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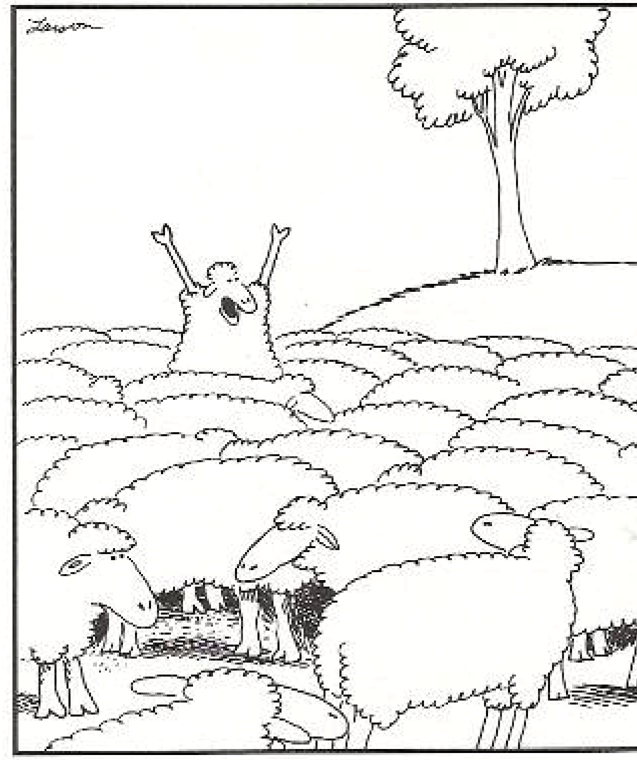
Session 01: Physiological limits related to intensive livestock farming systems



"Wait! Wait! Listen to me! ...
We don't *have* to be just sheep!"

Effect of milking interval on alveolar and cisternal compartments in the udder of dairy sheep

(S.01, #6, p. 3)

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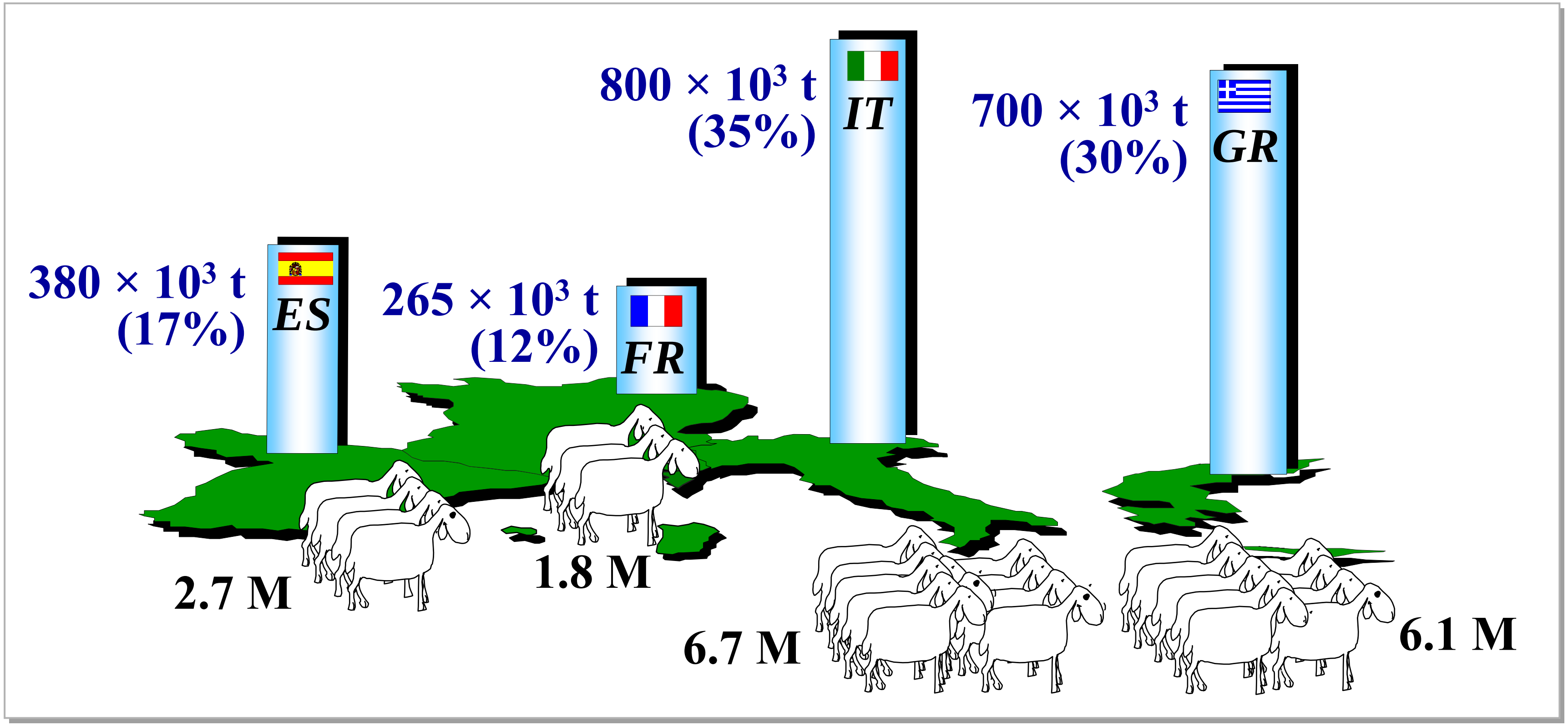
Introduction (1/2)

