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Soft goat cheese enriched with polyunsaturated fatty acids: manufacture, physico-chemical and sensorial characterizations

**J.Y.Gassi¹, M.Thève², E.Beaucher¹, B.Camier¹, M.B. Maillard¹, F.Rousseau¹, F.Gaucheron¹,
L. Leboeuf-Schneider², E.Lepage²**

¹UMR 1253 Science and Technology of Milk and Egg) INRA-Agrocampus Ouest, 65 rue de saint Briec, 35042 Rennes, France

²CCPA, ZA Nord-Est du Bois de Teillay, F-35150 Janzé, France³.

Emails : jean-yves.gassi@rennes.inra.fr – lleboeuf@ccpa.fr





Introduction

- Particular attention of the consumer to nutritional factors which can affect its health.
- The quantity and quality of lipids retains especially his attention.
- Milk and dairy products are considered rich in saturated fatty acids (SFA) compared to unsaturated fatty acids (UFA) \Rightarrow ratio $SFA/UFA = 65/35$

One way to decrease SFA and increase UFA in dairy products is to modify the composition of milk by the animal diet.

Research Questions and Objectives

- What are the effects on the feeding enriched in poly unsaturated fatty acids (PUFA) for goat on:
 - Global biochemical quality of milk ?
 - Lipid fraction (amounts of PUFA, Omega-3,...) ?
 - Cheese making parameters and cheese yields ?
 - Biochemical quality of cheeses during ripening ?
 - Sensorial quality of cheeses at the end of ripening ?



Strategy

Two groups of 30 Alpine dairy goats (GAEC La Blanchardière, France) were fed with a traditional ration (**control**) or a ration **supplemented** with PUFA (linseeds + rapeseeds + soya = CAPALIAMEGA from CCPA group)



1. Milks characterization total solids, contents in protein, fat and mineral, fatty acids profile and fat globule size distribution.
2. Monitoring of the cheese making parameters.
3. Evaluation of cheese proteolysis and lipolysis during ripening.
4. Sensory evaluation at day 30

These experiments were performed in triplicate.

Manufacture of soft cheeses

Materials and methods - Analyses

Dates: 5th, 19th mai & 3rd june

D - 1

Raw milk
Control \approx 100 kg

Raw milk
Supplemented \approx 100 kg

Pasteurization
72°C, 20 s

Characterisation

pH, A°D, DM, fat, lactose, protein, minerals, FA profile, fat globule size, microbiology

Lactic Acid Bacteria + GDL
Cold Maturation at 12°C

D

Warm Maturation at 34°C

Characterisation

pH, A°D, coagulation

Vats \approx 50 kg

Cheese making

D + 1

Whey

24 Control cheeses
24 Supplemented cheeses

Characterisation

pH, A°D, DM, fat, prot, minerals, microbiology

Ripening during 30 days

Characterisation

at D +1, 10 +20 +30
pH, DM, Fat, Prot, FA profile
D+30 FFA, sensorial analyses

Sensorial analyses

Sample : **Control Goat Cheese** vs **Supplemented Goat Cheese** (D + 30)

Panel: 12 subjects trained on cheeses

↪ Determination of the sensory profile by a descriptive approach

↪ Aspect

- ↪ Crust color (white to cream)
- ↪ Crust thickness (thin to thick)
- ↪ Chalky core size (not significant to very significant)
- ↪ Paste color (white to cream)

↪ Texture in mouth

- ↪ Firmness (not firm to very firm)
- ↪ Creaminess (not creamy to very creamy)
- ↪ Melting (not melting to very melting)
- ↪ Smoothness (not smooth to very smooth)
- ↪ Stickiness (not sticky to very sticky)
- ↪ Crust perception (not perceptible to very perceptible)

↪ Odour

- ↪ Overall intensity (mild to intense)

↪ Flavour

- ↪ Overall intensity (mild to intense)
- ↪ Goat aroma (mild to intense)
- ↪ Salty (not salty to very salty)
- ↪ Acid (not acid to very acid)
- ↪ Bitter (not bitter to very bitter)
- ↪ Cream aroma (absent to intense)
- ↪ Pungent taste (not pungent to very pungent)
- ↪ Mushroom aroma (absent to intense)
- ↪ Ammonia aroma (absent to intense)

Composition of cheese raw milks (control and supplemented)

