RELATIONSHIP BETWEEN MEAT QUALITY ATTRIBUTES AND ANIMAL PERFORMANCE OR CARCASS COMPOSITION IN BELGIAN BLUE DOUBLE-MUSCLED TYPE BULLS

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Introduction

The preference of the bovine meat industry in Belgium for double-muscled (DM) carcasses can largely be explained by their exceptional carcass quality and by an increasing demand to lean meat (Sonnet, 1982 ; Hanset *et al.*, 1989). Informations about quality attributes of such a meat are scarce and quite new (Clinquart *et al.*, 1994 ; Uytterhaegen *et al.*, 1994 and Fiems *et al.*, 1995). However meat quality of DM animals has not been directly related to meat or carcass composition. The objective of the present study was to investigate such relationships with Belgian Blue DM bulls.

Material and methods

Hundred ninety four double-muscled bulls from the Belgian Blue breed were fattened under similar conditions and surveyed for average daily gain (ADG) and feed efficiency (FE) at the experimental farm of the University of Liège. The fattening diet was based on dried sugar beet pulp and supplemented with cereals, middlings, soyabean meal, linseed meal, minerals and vitamins. The animals were slaughtered when they attained the finished state as estimated by palpation of the tailhead, the loin and the rib area. At slaughter hot carcass weight (HCW) was measured; temperature and pH were recorded 1h, 2h and 4h *post mortem* directly in the *longissimus thoracis* (LT) muscle. Two days later the 7-8-9th ribs were removed from the carcass and dissected in order to separate lean meat, fat and bone and to assess the carcass composition (Martin and Tooreele, 1962). The LT muscle was sampled for chemical composition and meat quality determination. Dry matter of meat samples was obtained by freeze-drying. Crude protein was measured by the Kjeldahl method with block digestion (Tecator) and subsequent automated ammonia determination by the Berthelot reaction using Technicon Autoanalyzer methodology. Ether extract was estimated by the official EC Soxhlet method. The cholesterol content was determined by a kit procedure from Boehringer Mannheim (cat n°139 050) using cholesterol oxidase and color development via formation of lutidine dye. The Hunter Lab device was used 48h *post mortem* for objectively measuring CIE L*a*b* parameters. A 2.5 cm thick cut of the LT muscle was used for estimating water holding capacity : drip loss was determined as the percentage weight loss after 6 days in a plastic bag at 2°C ; cooking loss was measured as the percentage weight loss after cooking in an open plastic bag in a waterbath during 60 min at 75°C. Warner-Bratzler peak shear force (WBPSF) was determined with a Lloyd LR5K device perpendicular to the fibre direction on 1.25 cm diameter cores obtained from the heated cut.

Results and discussion

Animal performance (Table 1) results confirm the high level of gain (ADG) which can be obtained with Belgian Blue bulls. This high growth rate was associated with a favourable feed efficiency (FE) intermediate between the values obtained by Boucqué *et al.* (1984) and those from Clinquart *et al.* (1995) with final liveweight (FLW) of 650 kg and 540 kg respectively. The dressing percentage (DP) (Table 2) was rather low in comparison with values usually reported with such bulls, due to the lack of fasting and the relatively short transport time (<1h). The lean meat (MTP) and adipose tissue (ATP) proportions corresponded to total amounts of 284 kg and 53kg respectively so that the lean meat yield was about 50% when related to the slaughter liveweight (SLW).

Table 1. - Animal performance (mean ± standard deviation)

Initial liveweight (kg)	367 ± 82
Final liveweight (kg)	602 ± 66
Duration (d)	175 ± 49
Average daily gain (kg/d)	1.44 ± 0.23
Feed efficiency (kg/kg)	6.70 ± 1.07
Final age (d)	603 ± 131

Table 2.- Carcass characteristics (mean ± standard deviation)

Slaughter liveweight (kg)	599 ± 67
Hot carcass weight (kg)	385 ± 46
Dressing percentage (%)	64.3 ± 1.8
Lean meat proportion (%/carcass)	73.7 ± 2.8
Adipose tissue proportion (%/carcass)	13.7 ± 2.6
Bone proportion (%/carcass)	12.6 ± 1.0

The pH values were 6.66±0.25, 6.44±0.27, 5.99±0.27 1h, 2h, 4h *post mortem* respectively. These values are low in comparison with other breeds as previously reported by Batjoens *et al.* (1989). The ultimate pH observed 48 h *post mortem* was 5.54±0.12. The 1h pH value was negatively correlated with FLW (r=-0.25, p<0.01), SLW (r=-0.217, p<0.01) and HCW (r=-0.20, p<0.05 to) but not with carcass and meat compositions.

