

Poster presentations

Session 29. Algae as animal feed

Poster 29.10

The effect of feeding long-chain polyunsaturated fatty acids to lambs in the rumen lipid metabolism

S.P. Alves, A. Francisco, J. Santos-Silva and R.J.B. Bessa

Poster
29.10

Effect of feeding long-chain polyunsaturated fatty acids to lambs in the rumen lipid metabolism

Susana P. Alves¹, Alexandra Francisco¹, José Santos-Silva², Rui J.B. Bessa¹

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BACKGROUND & OBJECTIVES

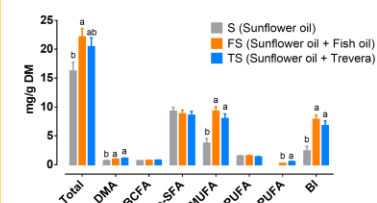
- Dietary long-chain polyunsaturated fatty acids (LC-PUFA) are extensively metabolized in the rumen producing several intermediates that might affect the microbial population in the rumen and the fatty acids that escape rumen.

This work aims to study the effect of two sources of LC-PUFA on fatty acid (FA) and dimethyl acetal (DMA) composition in the rumen of Merino Branco lambs

- 1) Fish oil
- 2) *Schizochytrium* sp lipid extract (Trevera®)

RESULTS & DISCUSSION

Effect of diet on the total FA and DMA in the rumen



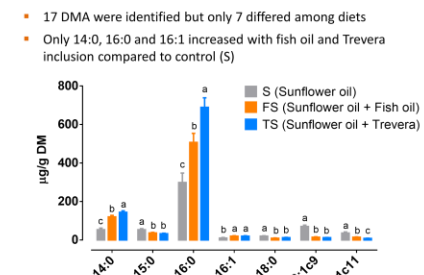
Abbreviations: Total = sum of fatty acid and dimethyl acetals; DMA = dimethyl acetal; BCFA = branched chain fatty acids; n-SFA = linear saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; LC-PUFA = long chain polyunsaturated fatty acids (C20); TC18 = sum of C18 fatty acids; BI = C18 bihydrogenation intermediates. Means with different letters differ (P<0.05).

Effect of diet in the major fatty acids (% of total peaks) in the rumen contents of lambs

	S	FS	TS
16:0	20.08 ^a ± 1.247	27.57 ^b ± 1.193	31.93 ^b ± 1.247
18:0	29.68 ^a ± 3.105	7.17 ^a ± 1.030	4.15 ^a ± 0.219
18:1 r10	2.40 ± 1.321	0.74 ± 0.095	0.57 ± 0.046
18:1 r11	3.42 ^b ± 0.483	24.10 ^a ± 1.621	24.86 ^a ± 1.555
18:1 c9	9.49 ± 0.523	9.85 ± 0.501	9.41 ± 0.523
18:2 r11c15	0.23 ^b ± 0.061	0.65 ^a ± 0.059	0.50 ^a ± 0.061
18:2 n-6	7.21 ^a ± 0.606	4.11 ^a ± 0.412	2.28 ^a ± 0.231
18:3 n-3	1.44 ^a ± 0.162	0.64 ^a ± 0.048	0.48 ^a ± 0.069
20:0	0.71 ^a ± 0.012	0.48 ^a ± 0.033	0.43 ^a ± 0.019
20:5 n-3 (EPA)	n.d.	0.19 ^a ± 0.015	0.04 ^b ± 0.005
22:0	0.79 ^a ± 0.027	0.45 ^b ± 0.026	0.45 ^b ± 0.027
22:5 n-3 (DPA)	n.d.	0.08 ^b ± 0.009	0.18 ^a ± 0.039
22:6 n-3 (DHA)	n.d.	0.09 ^b ± 0.016	1.45 ^a ± 0.104

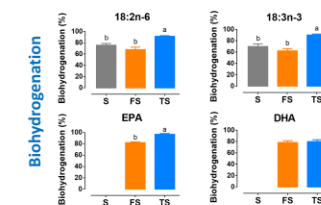
n.d. = not detected; ^{a,b} Means within a row with different superscripts differ (P < 0.05).

