Effect of feeding management and slaughter weight on carcass and meat quality of finishing bulls

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Abstract— **The impact on carcass and meat quality of grazing vs. indoor feeding during the growing period, followed by a similar indoor finishing (feeding management; FM), and slaughtering at 650 or 725 kg body weight (SW) was investigated in a 3x2 factorial design. One hundred and eleven Belgian Blue double-muscled bulls were involved. Animals of FM group 1 were turned out to pasture during summer and were supplemented daily with 2 kg dried beet pulp per animal. They were confined in loose houses during the winter period and fed grass silage supplemented with 2 kg concentrate. The other groups were confined permanently and received a diet of maize silage and concentrate (67:33 dry matter basis). The diet was restricted for a daily gain of ±0.85 kg (Group 2) or fed ad libitum (Group 3). From 400 kg onwards, all animals were finished indoors on maize silage and concentrate (50:50 dry matter basis). Bulls with a grazing period yielded a lower carcass weight and dressing percentage. Their meat was characterized by a paler colour, and higher drip and cooking losses. A heavier SW tended to increase carcass fat and intramuscular meat fat content, while meat moisture content and cooking loss were reduced. Significant interactions were found for dressing, carcass meat and fat content, waterholding capacity and meat tenderness. It is concluded that FM during the growing period as well as SW affect carcass and meat quality of Belgian Blue double-muscled bulls.**

Keywords— **Management, slaughter weight, meat quality**

I. INTRODUCTION

Several experiments have shown that nutritional factors or feeding management may affect carcass and meat quality in beef cattle [1, 2]. Indoor finishing on a similar diet, but with or without a previous grazing period also changed intramuscular fatty acid composition [3,4].

Grazing may become more important under extensive production systems. This extensification is inspired by the aim to improve environmental protection and animal welfare. Performance of grazing cattle is often reduced in comparison with indoor fed animals [3, 4]. However, this reduced growth rate can be compensated to some extent during the following re-alimentation period.

Increasing slaughter weight mostly results in a fatter carcass [5]. However, as double-muscled animals are characterised by a large lean meat deposition [6], this phenomenon may be of minor importance in this type of cattle. Consequently, the decision to slaughter at a higher weight may be dependent on animal performance and meat quality.

This report deals with the effect of grazing compared with indoor feeding during the growing period, followed by a similar indoor finishing on carcass and meat quality. Furthermore, the impact of slaughter weight is also investigated.

II. MATERIALS AND METHODS

One hundred and eleven 5-month old Belgian Blue double-muscled male calves were randomly divided into three groups with a different feeding management (FM). The first group was turned out to pasture during summer and supplemented with 2 kg dried sugar-beet pulp per day and per animal. During the winter period, these animals were confined in loose houses and fed grass silage supplemented with 2 kg concentrate. The other two groups stayed permanently indoors and were fed a diet of maize silage and concentrate (67:33 dry matter basis). The diet was restricted for a daily live-weight gain of ±0.85 kg (Group 2) or was freely available (Group 3). From 400 kg onwards all animals were finished on maize silage and concentrate (50:50 dry matter basis). Within each group two slaughter weights (SW) were studied: 650 kg or 725 kg.

Carcasses were classified according to the European classification scheme [7]. Dressing was calculated as cold carcass weight over empty body weight. Carcass

composition was assessed based on the dissection of the eighth rib cut [8]. Samples of the Longissimus thoracis (LT) were taken from the 8th rib interface of the right carcass half at 24 h post-mortem. The area of the LT was measured using a digitizer. The samples were also used to determine meat quality according to Boccard et al. [9]. Colour was measured with a Hunterlab Lab-Scan II (Hunter Associates Laboratory, INC; Reston, USA) at 10° observer and illuminant D65, and expressed in CIE L*a*b* units. Shear force value was determined on 10 cork-bore samples (1.25 cm diameter) perpendicular to the fibre direction with a Lloyd 1000S apparatus (Lloyd instruments, Southampton, UK) after an ageing period of 8 days. Meat samples of 2.5 cm thickness were first immersed in a waterbath at 75°C for 1 h and subsequently cooled under running tap water to room temperature.

