Physiological and Productive responses to a natural short-term heat wave in Holstein Friesian and Brown Swiss lactating cows

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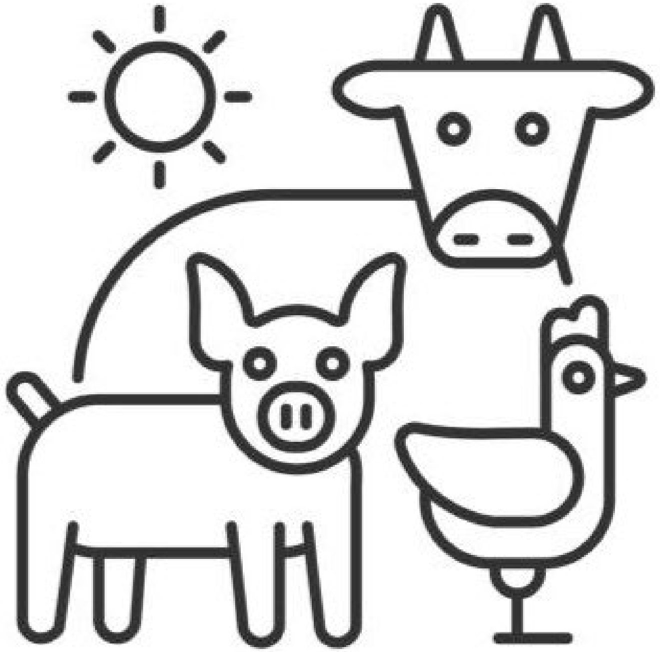
Climate change

Extreme temperatures



Effects on animal husbandry

Productions affected

Background…

J. Dairy Sci. 97:471–486
http://dx.doi.org/10.3168/jds.2013-6611

The effects of heat stress in Italian Holstein dairy cattle

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J. Dairy Sci. 103:8541–8553
https://doi.org/10.3168/jds.2020-18622

Estimation of maximum thermo-hygrometric index thresholds affecting milk production in Italian Brown Swiss cattle

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Aim...

physiological

productive

Patterns

oxidative

inflammatory patterns

managed identically on the same commercial farm

Experimental design

Department of Veterinary Medicine of the University of Bari
(approval no. 05/2022)

40 multipatous
daory cows

Parity = 2.80 ± 0.89
DIM = 106.40 ± 9.12
BCS = 2.41 ± 0.12

(n=20)

(n=20)

Parity = 2.60 ± 0.75
DIM = 102.60 ± 7.30
BCS = 2.67 ± 0.15

THI 4-day under heat stress threshold → **4-day natural heat wave**

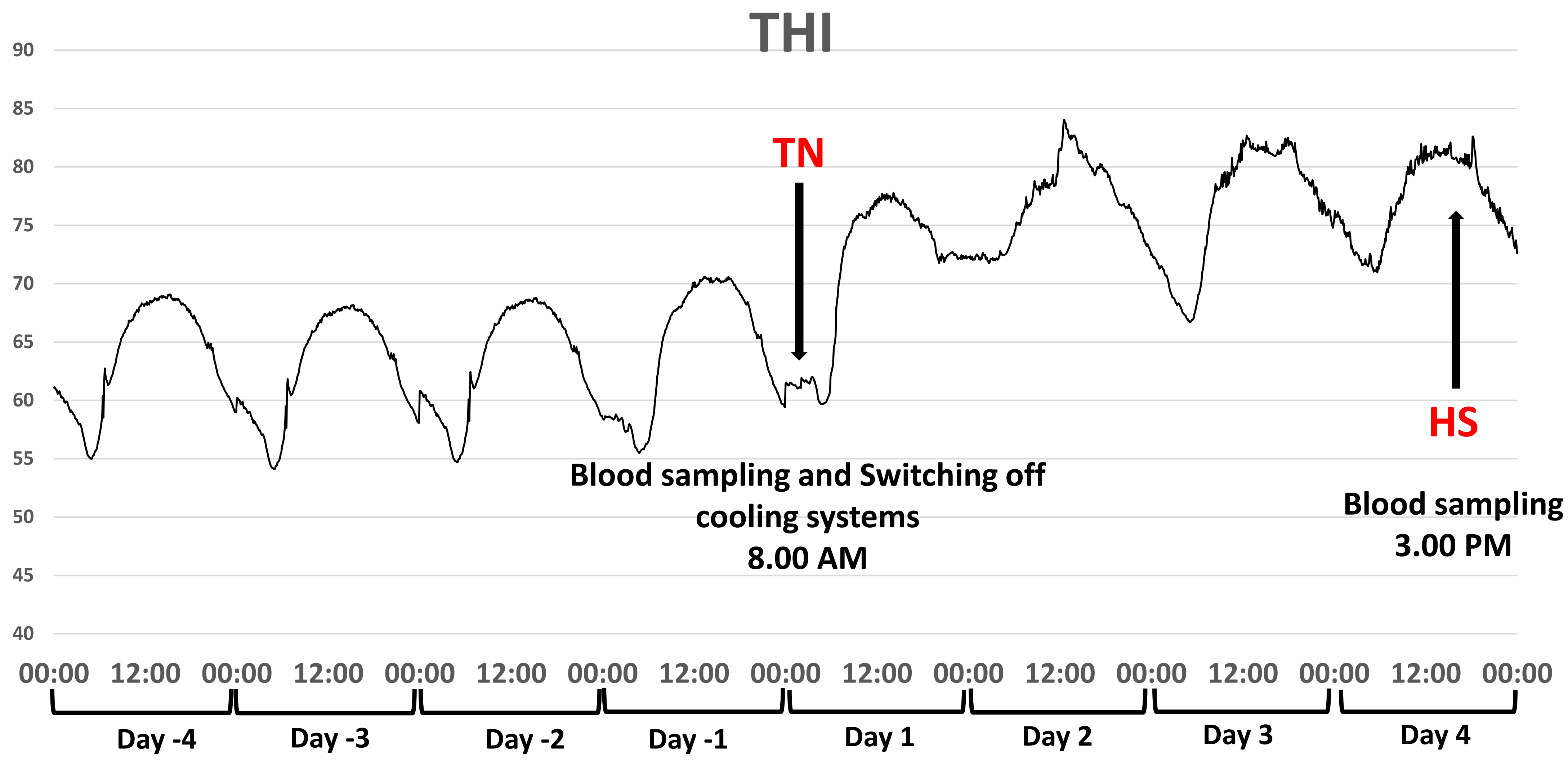
temperature
humidity
→ Every 5 minutes

THI

$$(1.8 \times AT + 32) - (0.55 - 0.0055 \times RH) \times [(1.8 \times AT + 32) - 58],$$

Kelly and Bond, 1971

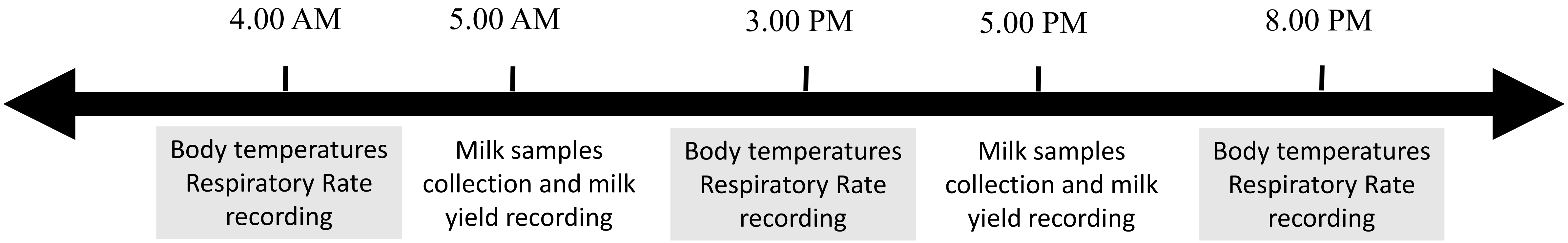
Experimental design




Internal Temperatur
Relative Humidity
-25 → 85°C
0 → 95% RH
TGU-4500
925389

Experimental design

Daily



Physiological parameters

- respiration rate (RR) → Visually by expert assessors
- rectal temperature (RT) → digital rectal thermometer

- conjunctiva temperature (CT)
- Muzzle temperature (MT)
- skin temperature (ST)

→

Bleul et al. (2019)

Materials and methods

Milk parameters

Fat
Protein
Casein
Lactose
short-chain fatty acids (**SFA**)
unsaturated fatty acids (**UFA**)
monounsaturated fatty acids (**MUFA**)
polyunsaturated fatty acids (**PUFA**)
curd firmness
clotting velocity
renneting time

ISO9622/IDF141, 2013

fat corrected milk (**FCM**) yield

4% FCM = 0.4 × milk + 15 × fat.

energy-corrected milk (**ECM**)

milk× [0.25 + (0.122 × %fat) + (0.077 × %protein)]

