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**Ph.D. ANIMAL
& FOOD
COURSE SCIENCE**
UNIVERSITY OF PADOVA

PHENOTYPIC AND GENETIC ASPECTS OF MILK FREEZING POINT IN PRIMIPAROUS HOLSTEIN FRIESIAN COWS

A. Costa, M. De Marchi, M. Cassandro, M. Penasa*

**angela.costa.1@phd.unipd.it*

University of Padova



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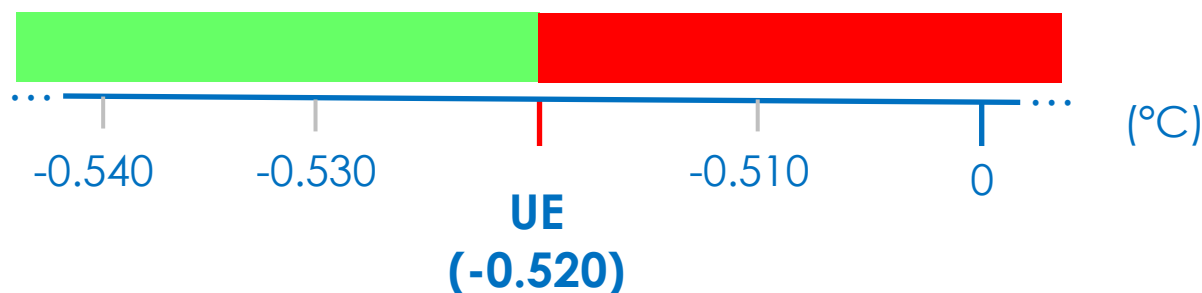
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What is milk freezing point (FRP)?

- Temperature at which milk freezes.
- Around -0.520°C in bulk milk (Fox et al., 2015).
- Affected by milk solids concentration (Hanuš et al., 2011).
- Higher values in diluted milk (undesirable).
- Recorded to search for milk adulteration (water addition) → importance in milk payment systems to check frauds.



- Legal threshold similar across countries (raw bulk milk).



(Council Directive 92/46/EEC)

- Penalties in milk payment systems:

<i>Dairy Farmers of Ontario</i>	Canada	-2 to -8 \$/hL
<i>Arlagården</i> ®	Denmark	total reimburse
<i>Warrnambool Butter & Cheese</i> ®	Australia	-50%





- In Italy

South Tyrol Dairy Association (Sennereiverband Südtirol, Bozen)

Freezing point (°C)	Penalty (€ detracted/kg milk)
-0.515	0.000
-0.510	0.005
-0.505	0.010
-0.501	0.014



Why studying FRP in individual milk?

- Few phenotypic studies (Kedzierska-Matysek et al., 2011).
- Only Jonkus & Paura (2011) reported genetic parameters.
- Never investigated in Italy.
- Enhance the knowledge of factors affecting FRP at cow level.
- Assess if milk FRP is genetically determined.



TO FACE UP: Anomalous FRP values in unadulterated milk (normal solids concentration)



AIMS

- 1) to investigate phenotypic aspects
and**
 - 2) to estimate genetic parameters**
- of FRP in individual milk from Italian
Holstein cows**



Data collection

- First-lactation cows.
- Bolzano province (North of Italy).
- December 2010 - December 2014.

Milk composition

- Fat, protein, lactose and FRP (MilkoScan™ FT6000).
- SCC (Fossomatic™) converted to SCS (Wiggans & Shook, 1987).

Editing

- Minimum 3 obs per contemporary group (HTD, herd-test-date) and minimum 3 obs per cow.
- Age at calving: from 20 to 40 months.
- DIM: from 6 to 480.
- ICAR guidelines (2016) for fat %, protein % and lactose %
- Milk yield: mean \pm 3 SD; FRP: mean \pm 2 SD.
- SCC: 1,000 to 10,000,000 cells/ml.



Final dataset

- 37,331 records
- 5,102 cows
- 435 herds

Pedigree

- 6 generations
- 22,822 animals

Softwares

- Phenotypic analysis: PROC MIXED of SAS 9.4 (SAS Institute Inc., Cary, NC)
- Genetic analysis: VCE6 (Groeneveld et al., 2010)



Model

Fixed effects

- Stage of lactation (13 classes) →
- HTD (7,597 contemp. groups)
- Calving season (4 classes)
- Age at calving (3 classes) →

I: 6 to 30 d
II to XI: monthly classes
XII: 330 to 390 d
XIII: >390 d

20 to 27 months
28 to 30 months
31 to 40 months

Random effects

- ANOVA: cow, residual
- GENETIC ANALYSIS: animal, permanent environmental, residual



