

Ewe pre-partum supplementation with polyunsaturated fatty acids affects lamb immunity and behaviour

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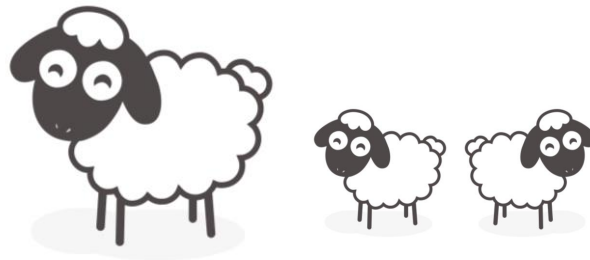
Introduction



- On the way towards of a more rational use of medicines, alternatives are necessary for enhanced animal health and resilience to challenges during life.
 - Supplementation of pre-partum diet with PUFA- ω -3:
 - Benefits the immune status of pregnant ewes (Caroprese *et al.*, 2015), and modifies colostrum fatty acid profile (Coleman *et al.*, 2018).
 - Benefits the brain development and early behaviour of lambs, and may increase their survival rate (Capper *et al.*, 2006)
 - Stress is negative for the immune response, health, and welfare of animals (Moberg, 2001), although PUFA- ω -3 may help to mitigate this (Kang and Weylandt, 2008).
- Can pre-partum PUFA- ω -3 supplementation result in advantages for the health and welfare of lambs under stressful conditions?**

Objective

To determine the effects of supplementing ewes with PUFA- ω -3 on the physico-chemical characteristics, fatty acids profile, and immunological quality of colostrum, and on the behaviour and immune response of lambs after being subjected to stress.

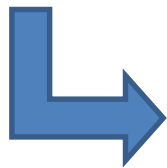


Methodology

Pre-partum



- 48 Latxa multiparous pregnant ewes; 2 treatments (2 replicates/treatment) during last 5 weeks of pregnancy.
- 2 isoproteic/isoenergetic diets:
 - Control ewes: 450 g concentrate + 450 g corn silage as-fed + Fescue hay *ad libitum*
 - Supplemented ewes: 450 g concentrate rich in PUFA- ω -3 (20% linseed meal; 14.5 g PUFA/kg concentrate; TradiLin®) + 450 g corn silage as-fed + Sainfoin hay *ad libitum*



