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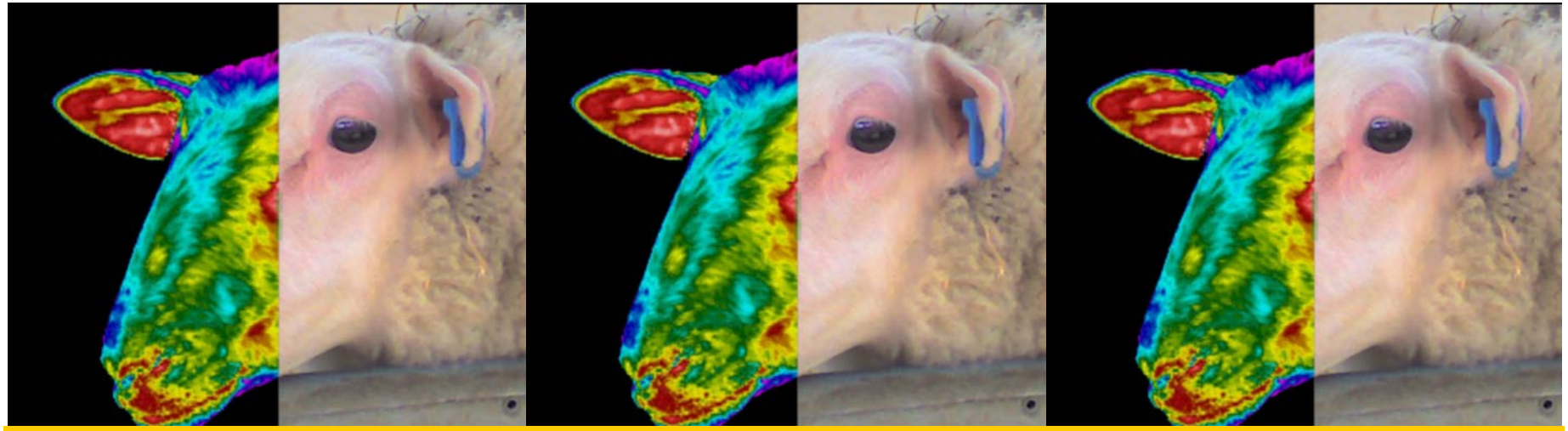

Using infrared thermography for detecting intramammary infections under practical and *E. coli* O55:B5 endotoxin challenge conditions in dairy ewes

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Introduction

Interest for the early detection of mammary infections (i.e., milk losses, costs).

Thermal response (fever) of animals to local (udder) and systemic inflammation.

Infrared thermography (IRT): a non invasive imaging technique based on heat emission from any kind of objects (i.e., machines, buildings, live).

IRT already used for studying**:**

- **Udder health** in dairy cows (Barth, 2000; Scott et al., 2000; Hovinen et al., 2008) and meat sheep (Martins et al., 2013).
- **Udder response to machine milking** in dairy sheep (Murgia et al., 2008) and dairy camels (Aljumaah et al., 2012).

Objectives & Experimental plan

To assess the use of infrared thermography (**IRT**) for detecting intramammary infections (**IMI**) in dairy ewes.

IMI

On-farm flock conditions

Exp. 1:
Early lactation
(n = 83 ewes)

Variation factors:
- Clinical & subclinical IMI
- Breed
- Milking schedule & time
- Ambient temperature

Simulated IMI conditions

Exp. 2:
Late lactation
(n = 9 ewes)

***E. coli* O55:B5 LPS**

Variation factors:
- Body temperature
- Time post-challenge
- Milk yield
- Milk composition

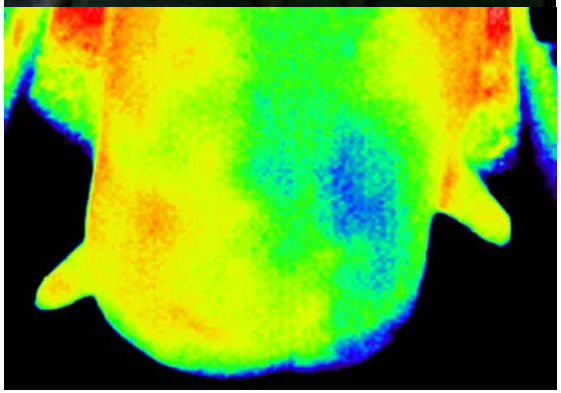
Material & Methods

Infrared camera: IRI 4010 (Irisys, Northampton, UK)

Item	Value
Temperature range	-10 a +250ºC
Resolution	0.1ºC
Accuracy	± 0.15ºC
Field of view (FOV)	20º × 15º
Zoom	× 2
Emissivity (0.2-1.0)	0.98
Detector resolution	160 ×120 pixels
Dimensions (mm)	230 × 120 × 110
Weight (g)	750
Image software	Irisys 4000 Series Imager v.1.0.0.17
Measurement area	30 × 25 pixels

