

Use of bio-loggers to assess heat stress in *Piedmontese* cows under different stocking densities

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Heat stress is a major challenge for cattle welfare, particularly in housed systems, where management factors, such as stocking density, may influence animals' ability to cope with high environmental temperatures. Within the BESOS_RP research project, an integrated sensor-based approach was applied to assess environmental parameters, and behavioural and physiological responses of *Piedmontese* beef cattle related to naturally occurring heat stress conditions.

The study involved 20 adult suckler cows, housed at two different stocking densities: high density (HD: 3.5 m² of resting area per cow; n = 10) and low density (LD: 5.0 m² per cow; n = 10). Implantable subcutaneous bio-loggers were used for continuous individual monitoring of core body temperature and cardiac activity. At the same time, commercial collar-based sensors recorded behavioural and functional parameters, including rumination and an indirect index of respiratory response associated with heat stress. Monitoring was carried out from early April to early October. Barn environmental conditions (air temperature and relative humidity) were continuously recorded and used to calculate the temperature-humidity index (THI). In analogy, saliva samples were collected at standardized time points and analyzed for salivary cortisol quantification as an endocrine indicator of stress.

Focusing on the hottest period (summer period: June – September), increasing THI values were associated with clear behavioural changes. In particular, when THI exceeded the 75% alert threshold, rumination progressively decreased as heat load increased in both groups, confirming its sensitivity as an early indicator of thermal discomfort. HD cows showed higher respiratory response indices and lower rumination levels than LD cows. In contrast, although body temperature increased with THI, no marked differences in body temperature or heart rate were observed across stocking densities, suggesting a condition of compensated physiological adaptation. Salivary cortisol concentrations did not differ significantly between the experimental groups, with a similar trend throughout the trial.

Overall, these results indicate that integrating implantable bio-loggers and wearable sensors allows a detailed, continuous assessment of heat stress in *Piedmontese* cows. Behavioural indicators derived from sensors, particularly rumination and respiratory-related indices, appear to be more sensitive to heat load and housing conditions than baseline physiological or endocrine parameters. This approach represents a valuable tool for improving welfare assessment and supporting management strategies aimed at mitigating heat stress in beef cattle production systems.