Protective effect on fatty acids

Methodology

Colostrum samples at birth and 24h post-partum

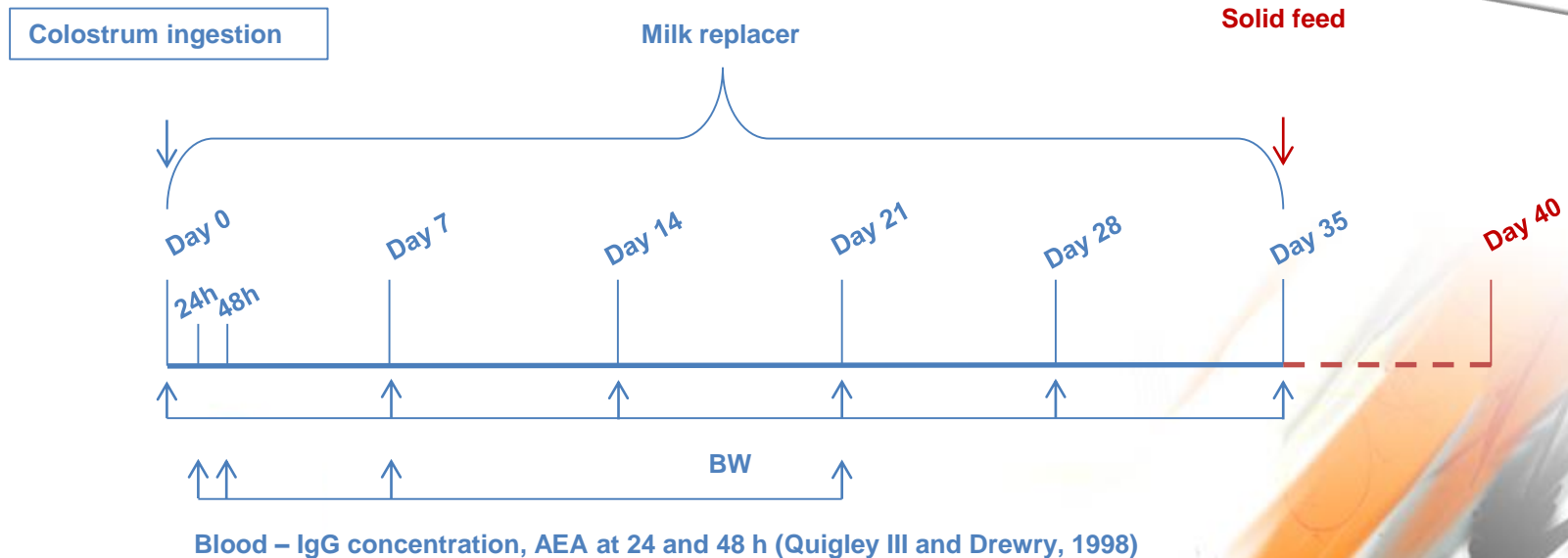
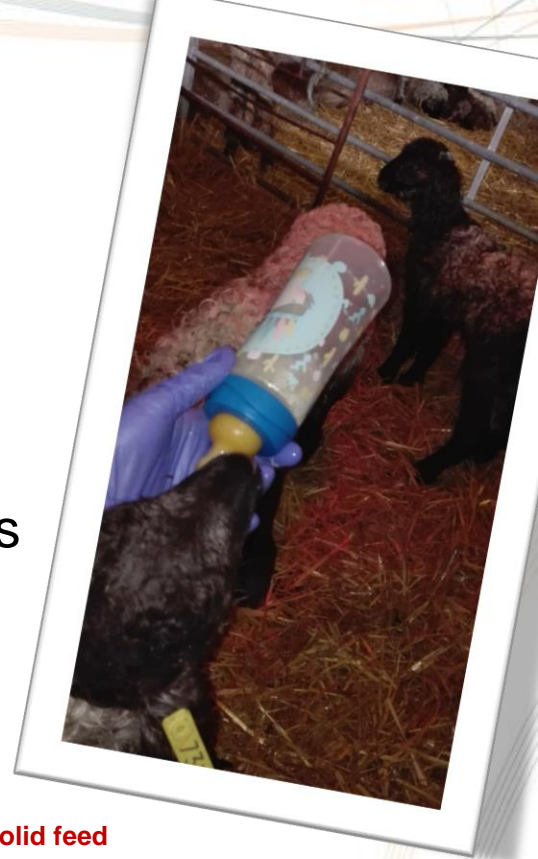
- From ewes whose birth could be monitored (n=36)
- At birth:
 - *Physical and biochemical characteristics*
 - *Somatic cell counts*
 - *Fatty acid profile*
 - *IgG concentration*
- 24 h post-partum:
 - *IgG concentration*



Methodology

Lambs, pre-weaning

- 20 lambs; 10 control/10 PUFA- ω -3; 9 males/11 females
- Housed in 1 of 2 postnatal pens
- Bottle fed with colostrum before 18 h of life (10% BW; Alves et al., 2015)



Methodology

Lambs – post-weaning



Aversive handling period (AH)

2 immobilizations/day; 30 min/immobilization; Destrez *et al.*, 2013)

Behaviour coping abilities: behaviour tests

Cell-mediated immune response: 1 ml PHA (1 mg/ml; Marini *et al.*, 2015) in scapular area

Day 0 (40 d of life)

Day 6 (46 d of life)

Day 12 (52 d of life)

Day 13 (53 d of life)

Day 14 (54 d of life)

Day 15 (55 d of life)

Day 16 (56 d of life)