Effect of diet in the DMA composition



- 17 DMA were identified but only 7 differed among diets
- Only 14:0, 16:0 and 16:1 increased with fish oil and Trevera inclusion compared to control (S)

- 65 FAME were detected in the rumen
- FS and TS increased the 18:1 r11 and reduced the 18:0 in the rumen compared to S
- EPA was highest with FS whereas DPA and DHA was highest with TS
- Biohydrogenation of 18:2n-6, 18:3n-3 and EPA was highest with TS diet



CONCLUSIONS

- Fish oil or Trevera, as a source of LC-PUFA, did not seem to inhibit growth of rumen bacteria as concentration of BCFA and DMA were not reduced compared to control
- Trevera increased the content of DPA and DHA in the rumen and Fish oil increased the content of EPA
- In forage based diets, both LC-PUFA sources can remarkably increase the content of 18:1r11 in the rumen, which is the precursor of the beneficial CLA-c9r11 in tissues

Material & Methods

- Experimental trial
- Sample preparation
- Statistical analysis

→ 36 Merino Branco lambs were distributed by 3 complete diets based on dehydrated lucerne (70% DM) and supplemented with:

- Group "S" – 6% sunflower
- Group "FS" – 4 % sunflower oil + 2% fish oil
- Group "TS" – 4% sunflower oil + 3.5% Schizochytrium sp extract, Trevera®

6 weeks

→ Rumen contents were collected and fatty acid methyl esters (FAME) and dimethyl acetals (DMA) were prepared by direct transesterification and analysed gas chromatography and mass spectrometry (Alves et al, 2017)

→ Data were analyzed using Proc MIXED of SAS (SAS Inst., Cary, NC, USA) with a model that included the diet as the single effect. Significance was declared at P<0.05

REFERENCES
Alves, S. P., A. Francisco, M. Costa, J. Santos-Silva, and R. J. B. Bessa. 2017. Animal Feed Science and Technology 225:157-172.

ACKNOWLEDGEMENTS
Financial support through the projects PTDC/CVT/133594/2008, PTDC/CAL-2002/29654/2017 and UIDB/CVT/00276/2019 from FCT are greatly acknowledged.



Effect of feeding long-chain polyunsaturated fatty acids to lambs in the rumen lipid metabolism

This work aims to study the effect of two sources of LC-PUFA on fatty acid (FA) and dimethyl acetal (DMA) composition in the rumen of Merino Branco lambs



- 1) Fish oil
- 2) *Schizochytrium* sp lipid extract (Trevera®)

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BACKGROUND & OBJECTIVES

- Dietary long-chain polyunsaturated fatty acids (LC-PUFA) are extensively metabolized in the rumen producing several intermediates that might affect the microbial population in the rumen and the fatty acids that escape rumen.

This work aims to study the effect of two sources of LC-PUFA on fatty acid (FA) and dimethyl acetal (DMA) composition in the rumen of Merino Branco lambs

- 1) Fish oil
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CONCLUSIONS

- Fish oil or Trevera, as a source of LC-PUFA, did not seem to inhibit growth of rumen bacteria as concentration of BCFAs and DMA were not reduced compared to control
- Trevera increased the content of DPA and DHA in the rumen and Fish oil increased the content of EPA
- In forage based diets, both LC-PUFA sources can remarkably increase the content of 18:1n11 in the rumen, which is the precursor of the beneficial CLA-9r11 in tissues

RESULTS & DISCUSSION

Effect of diet on the total FA and DMA in the rumen

Effect of diet in the DMA composition

- 17 DMA were identified but only 7 differed among diets
- Only 14:0, 16:0 and 16:1 increased with fish oil and Trevera inclusion compared to control (S)

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18:1 n11	3.42 ^a ± 0.463	24.10 ^b ± 1.621	24.80 ^b ± 1.555
18:1 n7	9.49 ± 0.523	9.85 ± 0.501	9.41 ± 0.523
18:2 n11c15	0.23 ^a ± 0.061	0.65 ^b ± 0.059	0.50 ^a ± 0.061
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n.d. = not detected. ^{a,b} Means within a row with different superscripts differ (P < 0.05).