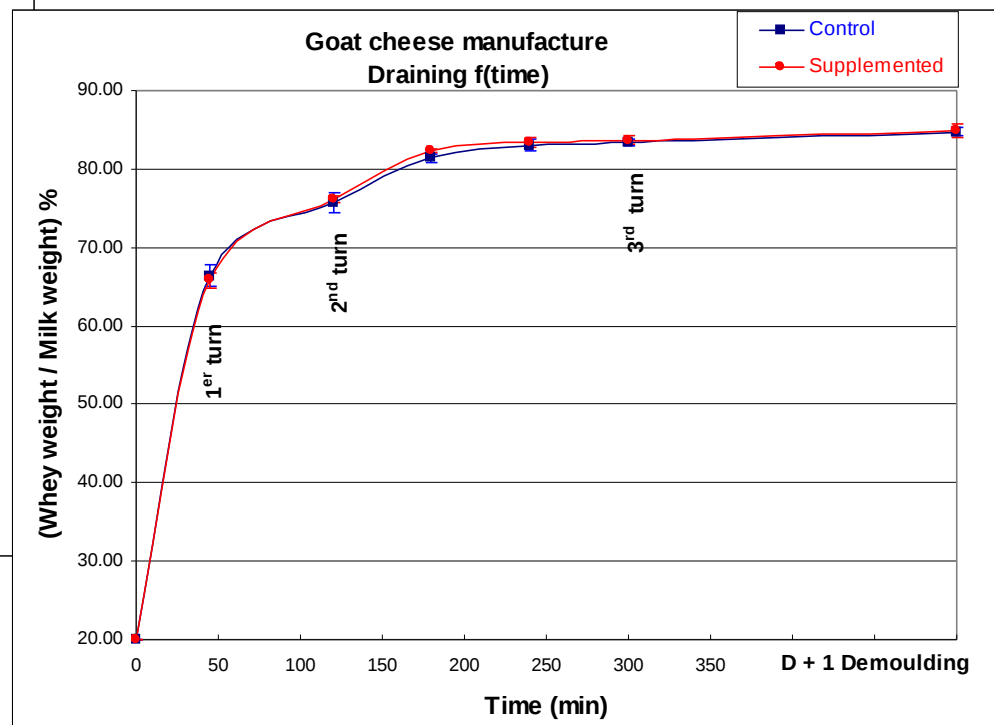
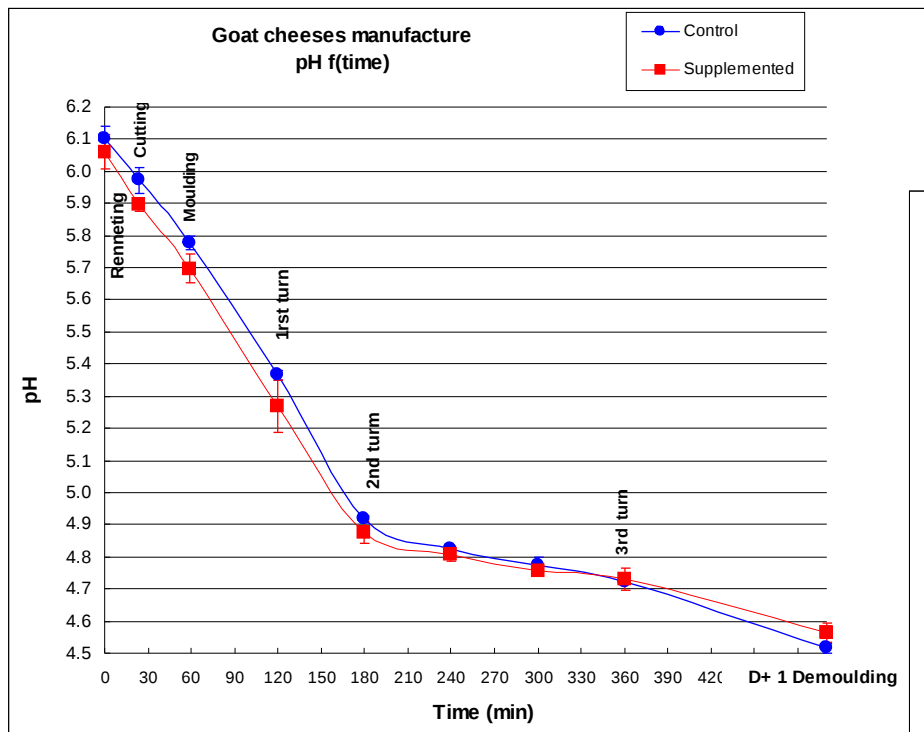
Control													
	pH	°D	DM	Fat	TN	NCN	NPN	Prot	CN	SP	Fat/Prot	Fat/CN	Ca
			g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg			g/kg
Means	6.71	19.0	120.9	35.3	33.0	7.5	2.7	30.3	25.5	4.8	1.2	1.4	1.20
SD	0.06	1.0	4.3	2.3	0.3	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.06

