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Effect of floor type on carcass and meat quality of intensively reared Simmental bulls

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Summary

*This study investigated the effect of floor type on carcass and meat quality of intensively reared Simmental bulls. The animals were housed in common pens on a concrete slatted floor (SF group, n=15) or a full floor with straw bedding (FF group, n=15). The space allowance in SF and FF groups was 4.7 and 6.0 m2 per bull, respectively. Diet in both groups was given as total mixture ration composed from maize grain and stalk silage, super-concentrate and hay (average composition per kg: 599 g of DM, 76 g of crude protein and 4.59 MJ of ME as feed). After the slaughter at similar age (494±17 days) and final body weight (597.5±56.4 kg), the carcass traits (hot carcass weight, dressing-out %, EUROP classes distribution) were determined. Meat pH and colour (CIE L*a*b*) was measured at the Longissimus thoracis muscle 24 h post mortem at the level of the 8th rib. The same muscle was sampled for chemical analysis of dry matter, protein, ash, total iron and intramuscular fat content. Data were analyzed by Student's t-test. In general, there was no significant effect (P>0.05) of floor type on any of carcass or meat quality traits and chemical composition, except for meat pH24 value and ash content, which in SF group shoved respectively lower and higher results than in the FF group: 5.61 vs. 5.68 (P=0.0168) and 10.53 vs. 10.36 g/kg (P=0.0466).*

Keywords: *beef cattle, Simmental breed, type of floor, carcass traits, meat quality*

Introduction

In intensive beef farming in Croatia, bulls are mainly kept indoors in common pens on concrete slatted floor or full floor with straw bedding. At both floor types the animals are usually housed loosely and at high stocking rates. The housing of animals in pens with a fully slatted floor has the advantages because it does not need any bedding material and a lower labour input is required to remove slurry than in a solid floor system (Lowe *et al.*, 2001; Cozzi *et al.*, 2005). However, the slatted floors are less favourable from the animal welfare point of view, as they are often too slippery and hence connected with higher culling rates due to the more frequent locomotion problems, such as leg fractures and lameness (Cerchiaro *et al.*, 2005; Schulze Westerath *et al.*, 2007). Moreover, significant behavioural alternations of bulls, both in lying and standing behaviour, are more often noted in pens with slatted floor than in pens with a bedded lying area (Absmanner *et al.*, 2009). With regard to influence of floor type (slatted vs. bedding) on fattening performances and carcass and meat quality traits, the previous works reported less clear effects, particularly when the space allowance of bulls is similar (Gottardo *et al.*, 2003). In present work, the effect of floor type on carcass and meat quality traits was investigated on a sample of Simmental bulls reared under intensive beef producing system in Croatia.

Material and methods

Animals, housing and diets

The investigation was conducted in 2008 on 30 Simmental bulls produced under an intensive rearing system on two commercial beef farms with a different type of animals' housing: a) at full concrete floor with straw bedding (Farm A, FF group, n=15) and b) at fully slatted concrete floor (Farm B, SF group, n=15). The FF bulls were kept loosely at common pen in the barn with closed walls on three sides and an open section toward the outdoor feeding corridor. The pen box had a length of 6.3 m at the lying area and 2.7 m at excrementary corridor, with a width of 10 m. The lying area in relation to the excrementary corridor is lower by 50 cm. The average space allowance was 6 m^2 per bull. The utilization of straw for floor bedding was around 5-6 kg per bull daily. The dirty corridor is cleaned 2 to 3 times a week, while the lying area was not cleaned during fattening. The SF bulls were housed inside the barn on a fully slatted concrete floor (15.5 cm width of beams, with the distance between beams of 35 mm). The animals were also kept loosely in a common pen with the dimensions 7x10 m. The av-

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erage space allowance in SF group was 4.7 m^2 per bull. The fattening and feeding technique were similar in both FF and SF groups; given that both investigated beef farms are operated under the same management system (*Belje d.d., AGROKOR*). In brief, bulls are fed with diets provided as total mixture ration (TMR) consisted of high moisture corn, corn silage, hay, and protein rich supplement (34 % of crude protein) based on soybean meal and rapeseed meal with a mineral and vitamin additive (30 000 U of vitamin A, 3 300 U of vitamin D3, 120 mg of vitamin E/kg and 37.5 mg Cu/kg of DM). The TMR was given in a single daily distribution at morning (average composition per kg: 599 g of DM, 76 g of crude protein and 4.59 MJ of ME as feed). The final age and live weight (mean ± standard deviation) was 491.2 ± 17.7 days and 596.7 ± 54.4 kg for FF bulls, and 495.8 ± 17.5 d and 598.3 ± 60.0 kg for SF bulls.