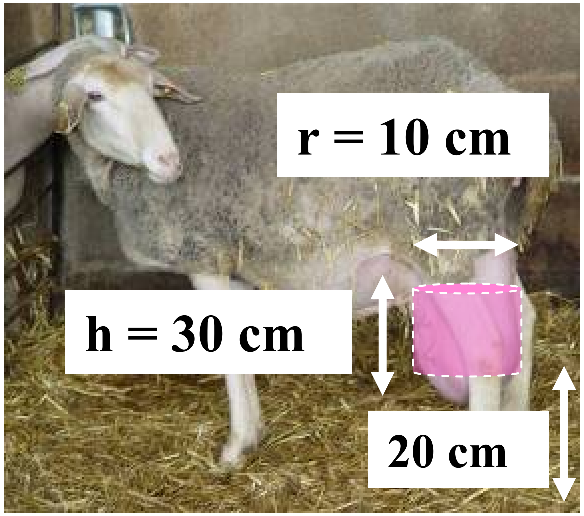
- **Dairy sheep industry** (FAOstat, 2004)**:**
  - **World: 220 M of dairy sheep producing 8.2 Mt of milk**
  - **Europe: 15% dairy sheep producing 35% milk (2.9 Mt)**
  - **Mainly located in the Mediterranean countries**
  - **Oriented to dairy products (cheese & yogurt)**



Introduction (2/2)

- **Structural constraints**
  - Increasing flock sizes (150 to 10,000 ewes)
  - Low unitary milk yield (0.2 to 2.0 L/milking)
  - Milking (2X daily) represents >50% working time in sheep dairy farms
  - High milking costs (0.1 to 0.3 €; ×100 dairy cow costs)

- **Biological features:**
  - Larger cisternal compartment (40-80%) than dairy cows
  - Large "effective storage volume" (~3 L)



$V = \pi r^2 h = 9{,}425\ cm^3$

Gland:Milk = 1:1

Cisternal (70%) = 3.2 L

Alveolar (30%) = 1.4 L

Objectives

To study the effect of milking interval on:

- **Udder compartments** (alveolar & cisternal)
- **Milk yield**
- **Milk composition**
- **Indicators of mammary epithelial cell tight junctions opening** (plasma and milk)

In 2 dairy ewe breeds at same lactation stage and under similar management conditions:

- **Manchega** (medium yield, high composition)
- **Lacaune** (high yield, medium composition)

Material and Methods (1/3)

- **24 dairy ewes at mid lactation** (DIM, 70 ± 3) **with healthy udders** (SCC, 64 ± 48 ×10^3 cells/mL; <5 cfu/mL)**, penned and fed indoors** (INRAtion v. 3.3)**:**
  - **Manchega** (n = 12; 70 kg BW; milk, **1.11 ± 0.09 L/d**)
  - **Lacaune** (n = 12 ; 76 kg BW; milk, **2.32 ± 0.11 L/d**)

- **Milking:** 2×12 parallel stalls milking parlor (Westfalia-Surge; 42 kPa, 120 p/min and 50%)
  - **Regular milkings (2X)**: **14-10 h** (8 am and 6 pm).
  - **Experimental milkings: 6 groups** of **4 ewes** according to a *crossover design* with **6 milking intervals** (**4, 8, 12, 16, 20,** and **24 h**) at random, replicated at wk 11 and 16.

		Treatment order					
Group	Ewes, n	1	2	3	4	5	6
1	4	24 h	4 h	20 h	8 h	16 h	12 h
2	4	4 h	8 h	20 h	16 h	12 h	24 h
3	4	16 h	4 h	24 h	8 h	12 h	20 h
4	4	20 h	4 h	12 h	8 h	24 h	16 h
5	4	8 h	4 h	24 h	12 h	20 h	16 h
6	4	12 h	4 h	16 h	8 h	20 h	24 h