Materials and methods

Biochemical parameters

alanine aminotransferase (**ALT**)
aspartate aminotransferase (**AST**)
alkaline phosphatase (**ALP**)
glucose (**Glu**)
blood urea nitrogen (**BUN**)
creatinine (**Crea**)
total serum protein (**TP**)
albumin (**Alb**)
globulins (**Glob**)
cholesterol (**Chol**)
triglycerides (**Trig**)
non-esterified fatty acids (**NEFA**)
calcium (**Ca**)
phosphate (**P**)
magnesium (**Mg**)
chloride (**Cl**),

De Palo et al., 2018

Materials and methods

Oxidative parameters

thiobarbituric acid reactive substances (**TBARS**)

protein carbonyls

ferric-reducing ability of the plasma (**FRAP**)

Radical scavenging activity of 2,2′-Azino-bis [3-ethylbenzothiazoline-6-sulphonic acid] (**ABTS**)

reactive oxygen metabolites **(ROMs)**

paraoxonase (**PON)**

Bertoni et al., 2008

Materials and methods

Inflammatory parameters

serum amyloid A (**SAA**) haptoglobulin (**HP**) heat shock protein 70 (**HSP70**)	}	Cloud-Clone ELISA kit
ceruloplasmin	→	Nomoto (1970)
paraoxonase	→	Ferré et al. (2002)

Statistical analysis

normal distribution

Shapiro-Wilk's test

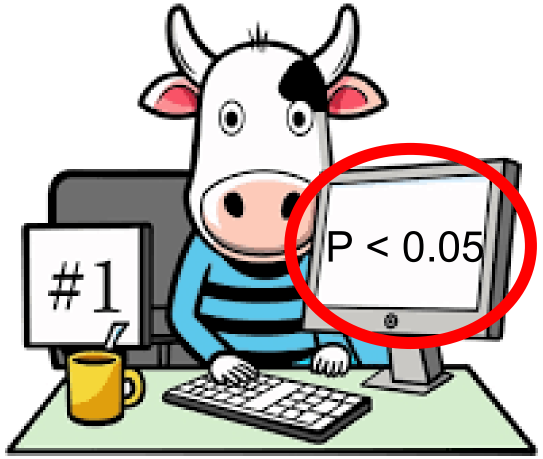
Analysis of variance (ANOVA)

$$y_{ijk} = \mu + \alpha_i + B_j + T_k + (B \times T)_{jk} + \varepsilon_{ijkl}$$

y_{ijk} = parameters (dependent variable)
μ = mean
α_i = dairy cow random effect within breed ($_i$ = 1,…20)
B = effect of the breed ($_j$ = 1, 2)

T = effect of the time
($_k$ = 1, ..., 5 for milk parameters;
1,…12 for physiological parameters;
1, 2 for biochemical, oxidative, and inflammatory parameters)

B × T = effect of the binary interaction between the two independent variables
($_{jk}$ = 1,…, 10 for milk parameters;
1,…24 for physiological parameters;
1,… 4 for biochemical, oxidative, and inflammatory parameters)
ε_{ijkl} = error



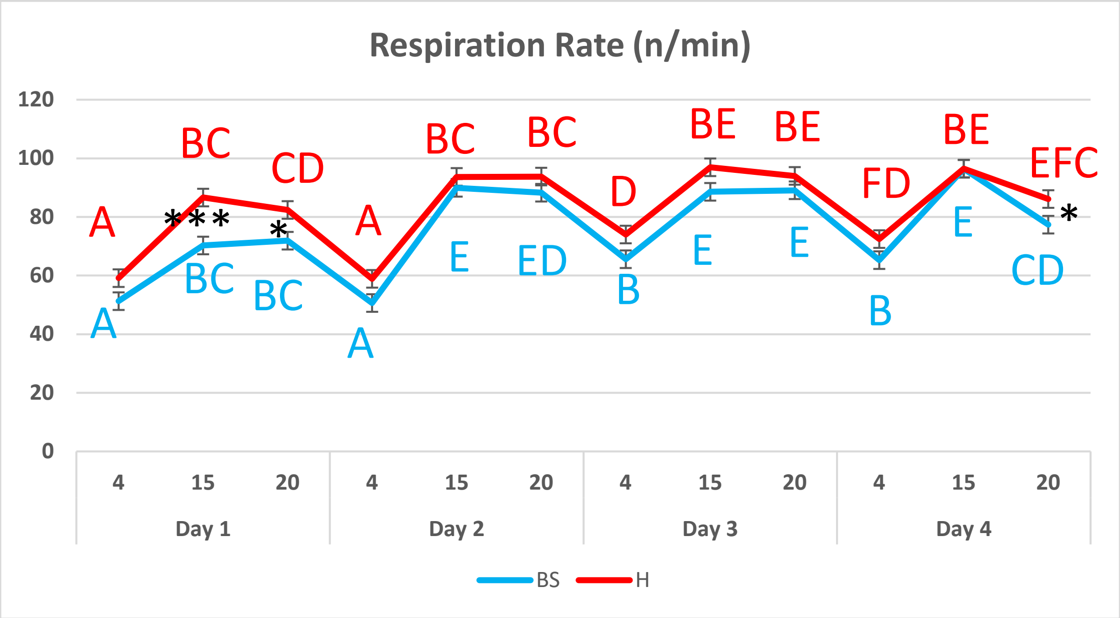
Tukey test

Repeated measures

Bonferroni test

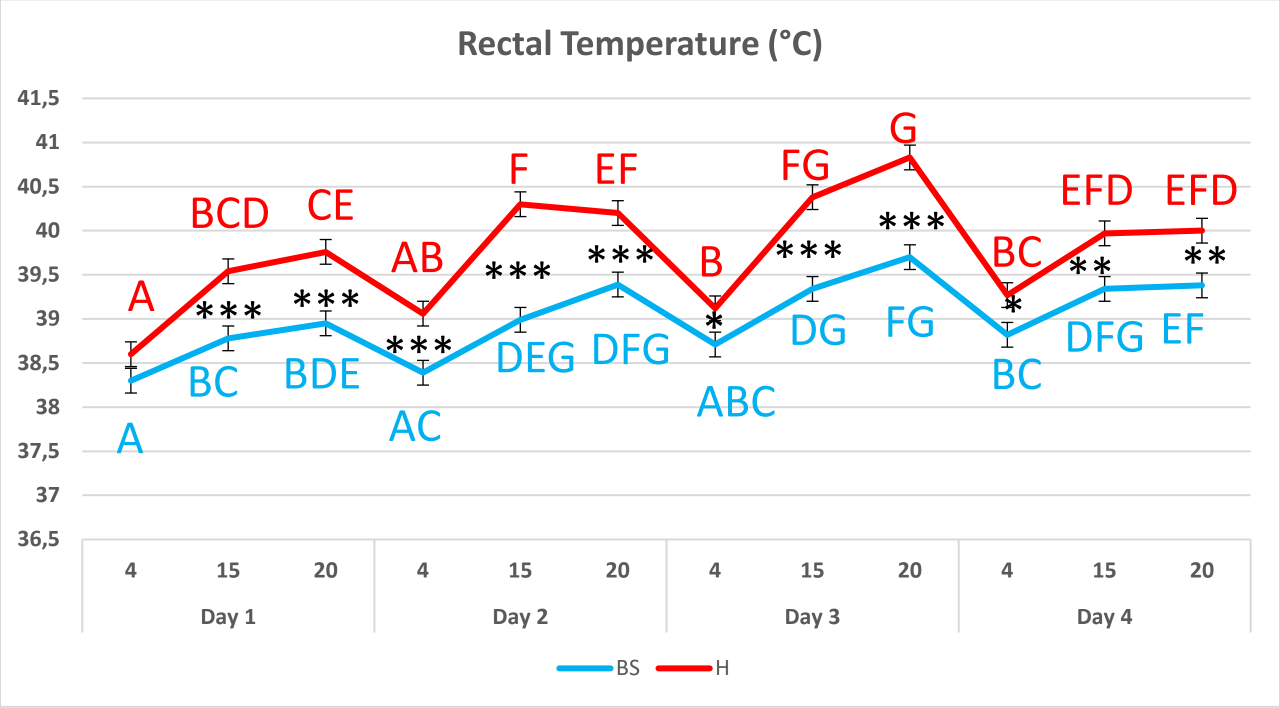
Pairwais comparison between breeds

Results



Breed: <.0001
Time: <.0001
Breed x time: <.0001

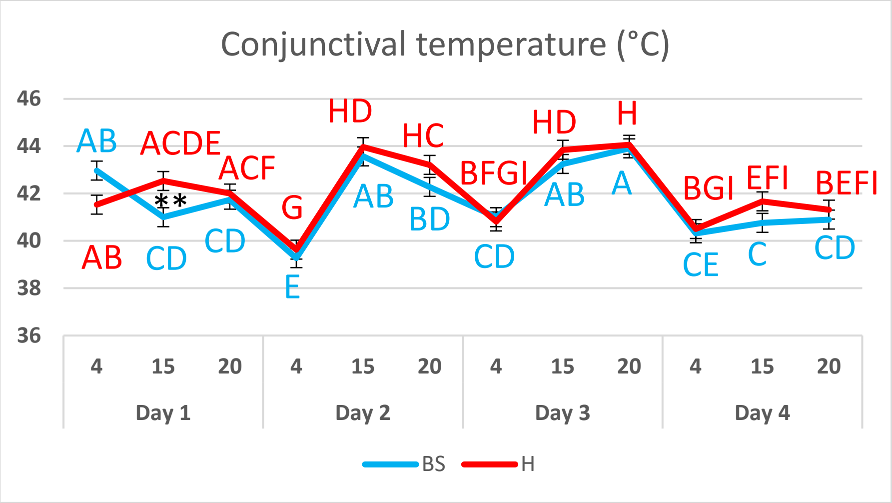
Breed: <.0001
Time: <.0001
Breed x time: <.0001



