Breed Variation in Wool Quality, Growth and Plasma Metabolites of Prime Lambs Fed Degummed Canola

A.E.O. Malau-Aduli[1,2], P.D. McEvoy[1], D. Parsons[1] and P.A. Lane[1].
[1]Anim Sci & Gen, TIA, Sch of Land & Food, University of Tasmania, [2]Vet & Biomed Sci, James Cook University, Australia

ABSTRACT: Purebred and first-cross Merino prime lambs were supplemented with degummed canola and had *ad libitum* access to lucerne hay in a nine-week feeding trial. The main objective was to evaluate the effects of supplementation, sire breed and sex on wool quality, digestibility, plasma metabolites, growth and body conformation of lambs sired by Dorset, White Suffolk and Merino rams under identical management conditions. Significant sire breed differences ($P<0.05$) in withers height, wool fibre diameter, wool yield and wool brightness were detected. However, degummed canola supplementation and sex had no effect on wool quality, plasma metabolites, dry matter intake, digestibility or average daily gain ($P>0.05$). These findings suggest that dual-purpose sheep producers can better manage and match their prime lamb breeding goals with feed resources by supplementing purebred Merino and terminally sired first cross Merino lambs with degummed canola without deleterious consequences on wool quality or fat-lamb income streams.
Keywords: Degummed canola; Prime Lambs; Wool; Sheep

Introduction

The growing profitability of dual-purpose meat and wool sheep enterprises has increased the complexity of breeding objectives in modern Australian sheep farming. The significant shift in the relative prices of wool and meat has been a dominant factor leading to wool producers adopting mixed commercial enterprises to provide flexibility and resilience against price variations (Warn et al., 2006).

In the absence of genetic antagonisms between meat and wool traits, breeders are increasingly combining the fine wool quality characteristics of Merino genetics with desirable carcass and growth traits of terminal sires to fully exploit heterosis in prime lamb production (Safari et al., 2005; Fogarty et al., 2005; Holman & Malau-Aduli 2012). However, there are now growing demands for the development and measurement of new attributes within lamb meat such as intramuscular fat, meat colour and omega-3 fatty acids (Mortimer et al., 2010). Long-chain polyunsaturated omega-3 fatty acids (LC PUFA n-3) play a critical role in the development of brain and retinal tissues and in the prevention of human diseases (Simopoulos, 1991; Kris-Etherton et al., 2002; Gebauer et al., 2006). Producers are under market-driven demand to improve the lipid profile of their animal products (Ponnampalam et al., 2006). Therefore, demands for the inclusion of these characteristics within genetic advancement programs gives credence to the value of undertaking sheep feeding trials targeting improvements of these attributes (Mortimer et al., 2010). Numerous studies have investigated the impact of different sources of omega-3 on lamb muscle. These include linseed and intensive pasture finishing (Kitessa et al., 2010), fish meal, canola meal and soy meal (Ponnampalam et al., 2001a), safflower, sunflower seed (Peng et al., 2010), fish oil (Ponnampalam et al., 2001b) and microalgae (Holman and Malau-Aduli 2013). Previous studies comparing lupins and canola by White et al., (2000) and Masters and Mata (1996) showed increased wool growth in response to canola, while Karlsson and Martinsson (2011) demonstrated improved lamb growth performance. Canola is favoured as a replacement to lupins because canola contains 2-5 times more of the essential amino acid methionine, has higher feed conversion efficiency and is more rumen- protected than lupins (Wiese et al., 2003). Thus, canola based supplements are increasingly included in diets for finishing lambs. However, despite the breadth of research undertaken, none has specifically looked at the impact of LC-PUFA n-3 on wool quality traits. This represents a major knowledge gap. Therefore, this study investigated the effects of degummed canola supplementation on wool quality and growth traits, plasma metabolite profiles, dry matter intake and digestibility in genetically divergent lambs under the same management conditions.

Materials and Methods

Animals and measurements. Twenty-four six months old lambs (average LW of 30.3 Kg and BCS 2.1) from Merino dams sired by Dorset, White Suffolk and Merino rams were randomly allocated into 3 treatments (8 lambs per treatment) and supplemented with 1Kg of an iso-energetic and iso-nitrogenous degummed canola oil based pellet per day for nine weeks at the following levels: a) High = 50mL/Kg, b) Control = no degummed canola-oil, and c) Medium = 50% high and 50% control pellets. All lambs were dewormed, allowed a three-week adjustment period, confined in 0.6 x 1.2m individual metabolic crates and had *ad libitum* access to lucerne hay and water. Dry matter intakes were recorded daily, body conformation and liveweight traits were taken weekly, while wool and blood samples were collected at the beginning and end of the experiment. Wool quality traits evaluated included mean fibre diameter (MFD), coefficient of variation, standard deviation, comfort factor, curvature, yield and colour (brightness and yellowness).

