UDK 636.02.033

Izvorni znanstveni članak
Original scientific paper

EFFECTS DIFFERENT TRANSPORT PERIOD AND MIXING OF GROUPS ON MEAT QUALITY OF SIMMENTAL BULLS

D. Marenčić, A. Ivanković, V. Pintić, R. Horvat-Marković, M. Horvat, M. Konjačić, N. Kelava

Summary

In the last few years, beef producers have had great problems with beef distribution, related primarily to the frequent incidence of dark, firm, dry meat. Consumers are unlikely to buy and consume such meat. The aim of this study was to examine the effect of transport period and mixing of groups during rest period in lairage on the quality of beef carcasses. The study included 40 Simmental bulls aged from 18 to 20 months. Ultimate pH value and meat colour were measured 24 hours post mortem in m. *longissimus* dorsi and m. *gracilis*. Only 45% of carcasses were within the standard pHu range. Results of transport period did not show significant effect on beef quality. In contrast to transport period, mixing of groups during rest period in lairage had highly significant adverse effect on beef quality ($p<0.001$). The effect of mixing of bulls during the resting period of 18 hours, could however be regarded of being the main stress factor.

Key words: Simmental bulls, beef meat, transport period, mixing of groups, pHu, colour.

Introduction

When transported from the farm to the slaughterhouse bulls are often exposed to different stressors that cause physical exhaustion and psychic stress (Tennessen et al., 1984; Shackelford et al., 1994; Grandin, 1997; Voisinet et al., 1997; Swanson and Morrow-Tesch, 2001), which can have an adverse effect on meat quality (Broom, 2003). The most common stressors during transportation of bulls are: fast and forced movements, exertion, jostling, breakdown of the group social structure due to mixing of

D. Marenčić, V. Pintić, College of Agriculture, Milislava Demerca 1, 48260 Križevci, Croatia;
A. Ivanković, M. Konjačić, N. Kelava, Department of Animal Production and Technology, Agricultural Faculty, University of Zagreb, Svetošimunska 25, 10 000 Zagreb, Croatia;
R. Horvat-Marković, M. Horvat, Podravka, Danica Ltd. Meat Industry, Đelekovačka cesta 21, 48000 Koprivnica, Croatia, e-mail: dmarencic@vguk.hr

bulls unknown to each other, strange environment, rough treatment of animals during loading and unloading, truck movement, noise, vibrations, centrifugal force, climatic conditions, shortage of food and water, etc.

Kenny and Tarrant (1987) report that preslaughter stress often leads to a decrease in muscle glycogen, lower rate of lactic acid synthesis and eventually to a high pH, making such beef DFD (dark, firm, dry). Prolongation of transport period from the farm to the slaughterhouse has commonly an adverse impact on beef quality but little is known about its direct influence on the texture or colour of beef (Tarrant et al., 1988; Tarrant, 1989; Grandin, 2000). Incidence of DFD meat increased with transport duration from the farm to the slaughterhouse (Brown et al., 1990). Long transport increases stress indicators such as serum cortisol, creatine kinase and lactate (Grandin, 2000). Short preslaughter transport period (< 4 hours) will produce no stress except in cases of other traumas (Tarrant et al., 1988; Tarrant, 1989; Grandin, 2000). According to Agnes et al. (1990), shorter transport may lead to weight reduction, drop in glycogen levels and raised muscle temperature, which is not always reflected in the ultimate pH (Maria et al., 2003). In same parts of Europe transport period to the slaughterhouse is relatively short, as in Croatian where it is typically less than six hours.

Although rest period in lairage can be beneficial for bulls exhausted by long transportation to the slaughterhouse, it can also cause unnecessary additional stress in animals transported from much shorter duration. Glycogen can be restored in lairage, where bulls can regain muscle energy source even if they are not fed (Warris et al., 1984). Mounier et al. (2006) found that a longer rest period in lairage lowers the ultimate pH (pH_u) value. Knowles (1999) emphasizes the need of a 24-hour rest period in lairage for physical recovery of bulls. However, a preslaughter rest may cause additional stress to bulls, especially if bulls are mixed with unfamiliar individuals while keeping them in lairage (Hedrick, 1981; Kenny and Tarrant, 1987). Mixing of bulls in lairage leads to commotion, intensified physical activity and more frequent incidence of DFD carcasses (Price and Tennessen, 1981).