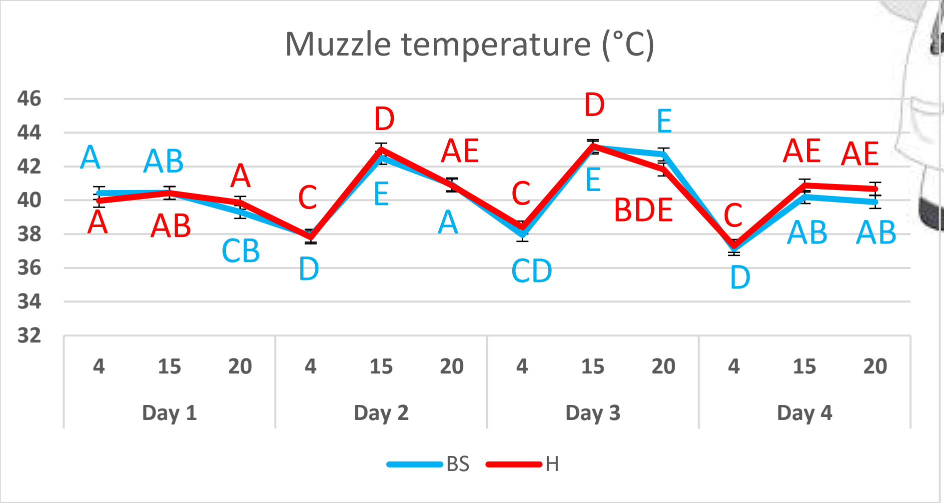
Different letters of the same color correspond to a statistically significant difference within the same breed: A, B, C, D, E, F, G = $p < 0.01$.
Asterisks correspond to a statistically significant difference between the breeds at the same Condition: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.01$.

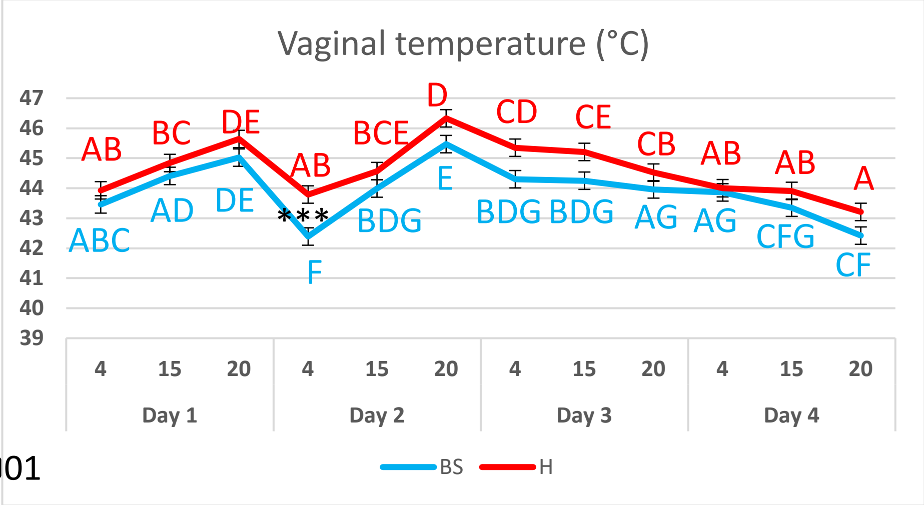
Results

Breed: 0.0044
Time: <.0001
Breed x time: <.0001

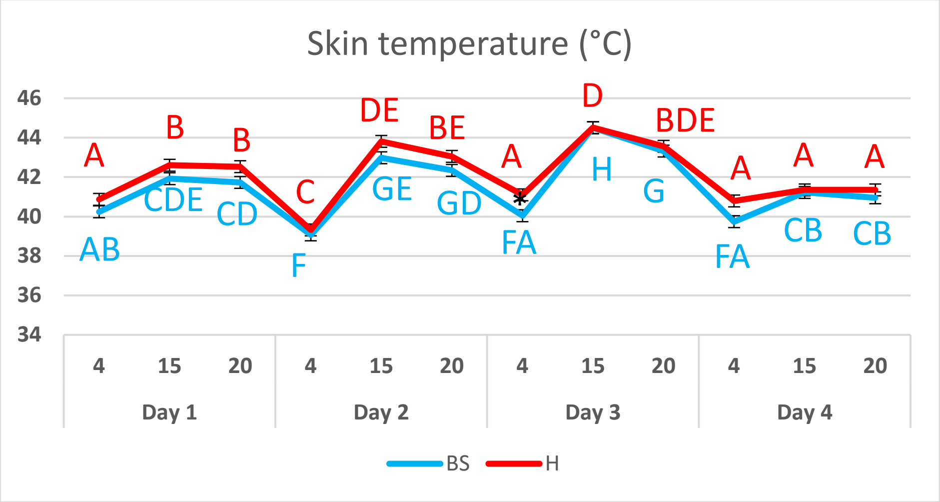


Breed: 0.7225
Time: <.0001
Breed x time: <.0001





Breed: <.0001
Time: <.0001
Breed x time: <.0001



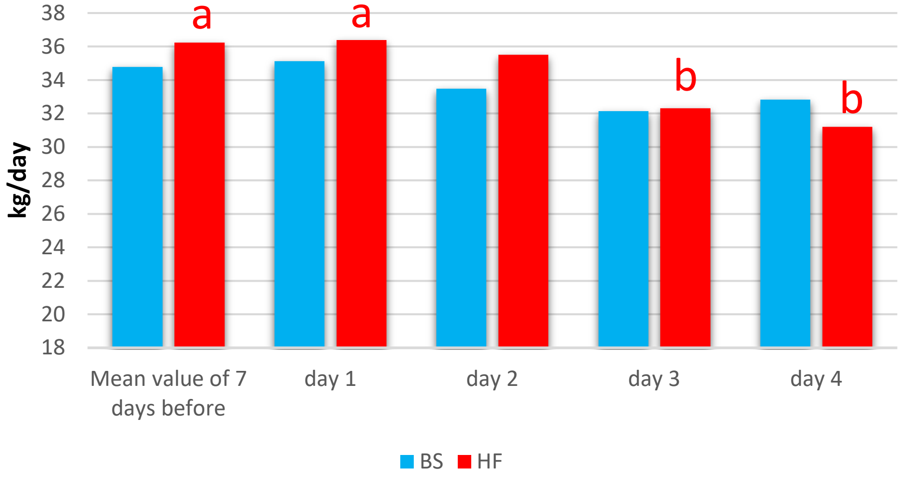
Breed: 0.5809
Time: <.0001
Breed x time: <.0001

Different letters of the same color correspond to a statistically significant difference within the same breed: A, B, C, D, E, F, G, H, I = $p < 0.01$.
Asterisks correspond to a statistically significant difference between the breeds at the same Condition: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.01$.

