

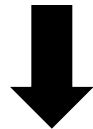
Cheese quality from grazing sheep supplemented with agro-industrial by-products

Bolletta V., Lilli E., Pauselli M., Sordini B., Mele M., Foggi G., Valenti B.

Introduction

Challenges in Livestock Industry

- Food-feed-fuel competition
- Rising feed price
- Climate changing
- Consumers demand high-quality products and animal welfare



Need for alternative feed formulations



Introduction

Agro-Industrial By-Products

- 20%-33% of agrifood productivity
- Local availability and competitive pricing
- Contain human-inedible nutrients and bioactive compounds
- Disposal costs



Objective

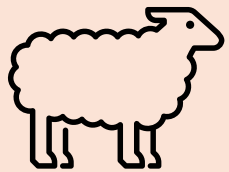
To evaluate the impact of supplementing grazing lactating Comisana ewes with a concentrate composed of **agro-industrial by-products** on the quality traits of **cheese**.



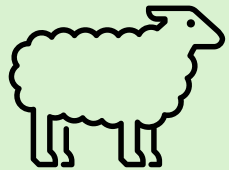
Methods

Animals and diet

CTRL (N=12)



63.96 kg
1054.17 g milk/d



EXP (N=12)

Pasture



6 hours/day

Pasture

CTRL concentrate



1 kg/day

EXP concentrate



37

42

days



Adapting
period

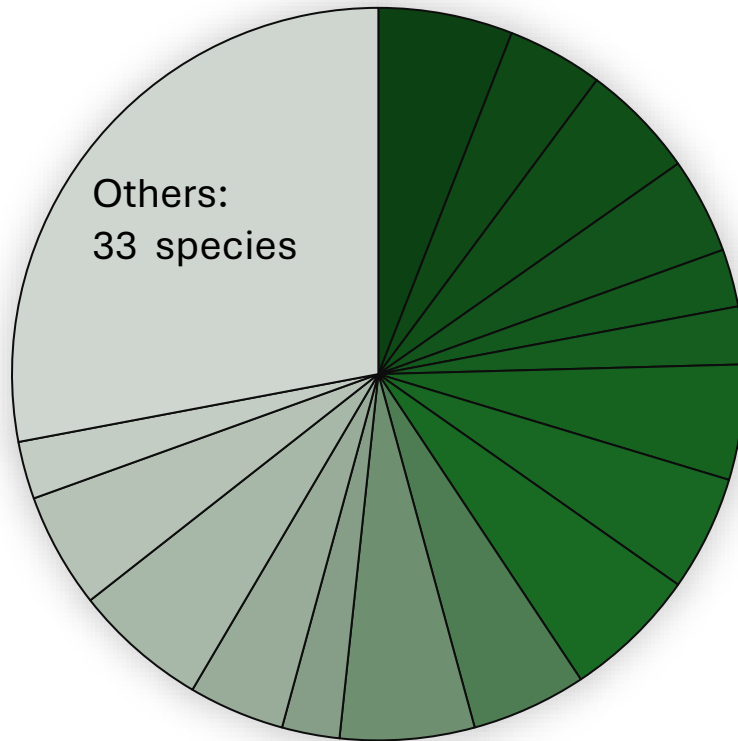
15

Weekly samplings

Methods

Diet: pasture

Pasture botanical composition



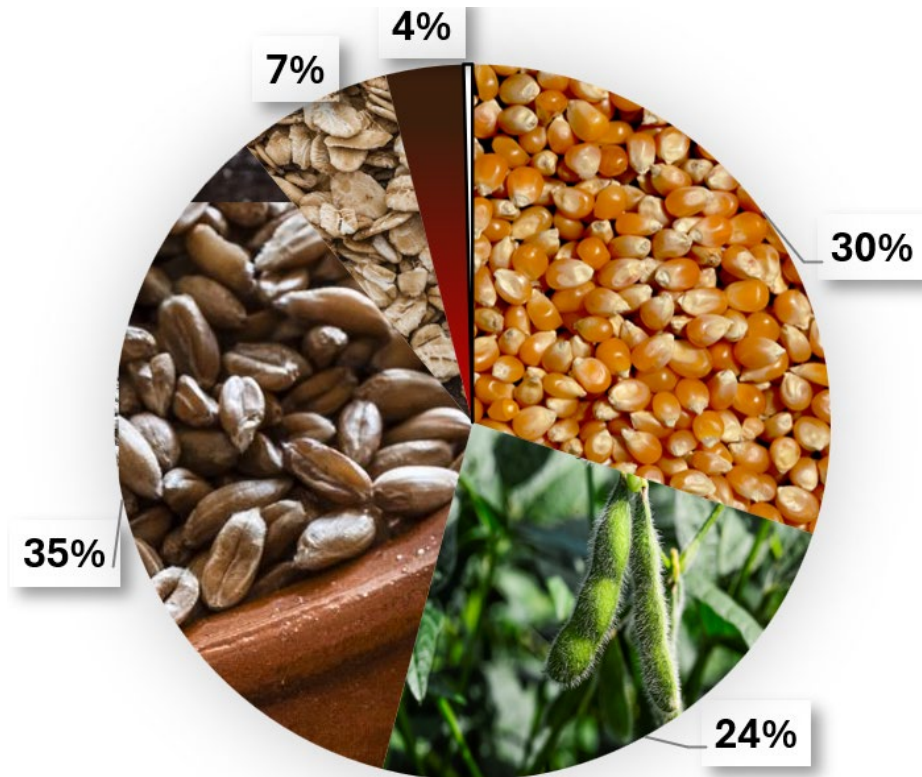
- *Avena barbata* Pott ex Link
- *Brachypodium rupestre* (Host) Roem. & Schult.
- *Cichorium intybus* L.
- *Clinopodium nepeta* (L.) Kuntze subsp. *nepeta*
- *Convolvulus arvensis* L.
