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Influence of seasonality on the comfort supplied by different materials used as cubicle flooring for dairy cows

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ABSTRACT: The comfort provided by four different cubicle floorings was evaluated with a preference test in relation to winter and summer seasons. The test showed that polyethylene vinyl acetate and polypropylene vinyl acetate mats were preferred during winter, while solid manure and wood shavings assured more comfort than inorganic floorings during summer period. Results obtained suggest that the resting comfort of cubicle floorings may be evaluated also in relation to environmental microclimatic patterns

Key words: Dairy cow, Season, Free stall flooring material, Behavior.

INTRODUCTION – Several studies have been conducted on productive (Srikandakumar and Johnson, 2004), reproductive (Oseni *et al.*, 2003) and behavioural (Tapki and Sahin, 2006) modifications in heat stressed dairy cows. Less investigated is the influence of cubicle flooring materials on the comfort of dairy cows in warm climate conditions. Manninen *et al.* (2002) revealed a greater preference of straw and soft rubber than of sand, both in winter and in summer. In winter, cows preferred straw cubicle flooring than plastic material. This trial, conducted in Finland, underlines the role of cubicle flooring materials in winter, but is poorly representative of temperate and sub-tropical areas, where in summer the thermo-hygrometric index easily exceeds dairy cow's thermo-neutrality limits (Kadzere *et al.*, 2002). In those environmental conditions, the cubicle flooring material may assume additional values, such as heat dissipation through contact (De Palo *et al.*, 2006). The aim of the present work is the evaluation of the preference of dairy cows for different cubicle flooring materials in summer and winter climate typical of Mediterranean Basin and sub-tropical areas.

MATERIAL AND METHODS – The test was conducted on 16 primiparous cows of the Italian Frisian breed. Eight animals calved in April 2004 and were used for summer trial. The other eight cows calved in October 2004, for the winter trial. All the animals, up to calving, were stabled on strawyard bedding. Straight after calving the cows were allocated to experimental pens where they spent three months in order to adapt to the experimental conditions (pre-experimental period). The pen in which the animals were held was provided with 32 cubicles arranged in two ranks placed head to head. The cubicle base surface was in concrete. The two ranks of cubicles were separated only by two steel tubes, allowing the presence of a shared lunging space. Four types of material were used for the cubicle floors: polyethylene vinyl acetate (EVA) and coated polypropylene vinyl acetate (PVA) mats, wood shavings and solid manure obtained from a separator. The four types of cubicle were alternated because, as a species, cows have a hierarchical organization that can involve particular social patterns (Tucker *et al.*, 2004). The pen was equipped with closed circuit television cameras with night vision, linked to video recorders. The first 72 hours of uninterrupted recording started at 8:00 a.m. in 4th August 2004. After 20 days, recordings were repeated in the same way (starting at 8:00 a.m. in 24th August 2004 and lasting after 72 hours). Winter recordings began the 4th January 2005 for 72 hours and were repeated in 24th January for another 72 hours. Data were obtained from continuous recordings by recording the time when a cow entered and left cubicle. The following data were obtained from the examination of the recordings: bed occupation time of the cubicles per day (BO), average duration of each lying down per day (L), duration of periods spent standing on the cubicle, with 2 or 4 feet per day (respectively S2F and S4F), number of interrupted attempts at lying down per hour (NIL), mean duration of a single lying bout in minutes (DLB), time spent ruminating in the cubicle, during lying down per day (R/L), agonistic interactions between animals per

hour (AI), duration of the feeding and rumination periods per day (respectively F and R). From the data obtained it was also possible to calculate at five-minute intervals two indexes which are useful for the evaluation of the dairy cow's well-being (Tapki and Sahin, 2006): proportion eligible lying (PEL: number lying/number in pen not eating) and cow comfort index (CCI: number lying/number touching a cubicle surface). In addition data loggers were arranged in the pen (175-H1 Testo). These recorded the temperature and relative humidity of the environment. The data acquired were used to calculate the temperature-humidity index (THI) over each hour interval, according to the equation suggested by Srikandakumar and Johnson (2004): THI = dry bulb temperature – 0.55*(1 – relative humidity) – (dry bulb temperature – 14.4), with relative humidity expressed as decimal and temperature in degrees Celsius. In advance, Shapiro-Wilk's test (1965) was carried out and showed that the variables analyzed have a normal distribution (P = 99.34%). The THI values were used for calculating the maximum, mean and minimum values during winter and summer. The data were then, submitted to variance analysis according to GLM procedure of the SAS (1990), utilizing the following model: $y_{ijk} = \mu + MAT_i + S_j + (MAT * S)_{ij} + \varepsilon_{ijk}$, where y_{ijk}: behavioural parameters; μ: mean; MAT_i: effect of the i^{th} type of material as cubicle flooring (i=1,…,4); S_j: effect of the j^{th} season class (j=1, 2); $(MAT*S)_{ij}$: effect of the interaction between the i^{th} type of material and the j^{th} season class; ε_{ijk}: error.

RESULTS AND CONCLUSIONS – Thermo-hygrometric indexes (THI) values recorded during summer (graph 1) were higher than thermo-neutrality ranges, causing heat stress in dairy cows (Ravagnolo and Mistzal, 2002); while THI calculated during winter, was included in that range, not causing stress in animals (Kadzere et al., 2002). Cows spent more time standing with front feet on EVA mat surface in summer period than in winter ($P < 0.01$); the number of interrupted lying (NIL) on the same material was lower in winter than in summer. ($P < 0.01$). The mean duration of every lying bout (DLB) was higher in summer than in winter ($P < 0.01$). Proportion eligible lying and cow comfort index (respectively PEL and CCI) increased from summer to winter ($P < 0.05$). Those results show a better use of EVA mats in winter than summer, although this material was equally used for lying in both seasons.