Results

Breed: 0.6455
Time: 0.0236
Breed x time: 0.6061

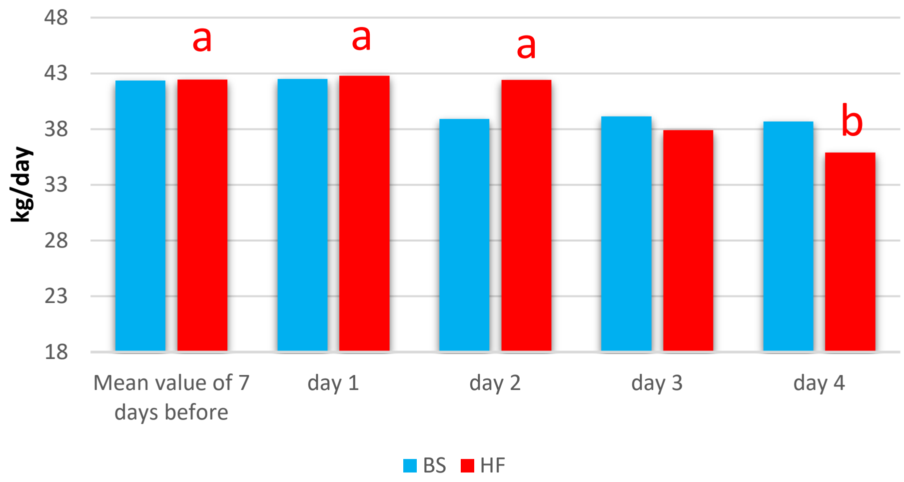
Milk Yield



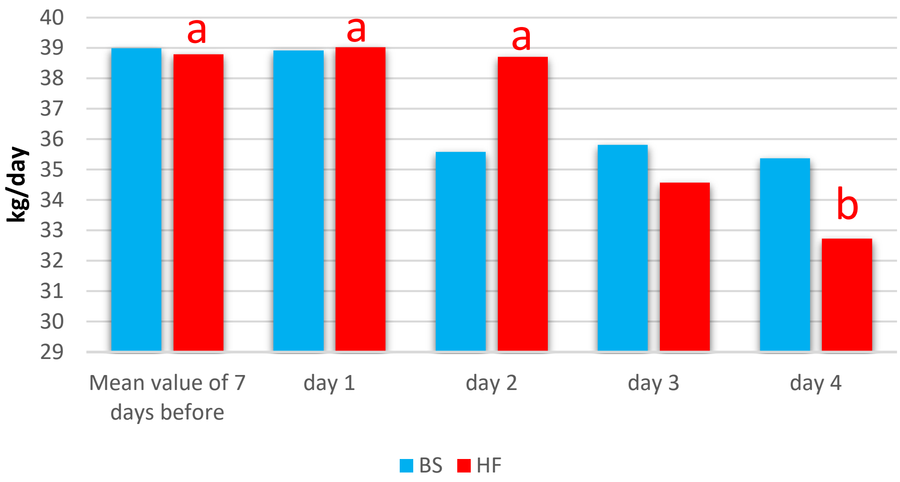
Breed: 0.9680
Time: 0.0307
Breed x time: 0.4133

Breed: 0.8957
Time: 0.0310
Breed x time: 0.4110

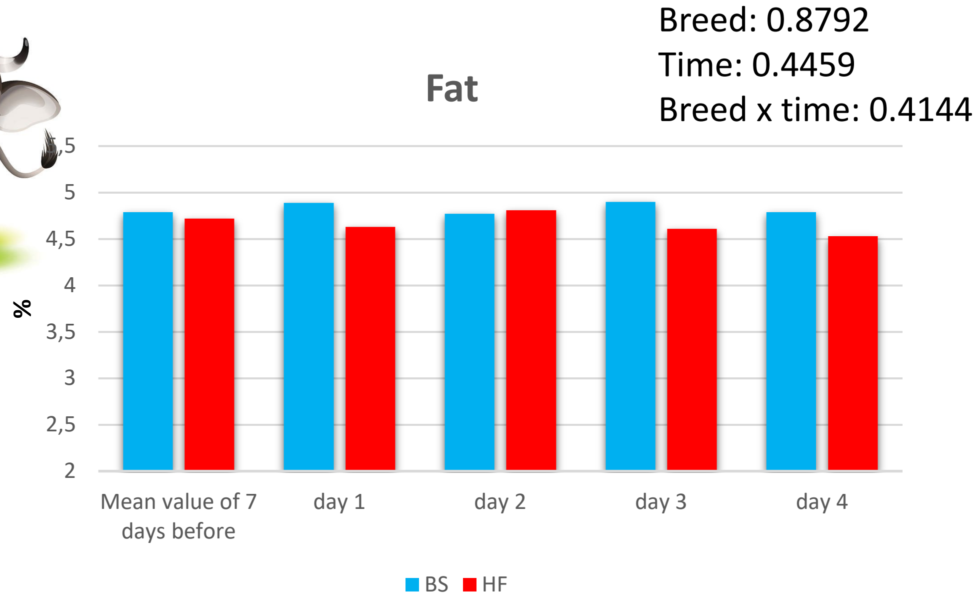
Fat corrected milk

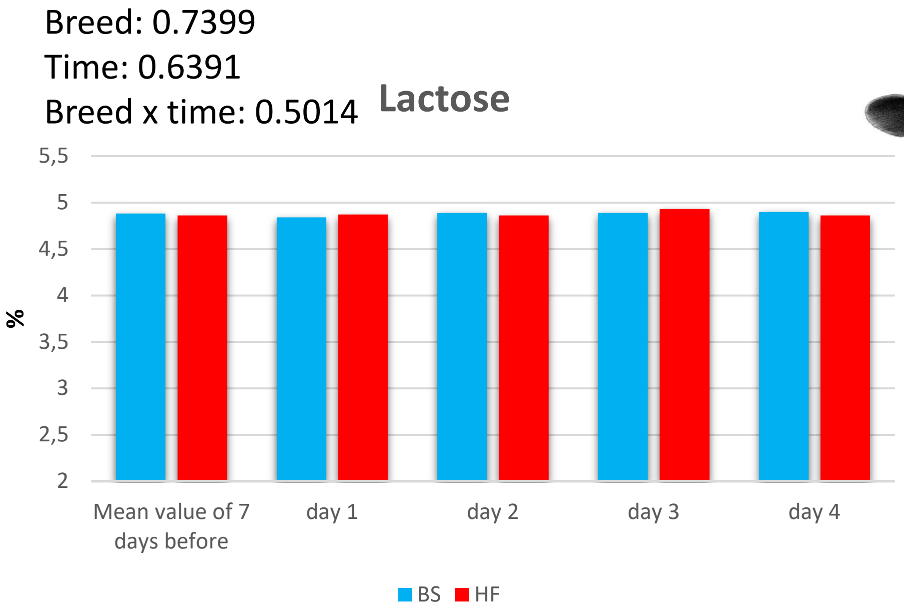


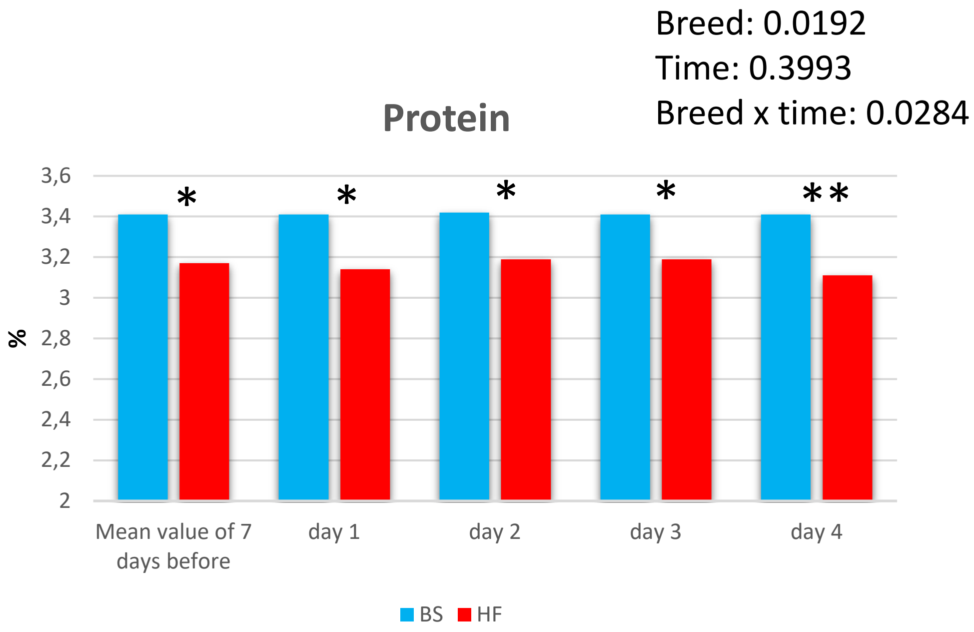
Energy corrected milk

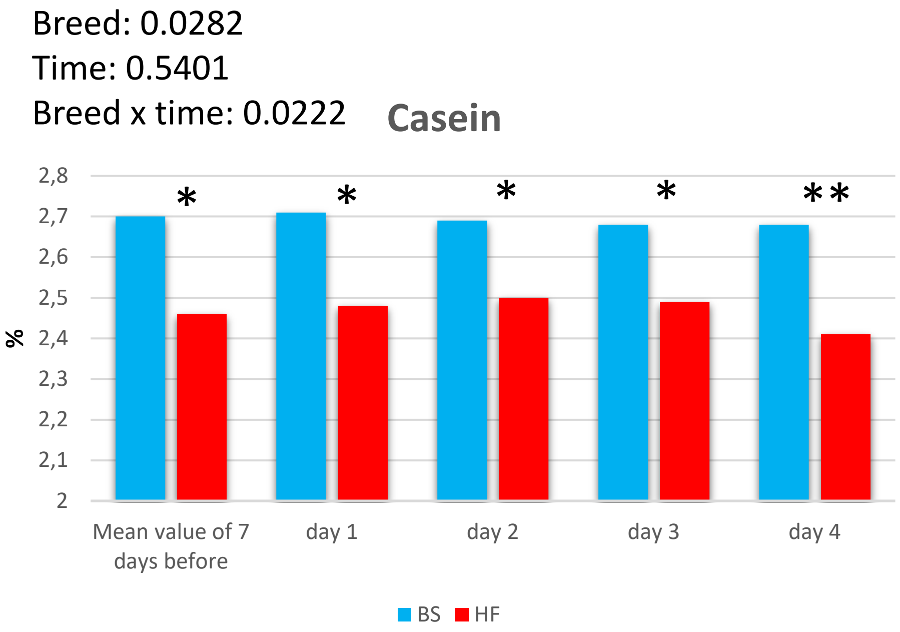


Different letters of the same color show statistical difference among times in the same breed: a, b = $P < 0.05$