Incidence of DFD meat is a serious problem in beef production; hence the aim of this study was to determine the possible effect of transport period and preslaughter mixing of groups in lairage on the meat quality of Simmental bulls.

Material and methods

Forty Simmental bulls aged between 18 - 20 months were used in the study. According to the transport distance, bulls were divided into two groups; the first group (TP 1) included 20 bulls whose transport from the farm to the slaughterhouse took less than 4 hours and the second group (TP 2) was made up of 20 bulls whose transport from the farm to the slaughterhouse was longer than 4 hours. Both groups (TP1 and TP2) were transported without any mixing the same day. According to the mixing in lairage, each transported groups (TP 1 and TP 2) were divided in two groups. Ten bulls from each transported period groups were mixed during resting period (18 hours) in lairage (RP 1), while the ten bulls from each transported period groups were driven to the slaughterline immediately after being unloaded (RP 2). The bulls fasted and had ad libitum access to water during 18 hours mixing period.

Animals were slaughtered according to the standard procedure. Carcasses were cooled under commercial conditions at 4 ^{o}C for 24 hours. Average carcass weight was 317 (± 31) kg. As quality indicators meat colour and pH_u were measured at 24 hours post-mortem plus 45 min after bloom time in two muscles (*m. gracilis* and *m. longissimus dorsi*) of the right carcass. Measurements were made on the section of *m. longissimus dorsi,* 3 cm thick removed from the area between the 12th and 13th ribs. Concentration of hydrogen ions (pH_u) was determined with a Eutech CyberScan pH 310 instrument. 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 a 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.

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 transport period (2 levels: less than 4 hours and more than 4 hours) and mixing of groups (2 levels: mixed group and unmixed group) plus interaction effect. The meat samples were classified into 3 classes according to Buchter (1981): normal meat (pH_u < 5.8), DFD suspected meat (pH_u 5.8 to 6.2) and DFD meat (pH_u > 6.2) and a comparative study was made relating to the parameters.

Results

Transport period had little influence on instrumental measurements of meat quality on both muscles studied (Table 1). No significant difference was found between bulls transported for a shorter and those transported for a longer period for either muscle studied, whereas mixing of groups had a significant effect on instrumental measurements of meat quality on both muscles studied. Bulls that were mixed in lairage for 18 hours had significantly poorer values of colour and pH_u parameters ($P<0.001$).

Table 1 – LEAST SQUARE MEANS (± S.E.) OF pHu AND COLOUR PARAMETERS FOR TWO DIFFERENT TRANSPORT PERIOD AND MIXING OF GROUPS.
Tablica 1. – SREDNJE VRIJEDNOSTI (± S.E.) PARAMETARA kpH I BOJE MESA OBZIROM NA DUŽINU TRANSPORTA I MIJEŠANJE GRUPA BIKOVA.

	Analysis	TP 1	TP 2	RP 1	RP 2
m.longissimus dorsi	pH_u	6.14±0.09	6.13±0.09	6.56^{a}±0.09	5.71^{b}±0.09
	L*	36.94±0.62	36.59±0.62	34.48^{a}±0.62	39.05^{b}±0.62
	a*	23.09±0.40	22.75±0.40	20.60^{a}±0.40	25.24^{b}±0.40
	b*	6.93±0.29	6.80±0.29	5.21^{a}±0.29	8.52^{b}±0.29
	C*	24.14±0.46	23.77±0.46	21.26^{a}±0.46	26.65^{b}±0.46
	H*	16.30±0.41	16.29±0.41	13.99^{a}±0.41	18.59^{b}±0.41
m. gracilis	pH_u	5.92±0.08	5.98±0.08	6.26^{a}±0.08	5.64^{b}±0.08
	L*	33.18±0.42	32.44±0.42	31.67^{a}±0.42	33.96^{b}±0.42
	a*	21.49±0.51	21.62±0.51	19.67^{a}±0.51	23.44^{b}±0.51
	b*	6.33±0.29	6.24±0.29	5.19^{a}±0.29	7.37^{b}±0.29
	C*	22.90±0.63	22.53±0.63	20.85^{a}±0.63	24.58^{b}±0.63
	H*	15.77±0.37	16.14±0.37	14.55^{a}±0.37	17.36^{b}±0.37

^{a,b} Different letters in the same row indicate significant difference, ($P<0.001$)