Material & Methods: Exp. 1

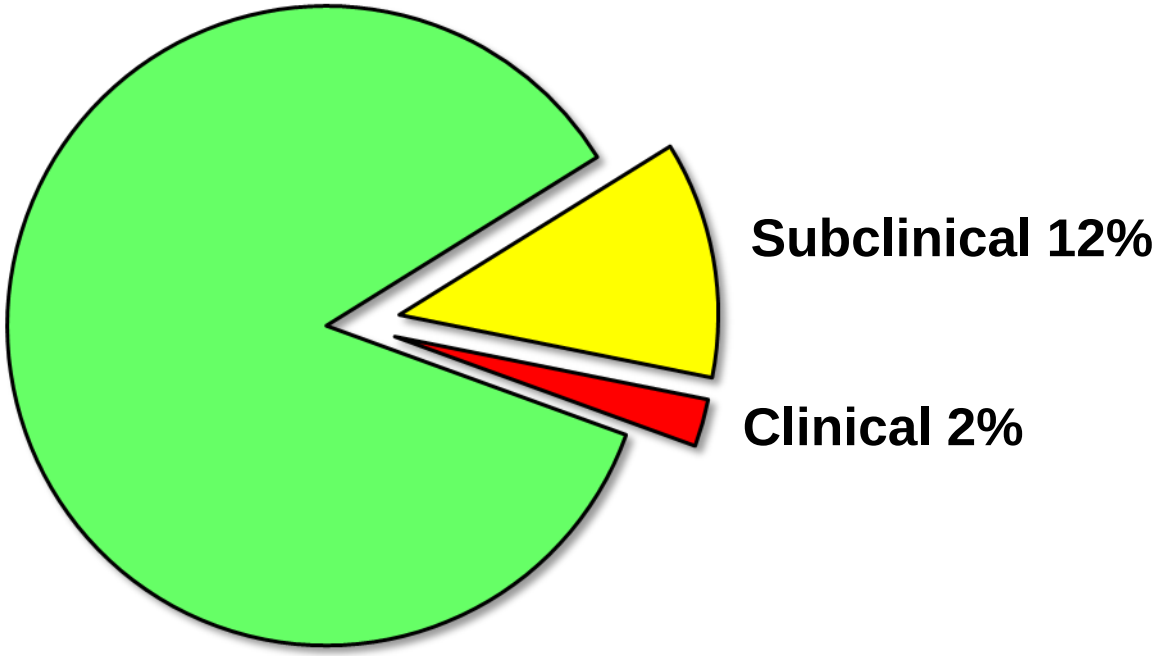
- **Animals:** 83 dairy ewes of 2 breeds (Manchega, n = 48; Lacaune, n = 35) in early lactation (1.57 ± 0.05 L/d).
- **Milking:** 2× (8 a.m. and 17 p.m.) machine milking (42 kPa, 120 ppm and 50% pulsation ratio).
- **IRT udder's images**:
  - Before and after milking.
  - 10 sessions (d 46 and 56).
- **Udder health by bacteriology**:
  - By udder half.
  - d 15, 34 and 64 of lactation.
  - Milk samples were streaked (0.01 mL), cultured (blood-agar plates, 37ºC) and examined after 18, 24 and 48 h.
- **Statistical analyses:** PROC MIXED of SAS v.9.1.



Results 1: Udder health

Medium prevalence of IMI in the studied dairy flock:

- Udder halves: 166 **healthy (86%)** vs. 20 **IMI (14%)**



- No effects were detected on milk yield: 1.37 ± 0.08 vs. 1.49 ± 0.06 L/d (*P* = 0.212)

Results 1: IRT general means

Temperatures of the udder of dairy sheep according to the studied variables (values are LSM)