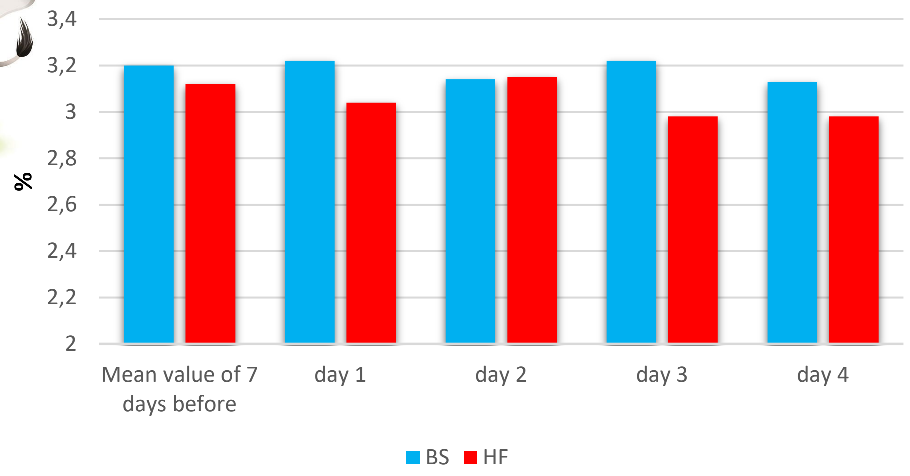


Differences between breeds in the same time are showed: * = P < 0.05, ** = P < 0.01

Results

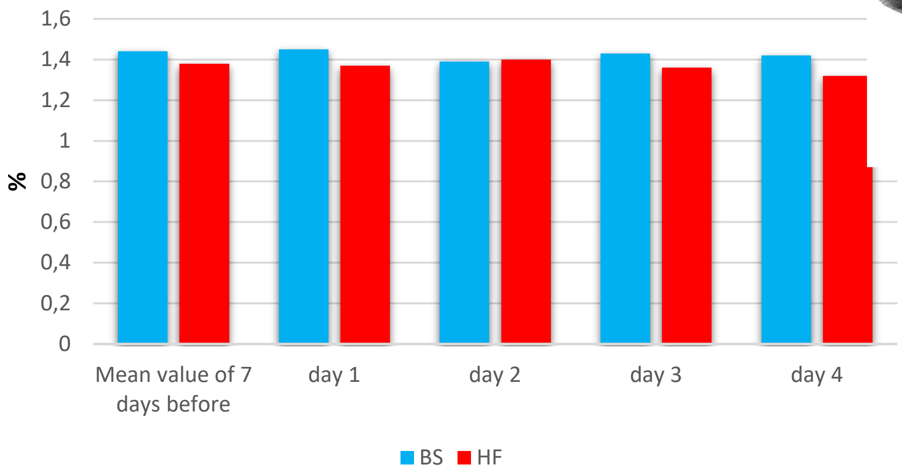
SFA

Breed: 0.2205
Time: 0.7118
Breed x time: 0.4672



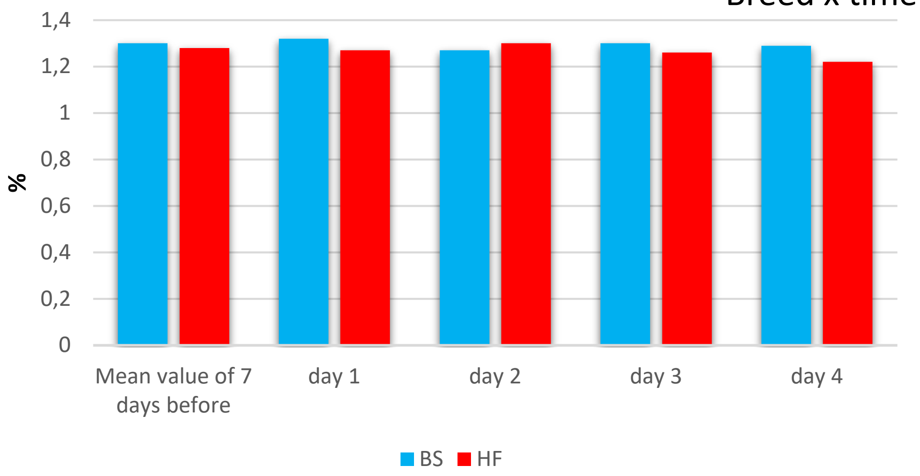
UFA

Breed: 0.1404
Time: 0.7909
Breed x time: 0.5655



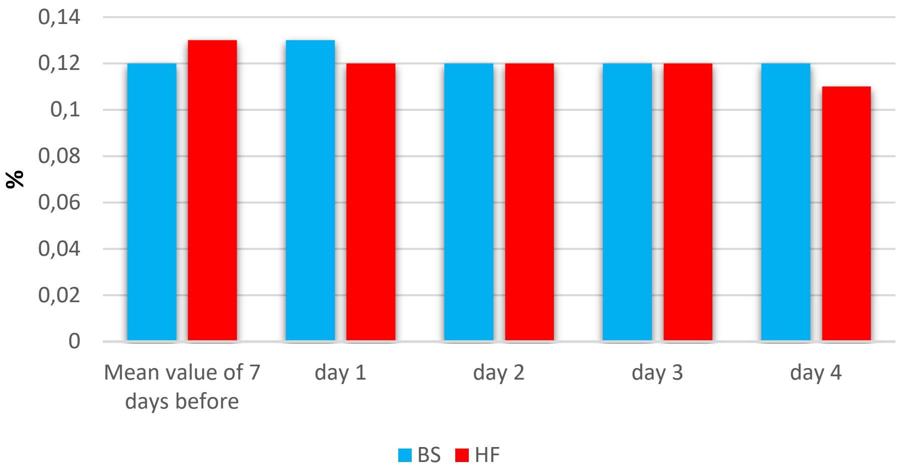
MUFA

Breed: 0.2353
Time: 0.8289
Breed x time: 0.6431



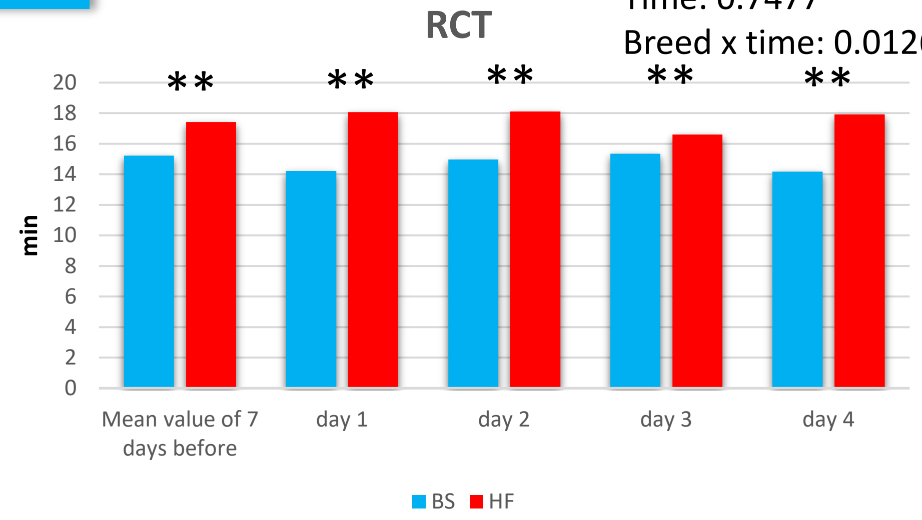
PUFA

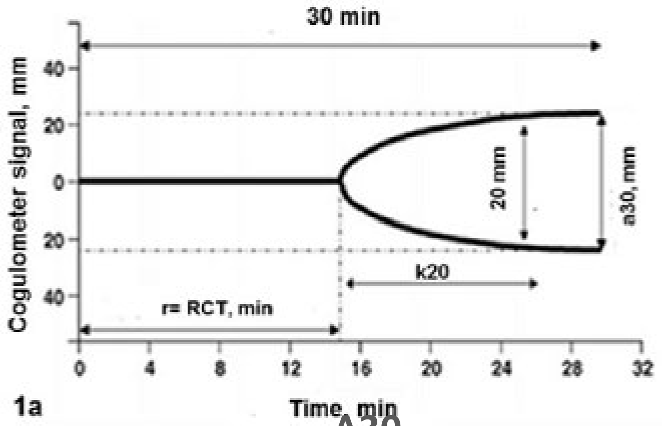
Breed: 0. 0108
Time: 0.6740
Breed x time: 0.7136