Carcass and meat quality traits

All animals were slaughtered on the same day at the commercial slaughterhouse (PIK Vrbovec) using the standard procedure and in accordance with established regulations (Anon., 2004 and 2006). The transport distance from farm to slaughterhouse was around 10 km for the farm A and around 80 km for the farm B. The dressing-out percentage (%) was calculated with the formulae: (hot carcass weight / live weight before slaughter) x 100. The carcass classification according to the EUROP system was performed on hot carcasses by authorized classifier (*Croatiakontrola d.o.o.*). The classification included the evaluation of carcass conformation (expressed as E-excellent, U-very good, R-good, O-fair or P-poor) and carcass fatness (fat cover expressed as 1-very low fat, 2-low fat, 3-average fat, 4-high fat or 5-very high fat). The pH value of *m.longissimus thoracis* was measured on the right side of carcass at 8th rib level by TESTO 230 pH meter (TESTO, Germany) with the penetration electrode (type 13) 24 hours (pH_{24}) *post mortem*. Meat colour was measured 24 hours *post mortem* by transferable Chroma-meter MINOLTA CR 410 (measurement area Æ 50 mm, illuminant D65, Konica Minolta, Japan) using the system CIE *L*a*b** (CIE, 1976). The measurements were taken on fresh cut surface of *m.longissimus thoracis* at the level of 8th rib after approximately 10 minutes of blooming time. The same muscle was sampled and stored frozen (-20 °C) until analyses of chemical composition.

Table 1 **Descriptive statistic for carcass traits of Simmental bulls kept on bedded full floor (FF) or slatted floor (SF)**

Floor type / carcass traits	Min.	Max.	Mean	SD	CV (%)
FF (n=15)					
Age (days)	470	527	491.2	17.69	3.60
Final weight (kg)	510	715	596.67	54.60	9.15
Carcass weight (kg)	303	431	357.14	33.59	9.41
Dressing out (%)	57.50	61.45	59.41	1.09	1.84
SF (n=15)					
Age (days)	470	531	495.8	17.45	3.52
Final weight (kg)	495	700	598.33	59.96	10.02
Carcass weight (kg)	300	421	358.00	38.58	10.78
Dressing-out (%)	56.13	61.86	59.82	1.69	2.83

Min. – minimum; Max. – maximum; SD – standard deviation; CV – coefficient of variation

Table 2 **Comparison of carcass traits of Simmental bulls kept on bedded full floor (FF) or slatted floor (SF)**

Carcass traits	Floor type		*P*-value
	FF (n=15)	SF (n=15)	
Age (days)	491.2 ± 4.57	495.8 ± 4.51	0.4793
Final weight (kg)	596.67 ± 14.01	598.33 ± 15.48	0.9371
Carcass weight (kg)	357.14 ± 8.98	358.00 ± 9.96	0.9497
Dressing-out (%)	59.41 ± 0.29	59.82 ± 0.44	0.4463

Mean ± standard error; Student t-test (two-sided)

Table 3 **Descriptive statistic for meat quality (*m.longissimus thoracis*) traits of Simmental beef bulls kept on bedded full floor (FF) or slatted floor (SF)**