Methods

- 36 Merino Branco lambs were distributed by 3 complete diets based on dehydrated lucerne (70% DM) and supplemented with:
 - Group "S" – 4% sunflower
 - Group "FS" – 4% sunflower oil + 2% fish oil
 - Group "TS" – 4% sunflower oil + 3.5% *Schizochytrium* sp extract, Trevera®
- 6 weeks
- Rumen contents were collected and fatty acid methyl esters (FAME) and dimethyl acetals (DMA) were prepared by direct transesterification and analysed gas chromatography and mass spectrometry (Alves et al. 2017).
- Data were analyzed using Proc MIXED of SAS (SAS Inst., Cary, NC, USA) with a model that included the diet as the single effect. Significance was declared at P < 0.05.

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ACKNOWLEDGEMENTS

Financial support through the project PTDC/CI/11484/2008, PTDC/CI/20029/2012 and PTDC/CI/11484/2008 from FCT and greatly acknowledged.

FCT

Material & Methods

Experimental
trial



→ 36 Merino Branco lambs feed dehydrated lucerne (70% DM) diets with:

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Sample
preparation



→ Analysis of fatty acid methyl esters (FAME) and dimethyl acetals (DMA)

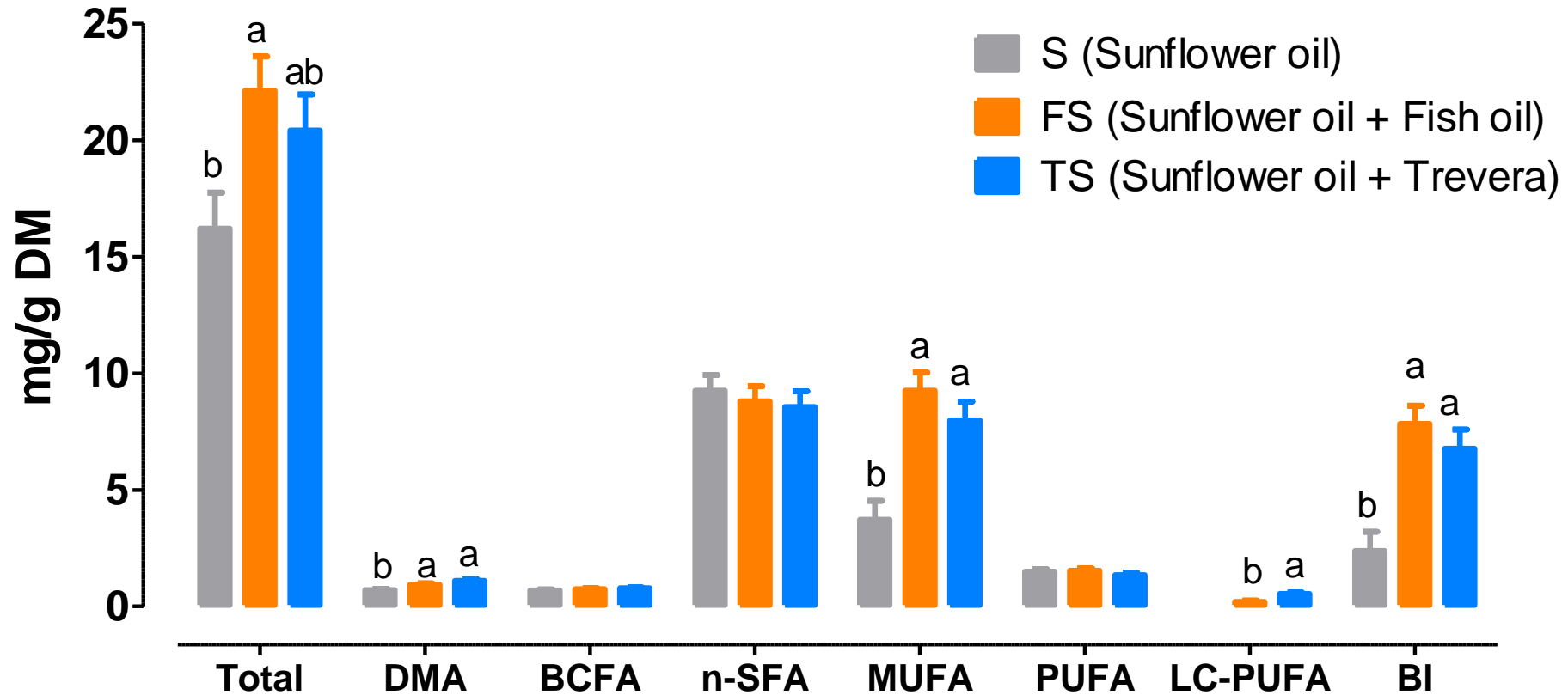
Statistical
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→ Data were analyzed using Proc MIXED of SAS with a model that included the diet as the single effect. Significance was declared at $P > 0.05$

