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COMPARISON OF BEEF PRODUCTION AND MEAT QUALITY OF HOLSTEIN BULLS FATTENED TO A LOWER LIVE WEIGHT IN LOOSE AND TETHERED HOUSING SYSTEMS*

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ABSTRACT

The experimental group consisted of 57 young Holstein bulls kept in the Czech Republic; 35 bulls were tethered and 22 bulls were loose housed. The aim of the study was to analyse and compare the effect of different housing systems on feedlot performance, carcass value and meat quality and their mutual relationship. The overall average values were as follows: feedlot performance parameters – live weight at slaughter 434.3 kg, age at slaughter 455.8 days, total weight gain 319.3 kg, duration of fattening 342.1 days, daily weight gain 941 g;

carcass value parameters – dressing percentage 51.0%, net daily weight gain 482 g, weight and proportion of kidney fat 3.9 kg, 1.8% resp., weight and proportion of fat trim 2.2 kg and 2.0% resp.; meat quality parameters – dry matter, fat and collagen content in muscle 23.8, 1.46 and 1.13% resp., pH_{24} 6.08, drip loss 0.849% and remission (525 nm) 6.4%. Loose–housed bulls showed significantly higher dressing percentage (by 1.3%), net daily weight gain (by 31 g), total weight gain (by 4.2 kg), dry matter content in muscle (by 0.3%) and highly significantly higher collagen content in muscle (by 0.13%) than tethered bulls. Weight and proportion of kidney fat were significantly higher in tethered bulls (by 1.3 kg resp. 0.6%). Coefficients of correlation were calculated to determine the relationships between feedlot performance parameters and parameters of carcass value and meat quality. There were differences in relationship between feedlot performance parameters and two of the carcass value parameters (weight and proportion of fat trim) and one meat quality parameter (collagen content) in different housing systems. While the coefficients of correlation were significant in tethered housing, they were not significant in loose housing.

Key words: Holstein bulls, loose and tethered housing systems, beef production, carcass value, meat quality

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INTRODUCTION

Meat production in cattle is generally known to be negatively correlated with milk production. However, dairy cattle and young bulls in particular are an important part of the total beef production. Many authors have studied beef production of young Holstein bulls (previously black and white cattle) in different conditions – loose housed or tethered or housed in both housing systems.

Chladek *et al.* [7] presented the results of a study in which they observed 78 black and white bulls housed in loose boxes and slaughtered at 430 to 530 kg of live weight. The dressing percentage was 52.0%, live weight before slaughter 436 kg, carcass weight 227 kg, daily weight gain 1 012 g and net daily gain 536 g. Ptacek and Suchanek [11] showed the results of fattening of 13 young black and white bulls fattened up to 471 kg (age 510 days). The daily weight gain was 920 g in the period from 6 moths of age to slaughter, net daily gain 475 g, dressing percentage 54.9% and weight of kidney fat 8.76 kg. Nosal and Pavlic [9] looked into the fattening of 13 young bulls with high proportion (more than 75%) of black and white cattle in their genotype. The bulls were fattened to 465.69 kg of live weight, the weight at slaughter was 440.08 kg, dressing percentage 56.51%, daily weight gain 1 080 g, weight and proportion of kidney fat 4.72 kg and 1.07% resp. (calculated from the live weight) and weight and proportion of fat from the half carcass were 8.68 kg and 7.09%. Chladek and Ingr [8] analysed meat quality of Holstein bulls. They found the following parameters in a group of 50 young bulls: live weight 431.6 kg at the age of 412 days, daily weight gain 1 094 g, net daily gain 569 g, weight and proportion of kidney fat 5.03 kg and 2.28% and weight and proportion of fat trim 3.64 kg and 3.3%. The analyses of MLLT showed pH_{24} 5.54, remission (525 nm) 7.73%, dry matter content 24.9%, fat content 1.86% and collagen 1.15%.