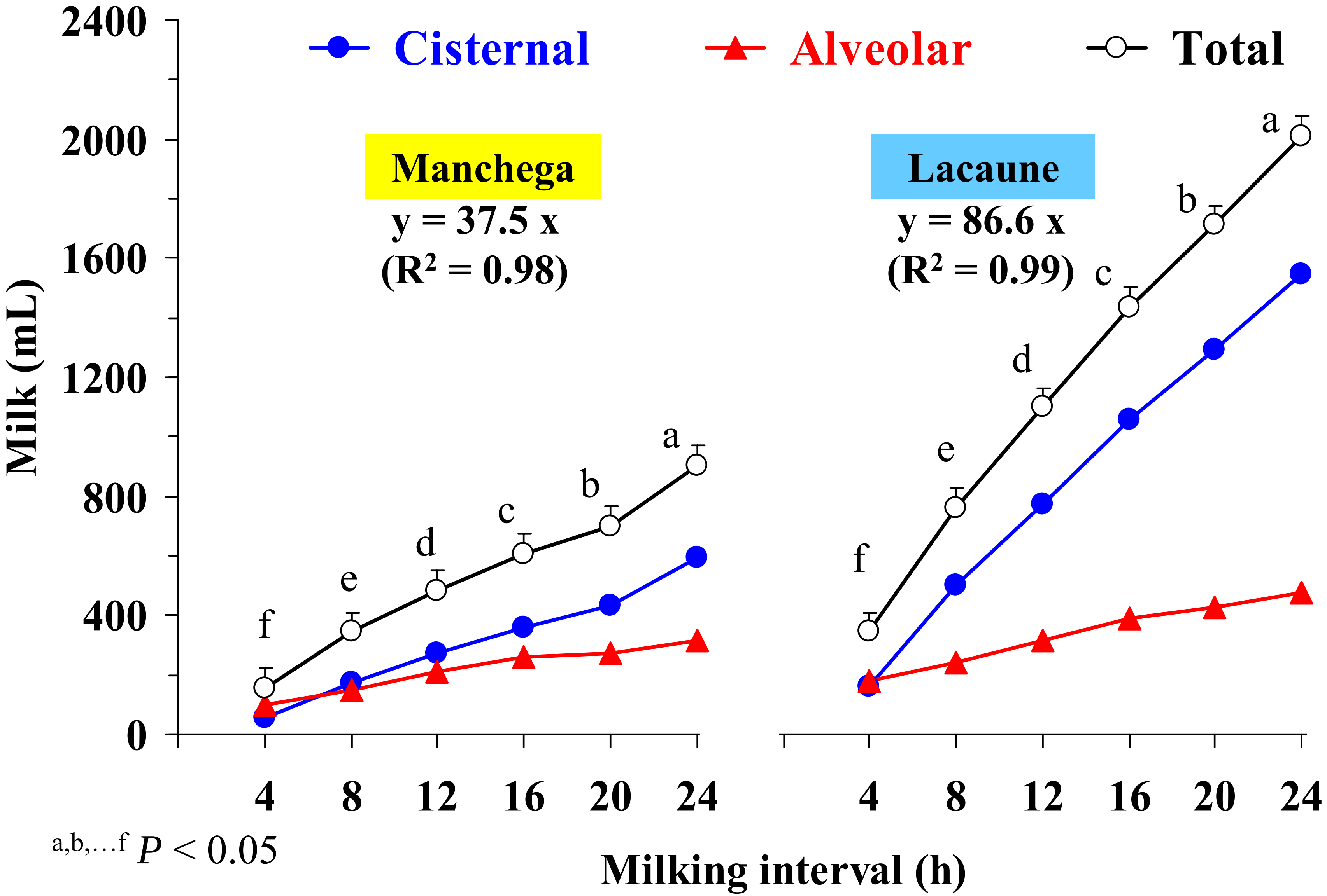
Material and Methods (2/3)

- **Milk compartments:**
  - **Residual milk removal (0 h):** milking after i.v. injection of oxytocin (2 IU/ewe; Veterin Lobulor, Lab. Andreu, Barcelona).
  - **Cisternal area (4, 8… and 24 h):** B-ultrasonography (Ultra Scan 900, Ami Medical Alliance, Montreal; Ruberte et al. (1994) after i.v. injection of an oxytocin blocking agent (0.8 mg/ewe; Tractocile, Ferrin lab., Madrid; Rovai et al., 2008).
  - **Cisternal milk (4, 8… and 24 h):** milking under Tractocile effects (<18 min; Wellnitz et al., 1999).
  - **Alveolar milk (4, 8… and 24 h):** milking after i.v. injection of oxytocin (2 IU/ewe).
- **Milk composition:** NIRA (InfraAlyzer-450, Bran+Luebbe, Norderstedt) for total solids, fat, protein, true protein, casein, and lactose.
  - **Cisternal milk** (4, 8… and 24 h)
  - **Alveolar milk** (4, 8… and 24 h)
- **SCC** (Somatic Cells Count)**:** automatic cell counter (Fossomatic 5000, Foss Electric, Hillerød) calibrated for sheep milk.

Material and Methods (3/3)

