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## THE IMPACT OF HEAT STRESS ON MILK FAT AND LACTOSE COMPOSITION IN ROMANIAN CATTLE

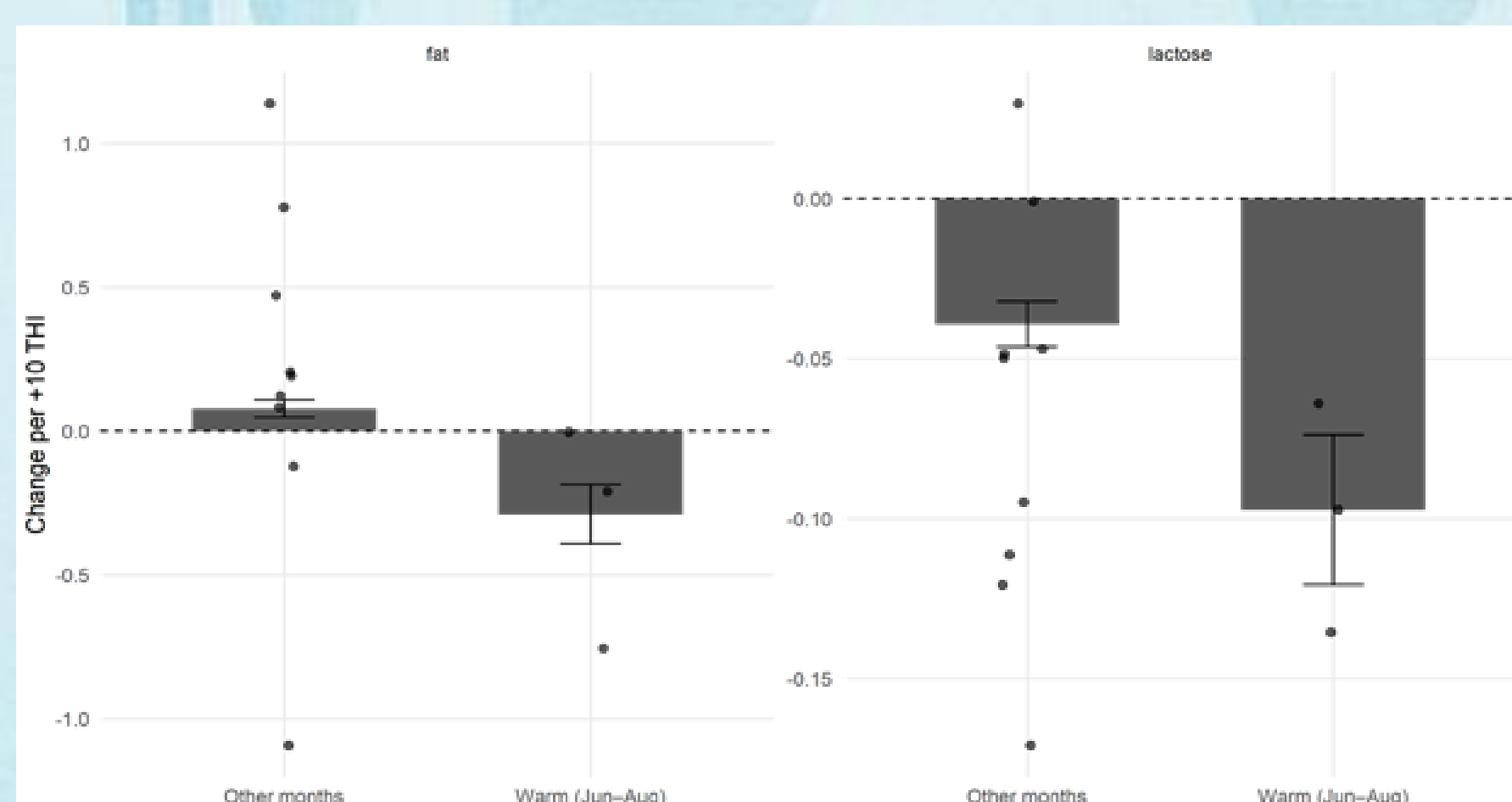
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**Abstract:** Heat stress, indexed by the Temperature–Humidity Index (THI), can alter milk composition; we aimed to quantify the association between daily THI and milk fat (%) and lactose (%) in Romanian Simmental and Romanian Brown cows using routine test-day records. We conducted a retrospective, repeated-measures study of 20,564 test-day observations from 1,123 cows (2014 to 2024), linking each control to same-day THI (observed range  $\approx 28.5$ –78.7). Linear mixed-effects models with a random intercept for cow included a THI $\times$ month interaction and adjustments for breed, parity, and a smooth term for days-in-milk; effects are reported per +10 THI. Results showed season-dependent responses. For fat, higher THI was associated with decreases in mid-summer and late winter (e.g., January  $-0.12$ , February  $-1.09$ , July  $-0.21$ , August  $-0.75$  per +10 THI), but with increases across much of spring and autumn (e.g., March  $+0.21$ , April  $+0.19$ , May  $+0.47$ , September  $+0.78$ , October  $+0.08$ , November  $+1.14$ , December  $+0.12$ ). For lactose, associations were predominantly negative year-round, with small exceptions (e.g., March  $+0.03$ ; April  $\sim 0$ ): decreases were observed in January  $-0.047$ , February  $-0.171$ , May  $-0.111$ , June  $-0.135$ , July  $-0.064$ , August  $-0.097$ , September  $-0.121$ , October  $-0.050$ , November  $-0.048$ , and December  $-0.095$  per +10 THI. A pooled comparison confirmed concurrent reductions in both fat and lactose during warm months (June–August), whereas outside summer, fat generally increased with THI while lactose remained mildly negative. In conclusion, rising THI is linked to a summer depression of milk fat and modest, broadly negative shifts in lactose; month-specific interactions highlight the importance of modeling seasonal context when evaluating milk-quality resilience in these breeds.