- *Crepis neglecta* L. subsp. *neglecta*
- *Dactylis glomerata* L. subsp. *glomerata*
- *Daucus carota* L. subsp. *carota*
- *Lolium perenne* L.
- *Lotus corniculatus* L. subsp. *corniculatus*
- *Plantago lanceolata* L.
- *Potentilla reptans* L.
- *Silene latifolia* Poir.
- *Trifolium pratense* L. subsp. *pratense*
- *Trifolium repens* L.
- *Verbascum sinuatum* L.
- Others



**Total identified:
49 species**

Methods

Diet: concentrates



Control concentrate ingredients

- Barley 35%
- Corn 30%
- Soybean meal 24%
- Wheat bran 7%
- Molasses 4%
- Vitamin and mineral mix 0.4%

Methods

Diet: concentrates

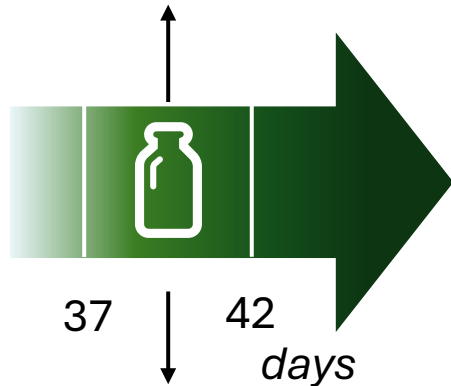
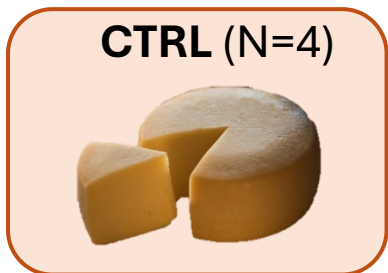


Experimental concentrate ingredients

- Wheat Bran 25%
- Alfalfa 20%
- Distillers 24%
- Rice husks 15%
- Olive pomace 10%
- Tomato peels 8%
- Molasses 2%
- Vitamin and mineral mix 0.4%

Methods

Cheesemaking and analyses



Cheesemaking

Bulk milk of the two groups collected for **5 days**

Stored at -30°C until **cheesemaking** (1 batch).

Standard cheesemaking for caciotta pecorino cheese

50 days of ageing



Lab Analysis

Fatty acids (FA)

Antioxidant capacity (AOX)

Lipid oxidation (TBARS, 0, 3, 7 days)

Color evolution (CIELab, 0, 3, 7 days)

Sensory properties (0, 3, 7 days)

Triangular test (0, 3, 7 days)



Statistical Analysis

- FA, AOX

Linear model: $\beta_0 + \beta_1 * \text{Diet} + \text{Cheese Wheel}_{\text{random}}$

