

**EFFECT OF PRE-SLAUGHTER REST PERIOD ON SOME  
PHYSICOCHEMICAL PROPERTIES OF SIMMENTAL BEEF****Marenčić, D.<sup>1</sup>, A. Ivanković<sup>2</sup>, V. Pinti<sup>1</sup>, Nikolina Kelava Ugarković<sup>2</sup>,  
T. Jakopović<sup>3</sup>****Summary**

The objective of this research was to examine the effect of pre-slaughter rest period in lairage on the Simmental beef quality. The study was conducted on 400 cattle (200 bulls and 200 heifers), aged from 13 to 16 months. The cattle were divided in two groups; the first group included 100 bulls and 100 heifers that were rested for 18 hours in lairage prior to slaughter, while the second group (unrested) included 100 bulls and 100 heifers which were taken to the slaughterline immediately after being unloaded. Quality indicators pH, EC and meat colour values were measured 24 hours post-mortem. Heifers had significantly lower muscle pH<sub>24</sub>, EC value and significantly higher L\*, b\* and h\* value, while bulls had significantly higher parameters pH<sub>24</sub> and EC value (P<0.001). Bulls rested in lairage had significantly higher pH<sub>24</sub> (P<0.01) and significantly lower L\*, b\* and h\* value compared with unrested bulls (P<0.05), while rested heifers had significantly lower pH<sub>24</sub> (P<0.001) and significantly higher L\* and h\* value, compared with unrested heifers (P<0.05). Our results indicate that the rest period in heifers could have a beneficial effect on beef quality, while in bulls rest period is not recommended.

Key words: Simmental, beef, pre-slaughter rest period, quality parameters.

**Introduction**

In recent years a major problem in the beef chain production, which can lead to economic losses has been a frequent occurrence of dark, firm, dry beef (DFD). Consumers prefer a light pink to bright red colour and they will strongly reject dark coloured beef, believing that it is from old or sick cattle or that it is badly contaminated (McIntyre, 2000). Cattle handling before slaughter can have an adverse effect on beef quality.

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During transfer to the slaughterhouse cattle are often exposed to various stressors such as fast or forced movements, exertion, jostling, breakdown of the social group, strange environment, rough treatment (during loading and unloading), novelty, track movement, noise, vibrations, centrifugal force, climatic conditions, shortage of food and water (Shackelford et al., 1994; Grandin, 1997; Swanson and Morrow-Tesch, 2001; Broom, 2003; Marenčić et al., 2009). When cattle is stressed, there is a rapid release of catecholamines (norepinephrine, epinephrine, dopamine) which result in glycogen depletion (Lacourt and Tarrant, 1985) causing lower rate of post-mortem lactic acid synthesis, high ultimate pH, undesirable colour, making such beef DFD. Tatum (2007) maintained that bulls and heifers react differently on stressful situation, due to difference in temperament, hormonal effect (endogenous hormonal level) and calpastatin activity. The rest period is the time needed by cattle to recover from stress arisen during displacement from farm to slaughterhouse. It appears that a rest period in lairage may partly restore lost glycogen in cattle. The rest period in lairage can be beneficial for cattle exhausted by long transportation to the slaughterhouse, but it can also cause unnecessary additional stress in cattle transported from much shorter distances (Marenčić et al. 2009). In cattle glycogen supplies can be restored in lairage, even if they are not fed (Warriss et al., 1984). Mounier et al. (2006) found that a longer rest period in lairage lowers the ultimate pH (pHu) value. Knowles (1999) reports that a resting time of 24 hours, with feed and waters available, makes it possible to recover from the stress. Gallo et al. (2003) found that a prolonged lairage over 16 hours leads to an increase in ultimate pH and to DFD beef. Similar negative results on beef quality were found by Liotta et al. (2007) prolonging the resting time over 36 hours after long journeys. However, a pre-slaughter rest may cause additional stress to cattle, especially if cattle are mixed in new, mutually unknown groups while resting in lairage (Kenny and Tarrant, 1987). Incidence of DFD meat is a serious problem in beef production; hence the objective of this research was to examine the effect of pre-slaughter rest in lairage on the beef quality of Simmental bulls and heifers.