Blood (EDTA), plasma cortisol (ELISA)

Behavioural tests; post-test blood; cortisol, IL-2, IL-10, IL-1 β (ELISA)

Pre-PHA skinfold thickness, skin T

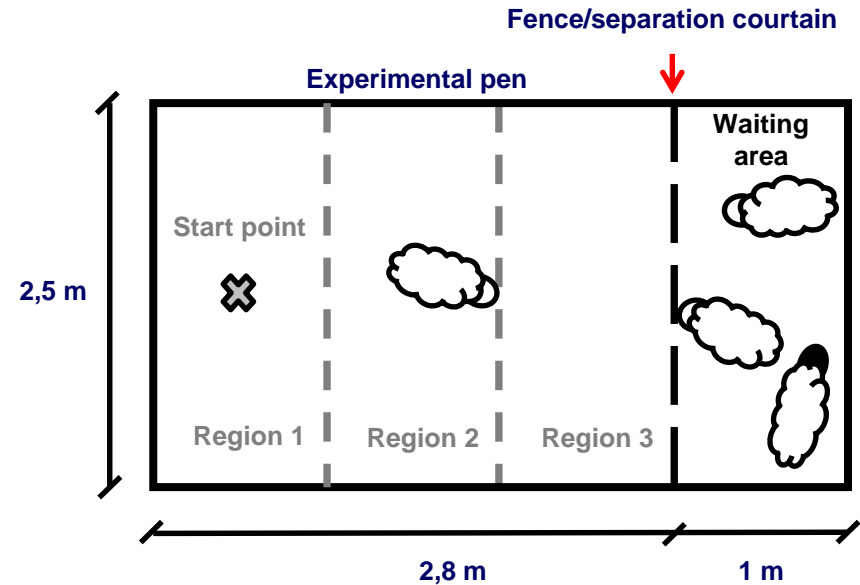
PHA

Blood 24, 48 h post-PHA; cortisol, IL-2, IL-10, IL-1 β

Skinfold thickness, skin T 24, 48, 72 h post-PHA

Methodology

Behaviour tests



Social isolation test (5 min):

Position/behaviour every 10 s

- Use of space: total distance (m), angular dispersion (trajectory tortuosity)
- Behaviour: stand inactive (%), move (%), explore (%), rest (%), escape attempt (%)

Vocalizations (n); total excretions (urinations + defecations; n)

Social motivation test (5 min):

Latency to movement (s); latency to reach other lambs (s); time spent on each region (%)

Position/behaviour every 10 s

- Use of space: total distance (m), angular dispersion (trajectory)
- Behaviour: stand inactive (%), move (%), explore/interact with lambs (%), rest (%), escape attempt (%)

Vocalizations (n); total excretions (urinations + defecations; n)

Methodology

Statistical analysis

Generalized linear mixed models ($P < 0,05$); means separation using Tukey tests for multiple comparisons (SAS software)

Ewe variables

Fixed effects:

- Birth type, pre-natal diet.
- Case of repeated measures: time, time×pre-natal diet.

Covariates:

- Duration of gestation, number of birth, pre-partum body condition, milk production during previous year.

Random effect:

- Pre-natal pen

Lamb variables

Fixed effects:

- Sex, pre-natal diet, sex×pre-natal diet
 - BW until weaning and during AH: pregnancy duration, birth type
- Case of repeated measures: time, time×sex time×pre-natal diet

Random effect:

- Post-natal pen
 - For behaviour: test group

Results. Colostrum physico-chemical traits

	Control		PUFA- ω 3		P
	Mean	SE	Mean	SE	
Volume (ml)	1410	191	1501	232	0.814
Density (g/l)	1041	1.86	1042	2.19	0.323
pH	6.47	0.10	6.40	0.08	0.527
Fat (%)	11.99	1.24	11.82	0.97	0.085
Protein (%)	14.44	0.97	12.22	0.88	0.148
Lactose (%)	3.12	0.21	3.33	0.24	0.416
Ash (%)	0.96	0.04	1.00	0.03	0.628
Dry matter (%)	32.26	1.91	27.43	1.74	0.115
SCC ($\times 10^3$ cel/ml)	410.7	153.8	486.7	204.1	0.548