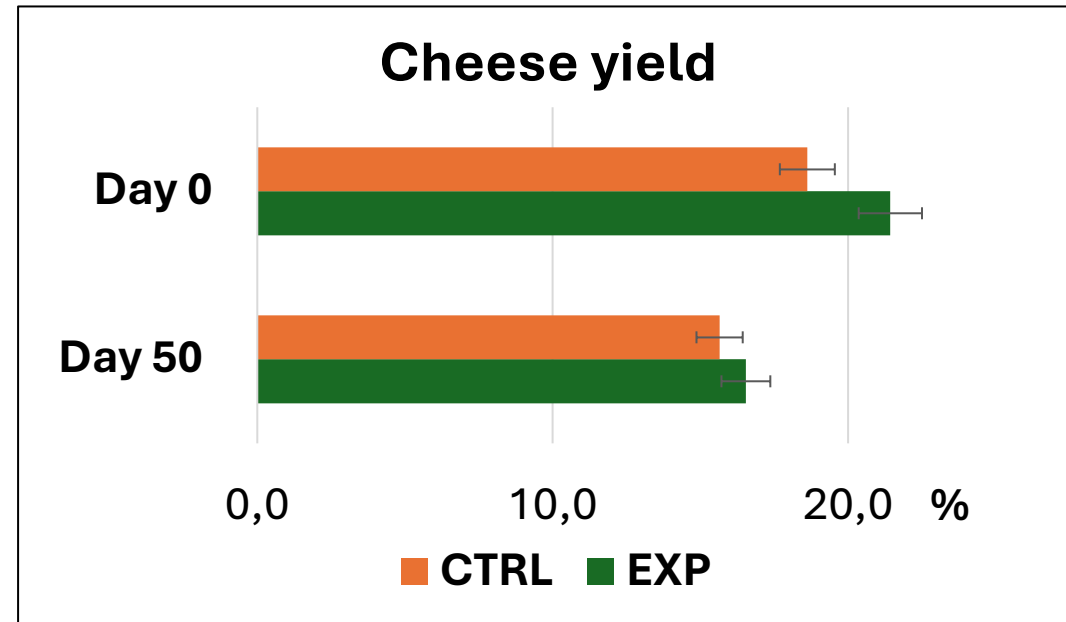
- TBARS, CIELab, Sensory

Mixed Model: $\beta_0 + \beta_1 * \text{Diet} + \beta_2 * \text{Time} + \beta_3 * (\text{Diet} \times \text{Time}) + \text{Cheese Wheel}_{\text{random}}$

Principal Component Analysis

Results

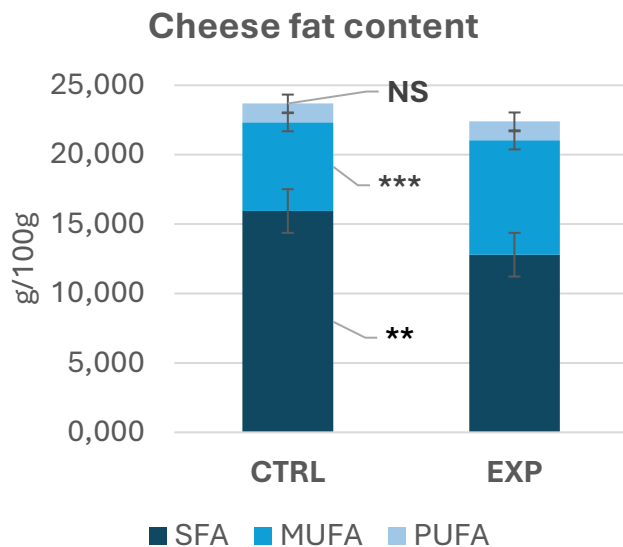
Cheese yield and chemical composition



	CTRL	EXP	SEM	P-value
DM (%)	63.9	66.3	1.06	0.316
N total (%DM)	39.1	37.6	1.11	0.559
EE (%DM)	53.1	51.4	0.584	0.178
Ash (%DM)	4.23	5.04	0.228	0.058

Results

Fatty acids

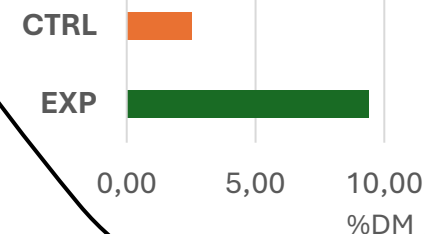


Cheese saturated fatty acids

	Diet		SEM	P-value
	CTRL	EXP		
C4:0	0.072	0.073	0.011	0.961
C6:0	↑ 0.817	↓ 0.456	0.093	0.023
C8:0	↑ 1.807	↓ 0.824	0.224	0.000
C10:0	↑ 7.303	↓ 2.799	1.020	0.000
C12:0	↑ 4.093	↓ 1.840	0.507	0.000
C14:0	↑ 10.000	↓ 6.463	0.800	0.000
C15:0	0.883	0.836	0.018	0.201
C16:0	23.859	23.336	0.465	0.631
C17:0	0.574	0.573	0.015	0.975
C18:0	↓ 11.860	↑ 15.531	0.881	0.007
C20:0	0.029	0.018	0.005	0.285
C21:0	0.115	0.090	0.018	0.550
C22:0	↓ 0.148	↑ 0.187	0.009	0.001
C23:0	0.068	0.076	0.003	0.191
C24:0	↓ 0.063	↑ 0.096	0.008	0.007