Slightly higher proportion of DFD and DFD suspected meat on *m. longissimus dorsi* and *m. gracilis* was observed in the group of bulls transported for a longer period (Table 2). Much higher proportion of DFD and DFD suspected meat on both muscles studied was found in the group of bulls which have been mixed during 18 hours rested period in lairage. A considerably higher proportion of DFD suspected meat and DFD meat was recorded in groups of bulls that were mixed during rested period in lairage (TP 2/RP 1; TP 1/RP 1), whereas the percentage of DFD suspected meat and DFD meat in groups of

bulls that were slaughtered without resting (TP 2/RP 2; TP 1/RP 2) remained at low level in both muscles studied (Table 2).

Table 2 – EFFECT OF TRANSPORT PERIOD AND MIXING OF GROUPS DURING RESTING PERIOD ON THE FREQUENCY DISTRIBUTION OF MEAT QUALITY CLASSES
Tablica 2 – UTJECAJ DUŽINE TRANSPORTA I MIJEŠANJA GRUPA BIKOVA TIJEKOM ODMORA NA DISTRIBUCIJU KVALITIVNIH KLASA JUNEĆEG MESA

	Groups	Normal meat (pH < 5.8)	DFD suspected meat (pH 5.8 to 6.2)	DFD meat (pH > 6.2)	Chi^2- test
TRANSPORT TIMES					
m. longissimus dorsi	TP 1	50%	10%	40%	NS
	TP 2	40%	25%	35%	
m. gracilis	TP 1	55%	15%	30%	NS
	TP 2	50%	30%	20%	
MIXING OF GROUP					
m. longissimus dorsi	RP 1	10%	20%	70%	***
	RP 2	80%	15%	5%	
m. gracilis	RP 1	20%	30%	50%	***
	RP 2	85%	15%	/	
COMBINED EFFECT (transport times × mixing of group)					
m. longissimus dorsi	TP 1/RP 1	20%	/	80%	NS
	TP 2/RP1	/	40%	60%	
	TP 1/RP 2	80%	20%	/	NS
	TP 2/RP 2	80%	10%	10%	
m. gracilis	TP 1/RP 1	20%	20%	60%	NS
	TP 2/RP 1	20%	40%	40%	
	TP 1/RP 2	90%	10%	/	NS
	TP 2/RP 2	80%	20%	/	

*** P<0,001; NS – non significant

In general, transport period had less influence on instrumental measurements of meat quality than the mixed groups during the rest period in lairage (Table 3). No significant interaction was determined for parameter L* on *m. longissimus dorsi* between bulls transported for a shorter period without mixing of groups (TP 1/RP 2) and bulls transported for a shorter period which were mixed in lairage for 18 hours (TP 1/RP 1), and on *m. gracilis* for parameters L* and Hue between bulls transported for a longer period without

mixing of groups (TP 2/RP 2) and bulls transported for a longer period that were not mixed during the rest period in lairage (TP 2/RP 2). Differences in mean pH_u and colour values in *m. longissimus dorsi* between differently handled bulls with respect to mixed groups during the rest period in lairage were highly significant (P<0.001) whereas the differences in mean pH_u and colour values in *m. gracilis* between groups of bulls were significant, but at a slightly lower level (P<0.05; P<0.01).

Table 3 – INTERACTIVE VALUES OF MEAT COLOUR AND pH_u FOR DIFFERENTLY HANDLED BULLS WITH RESPECT TO TRANSPORT PERIOD AND MIXING OF GROUPS.
Tablica 3. – INTERAKTIVNE VRIJEDNOSTI kpH I BOJE JUNEĆEG MESA GRUPA RAZLIČITO TRETIRANIH BIKOVA OBZIROM NA DUŽINU TRANSPORTA I MIJEŠANJE GRUPA.