Beef production in tethered black–and–white bulls was described for example by Dobicki [3, 4]; the live weight of bulls was 451 kg at the age of 448.9 days, dressing percentage 58.0%, kidney fat weight 2.51 kg, fat trim weight 3.79 kg; the dry matter and fat content in muscle were 24.8% and 1.62% resp. and pH_{24} 5.33. Franc *et al.* [6] studied results of fattening of 16 black and white bulls and found the following values: the live weight at slaughter 547.8 kg and age 671.36 days, net weight gain 454 g and muscle characteristics – pH_{24} 5.85, dry matter content 24.35%, fat content 2.0% and remission (522 nm) 8.63%. Teslik *et al.* [13] described meat quality of 16 black and white bulls fattened up to 516.68 kg and age 475.93 days with daily weight gain 1.296 kg and net weight gain 0.548 kg (from the beginning of

fattening at 223.62 kg of live weight to slaughter weight). The dressing percentage was 56.0%, weight of kidney fat 7.58 kg and separable fat 2.25 kg (1.59%). Some of the observed physical characteristics were pH_{24} 5.69, remission (685 nm) 30.55%; sirloin contained 4.61% fat, 26.42% dry matter and 3.32% N. Nosal and Cuboj [10] presented results of fattening of 12 bulls with high proportion (87.5–100%) of Holstein genotype. The live weight at the end of fattening was 373.3 kg, dressing percentage 53.82%, daily weight gain 1 069 g, weight and proportion of kidney fat 4.59 kg and 1.23% (of live weight) resp., while the weight and proportion of fat in carcass half were 5.25 kg and 5.56% resp.

Braun and Lizal [1] observed beef production in bulls housed in both types of housing – loose and tethered. Tethered bulls showed higher weight at the end of fattening (by 15.1 kg) and lower age at the end of fattening (by 27 days), lower dressing percentage (by 1.16%), higher weight of kidney fat (by 0.9 kg) and higher dry matter and fat content in muscle (both by 0.19%). However, it is important to point out that the authors applied extensive system of fattening with daily weight gain less than 700 g. Also Golda and Cízek [5] found out that tethered bulls showed higher live weight at the end of fattening (by 11 kg), daily weight gain (by 10 g) and weight of kidney and kidney fat (by 5.2 kg) while the age at slaughter and net gain were the same and dressing percentage was lower (by 0.8%) than that of the bulls housed in loose boxes. Buryska [2] studied fattening of bulls of dual–purpose Czech Spotted cattle. Tethered bulls reached highly significantly higher live weight at the end of fattening (by 24.34 kg), weight and proportion of kidney fat (by 2.22 kg, 0.93% resp.), pH_{24} (by 0.36), dry matter and fat content in muscle (by 0.67% and 0.83% resp.), while the dressing percentage was highly significantly lower (by 1.82%) compare to loose–housed bulls.

MATERIALS AND METHODS

The aim of this study was to evaluate the effect of tethered and loose housing on some parameters of feedlot performance, carcass value and meat quality in Holstein bulls fattened to 450 kg of live weight. The study was carried out in the group of 57 bulls, of which 35 bulls were tethered and 22 were loose housed. Both types of housing had sawdust bedding.

The ration was based on *ad libitum* intake of crushed grain (barley and wheat), limited amount of protein concentrate (including required vitamins and minerals) and restricted amount of alfalfa hay. The nutritional value of the ration was calculated in order to secure 1.3 kg of daily weight gain, according to recommendations of Sommer [12].

The following beef production parameters were evaluated on the day of slaughter: live weight and age, total weight gain and duration of fattening period, daily weight gain and net weight gain, carcass weight and dressing percentage and weight and proportion of kidney fat. The weight and proportion of fat trim in the right half of the carcass were recorded 24 hours after slaughter. Samples of meat from the same half were taken for laboratory analyses of the following meat quality parameters: dry matter content, fat and collagen in MLLT muscle between the 8^{th} and 9^{th} pectoral vertebra, pH_{24}, remission on cut (525 nm) and drip loss.

The data were analysed for mean values (x), standard deviation (s), coefficient of variation (V) and coefficient of correlation (r). One–way analysis of variance was applied to compare data on beef production in two different housing systems.