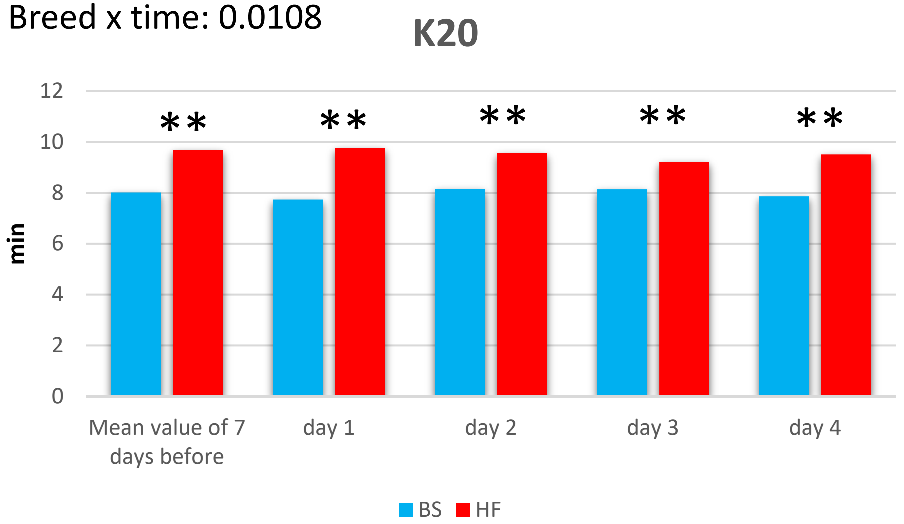
Results

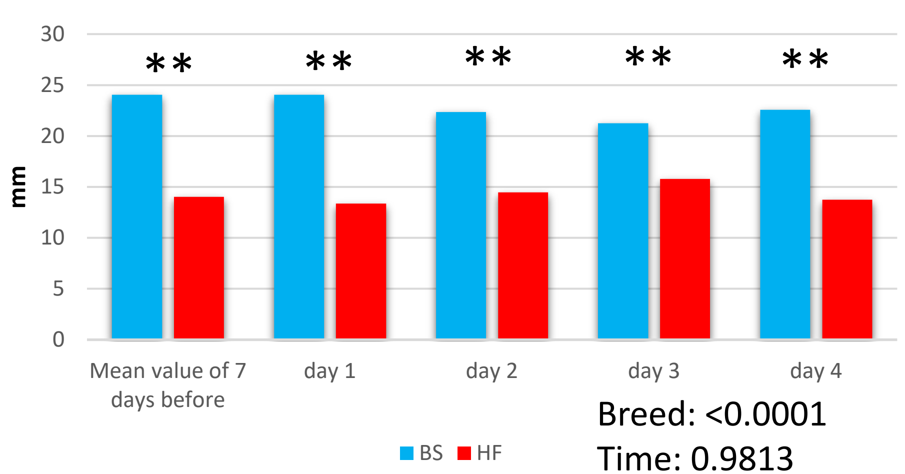
Breed: <0.0001
Time: 0.7477
Breed x time: 0.01263





Breed: <0.0001
Time: 0.8807
Breed x time: 0.0108

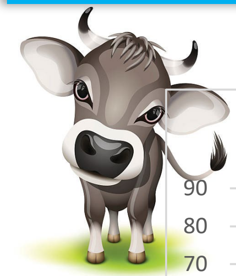




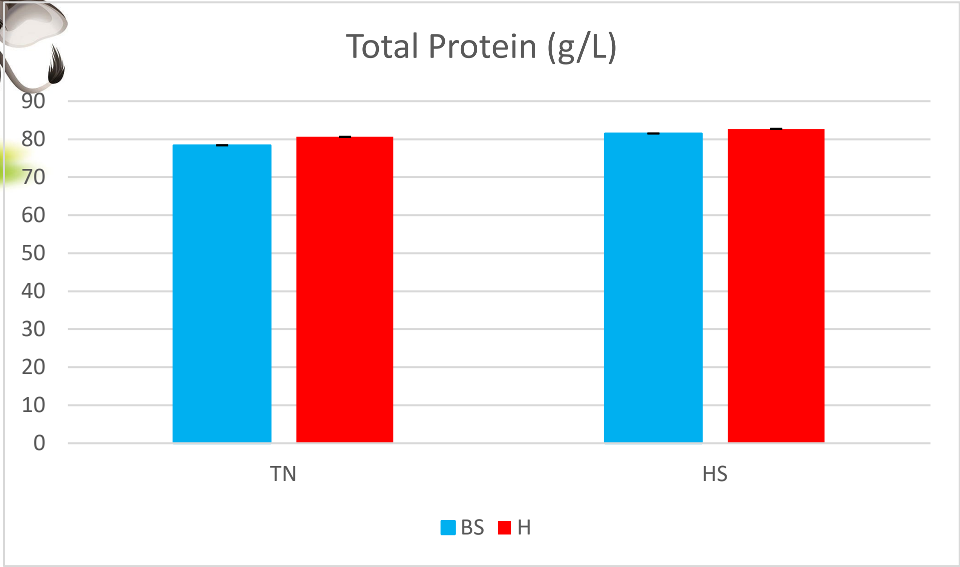
Breed: <0.0001
Time: 0.9813
Breed x time: 0.0191

