Welfare and meat quality of beef cattle housed on two types of floors with the same space allowance

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ABSTRACT

Growth performance, behaviour, cleanliness, carcass traits and meat quality of 48 Simmental young bulls housed on slatted floor or on straw bedding with the same space allowance were compared in the study, which lasted 250 days. The animals (initial body weight = 321.2 ± 34.1 kg) were assigned to 8 balanced groups, according to their initial body weight. All the groups were reared in separate pens with a space allowance of 3 m²/head. Four pens had a concrete floor covered with a straw bedding while the other pens had a fully slatted floor made of concrete slats. All the animals received the same diet provided ad libitum.

Type of floor did not affect the bulls' daily gain, feed intake and feed efficiency. Health status of the animals was satisfactory throughout the trial and several blood indicators of chronic stress were not modified by the treatment. Behavioural observations carried out at d 10, 80, 180 and 240 showed differences only on some behaviours due to the type of floor. In particular, the straw bedding increased eating behaviour and it encouraged the simultaneous presence of more bulls at the manger. Regardless of the type of floor, the progress of the trial showed a linear increase of animals' inactivity (P<0.05) while linear decrease of bulls' lying (P<0.01), eating (P<0.001) and ruminating (P<0.01) was observed. These results can be referred to the growth of the animal body frame, which made the space allowance progressively limiting.

In the straw bedded pens, clean straw was added weekly and fully renewed every 3 weeks, but this bedding management did not allow a satisfactory cleanliness of the animals in comparison with the slatted floor. However, the worse cleanliness of the bulls on the straw did not promote their grooming activity. Young bulls were slaughtered at a final weight of 614.6 ± 14.7 kg and their carcass traits and meat quality were not affected by the treatment.

The straw bedded system cannot always be considered the cleanest solution for the housing of beef cattle and its frequent renewal must be carried out, particularly when animals are kept with a minimum space allowance. The minimal differences observed for all the parameters measured in the study between the two types of floors must be related to the adoption of the same space allowance/animal and this factor has shown to be the most critical housing parameter affecting beef cattle welfare during the fattening period.

Keywords: Beef cattle, Type of floor, Welfare, Meat quality

RIASSUNTO
BENESSERE E QUALITÀ DELLA CARNE DI VITELLONI ALLEVATI SU DUE TIPI DI PAVIMENTAZIONE A PARITÀ DI SUPERFICIE PER CAPO

Lo studio ha valutato le performance di crescita, il comportamento, lo stato di pulizia, le caratteristiche della carcassa e
la qualità della carne di 48 vitelloni Pezzati Rossi allevati, con la stessa disponibilità di spazio/capo, in box multipli con pavimentazione a grigliato o su lettiera permanente in paglia. Gli animali (peso vivo medio iniziale 321.2 ± 34.1 kg) sono stati ripartiti in 8 gruppi bilanciati sulla base del peso iniziale e allevati in box multipli per 250 giorni. Tutti i box avevano le medesime dimensioni e garantivano uno spazio/capo di 3 m$^2$; in 4 box la pavimentazione era a grigliato, mentre nei restanti era presente una lettiera in paglia. Il programma di alimentazione ha previsto la somministrazione ad libitum di una dieta preparata con il metodo unifeed a tutti i soggetti in prova.

Il tipo di pavimentazione non ha modificato l’accrescimento, il consumo alimentare e l’indice di conversione degli animali. Lo stato di salute è risultato soddisfacente in tutti i soggetti e una serie di indicatori ematici di stress cronico ha fatto rilevare valori normali e simili tra le tesi. Le osservazioni comportamentali realizzate al 10°, 80°, 180° e 240° giorno di prova hanno evidenziato delle differenze significative tra i due tipi di pavimentazione solo per alcune variabili. In particolare, la lettiera ha aumentato la frequenza dell’attività di ingestione (20.0 vs 15.9%; P<0.01), favorendo anche la contemporanea presenza di un maggiore numero di animali in mangiatoia. Nel corso della prova, i soggetti di entrambe le tesi hanno fatto rilevare un aumento lineare dell’inattività (P<0.05), mentre decubito (P<0.01), attività di ingestione (P<0.001) e di ruminazione (P<0.01) sono diminuiti progressivamente. Questi risultati sono riferibili ad un progressivo effetto limitante della superficie/capo entro box dovuto alla crescita degli animali.