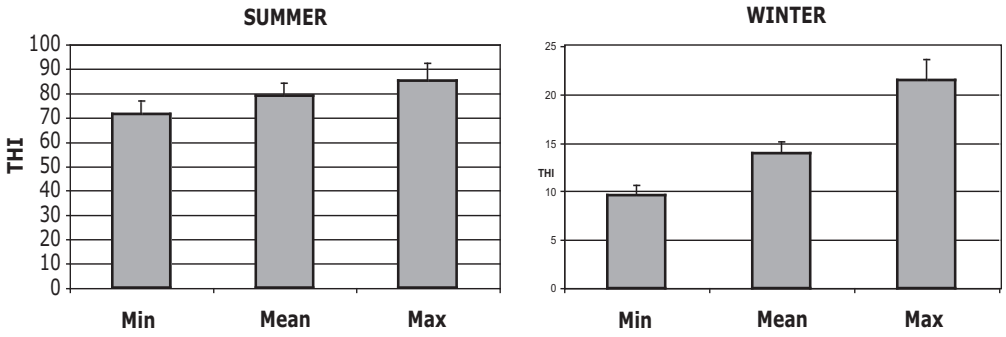
Table 1. Effect of season on duration of lying (L), bed occupation (BO), standing with four (S4F) and two (S2F) feet, number of interrupted lying down (NIL), duration of lying bouts (DLB), duration of ruminating while lying (R/L), proportion eligible lying (PEL) and cow comfort index (CCI) for each cubicle flooring material.

	E.V.A.		P.V.A.		Wood shavings		Solid manure	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
BO, %	41.97±8.29	41.93±7.87	22.36±4.22 x	33.92±4.38 y	19.59±3.85	13.12±1.75	16.08±1.93	11.03±1.69
L, %	45.74±8.90	44.06±5.46	18.00±2.87 X	35.30±3.32Y	22.14±2.03 X	11.53±1.68 Y	14.11±1.47 X	9.11±1.18 Y
S4F, %	29.30±2.53	22.63±1.97	27.52±2.61	22.27±2.47	15.96±2.60X	27.09±2.49Y	27.22±2.32	28.01±2.17
S2F, %	35.77±3.45 X	19.20±2.38 Y	45.49±4.91 X	17.93±1.37 Y	7.01±1.04 X	30.81±3.02 Y	11.72±1.05 X	32.07±3.05
R/L, %	26.4±2.6	28.5±2.7	22.5±2.4 X	26.0±2.2 Y	25.7±2.6	24.7±2.6	25.4±2.4 X	20.8±2.3 Y
NIL, n°/h	0.4±0.0 X	0.1±0.1 Y	1.1±0.1 X	0.2±0.1 Y	0.5±0.1 X	0.3±0.1 Y	0.6±0.1 X	0.2±0.1
DLB, Min	71.9±5.7 X	45.1±5.3 Y	95.4±5.8 X	58.5±5.9 Y	72.5±7.4 X	38.3±5.7 Y	73.3±8.7 X	32.5±6.9
PEL1, %	70.3±4.9 x	82.5±4.7y	29.6±4.1 X	78.1±4.9 Y	77.8±4.7 x	70.3±4.6 y	82.6±5.2 x	64.7±5.3
CCI2, %	79.7±5.1 x	95.3±5.0 y	58.8±4.6 X	94.4±5.6 Y	82.6±5.0	79.7±4.9	64.2±4.8	75.0±5.4

Different letters within line and for each material indicate statistically significant difference (x, y: P < 0.05; X, Y: P < 0.01).

Bed occupation (BO) of PVA mats floored cubicles was greater in winter than in summer ($P < 0.05$), as lying (L) ($P < 0.01$). It was observed a drop of standing time with front feet (S) from summer to winter ($P < 0.01$). The rumination during lying (R/L) on PVA mats increased in winter ($P < 0.01$). The NIL and DLB were higher on summer than winter ($P < 0.01$). PEL and CCI were under the optimum limits reported by Tapki and Sahin (2006) during summer and rose to satisfying values during winter ($P < 0.01$). So, PVA mats improved the comfort supplied to dairy cows more in winter than in summer. In winter the preference for wood shavings for lying was half what it was in summer ($P < 0.01$), while standings (S2F and S4F) on cubicle surface increased ($P < 0.01$). The NIL and DLB were lower in winter than in summer ($P < 0.01$). The PEL decreased from summer to winter ($P < 0.05$). The results clearly indicate that wood shavings provide less comfort in winter than in summer. The preference for lying (L) on solid manure cubicle flooring was reduced of 35.46% in winter than summer ($P < 0.01$). In addition, S2F increased in winter ($P < 0.01$), while R/L dropped in the same season ($P < 0.01$). NIL and DLB were lower in winter than in summer ($P < 0.01$). PEL was lower in winter than in summer ($P < 0.05$). Solid manure cubicle flooring was more comfortable in summer than in winter. The obtained results suggest that the materials employed as cubicle flooring do not assume an absolute criterion in relation to the comfort of the dairy cows, but they have a different value according to the microclimatic conditions in which they are used. In particular, in conditions of heat stress, the material on which the cow lies must perform additional functions of extreme importance, such as the dissipation of body heat, as well as sweating and transpiration.

Figure 1. Maximum, mean and minimum THI values measured during the winter and summer. trial.



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