RESULTS

Some parameters of feedlot performance of Holstein bulls are presented in Table 1. The mean live weight at slaughter was 434.3 kg and age at slaughter 455.8 days. The total duration of fattening was 342.1 days with total weight gain 319.3 kg which gave daily weight gain 941 g. The highest coefficient of variation was found in total duration of fattening (11.81%) and the lowest one in live weight before slaughter (6.09%). The differences between parameters of feedlot performance in two different types of housing were not significant except for the total weight gain, which was significantly higher (by 4.2 kg) in loose housing.

Meat production parameters are shown in Table 2. The carcass weight was 221.3 kg, dressing percentage 51.0% and net daily gain 482 g. The weight of kidney fat was 3.9 kg and proportion 1.8%, the weight of fat trim from the right carcass half was 2.2 kg (2.0%).

Table 1. Some feedlot performance parameters of young Holstein bulls

Feedlot performance parameter	Unit	x	δ	v%	Tethered	Loose
Group size	number	57			35	22
Live weight at slaughter	kg	434.3	26.47	6.09	441.3	423.2
Age at slaughter	day	455.8	35.17	7.72	459.5	450.0
Total weight gain	kg	319.3	31.09	9.74	317.7 a	321.9 b
Total duration of fattening	day	342.1	40.39	11.81	344.4	338.5
Daily weight gain	g	941	103	10.95	930	959

a–b – significant difference.

Table 2. Some carcass value parameters of young Holstein bulls

Carcass value parameter	Unit	x	δ	v%	Tethered	Loose
Group size	number	57			35	22
Carcass weight	kg	221.3	13.59	6.14	222.7	219.0
Dressing percentage	%	51.0	1.59	3.12	50.5 a	51.8 b
Net daily weight gain	g	482	54	11.20	470 a	501 b
Weight of kidney fat	kg	3.9	1.70	43.59	4.4 a	3.1 b
Proportion of kidney fat	%	1.8	0.76	42.22	2.0 a	1.4 b
Weight of fat trim[1]	kg	2.2	1.46	66.36	2.4	1.9
Proportion of fat trim[1]	%	2.0	1.26	63.00	2.2	1.8

[1] calculated from the right carcass half.
a–b – significant difference.

The highest variability was found in fat trim (66.36%) and the lowest in dressing percentage (3.12%). The differences in carcass value parameters between two different types of housing were not significant except for the dressing percentage and net daily gain, which were significantly higher (by 1.3% and 31 g resp.) in loose housing, and weight and proportion of kidney fat, which were significantly higher (by 1.3 kg and 0.6% resp.) in tethered housing.

Some parameters of meat quality are shown in Table 3. The muscle contained 23.8% of dry matter, 1.46% of fat and 1.13% of collagen. The drip loss was 0.849%, pH_{24} 6.06 and remission 6.4%. The highest variability (53.12%) was found in drip loss and the lowest

(4.75%) in dry matter content in muscle. The differences in observed parameters of meat quality between different types of housing were not significant except for the dry matter content in muscle, which was significantly higher (by 0.3%) in loose housing, and collagen content in muscle, which was highly significantly higher (by 0.13%).

Table 3. Some meat quality parameters of young Holstein bulls

Meat quality parameter	Unit	x	δ	v%	Tethered	Loose
Group size	number	57			35	22
Dry matter content in muscle	%	23.8	1.13	4.75	23.7 a	24.0 b
Fat content in muscle	%	1.46	0.76	52.05	1.54	1.30
Collagen content in muscle	%	1.13	0.28	24.78	1.08 A	1.21 B
Drip loss (48 h p.m.)	%	0.849	0.451	53.12	0.925	0.729
pH_{24}		6.06	0.58	9.57	6.04	6.08
Remission on cut (24 h p.m.)	%	6.4	2.39	37.34	6.8	5.8

a–b – significant difference.
A–B – highly significant difference.

