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BEHAVIOURAL RESPONSE TO DIFFERENT CLIMATIC CONDITIONS OF BEEF CATTLE IN INTENSIVE REARING SYSTEMS

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Original scientific paper

SUMMARY

The study aimed to evaluate the behaviour of beef cattle reared in intensive systems in northern Italy under different climatic conditions. In particular, it considered 3 levels of THI (Temperature-Humidity-Index) in order to evaluate the coping response to heat stress conditions regarding changes of beef cattle nutritional and social behaviours, drinking frequency and resting time. Behavioural observations were carried out from July to October 2005, during hot (THI above 78), mild (THI 76) and cool (THI below 72) conditions, on 24 finishing French crossbred bulls. The animals were housed in 6 fully slatted floor group pens of 4 bulls each. Within each class of THI, behaviours were recorded in two sessions of 24 hours using a 5 minute interval scan sampling technique. A focal animal was chosen in order to count the number of visits at the waterer. Results showed that eating behaviour was maximum during the first 8 hours after fresh feed delivery. However, in the same interval, when THI was above 78, eating activity was penalized while an increase of ruminating was observed. The overall number of visits at the waterer was increased by the heat stress condition and they were mainly concentrated in the hottest hours of the day. Hot environment also affected beef cattle social behaviour increasing agonistic interactions and mounts among penmates. Since heat stress affected bulls behaviour impairing their welfare, the adoption of cooling devices should be recommended.

Key-words: beef cattle, temperature humidity index, heath stress, behaviour

INTRODUCTION

The report on beef cattle welfare, edited by the Scientific Committee on Animal Health and Animal Welfare (2001), suggested that the highest threshold temperature guaranteeing a sustainable welfare condition for this category of animals is up to 30° C when humidity is below 80% while it falls under 27° C if the humidity level is higher. Therefore, in order to identify potential conditions of heat stress at the farm level a Temperature-Humidity-Index (THI) should be considered instead of temperature and humidity separately (NOAA, 1976). THI is commonly applied to estimate heat stress in dairy cows. When THI values were above 75, cows showed physiological signs of stress such as increased body temperature and modification of hearth and respiratory rates (Abeni et al., 1993). The same environmental conditions modified also dairy cattle feeding behaviour and resting. The variations of feeding behaviour led to a reduced dry matter intake affecting consequently milk production (Bernabucci and Calamari, 1998). Similarly to dairy cattle, studies carried out on feedlot beef cattle exposed to hot environment, showed a reduced feed intake and worsened growth performances (Mitlöhner et al., 2001; Brown-Brandl et al., 2006). None similar investigation has been carried out on beef cattle reared indoors in intensive systems. Despite, this type of housing is distributed over most of the European Countries and is predominant in north Italy for the fattening of about 2 millions of bulls each year (Cozzi and Ragno, 2003). Climatic conditions in northern Italy, during summer, are very often adverse for animal welfare and therefore the present study aimed to evaluate behavioural response of this category of cattle to different levels of THI.