Nei box con lettiera permanente, nuova paglia veniva aggiunta settimanalmente e la stessa lettiera veniva completamente rinnovata ogni 3 settimane. Questa modalità di gestione non si è rivelata in grado di garantire una adeguata pulizia del corpo degli animali rispetto a quanto osservato con il grigliato. La maggiore sporcizia degli animali non ha comunque stimolato la loro attività di auto e reciproca pulizia. Gli animali sono stati macellati ad un peso finale di 614.6 ± 14.7 kg e le caratteristiche della carcassa nonché i rilievi di qualità della carne non sono stati modificati dal tipo di pavimentazione presente nel box.

Sulla base dei risultati dello studio, la lettiera permanente non può essere sempre considerato il tipo di pavimentazione più pulito per i vitelloni ed un suo frequente rinnovo deve essere previsto in tutte le situazioni di stabulazione intensive che adottano uno spazio/capo minimo. Le limitate differenze osservate tra i due tipi di pavimentazione per le variabili considerate in questo studio, sono attribuibili essenzialmente all’adozione dello stesso spazio/capo. Proprio questo fatto sembra giocare un ruolo più determinante del tipo di pavimentazione nel condizionare lo stato di benessere dei vitelloni durante il periodo di allevamento.

Parole chiave: Bovini da carne, Tipo di pavimentazione, Benessere animale, Qualità della carne

Introduction

The Italian rearing system of beef cattle is mainly based on the fattening of young bulls under intensive rearing conditions. The main features of Italian beef farms are the high stocking rate and the loose housing of the animals in multiple pens indoors. A full concrete slatted floor is the most frequent type of housing surface adopted in these beef farms because it does not require any bedding material and it has a lower labor cost to remove slurry. Several studies had considered the effect of space availability on beef cattle welfare allowing the Scientific Committee on Animal Health and Animal Welfare of the European Union to recommend a minimum space allowance of 3 m$^2$/head for an animal expected to reach 500 kg plus 0.5 m$^2$ for each 100 kg over the 500 (EU-SCAHAW, 2001). Regarding the type of floor to be adopted in the intensive system of beef production, criticism has been raised against the slatted floor in comparison with deep bedding, particularly from the animal welfare point of view. According to the ITEB (1983), bulls reared on slatted floors have shown a higher culling rate than those on straw bedding when the same space allowance is adopted. Leg problems and lameness are the main lesions occurring on slatted floor (Murphy et al., 1987). Moreover, this type of floor has been shown to affect bulls’ behaviour by increasing abnormal positions both in standing and in lying (Wierenga, 1987) and by reducing the frequency of lying down and getting up (Andreae and Smidt, 1982).

Less clear are the effects of the two types of floors on bulls’ cleanliness and performance. Comparisons made by Andersen et al., (1991) and Lowe et al., (2001) found beef cattle housed on slatted floors to be significantly dirtier than those on straw bedding. On the contrary, Scott and by Kelly (1989) observed that straw bedding is not the cleanest housing system, particularly when the bedding is not regularly renewed.
As regards the productive performance, Hardy (1980) found better growth performance for steers reared on bedding than on slatted floors, but the comparison was made with a different space allowance (7.7 vs 2.1 m²/head, respectively). Instead, Andersen et al., (1991) reported similar performance between the two types of floors when the space allowance was the same.

Aimed at achieving a better understanding of the effect the type of floor has on beef cattle welfare and production under an intensive rearing system, the present study compared growth performance, behaviour, cleanliness, carcass traits and meat quality of Simmental young bulls reared on slatted floors or on straw bedding with the same space allowance.

Material and methods

Animals, treatments and management

A batch of 48 Simmental young bulls (average initial body weight = 321.2 ± 34.1 kg) was used in the study, which lasted 250 days, from July 2001 to March 2002. The animals were assigned to 8 balanced groups of 6 animals each according to their initial body weight. All the groups of animals were reared in separate pens within the same barn with a space allowance of 3 m²/head in accordance with the recommendations of EU-SCAHAW (2001).

Two types of floors (slatted floor vs straw bedded) were compared in a 2x2 factorial arrangement with the space at the manger (60 vs 80 cm/head) with 2 replications per factorial combination. Four pens had a concrete floor covered with straw bedding and clean straw was added weekly and fully renewed every 3 weeks. The other 4 pens, located in front of the straw bedded ones, had a self-cleaning type of floor, fully slatted made of concrete slats 12.5 cm wide with slits 3 cm wide and 100 cm long. Each pen was provided with two water tanks allowing the animals free access to the drinking water.