Descriptive statistics

Trait	Mean	CV (%)
Freezing point (°C)	-0.528	1.33
Milk yield (kg/d)	26.04	22.89
Fat (%)	3.99	15.79
Protein (%)	3.39	10.62
Lactose (%)	4.83	3.11
Somatic cell score	2.55	65.88

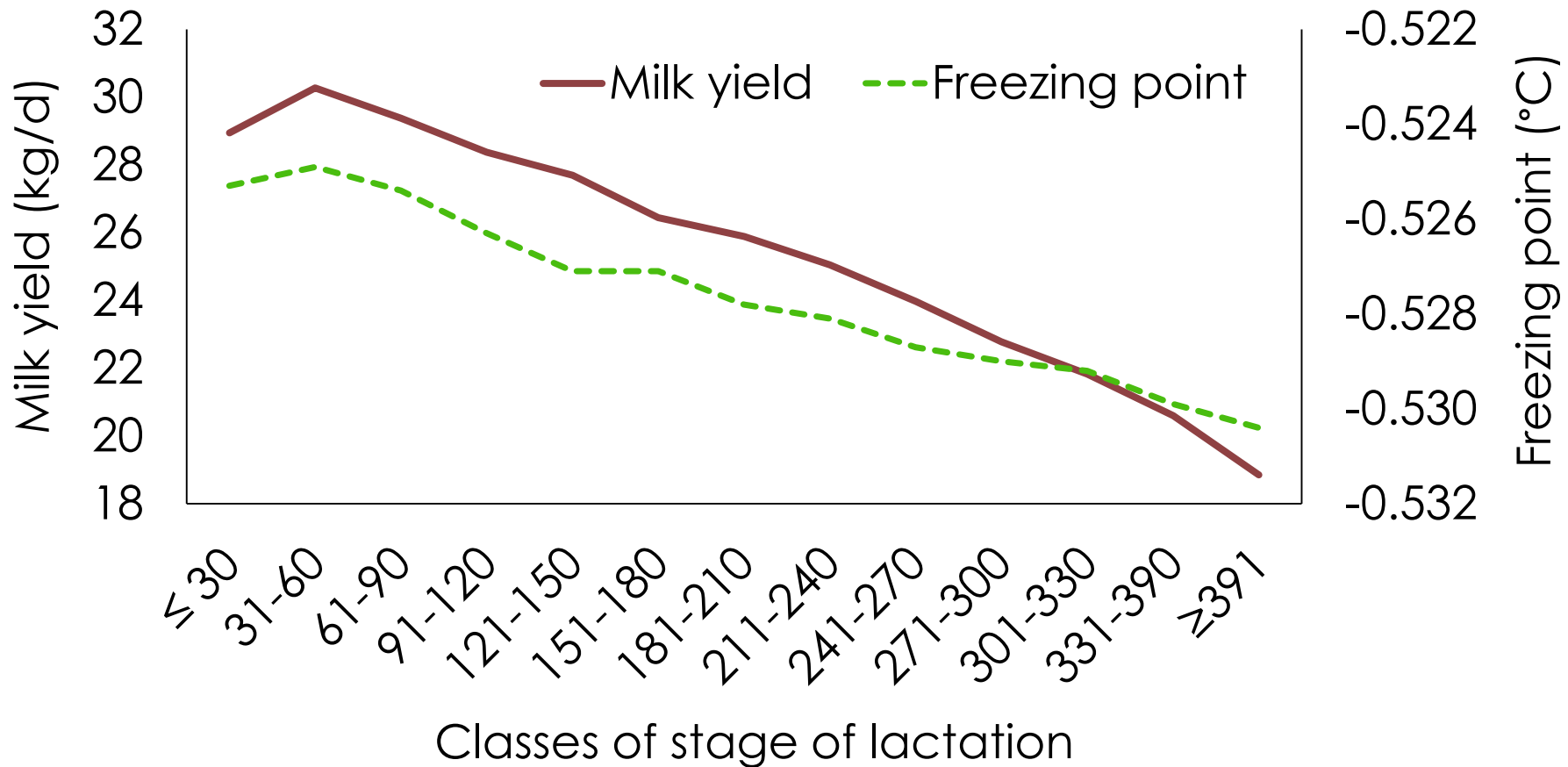


Analysis of variance for FRP

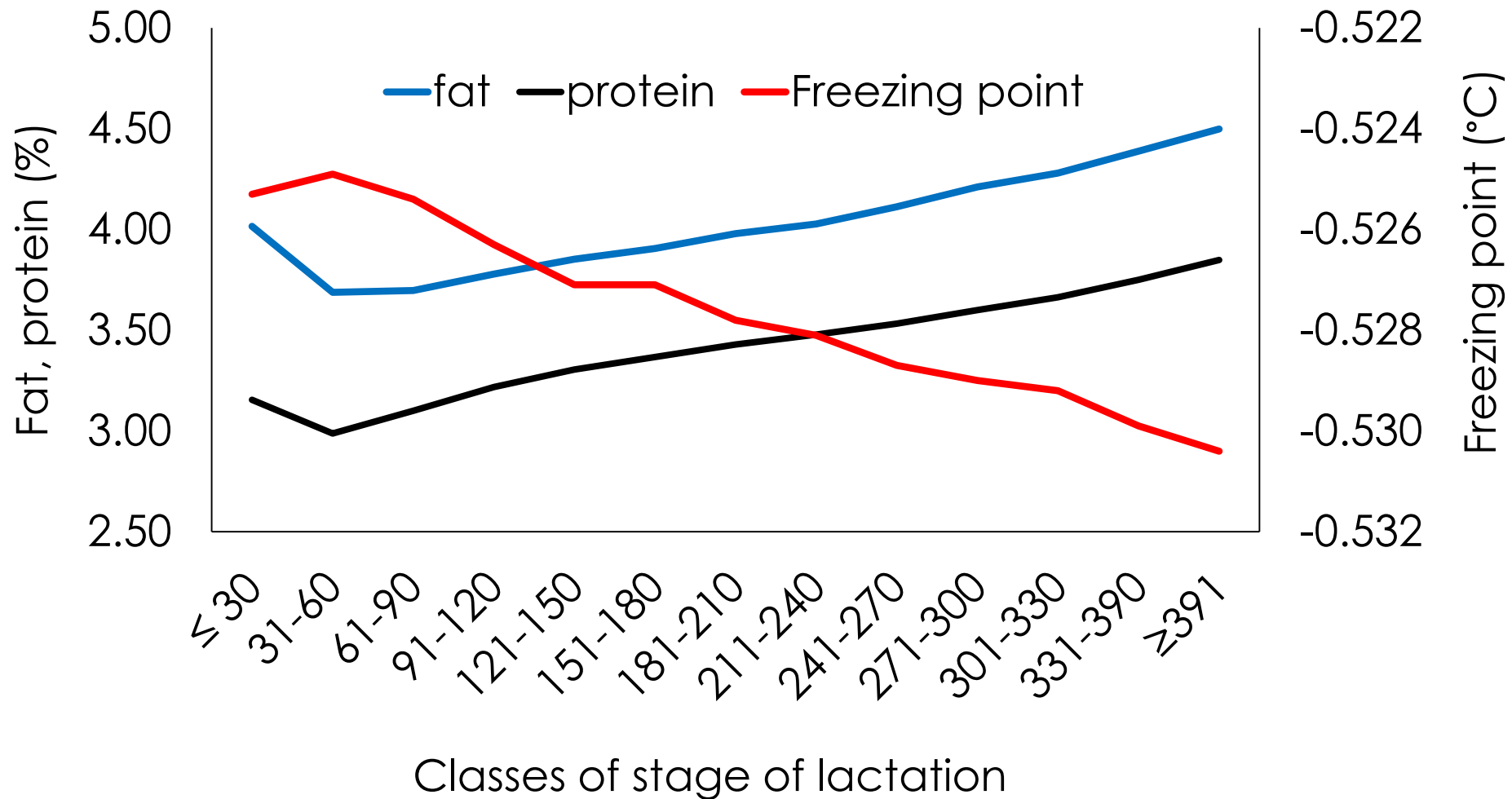
Fixed effect	Degrees of freedom	Significance	RSD
HTD	7,596	< 0.001	0.005
Stage of lactation	12	< 0.001	
Calving season	3	0.610	
Calving age	2	0.494	



Least squares means of FRP and milk yield over the lactation



Least squares means of FRP, fat % and protein % over the lactation



Genetic parameters

Trait	Heritability	Repeatability	r_g of FRP with
FRP (°C)	0.12 (0.02)	0.27	-
Milk yield (kg/d)	0.19 (0.03)	0.61	0.15 (0.02)
Fat (%)	0.31 (0.03)	0.52	0.07 (0.02)
Protein (%)	0.39 (0.04)	0.64	-0.32 (0.08)
Lactose (%)	0.46 (0.04)	0.64	-0.52 (0.06)
Somatic cell score	0.12 (0.03)	0.54	0.29 (0.11)



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Conclusions and perspectives

Milk freezing point:

- Affected by stage of lactation and HTD
- Low (but exploitable) heritability and repeatability
- Moderate gen. corr. with lactose %, protein % and SCS

Italian HF selection index includes protein (kg/d and %) and SCS, and therefore **indirect selection for FRP** should be in the right way and already in progress.

Genetic trend and correlation with other traits: to be deepened





Thank you for your attention



Sennereiverband Südtirol
Federazione Latterie Alto Adige

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