### *Material and methods*

Two hundred non-castrated Simmental bulls and two hundred heifers, aged between 13-16 months, were used in the study. Cattle production system (housing, feeding management and nutritional status) was the same on all three farms. Cattle were kept in large partially shaded multiple pens (approximately 10 cattle in 61 m<sup>2</sup> pen) with appropriate feedlot. Bulls and heifers were kept in pens separately. The cattle were fed *ad libitum* with same diet, based on maize silage and concentrates, and also had *ad libitum* access to water during whole fattening period. The average nutritional content of the feeds was approximately 7.6 MJ ME/kg dry matter and 950 g crude protein. From farm to slaughterhouse cattle were unmixed transported in groups of ten. The stocking density in a lorry was approximately 1.5 m<sup>2</sup>/cattle. Transport was conducted in early morning hours and lasted approximately 265 min. According to the pre-slaughter rest period in lairage cattle were divided in two groups; the first group included hundred bulls and hundred heifers that were rested for 18 hours in lairage prior to slaughter, while the second group (unrested) included hundred bulls and hundred heifers which were taken to the slaughterline immediately after being unloaded. Cattle fasted, but had *ad libitum* access to water during the rest period. The stocking density in lairage was approximately 2 m<sup>2</sup>/cattle. The cattle were slaughtered according to a standard procedure. Carcasses were chilled under commercial condition at 4 °C for 24 hours. As quality indicators pH, EC and meat colour values were measured 24 hours post-mortem (plus 80 minutes bloom time) on the right side of *m. longissimus dorsi* removed from the area between 6<sup>th</sup> and 7<sup>th</sup> ribs. Concentration of hydrogen ions (pH) was determined with Euteh CyberScan pH 310 instrument. Electrical conductivity (EC) was determined with LF-Cotrol system instrument (Würthinger, Pettenbach, Austria) in millisiemens/cm (mS/cm). In order to evaluate the colour pattern, CIE (Comission Internationale de l'Eclairage) values were measured (L\* (Lightness), a\* (Redness), b\* (Yellowness), C\* (Chroma), and h\* (Hue) using Minolta Chroma Meter CR-410 (Minolta Co., Ltd., Japan) on a 50-mm diameter measurement area. The colour spectrum was determined under standard D65 illumination. Carcasses traits (carcasses

weight, E U R O P carcass classification and fat score) were measured by Agroiinspekt d.o.o. Statistical analysis was carried out using the least square methodology of the GLM procedure (SAS, 1999), fitting a two-way model with a fixed effect of sex (2 levels: bulls and heifers) and rest period (2 levels: 18 hours rested and unrested). The meat samples were classified into 3 classes according to Buchter (1981): normal meat ( $\text{pH}_{24} < 5.8$ ), DFD suspected meat ( $\text{pH}_{24} 5.8$  to  $6.2$ ) and DFD meat ( $\text{pH}_{24} > 6.2$ ) and their significant level was examined using the  $\text{Chi}^2$ -test.

### Results and discussion

According to E U R O P standard, in this study carcass classes E were dominant (52.5%) followed by carcass classes U (42.0%) and R (5.5%). As shown table 1 the average carcass weight of bulls was 354.98 kg, while the average carcass weight of heifers was 270.53 kg.