All the animals were fed the same diet provided ad libitum as total mixed ration in a single daily distribution at 08.30 h. Feed composition of the diet is reported in Table 1. Samples of the diet were collected monthly and analyzed for dry matter, crude protein, ether extract, and ash according to AOAC methods (1990). Analysis of neutral detergent fiber of the same samples was carried out according to Van Soest et al. (1991) and the nonfibrous carbohydrates content was calculated

Table 1. Feed composition and chemical analysis of the diet provided to the young bulls during the experiment.

| Ingredients                        | % as fed   | 76.5 |
|------------------------------------|------------|------|
| Maize silage                       |            |      |
| Dried sugar beet pulp              |            | 8.2  |
| Proteins, minerals and vitamins mix |            | 7.6  |
| Maize meal                         |            | 5.5  |
| Wheat straw                        |            | 2.2  |

Chemical composition:

|                         | %       | 47.3 ± 3.3 |
|-------------------------|---------|------------|
| Dry matter              |         |            |
| Crude protein           | DM      | 11.8 ± 0.6 |
| Ether extract           |         | 2.6 ± 0.2  |
| Ash                     |         | 5.6 ± 0.7  |
| Neutral detergent fiber |         | 39.3 ± 1.4 |
| Nonfibrous carbohydrates content | | 29.5 ± 3.1 |
| Unité Fouragère Viande  |/kg DM   | 0.85 ± 0.4 |

(1) Premix supplied (on DM basis): 38% of crude protein, 2% of fat, 15,000 U of vitamin A, 1600 U of vitamin D₃, 150 mg of vitamin E/kg, 60 mg Zn/kg, 60 mg Mn/kg, 60 mg Fe/kg, 12 mg Cu/kg, 2 mg Cb/kg, 0.05 mg Se/kg.
as proposed by Mertens (1992). The energy density of the diet was calculated by using the Unité Fouragère Viande values given by INRA (1988) for all the ingredients.

**Animals’ growth performance and cleanliness**
Average daily gain was calculated by weighting the animals at the beginning and at the end of the experimental period. Twice a week the amount of diet delivered in each pen and the residue recovered after 24h were measured to estimate feed intake of each pen. Pen feed efficiency was calculated by dividing the average intake for the average daily gain.

Individual body cleanliness evaluation was carried out at d 80, 180 and 240 by a visual evaluation of the dirty area of the ventral part of the body and of the hind legs. Adapting the procedure proposed by Cozzi et al. (2002) for the veal calf, cleanliness was scored using a 3-point scale: 1 (clean) = dirty area <500 cm²; 2 (dirty) = 500< dirty area <800 cm²; 3 (very dirty) = dirty area > 800 cm².

**Animals’ health status and behaviour**
The bulls’ health status was monitored daily and any pathological event and medical treatment was recorded during the trial. Blood samples were taken from all the animals at the beginning, at d 81, 181 and at the end of the experiment by jugular venous puncture before the feed delivery using vacutainer tubes (Becton Dickinson Inson, Meylan Cedex, France). White blood cells, neutrophils, lymphocytes and hematocrit were measured on samples collected with KEDTA using an automatic cell counter, Cell-Dyn 3500R (Abbott, Abbott Park, IL, USA). Heparinized tubes were used to take the samples for the determination of total plasma proteins concentration which was carried out as described by Koller (1984).

Cattle behaviour was evaluated in four following observation sessions at d 10, 80, 180 and 240 of the experimental period. Direct observations of the animals were carried out by trained personnel using a scan-sampling technique (Martin and Bateson, 1993) with a 5 min interval between scans. Every observation session was carried out for 10 hours starting in the morning, 1 hour before the feed delivery. At each scan, the number of animals lying, inactive, eating at the manger, ruminating, sniffing-licking and grooming (allo- and auto-) were recorded per pen along with the number of bulls standing at the manger at the same time. The number of conflicts (fights and mounting activities) observed during the same observation period in each pen was also recorded with the behaviour sampling technique (Martin and Bateson, 1993).