Feed analysis. Dry matter content of feed was determined by drying samples to a constant weight at 65°C in a fan-forced oven. Ash content was determined by combusting samples in a furnace at 550°C for 5 hours. Neutral detergent fibre and acid detergent fibre contents were measured using an Ankom fibre analyser (ANKOM^{220}; ANKOM Technology, USA) (van Soest *et al.* 1991). Total N content was measured using the Kjeldahl method; these values were multiplied by 6.25 to compute crude protein values. Ether extract was determined using an Ankom fat/oil extractor (ANKOM^{XT15}; ANKOM Technology, USA).

Table 1. Nutrient composition of experimental feed [¥]

Component[§]	High	Control	Lucerne hay
MC	8.2	9.1	14.4
Dry Matter	91.8	90.9	85.6
Crude Protein	12.7	10.4	17.0
ADF	8.0	9.0	44.9
NDF	20	21.1	36.2
CF	6.2	2.1	9.3
Ash	9.7	8.9	6.8
TDN	75.7	72	55.3
NEL	0.8	0.8	Not available
NEM	0.8	0.8	Not available
NDFn	18.6	19.6	33.5
NFC	52.8	59	35.2
ME (MJ kg^{-1} DM)	12.11	11.43	8.4

[¥] MC = moisture content, %DM = percentage dry matter, RDP = rumen degradable protein, NDF = neutral detergent fibre, ADF= acid detergent fibre, NDFn = nitrogen free NDF, NFC = non-fibrous carbohydrate, CF = crude fat, TDN = total digestible nutrients, NEL = net energy of lactation, NEM = net energy of maintenance and ME = metabolisable energy.

Plasma metabolites. Blood samples were collected via jugular venipuncture in heparin tubes and centrifuged at 1,000 x g for 15 min at 4^{0}C (Carro et al., 2006; Ponnampalam et al., 2001b). Plasma was separated and immediately frozen at -20^{0}C until determination of urea, calcium (Ca2+), magnesium (Mg2+), βeta-hydroxybutyrate (BHB), cholesterol (Chol), glucose (Glu) and non-esterified fatty acids (NEFA).

Statistical analysis. All data were analysed using PROC GLM (Statistical Analysis System). Initial summary statistics were calculated and scrutinised for error. The model tested the fixed effects of supplementation level, sire breed, sex and their interactions. Differences between mean values established using Tukey's test at $P<0.05$ threshold.

Table2. Effect of sire breed, omega-3 supplementation level and sex on wool quality (LSM± SE).

	Fibre diameter (µm)	CF (%)	Y-Z
Sire breed			
Dorset	23.8 ± 0.90^a	92.95 ± 1.31^c	8.9 ± 0.1^a
White Suffolk	21.8 ± 0.7^b	96.12 ± 1.05^b	8.8 ± 0.1^a
Merino	16.9 ± 0.8^c	99.70 ± 0.06^a	7.3 ± 0.2^b
Level			
Control	20.5 ± 0.9	96.6 ± 1.1	8.5 ± 0.2
Medium	21.3 ± 0.8	95.5 ± 1.0	8.8 ± 0.1
High	20.7 ± 0.9	95.7 ± 1.4	8.6 ± 0.1
Sex			
Ewes	20.6 ± 0.6	97.1 ± 0.9	8.7 ± 0.2
Wethers	21.1 ± 0.8	95.4 ± 1.1	8.6 ± 0.1

[¥] CF =Comfort factor, Y-Z=Yellowness. Column means bearing different superscripts differ ($P<0.05$)

Results and Discussion

Omega-3 supplementation induced no significant changes in wool quality traits (Table 2). This indicates that wool quality is not impacted upon by time-limited dietary provisions of omega-3 fatty acids. It may well be that nutrient partitioning following digestion and absorption of degummed canola favours both wool and muscle development without detrimental impacts. Expected sire breed differences were detected, with the finest quality wool seen in the superfine Merinos, followed by the White Suffolks and Dorset sired progeny (Table 2). The Merinos also had the finest fibre diameter and greatest wool yield compared to White Suffolk and Dorset sired lambs. This reaffirms the known decrease in follicle density and reduced proportion of secondary fine fibre follicle initiation, seen with cross-bred sheep (Hocking-Edwards et al., 1996; Rogers 2004). Beneficial properties of the iso-energetic feed supplement provided for Merinos, were also shown through omega-3 interactions with wool brightness. The medium omega-3 supplemented Merinos showed the most promising results for wool brightness index. This reflected variable nutrient partitioning between sire breeds and the influence of the maternal Merino in wool growth of first cross lambs. It is also indicative of the expected increased wool variability seen with paternal sire breed genetics. Small variations in wool quality with sex were most likely associated with hormonal variation affecting nutrient partitioning pathways.