The relationships between parameters of feedlot performance and carcass value are described in Table 4. Overall values of coefficients of correlation show that the observed parameters of feedlot performance highly significantly or significantly (total duration of fattening, r = 0.295) affected carcass weight (coefficients of correlation ranged from 0.385 to 0.875). Parameters of feedlot performance also highly significantly affected net weight gain (r ranged from 0.341 to 0.928) however the effect was negative at age at slaughter and total duration of fattening (r = –0.482 and r = –0.536 resp.). Similarly, the weight and proportion of fat trim were also highly significantly affected by all the parameters of feedlot performance (except the daily weight gain), the coefficients of correlation ranged from 0.352 to 0.485 resp. from 0.367 to 0.475. The live weight affected proportion of fat trim only significantly (r = 0.290). Feedlot performance parameters did not have a significant effect on dressing percentage, weight and proportion of kidney fat, only live weight significantly affected weight of kidney fat (r = 0.287).

Table 4. Coefficients of correlation between some parameters of feedlot performance and carcass value

Carcass value parameter	Experimental group	Feedlot performance parameter				
		live weight at slaughter	age at slaughter	total weight gain	total duration of fattening	daily weight gain
Carcass weight	total	0.875**	0.376**	0.781**	0.295*	0.385**
	tethered	0.923**	0.408**	0.832**	0.442**	0.336*
	loose	0.829**	0.255	0.729**	–0.112	0.538**
Dressing percentage	total	–0.243	–0.004	0.110	0.186	–0.110
	tethered	–0.020	0.131	0.298	0.352*	–0.143
	loose	–0.298	–0.081	–0.248	0.066	–0.227

Net daily weight gain	total	0.341**	–0.482**	0.393**	–0.536**	0.928**
	tethered	0.432**	–0.515**	0.342*	–0.456**	0.948**
	loose	0.559**	–0.420**	0.535*	–0.766**	0.921**
Weight of kidney fat	total	0.287*	–0.031	0.069	–0.066	0.133
	tethered	0.201	–0.159	0.075	–0.173	0.310
	loose	0.147	0.295	0.240	0.223	–0.050
Proportion of kidney fat	total	0.180	–0.090	–0.033	–0.177	0.096
	tethered	0.088	–0.227	–0.028	–0.246	0.292
	loose	–0.015	0.235	0.081	0.240	–0.159
Weight of fat trim[1]	total	0.352**	0.385**	0.474**	0.485**	–0.081
	tethered	0.394*	0.398*	0.539**	0.537**	–0.096
	loose	0.083	0.204	0.282	0.196	0.072
Proportion of fat trim[1]	total	0.290*	0.367**	0.424**	0.475**	–0.122
	tethered	0.332	0.382*	0.493**	0.524**	–0.124
	loose	–0.029	0.167	0.170	0.209	–0.007

*** p < 0.05; ** p < 0.01.**
[1]Explanations as in Table 2.

There were differences in relationship between all feedlot performance parameters (except daily weight gain) and two of the carcass value parameters (weight and proportion of fat trim) in different housing systems. While the coefficients of correlation were highly significant or significant in tethered housing, they were not significant in loose housing. The tendency was similar in the relationship between the age at slaughter and total duration of fattening and carcass value.

The coefficients of correlation between feedlot performance parameters and meat quality are shown in Table 5. The overall values show that meat quality parameters were most of all affected by total duration of fattening. Total duration of fattening highly positively affected dry matter and collagen content in muscle (r = 0.461 and r = 0.397 resp.), significantly affected drip loss (r = 0.287) and highly negatively affected pH_{24} (r = –0.429). Total weight gain highly significantly affected collagen content in muscle (r = 0.372), significantly affected dry matter content and fat content in muscle (r = 0.288 and r = 0.262 resp.) and significantly negatively affected pH_{24} (r = –0.293). A highly significant positive coefficient of correlation was found between the age at slaughter and collagen content in muscle (r = 0.429), significant positive correlation was found between age at slaughter and dry matter content in muscle (r = 0.290) and significant negative coefficient was found between age at slaughter and pH_{24} (r = –0.336).

