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Effect of transport time on meat quality of Simmental bulls and heifers

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Abstract

The aim of this study was to examine the effect of transport time on meat quality of Simmental bulls and heifers. The study was conducted from October 2008 to September 2009 on 1938 cattles aged from 13 to 16 months. As quality indicators pH, meat colours value were measured 24 h post-mortem on *m. longissimus dorsi*. Bulls transported from a shorter journey had worse pH_{24} ($P<0.001$) and L* value ($P<0.05$), compared with bulls transported from medium journey, whereas bulls transported from longer journey had higher L* value ($P<0.01$). Heifers submitted to shorter journey had higher pH_{24} value ($P<0.001$). This study shown that shorter journey was physically very demanding and affected on final beef quality product.

Key words: beef, transport time, stress, sex, meat quality

Utjecaj vremena transporta na kakvoću mesa muške i ženske simentalske junadi

Sažetak

Cilj ovoga rada je utvrditi utjecaj transporta na kakvoću mesa muške i ženske simentalske junadi. Istraživanje je provedeno u razdoblju od listopada 2008. do rujna 2009. na 1938 jedinki u dobi od 13-16 mjeseci. Mjerenja vrijednosti parametara pH i boje vršena su 24 sata *post-mortem* na *m. longissimus dorsi*. Muška junad transportirana s kraće udaljenosti imala je značajno lošiji pH_{24} ($P<0,001$) i L* vrijednost ($P<0,05$) u usporedbi s muškom junadi transportiranom iz srednje duge udaljenosti, dok je muška junad trasportirana s duže udaljenosti imala značajno veću L* vrijednost ($P<0,01$). Ženska junad transportirana s kraće udaljenosti imala je značajno veću pH_{24} vrijednost ($P<0,001$). Ova studija pokazuje kako je kraći transport bio fizički vrlo zahtjevan i značajno je utjecao na smanjenje kakvoće junećega mesa.

Ključne riječi: juneće meso, vrijeme transporta, stres, spol, kakvoća

Introduction

Cattle handling before slaughter can have an adverse impact on meat quality. During transfer to the slaughterhouse cattle can be 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 condition, shortage of food and water (Grandin, 1997; Swanson and Morrow-Tesch 2001; Broom 2003; Marenčić et al. 2009). When cattle is stressed in the pre-slaughter environment, there is a rapid release of catecholamines (norepinephrine,

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epinephrine, dopamine) which result in glycogen depilation (Lacourt and Tarrant 1985) causing lower rate of post-mortem lactic acid synthesis, high ultimate pH, undesirable colour, making such beef dark, firm, dry (DFD). Tatum (2007) reported that in stressful situations bulls and heifers react differently, due to difference in temperament, hormonal effect (endogenus hormonal level) and calpastatin activity. Wulf et al. (1997) also found that bulls were more temperamental than heifers. Shorter transport may lead to weight reduction, drop in glycogen reserves and increased muscle temperature, which is not always reflected in ultimate pH (Agnes et al. 1990; Maria et al. 2003). Prolongation of transport time from the farm to the slaughterhouse has commonly an adverse effect on beef quality but little is known about its direct influence on the texture or colour of beef (Garndin 2000). In some parts of Europe transport period to the slaughterhouse is relatively short, as in Croatian where it is typically less than six hours. Incidence of DFD meat is a serious problem in beef production; hence the objective of this study was to examine the effect of transport time on beef quality and improvement of animal welfare.

Material and methods

Seven hundred thirty-two Simmental bulls and one thousand two hundred six heifers aged between 13-16 months were used in the study. Cattle were transported in groups of fifteen without any mixing from October 2008 to September 2009. Cattle were submitted into tree transport time groups; the first group included 325 bulls and 413 heifers transported from the farm to slaughterhouse in approximately 24 min, the second group included 212 bulls and 388 heifers transported from the farm to slaughterhouse in approximately 92 min, and the third group was made up of 195 bulls and 405 heifers transported from the farm to slaughterhouse in approximately 265 min. The cattle were slaughtered according to the standard procedure, immediately after being unloaded. Carcasses were chilled under commercial condition at 4^0C for 24 hours. As quality indicators, pH and meat colours values were measured 24 hours post-mortem (plus 80 min bloom time) on the right side of *m. longissimuss dorsi* removed from the area between 6^{th} and 7^{th} ribs. Concentration of hydrogen ions (pH) was determined with a Euteh CyberScan pH 310 instrument. In order to evaluate the colour pattern, CIE (Comission Internationale de l'Eclairage) value were measured (L*, a*, b*) using a Minolta Chroma Meter CR-410. The colour spectrum was determined under standard D65 illumination. Statistical analysis was carried out using the GLM procedure (SAS 1999). The meat samples were classified into 3 classes according to Buchter (1981): normal meat (pH_{24} < 5.8), DFD suspected meat (pH_{24} 5.8 to 6.2) and DFD meat (pH_{24} >6.2).

Results and discussion

The average carcass weight of bulls was 363.26±34.17 kg., while the average carcass weight of heifers was 271.65±19.94 kg. During the fattening period of 14.35±0.76 months, heifers had significantly lower average net weight gain 0.623±0.04 kg/d, compared with bulls whose average net weight gain was 0.770±0.07 kg/d, during 15.52±0.73 months of fattening period (P<0.001). According to E U R O P standard, in this study carcass classes E were dominant (47.72%) followed by carcass classes U (42.06%), R (9.96%) and O (0.26%). Heifers produced carcasses with significantly higher fat score (3.26±0.51; 2.99±0.36), 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 higher final weight produced lower fat score. The effect of different transport time (short journey, medium journey, long journey) on meat quality of bulls and heifers are shown in table 1.

