Prolonged and continuous heat stress in cattle: Physiology, welfare, and electrolyte and nutritional interventions.

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Declaration

I declare that this is my own account of my research and contains as its main content work which has not been submitted for a degree at any tertiary institution.

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David Thomas Beatty
Abstract

The live export of cattle is an important industry for Australia. Concerns have arisen about animal welfare and in particular heat stress which may cause production losses and death. Cattle shipped live to the Middle East from a southern Australian winter can face continuous and prolonged periods of high heat and humidity as they cross the equator and arrive into a northern hemisphere summer, leading to heat stress and excessive heat load. Some live animal exporters treat heat stressed cattle with electrolyte supplements, but no scientific data exists as to whether this is beneficial to cattle in these unique environmental conditions.

In response to industry’s concerns, the experiments described here monitored the physiological responses of *Bos taurus* and *Bos indicus* to conditions similar to those experienced by cattle being shipped from southern Australian to the Middle East. Initial experiments were conducted in climate controlled rooms at Murdoch University where intensive monitoring was possible. In the *Bos taurus*, increases in core body temperature, reductions in feed intake, and increased water intake were measured. There were also changes in blood gas variables consistent with the observed panting causing a compensated respiratory alkalosis. Following the heating period, there were decreases in blood and urinary pH. *Bos indicus* showed similar responses to the heat, but the changes were less pronounced at the temperatures tested. A pair feeding experiment was conducted to separate the effects of heat from the reductions in feed intake, and this indicated that the major measured effects were due to the responses to heat. On the basis of the measured responses, an electrolyte supplement was formulated and tested on *Bos taurus*, in the climate controlled rooms, and then on a commercial live export vessel. Results from these experiments indicated improved buffering capacity and a weight advantage for supplemented cattle, even in the absence of extreme heat stress.
A final experiment investigated the effects of amount and quality of roughage in a pelleted feed on core and rumen temperature and feed intakes in *Bos taurus* subjected to hot environmental conditions in climate controlled rooms at Murdoch University. Both pelleted feeds had approximately the same metabolisable energy and crude protein but differed in content and type of roughage. There were no differences in feed intake, core temperature or rumen temperature between diets.

This work has led to a greater understanding of the physiological responses of cattle to prolonged and continuous high heat and humidity, the requirements and effects of supplemental electrolytes in these conditions, and the effect of manipulating export diets. The demonstration of advantages in weight and buffering capacity with the electrolyte supplement highlights future areas of research to investigate electrolyte doses, route and types of supplementation, and dietary manipulation.
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List of Abbreviations

AUD  Australian dollar
ABE  Acid base excess
ACTH Adrenocorticotropic hormone
ADH  Antidiuretic hormone
AG   Anion gap
bpm  Breaths/beats per minute
BW   Body weight
Ca   Calcium
Cl   Chloride
Cr   Creatinine
DCAD Dietary Cation Anion Difference
DMI  Dry matter intake
EHL  Excessive heat load
FER  Fractional Excretion Ratio
GH   Growth hormone
HCO$_3^-$ Bicarbonate ion
H$^+$ Hydrogen ion
HR   Heart rate
H$_2$CO$_3$ Carbonic acid
H$_2$O  Water
K    Potassium
Mg   Magnesium
MLA  Meat and Livestock Australia
MEI  Metabolisable energy intake
Na   Sodium
NH$_3$ Ammonia
pCO$_2$ Partial pressure carbon dioxide
ppm  Parts per million
P    Phosphorous
pO$_2$ Partial pressure oxygen
RR   Respiratory rate
RH   Relative humidity
SID  Strong ion difference
T$_a$ Ambient temperature
T$_c$ Core body temperature
T$_4$ Thyroxine
T$_3$ Triiodothyronine
WB   Wet bulb
WBT  Wet bulb temperature
Published and Submitted Papers and Conference Proceedings

Published papers


Submitted papers


Published conference proceedings