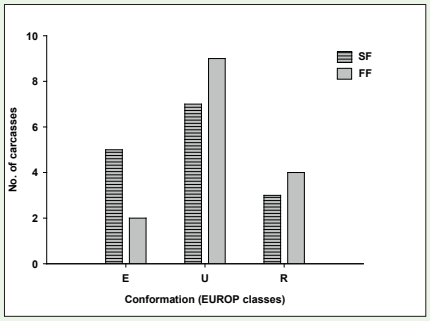
Floor type / meat quality traits	Min.	Max.	Mean	SD	CV (%)
FF (n=15)					
pH 24	5.56	5.75	5.68	0.05	0.93
Brightness *L**	36.99	41.64	39.57	1.62	4.08
Redness *a**	22.19	26.68	23.96	1.18	4.91
Yellowness *b**	6.69	11.43	8.94	1.21	13.59
Dry matter (g/kg)	243.20	271.10	253.62	9.86	3.89
Protein (g/kg)	210	228.50	220.50	5.41	2.45
Intramuscular fat (g/kg)	16.00	50.20	25.11	10.14	40.38
Ash (g/kg)	10.10	10.90	10.36	0.20	1.92
Fe (mg/kg)	15.20	22.30	17.70	1.84	10.40
SF (n=15)					
pH 24	5.52	5.87	5.61	0.09	1.54
Brightness *L**	37.96	44.24	40.47	1.84	4.53
Redness *a**	21.39	25.75	24.31	1.20	4.92
Yellowness *b**	7.26	11.55	9.67	1.13	11.64
Dry matter (g/kg)	242.30	268.40	254.87	7.83	3.07
Protein (g/kg)	202.20	236.20	221.46	9.03	4.08
Intramuscular fat (g/kg)	10.90	39.50	25.87	8.53	32.96
Ash (g/kg)	10.20	11.00	10.53	0.24	2.26
Fe (mg/kg)	11.30	23.30	18.15	3.05	16.81

Min. – minimum; Max. – maximum; SD – standard deviation; CV – coefficient of variation

Table 4 **Comparison of meat quality (*m.longissimus thoracis*) traits of Simmental beef bulls kept on bedded full floor (FF) or slatted floor (SF)**

Meat quality	Floor type		*P*-value
	FF (n=15)	SF (n=15)	
pH 24	5.68 ± 0.01	5.61 ± 0.02	0.0168
Brightness *L**	39.58 ± 0.42	40.47 ± 0.47	0.1678
Redness *a**	23.96 ± 0.30	24.31 ± 0.31	0.4242
Yellowness *b**	8.94 ± 0.31	9.67 ± 0.29	0.0983
Dry matter (g/kg)	253.62 ± 2.55	254.87 ± 2.02	0.7028
Protein (g/kg)	220.50 ± 1.40	221.46 ± 2.33	0.7265
Intramuscular fat (g/kg)	25.11 ± 2.62	25.87 ± 2.20	0.8258
Ash (g/kg)	10.36 ± 0.05	10.53 ± 0.06	0.0466
Fe (mg/kg)	17.70 ± 0.48	18.15 ± 0.79	0.6261

Mean ± standard error; Student t-test (two-sided)



Graph 1 **Distribution of carcasses within EUROP conformation classes**
(FF – full floor, SF – slatted floor)

Chemical analysis

The moisture, ash, protein and fat content were determined by standard methods for meat and meat products group (Anon., 1997, 1998, 1978 and 2001, respectively). The total iron (Fe) was determined by atomic absorption spectrophotometric method.

Data analysis

For all variables the descriptive statistic is calculated. Group means were compared by Student's t – test using PROC TTEST procedure, while the differences among proportions of EUROP classes were analysed by Chi-square test using PROC FREQ procedure and Fisher's exact test option of SAS (SAS, 2002).

Results and discussion

The descriptive statistics and comparison of carcass traits of FF and SF bulls are given in Tables 1 and 2, respectively.

All carcasses were classified within EUROP conformation classes E, U and R with the following distribution: 2, 9 and 4 in FF group, and 5, 7 and 3 in SF group, respectively (Graph 1). The proportions of classes did not differ significantly among the groups (*P*=0.6160, Fisher's exact test). Considering the degree of fatness, the majority of carcasses were graded as 3, except of 13.3 % and 6.7 % of carcasses in FF group, which received a rating 4 and 2, respectively (data not shown).

The descriptive statistics and comparison of meat quality traits of FF and SF bulls are given in Table 3 and 4, respectively.