Table 1. Least square mean (±S.E.) of pH_{24}, muscle colours in terms of three different transport time.

Parameters	sex	Short journey (24 min)	Medium journey (92 min)	Long journey (265 min)	Significance level
pH_{24}	bulls	5.63^{a}±0.007	5.59^{b}±0.008	5.61^{ab}±0.009	***
	heifers	5.59^{a}±0.004	5.56^{b}±0.004	5.57^{ab}±0.004	***
L*	bulls	41.56^{a}±0.14	42.14^{b}±0.17	42.40^{b}±0.18	* and **
	heifers	43.62±0.10	43.91±0.10	43.87±0.10	NS
a*	bulls	29.07±0.10	29.27±0.12	29.27±0.13	NS
	heifers	28.75±0.07	28.94±0.07	28.84±0.07	NS
b*	bulls	11.27±0.07	11.38±0.09	11.49±0.10	NS
	heifers	11.68±0.05	11.82±0.05	11.80±0.05	NS

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

Transport time had significant influence on beef quality indicators in study sample. Bulls transported from a shorter journey had significantly worse pH_{24} ($P<0.001$) and L* value ($P<0.05$), compared with bulls transported from medium journey, whereas bulls transported from longer journey had significantly higher L* value, compared with shorter journey ($P<0.01$). Heifers submitted to shorter journey had significantly higher pH_{24} value, compared with heifers transported from medium journey ($P<0.001$). No significant difference were observed for other parameters (a*, b*) between different transported bulls, and between different transported heifers ($P>0.05$). From this result it seems that cattle (bulls and heifers) subjected to shorter journey was more stressful, than cattle transported from medium and longer ones. Our result is in line with several groups also indicating that shorter journey was more stressful than longer journey (Sartorelli et al. 1992; Tarrant et al. 1992; Villarroel et al. 2003). Gregory (1998) and Sanz et al. (1996) concluded that shorter journey gave cattle less time to adapt to the new situation and cattle arrived to slaughterhouse with lower glycogen reserves, causing post-mortem lower rate of lactic acid synthesis, high ultimate pH and undesirable colour. Honkavaara et al. (2003) reported that longer journey gives cattle the opportunity to acclimate and as journey progresses, the environmental inside of the track become less novel and less stressful. In the presented study, in bulls beef longer journey slightly increases pH_{24}, while in heifers beef longer journey slightly increases pH_{24} and decreases L*,a*,b*, but there were no significant differences compared with medium journey ($P>0.05$). Maria et al. (2003) and Villarroel et al. (2003) noted that longer journey up to 6 hour slightly increases pH and decreases colour parameters (L*, a*, b*). In cattle, shorter journey (<4 h) does not normally cause severe stress unless there is trauma (Grandin 2000; Tarrant 1989) but little is known about their effect on beef texture or colour (Maria et al. 2003). The lack of effect on ultimate pH could occur when transport is only slightly stressful and animals are in good condition. Some other studies found that longer journey significantly increases pH value, and decreases colours (Browen et al. 1990; Batista et al. 1999; Joaquim 2002).

Table 2. Effect of transport time on the frequency distribution of beef quality classes.

Sex	Transport	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	Short journey	88%	10.15%	1.85%	***
	Medium journey	94.81%	3.77%	1.42%	NS
	Longer journey	94.36%	4.10%	1.54%	NS
Heifers	Short journey	94.19%	6.05%	-	***
	Medium journey	97.16%	2.84%	-	NS
	Longer journey	96.79%	2.96%	0.25%	NS

***($P<0.001$); NS= not significant

A considerably higher proportion of DFD suspected and DFD meat was recorded in groups of bulls and heifers transported from shorter journey, whereas the percentage of DFD and DFD suspected meat in groups of bulls and heifers transported from medium and longer journey remained at low level. These results suggest that bulls and heifers subjected to shorter journey have higher tendency to produce DFD and DFD suspected meat than bulls and heifers transported from medium and longer journey. Nanni Costa (2009) concluded that acute stress related to shorter transport and pre-slaughter handling reduce glycogen content, insufficient post mortem acidification and the consequence is DFD beef. Warriss et al. (1995) and Pettiford et al. (2008) observed that loading and the initial stage of transport are the most stressful and after this initial period, animal adapt to the transport conditions. A highly energetic diet seemed to protect cattle from potentially glycogen-depleting stressors (Immonen et al. 2000; Haratung et al. 2003; Marahrens et al. 2003) In the presented study, slightly lower incidence of DFD and DFD suspected meat was determined in the group of bulls transported for a medium journey, compared with longer journey. Joaquim (2002) recorded a significantly higher incidence of DFD suspected beef in cases of longer transport, compared to shorter transport. Longer transport time increases the incidence of DFD meat (Poulanne and Aalto 1981). Brown et al. (1990) reported that long-duration transport (≥ 240 km) increased the incidence of DFD meat.

Conclusion

The results suggest that shorter journey were physically very demanding leaving cattle less time to adapt on new situation and affected glycogen-depletion, causing lower rate of post-mortem lactic acid synthesis, higher ultimate pH_{24}, making beef dark, firm, dray (DFD).

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