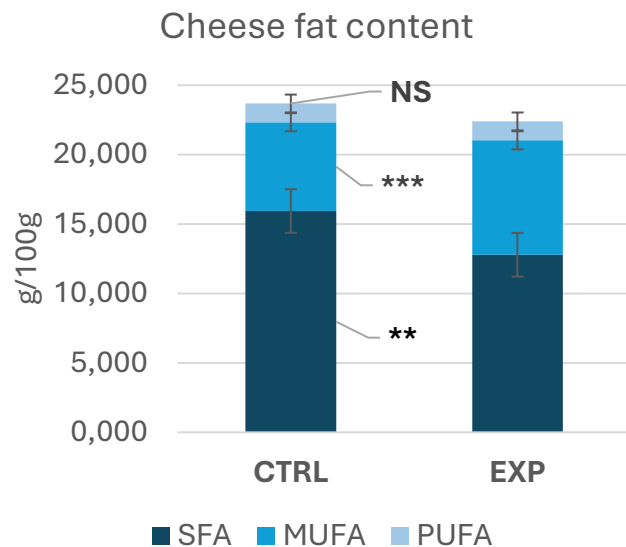


Concentrates ADL



Results

Fatty acids

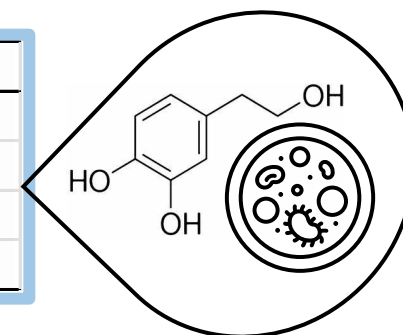


Cheese unsaturated fatty acids

	Diet		SEM	P-value
	CTRL	EXP		
MUFA	↓ 24.763	↑ 34.257	2.210	0.002
<i>C12:1 c9</i>	↑ 0.098	↓ 0.050	0.011	0.001
<i>C14:1 t9</i>	↑ 0.299	↓ 0.227	0.016	0.001
<i>C14:1 c9</i>	↑ 0.196	↓ 0.109	0.020	0.000
<i>C16:1 t9</i>	↓ 0.129	↑ 0.203	0.018	0.009
<i>C17:1 c9</i>	↑ 0.793	↓ 0.674	0.030	0.013
<i>C18:1 t678</i>	↓ 0.284	↑ 0.759	0.108	0.000
<i>C18:1 t9</i>	↓ 0.362	↑ 0.710	0.079	0.000
<i>C18:1 t10</i>	↓ 0.847	↑ 1.061	0.055	0.021
<i>C18:1 t11</i>	↓ 1.580	↑ 3.148	0.355	0.000
<i>C18:1 c6</i>	↓ 0.756	↑ 1.323	0.128	0.000
<i>C18:1 c9</i>	↓ 18.584	↑ 24.893	1.500	0.005
<i>C18:1 c11</i>	↓ 0.371	↑ 0.432	0.014	0.001
<i>C18:1 c12</i>	↓ 0.293	↑ 0.486	0.044	0.000



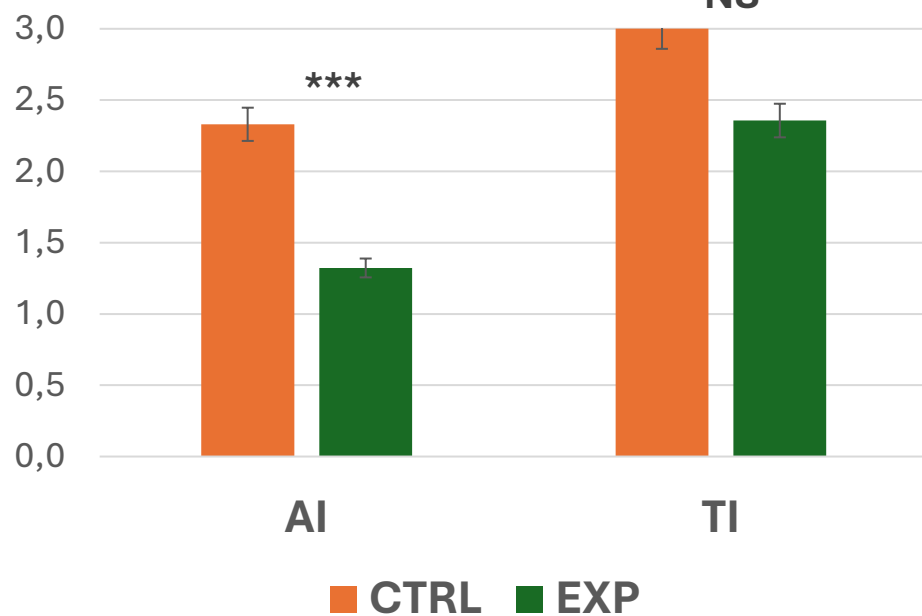
	Diet		SEM	P-value
	CTRL	EXP		
PUFA				
<i>C18:2 n-6</i>	↓ 2.615	↑ 2.983	0.100	0.043
<i>C18:3 n-3</i>	↓ 0.415	↑ 0.481	0.017	0.028
<i>C18:2 c9t11</i>	↓ 0.725	↑ 1.312	0.134	0.001