RESULTS & DISCUSSION

Effect of diet on the total FA and DMA in the rumen




Effect of feeding long-chain polyunsaturated fatty acids to lambs in the rumen lipid metabolism

RESULTS & DISCUSSION

	Sunflower	Fish oil	Trevera
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- Fish oil or Trevera, as a source of LC-PUFA, did not seem to inhibit growth of rumen bacteria as concentration of BCFA and DMA were not reduced compared to control
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ACKNOWLEDGEMENTS

Financial support through the projects PTDC/AGR/102936/2016, PTDC/AGR/20029/2014/0107 and UIDB/00559/2019 from ICI and greatly appreciated.

FCT



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29.11

Effect on milk quality of replacing soybean meal with spirulina in a hay-based diet for dairy cows

E. Manzocchi, M. Kreuzer and K. Giller

Effects on milk quality of replacing soybean meal with Spirulina in a hay-based diet for dairy cows

Elisa Manzocchi, Michael Kreuzer, Katrin Giller
ETH Zurich, Institute Agricultural Science, Animal Nutrition, Zurich, Switzerland

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Introduction

- The cyanobacterium *Spirulina (Arthrospira platensis)* is a promising novel protein source replacing soybean meal extensively used in dairy cows' diets
- Its high proportion of beneficial fatty acids might improve the nutritional quality of the milk by increasing the contents of vitamins and unsaturated fatty acids, but also lead to off-flavours
- Effects on nutritional and organoleptic properties of milk and dairy products are unknown

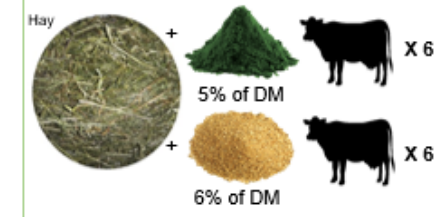


Material & Methods

Feeding experiment

Two isoenergetic and isonitrogenous diets fed *ad libitum*

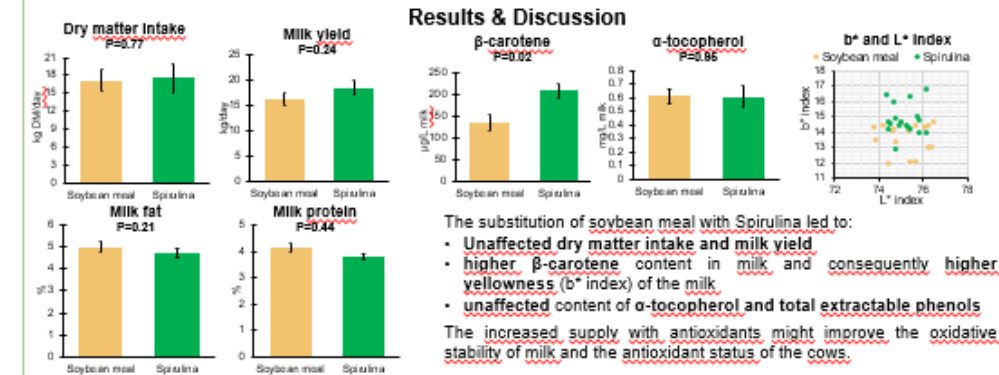
- Free-stall barn equipped with individual automatic feeding troughs
- 15 days of adaptation to the diet and 15 days of sampling period



Realized nutrient composition of the diet (g/kg DM)	Spirulina Diet	Soybean Diet
Ether extract	2.49 ± 1.0	1.73 ± 2.0
Crude protein (N x 6.25)	149 ± 13.8	154 ± 13.8
NDF	480 ± 18.7	494 ± 30.1
ADF	290 ± 15.3	312 ± 16.5
ADL	43.2 ± 2.8	55.0 ± 7.4
Gross energy (MJ/kg DM)	16.5 ± 0.4	16.6 ± 0.05

TAKE HOME MESSAGE

The substitution of soybean meal with Spirulina did not affect either feed intake or milk gross composition, but led to an increased β -carotene content and, consequently, to a higher yellowness of the milk.