Results. Colostrum fatty acid profile

Fatty acid (mg/g fat)	Control	PUFA- ω 3	SE	P	Fatty acid (mg/g fat)	Control	PUFA- ω 3	SE	P
SFA	446.8	489.3	17.5	0.190	C12:0	12.9	16.0	0.9	0.050
MUFA	285.0	277.4	13.2	0.235	C15:0	3.2	4.9	0.5	0.035
t-MUFA	27.1	42.4	2.9	0.041	11t-C:18:1 (n7) (VA)	12.5	25.4	2.0	0.007
c-MUFA	265.8	222.3	17.0	0.114	C18:3 (n3)-ALA- ω 3	4.9	9.8	0.7	0.010
PUFA	39.5	52.0	2.5	0.008	9c11t-CLA	8.6	13.2	0.9	0.008
PUFA- ω 3	10.3	16.1	0.6	0.004	n6/n3	1.9	1.4	0.08	0.008
Sum CLA	9.2	14.8	1.0	0.005					

Results. Colostrum IgG concentration

	Control		PUFA- ω 3		
	Mean	SE	Mean	SE	P
IgG at birth (mg/ml)	39.88	2.57	40.54	3.70	0.516
IgG 24 h after birth (mg/ml)	8.44	1.28	7.66	1.28	0.685



Results. Colostrum IgG reference values

Colostrum IgG concentration at birth – comparison with other breeds

- ✓ Polypay
- ✓ Karakul
- ✓ Santa Inês

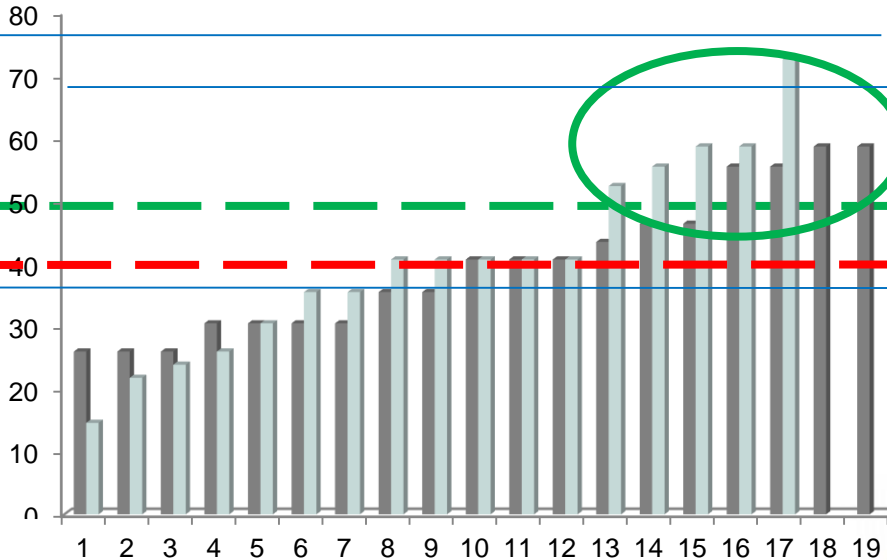
Recommended value
(Suraya and Yaakub, 2011;
Drikic et al., 2018)