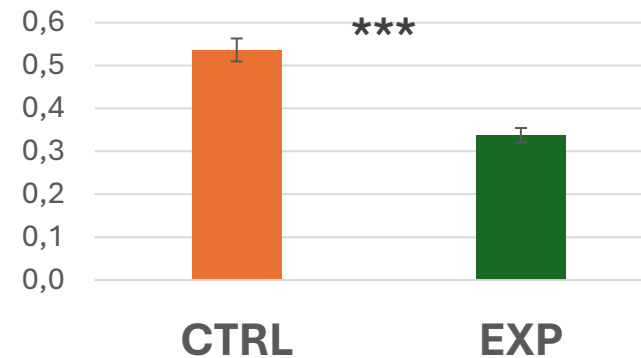
Results

Fatty acids

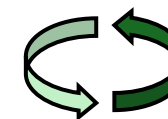
Health indices



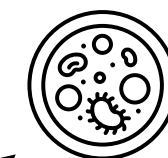
C18:1 t10/t11 ratio



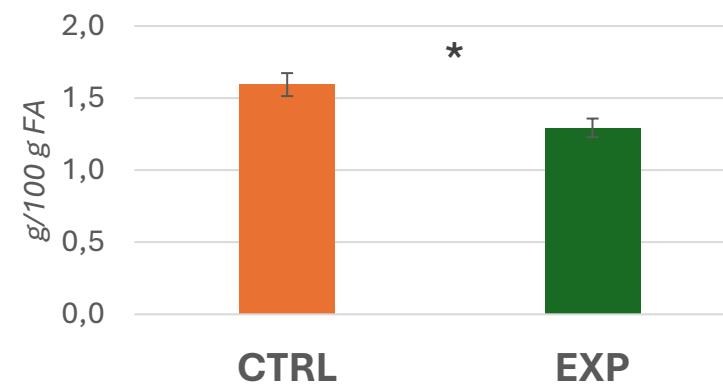
metabolism



microorganisms



OBCFA

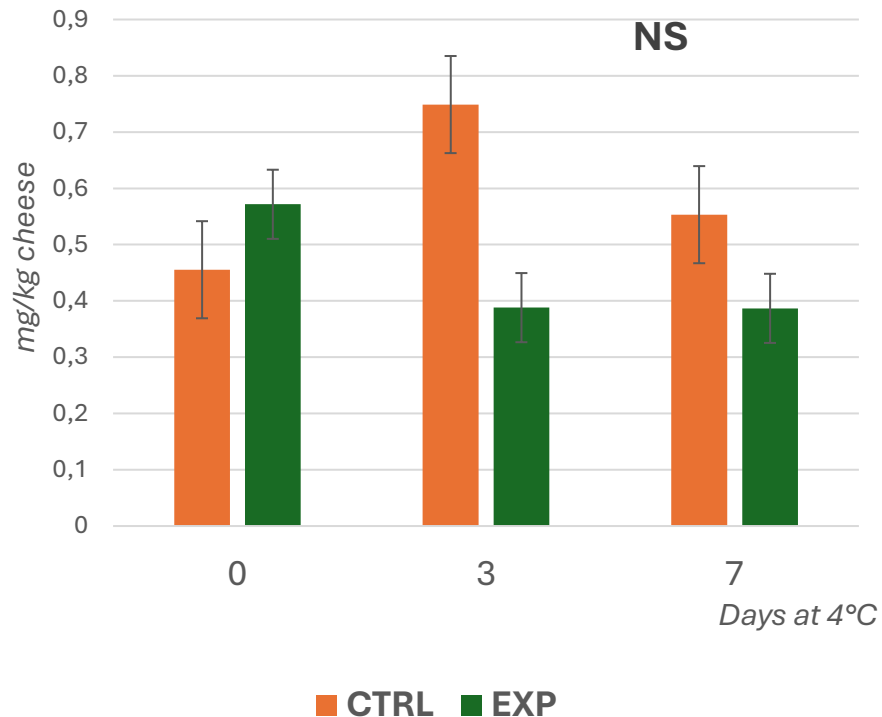


Titolo asse

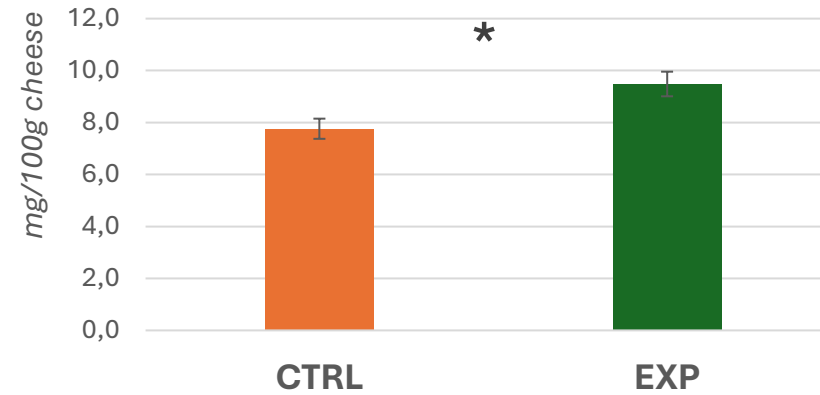
Results

Lipid oxidation and Antioxidant capacity

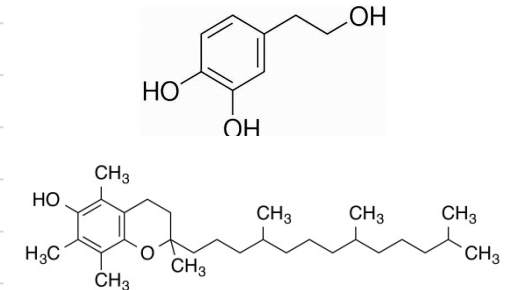
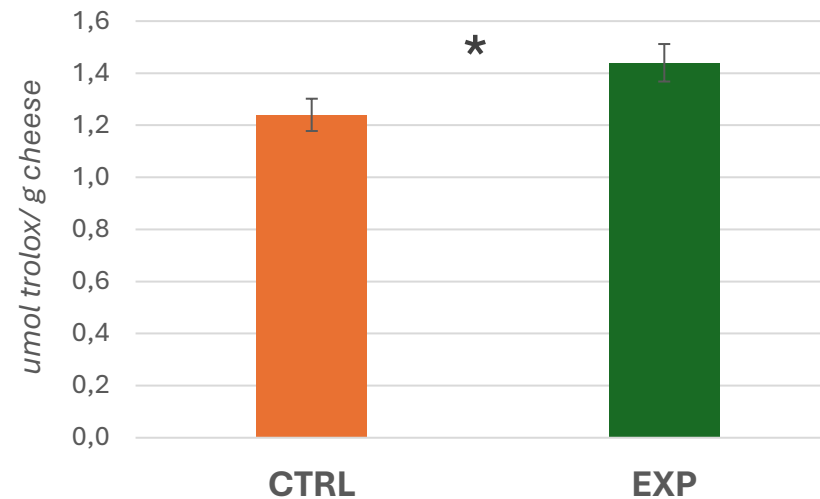
Lipid oxidation - TBARS