**Slaughter measurements and meat quality evaluation**
Animals were slaughtered at the same day and their carcasses were weighed to calculate individual dressing percentage and then graded for conformation and fatness according to the European grading scheme (OPIVAL, 1984). A joint sample of the longissimus thoracis muscle was excised from the 5th to the 9th rib of each right half carcass 48 hours after the slaughter. The samples were vacuum packaged and stored at 4°C in a chilling room for an ageing period of 7 d. Meat chemical analysis considered pH, dry matter, ash and intramuscular fat content, measured as ether extract (AOAC, 1990). Meat color was measured with a CR 100 Chromameter (Minolta Camera, Osaka, J) equipped with C illuminant on samples exposed for 1 h to air at 2°C (Boccard et al., 1981). Color data were expressed according to the Hunter-Lab system. Weight cooking losses were determined on 2.5 cm-thick steaks heated in a water bath at 75°C for 50 min and then cooled in running tap water for at least 40 min (Boccard et al., 1981). The instrumental measurement of meat tenderness was carried out using a Warner-Bratzler shear force meter (Instron Ltd., High Wycombe, UK) on cylindrical core samples of cooked meat 1.25 cm in diameter (Joseph, 1979).

**Statistical analysis**
A linear model which considered the effects of type of floor, space at the manger and their interaction was used to process data of growth and slaughter performance, and meat quality. The ANOVA was performed within PROC-GLM (SAS, 1989) and the pen was the experimental unit for feed intake and feed efficiency. Blood data were
analyzed with the same statistical model using the repeated measurements option. Kruskal-Wallis test within PROC NPAR1WAY (SAS, 1989) was performed for the analysis of cleanliness and carcass SEUROP and fatness scores.

The number of animals observed per each scan to perform a given behaviour was divided by the total number of animals housed in the pen and behavioural data from scan sampling were then transformed into frequencies. All the behavioural variables were then tested for their normal distribution with the PROC UNIVARIATE of SAS (1989) and they showed values of W>0.80 for the Shapiro-Wilk test. Therefore, their distribution was considered normal and they were submitted to ANOVA within PROC GLM (SAS, 1989). The model used the repeated measurements option and time effect was tested considering the day of observation as repetition.

**Results**

No significant interaction among the two main factors considered in the study (type of floor and space at the manger) was observed in the statistical analysis, allowing a separate discussion of their results. The results obtained for the space at the manger effect are discussed in a separate article.

**Figure 1.** Cleanliness evaluation (least squares means ± SED) of hind legs (A) and ventral part (B) of the body of fattening young bulls housed in multiple pens with different types of floors recorded at d 80, 180, 240 of the trial. Cleanliness score: 1=clean, 2=dirty and 3=very dirty. *** Means are significantly different for P< 0.001.

| Table 2. Growth performance of fattening young bulls housed in multiple pens with different types of floors. |
|-------------------------------------------------|-------------------------------------------------|------------------|
| Live weight:                                     | Type of floor                                  | SED1             |
| - initial kg                                     | Slatted                                        | Straw bedded     |
| - final                                          | 321.3                                          | 321.1            |
| Average daily gain g/d                          | 613.3                                          | 615.9            |
| Dry matter intake kg/d                          | 1161                                           | 1172             |
| Feed efficiency                                 | 9.01                                           | 8.90             |
|                                                 | 7.79                                           | 7.62             |

1 Standard error of the difference.
Animals’ growth performance, cleanliness, health status and behaviour

The different types of floor did not affect bulls’ daily gain resulting in an average final live weight of 615 kg (Table 2). Also dry matter intake and feed efficiency were not modified by the treatment. The cleanliness evaluation carried out at following times of the experimental period showed bulls housed on straw bedding being always dirtier than those on slatted floor (Figure 1). This result was observed either in the ventral part of the body or in the hind legs.

The health status of all the animals was satisfactory throughout the study and no specific pathologies or medical treatments were recorded. Repeated blood samples taken during the progress of the trial showed no differences for the measured chronic stress indicators in relation to the different type of floor (Table 3). The behavioural observations carried out during the trial showed a progressive decrease of the lying (P<0.01), eating (P<0.001) and ruminating (P<0.01) for both types of floors according to a significant linear time effect (Figure 2). On the contrary, a linear increase of animals’ inactivity was observed (P<0.05) during the trial regardless of the treatment. The frequency of the lying behaviour was lower for the bulls kept on slatted floor only at the last observation session (P<0.05), whereas the repeated measurements of the eating behaviour showed a higher frequency for bulls reared on straw bedding than on slatted floors (20.0 vs 15.9%; P<0.01). The frequency of sniffing-licking and grooming behaviours were not modified by either type of floor or time (Figure 2). Aggressive encounters and mountings were not affected by the different type of floor (Figure 3), while they showed a positive linear time effect (P<0.01). The most frequent eating conditions recorded in the pen during the trial showed a single or a couple of bulls standing at the manger at the same time (Figure 4). However, the repeated measurements recorded for these two conditions revealed a similar frequency between the two types of floors (single bull: 29.6 vs 31.2%; P = 0.30; couple of bulls: 27.7 vs 24.5%; P = 0.22 for straw bedded vs slatted floor). On the contrary, in the straw bedded pens the repeated measurements showed a significant increase of the frequency of 3 (19.3 vs 12.7%; P<0.05) or 5-6 animals (3.8 vs 1.6%; P<0.05) standing at manger at the same time.