Muscle	Meat quality trait	Least square means				RME	Significance		
		TP1		TP2					
		RP1	RP2	RP1	RP2		TP	RP	TP × RP
m. longissimus dorsi	pH_u	6.61^{a}	5.68^{b}	6.51^{a}	5.74^{b}	0.13	NS	***	NS
	L*	35.5^{a}	38.37^{ab}	33.46^{a}	39.72^{b}	*0.87*	NS	TP2 ***	NS
	a*	20.99^{a}	25.19^{b}	20.21^{a}	25.29^{b}	*0.57*	NS	***	NS
	b*	5.35^{a}	8.50^{b}	5.07^{a}	8.54^{b}	*0.41*	NS	***	NS
	C*	21.68^{a}	26.60^{b}	20.83^{a}	26.70^{b}	*0.87*	NS	***	NS
	H*	14.03^{a}	18. 56^{b}	13.96^{a}	18.62^{b}	*0.57*	NS	***	NS
m. gracilis	pH_u	6.30^{a}	5.65^{b}	6.22^{a}	5.63^{b}	*0.11*	NS	**	NS
	L*	31.73^{a}	34.64^{b}	31.61^{a}	33.27^{ab}	*0.59*	NS	TP1**	NS
	a*	19.27^{a}	23.70^{b}	20.06^{a}	23.18^{b}	*0.71*	NS	*	NS
	b*	4.83^{a}	7.65^{b}	5.55^{a}	7.10^{b}	*0.41*	NS	*	NS
	C*	20.88^{a}	24.91^{b}	20.82^{a}	24.25^{b}	*0.89*	NS	*	NS
	H*	13.79^{a}	17.74^{b}	15.31^{a}	16.97^{ab}	*0.53*	NS	TP1*	NS

Different letters in the same row $^{(a,b,)}$ indicate significant difference (* P<0,05; ** P<0,01; *** P<0,001)

Discussion

Transport period had no significant influence on beef quality indicators in the studied sample. No significant influence of transport on beef quality indicators was observed in some earlier investigations either (Fernandez et al., 1996; Maria et al., 2003). Jones et al. (1988) noted an insignificant adverse effect of transport period on beef quality indicators. Joaquim (2002) recorded a significantly higher incidence of DFD suspected beef in cases of

longer transport compared to shorter transport. Longer transport period increases the incidence of DFD meat (Poulanne and Aalto, 1981). Brown et al. (1990) reported that long-distance transport (≥ 240 km) increased the incidence of DFD meat.

Slightly higher pH_u values were determined in this study in the group of bulls transported for a longer period (TP 2) compared to pH_u values of the group of bulls transported for a shorter period (TP 1), but the differences were not significant. Batista de Deus et al. (1999) however, found that at different transport duration (46 to 460 km) with rest periods and 12-hour fasting, ultimate pH increased with increasing duration to the slaughterhouse. Regarding the determined incidence of DFD meat (pH_u value criterion), slightly lower incidence of DFD and DFD suspected meat was determined in the group of bulls transported for a shorter period (TP 1; Table 2). In this study, *m.longissimus dorsi* of 50% of bulls transported for a shorter period had DFD suspected meat while 60% of bulls transported for a longer period had DFD suspected meat. Joaquim (2002) recorded 38.4% of DFD suspected cases for longer transport, and 13.34% of suspected cases for shorter transport. Slightly more unfavourable values of meat colour parameters were determined for bulls transported for a longer period (TP 2) compared to the group of bulls transported for a shorter period before being slaughtered (TP 1), but the differences were not statistically significant. Fernandez et al. (1996) concluded earlier that transport period with feeding in lairage had no influence on L*, a* and b* values. Lesnik et al. (2001) came to similar conclusions in their investigations.

In this study highly significant differences were recorded in the values of meat quality indicators between the group of bulls mixed during resting period in lairage and the group of bulls that were not mixed in lairage. Values of meat quality indicators (pH_u, L*, a*,b*, C* and H*) for the group of bulls mixed in lairage prior to slaughtering (RP 1) are significantly poorer compared to the values for group of bulls which were not mixed in lairage (RP 2). Values found for pH_u in *m. longissimus dorsi* and *m. gracilis* in (RP 1) bulls (6.56; 6.26) are much less favourable than the values for (RP 2) bulls (5.71; 5.64) (Table 1). Some earlier studies support these conclusions, reporting that bulls were not recovered in lairage if they came from different herds (Hedrick, 1981; Price and Tennessen, 1981; Kenny and Tarrant, 1987). Price and Tennessen (1981) reported that mixing bulls in lairage leads to their

commotion, intensified activity and higher incidence of DFD carcasses (increased from 2 to 73%).