Antioxidant capacity - Folin assay



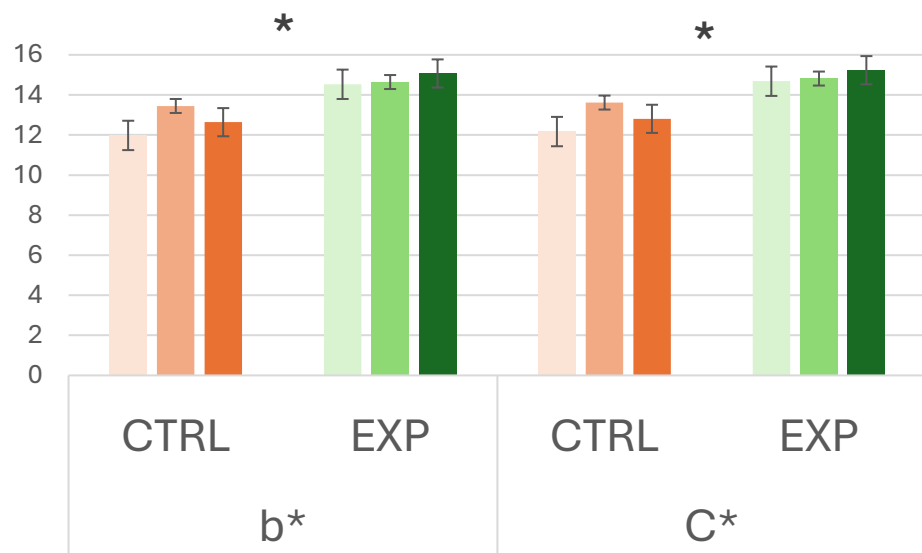
Antioxidant capacity - TEAC



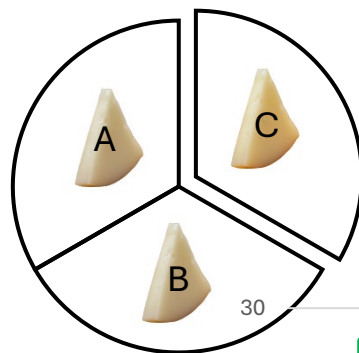
Results

Triangular test and color

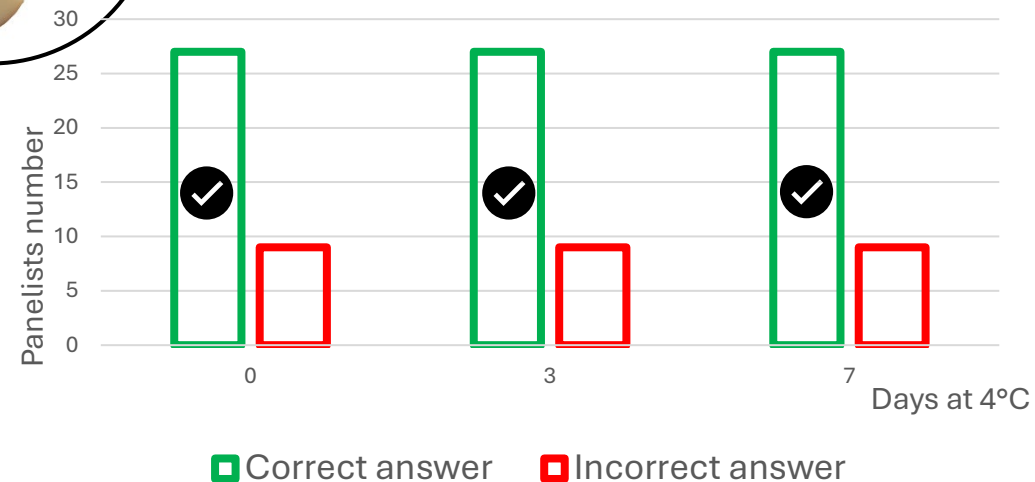