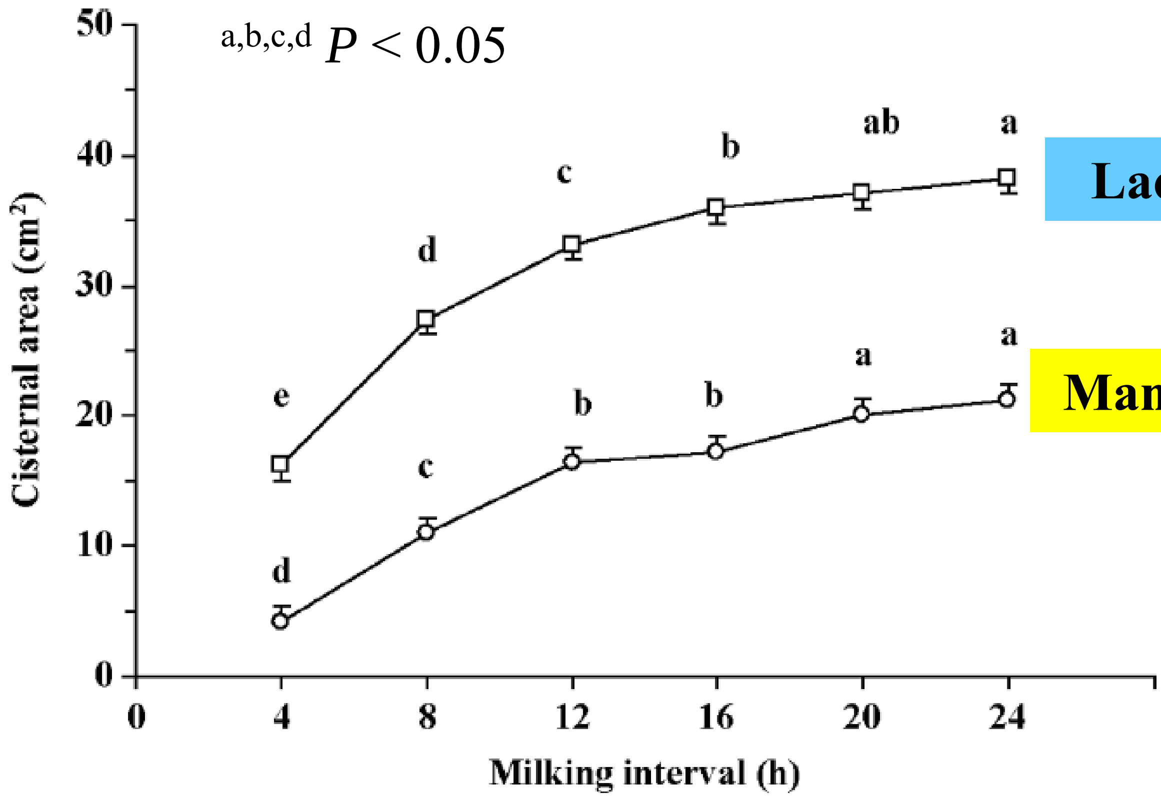
- **Blood sampling and analyses:** at each milking interval from the jugular vein using heparinized tubes. Refrigerated (4°C) and centrifuged (490 × g, 15 min) for plasma (−20°C).
  - **Lactose**: enzymatic assay (Lactose/D-Galactose UV-method; Boehringer Mannheim/R-Biopharm, Darmstadt).
  - **Na and K:** Inductively coupled plasma atomic emission spectroscopy (Chemical Analysis Service, UAB).
- **Statistical Analyses:** PROCMIXED of SAS v.8.2. and differences between LSM were determined with the PDIFF test of SAS.

Results (1/7): Milk accumulation in the ewe's udder according to milking interval and breed