Mohan Raj et al. (1992) found that mixed bulls had significantly poorer values of L*, a*, b*, C* and higher pH_u value compared to unmixed bulls. Mohan Raj (1988) also found that preslaughter mixing of bulls for only one hour in lairage increased the incidence of DFD meat by 23.5%. The same author suggests that keeping mixed bulls in lairage overnight should be avoided even for a short period in order to keep the DFD meat incidence low. Gallo et al. (2003) report that a rest period longer than 16 hours increased the ultimate pH.

This study has shown that transport period does not have a significant influence on beef quality indicators. The observed slightly more unfavourable values of meat colour parameters in the group of bulls transported for a longer period are not significant different compared to the group of bulls that were transported for a shorter period. The preslaughter mixing of bulls group during resting period in lairage had an adverse effect on beef quality in the studied sample. Values of beef quality indicators (pH_u, L*, a*,b*, C* and H*) in the group of bulls that were mixed in lairage before being slaughtered were significantly poorer compared to bulls slaughtered immediately upon arrival at the slaughterhouse, without any mixing. Stress occurring during the grouping and mixing of bulls in lairage boxes, namely establishment of dominance hierarchy, is the main cause of such negative results. Therefore, the mixing of bulls during the rest period in lairage did not give the expected results in the studied sample but caused further decline of the values of beef quality indicators. In summary, to provide good quality beef for the market, it is recommended to avoid the mixing of bulls in lairage, i.e., to avoid the occurrence of stress that has an adverse effect on beef quality parameters..

REFERENCES

1. Agnes F., Sartorelli P., Borrow H.A., Locatelli A. (1990): Effect of transport loading or noise on blood biochemical variables in calves. Journal of Veterinary Research, 51, 1679-1681.

2. Batista de Deus J.C., Silva W.P., Soares, J.G.D. (1999): Efeito da distância de transporte de bovinos no metabolismo postmortem. Revista Brasileira de Agrociência, 5, 152-156.

3. Broom D.M. (2003): Transport stress in cattle and sheep with details of physiological, ethological and other indicators. Deut. Tierarztl. Woch., 110, 83-88.

4. Brown S.N., Bevis E.A., Warris P.D. (1990): A estimate of the inicidence of dark cutting beef in the United Kingdom. Meat Science, 27, 249-258.

5. Buchter L. (1981): Identification and minimisation of DFD in young bulls in Denmark. In: Hood, D. E. and Tarrant, P. V. (eds.). The problem of dark cutting beef. Current Topics in Veterinary Medicine and Animal Science, Martinus Nijhoff, Hague, pp. 289-302.

6. Fernandez X., Monin G., Culioli J., Legrand I., Quilichini Y. (1996): Effect of duration of feed withdrawal and transportation time on muscle characteristics and quality in Friesian-Holstein calves. Journal of Animal Science, 74, 1576-1583.

7. Gallo C., Lizondo G., Knowles T.G. (2003): Effects of journey and lairage time on steers transported to slaughter in Chile. Vet. Rec., 152, 361-364.

8. Grandin T. (1997): Assessment of stress during handling and transport. Journal of Animal Science, 75, 249-257.

9. Grandin T. (2000): Management and economic factors of handling and transport. In: Grandin, T. (ed.), Livestock Handling and Transport. CABI Publishing, New York, pp. 1-14.

10. Hedrick H.B. (1981): Preventive treatments during the pre-slaughter period. In: Hood D.E., Tarrant P.V. (eds.). The problem of dark cutting beef. Martinus Nijhoff, Hague, Netherlands, pp. 213-228

11. Joaquim C.F. (2002): Efeitos da distancia de transporte em parâmetros postmortem de carcaças bovinas. MSc thesis, Universidade Estadual Paulista, Botucatu, Sâo Paulo, Brazil.

12. Jones S.D.M., Schaefer A.L., Tong A.K.W., Vincent B.C. (1988): The effects of fasting and transportation on beef cattle - Body component changes, carcass composition and meat quality. Livestock Production Science, 20, 25-35.

13. Kenny F.J., Tarrant P.V. (1987): The reaction of young bulls to short-haul road transport. Applied Animal Behaviour Science, 17, 209-227.

14. Knowles T.G. (1999): A review of the road transport of cattle. Vet. Rec., 126, 197-201.

15. Lesnik B.J., Fernandez X., Gozzi G., Florand L., Veissier I. (2001): The influence of farmer behaviour on calves reactions to transport and quality of veal meat. Journal of Animal Science, 79, 642-652.