MATERIAL AND METHODS

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The behavioural study was carried considering three different microclimatic conditions: THI below 72, THI = 76 and THI above 78. THI below 72 is considered the thermal neutral zone, THI of 75-76 falls in the interval of mild heat stress, while THI above 78 was the minimum threshold of heat stress considered dangerous for the animals (Armstrong, 1994). In order to find these environmental conditions the study was extended from July to October 2005 and experimental days were decided on the basis of the forecast of the local agency for the weather control.
The trial was carried out in an intensive commercial farm located in Brugine - Province of Padova which fattened 1800 beef cattle/year. Behavioural observations were performed on a batch of twenty-four French crossbred bulls, housed in six group pens balanced for their initial body weight (508 ± 47 kg). The pens had fully slatted floor and the space allowance was 4.5 m^2/head. Bulls were fed *ad libitum* the same total mixed ration (TMR), distributed once a day at 9:30 AM. The diet was based on maize silage and was formulated (Crude protein = 13.3 % DM; NDF = 31.6 % DM; Non-fibrous Carbohydrates = 45.2 % DM) in order to cover the nutritional requirements for a hypothetical average daily gain of 1.3 kg/head (INRA, 1988). All the animals had free access to fresh water, provided by one pressure-waterer per each pen.
Two days of observations were dedicated to every THI condition considered in the study (Hot, Mild and Cool). Each session started in the morning after feed delivery and lasted for 24 hours. Direct observations of the animals were carried out by trained personnel using a scan sampling technique with a 5 min interval between scans (Martin and Bateson, 1993). At each scan the number of animals per pen lying, resting, eating and ruminating was recorded. The number of social events such as fights and mounts per pen were noted using the behaviour sampling technique while the number of visits at the waterer was recorded just for the focal animal (Martin and Bateson, 1993). The subjects chosen for the focal sampling were the easiest ones to distinguish among the penmates.
Behavioural data obtained from scan sampling, were expressed in minutes assuming that each behaviour persisted for the entire 5 minutes scan interval (Maekawa et al., 2002). Events related to social behaviour (mounts and fights) and water consumption occurrences were considered as a number of events. Data were analysed by PROC GLM (SAS, 1990) and the statistical model adopted considered the effects of THI and pen. Data of each day of observation were then grouped in three following time aggregates according to the method proposed by Cozzi and Gottardo (2005). The intervals ranged from the time of diet delivery to 8 h after diet delivery (0-8), from 9 to 16 h (9-16) and from 17 to 24 h after diet delivery (17-24). This data set was submitted to statistical analysis adopting a model which considered the effects of THI and pen, daytime interval and THI per daytime interval interaction. Results were considered statistically significant for $P<0.05$.

RESULTS AND DISCUSSION

Data in Table 1, collected using the scan sampling technique and related to 24 hours of observations, showed that lying, resting and eating time were not affected by the environmental conditions, while hot climate significantly increased time spent ruminating. This significant change in behaviour is not in agreement with the expected results considering that previous studies reported a reduced rumination under heat stress conditions both in dairy cows (Collier et al., 1982; Tapkı and Şahin, 2006) and ewes (Costa et al., 1992). In this research, the longer rumination observed could be due to an attempt of cattle to control the reduction of ruminal pH likely due to the high starch content of the diet and to a diminished salivary buffering capacity consequent to an excessive urinary excretion of carbon as shown by Collier et al. (1982).

Table 1. Lying, resting, eating and ruminating time and drinking events performed by beef cattle under different THI conditions

Type of behaviour	Unit	Temperature Humidity Index (THI)			RMSE
		above 78 - Hot	75-76 - Mild	below 72 - Cool	
Lying	min	798	791	816	48.21
Resting	min	235	265	258	54.09
Eating	min	106	114	117	17.71
Ruminating	min	359[a]	310[b]	303[b]	44.69

Drinking	number	14.33[a]	11.08[ab]	9.75[b]	4.70

Values with different superscript letters within a row differ significantly (P<0.05)

Regardless the THI conditions, eating was highest during the first 8 hours following the diet delivery when a fresh-made feed was available (Figure 1) and this is in agreement with the result of a previous study by Cozzi and Gottardo (2005). Moreover, the interaction Daytime interval x THI showed, in the first 8 h after feed delivery, at the highest THI, a significant reduction of time spent by the animals eating (Figure 1) while increased rumination (Figure 1). Considering that in the same period, lying time (Figure 1) was not affected by different THI levels, it is likely that rumination was performed in the standing position as an attempt of the bulls to dissipate body heat.