Liveweight, body conformation parameters (chest girth, withers height, body length) and feed conversion ratio (feed consumed/weight gained) were not significantly affected by canola-oil based omega-3 supplementation. No differences were detected between the sexes; while increased withers height growth in White Suffolk was the only effect observed between sire breeds. Regardless of the

level of omega-3 supplementation, dry matter intake and digestibility did not differ between sire breeds or sex, which was reflective of the diets being homogenous for energy content, acid detergent fibre and neutral detergent fibre. It also further highlighted the impact of the maternal Merino genetics in suppressing sire breed feed efficiency differences that may be otherwise detected in a purebred scenario.

Table 3. Effect of sire breed on plasma metabolites (mmol/L).[¥]

	Urea	Ca	Mg	BHB	Chol	Glu	NEFA
Dorset	6.8	2.6	1.0_{ab}	0.4	1.4	3.9^{b}	0.2
Merino	6.9^{b}	2.6	1.0_{b}	0.4	1.3	4.5^{a}	0.3
White Suffolk	8.5^{a}	2.6	2.1_{a}	0.4	1.3	3.7^{c}	0.3

[¥] Within column means bearing different superscripts differ ($P<0.05$)

Plasma metabolite analysis was carried out mainly as a health index to see if the liver or kidney was being over-loaded with metabolic stress, but the results in Table 3 further demonstrate sire breed variation without any negative health implications associated with omega-3 supplementation. The differences detected in omega-3 supplemented lambs with regards to Mg and Glucose were within the expected range.

Conclusions

This study showed supplementation with degummed canola did not affect plasma metabolite profile, wool quality or growth traits; however, sire breed did. These outcomes indicate that about 18-20% of the residual variance in supplemented prime lambs is attributable to sire genetics, which can be appropriately harnessed by producers to match supplementary feeds to meet dual-purpose specifications dictated by the market.

Literature Cited

Carro, M. D., Ranilla, M. J., Giraldez, F. J. et al., (2006). J. Anim. Sci. 84:405-410.

Fogarty, N. M., Ingham, V. M., Gilmour, A. R. et al., (2005). Aust. J. Agr. Res. 56:455-463.

Gebauer, S. K., Psota, T. L., Harris, W. S. et al., (2006). Am. J. Clin. Nutr. 83:1526-1535.

Hocking Edwards, J. E., Birtles, M. J, Wickham, G. A. et al., (1996). J. Agric. Sci. 126:363-370.

Holman, B. W. B., and Malau-Aduli, A. E. O (2013). J. Anim. Physiol. A. Nutr. 97:615-623.

Holman, B. W. B., Kashani, A., and Malau-Aduli, A. E. O (2012). Am. J. Exp. Agr. 2:160-173.

Karlsson, L., and Martinsson, K. (2011). Livest. Sci. 138: 125-131.

Kitessa, S., Liu, S., Briegel, J., et al. (2010). Anim. Prod. Sci. 50:130-137.

Kris-Etherton, P. M., Harris, W. S., Lawrence, J. et al., (2002). Circulation 106:2747-2757.

Masters, D. G., and Mata, G. (1996). Aust. J. Agric. Res. 47:1291-1303.

Mortimer, S. I., van der Werf, J. H. J., Jacob, R. H. et al., (2010). Anim. Prod. Sci. 50:1135-1144.

Ponnampalam, E. N., Mann, N. J., and Sinclair, A. J. (2006). Asia Pacific J. Clin. Nutr. 15:21-29.

Ponnampalam, E. N., Sinclair, A. J., Egan, A. R. et al., (2001a). J. Anim. Sci. 79:698-706.

Ponnampalam, E. N., Sinclair, A. J., Egan, A. R., et al., (2001b). J. Anim. Sci. 79:895-903.

Rogers, G. E. (2004). Int. J. Dev. Biol. 48: 163-170.

Safari, E., Fogarty, N. M., and Gilmour, A. R. (2005). Livest. Prod. Sci. 92:271-289.

Simopoulos, A. P. (1991). Am. J. Clin. Nutr. 54:438–463.

Van Soest, P. J., Roberts, J. B., and Lewis, B. A. (1991). J. Dairy Sci. 74:3583-3597.

Warn, L. K., Geenty, K. G., and McEachern, S. (2006). Int. J. Sheep Wool Sci. 54: 60-69.

Wiese, S. C., White, C. L., Masters, D. G., et al., (2003). Aust. J. Expt. Agric. 43:1193-1197.

White, C. L., Young, P., Phillips, N., et al. (2000). Aust. J. Agric. Res. 51:173-183.