16. Maria G.A., Villarroel M., Sanudo C., Olleta J.L., Gebresenbet G. (2003): Effect of transport time and ageing on aspects of beef quality. Meat Science, 65, 1335-1340.

17. Mohan Raj A.B. (1988): Biochemical, physiological and behavioural parameters as determinants of meat quality. Degree Diss., The Queen's University of Belfast, Ireland.

18. Mohan Raj A.B., Moss B.W., Rice D.A., Kilpatrick D.J., McCaughey A., McLauchlan W. (1992): Effect of mixing male sex types of cattle on their meat quality and stress-related parameters. Meat Science, 32, 367-386.

19. Mounier L., Dubroeucq H., Andanson S., Veissier I. (2006): Variations in meat pH of beef bulls in relation to conditions of transfer to slaughter and previous history of the animals. Journal of Animal Science, 84, 1567-1576.

20. Poulanne E., Aalto H. (1981): The incidence of dark-cutting beef young bulls in Finland. Current Topics in Veterinary Medicine, 10, 462-475.

21. Price M.A., Tennessen T. (1981): Preslaughter management and dark-cutting in the carcasses of young bulls. Journal of Animal Science, 61, 205-208.

22. SAS (1999): SAS® Software, SAS Institute Inc., Cary, North Carolina, USA.

23. Shackelford S.D., Koohmaraie M., Wheeler T.L., Cundiff L.V., Dikeman M.E. (1994): Effect of biological type of cattle on the incidence of the dark, firm and dry condition in the longissimus muscle. Journal of Animal Science, 72, 337-343.

24. Swanson J.C., Morrow-Tesch J. (2001): Cattle transport: Historical, research and future perspectives. Journal of Animal Science, 79, 102-109.

25. Tarrant P.V., Kelly F.J., Harrington D. (1988): The effect of stocking density during 4 hour transport to slaughter, on behaviour, blood constituents and carcass bruising in Friesian steers. Meat Science, 24, 209-222.

26. Tarrant P.V. (1989): Animal behaviour and environment in the dark-cutting condition in beef. Irish Journal of Food Science and Technology, 13, 1-21.

27. Tennessen, T., Price, M. A. and Berg, R. T. (1984): Comparative responses of bulls and steers to transportation. Can. Journal of Animal Science, 64, 333-338.

28. Voisinet B.D., Grandin T., O'Connor S.F., Tatum J.D., Deesing M.J. (1997): Bos indicus-cross feedlot cattle with excitable temperaments have tougher meat and higher incidence of borderline dark cutters. Meat Science, 46, 367-377.

29. Warris P.D., Kestin S.C., Brown S.N., Wilkins L.J. (1984): The time required for recovery from mixing stress in young bulls and the prevention of dark-cutting beef. Meat Science, 32, 59-64.

.

UTJECAJ DUŽINE TRANSPORTA I MIJEŠANJA GRUPA NA KAKVOĆU JUNEĆIH TRUPOVA SIMENTALSKIH BIKOVA

Sažetak

Proizvođači junećega mesa proteklih godina imaju značajne probleme u plasmanu junetine, prvenstveno zbog učestalije pojave tamnog suhog i tvrdog mesa (DFD). Potrošači takvo meso nerado kupuju i konzumiraju. Cilj ovog istraživanja je utvrditi značajnost utjecaja dužine transporta i miješanja grupa bikova tijekom odmora u stočnom depou na kakvoću junećih trupova. Istraživanje je uključilo 40 simentalske junadi u dobi od 18 do 20 mjeseci. Mjerenje konačne pH vrijednosti i boje mesa vršena su 24 sata post mortem na *m. longissimus dorsi* i *m. gracilis*. Samo je 45% trupova imalo vrijednost kpH u poželjnom intervalu. Istraživanjem nije utvrđen značajan utjecaj dužine transporta na pokazatelje kakvoće junećih trupova. Miješanje grupa bikova tijekom odmora u stočnom depou ima značajan utjecaj na kakvoću junećih trupova ($p<0.001$). Utjecaj miješanja grupa bikova tijekom odmora u stočnom može se smatrati jednim od glavnih uzročnika stresa odgovornog za pojavu DFD junećega mesa.

Ključne riječi: simentalski bikovi, meso, transport, miješanje grupa, pH, boja.

Primljeno: 15.2.2010.