Supplemented													
	pH	°D	DM	Fat	TN	NCN	NPN	Prot	CN	SP	Fat/Prot	Fat/CN	Ca
			g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg			g/kg
Means	6.72	18.0	125.1	38.8	33.5	7.8	2.7	30.8	25.7	5.1	1.3	1.5	1.23
SD	0.02	0.0	4.2	2.6	0.4	0.3	0.2	0.5	0.7	0.2	0.1	0.1	0.06

➡ **Supplemented milk:** DM (+3,5%), Fat (+9,9%), proteins (+1,7%) & calcium (+2,5%)

➡ Fat globule size was similar (~4 μm)

Acidification and drainage (control vs supplemented)



➡ Cheese curd acidification and draining were similar.

Composition of wheys (control vs supplemented)

Control										
	pH	°D	DM	Fat	TN	NCN	NPN	Prot	SP	Ca
			g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg
Mean	4.62	123	63.8	1.3	8.8	8.5	4.1	4.7	4.4	0.89
SD	0.04	8	0.9	0.4	0.1	0.1	0.2	0.1	0.1	0.06

Supplemented										
	pH	°D	DM	Fat	TN	NCN	NPN	Prot	SP	Ca
			g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg
Mean	4.65	121	64.7	1.3	8.9	8.6	4.0	4.8	4.5	0.93
SD	0.05	8	0.9	0.4	0.2	0.2	0.2	0.1	0.0	0.05

➡ **Supplemented Whey:** DM (+1,3%), proteins (+2,9%)

Cheese Yield at demoulding step (control vs supplemented)

	Gross cheese yield: kg per 100 kg de lait			Corrected cheese yield*: kg per 100 kg de lait		
Dates	Control	Supplemented		Control	Supplemented	
05 05	15.56	16.01	+ 2.89 %	15.75	16.33	+ 3.68 %
19 05	15.68	15.91	+1.52 %	15.79	16.70	+ 5.76 %
03 06	14.59	15.16	+ 3.91%	14.67	15.80	+ 7.70 %

$$\text{*Corrected Cheese Yield} = \frac{\text{Cheese DM} - \text{Whey DM}}{\text{Cheese reference DM (440 g/kg)} - \text{Whey DM}}$$

➡ Corrected **Supplemented Cheese** Yield + 5.7%

Composition of cheeses at D+1 demoulding step (control vs supplemented)