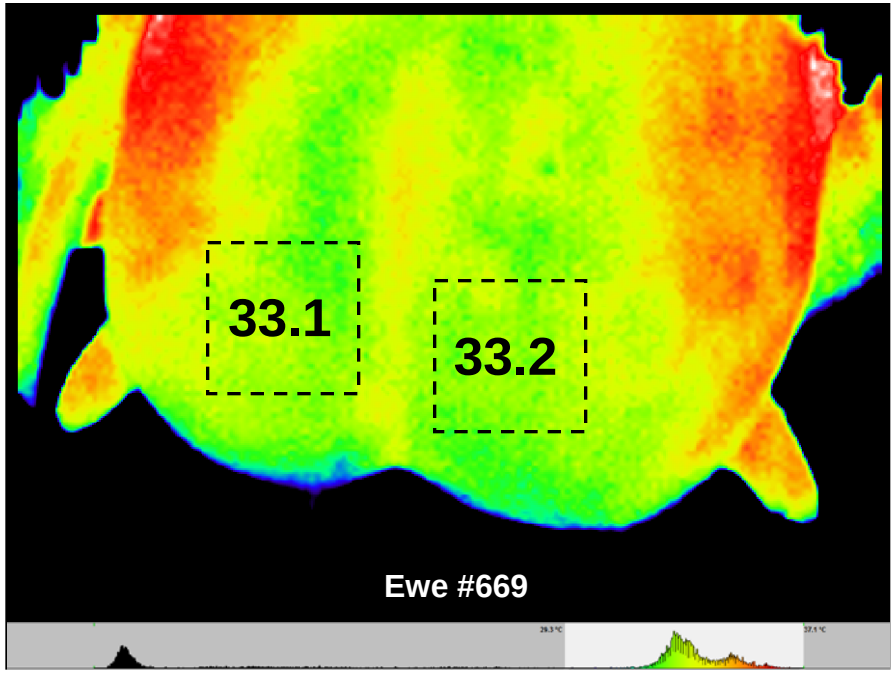
Variable	Contrasts			
	Category 1	Category 2	± SEM	*P* =
Breed (1, Man.; 2, Lac.)	32.88	33.23	0.11	0.003
Udder side (1, Left; 2, Right)	33.05	33.06	0.11	0.879
Milking schedule (1, a.m.; 2, p.m.)	32.66	33.45	0.06	0.001
Milking moment (1, Before; 2, After)	32.99	33.12	0.05	0.014
Udder health (1, Healthy; 2, IMI)	33.11	33.00	0.16	0.484

Results 1: IRT healthy udders

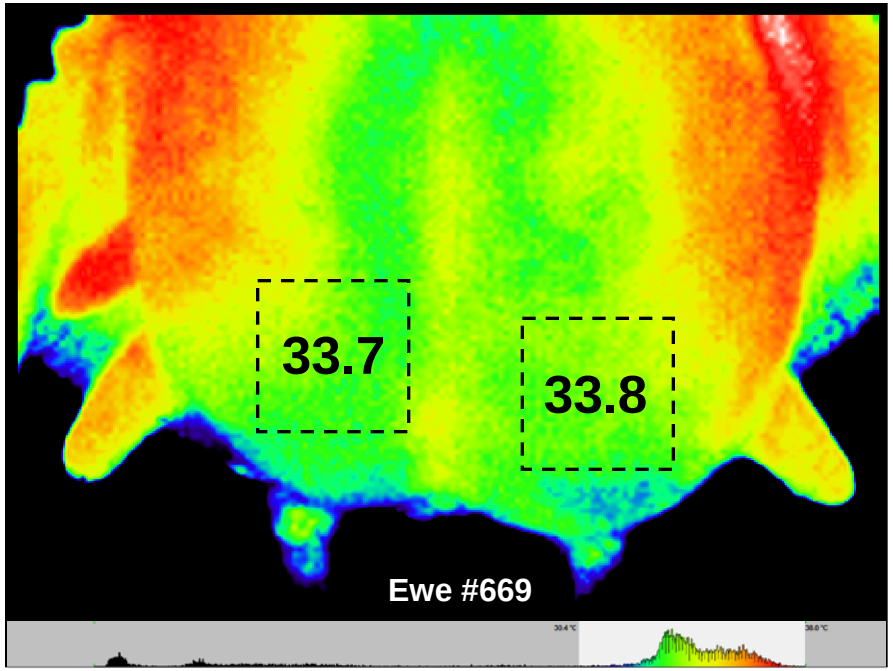
Udder temperature of healthy udders:

- Ranged between 28 (cistern) and 39ºC (groin)
- Udder temperature **increased after milking** (*P* < 0.001).

Before (29.3 to 37.1ºC)



After (30.4 to 38.0ºC)