This project is financially supported by the H. Wilhelm Schaumann Stiftung

29.12

Animal performance and milk fatty acid profile of ewes fed algae oil

T. Manso, B. Gallardo, P. Gómez-Cortés, M.A. de la Fuente, P. Lavín and A.R. Mantecón



Universidad de Valladolid



Animal performance and milk fatty acid profile of ewes fed algae oil

Manso, T.^{1*}, Gallardo, B.¹, Gómez-Cortés, P.², de la Fuente, M.A.², Lavín, P.³, Mantecón, A.R.³

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²Instituto de Investigación en C. de la Alimentación (CSIC-UAM), 28049 Madrid, Spain.

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Introduction

Eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids, both n-3 fatty acids naturally present in marine lipid supplements, have been associated with a decreased risk of developing cardiovascular diseases and the prevention of neurological diseases, among other beneficial effects on human health. Nevertheless, its presence in dairy fat is extremely low.

Objective

The proposal of this research was to use algae oil in the diet of dairy sheep to increase the levels of long-chain n-3 fatty acids (EPA and DHA) in milk fat, in order to enhance its nutritional value.

Material and methods

Thirty-six Churra ewes
58.4 ± 3.26 kg live weight
42 ± 2.3 days in milk

Six lots (6 ewes/lot)
Three lots per treatment
Two dietary treatments

Ingredients, % as fed

Dehydrated alfalfa	38.26	38.26
Soybean meal	16.72	16.72
Corn grain	11.49	11.49
Oat grain	10.09	10.09
Barley grain	7.63	7.63
Beet pulp	7.63	7.63
Molasses	4.86	4.86
Hydrogenated palm oil	2.34	-
Algae oil ¹	-	2.34
Vitamin mineral premix	0.98	0.98

Total Mixed Ration	
Control	ALG
38.26	38.26
16.72	16.72
11.49	11.49
10.09	10.09
7.63	7.63
7.63	7.63
4.86	4.86
2.34	-
-	2.34
0.98	0.98



- Intake of dry matter was recorded daily for each experimental lot.
- Ewes were milked twice daily throughout the experimental period (6 weeks).
- Individual milk yield and composition was recorded weekly and fat, protein and total solids content of milk were analysed using a MilkoScan-400 analyser.
- On day 42 of the experimental period a pooled sample of milk of each lot was collected and analysed by gas chromatography.
- Data were evaluated by the MIXED and GLM procedure of SAS.

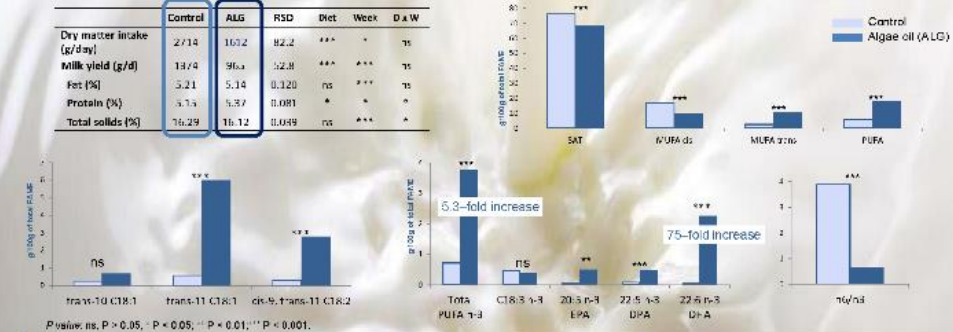
¹ BTSA Biomera Tech (A 40 Feed): docosahexaenoic acid (DHA) 400 mg/g.

Results

Dry matter intake, milk production and composition

	Control	ALG	RSD	Diet	Week	D x W
Dry matter intake (g/day)	2714	1672	82.2	***	-	ns
Milk yield (g/d)	1474	963	52.8	***	***	ns
Fat (%)	5.21	5.14	0.120	ns	***	ns
Protein (%)	3.13	3.37	0.081	*	*	*
Total solids (%)	16.29	16.12	0.049	ns	***	*

Milk fatty acid profile



P value: ns, P > 0.05; * P < 0.05; ** P < 0.01; *** P < 0.001.