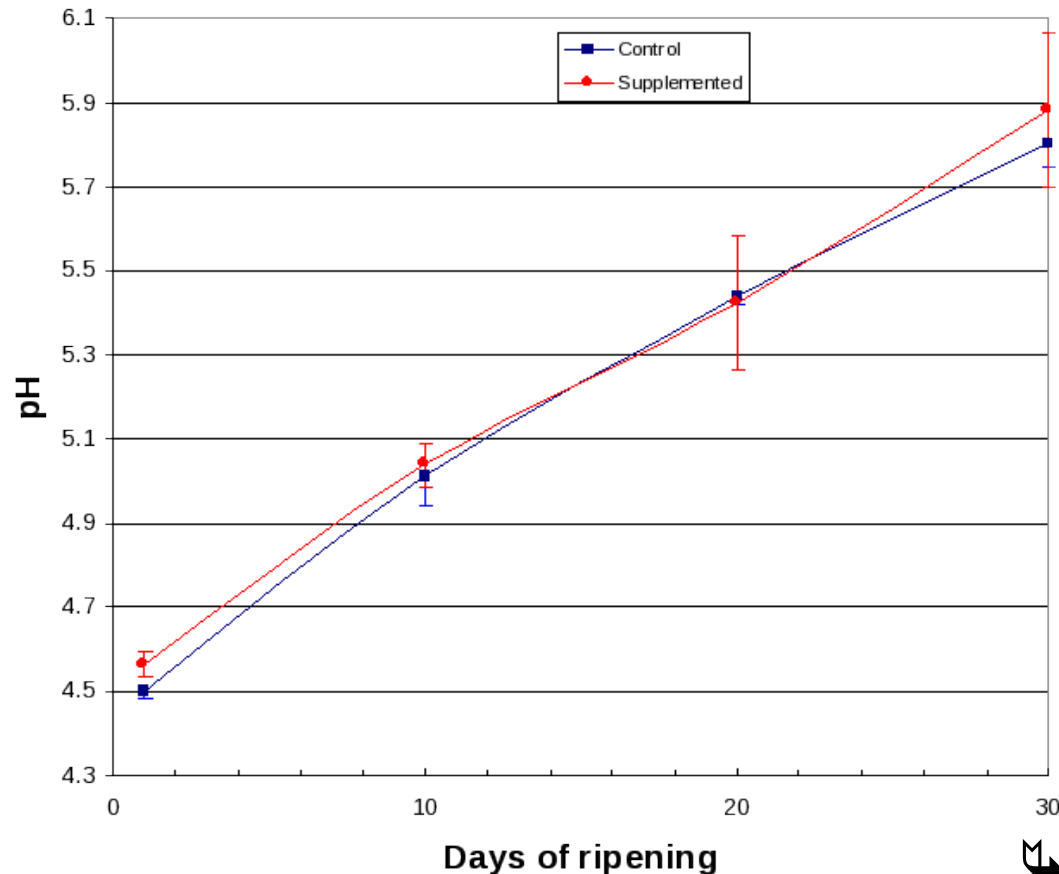
Control												
	pH	DM g/kg	Fat g/kg	TN g/kg	NCN g/kg	NPN g/kg	Ca g/kg	FDM %	MFFB %	NPN/NT %	NCN/NT %	Ca/FFDM %
Means	4.52	443.2	232.5	175.1	12.4	6.5	3.08	52.5	72.6	3.7	7.1	1.46
SD	0.02	1.7	8.2	6.1	1.0	0.1	0.08	1.7	0.7	0.1	0.3	0.08

Supplemented												
	pH	DM g/kg	Fat g/kg	TN g/kg	NCN g/kg	NPN g/kg	Ca g/kg	FDM %	MFFB %	NPN/NT %	NCN/NT %	Ca/FFDM %
Means	4.56	454.0	247.5	171.4	12.0	6.3	2.84	54.5	72.6	3.7	7.0	1.37
SD	0.03	6.0	4.2	6.2	0.5	0.2	0.04	1.0	0.8	0.0	0.1	0.03

- ➡ **Supplemented cheese:** DM (+2.4%), FDM (Fat in Dry Matter +3.94%)
- ➡ Cheese humidity similar (Moisture in Fat Free Basis)
- ➡ Proteolysis levels similar
- ➡ **Control cheese** more mineralized (Calcium / Fat Free Dry Matter) (+6.4%)

Cheese pH during ripening (control vs supplemented)