The statistical analysis was based on a 3x2 factorial design with FM and SW as the main factors. As age at slaughter was different between groups due to FM and SW, results were analysed with slaughter age as covariate. Data are presented as least square means.

III. RESULTS AND DISCUSSION

A. Carcass quality

The main factors FM and SW exerted a significant effect on age at slaughter: the more extensive FM (Groups 1 & 2) and the heavier SW resulted in an increased age at slaughter. Carcass quality parameters are shown in Table 1. Beside the expected effect of SW on cold carcass weight, the latter was also significantly affected by FM. The more extensive grazing system resulted in a lower carcass weight, although empty body weight was not affected. Dressing was affected by FM but not by SW. Significant effects on carcass classification and composition were also observed. An increased dressing with a higher body weight is in agreement with the results of Barber et al. [10], who compared light weight, middle weight and heavy weight steers. LT muscle fat content increased from the light weight to the middle weight group, but did not differ between the middle and heavy weight groups.

Variable effects on carcass quality have been reported due to a previous grazing period. Hornick et al. [3] found a lower dressing proportion compared to permanent indoor feeding when stocking rate was increased up to 10 bulls per ha, but not in the case of 6 bulls per ha. A lower dressing proportion was also observed for those animals which remained at pasture in experiments of Keane and Allen [5]. No differences were reported by Dufrasne et al. [11] when grazing at a stocking rate of 6 bulls per ha was compared with indoor feeding. A reduction of the dressing percentage in grazing animals can be explained by the bulkiness of the fresh grass because of its low dry matter content.

Variable results with regard to the effect of grazing on carcass composition were also found. Composition was not modified [3], while a higher [5] as well as a lower fatness [11] were reported for a grazing system. However, differences found by Keane and Allen [5] may be explained by the fact that bulls were involved for indoor feeding, compared with steers for grazing. Bulls normally produce carcasses with less fat and more lean meat [12]

B. Meat quality

Meat quality parameters are given in Table 2. Grazing resulted in higher drip and cooking losses. Lightness (L*) of meat of grazing animals also tended to be higher than in the other groups, while redness (a*) was lower. Shear force values were highly variable so that differences between groups were not significant. Due to small variations within groups, contents of moisture and protein were different, but the practical meaning may not be of great importance. Significant effects of FM on meat quality have been reported [5], but the different FM immediately preceded slaughter. In experiments of Myers et al. [13], where a different FM was followed by a similar finishing diet, no effect on meat quality was observed. Experiments with double-muscled animals are scarce, but Hornick et al. [3] found that a grazing period followed by an indoor finishing on a concentrate diet compared to a constant indoor concentrate diet resulted in darker meat with less cooking losses and a lower moisture content. These meat quality traits were in contradiction with our findings. Priolo et al. [14] found that meat from animals finished on pasture is darker than meat from animals finished on concentrate. These authors further stated that meat

Table 1. Effect of feeding management (FM) and slaughter weight (SW) on slaughter data and carcass quality