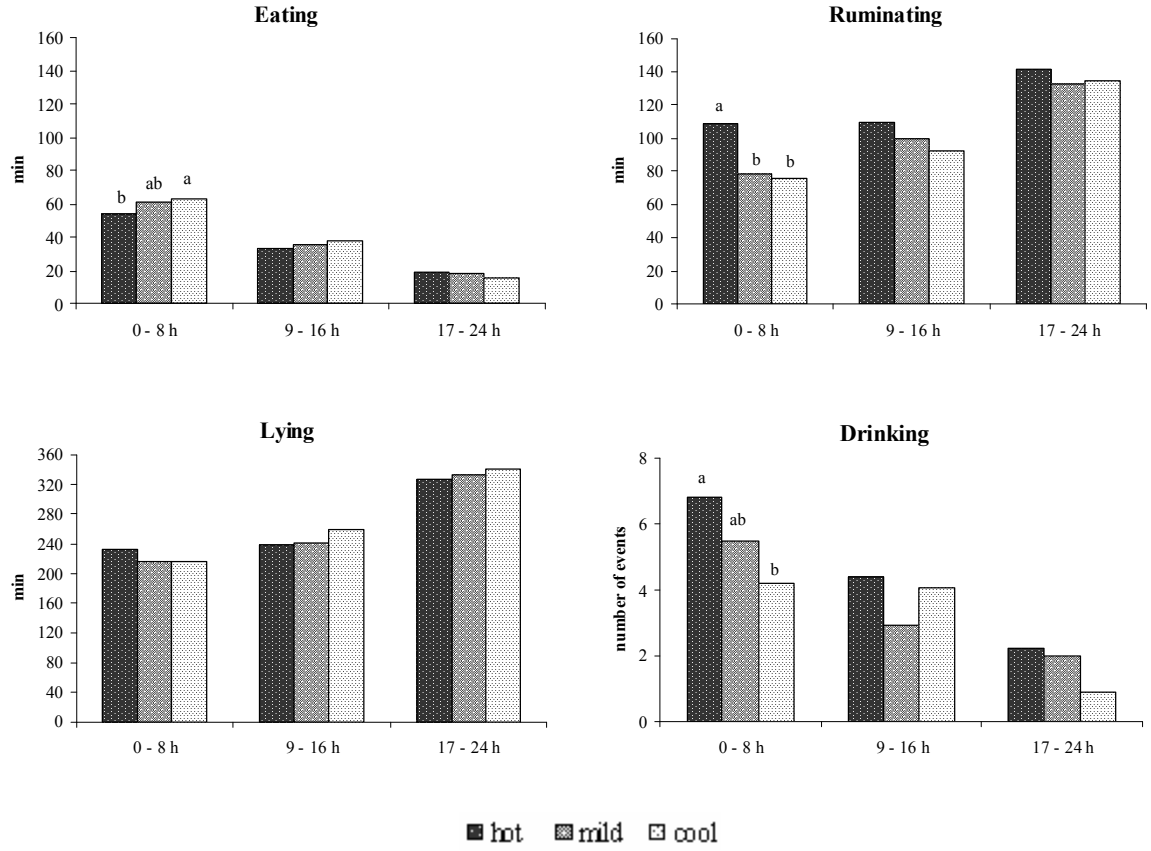

Figure 1. Least square means of the time (min) spent eating (RMSE = 10.72), ruminating (RMSE = 21.79), lying (RMSE = 19.63) and of the number of drinking events (RMSE = 6.34) performed by beef cattle under different climatic conditions recorded in three time intervals from diet delivery (0-8 h; 9-16 h and 17-24 h)

Under heat stress condition, the greater water demand by the bulls was the explanation for the significant increase in the number of visits at waterer (Table 1). Moreover, when THI was above 78, the need to drink water (Figure 1) was particularly accentuated during the first time interval after diet delivery (0-8 h). Beef cattle drinking requirements are greater under thermal stress conditions because water is consumed for heat dissipation (via panting and sweating) and for cooling down the reticulo-rumen (Collier et al., 1982).

Despite the lack of significant statistical differences, there was a positive relation between the increase of THI and the number of mounts among penmates (Table 2). This result, which was previously observed also by Lewis (1985) in dairy cows and by Mitlöhner et al. (2002) in grazing heifers could be the consequence of an increased nervousness of the animals. On the other hand the similar number of

fights recorded under different climatic conditions (Table 2) supports the hypothesis that thermal discomfort did not increase aggressiveness in bulls.

Table 2. Number of mounting and fighting performed by beef cattle under different THI conditions

Event	Unit	Temperature Humidity Index (THI)			RMSE
		above 78 - Hot	75-76 – Mild	below 72 - Cool	
Mounts	number	7.75	5.17	3.58	7.71
Fights	number	26.83	25.33	28.67	12.56

CONCLUSION

The effects of heat stress are often seen as a reduction of productive performances but animal welfare is noteworthy as well. Cattle behaviour is directly related to its status of well-being, therefore study of changes in behaviours could be used to identify a dreadful environment. In particular, the results of the present study showed that a hot environment adversely affected eating behaviour of the bulls while the higher rumination activity represented an attempt to cope with the peak of fermentative activity in the rumen which follows the main meal of the animal right after the provision of the fresh TMR. Therefore, behavioural observation of beef cattle reared in indoors systems are a useful tool to develop and test cooling devices and management strategies to improve beef cattle welfare and performance during the hot season.

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