Table 1 – SEX EFFECT ON pH, EC, MEAT COLOURS AND CARCASS TRAITS  
Tablica 1. – UTJECAJ SPOLA NA PARAMETRE  $\text{pH}_{24}$ , EC, BOJU MESA I ODLIKE JUNEĆIH POLOVICA

Parameters	sex	LSM <sup>b</sup>	sd	s	min	max	CV
				$\bar{x}$			
<i>Carcass traits</i>							
Aged (months)	bulls	15.39 <sup>a</sup>	0.84	0.06	12.87	16.55	5.46
	heifers	13.70 <sup>b</sup>	1.37	0.09	10.22	23.15	10.03
Carcass weight, kg.	bulls	354.98 <sup>a</sup>	37.02	2.81	214	445	10.43
	heifers	270.53 <sup>b</sup>	22.83	1.43	122.00	343.00	8.44
EUROP classification <sup>a</sup>	bulls	4.53 <sup>a</sup>	0.60	0.04	3.00	5.00	13.15
	heifers	4.44 <sup>a</sup>	0.60	0.04	3.00	5.00	13.47
Fat score	bulls	2.97 <sup>a</sup>	0.32	0.02	2.00	4.00	10.81
	heifers	3.27 <sup>b</sup>	0.52	0.03	2.00	5.00	16.04
<i>Beef quality</i>							
$\text{pH}_{24}$	bulls	5.61 <sup>a</sup>	0.16	0.01	5.46	6.46	2.88
	heifers	5.57 <sup>b</sup>	0.10	0.01	5.42	6.26	1.72
EC	bulls	6.28 <sup>a</sup>	1.24	0.09	3.10	9.40	18.16
	heifers	4.66 <sup>b</sup>	0.95	0.06	1.00	7.10	20.40
L*	bulls	41.10 <sup>a</sup>	2.58	0.20	33.69	54.89	6.28
	heifers	43.65 <sup>b</sup>	1.72	0.11	35.97	49.92	3.93
a*	bulls	28.94 <sup>a</sup>	1.66	0.13	21.96	32.86	5.74
	heifers	28.78 <sup>a</sup>	1.48	0.09	22.87	32.68	5.15
b*	bulls	11.24 <sup>a</sup>	1.23	0.09	5.71	14.42	10.93
	heifers	11.71 <sup>b</sup>	0.99	0.06	5.43	14.21	8.43
C*	bulls	31.06 <sup>a</sup>	1.95	0.15	22.69	35.81	6.28
	heifers	31.14 <sup>a</sup>	1.72	0.11	24.22	35.31	5.52
h*	bulls	21.11 <sup>a</sup>	1.28	0.10	14.57	24.61	6.08
	heifers	22.00 <sup>b</sup>	1.14	0.07	12.46	24.61	5.17

Different letters in the same column indicate significant differences, ( $P < 0.001$ ).

<sup>a</sup> EUROP classification: from 5 (E=excellent) to 1 (P=weak)

LSM<sup>b</sup>- the least square means

Heifers produced carcasses with significantly higher fat score compared with bulls ( $P < 0.001$ ). These results confirm previous conclusions that heifers slow down in muscles gain earlier, and also start earlier to accumulate fat thickness, compared with bulls, whose at higher final weight produced lower fat score. In the presented study, heifers meat had significantly higher colours values ( $L^*$ ,  $b^*$ ,  $h^*$ ), while bulls beef had significantly higher parameters  $pH_{24}$ , and EC ( $P < 0.001$ ). Our research agree with Page et al. (2001) and Wulf et al. (1997), who also reported that bulls produced beef with higher  $pH_{24}$  values and lower  $L^*$  and  $b^*$  values. Some authors (Voisinet et al., 1997; Wulf et al., 1997; Page et al., 2001; Tatum et al., 2007) found that heifers typically produced carcasses with higher marbling score, which affected the  $L^*$  and  $b^*$  values. Swantek et al. (1992) and Aldai et al. (2006) reported that animals with higher intramuscular fat content (marbling) had lower results for juice loss and EC. The effects of different rest period on meat quality of bulls and heifers are shown in Table 2.

