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Effect of hot season and type of floor on the microclimate conditions in the pens of beef cattle intensive farms

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ABSTRACT

A study was conducted on a sample of 20 beef cattle farms to verify the effect of season and type of floor on microclimate parameters. Ten farms had multiple pens with slatted floor and 10 with littered floor. Temperature, humidity, THI, NH_3 and CO_2 were measured with specific instruments during two inspections in summer and winter time. A short interview was also made with the stockman about the adoption of several managing strategies to limit heat stress on animals during the hot period. As expected temperature and THI values recorded in the summer were significantly higher than the winter ones while there were no difference due to the type of floor in the pen. The THI values observed in littered and slatted floor pens (78.6 and 79.0 respectively) in the summer inspection were over 75, the recognized threshold for heat stress in cattle. Noxious gasses concentrations were unaffected by season and type of floor resulting far below their toxic concentration for cattle. According to the stockman interviews, there is a clear perception of the detrimental effect of the hot season on cattle welfare which impairs feed intake. Some preventive strategies are applied in most cases but they appear insufficient and often not operative when needed.
(Keywords: beef cattle, microclimate conditions, hot season, type of floor)

INTRODUCTION

Farm microclimate conditions are a factor that can significantly affect beef cattle performance (*Mitlöhner et al*., 2001). Critical summer weather conditions have shown to impair the animal welfare by increasing body temperature and reducing feed intake (*Lefcourt* and *Adams*, 1996). Under intensive rearing systems, the effect of the hot climate on the beef cattle response can be exacerbated by the heat increment induced by feeding diets rich in concentrates (*Mader*, 2003). Moreover, the health status of the animal can be worsened by the enhanced concentrations of noxious gasses promoted by an increased fermentation of bedding material and animal wastes. Reference thresholds for temperature, humidity and noxious gasses concentrations can be found in the literature in order to assess the welfare of confined beef cattle during the summer (*SCAHAW*, 1999 and 2001; *Holt et al*., 2004). The aim of present study was to evaluate the change of some of these microclimate parameters from winter to summer time in a sample of Italian beef cattle farms located in the Po Valley which adopted a different type of floor in their pens. The farmers attitude towards specific management strategies to be applied in the attempt to relieve cattle heat stress was also recorded by a focused interview.

MATERIALS AND METHODS

The study was conducted on a selected sample of 20 intensive beef cattle farms located in the Veneto Region (Italy) within a maximum distance of 60 km at iso-climatic weather conditions. All farms had close barns, ten of them had multiple pens with straw bedded floor while the remaining 10 had slatted floor pens. All farms were visited in two times of the year, August 2005 and February 2006, in order to compare the microclimate conditions during the warm and the cold seasons. The inspection was carried out between 11.00 AM and 02.00 PM by a trained technician who was in charge to measure several microclimate parameters. Temperature and humidity were recorded by a HD206-2 Datalogger (Delta Ohm, Padova, Italy) while the concentrations of CO_2 and NH_3 were detected by a Drager CMS (Dräger Safety AG & Co. KGaA, Luebeck, Germany). All the measurements were taken holding the instruments inside the pen at 150 cm of height in order to closely resemble to breathing height of the animal in standing position. The ventilation systems were never working at the time of data recording and this situation was not imposed by the technician. Experimental temperature and humidity data were used to calculate the Temperature Humidity Index (THI) according to the following equation: THI=TF-(0.55-[0.55*RH/100)]*(TF-58) (*Ominski et al.*, 2002) where T F is the temperature in Fahrenheit degrees and RH is the relative humidity value.

At the end of the summer visit, a short interview was also made to each farmer in order to know possible changes in the management of the animals and in their behaviour during the hot season. Most of the questions were about the adoption of devices and strategies capable to alleviate heat stress of cattle. A few questions were also addressed to assess change in cattle feed intake and health problems during the hot season.

All microclimate data were submitted to a repeated measures analysis of variance within GLM procedure of *SAS System* (1990). Season, pen type of floor and their interaction were the factors included in the statistical model. The minimum threshold for the statistical significance was $P<0.05$.

RESULTS AND DISCUSSION

The general description of the selected sample of farms used in the study is reported in *Table 1*. The farm size, measured as number of cattle, was similar for both types of floor either as average or as standard deviation. Animals on slats were mainly of French origin while dual purpose breeds cattle number was higher in the farms with littered floor.

Table 1

General description of the sample of beef cattle farms used in the study

Number of farms	Type of floor	
	Litter	Slats
	10	10
Cattle, (mean ± SD)	592.0 ± 570	575 ± 557
Main cattle genotypes: (n. of farms)		
French pure and crossbred	6	9
Double purpose breeds	4	1
Space allowance, (m^2/head)	5.0 ± 1.9	3.1 ± 0.4

Microclimate conditions

Average temperatures recorded in the two periods of the year are shown in *Table 2*. As expected, summer values were significantly higher than the winter ones whereas no difference was observed for the different type of floor in the pen.