The chemical and quality characteristics of the meat are presented in tables 3 and 4. The ether extract (LLT) and cholesterol contents in LT were low, corresponding to 1g and 0.039g when expressed to 100 g of fresh meat. The L* value was positively correlated with ADG (r=+0.32, p<0.001) and negatively with FE (r=-0.27, p<0.001) ; it could therefore be suggested that animals with a high growth rate produce a paler meat. The hue parameters a* and b* were positively correlated with FLW, SLW and HCW (r=+0.30 to +0.39, p<0.001) independently of age. The hue was also negatively correlated with MTP (r=-0.28, p<0.001 for a*; r=-0.17, p<0.05 for b*) and positively correlated with ATP (r=+0.28, p<0.001 for a*; r=+0.25, p<0.001 for b*) indicating that an increase of meat proportion results in a reduction of hue. No relationship was found between color parameters and chemical composition of the meat.

Table 3. - Chemical composition of the *longissimus thoracis* muscle

Dry matter (%)	24.3 ± 1.0
Ash (% in dry matter)	4.7 ± 0.6
Crude protein (% in dry matter)	90.8 ± 3.1
Ether extract (% in dry matter)	4.0 ± 2.0
Cholesterol (% in dry matter)	0.160 ± 0.035

Table 4.- Quality characteristics of the *longissimus thoracis* muscle

CIE L* (%)	42.6 ± 3.4
CIE a*	17.0 ± 2.1
CIE b*	16.9 ± 1.8
Drip loss (%)	5.1 ± 1.4
Cooking loss (%)	26.2 ± 4.9
Warner-Bratzler peak shear force (N)	37.7 ± 11.6

The correlations between water holding capacity and animal performance or carcass composition were poor and not constant. The relationship was more pronounced with meat composition : both losses were positively related with LT protein content (PLT) (r=+0.18, p<0.05 for drip; r=+0.28, p<0.001 for cooking loss) but cooking loss only was significantly correlated with LLT (r=-0.20, p<0.01). It has previously been shown by Clinquart *et al.* (1994) and Fiems *et al.* (1995) that the water holding capacity of the Belgian Blue meat is not reduced as compared to breeds with a significantly higher fat content in the carcass and in the meat. The lack of strong and consistent correlations in the present experiment between water holding capacity and carcass or meat composition is therefore not surprising.

The mean WBPSF was low in comparison of previous results reported by Batjoens *et al.* (1989), Uytterhaegen *et al.* (1994) and Fiems *et al.* (1995) with Belgian Blue bulls. The difference could be partially explained by difference in animal performance since highly significant correlations were observed in the present experiment between animal performance and tenderness. The WBPSF was positively correlated with SLW (r=+0.21, p<0.05), HCW (r=+0.27, p<0.001) and DP (r=+0.33, p<0.001). It was not an age effect since the correlation between WBPSF and age was poor (r=0.002) and not significant. The highly significant relationship observed with SLW and DP could be explained by the positive effect of SLW on DP in the Belgian Blue breed, the correlation between the two last parameters being significant (r=0.18, p<0.05). From 8 experiments in which Belgian Blue DM bulls were studied by several authors, Clinquart *et al.* (1997) previously reported significant correlations between SLW and DP (r=0.54). By contrast, the correlations between WBPSF and carcass composition were poor and not significant (r=0.059 for MTP and r=-0.003 for ATP). However, there is support for a relationship between tenderness and carcass composition since a higher correlation coefficient (r=0.16 between WBPSF and MTP) was reported by Fiems *et al.* (1995). It can be therefore concluded from these results that tenderness could be altered to a greater extent by the final liveweight than by age. The correlation between animal performance and tenderness could be indirectly explained by the effect of the chemical composition of meat : a negative correlation being found with LLT (r=-0.16, p<0.05) while the correlation was positive and significant with PLT (r=+0.19, p<0.01). These opposite effects of protein and lipid fractions on tenderness could be linked to their different mechanical resistance, the resistance of myofibrillar proteins to shearing being higher than that of lipids. The variation in meat composition could only partially contribute to the effect of animal performance on tenderness since the relationships between meat composition and SLW, HCW and DP were not constant. *Post mortem* ageing could also partially account for the relationship between tenderness and animal performance. Further investigations are needed to assess the links between *in vivo* protein turnover and *post mortem* protein degradation.

In conclusion, all quality attributes of meat produced by Belgian Blue DM bulls could be influenced by animal performance. Furthermore the color characteristics could be related to carcass composition but not with chemical composition. By contrast the water holding capacity and tenderness seem to be linked to a greater extent to chemical composition.

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