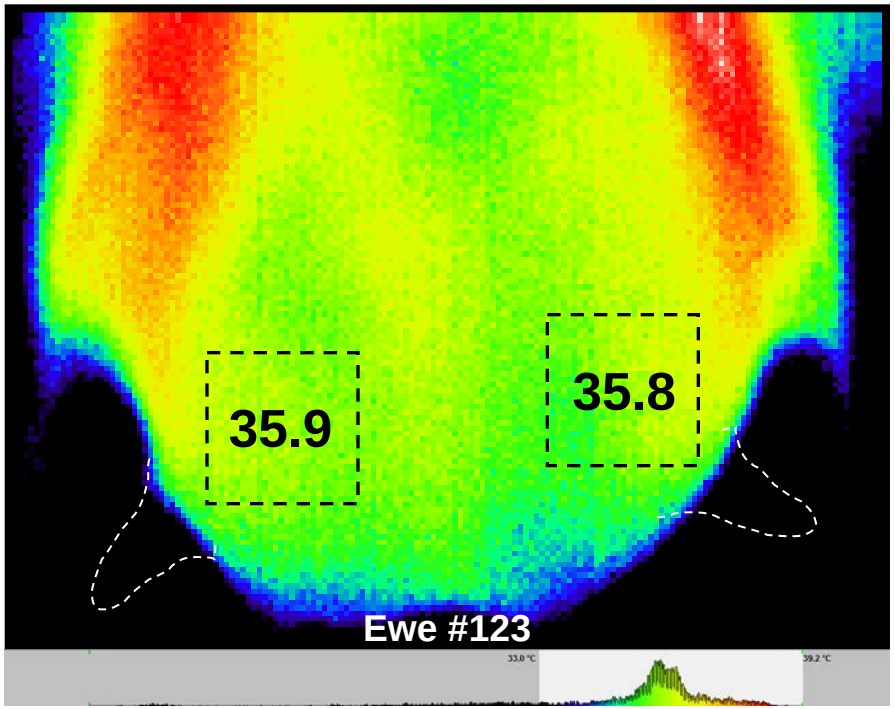


Results 1: IRT infected udders

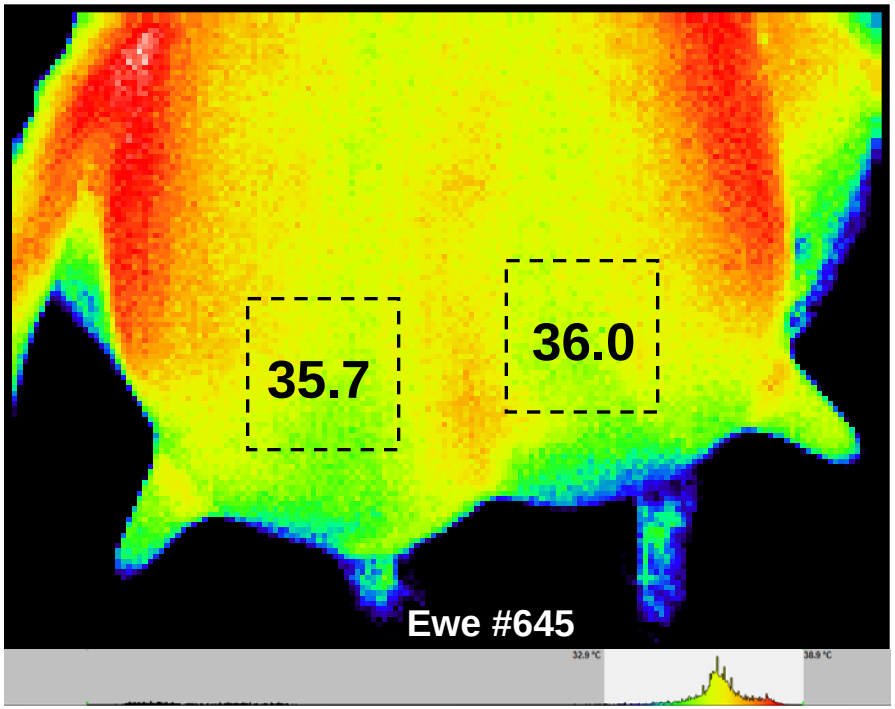
Udder temperature of IMI udders:

- Similar range of temperatures than healthy udders.
- No differences between healthy and clinical or subclinical IMI (*P* = 0.484).

Healthy (33.0 to 39.2ºC)



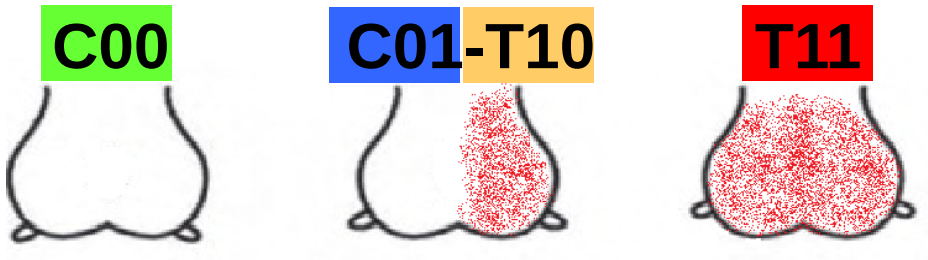
Clinical IMI (32.9 to 38.9ºC)



Material & Methods: Exp. 2

- **Animals:** 9 Lacaune ewes in late lactation (0.58 ± 0.03 L/d), allocated in 3 balanced groups and machine milked 1x (8 a.m.).
- ***E. coli* O55:B5 endotoxin challenge**:

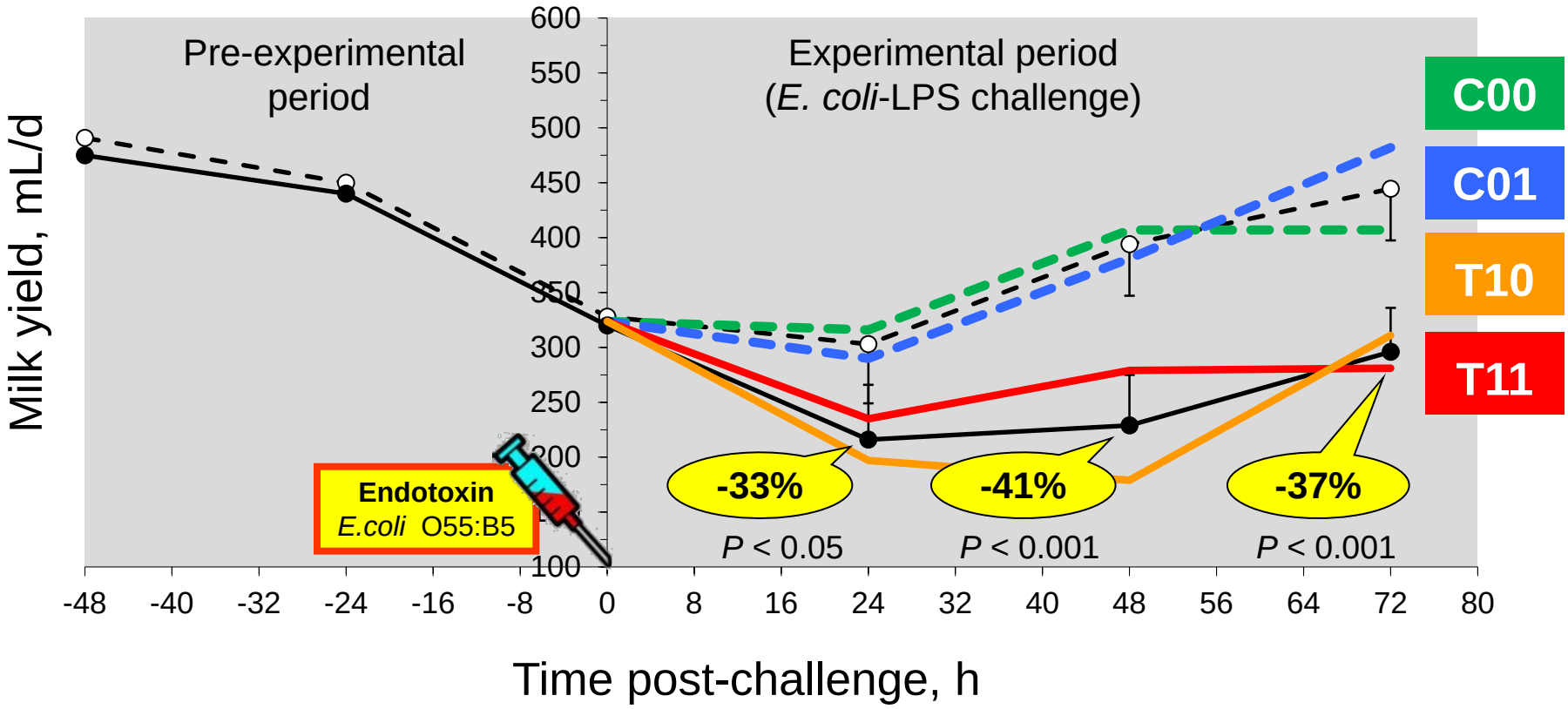
  - Infusion of 0.083 µg LPS/kg BW per udder half.
  - Controls without infusion.



- **Measurements after challenge**:
  - **IRT** from de udders (every 2 h (0 to 12 h), 24, 25, 28, 32, 36, 48, 49, 72 y 73 h).
  - **Milk yield and composition** (including lactose and SCC).
  - **Vaginal temperature** (ºC): every 2 h (2 to 12 h); every 12 h (12 to 24 h) and every 24 h (24 a 72 h).
- **Statistical analyses:** PROC MIXED of SAS v.9.1.

