Feed Intake Variation in Crossbred Lambs Supplemented with Spirulina

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ABSTRACT: Genetically divergent prime lambs were supplemented with Spirulina and had *ad libitum* access to Lucerne hay in a nine-week feeding trial. The main objective was to model residual feed intake, liveweight gain, standardised daily feed intake (SDFI), feed conversion ratio and daily feed intake (DFI) and test for sire breed and sex variations. Level of Spirulina supplementation and sex were found to have no independent effects on lamb feed intake (P>0.05). However, DFI and SDFI in Merino sired lambs were lower than in their crossbred counterparts (P<0.023). Merino ewe lambs consumed more Lucerne hay than wethers (P<0.05). These findings could prove useful when balancing feed resources to match Spirulina supplementation levels and lamb breeding management goals.
Keywords: *Arthrospira platensis*; Protein-supplementation; Crossbred; Sheep

Introduction

Spirulina (*Arthrospira platensis*) is a protein-rich cyanobacterium increasingly recognised as a livestock feed and supplement (Holman and Malau-Aduli 2013). Protein supplementation represents a significant cost to Australian prime lamb producers, and research efforts to reduce feed intake without compromising quality and animal growth are desirable.

Lamb supplementation has produced varied effects on feed intake. Doyle et al. (1988) linked oat grain and sunflower meal supplementation with reduced basal diet intake. However, Salisbury et al. (2004) reported that protein supplementation promotes feed intake. Whether this divergence is due to supplement type or lamb sire breed and sex effects is unknown. Therefore, this study investigated the effects of Spirulina supplementation on feed intake in lambs of different sire breeds and sex as obtainable in a typical Australian sheep industry.

Materials and Methods

Animals. Twenty-four lambs were randomly selected from a commercial flock at 6 months of age and randomly allocated into treatment groups representing: 3 sire breeds (Dorset, Merino, White Suffolk;), 4 Spirulina levels (CONTROL 0mL, LOW 50mL, MEDIUM 100mL, HIGH 200mL; and 2 sex categories (ewes, wethers). Spirulina was supplemented daily in a 1g:10mL water suspension using a sheep oral drench. Lambs were also provided 150g of barley grain per day. Throughout the 9-week trial, which included a 3-week adjustment period, all lambs were confined within 0.6 x 1.2m metabolic crates and had *ad libitum* access to Lucerne hay. Daily consumption was recorded.

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). Feed intake was modelled using several industry-applied equations as described by Refstie et al. (1998) and Koch et al. (1963).

Statistical analysis. All data were analysed using Statistical Analysis System (SAS) software. Initial summary statistics were calculated and scrutinised for error. Data were then fitted into a Factorial ANOVA model with Spirulina level, sire breed, sex and their interactions as fixed effects and feed intake values as dependent variables. Duncan's multiple range test was used to interpret differences (P<0.05).

Results and Discussion

This study found Spirulina to contain 65% crude protein, 32.6% NDF, 5.9% EE and 96.0% DM (Table 1). This confirms the nutrient-rich composition of Spirulina over and above that of the basal diet of lucerne hay.

Table 1. Chemical composition of feed elements[¥]

Chemical composition	Spirulina	Lucerne hay
Moisture[§]	4.0	9.4
DM[§]	96.0	90.6
NDF[#]	32.6	36.0
NDFn[#]	30.3	33.5
ADF[#]	18.3	29.0
NFC[#]	7.9	35.2
Ash[#]	9.5	6.9
EE[#]	5.9	1.9
CP[#]	62.2	22.5
ME[¦]	1707.5	1689.3

[¥] Dry matter (DM), neutral detergent fibre (NDF), nitrogen free NDF (NDFn), non fibrous carbohydrate (NFC), acid detergent fibre (ADF), ether extract (EE), indigestible organic matter (IOM), and metabolisable energy (ME).
[§] g/100g Fresh weight. [#]g/100g DM. [¦]kJ.100g DM

Spirulina supplementation had no effect on feed intake in any of the models assessed (*P*>0.05; Table 2). Lamb feed intake has been previously associated with total dietary protein content (Hertz et al. 2012) and NDF to crude protein ratio (Moore et al. 1999). These findings can be summarised as voluntary feed intake which generally increases as feed quality decreases. Consequently, we suggest herein, that levels of Spirulina supplementation in this study were conservatively small as to influence either total dietary NDF:crude protein ratio, hence the non-significant effect observed.

