International Journal of Veterinary Science and Medicine (2015) 3, 13–20

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International Journal of Veterinary Science and Medicine

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Full Length Article

Effect of Spirulina supplementation on plasma metabolites in crossbred and purebred Australian Merino lambs

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Received 29 October 2014; revised 8 February 2015; accepted 11 August 2015
Available online 24 October 2015

KEYWORDS

Arthrospira platensis;
Protein-rich supplementation;
Plasma metabolites;
Sheep;
Ovine

Abstract The effect of supplementing purebred and crossbred Merino lambs with *Arthrospira platensis* (Spirulina) on plasma metabolite concentrations under pasture-based management system and the influences of sire breed and sex were investigated. A completely randomized experimental design balanced by 4 sire breeds (Merino, White Suffolk, Dorset and Black Suffolk), 3 Spirulina supplementation levels (0, 100 and 200 ml representing the control, low and high, respectively) and 2 sexes (ewe and wether lambs) was utilised. All lambs had *ad libitum* access to the basal diet of ryegrass pastures and barley. Lambs in the treatment groups were individually drenched daily with Spirulina prior to being released with the control group of lambs for grazing over a 6-week period following a 3-week adjustment phase. At the start and completion of the feeding trial, blood samples were centrifuged and plasma metabolites measured. Data were analysed with Spirulina supplementation level, sire breed, sex and their second-order interactions fitted as fixed effects and metabolite concentrations as dependent variables. Gamma-glutamyl transferase (GGT) concentrations decreased (from 79.40 to 69.25 UI) and glucose increased (from 3.81 to 4.19 mmol/L) as the level of Spirulina supplementation increased from 0 ml in the control to 200 ml in the high treatment groups ($P < 0.05$). Lambs supplemented at low Spirulina levels had the highest creatinine concentrations (61.75 μmol/L). Interactions between sex and supplementation level significantly

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Peer review under responsibility of Faculty of Veterinary Medicine, Cairo University.

http://dx.doi.org/10.1016/j.ijvsm.2015.08.001

affected glucose, aspartate aminotransferase (AST) and Mg concentrations ($P < 0.05$), while sire breed and supplementation level interactions influenced albumin to globulin (A/G) ratio, creatinine and GGT concentrations. It was demonstrated that Spirulina supplementation does not negatively impact lamb health and productivity.

1. Introduction

Spirulina (*Arthrospira platensis*) is a filamentous cyanobacterium which has been the recent subject of several feeding trials with agriculturally significant animal species [1]. However, to the best of our knowledge, published information regarding the metabolite response of crossbred and Merino purebred lambs to Spirulina supplementation remains relatively scarce, hence the need to fill this knowledge gap.

In Australia, crossbred Merino lambs are generally a product of dual-purpose sheep production systems. These systems typically mate meat-type rams with a core Merino flock to introduce both desirable meat and wool traits into the subsequent progeny [2]. Resultant lambs are routinely supplemented with protein-rich feed types to optimise growth and productivity [3]. Consequently, dual-purpose producers are best situated to exploit the current high lamb meat prices [4] without abandoning their traditional wool interests. In dual-purpose systems, as in other sheep producing systems, lamb health is equally as important as productivity and profitability.

Knowledge of haematological metabolite concentrations is valuable in understanding individual lamb health and productivity status [5,6]. Hence, quantifying key haematological metabolite concentrations has been applied to measure the response of lambs to alternative diets and feed supplements [7]. The hypothesis tested was that: Spirulina supplementation will not be detrimental to the health and productivity of lambs as indicated by plasma metabolite and electrolyte profiles, but significant interactions between supplementation level, sire breed and sex will be the key drivers of variation. Therefore, the primary objective of this study was to investigate the effects of Spirulina supplementation at differing levels to crossbred and purebred Merino lambs on haematological metabolites as indicators of health and productivity. The secondary aim was to evaluate the interactions of Spirulina supplementation levels with sire breed and sex.

2. Materials and methods

This study was conducted at the University Farm, Cambridge, Hobart, Tasmania, Australia, and was approved by the Tasmanian Animal Ethics Committee in accordance with the 1993 Tasmania Animal Welfare Act and the 2004 Australian code of Practice for the Care and Use of Animals for Scientific Purposes.

2.1. Animal management and experimental design

Using a 1:100 mating ratio, approximately 1600 Merino ewes were mated with 16 terminal sire rams of different breeds – Black Suffolk, Dorset, Merino, and White Suffolk. All progeny were identified with National Livestock Identification ear tags before being weaned onto ryegrass pasture at 16 weeks of age. At 6 months old, 48 lambs were randomly allotted into a completely randomized block experimental design balanced by sire breed, Spirulina supplementation levels and sex, respectively.

The Spirulina was commercially purchased (TAAU, Darwin, AUS) as a powder (Table 1) which was then made into a water suspension using a Spirulina to water ratio of 1 g:10 mL. This was daily given to the lambs using a sheep drench to directly deliver each lamb's assigned Spirulina level of supplementation – control (0 mL), low (100 mL), and high (200 mL). Supplementation continued over the 9-week feeding trial duration, consisting of a 3-week adjustment phase and

Table 1 Nutrient composition of Spirulina and basal diet of ryegrass pasture and barley grain.

Chemical composition	Feed components			Unit
	Spirulina	Barley grain	Ryegrass pasture	
Moisture	4.0	6.8	55.3	g/100 g fresh wt
DM	96.0	93.2	44.7	g/100 g fresh wt
NDF	32.6	18.5	22.4	g/100 g DM
NDFn[3]	30.3	17.2	20.8	g/100 g DM
ADF	18.3	6.0	23.0	g/100 g DM
NFC	7.9	68.7	43.5	g/100 g DM
Ash	9.5	3.2	11.9	g/100 g DM
EE	5.9	2.0	3.0	g/100 g DM
CP	62.2	8.9	20.8	g/100 g DM
ME[5]	1707.5	1723.7	1701.1	kJ/100 g DM

Note: 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). Moisture = 100 − DM. NDFn = NDF × 0.93 [38]. NFC = 100 − (NDFn + CP + EE + Ash) [38]. ME = 4194 − (9.2 × Ash) + (1.9 × CP) + (3.9 × EE) − (3.5 × NDF) [39].