Slaughter measurements and meat quality evaluation

At the slaughterhouse, there were no differences for carcass weight and dressing percentage due to the type of floor (Table 4). Also carcass conformation and fatness scores were not modified by the treatment. Meat chemical composition and quality traits measured on longissimus thoracis muscle were not affected by the different type of floors compared in the trial (Table 4).

Discussion

The present study was carried out comparing the two types of floors with the same space allowance of 3m² per animal within the pen. Under this housing condition there was no treatment effect on feed intake and growth performance, supporting the previous findings of Andersen et al. (1991).

Table 3. Hematological values of fattening young bulls housed in multiple pens with different types of floors.

|                         | Slatted | Straw bedded | SED¹ |
|-------------------------|---------|--------------|------|
| White blood cells       | 10³ cells/µl | 8.24         | 7.95 | 1.50 |
| Neutrophils             | "       | 3.31         | 3.02 | 0.77 |
| Lymphocytes             | "       | 3.88         | 4.02 | 0.90 |
| Neutrophils: Lymphocytes ratio | %     | 0.90         | 0.79 | 0.26 |
| Hematocrit              | %       | 36.31        | 35.59 | 2.62 |
| Total protein           | g/dl    | 75.18        | 73.27 | 3.77 |

¹ Standard error of the difference.
In recent years, body cleanliness, besides being an important trait for the evaluation of beef cattle welfare, has also been related to the food safety after the occurrence of meat contamination episodes with *Escherichia coli* 0157:H7. Actually in the United Kingdom, a cleanliness assessment is mandatory in cattle prior to slaughter and animals can be rejected at the abattoirs if their score is above a certain threshold of dirtiness (MAFF, 1998). In this regard, the results of the present research showed that straw bedded floor was not able to allow satisfactory cleanliness of the animals in comparison to the slatted one. It must be pointed out that the schedule for the maintenance of the straw bedding adopted in the research resembled the ordinary procedures used by many commercial beef farms in Italy. Therefore, supporting the previous findings of Scott and Kelly (1989), the straw bedded system cannot always be considered the cleanest solution for the housing of beef cattle, in particular when animals are kept with a minimum space allowance as used in the intensive rearing systems.

**Figure 2.** Development of the frequencies of lying, inactive, eating, ruminating, sniffing-licking and grooming (least squares means ± SED) in fattening young bulls housed in multiple pens with different types of floors recorded at d 10, 80, 180, 240 of the trial.

** means are significantly different for P< 0.01.

* means are significantly different for P< 0.05.
Health status is an important welfare indicator in farm animals and a fundamental target to be reached in order to allow a satisfactory quality of life during their husbandry. In this study, all the physiological stress indicators monitored fell into the normal range for growing cattle (Jain, 1986) and the health status of the young bulls was good throughout the experimental period. No specific medical treatments were required for either type of floors and this result is in contrast with a previous study carried out by ITEB (1983) with French beef breeds where beef cattle reared on slatted floors showed a percentage of treatments for leg problems almost double that of animals housed on straw. The disagreement between the two studies may arise from the different breed used in the experiments. The Simmental bulls used in the present study are a dual purpose breed with better adaptability to the intensive rearing system than the French beef breeds specialized for meat production considered by ITEB (1983). Moreover, the lack of any leg problems observed in this trial may also be explained by the moderate energy density of the diet which certainly prevented the occurrence of metabolic acidosis, one of the main causes of clinical lameness in young fattening cattle (Volker et al., 2000).

The progressive growth of the animal body frame during the experiment led to reduced lying. However, this decrease was particularly marked for the young bulls housed on slatted floor indicating that when space allowance becomes limiting, animals may have problems in performing normal lying down behaviour. Space allowance was set to 3 m$^2$/head during the entire study but the progressive decrease in lying seems to support the recommendation of the EU-SCAHAW (2001) which suggests a minimum space allowance of 3.5 m$^2$/head for the welfare of finishing cattle expected to reach a final weight of 600 kg. A consequence of the reduced lying was the increased inactivity of the bulls which, according to Wiepkema et al. (1983) can be considered as a redirected behavioural substitute for lying down.