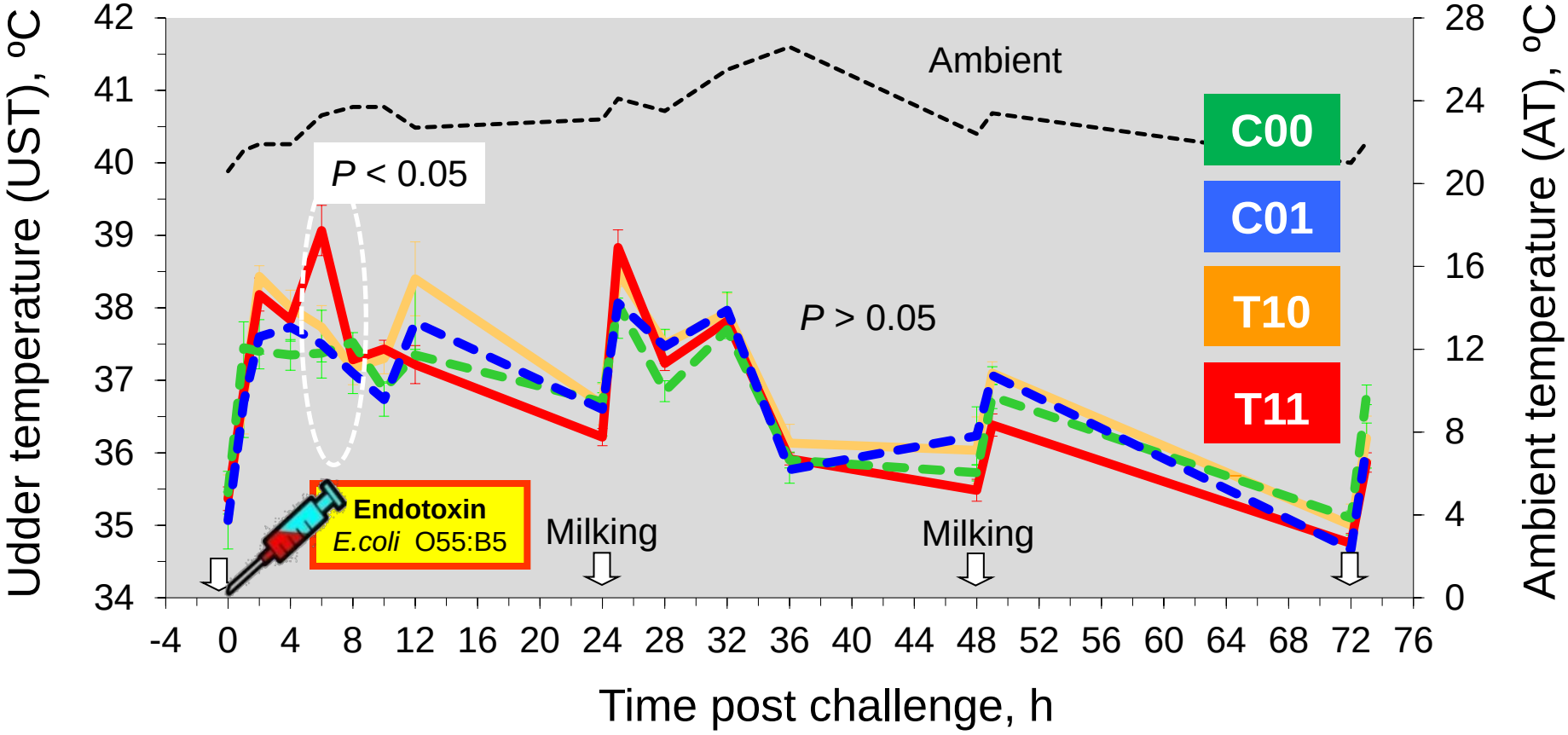
Results 2: Milk yield

Effect of *E. coli* O55:5 endotoxin infusion in the udder on milk yield of dairy ewes according to treatments (values are LSM; Ë, control; Ï , infused)



Results 2: IRT

Effect of *E. coli* O55:5 endotoxin infusion in the udder on milk yield of dairy ewes according to treatments (values are LSM; Ë, control; Ï , infused)



Udder temperatures increased after milking ($P < 0.001$), but not by effect of treatment ($P = 0.752$), except for T11 at 6 h ($P < 0.05$).

Results 2: IRT

Effect of *E. coli* O55:5 endotoxin infusion in the udder on milk composition of dairy ewes according to treatments (values are LSM; Ë, control; Ï , infused)

Item	Time, h	Control		Treated		SEM	Effect (*P* =)
		C00	C01	T10	T11		
Lactose, %	6	4.46^{c}	4.51^{c}	**2.73^{a}**	**3.47^{b}**	0.12	0.001
	24	4.29^{c}	4.48^{c}	**2.02^{a}**	**2.92^{b}**	0.10	0.003
	48	4.13^{c}	4.42^{c}	**2.90^{a}**	**3.11^{a}**	0.13	0.003
	72	4.12^{ab}	4.23^{bc}	**3.59^{a}**	**3.73^{ac}**	0.13	0.002
Log_{10} SSC	6						
	24						
	48						
	72						

$^{a–c}$ $P < 0.05$.