[a,b,…f] $P < 0.05$

Results (2/7): Cisternal area according to milking interval and ewe breed

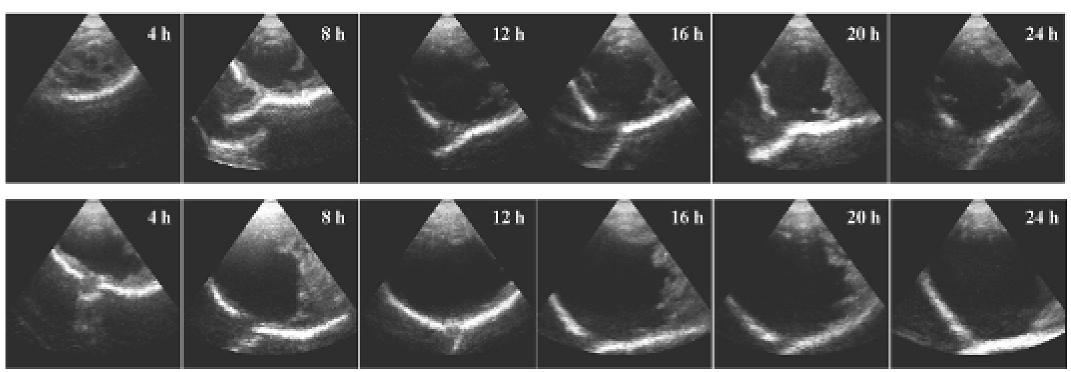


Lacaune

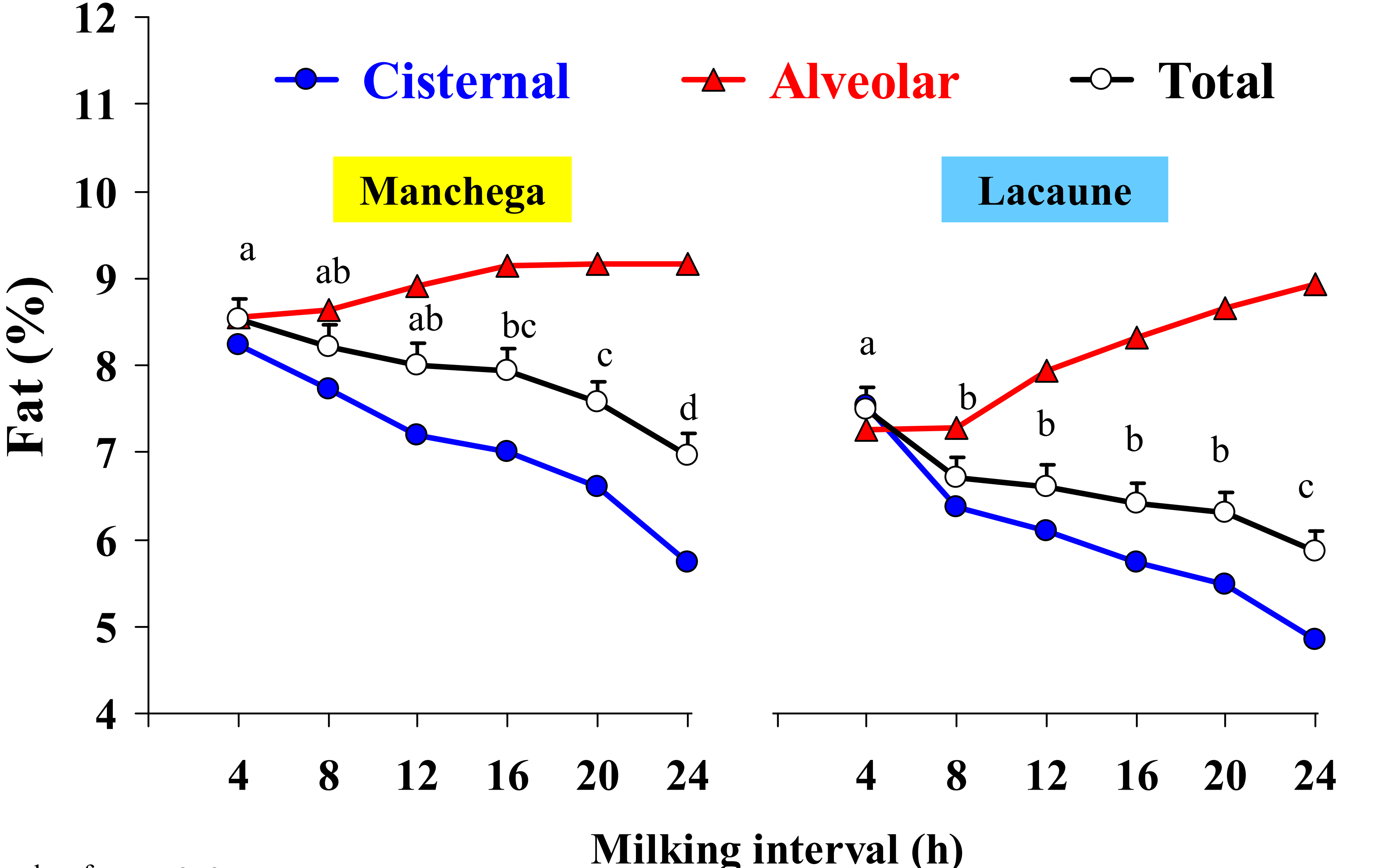