From the results presented in Table 1 and 3, a general homogeneity of analyzed carcass and meat quality variables could be seen, except for meat colour *b**, Fe content and, particularly intramuscular fat content with established higher degrees of variation. The average values of meat pH24 in present study are in a good agreement with previously reported results by Marenčić *et al.* (2012) for Simmental bulls of similar age and carcass weight, while the present meat colour parameters *L**, *a** and *b** are generally lower compared with the above research, i.e. we found slightly darker and less red meat. The chemical composition of longissimus muscle reported here is comparable with the results for Simmental bulls aged about 420 days given by Štoković *et al.* (2009) in terms of dry matter, protein and ash content, but lower in terms of

the most variable component – intramuscular fat. However, a better parallel regarding age/weight-muscle composition pattern could be established with the data of Bureš *et al.* (2006), who reported a very similar muscle composition, including the intramuscular fat content in Simmental bulls aged 508 days and weighted live and slaughtered 632 kg and 364 kg respectively. Compared with yearling Simmental "baby-beef" bulls (Karolyi *et al.*, 2011) the average intramuscular fat content found in this study was expectedly higher, roughly twofold. The average content of Fe was within the ranges reported for beef in literature (Schönfeldt and Hall, 2011).

Considering the effects of floor type on investigated variables, the results in Graph 1 and Table 2 indicated that FF and SF bulls did not differ ($P>0.05$) in terms of final and carcass weight, dressing-out percentage and EUROP classification. Regarding the meat quality traits (Table 4), there was a small but statistically significant difference in meat pH24 value, which in FF group showed higher result than in SF group (5.68 vs. 5.61, $P=0.0168$). There was no influence ($P>0.05$) of floor type on meat colour parameters L^* and a^*, while parameter b^* tended ($P<0.1$) to be higher in SF bulls. The chemical composition of meat was also similar ($P>0.05$) between groups, except for ash content, which was slightly higher in SF than in FF animals (10.53 vs. 10.36 g/kg, $P=0.0466$). However, the total iron content did not differ ($P>0.05$) between groups. The present results on carcass traits and meat quality are in a good concordance with previous studies where the lack of influence of floor type (bedding vs. slatted) on carcass and meat quality traits was reported in young bulls with the same space allowance (Gottardo *et al.*, 2003) and finishing steers (Lowe *et al*, 2001). It is well known that the rate and extent of *post mortem* glycolysis depends on the level of glycogen in the muscle of animal before death (Gregory, 2003). For example, if glycogen in muscles was depleted due to exhausting of animals prior to slaughtering (transportation, handling, fighting, etc.) the low glycogen content will result in higher ultimate meat pH (Aaslyng, 2002). Hence, with regard to meat pH, which in this study showed a small but significant group effect, it could be supposed that the observed differences are mainly due to pre-slaughter handling, including the duration of animal transportation and/or lairage time, and less due to floor type effect. Anyway, the observed differences in pH between the groups were small, with values generally within the range of normal *post mortem* glycolysis for beef. It is also known from the literature that higher myoglobin levels are found in the muscles of more active compared with sedentary animals (Warriss, 2000). As slatted floors generally may cause more muscle tension and animal activity compared with deep bedding, it could be supposed that SF bulls might have darker meat colour with higher iron content than FF bulls. However, such assumptions were not supported by present results.

Conclusions

Simmental bulls of comparable age/weight reared on slatted or full floor with straw bedding under an intensive beef farming system showed in present study a similar carcass and meat quality traits. These results support the previous findings that floor type has a minor influence on carcass and meat quality of intensively reared bulls, particularly when space allowance per head is comparable. However, in order to further confirm the results of present study, the research should be repeated on a larger number of animals and in more controlled experimental conditions.