pH evolution

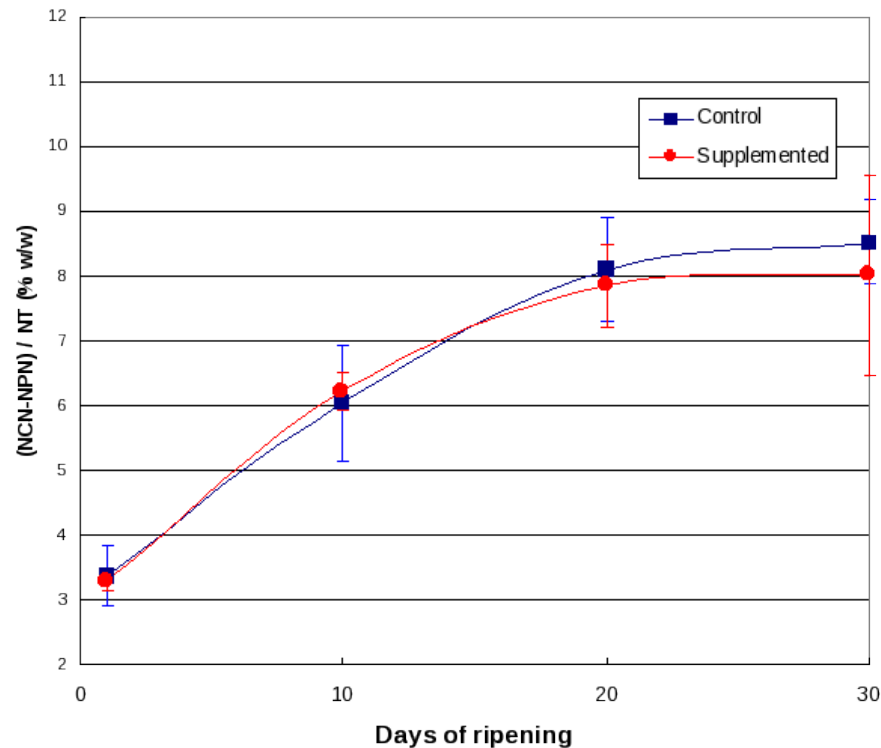


↘ pH ↗ (lactic acid ↘ and NH_3 ↗)

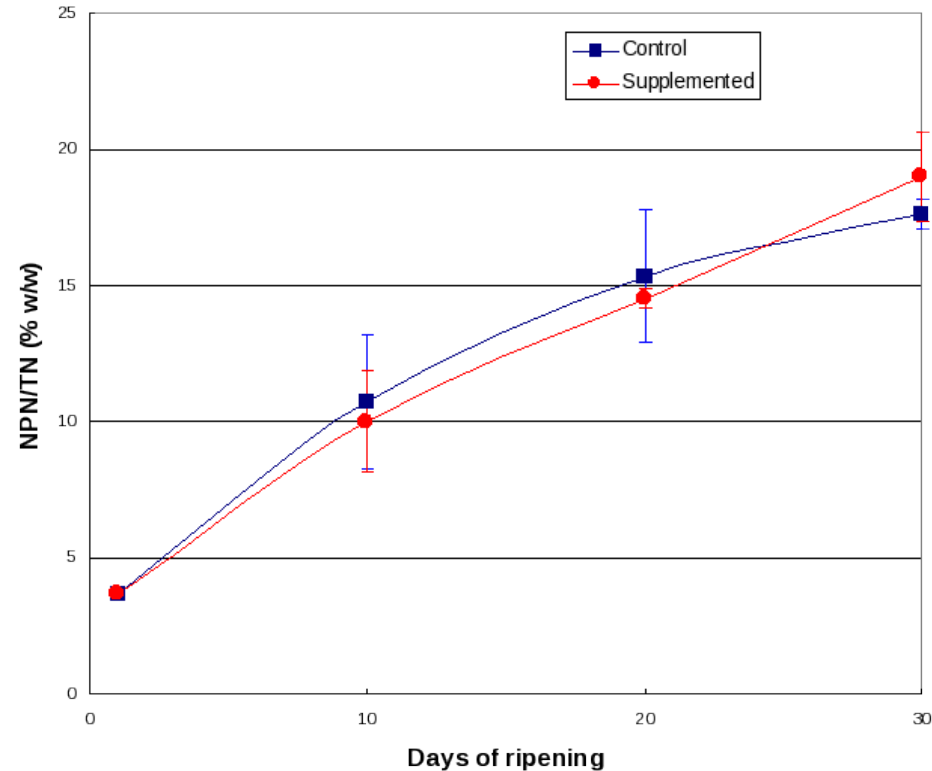
↘ Similar pH evolution

Proteolysis during ripening (control vs supplemented)