Manchega

Manchega

Lacaune

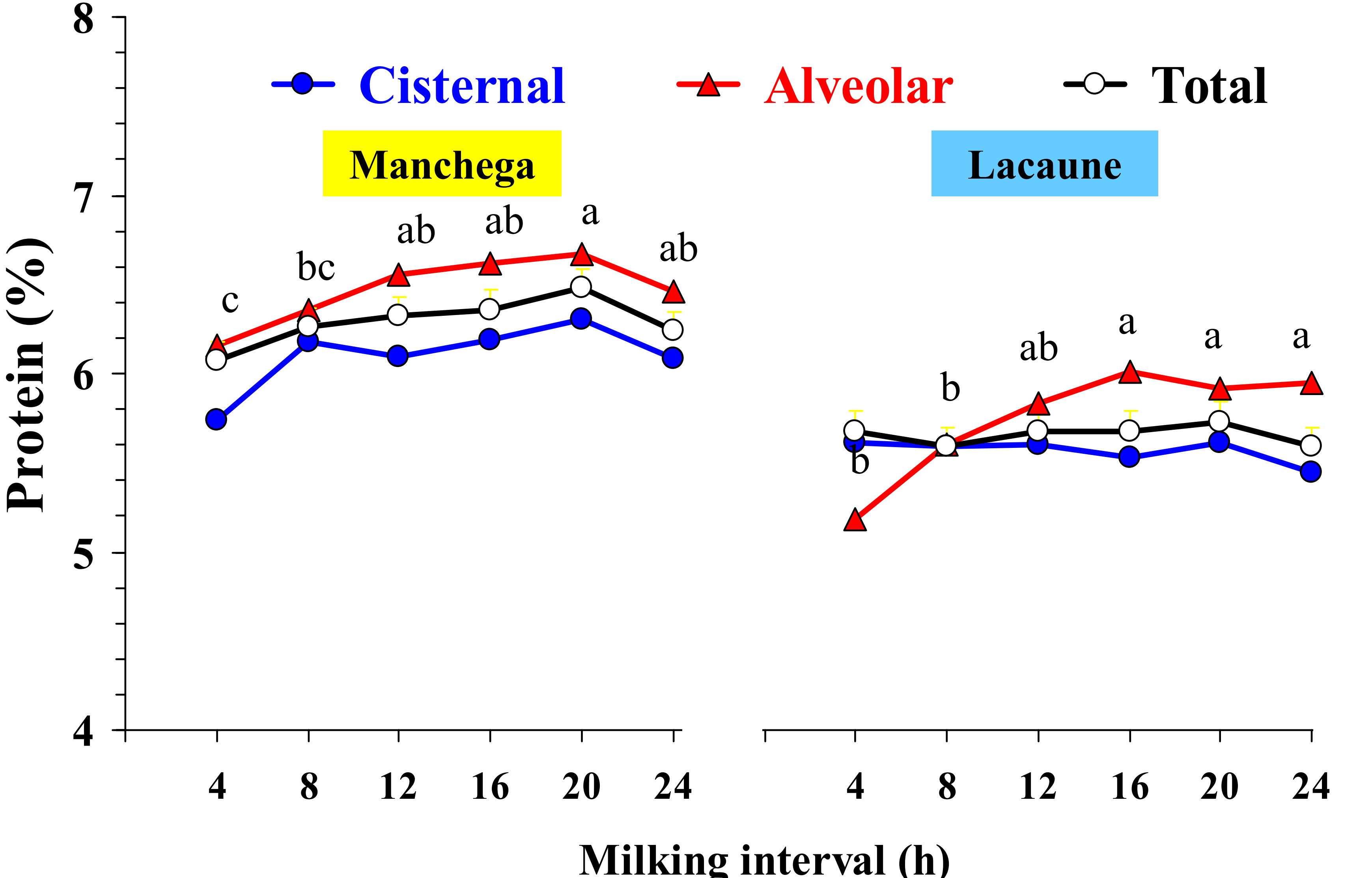


Results (3/7): Milk fat content in the ewe's udder according to milking interval and breed