Results 2: IRT

Effect of *E. coli* O55:5 endotoxin infusion in the udder on milk composition of dairy ewes according to treatments (values are LSM; Ë, control; Ï , infused)

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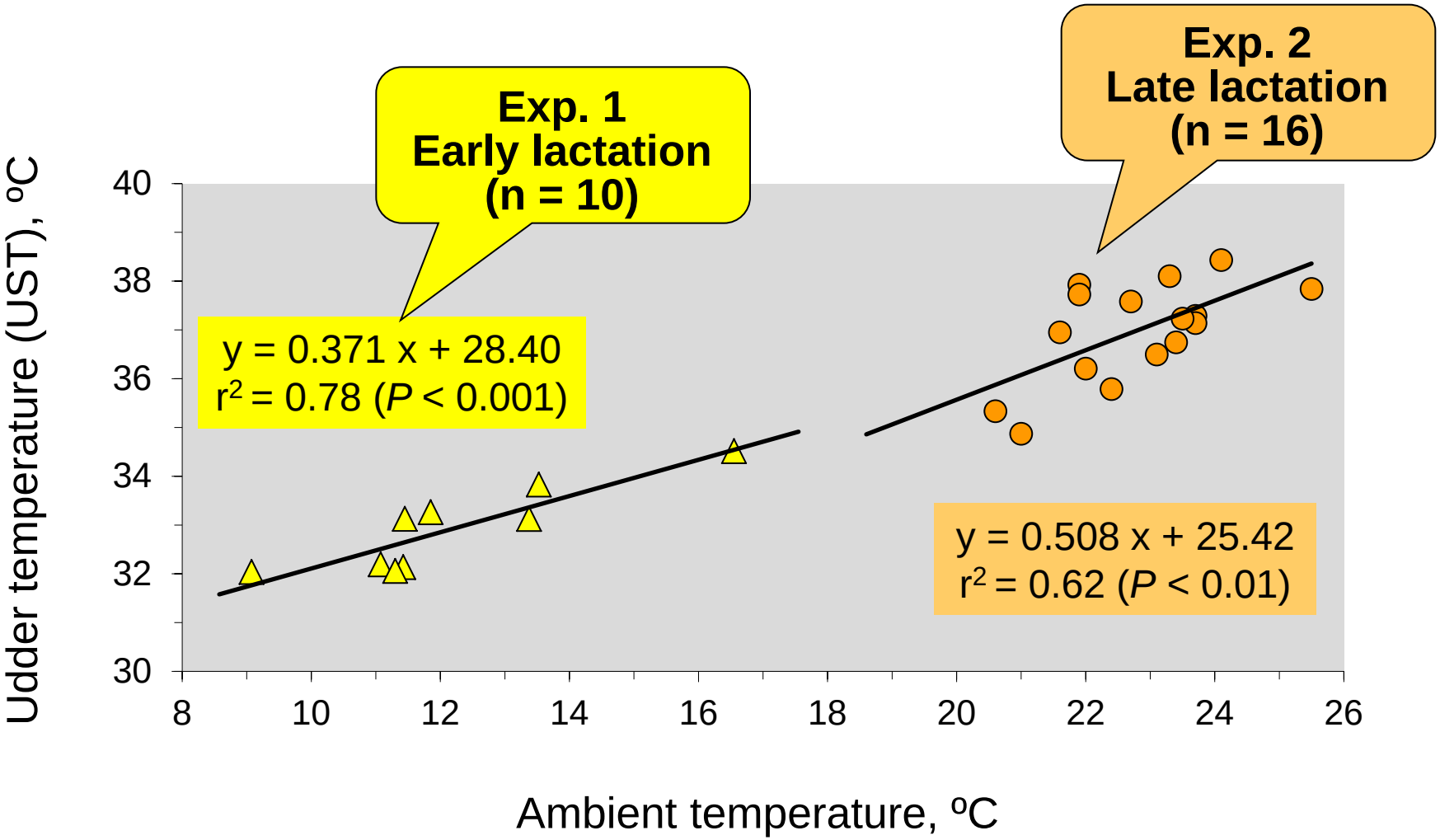
	72	4.12^{ab}	4.23^{bc}	**3.59^{a}**	**3.73^{ac}**	0.13	0.002
Log_{10} SSC	6	5.66^{a}	5.88^{a}	7.22^{b}	7.27^{b}	0.06	0.001
	24	5.46^{a}	5.91^{a}	6.24^{a}	7.32^{b}	0.17	0.005
	48	5.32^{a}	5.49^{a}	7.28^{b}	7.13^{b}	0.05	0.001
	72	5.24^{a}	5.24^{a}	6.37^{b}	6.69^{b}	0.07	0.001

$^{a–c}$ $P < 0.05$.