Table2 – THE EFFECT OF REST PERIOD ON  $pH_{24}$ , EC, AND CIE COLOUR VALUE OF SIMMENTAL BULLS AND HEIFERS  
 Tablica 2. – UTJECAJ ODMORA PRIJE KLANJA NA  $pH_{24}$ , EC I CIE PARAMETRE BOJE KOD MUŠKE I ŽENSKE SIMMENTALSKE JUNADI

Parameters	Sex	Rested	Unrested	$s \bar{X}$	Significance level
$pH_{24}$	bulls	5.65 <sup>a</sup>	5.58 <sup>b</sup>	0.02	**
	heifers	5.54 <sup>a</sup>	5.59 <sup>b</sup>	0.01	***
EC	bulls	6.73	6.90	0.13	NS
	heifers	4.68	4.65	0.008	NS
$L^*$	bulls	40.68 <sup>a</sup>	41.51 <sup>b</sup>	0.27	*
	heifers	43.87 <sup>a</sup>	43.43 <sup>b</sup>	0.15	*
$a^*$	bulls	28.77	29.11	0.18	NS
	heifers	28.83	28.73	0.13	NS
$b^*$	bulls	11.06 <sup>a</sup>	11.43 <sup>b</sup>	0.13	*
	heifers	11.78	11.64	0.09	NS
$C^*$	bulls	30.83	31.29	0.21	NS
	heifers	31.15	31.14	0.15	NS
$h^*$	bulls	20.89 <sup>a</sup>	21.33 <sup>b</sup>	0.14	*
	heifers	22.16 <sup>a</sup>	21.85 <sup>b</sup>	0.10	*

Different letters in the same row indicate significant differences, NS= not significant; \*( $P < 0.05$ ); \*\*( $P < 0.01$ ); \*\*\*( $P < 0.001$ ).

Pre-slaughter rest period in lairage had a significant influence on beef quality indicators in this study. Our results are in agreement with several researchers who also found that pre-slaughter rest period in lairage had significant effect on beef quality (Knowles, 1999; Kenny and Tarrant, 1987; Gallo et al., 2003; Mounier et al., 2006; Ferreira et al., 2006). In this study, bulls that were rested 18 hours in lairage prior to slaughter had significantly higher  $pH_{24}$  ( $P < 0.01$ ) and significantly lower  $L^*$ ,  $b^*$  and  $h^*$  value compared with unrested bulls ( $P < 0.05$ ), while rested heifers 18 hours in lairage prior to slaughter had significantly lower  $pH_{24}$  ( $P < 0.001$ ) and significantly higher  $L^*$  and  $h^*$  value, compared with unrested heifers ( $P < 0.05$ ).

As shown in Table 3, significantly higher proportion of DFD suspected meat and DFD meat was recorded in groups of bulls that were rested 18 hours in lairage prior to slaughter, whereas the percentage of DFD suspected meat and DFD meat in groups of bulls that were slaughtered unrested were significantly lower ( $P < 0.01$ ). In contrast to bulls, heifers that were kept 18 hours in lairage prior to slaughter had significantly lower incidence of DFD and DFD suspected meat, compared with unrested heifers ( $P < 0.05$ ).

Table 3 – EFFECT OF REST PERIOD ON THE FREQUENCY DISTRIBUTION OF BEEF QUALITY CLASSES ACCORDING TO *Buchter* (1981)

Tablica 3. – UTJECAJ DUŽINE ODMORA NA DISTRIBUCIJU KVALITATIVNIH KLASA JUNEĆEG MESA PREMA *Buchter* (1981)

Sex	Rest period	Normal meat ( $pH_{24} < 5.8$ )	DFD suspected meat ( $pH_{24} 5.8$ to $6.2$ )	DFD meat ( $pH_{24} > 6.2$ )	Sign. level
bulls	rested	88.50%	8.05%	3.45%	**
	unrested	97.70%	2.30%	-	
heifers	rested	97.66%	1.56%	0.78%	*
	unrested	92.97%	7.03%	-	