Latxa

- ✓ Rambouillet
- ✓ Targhee
- ✓ Columbia
- ✓ Finn crossbreed
- ✓ Aragonesa

- ✓ Lacaune Dairy
- ✓ East Frisian Milk

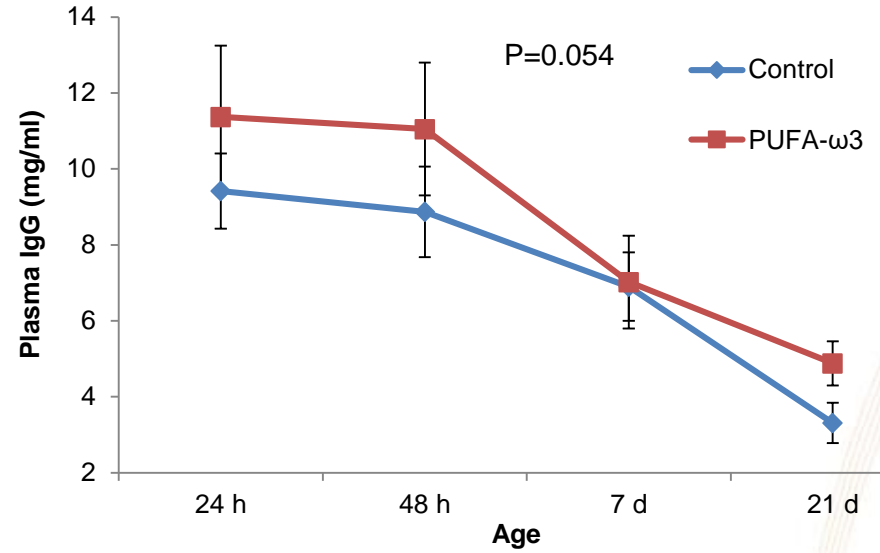
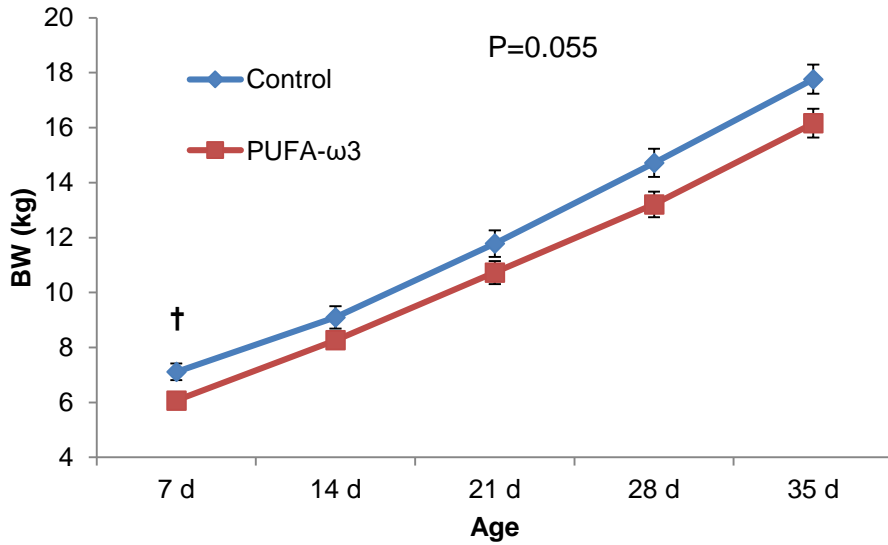
[mg/ml]



