



**Production performance, milk composition and cheese  
quality of crossbred dairy sheep supplemented with  
dietary omega-3 oils**

By

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## **Declaration**

I hereby declare that:

- The research presented and reported in this thesis was conducted in accordance with the University of Tasmania Animal Ethics Committee Guidelines, the 1993 Tasmanian Animal Welfare Act and the 2004 Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (Animal Ethics Permit Number A0015657).
- To the best of my knowledge and belief, this thesis contains no material which has been accepted for the award of a degree or diploma by the University or any other tertiary institution. The thesis contains no material previously published or written by any other person (s) except where background information duly acknowledged is made in the text of the thesis.

## **Statement of the Contribution of Others**

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## Abstract

This thesis primarily investigated the effect of supplementing pasture-based dairy sheep with different plant oil-infused and rumen-protected pellets containing eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) on lactation performance, milk and cheese fatty acid composition and cheese eating quality. It was hypothesised that plant oil supplements would interact with sire breed to influence feed intake, body condition score, milk yield and composition, milk and cheese fatty acid contents and sensory attributes of ripened cheese.

Sixty dairy ewes in mid-lactation, balanced by liveweight, milk yield, parity, and sire breed were randomly allocated into 6 treatment groups of 10 ewes each, that were: (1) supplemented with on-farm existing commercial wheat-based pellets without oil inclusion (control) or supplemented with wheat-based pellets infused with 50 mL/kg dry matter of oils from (2) canola, (3) rice bran, (4) flaxseed, (5) safflower, and (6) rumen-protected EPA + DHA in a 10-week supplementary feeding trial including a 2-week adjustment period. All supplementary diets included the same level of 50 mL/kg DM of oil except for the control group, and all diets were isocaloric and isonitrogenous. Experimental animals were grazed in the same paddock with *ad libitum* access to pasture, hay, and water. During milking time, each ewe was fed 1 kg/day of the supplemented pellets individually in the milking parlour.

Data on weekly body condition score, daily feed intake, feed composition, weekly bulked fresh milk, raw milk, and ripened cheese samples were collected. Feed intake, body condition score, milk yield, milk composition, fatty acid composition of milk and cheese, and cheese sensory attributes were analysed in SAS with sire breed, diet, and week of supplementation and their second-order interactions as fixed effects.

It was demonstrated that oil supplementation and sire breed affected animal performance, productivity and quality of milk and its processed product, in that:

- 1) Rumen-protected oil pellet containing EPA + DHA was the most effective diet that improved milk production, n-3 long-chain ( $C \geq 20$ ) polyunsaturated fatty acids (n-3 LC-PUFA) in fresh milk and ripened cheese without any negative effect on animal performance and cheese eating quality. A serving of milk and cheese reached the “good source” and “source” levels of n-3 LC-PUFA, respectively;
- 2) Flaxseed oil supplementation elicited not only the highest concentration of  $\alpha$ -linolenic acid (ALA, 18:3n-3) in both fresh milk and ripened cheese, but also improved all cheese eating sensory traits. Flaxseed oil also significantly increased n-3 LC-PUFA in milk because a serving of fresh milk met the claimed “source” of n-3 LC-PUFA;
- 3) Safflower oil diet considerably improved milk, fat and protein yields. More importantly, this diet also had the most efficiency at enhancing the level of linoleic acid (18:2n-6) in milk and cheese. Safflower oil inclusion had no effect on cheese eating quality;
- 4) Rice bran oil was the sole diet that improved milk yield with an increase in protein content. However, adding rice bran oil to the diet of grazing dairy ewes had only minor effects on altering milk and cheese PUFA composition. Together with flaxseed oil, rice bran oil significantly enhanced consumer acceptability of ripened cheese;
- 5) Canola oil was found to have minor but statistically significant effect on milk yield, body condition score, and docosapentaenoic acid (DPA, 22:5n-3) content in milk;
- 6) Sire breed and its interaction with diet affected milk yield in crossbred Awassi x East Friesian ewes.

Taken together, these outcomes suggest the use of infused plant oil and rumen-protected oil supplements in crossbred Awassi x East Friesian to best optimise overall milk and cheese quality and productivity of dairy sheep under a typical on-farm Australian grazing system.

## Thesis Publications

### Peer-reviewed Journal Papers with 2017 Impact Factor (IF)

1. Nguyen QV, Malau-Aduli BS, Cavalieri J, Nichols PD, Malau-Aduli AEO 2019. Enhancing omega-3 long-chain polyunsaturated fatty acid content of dairy-derived foods for human consumption. *Nutrients* 11(4): 743 (IF 4.196) <https://doi.org/10.3390/nu11040743>
2. Nguyen QV, Le HV, Nguyen DV, Malau-Aduli BS, Nichols PD, Malau-Aduli AEO 2019. Enhancement of dairy sheep cheese eating quality with increased omega-3 long-chain polyunsaturated fatty acids. *Journal of Dairy Science* 102(1): 211-222 (IF 2.749) <https://doi.org/10.3168/jds.2018-15215>
3. Nguyen QV, Le VH, Nguyen DV, Malau-Aduli BS, Nichols PD, Malau-Aduli AEO 2018. Supplementing grazing dairy ewes with oil and rumen-protected EPA+DHA pellets enhances health-beneficial n-3 long-chain polyunsaturated fatty acids in sheep milk. *European Journal of Lipid Science and Technology* 120 (6): 1700256 (IF 2.145) <https://doi.org/10.1002/ejlt.201700256>
4. Nguyen QV, Le HV, Nguyen DV, Nish P, Otto JR, Malau-Aduli BS, Nichols PD, Malau-Aduli AEO 2018. Supplementing dairy ewes grazing low quality pastures with plant-derived and rumen-protected oils containing Eicosapentaenoic Acid and Docosahexaenoic Acid pellets increases body condition score and milk, fat, and protein yields. *Animals* 8 (12): 241 (IF 1.654) <https://doi.org/10.3390/ani8120241>

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