carcass weight was recorded. Loin muscle depth and fat depth at the P2 site (65 mm from the midline over the last rib) were measured using a PorkScan ultrasound system (PorkScan Pty Ltd, Canberra, Australia). Dressing percentage was calculated from the individual live weight and carcass weight measures. The pH of loin muscle between 12th and 13th rib was measured at 45 min and 24 h post-slaughter using a portable pH/temperature metre Model 6009 (Jenco Electronic Ltd, Taipei, Taiwan) fitted with a polypropylene spear-type gel electrode (Ionode IJ42S, QLD, Australia) and a temperature probe.

Table 1
Ingredient composition and analysed nutrient profile of each of the experimental finisher diets as a percentage of diet on an as-fed basis.

	Control	Lecithin (4 g/kg)	Lecithin (20 g/kg)	Lecithin (80 g/kg)
Wheat	62.4	58.0	56.8	53.0
Barley	10.6	15.0	15.0	14.4
Millmix	13.9	12.9	13.0	14.0
Canola meal 36%	3.4	4.0	4.4	5.0
Meat meal	1.5	1.5	1.5	2.1
Water	1.0	1.0	1.0	1.0
Natuphos 5000	0.01	0.01	0.01	0.01
Porzyme 9310	0.02	0.02	0.02	0.02
Tallow	4.5	4.5	3.60	0
Salt	0.2	0.2	0.2	0.2
Limestone	1.8	1.8	1.8	1.7
Lysine HCl	0.44	0.44	0.43	0.42
Threonine	0.15	0.14	0.14	0.14
Copper premix	0.10	0.10	0.10	0.10
Rivalea finisher mix	0.07	0.07	0.07	0.07
Rumensin 100	0.08	0.08	0.08	0.08
Red micro-grits	0.1	0.1	0.1	0.1
Betaine	0.1	0.1	0.1	0.1
Lecithin	0	0.4	2.0	8.0
Estimated nutrient composition[a]				
DE, MJ/kg	14.2	14.2	14.2	14.2
Dry matter	89.1	89.1	89.0	89.2
Crude protein	15.4	15.4	15.3	15.4
Crude fat	6.0	6.2	6.1	5.9
Crude fibre	3.8	3.9	4.0	4.0
Total lysine	0.85	0.85	0.85	0.85
Available lysine: DE ratio g/MJ DE	0.60	0.60	0.60	0.60

[a] Estimated from Rivalea Australia Pty Ltd (NSW, Australia) composition data.

2.3. Meat quality assessment

Twenty-four hours post-slaughter the *longissimus lumborum* muscle (loin) was removed from the right side of each pig carcass. Colour (L*, a* and b*) was measured with a Minolta Chromameter CR-400 (Minolta, Osaka, Japan) using D65 lighting, a 2° standard observer, and an 8-mm aperture in the measuring head, standardised to a white tile after a bloom time of 30 min. L* values correspond to lightness, a* values to redness and b* values to yellowness in the three-dimensional HunterLab colour space. Drip loss on the loin chops was measured using the suspension method (Honikel, 1998). The loin muscle was cut to a 40 g strip (40 × 10 × 80 mm). The strip was weighed then hung in a plastic zip lock bag and placed in a temperature controlled cabinet at 2 °C for 24 h. Excess moisture was then lightly removed from the muscle surface and samples were re-weighed. Drip loss was calculated and the weight loss was expressed as a percentage of initial weight. The loin muscle samples for collagen content analysis were vacuum packed and stored at −20 °C until ready for use. Meanwhile, loin muscle samples for texture analysis were vacuum packed and left to age for five days at 4 °C. Following ageing, the muscle samples were stored at −20 °C until ready for use.

2.4. Pork texture assessment

2.4.1. Sample preparation and cooking method

The cooking procedure was adopted from the method of Bouton, Harris, and Shorthose (1971). The loin muscle was cut to a 70 ± 5 g cube (40 × 40 × 40 mm). The cube was weighed then cooked in water bath at 70 °C for 35 min. After removal from the water bath, the samples were allowed to cool in ice cold water for 20 min, patted dry to remove excess moisture and re-weighed before being refrigerated overnight. The weight loss during cooking was calculated as a percentage of weight loss before and after cooking.

2.4.2. Warner–Bratzler shear force and compression analyses

Assessment of the cooked meat texture was determined using Warner–Bratzler shear force and compression analyses as described by Bouton and Harris (1972a). For shear force, the sample was cut into six rectangular strips of 1 cm^2 cross section, parallel to the muscle fibres. Shear force blade (V-shaped) was fitted to the LF Plus machine (Lloyd Instruments Ltd, Fereham Hants, UK) and the crosshead speed was set at 300 mm/min and a 1 kN load cell was used. The mean of the peak shear force was used as an estimate of tenderness. For compression analysis, the sample was cut into six cross-section samples (1 cm thick) with the fibres lying perpendicular on the face of the largest area. A flat-ended plunger with 0.63 cm surface diameter was fitted to the LF Plus machine. Firstly, the plunger was driven vertically at about 80% through the sample. The peak force required for the first compression was measured and this is defined as hardness. Secondly, the plunger was withdrawn and then returned to the same damaged area to measure the work done in repeating the first action. Cohesiveness is defined as the ratio of the work done during the second compression and that done during the first compression. Chewiness is defined as the product of hardness and cohesiveness (Bouton and Harris, 1972a).

2.4.3. Collagen content analysis

Hydroxyproline content was determined using a colorimetric method developed by Kolar (1990) with minor modifications. Hydroxyproline was oxidised to pyrrole with chloramine-T reagent. Then, the complex formed by the liberated pyrrole and 4-dimethylaminobenzaldehyde was determined by the colorimetric method. The absorbance values of the sample solutions were measured on a plate reader (Thermo Multiskanner®, Vantaa, Finland) at 558 nm wave length. The concentration of hydroxyproline (μg/ml) was determined from a standard curve. A factor of 7.46 was used to convert hydroxyproline values into