\*( $P < 0.05$ ); \*\*( $P < 0.01$ )

Our results indicate that the pre-slaughter rest period in lairage had an adverse effect on bulls' beef quality in contrast to heifers' beef where the pre-slaughter rest period had a beneficial effect. The authors think that such adverse results on the pre-slaughter rest period in lairage between bulls and heifers were primarily caused by the difference in their temperament and reaction on pre-harvest stress. Bulls are animals with

more agitated behaviour, and such behaviour usually intensifies physical and psychological stressors which often lead to a decrease in muscle glycogen, causing lower rate of post-mortem lactic acid synthesis, high ultimate pH and undesirable colour, producing DFD beef. Our results are in agreement with several researchers who also found that bulls and heifers react differently on pre-slaughter rest period due to their difference in temperament (Kenny and Tarrant, 1987; Scanga et al., 1998; Gallo et al., 2003; Mounier et al., 2006). Wulf et al. (1997) also found that bulls were more temperamental than heifers. Tatum et al. (2007) reported that cattle with more excitable temperaments had higher final muscle pH measurements, dark muscle colour, higher calpastatin activities, higher shear force values, and lower sensory panel ratings for tenderness and flavour, compared with cattle having calmer temperaments. Gruber et al. (2006) found that cattle exhibiting calm behaviour had lowest blood lactate levels, whereas agitated behaviour of cattle could affect pH value.

### *Conclusion*

The results indicate that an 18 hours rest period in lairage prior to slaughter is not recommended for bulls, due to bulls temperament and agitated behaviour, while in heifers the same rest period prior to slaughter could have beneficial effects on beef quality indicators, due to heifers' calm behavior.

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## UTJECAJ ODMORA PRIJE KLANJA NA FIZIKALNO-KEMIJSKE ODLIKE MESA SIMENTALSKE JUNADI

### Sažetak

Cilj rada je bio ispitati utjecaj odmora u oborima stočnog depoa na kakvoću mesa muške i ženske simentalne junadi. Istraživanje je provedeno na 400 junadi (200 muških i 200 ženskih) u starosti od 13 do 16 mjeseci. Junad je bila podijeljena u dvije grupe; u prvu grupu ušlo je 100 muške i 100 ženske junadi koja je odmarana 18 sati u oborima stočnog depoa prije klanja, dok je u drugu grupu ušlo također 100 muške i 100 ženske junadi koja je bez odmora proslijeđena na liniju klanja. Kvalitativni pokazatelji pH, EC i boja mesa mjerena su 24 sata post mortem. Meso ženske junadi imalo je značajno niže vrijednosti parametra  $pH_{24}$ , EC i značajno više vrijednosti parametara  $L^*$ ,  $b^*$  i  $h^*$ , dok je meso muške junad imala značajno veće vrijednosti parametara  $pH_{24}$  i EC ( $P < 0,001$ ). Meso muške junadi odmarane u oborima stočnog depoa prije klanja imalo je značajno veću vrijednost parametra  $pH_{24}$  ( $P < 0,01$ ) i značajno niže vrijednosti parametara  $L^*$ ,  $b^*$  i  $h^*$  u usporedbi s mesom muške junadi klane bez odmora ( $P < 0,05$ ), dok je meso ženske junadi odmarane u oborima stočnog depoa prije klanja imalo značajno nižu vrijednost parametra  $pH_{24}$  ( $P < 0,001$ ) i značajno više vrijednosti parametara  $L^*$  i  $h^*$  u usporedbi s mesom ženske junadi klane bez odmora ( $P < 0,05$ ). Naši rezultati sugeriraju da odmor ženske junadi u oborima stočnog depoa prije klanja može imati povoljan utjecaj na kakvoću mesa, dok se odmor muške junadi ne preporuča.

Ključne riječi: simentalac, junetina, odmor prije klanja, kvalitativni parametri.

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