Color evolution – CIE-Lab



Cheese color was affected by the sheep diet



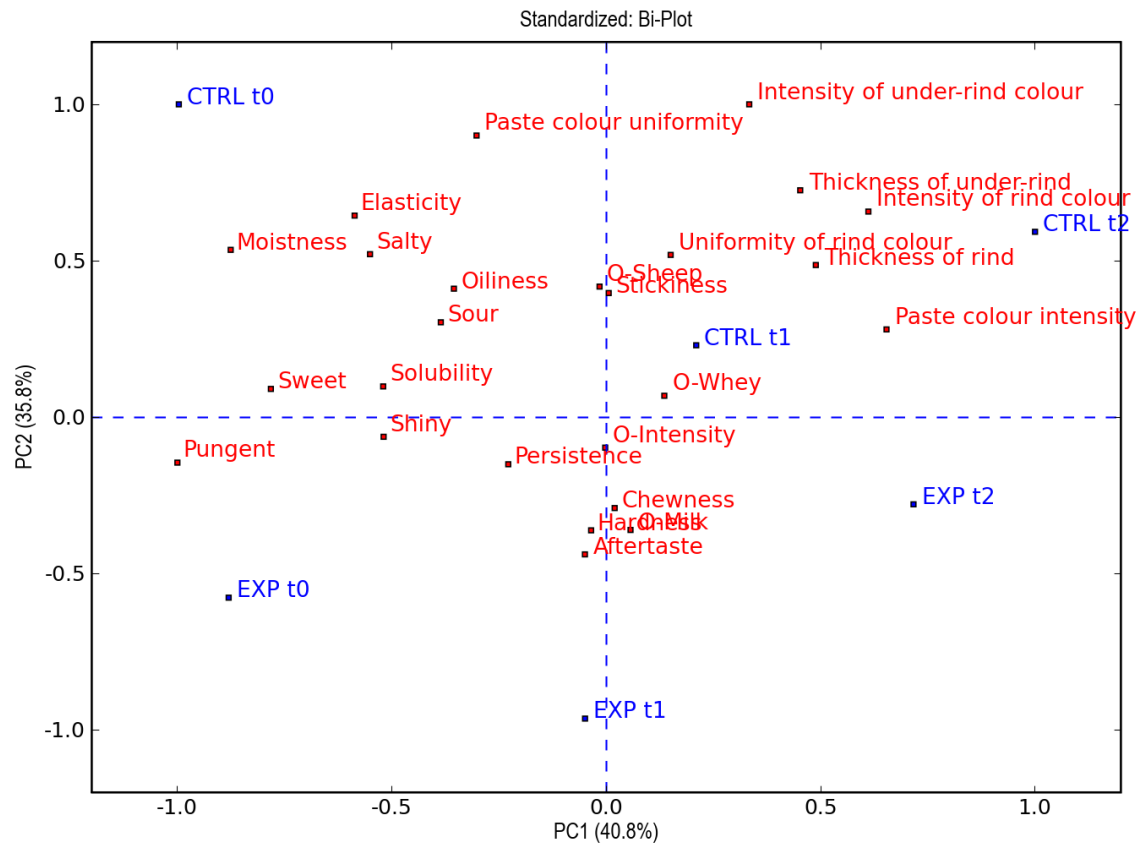
Triangular test



At 0, 3 and 7 days of refrigerate storage, 75% of the panelists found differences between CTRL vs EXP ($\alpha = 0.01$)