(NCN-NPN)/NT evolution



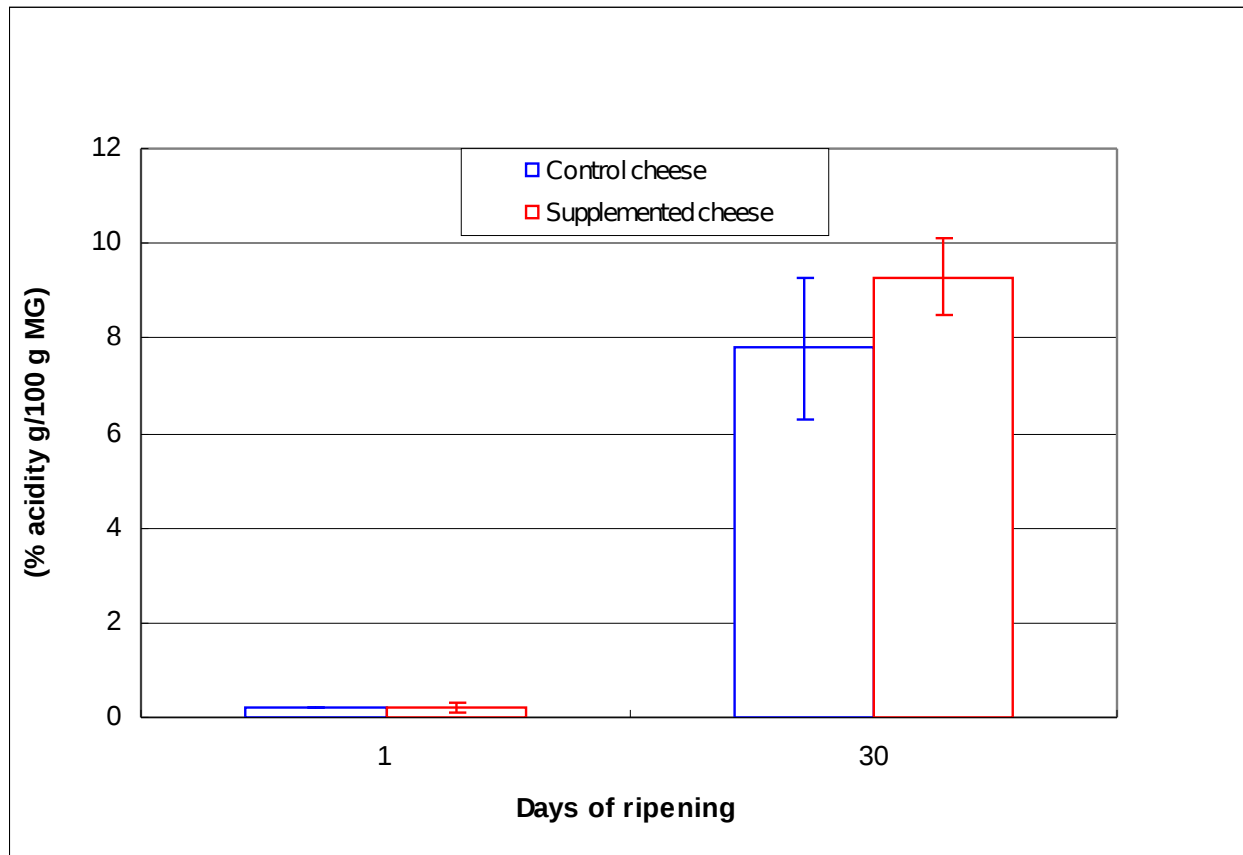
NPN/NT evolution



➡ Proteolysis during ripening was equivalent.

Lipolysis during ripening (control vs supplemented)

Free Fatty Acid evolution



➡ Lipolysis during ripening was equivalent.

Cheese lipid composition after 30 days of ripening (control vs supplemented)

Results and discussion



Cheese at D + 30		
Fatty acids	Control	Supplemented
Saturated FA	65.8 ± 1.6	60.4 ± 0.7
C16:0	23.9 ± 0.5	19.0 ± 0.6
Unsaturated FA	31.7 ± 1.5	36.5 ± 0.6
C18:1	24.8 ± 1.5	27.8 ± 1.0
Monounsaturated FA	26.4 ± 1.6	29.4 ± 1.0
Polyunsaturated FA	5.3 ± 0.2	7.1 ± 0.7
CLA	0.8 ± 0.0	1.2 ± 0.1
Omega 3 n-3	0.8 ± 0.1	1.8 ± 0.4
ALA	0.8 ± 0.1	1.7 ± 0.4
Omega 6 n-6	3.6 ± 0.0	3.8 ± 0.1
LA	3.1 ± 0.1	3.1 ± 0.0
Total trans FA	4.0 ± 0.4	6.5 ± 0.7
LA/ALA	3.9 ± 0.7	1.8 ± 0.4
n-6/n-3	4.5 ± 0.8	2.0 ± 0.4