Table 5. Coefficients of correlation between some parameters of feedlot performance and meat quality

Meat quality parameter	Experimental group	Feedlot performance parameter				
		live weight at slaughter	age at slaughter	total weight gain	total duration of fattening	daily weight gain
Dry matter content in muscle	total	0.068	0.290*	0.288*	0.461**	–0.244
	tethered	0.146	0.305	0.285	0.452**	–0.278
	loose	0.038	0.351	0.280	0.603**	–0.296

Fat content in muscle	total	0.228	0.201	0.262*	0.291*	–0.086
	tethered	0.274	0.235	0.301	0.320	–0,090
	loose	–0.043	–0.114	0.139	0.120	–0,027
Collagen content in muscle	total	0.244	0.429**	0.372**	0.397**	–0.083
	tethered	0.473**	0.500**	0.463**	0.518**	–0.157
	loose	0.045	0.365	0.010	0.086	–0.044
Drip loss (48 h p.m.)	total	0.228	0.202	0.175	0.287*	–0.166
	tethered	0.219	0.136	0.272	0.202	0.017
	loose	0.110	0.312	0.097	0.460*	–0.341
pH_{24}	total	0.090	–0.336*	–0.293*	–0.429**	0.191
	tethered	0.049	–0.410*	–0.243	–0.488**	0.359*
	loose	–0.320	–0.132	–0.449*	–0.285	–0.077
Remission on cut (24 h p.m.)	total	–0.079	–0.150	–0.172	–0.177	0.015
	tethered	–0.167	–0.180	–0.178	–0.245	0.104
	loose	0.146	–0.191	–0.114	–0.098	–0.060

*** p < 0.05; ** p < 0.01.**

The effect of live weight before slaughter and daily weight gain on meat quality parameters was not significant. Similarly, feedlot performance parameters did not significantly affect remission. The differences between the two types of housing were found in coefficients of correlation between all the parameters of feedlot performance (except daily weight gain) and collagen content in muscle. Those coefficients were significant for tethered bulls and they were not significant for the loose–housed bulls.

DISCUSSION

One of the feedlot performance parameters, total weight gain, was significantly different in different housing systems. Tethered bulls had significantly lower dressing percentage (by 1.3%) and daily weight gain than loose–housed bulls. This difference was due to the higher weight and proportion of kidney fat. This result is in agreement with results of other authors who also found lower dressing percentage in tethered bulls, e.g. Buryska [2] – the dressing percentage was lower by 1.82% (in animals with higher live weight by 4.48%); Golda and Cízek [5] found only non–significant difference 0.8%; in the study of Braun and Lizal [1] the dressing percentage was lower by 16%, however the significance of this result was not stated.

The overall dressing percentage was lower than that presented by most of the authors quoted above. It is similar to the dressing percentage found by Chladek and Ingr [8], Chladek *et al.* [7] and Nosal and Cuboň [10]. The values found by other authors are significantly higher. However, in some cases the dressing percentage is calculated as a proportion of live weight minus the weight of stomach content (up to 8%). Thus calculated values are about 5% higher. In our case, we did not lower live weight.

The weight and proportion of kidney fat are lower that those found by other authors or just comparable. Lower values are presented by Dobicki [3, 4], comparable values were found by Nosal and Pavlic [9] or Nosal and Cuboň [10], considerably higher values were presented by Teslik *et al.* [13], and Ptacek and Suchanek [11] found the highest values, surprisingly in loose–housed bulls.

Positive effect of tethered housing system on weight and proportion of kidney fat probably reflected in significance of coefficients of correlation between feedlot performance parameters and weight and proportion of fat trim. However, our values of weight and proportion of fat trim were lower than those of all the quoted authors, except for Teslik *et al*. [13].

In our study the dry matter content in muscle was significantly lower in tethered bulls which is not in agreement with Buryska [2] or Braun and Lizal [1] who found higher values or tendency towards higher values in tethered bulls.

The highly significant effect of loose housing on collagen content in muscle of loose–housed bulls is similar to that found by Chládek and Ingr [8]. Unfortunately, not many authors dealt with this problem, so the further comparison is not possible. Our results may suggest positive effect of extended motion of loose–housed bulls on collagen content in muscle. However, this is just a speculation and further research is needed to confirm it. Fat content in muscle and pH values were not affected by type of housing in our study, in contrast to the results of Buryška [2], who found positive effects.