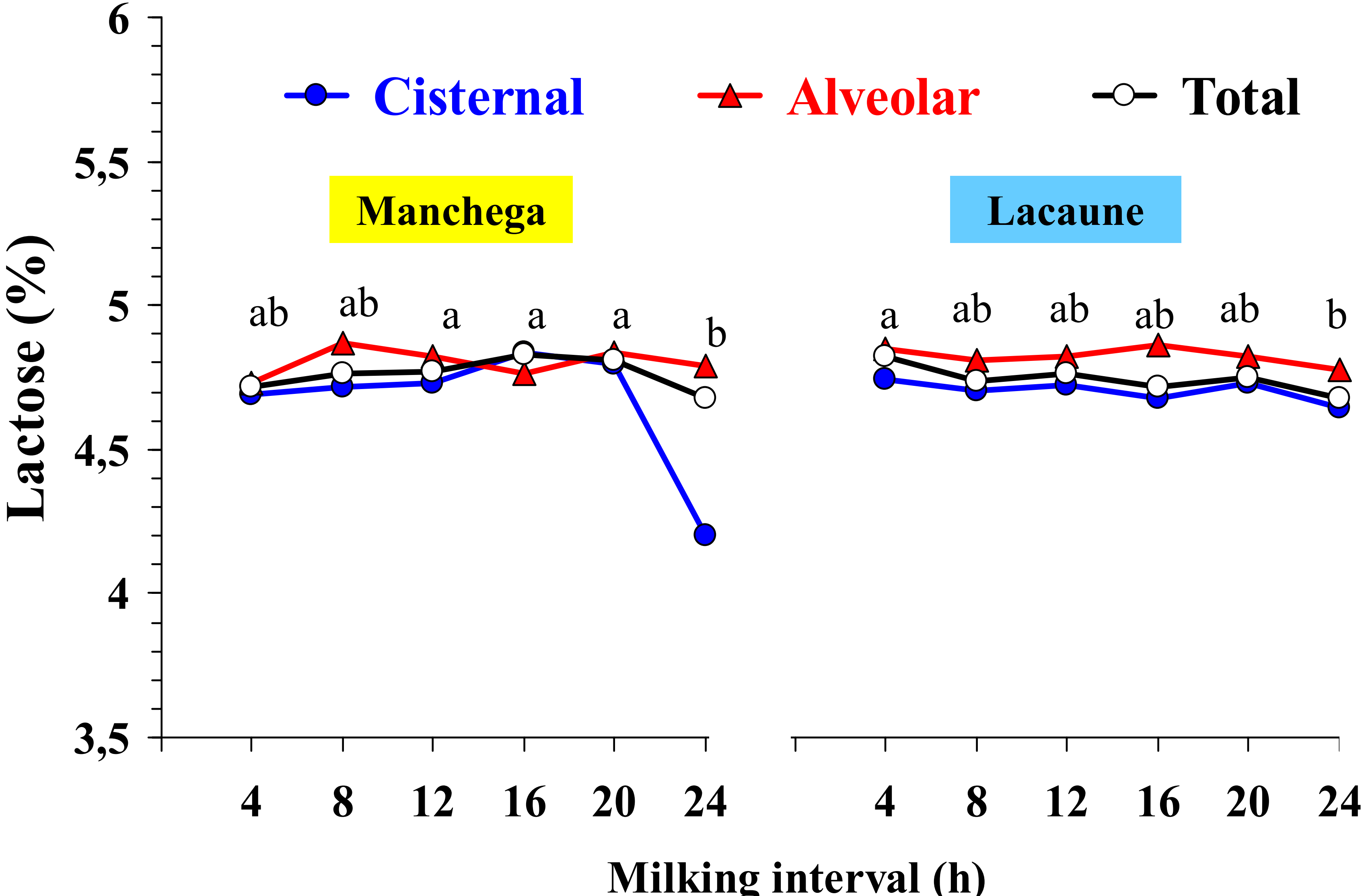
[a,b,…f] $P < 0.05$

Results (4/7): Milk total protein content in the ewe's udder according to milking interval and breed



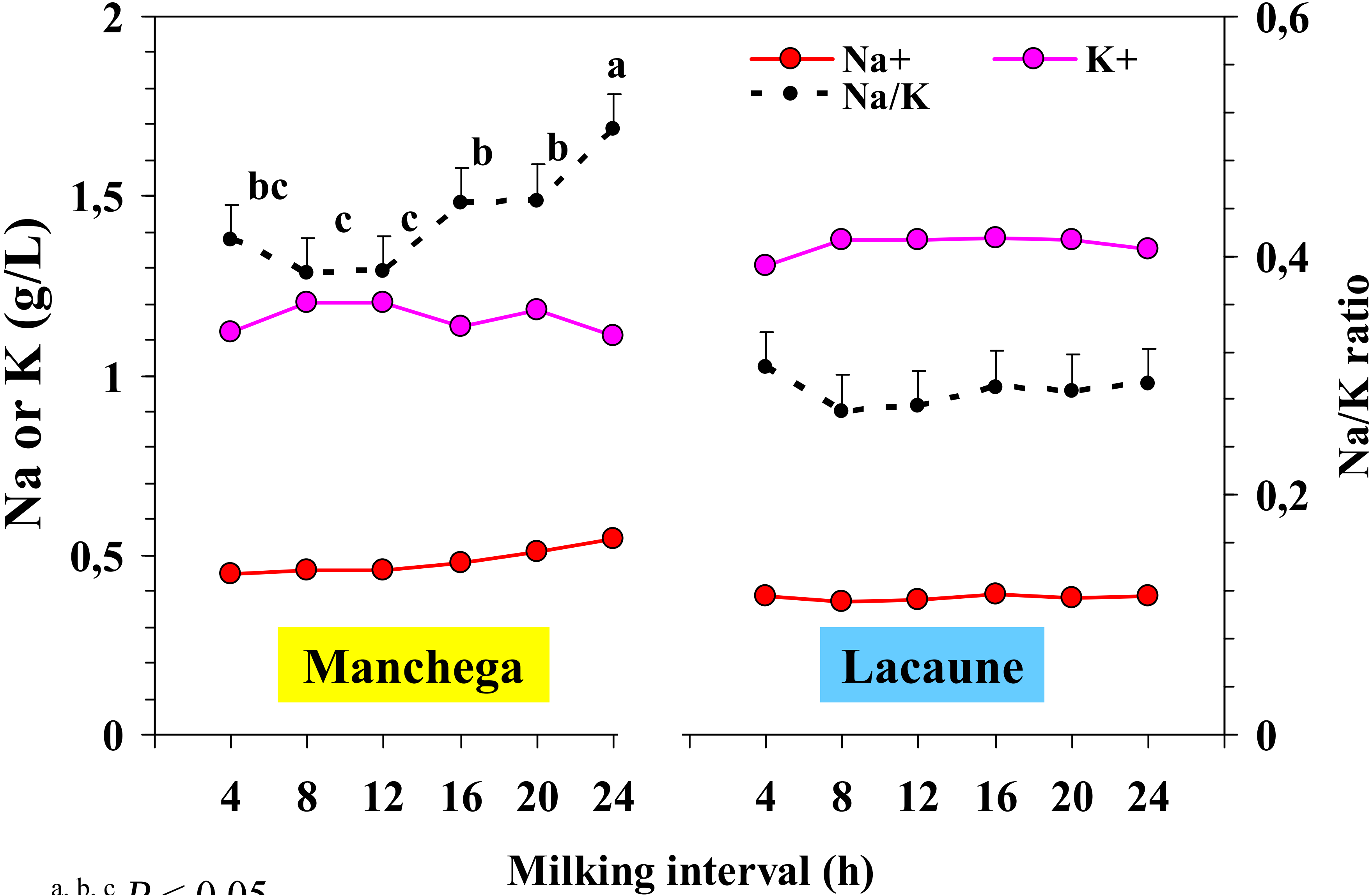
[a,b] $P < 0.05$

Results (5/7): Milk lactose content in the ewe's udder according to milking interval and breed