Differences between **control** and
supplemented

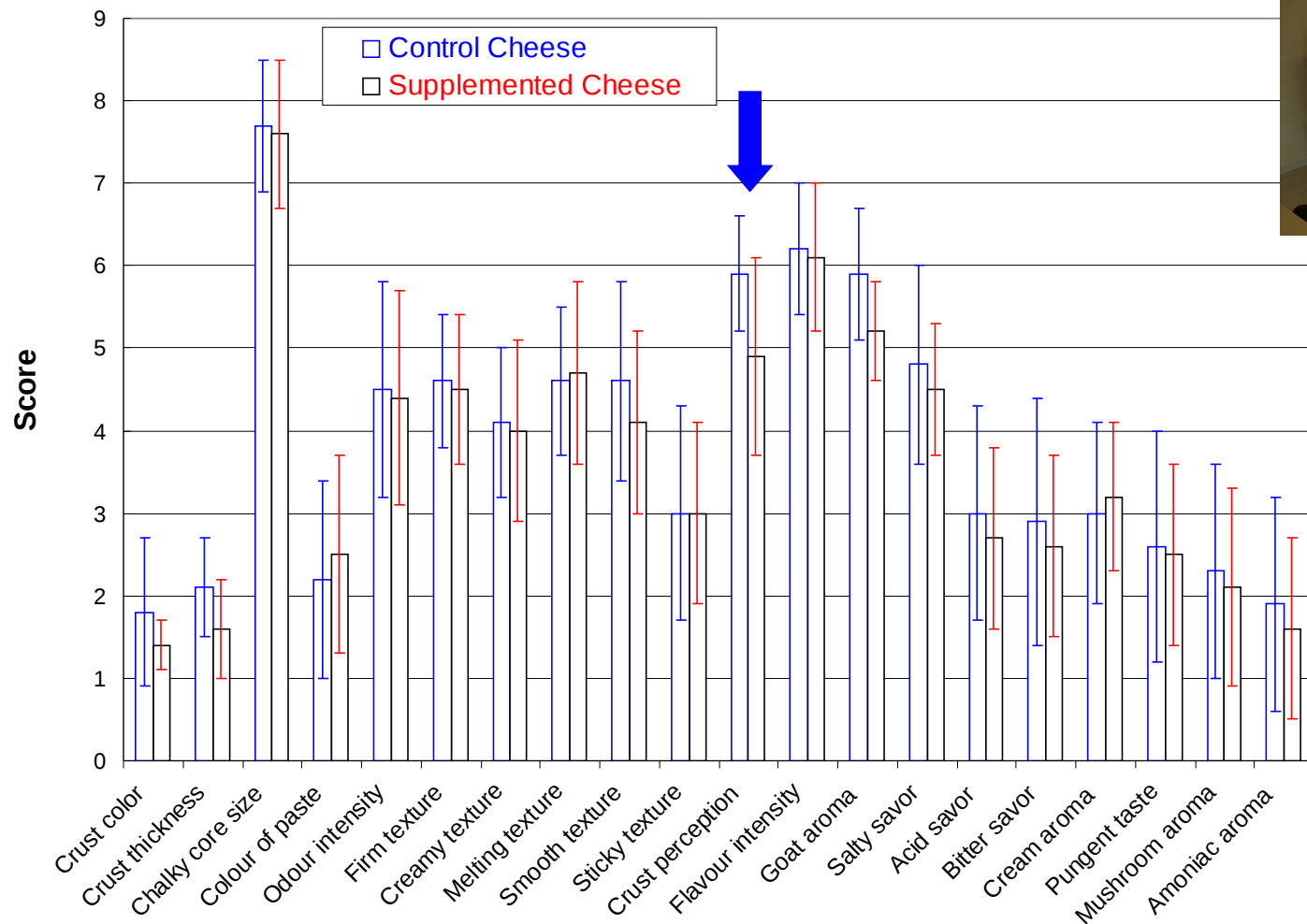


↘ Decrease in SFA

↘ Increase in PUFA

↘ ☹ Increase in Total trans FA

Sensorial analyses of cheeses



➡ Global sensorial analyses were similar for both cheeses

➡ Crust more perceptible ($P=0.046$)

Conclusion and Perspectives

- Composition **supplemented** milk (DM, fat & protein) > **control** milk.
- Cheese manufactures were similar (acidification & drainage).
- Cheese yield **↗** 5.7 % with **supplemented** milk (higher fat and protein contents).
- Biochemical modifications (proteolysis and lipolysis) during ripening \Rightarrow equivalent.
- Cheese fat composition was different: **↗** PUFA (for example, C18:3 (n-3) increased from 0.8 to 1.83 %) and a **↘** in SFA (66.8 to 60.4 %).
- Sensorial analyses \Rightarrow similar for both cheeses (except crust perception)
- It was possible to make soft goat cheese with milk enriched with PUFA. The parameters of the cheese making and the final quality of the cheese were positively affected.
- The development of this type of cheese is in progress to be commercialised.

Thank you for your attention