Results 2: Ambient temperature by session



Udder and ambient temperature correlated throughout the experiments.

Conclusions

IRT was a simple and fast non invasive technique for measuring the udder temperature of dairy ewes in the milking parlor.

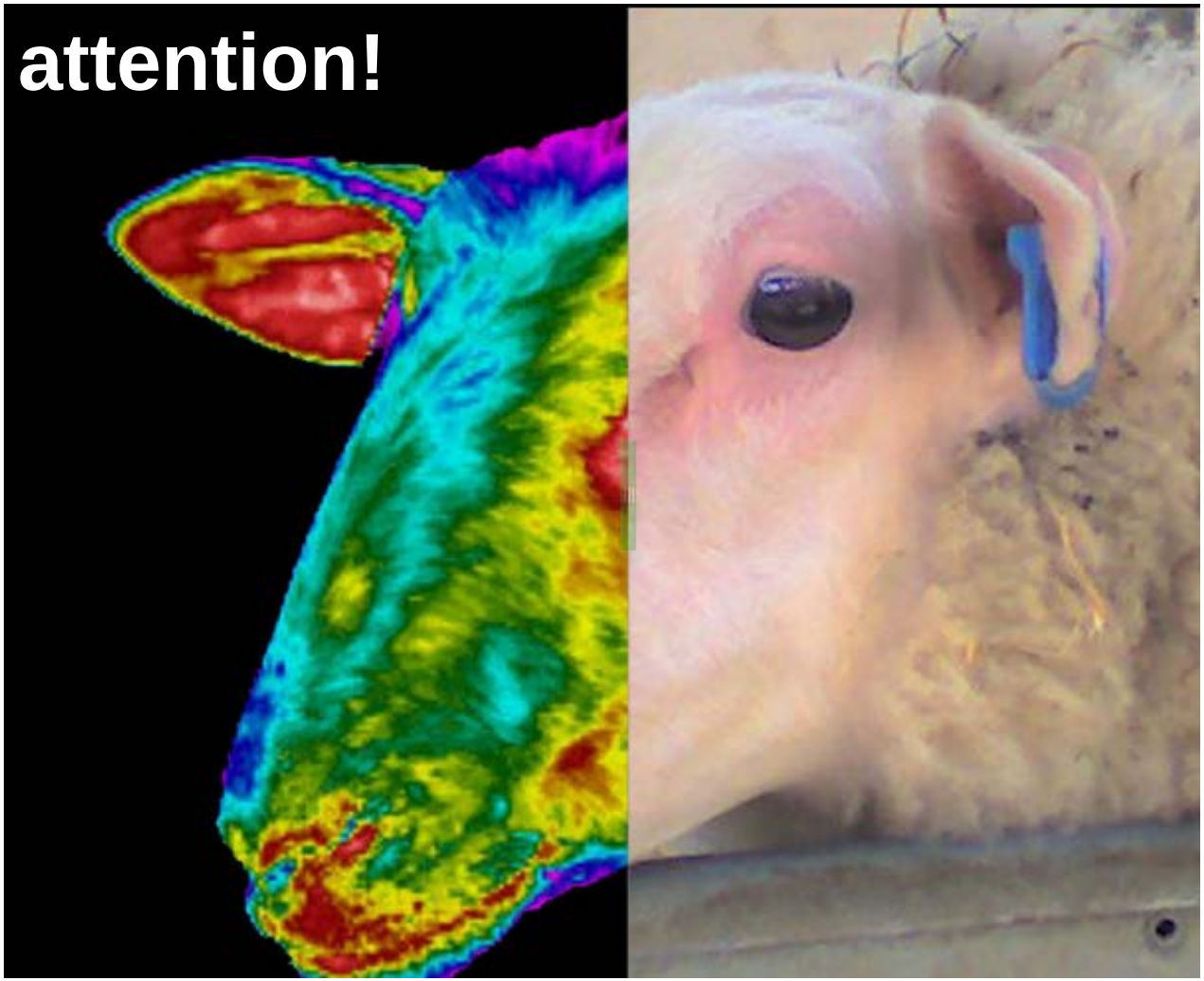
Despite the sensitivity of the camera used (±0.15 ºC) no differences were detected between healthy and infected (naturally or *E. coli.* endotoxin infused) udders.

Our results did not support the previous recommendation of using IRT for detecting IMI in dairy cows (Scott et al., 2000; Willard et al., 2007; Hovinen et al., 2008) and in meat sheep (Martins et al., 2013).

Autocorrelation of udder and ambient temperature and blood flow changes.

Other IRT uses are foreseen (i.e., evaluation of the effects of milking conditions) and needs further research.

Thanks for attention!



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