Results

Sensory analysis



PC1: Storage time

Descriptors

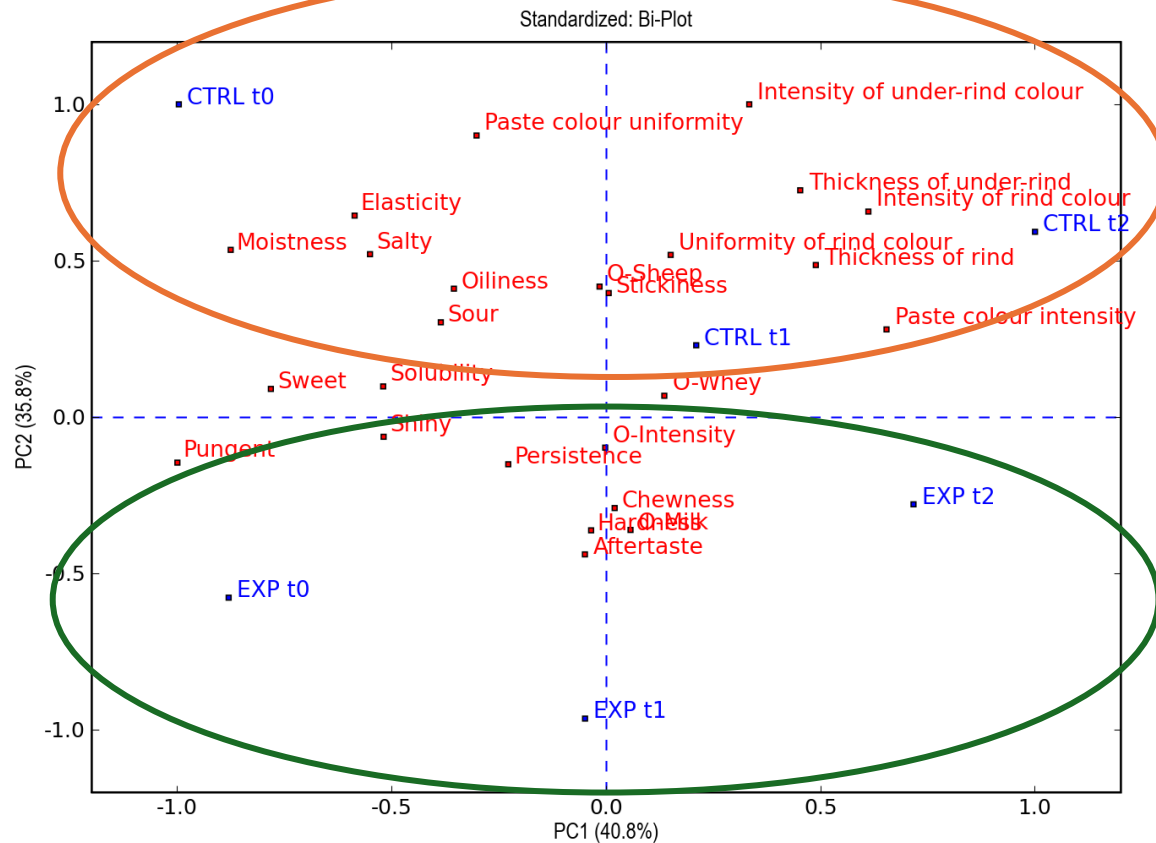
Spiciness, elasticity, brightness, moisture, sweetness, saltiness, acidity, and oiliness.

Descriptors increased during storage:

Paste color intensity, crust color intensity, crust thickness, nail thickness, and nail color intensity

Results

Sensory analysis



PC2: Sheep diet

Descriptors

Paste color, crust color, crust thickness, nail thickness, sheep odor, elasticity, moisture, acidity, saltiness, and oiliness.

Conclusions



- Integration of **agro-industrial by-products** in sheep diet improved the cheese's **nutritional profile**:
Increased content of health-positive fatty acids
Lower atherogenic index
- The experimental cheese was **stable** during 7 days of storage in **self-service-like conditions**.
- Panelists found **differences** in control cheese and experimental cheese
Mainly **appearance-related**
No off-flavors were found in the experimental cheese.
- Cheese from sheep fed on pasture and by-products has interesting nutritional and organoleptic qualities, promoting **circular economy**

75° EAAP Congress Florence, September 2024

Bolletta V., Lilli E., Pauselli M., Sordini B., Mele M., Foggi G., Valenti B.

**Thank you for your
kind attention.**



Contact:

viviana.bolletta@dottorandi.unipg.it