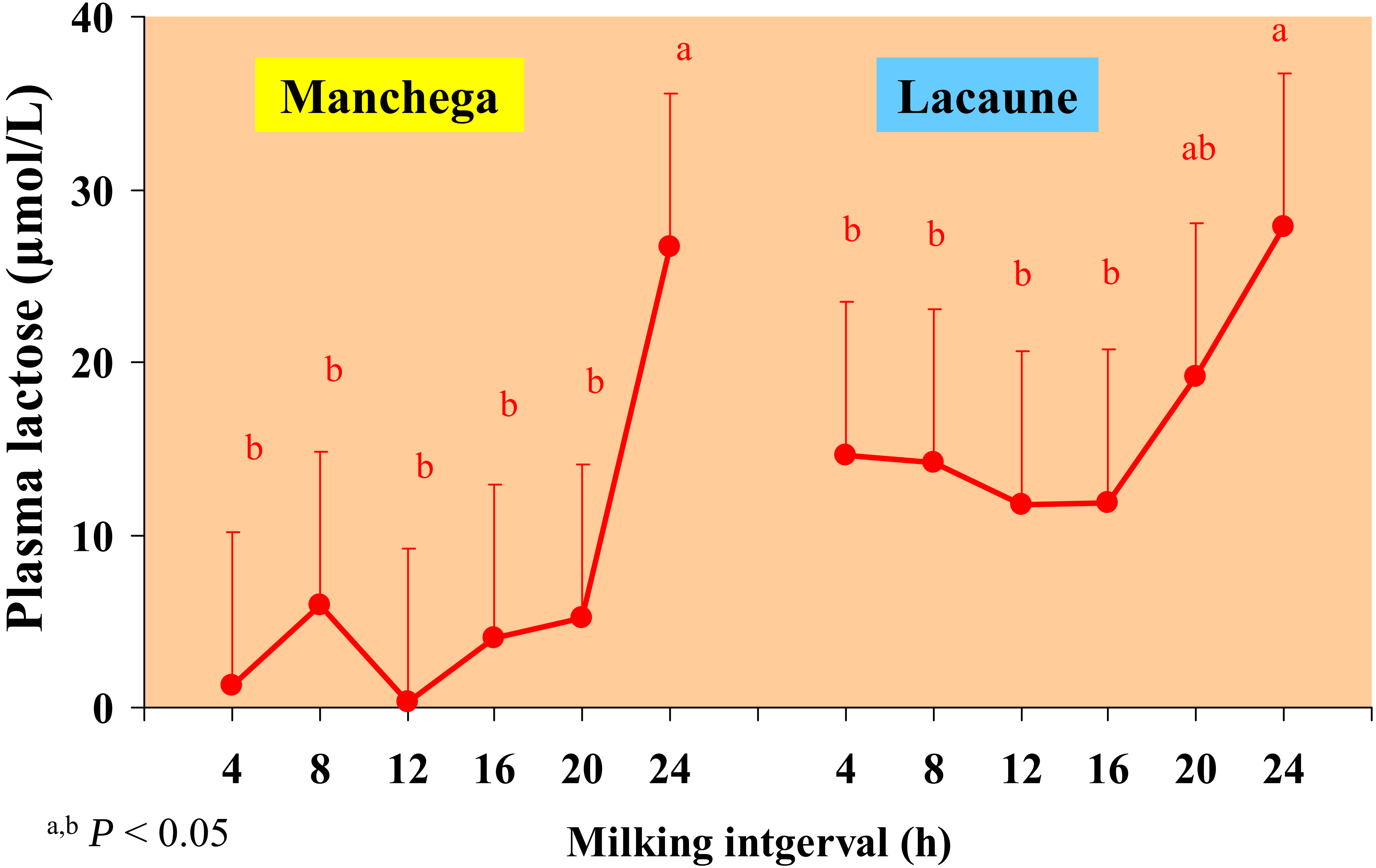
[a,b] $P < 0.05$

Results (6/7): Milk Na and K content in the ewe's udder according to milking interval and breed



a, b, c $P < 0.05$

Results (7/7): Lactose content in plasma of dairy ewes according to milking interval and breed



[a,b] $P < 0.05$

Conclusions

- **Both dairy breeds stored large amounts of milk within the cisterns and were able to tolerate extended milking intervals during short-term.**
- **Milk fat content decreased when milking interval was extended, but milk protein steadied.**
- **Ultrasonography was useful for evaluating cistern size and identifying large-cisterned ewes.**
- **High-yielding ewes presented greater cisternal compartment suggesting easier adaptation to extended milking intervals.**
- **Tight junction disruption differed according to breed, being earlier in Manchega (small cisterns) than in Lacaune ewes (large cisterns).**
- **Dairy ewes may be able to support 20 h of udder filling without negative effects on milk yield or milk composition, making possible the use of once-a-day or occasional (weekend) milking omission schedules.**

Thanks for your attention!