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Einfluss der Bodenart auf Eigenschaften des Rumpfes und Fleischqualität der Simmentaler Fleckviehstiere aus intensiver Zucht

Zusammenfassung

*In dieser Arbeit wurde der Einfluss der Bodenart auf Eigenschaften und Fleischqualität der Simmentaler Fleckviehstiere aus intensivem System der Herstellung von Rindfleisch in Republik Kroatien untersucht. Während der Mast wurden die Tiere in gemeinsamen Boxen auf gitterförmigem Zementboden (RP Gruppe, n=15) oder auf vollem Boden mit Strohstreu (PP Gruppe n=15) gehalten. Die durchschnittliche Bodenfläche pro Stier betrug 4.7 m2 in RP Gruppe und 6.0 m2 in PP Gruppe. Die Fütterung erfolgte in Form von kompletten gemischten Portionen, zusammengesetzt aus Ensilage der Maiskörner und der ganzen Stiele, Superkonzentrat und Heu (durchschnittliche Zusammensetzung pro kg: 599 gof ST, 76 g of SP und 4.59 MJ of ME). Die Stiere wurden im ähnlichen Alter (494 ± 17 Tage) und in ähnlicher körperlicher Endmasse (597±56,4 kg) geschlachtet und es wurden die Eigenschaften des Rumpfes bestimmt (Schlachtmasse warm, Schlachtrandman %, EUROP Klassifikation der Rümpfe). Farbe (CIE L *a*b*) und pH des Fleisches wurden auf der Muskel Longissimus thoracis 24 Stunden post mortem in der Ebene der 8. Rippe gemessen. Dieselbe Muskel wurde zur Musterprobe für chemische Analyse des Gehaltes von Trockensubstanz, Proteine, Asche, Gesamteisen und intramuskulärem Fett genommen. Die Angaben wurden mittels Student-t-Test verarbeitet. Generell gesehen, es wurde kein bedeutender Einfluss ($P>0.05$) von Art des Bodens auf irgendwelche der analysierten Eigenshaften des Rumpfes oder auf Qualität und Zusammensetzung des Fleisches festgestellt, außer für pH24 und Aschegehalt, deren Werte niedriger bzw. höher bei RP als bei PP Gruppe waren: 5,61 gegen 5,68 ($P=0.0168$), bzw. 10,53 gegen 10,36 g/kg ($P=0.0466$).*

Schlüsselwörter: *Mastrinder, Simmentaler Fleckviehrasse, Art des Bodens, Eigenschaften des Rumpfes, Fleischqualität*

L'effetto del tipo di pavimento sulle caratteristiche delle carcasse e sulla qualità della carne della razza bovina Simmental dell'allevamento intensivo

Sommario

*Nel presente lavoro è stato esaminato l'effetto del tipo di pavimento sulle caratteristiche delle carcasse e sulla qualità della carne della razza bovina Simmental dell'allevamento intensivo nel sistema di produzione della carne bovina in Repubblica di Croazia. Durante l'allevamento gli animali sono tenuti in box comuni su un pavimento grigliato-fessurato in cemento (il gruppo RP, n=15) o su un pavimento pieno con lettiera di paglia (il gruppo PP, n=15). La superficie media per un vitello è stata 4,7 m^2 nel gruppo RP e 6.0 m^2 nel gruppo PP. Sono stati alimentati con un pasto completamente mescolato dell'insilato di mais (granella e stelo), super-concentrato e fieno (la composizione media al kg: 599 g di ST, 76 g di SP e 4,59 MJ di ME). I bovini sono stati macellati all'età (494±17 giorni) e al peso finale simili (597,5±56,4 kg) e sono state determinate le caratteristiche delle carcasse (il peso a caldo della carcassa alla macellazione, la % di randman, la classificazione (EUROP) delle carcasse). Il colore (CIE L*a*b*) e il valore di pH della carne sono stati misurati 24 ore post mortem sul muscolo Longissimus thoracis a livello dell'ottava costa. Sullo stesso campione è stata effettuata l'analisi chimica della sostanza secca, delle proteine e delle ceneri, del ferro totale e del contenuto di grasso intramuscolare. I dati sono stati elaborati con il test t di Student. In generale, la ricerca non ha indicato un effetto di rilievo ($P>0.05$) del tipo di pavimento su qualsiasi caratteristica analizzata della carcassa o della qualità e la struttura della carne, eccetto per il valore di pH e per il contenuto delle ceneri, i cui valori sono stati inferiori nel gruppo PP rispetto al RP: 5,61:5,68 ($P=0.0168$), ovvero 10,53:10,36 g/kg ($P=0.0466$).*

Parole chiave: *bovini da ingrasso, razza Simmental, caratteristiche della carcassa, qualità della carne*

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