### • Introduction

Heat stress, quantified by the Temperature–Humidity Index (THI), is a major challenge for dairy production, influencing not only milk yield but also its composition. Milk fat and lactose are key quality traits that respond to thermal stress. This study evaluated how daily THI fluctuations affect milk fat (%) and lactose (%) in Romanian Simmental and Brown cows over a 10-year period. Understanding these seasonal associations can guide strategies for monitoring milk quality resilience and managing heat load in dairy herds.



### • Material and method

A retrospective dataset of 20,564 test-day records from 1,123 cows (2014–2024) was analyzed. Daily THI values were matched to each milk control record by date. After quality control, linear mixed-effects models with a random intercept for cow were fitted separately for fat and lactose. Models included a THI  $\times$  month interaction and adjustments for breed, parity, and days in milk (modeled with natural splines). Effects were expressed per +10 THI units with cluster-robust SEs and Benjamini–Hochberg FDR correction.

### • Results and discussions

TextRising THI was significantly associated with lower milk fat during summer (notably July and August) and late winter (February), with the largest declines recorded in February ( $-1.09$  % per +10 THI) and August ( $-0.75$  % per +10 THI). In contrast, fat increased with THI in spring and autumn, peaking in November ( $+1.14$  % per +10 THI). Lactose showed broadly negative associations year-round, with the strongest decreases in February ( $-0.17$  %), June ( $-0.14$  %), and September ( $-0.12$  %), while only March ( $+0.03$  %) showed a slight positive change and April remained nearly unaffected. Seasonal synthesis confirmed that summer THI elevations depress both fat and lactose, whereas outside the warm season, fat tends to rise with moderate THI increases. These results align with international findings showing fat as the most heat-sensitive milk component, while lactose remains relatively stable, reflecting its physiological role in maintaining osmotic balance and indicating milk fat as a more reliable biomarker of thermal stress.

### • Conclusions

The study demonstrates that heat stress significantly alters milk composition in Romanian dairy breeds. Milk fat decreases sharply under high THI, especially in summer, whereas lactose remains comparatively constant. Fat percentage is thus a sensitive biomarker of thermal stress, highlighting the importance of incorporating THI-based monitoring in milk-quality management and climate-resilience strategies for dairy herds.