CONCLUSIONS

1. The feedlot performance parameters – live weight at slaughter 434.3 kg, age at slaughter 455.8 days, total weight gain 319.3 kg, duration of fattening 342.1 days, daily weight gain 941 g; carcass value parameters – dressing percentage 51.0%, net daily weight gain 482 g, weight and proportion of kidney fat 3.9 kg, 1.8% resp., weight and proportion of fat trim 2.2 kg and 2.0% resp.; meat quality parameters – dry matter, fat and collagen content in muscle 23.8, 1.46 and 1.13% resp., pH_{24} 6.08, drip loss 0.849% and remission (525 nm) 6.4%.
2. Loose–housed bulls showed significantly higher dressing percentage (by 1.3%), net daily weight gain (by 31 g), total weight gain (by 4.2 kg), dry matter content in muscle (by 0.3%) and highly significantly higher collagen content in muscle (by 0.13%) than tethered bulls. Weight and proportion of kidney fat were significantly higher in tethered bulls (by 1.3 kg resp. 0.6%).
3. There were differences in relationship between feedlot performance parameters and two of the carcass value parameters (weight and proportion of fat trim) and one meat quality parameter (collagen content) in different housing systems. While the coefficients of correlation were significant in tethered housing, they were not significant in loose housing.
4.

REFERENCES

1. Braun B., Lízal F., 1970. Feeding high rations of maize cobs, molasses and urea to bulls and oxen. Zivoc.Vyr. 15: 639–638 [in Czech].
2. Buryska J., 1985. The quality of the meat of bullock in relation to housing systems. Zivoc. Vyr. 30: 707–716 [in Czech].
3. Dobicki A., 1971a. Intensive fattening of young Black–Pied and Red–Pied Lowland bulls. Part I. Fattening results and economic analysis. Rocz. Nauk Rol. B–93–1: 7–22 [in Polish].
4. Dobicki, A., 1971b. Intensive fattening of young Black–Pied and Red–Pied Lowland bulls. Part II. Carcass quality and physiochemical properties of meat. Rocz. Nauk Rol. B–93–1: 23–46 [in Polish].
5. Golda J., Cizek J., 1982. Meat efficiency of bulls crossed with the Black–Pied Cattle the Holstein breed. Zivoc.Vyr. 27: 345–352 [in Czech].

6. Franc C., Teslik J., Urban F., Bouska J., Rehak D., Zivocka J., 1993. Nutritive, technological and sensory properties of meat of bulls of Czech Pied, Lowland Black–Pied and Polled Hereford breeds. Zivoc. Vyr. 38: 73–83 [in Czech].
7. Chladek G., Soutor J., Ingr I., Krasa A., 1997. Meat efficiency of bullocks of the Black Pied breed fattened to 430–530 kg of body weight. Acta Univ. Agric. Silvic. Mendel. Brun (Brno) 55: 13–18.
8. Chladek G., Ingr I., 2001. Meat production and quality of Holstein bulls fattened to 405–480 kg of live weight. Czech J. Anim. Sci. 46: 370–374.
9. Nosal V., Pavlic M., 1988. Bullock with a high hereditary proportion of the Black–Pied Lowland breed: Dressing percentage at fattening to lower slaughter weights. Zivoc. Vyr. 33: 809–820 [in Czech].
10. Nosal V., Cubon J., 1994.Production of baby beef when commercial crossing with meat breed used. Zivoc. Vyr. 39: 467–474 [in Czech].
11. Ptacek J., Suchanek B., 1985. Meat efficiency of bulls of five genotypes during fattening to various body weights. Zivoc. Vyr. 30: 689–698 [in Czech].
12. Sommer A. 1994. Nutrition requirements and tables of the native values of the feed for ruminants. CAZV, komise výživy hospodářských zvířat, Vyd. 1 Pohorelice, CZS VUVZ [in Czech].
13. Teslik V., Burda J., Urban F., Barton L., Rehak D., 1995. Beef performance of bulls of the Czech Pied and Black–Pied cattle during intensive fattening to the weight of 530 kg. Zivoc. Vyr. 40: 227–232 [in Czech].

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