Differences between breeds in the same time are showed: ** = P < 0.01

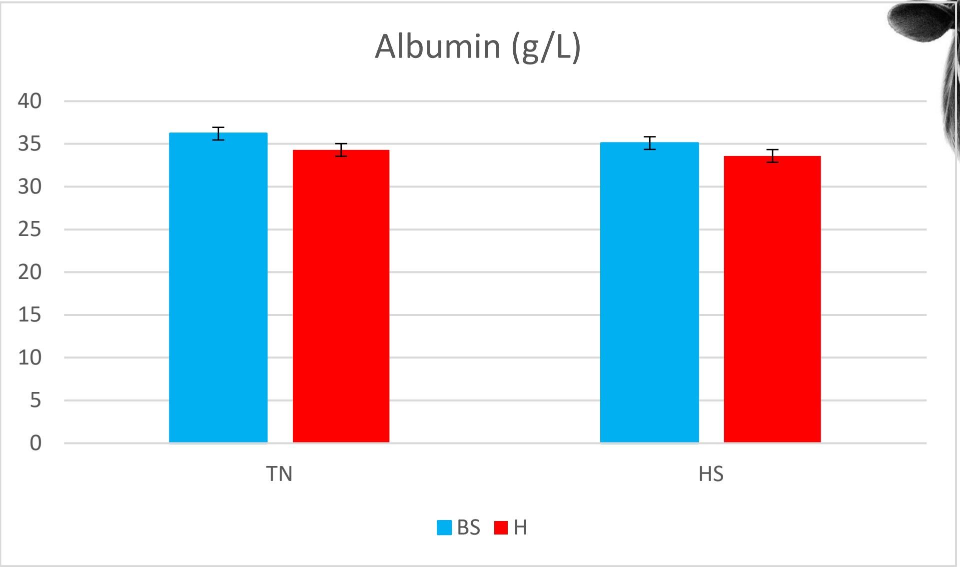
Results

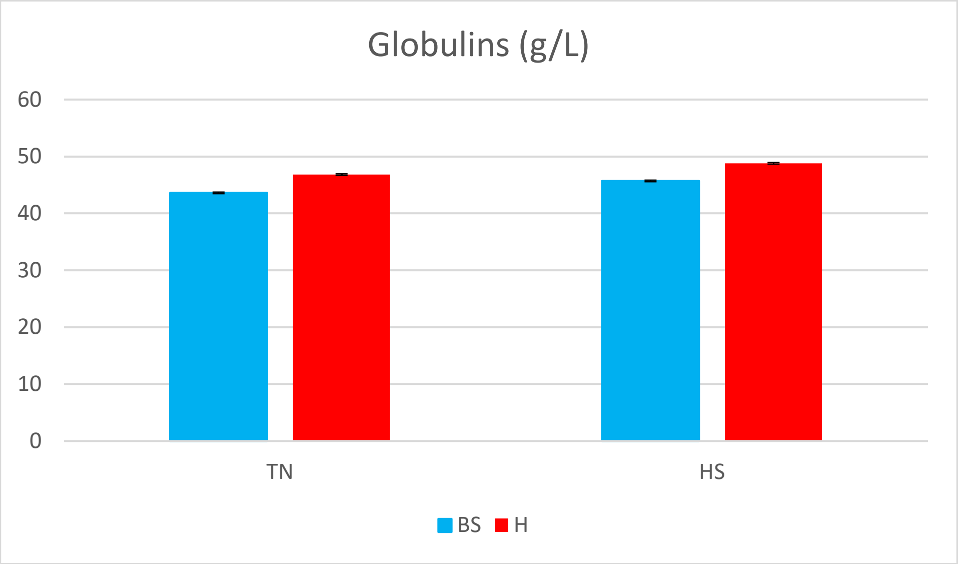


Breed: 0.1918
Time: 0.1421
Breed x time: 0.7040



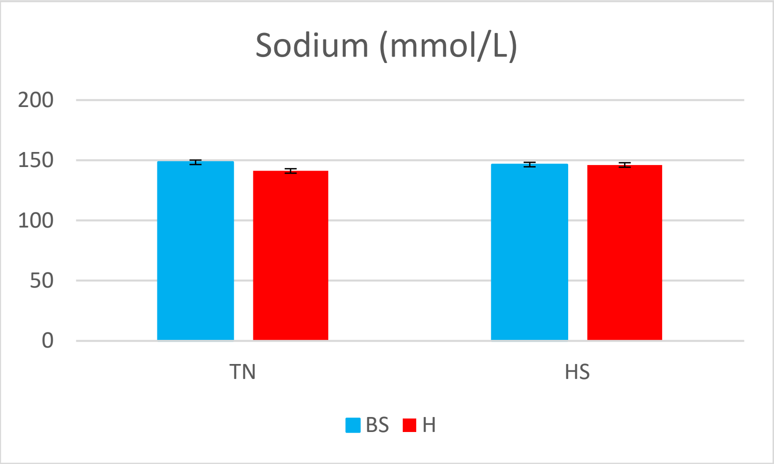
Breed: 0.2252
Time: 0.5720
Breed x time: 0.3982



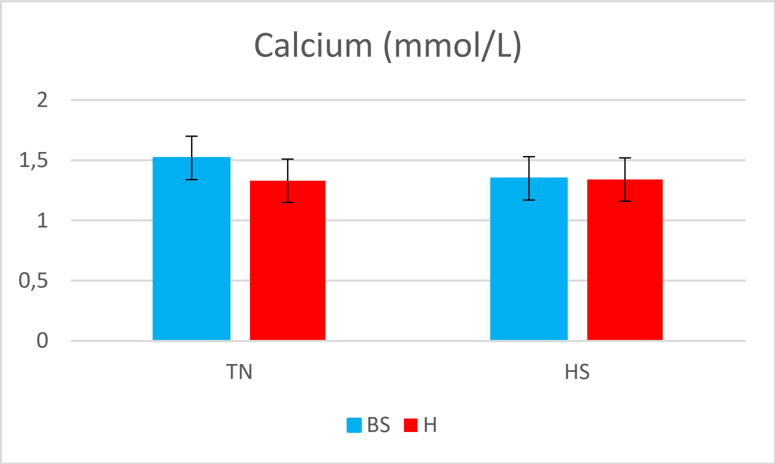


Breed: 0.1333
Time: 0.1616
Breed x time: 0.9565

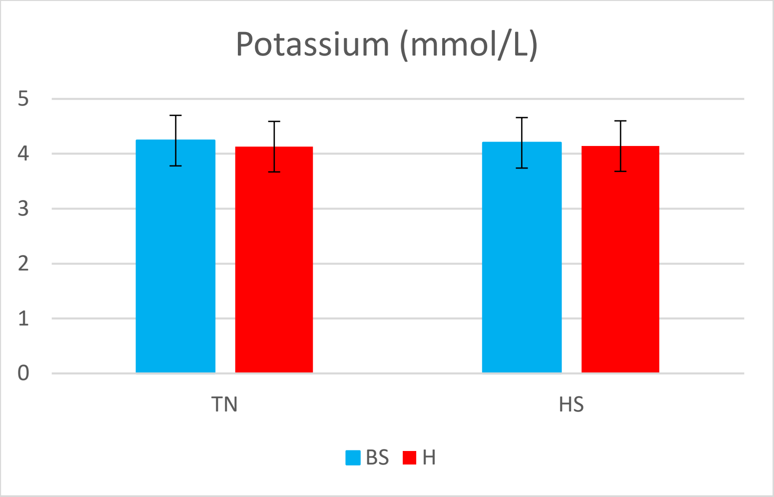
Results



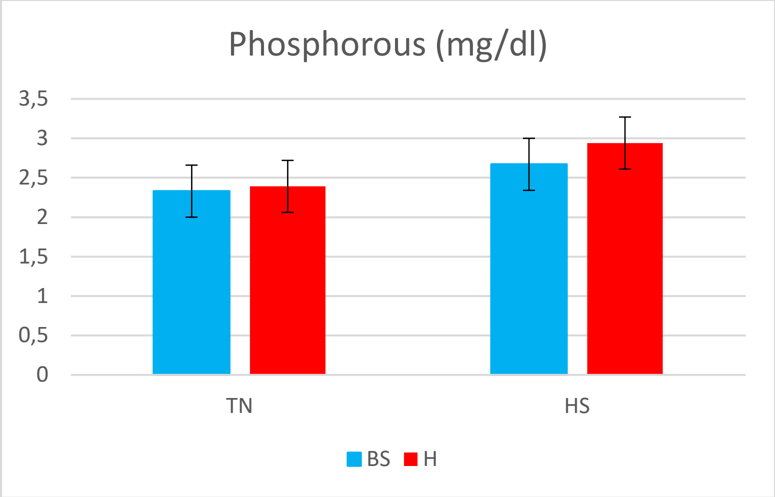
Breed: 0.4367
Time: 0.3858
Breed x time: 0.0562