■ CONTROL ■ PUFA- ω 3

Results. Lambs

Pre-weaning



	Control		PUFA- ω 3		
	Mean	SE	Mean	SE	P
AEA (%)	15.68	3.28	17.27	3.39	0.772

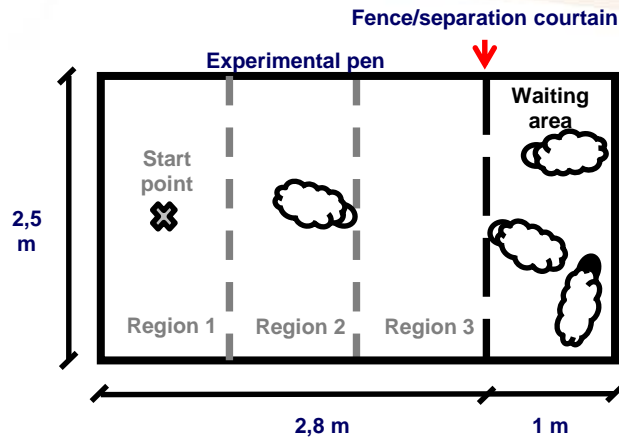
Results. Lambs

Social isolation

	Control	PUFA- ω 3	P
Stand inactive (%)	53.4 \pm 8.8	44.2 \pm 8.7	0.058

	Male	Female	P
Escape attempts (%)	19.4 \pm 7.7	7.5 \pm 3.6	0.002
Angular dispersion	0.37 \pm 0.03	0.29 \pm 0.02	0.034

	Control		PUFA- ω 3		P
	Male	Female	Male	Female	
Time close to other lambs (%)	85.3 \pm 10.2 ^c	92.1 \pm 5.9 ^b	89.6 \pm 7.6 ^{bc}	98.4 \pm 1.3 ^a	<0.001
Total excretions (n)	0.03 \pm 0.27 ^{ab}	0.77 \pm 0.27 ^a	0.25 \pm 0.28 ^{ab}	0.00 \pm 0.27 ^b	0.022

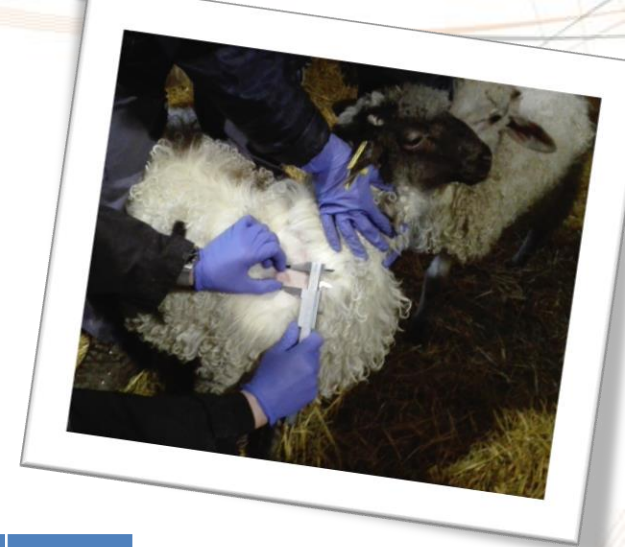


Social motivation

	Control	PUFA- ω 3	P
Stand inactive (%)	51.1 \pm 9.0	41.8 \pm 8.7	0.058
Interaction lambs (%)	24.3 \pm 7.8	39.9 \pm 10.0	0.002
Angular dispersion	0.24 \pm 0.02	0.32 \pm 0.03	0.051

Results. Lambs

Cell-mediated response to PHA challenge



	24 h	48 h	72 h	P
Skinfold thickness (cm)	0.97 ± 0.04a	0.89 ± 0.03a	0.75 ± 0.02b	<0.001
Skin temperature (° C)	32.6 ± 0.3a	32.4 ± 0.3a	32.0 ± 0.3b	0.038

	Control	PUFA- ω 3	P
Cortisol (ng/ml)	83.2 ± 10.1	74.9 ± 8.0	0.034
IL-2 (pg/ml)	51.4 ± 0.2	53.8 ± 0.9	0.003
IL-10 (pg/ml)	14.9 ± 0.5	14.3 ± 0.4	0.318
IL-1β (pg/ml)	40.1 ± 2.8	43.2 ± 3.9	0.540

Conclusions



- Pre-partum diet modifies the fatty acid profile of colostrum right after birth
- Pre-partum diet supplementation affects lamb behaviour and immune response of lambs

Thanks! 😊

- PUFA- ω 3 lambs showed different behaviours and social behaviours, and by sex.
- PUFA- ω 3 lambs showed lower immune response (IL-2) and lower plasma cytokine levels after PHA injection



Department of Economic Development and Infrastructures of the Basque Government
(Initiative on the rational use of antibiotics in livestock)