Table 4. Slaughter performance and meat quality evaluation of fattening young bulls housed in multiple pens with different types of floors.

| Carcass traits: | Type of floor | SED$^\text{1}$ |
|-----------------|---------------|--------------|
|                  | Slatted       | Straw bedded |          |
| weight (kg)      | 352           | 355.3        | 32.4     |
| dressing percentage (%) | 57.4   | 57.7         | 1.7      |
| SEUROP score$^{(2)}$ | 3.96 ± 0.21 | 3.96 ± 0.20  |          |
| fatness score$^{(3)}$ | 2.39 ± 0.50  | 2.25 ± 0.44  |          |

| Meat quality traits: | Type of floor | SED$^\text{1}$ |
|----------------------|---------------|--------------|
|                      | Slatted       | Straw bedded |          |
| pH                   | 5.51          | 5.51         | 0.03     |
| dry matter (%)       | 28.4          | 28.2         | 2.95     |
| ash                  | 4.2           | 4.1          | 0.99     |
| ether extract (%)    | 15.0          | 14.3         | 4.66     |
| lightness L          | 39.5          | 39.5         | 2.06     |
| redness a            | 24.0          | 23.2         | 1.37     |
| yellowness b         | 12.2          | 11.6         | 1.1      |
| cooking weight losses (%) | 29.7     | 30.1         | 2.23     |
| shear force kg/cm$^2$ | 4.6           | 4.5          | 0.64     |

$^1$ Standard error of the difference.
$^{(2)}$ 1 = poor to 5 = excellent.
$^{(3)}$ 1 = minimum to 5 = maximum.
The straw bedding affected the eating behaviour of the animals either increasing its frequency during the 10 hours of observation period or encouraging the simultaneous presence of more bulls at the manger. Since cattle kept as a herd usually synchronize their feeding time, even when feed is continuously available (Arnold and Dudzinski, 1978), the latter result seems to indicate that in a confined environment the straw bedding would better meet the natural social behaviour of cattle during the feeding time.

The rumination behaviour was not affected by the type of floor and its progressive reduction observed during the study can be related to the decreased lying time, as cattle prefer to ruminate when lying down (Fraser and Broom, 1990). Despite of the worse cleanliness score of the bulls housed on the straw, their grooming activity was similar to the one recorded for the animals on slatted floor. Therefore, from the behavioural point of view, this finding suggests that in beef cattle grooming activity is not promoted by an increase in the body dirtiness. Instead, the performance of this behaviour seems dependent on stress factors like ectoparasites infestation (Weeks et al., 1995), or the deprivation of movement in tethered cattle (Andrighetto et al., 1999). Sniffing-licking activity was similar between the two types of floors showing that the bedding material did not act as environmental enrichment for the bulls reared under intensive systems.

Even the number of conflicts among pen-mates was not affected by the treatment and its increase observed in the last two observation sessions seems to be related to the growth of the bulls’ body frame which led to a progressive restriction of the space allowance in the pen.

Carcass traits and meat quality were not affected by the different types of floors compared in the study confirming the previous result of Lowe et al. (2001) on finishing steers. These results show the marginal role of the housing structures on determining carcass and meat quality of young bulls. A further support to this finding comes from Andersen et al. (1997) who did not observe any difference in slaughter performance and meat quality due to the floor space allowance. It is likely that the effect of the housing structures on meat quality traits becomes appreciable only when they represent a real source of chronic stress for the animals.

**Conclusions**

Simmental young bulls reared on slatted floors or on straw bedding under an intensive rearing system showed similar growth performance, health status, carcass traits and meat quality. It must be pointed out that the absence of differences
between the two types of floors was obtained with the adoption of the same space allowance per animal and this factor has been shown to be the most critical housing parameter affecting cattle welfare during the fattening period.

The different types of floors did not represent a source of chronic stress for the animals and it affected only some behavioural traits. The straw bedding increased the frequency of eating behaviour and it encouraged the simultaneous presence of more bulls at the manger. On the other hand, the type of floor had a strong effect on bulls’ cleanliness as the animals housed on straw were always dirtier than those on slatted floors. Therefore, the straw bedded system cannot always be considered the cleanest solution for the housing of beef cattle, and its frequent renewal must be suggested, particularly when animals are kept with a minimum space allowance as in the intensive rearing systems.

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Figure 4. Frequency of number of animals standing at the manger at the same time (least squares means ± SED) observed at d 10, 80, 180 and 240 in fattening young bulls housed in multiple pens with different types of floors.
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