Breed: 0.2934
Time: 0.4322
Breed x time: 0.4050

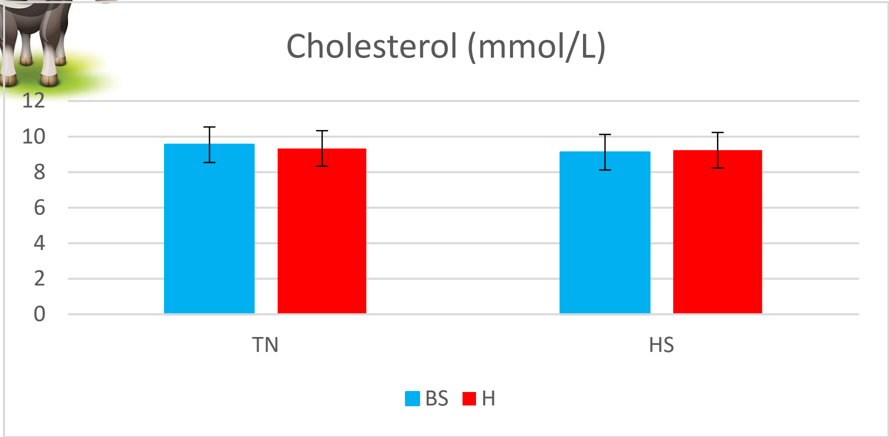


Breed: 0.0970
Time: 0.7661
Breed x time: 0.5670

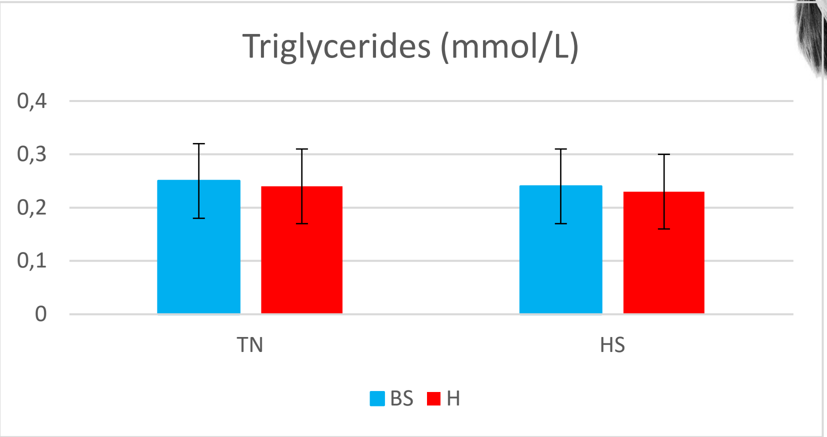


Breed: 0.1522
Time: 0.4204
Breed x time: 0.4727

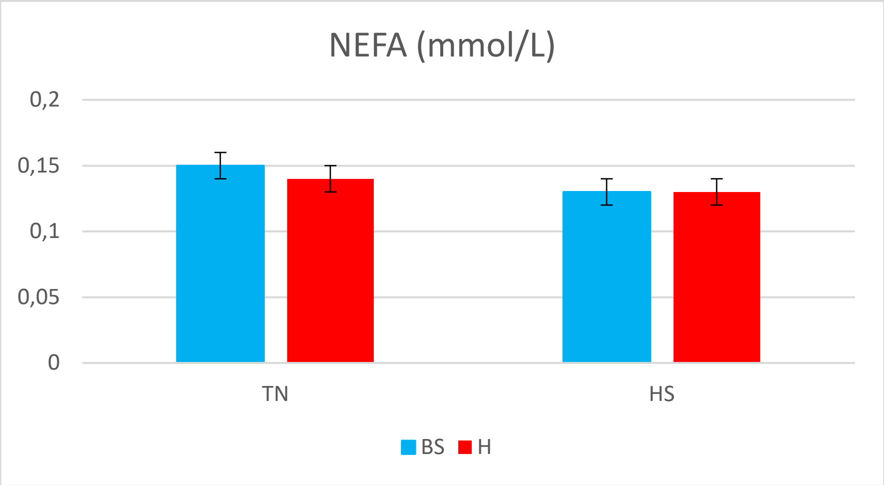
Results



Breed: 0.2213
Time: 0.7836
Breed x time: 0.9369

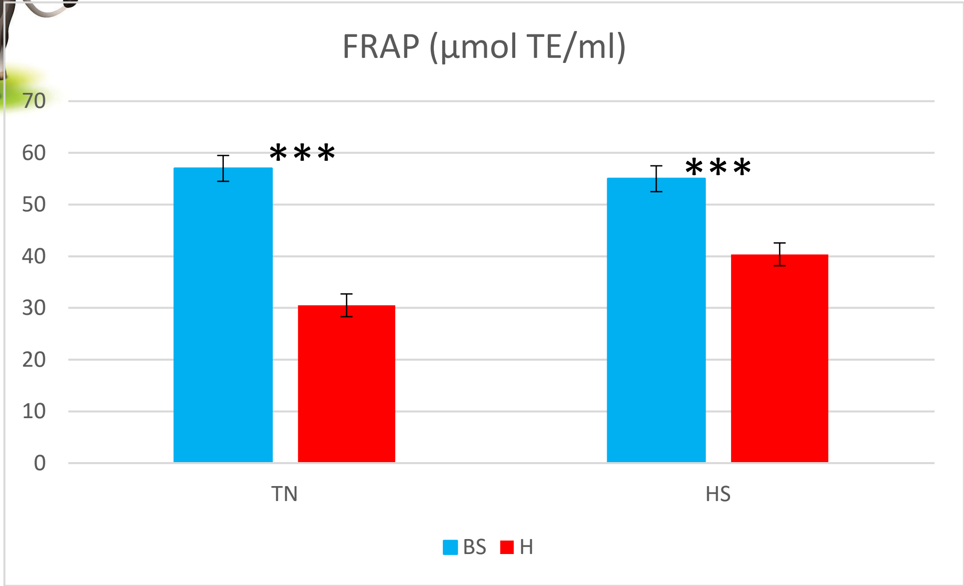


Breed: 0.8146
Time: 0.3358
Breed x time: 0.5582

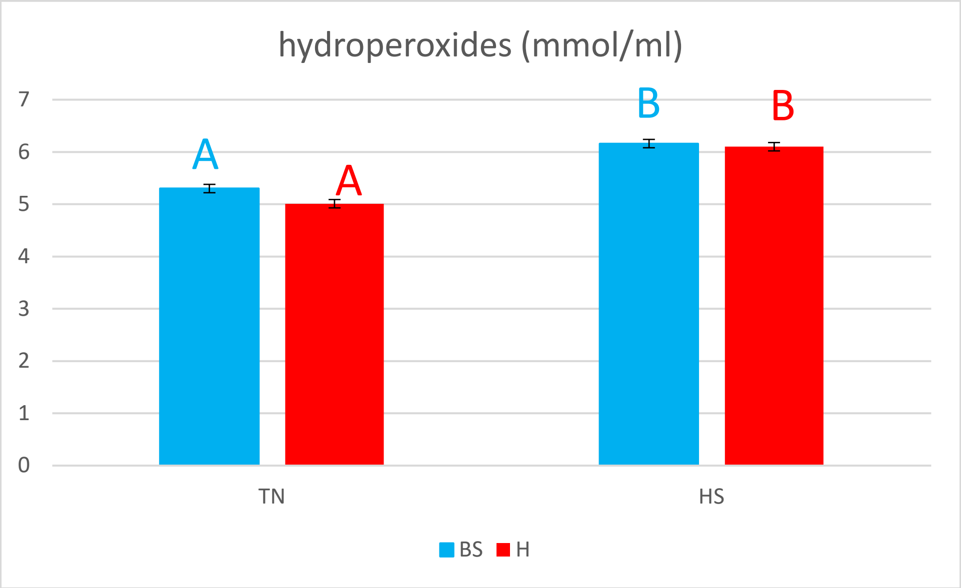


Breed: 0.6628
Time: 0.4248
Breed x time: 0.3112

Results



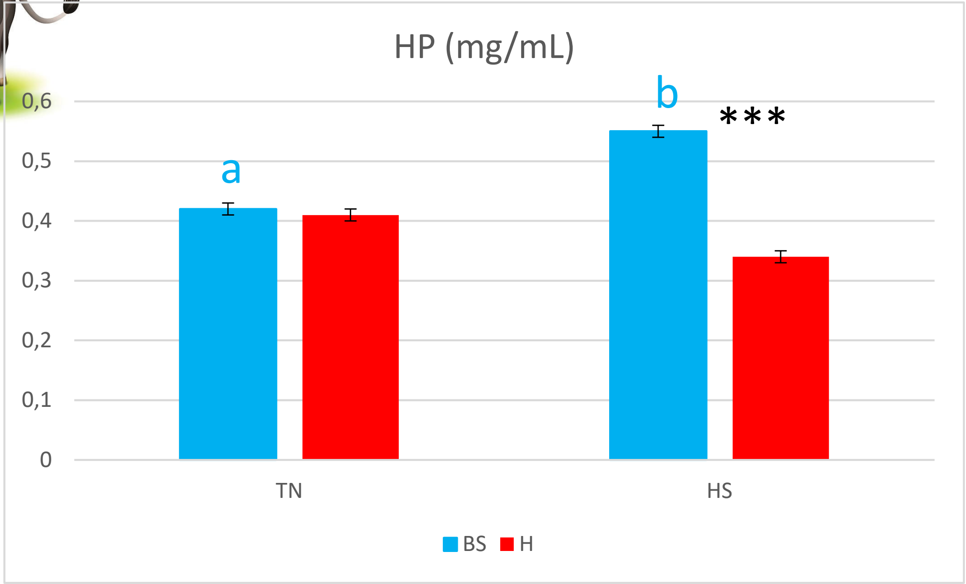
Breed: 0.0007
Time: 0.7836
Breed x time: 0.9369

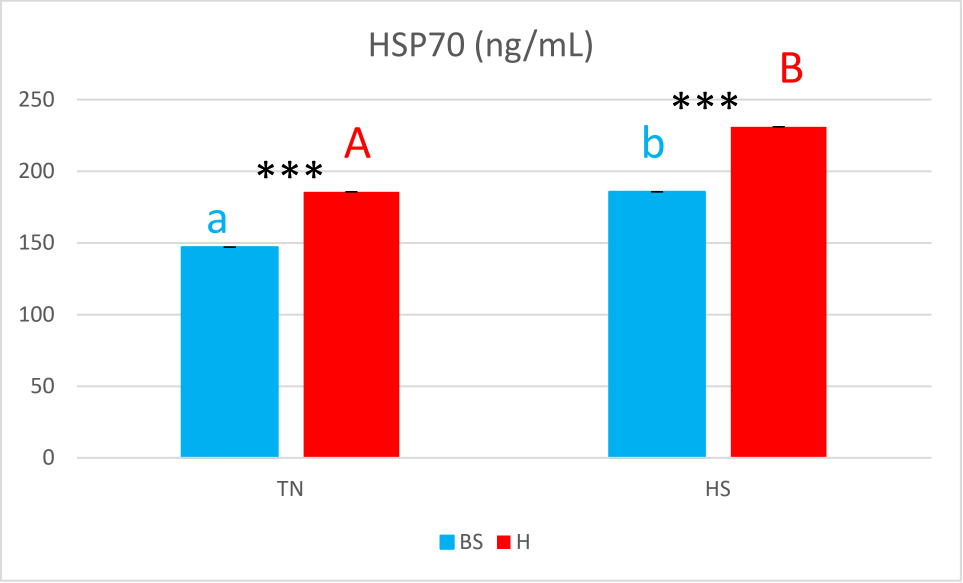


Breed: 0.0007
Time: 0.7836
Breed x time: 0.9369

Different letters of the same color show differences between the conditions within the same breed: A, B = P < 0.01
Differences between breeds in the same time are showed: *** = P < 0.001

Results





Different letters of the same color show differences between the conditions within the same breed: A, B = P < 0.01; a, b = P < 0.05
Differences between breeds in the same time are showed: *** = P < 0.001

Concluding

- RT in Holstein cows was higher when THI increased
- Holstein RT showed also more significant revovery during night hours
- RR, ST, VT, CT, CT, and MT did not show differences between breeds
- HSP70 show differences between breeds
- This could confirm that a greater capacity for heat dissipation through panting and the skin does not characterize Brown Swiss cows


THANKS !!