Conclusions

- A significant improvement in the levels of EPA, DPA and DHA in milk was detected when algae oil was incorporated in the diet of lactating ewes.
- Levels of other fatty acid potentially beneficial for health, as *cis*-9, *trans*-11 C18:2 (CLA), were also increased and there were no differences in some putative fat synthesis inhibitors, such as *trans*-10 18:1.
- New techniques of n-3 rumen protected fat should be developed to avoid the negative effects of algae oil on animal performance.

Acknowledgments: this work was carried out through a collaboration between CF Agraria "Villalba" and the University of Valladolid and has been subsidized by the Ministerio de Economía y Competitividad (MINECO, AGL2016-75159-C2).

29.13

Changes in milk-fed lamb performance in response to marine algae supplement in the diet of dairy sheep

B. Gallardo, P. Lavín, A.R. Mantecón and T. Manso

Changes in milk-fed lamb performance in response to marine algae supplement in the diet of dairy sheep



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¹ETS Ingenierías Agrarias, Universidad de Valladolid, 34004 Palencia, Spain.

²Instituto de Ganadería de Montaña (CSIC-ULE), 24346 Grulleros, León, Spain.

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INTRODUCTION AND OBJECTIVE

The use of marine lipids as a new feedstuff in ruminant nutrition has received considerable attention in recent years, due to the high content in n-3 long-chain fatty acids (DHA and EPA) associated with beneficial effects on human health. These n-3 fatty acids could be transferred into milk and meat. However, it has been shown that marine lipids affect the pathways of lipid biogenesis in the rumen with possible implications on animal performance. The information available on the effects on ewe and suckling lamb performance when a dam diet is supplemented with marine algae is limited.

The objective of the current research was to evaluate the effects of supplementing lactating ewe diets with marine algae meal on milk and suckling lamb performance.



MATERIAL AND METHODS

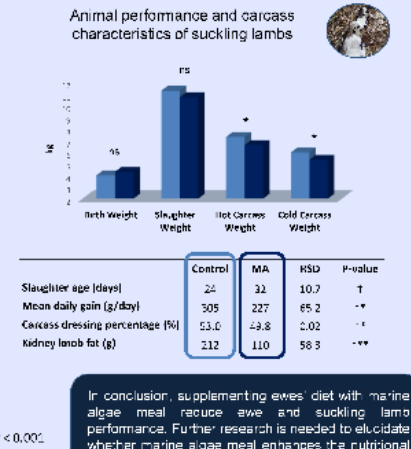
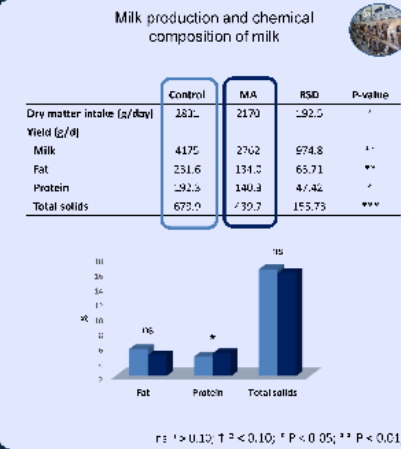
- Two days after lambing, twenty-four Churra ewes were selected and assigned to one of the two dietary treatments (12 ewes per treatment).
- Milk production was recorded in each ewe once a week during the first month of lactation by the oxytocin technique (McCance 1959).
- Milk chemical composition was analysed by MilkoScan-400 analyser.
- Lambs were nourished exclusively by suckling until they were slaughtered with approximately 11 kg live weight. Carcass dressing percentage was calculated as the ratio of cold carcass weight to slaughter live weight.
- Data were evaluated by the GLM procedure of SAS.

Ingredients	% as fed	Control	MA
Dehydrated alfalfa		38.28	37.36
Soyabean meal		16.72	16.33
Com grain		11.49	11.22
Oat grain		10.06	9.86
Bailey grain		7.83	7.46
Beet pulp		7.83	7.46
Molasses		4.86	4.76
Calcium soap of palm oil ¹		2.34	-
Marine algae meal ²		-	4.68
Vitamin mineral premix		0.98	0.98

¹McCance, J. (1959). *Anal. J. Agric. Res.* 10, 936-965

²Maraspo, P., *Diogenes-Teufel Feed.*

RESULTS



In conclusion, supplementing ewes' diet with marine algae meal reduce ewe and suckling lamb performance. Further research is needed to elucidate whether marine algae meal enhances the nutritional quality of ewe milk and of suckling lamb's meat.

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