Humidity mean values were not affected by season and type of floor (*Table 2*). However, when considering the effect of these parameters on the animal welfare, it is more realistic to combine them in a single index like the THI (*NOAA*, 1976). The calculation of THI in the present study showed a significant difference of the season without any effect due to the type of floor (*Table 2*). The values measured in the hot period resulted above 75 which is recognized as the minimum threshold of heat stress for cattle (*Mader* and *Davis*, 2004; *Holt et al*., 2004; *West*, 2003).

The average concentrations of two noxious gasses like NH_3 and CO_2 are reported in *Table 2*. The season, the type of floor and their factorial combination had no effect on these parameters.

Table 2

Effect of season and type of floor on microclimate parameters in the pen

		Summer		Winter		Significance			rmse
		litter	slats	litter	slats	season	floor	season*floor	
Temperature	°C	29.2	29.3	6.8	7.5	P<0.0001	ns	ns	3.90
Humidity		59.6	60.7	63.3	54.3	ns	ns	ns	13.06
THI		78.6	79.0	47.2	48.5	P<0.0001	ns	ns	5.66
NH_3	ppm	3.2	5.8	3.0	0.9	ns	ns	ns	5.77
CO_2	ppm	970.0	829.0	776.0	799.0	ns	ns	ns	431.15

The values observed for both gasses in the summer inspection tended to be higher than those recorded in winter but their difference did not reach the minimum threshold for the statistical significance due to the great variation observed within factor. In the case of NH_3 the P value for the season contrast resulted <0.07. According to *SCAHAW* (2001), the welfare of beef cattle is impaired when the levels of NH_3 and CO_2 are higher than 20 ppm and 5000 ppm respectively. The comparison of these values with those recorded in the present study, even during hot season, showed the absolute lack of risk for the animals.

Farmers interview

The frequency of the answer of the farmers as regards to the adoption of a set of solutions to alleviate cattle heat stress during the summer are reported in *Table 3*.

Most of the farms and those adopting the litter in particular way had ventilation systems to be used in hot days. Artificial ventilation is considered a good solution to alleviate the stress of animals that have to cope with hot climate conditions (*SCAHAW*, 1999) and the THI values recorded during our summer inspection (*Table 2*) should have strongly advised to their adoption. However, it must be pointed out that none of them were operating during the inspection.

The strategy to shift the time of feed distribution towards the late evening hours is considered a way to stimulate feed intake in cattle under heat stress conditions (*Mader*, 2002; *Holt et al*., 2004). This guideline was adopted by about half of the farms of our sample but, according to stockman report it was not able to prevent the drop of intake by the animals in the summer (*Table 4*). The increase in the watering system is also a

recommended strategy to compensate the greater water losses due to the activation of thermoregulatory mechanisms by the animals (*Shalit et al*., 1991). However none of the farms provided additional waterers in the hot season (*Table 3*) and this decision could also explain the reduced feed intake by cattle. An adaptation behaviour of cattle under hot critical conditions is to increase the distance between animals (*SCAHAW*, 1999) and an increase in the space allowance in the pen should promote this behaviour. This strategy seems to be adopted particularly by farms with slatted floor pens (*Table 3*) where cattle are housed at a higher density (*Table 1*).

Table 3

Frequency of adoption of different solution to alleviate heat stress during the summer in beef cattle farm with different type of floor in the pens

	litter		**slats**		**total**
Management strategies:	Yes	No	Yes	No	
Ventilation systems	8	2	6	4	20
Change in time of diet distribution	5	5	4	6	20
Additional waterers in the pen	0	10	0	10	20
More frequent litter renewal	6	4	-	-	10
Increase in space allowance	4	6	6	4	20

Table 4

Effects of the summer microclimate conditions on beef cattle intake and health status as reported by the stockman of farms with different types of floor in the pens

Effects	**litter**		**slats**		**total**
	Yes	No	Yes	No	
Decrease in animal feed intake	8	2	6	4	20
Increase in pathologies	5	5	5	5	20
Increase in lameness	2	8	4	6	20

When the stockman was questioned about the incidence of cattle health problems in the summer in comparison to the cooler seasons, there was not a clear indication for an increase in pathologies (respiratory problems, tail necrosis etc) in both types of floor (*Table 4*). On the contrary, the number of lameness animals seems not to be increased in the hot season particularly in pens with littered floor (*Table 4*). A possible behavioural explanation for this result might be the reduced motivation of the animals to stand and move when exposed to hot temperature. *Mitlöhner et al.* (2001) observed a significant increase in lying behaviour in beef heifers exposed to heat stress without any shading and cooling device.

CONCLUSIONS

The microclimate conditions in the rearing facilities represent an outstanding issue in the assessment of animal welfare. The present study carried out on a sample of beef farms located in the main area for beef production of Italy, the Eastern Po Valley, has shown that, regardless of the type of floor, cattle are likely to be exposed to heat stress during the summer season. Farmers are aware of this problem which results in a lower feed

intake by the animals but their preventive strategies are limited and often not operative when needed. The concentrations of two noxious gasses like NH_3 and CO_2 measured in the pens during the summer inspection did not differ from the values recorded in winter time and no type of floor effect on these parameters was observed. The experimental data for both gasses were far below their toxic concentration for cattle suggesting that they are a minor source of risk for the welfare of the animals in the housing structures for beef cattle of the Po Valley.

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