	Feeding management			Slaughter weight (kg)		Pooled s.d.	Significance		
	1	2	3						
	Grazing	Indoors		650	725		FM	SW	FMxSW
		Restricted	Ad lib.						
Finishing period (d)	201[ab]	195[a]	222[b]	176	236	37	0.006	<0.001	0.112
Age at slaughter (d)	649	618	572	585	641	64	<0.001	<0.001	0.043
Empty body weight (kg)	650	650	647	619	679	19	0.793	<0.001	0.419
Cold carcass weight (kg)	469[a]	477[b]	478[b]	452	497	14	0.014	<0.001	0.531
Dressing (%)	72.1[a]	73.4[b]	73.8[b]	73.1	73.1	1.1	<0.001	0.772	<0.001
LT area (cm^2)	146[a]	158[b]	149[ab]	149	153	23	0.096	0.336	0.824
SEUROP-classification									
Conformation	17.2	17.4	17.3	17.3	17.3	1.0	0.474	0.839	0.465
Fat covering	6.1	5.7	5.8	5.6	6.0	0.9	0.277	0.102	0.972
Carcass composition (%)									
Meat	76.1	76.2	76.4	76.5	76.0	1.7	0.766	0.202	0.049
Fat	12.3	11.7	11.6	11.5	12.1	1.6	0.188	0.075	0.031
Bone	11.6	12.1	12.0	12.0	11.9	1.1	0.138	0.536	0.636
Meat production coefficient (%)	54.9[a]	55.9[b]	56.4[b]	55.9	55.6	1.7	0.002	0.449	0.001

[abc] Values without or with the same superscripts are not different (P > 0.05)

Table 2. Effect of management system, and slaughter weight (kg) on meat quality parameters of the Longissimus thoracis

	Feeding management			Slaughter Weight (kg)		Pooled S.d.	Significance		
	1	2	3						
	Grazing	Indoors		650	725		FM	SW	FMxSW
		Restricted	Ad lib.						
Ultimate pH	5.5	5.5	5.5	5.5	5.5	0.1	0.129	0.623	0.974
Colour (CIE-lab)									
L*-value	46.4[a]	44.0[b]	42.8[b]	44.6	44.2	3.9	0.002	0.672	0.692
a*-value	16.6[a]	17.5[b]	17.4[ab]	16.9	17.4	1.8	0.079	0.183	0.810
b*-value	15.1	15.1	14.5	14.8	15.0	1.8	0.385	0.477	0.661
Waterholding capacity (%)	33.0	32.7	32.6	33.3	32.2	2.2	0.745	0.021	0.045
Drip loss (%)	8.1[a]	7.2[b]	7.4[ab]	7.6	7.6	1.6	0.048	0.956	0.366
Cooking loss (%)	24.8[a]	23.8[b]	23.5[b]	24.4	23.7	1.6	0.003	0.055	0.130
Shear force (N)	38.8	40.0	43.4	42.0	39.5	10.6	0.224	0.256	0.069
Chemical composition (%)									
Moisture	75.7[a]	75.4[b]	75.4[b]	75.6	75.4	0.3	0.003	0.003	0.750
Protein	22.1[a]	22.4[b]	22.4[b]	22.3	22.4	0.3	0.002	0.128	0.261
Fat	1.1	1.1	1.2	1.1	1.2	0.3	0.783	0.067	0.446

[ab] Values with the same superscripts are not different (P > 0.05)

colour may be influenced by carcass fatness. No differences in fat content were found in our experiment, so that it is unlikely that it can explain the opposite results.

SW exerted a significant effect on waterholding capacity, a*-value and chemical composition. An interaction between FM and SW was found for the waterholding capacity, while there was a tendency for an interaction with regard to shear force value and muscle fat content. Differences due to SW are related to age, and age affects colour intensity [15]. However, Bowling et al. [16] showed that myoglobin content, which is a determinant of colour, may also be affected by management systems: steers slaughtered after 255 days on a concentrate diet had a similar myoglobin content as those slaughtered after several periods of pasture, taking 561 to 660 days. Age also may negatively affect meat tenderness due to a reduced collagen solubility [17], but the literature is equivocal on the effect of age on tenderness [15, 16]. Increased

age at slaughter or slaughter weight mostly results in a fatter carcass and meat [5, 16], but differences reported by these authors are considerably higher than in our double-muscled animals. The latter are known to have a low fat content [6]

IV. CONCLUSIONS

Despite of a similar finishing diet, fed during at least 175 days, FM still exerted a significant effect on carcass weight, dressing, meat colour, cooking loss and chemical composition of LT. An increased SW improved the waterholding capacity. Chemical composition of LT was modified but the biological significance may be of minor importance.

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