Table 2. Spirulina supplementation level effect on daily feed intake (DFI), residual feed intake model (RFI), residual liveweight gain model (RLG), standardised daily feed intake model (SDFI), feed conversion ratio (FCR) means (standard error).

	CONTROL	LOW	MEDIUM	HIGH
DFI	1.33 (0.04)	1.37 (0.05)	1.34 (0.05)	1.34 (0.05)
RFI	66.76 (0.90)	63.92 (2.50)	65.82 (0.88)	66.47 (2.16)
RLG	19.14 (0.84)	18.83 (0.68)	18.44 (0.84)	19.00 (0.60)
SDFI	23.97 (0.67)	24.90 (0.78)	24.57 (0.79)	25.08 (0.83)
FCR	31.41 (4.54)	28.75 (4.07)	17.02 (1.70)	16.39 (8.36)

Table 3. Sire breed effect on daily feed intake (DFI), residual feed intake model (RFI), residual liveweight gain model (RLG), standardised daily feed intake model (SDFI), feed conversion ratio (FCR) means (± standard error). [¥]

	Dorset	Merino	White Suffolk
DFI	1.41^{a} (0.01)	1.20^{b} (0.02)	1.42^{a} (0.02)
RFI	63.66^{b} (0.63)	69.06^{a} (1.40)	64.50^{b} (1.57)
RLG	19.38^{a} (0.42)	17.25^{b} (0.33)	19.93^{a} (0.60)
SDFI	25.63^{a} (0.15)	22.46^{b} (0.34)	25.80^{a} (0.44)
FCR	21.37 (7.20)	23.13 (3.78)	25.66 (3.33)

[¥]Within a row, means without a common superscript differ (*P*<0.05)

Table 4. Sex effect on daily feed intake (DFI), residual feed intake model (RFI), residual liveweight gain model (RLG), standardised daily feed intake model (SDFI), feed conversion ratio (FCR) means (± standard error)

	Ewe	Wether
DFI	1.34 (0.03)	1.35 (0.04)
RFI	64.36 (1.16)	67.12 (1.17)
RLG	18.29 (0.41)	19.42 (0.54)
SDFI	24.60 (0.41)	24.66 (0.64)
FCR	23.19 (4.90)	23.59 (3.04)

This study found that feed intake varied significantly depending on lamb sire breed, with Dorset and White Suffolk sired lambs consuming more than Merino lambs as demonstrated in DFI, RFI, RLG and SDFI models (*P*<0.05; Table 3). Lamb liveweight and growth variations as a result of sire breed differences have been widely reported, generally, with lambs having meat type terminal sires out performing purebred Merinos (Fogarty et al. 2005; Holman et al. 2012). Lamb liveweight has also been closely aligned to feed intakes (Hill 2012). It is this relationship and the variations in liveweight between sire breeds that explain the observed differences in feed intake, especially DFI and SDFI values (*P*<0.023), in Merino sired ewe lambs compared to their wether counterparts (Figure 1.)

Sex did not independently affect feed intake (*P*>0.05; Table 4). However, differences in feed intake values between the models are based on different input variables used.

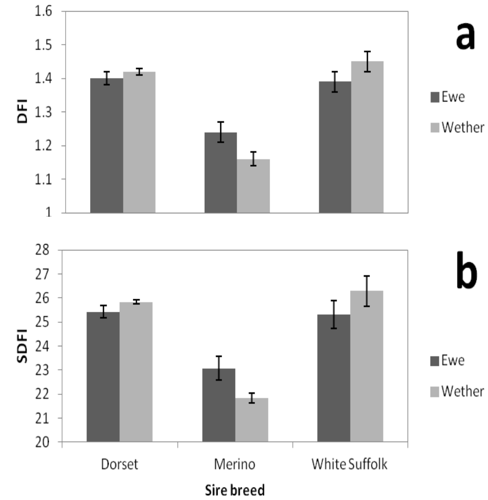

Figure 1: Sire breed and sex interactions on a) daily feed intake (DFI); and b) standardised daily feed intake (SDFI).

Conclusions

This study showed Spirulina supplementation did not effect lamb feed intake. However, sire breed and its interaction with sex were found to affect feed intake, with crossbred Merino lambs consuming more than their purebred counterparts. These outcomes indicate that most of the variation in lamb feed intake is dependent on its genetics; however, this requires further confirmation with larger feeding trials. The information in this study could be very useful to prime lamb producers considering Spirulina supplementation while balancing the impact on feed resources.

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