CARCASS CHARACTERISTICS AND MEAT QUALITY OF DUAL PURPOSE TYPE BULLS AS INFLUENCED BY TWO GROWTH PATTERNS DURING THE GROWING PERIOD

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SUMMARY

Two different growth rates (1.13 kg/d in group '+' and 0.34 kg/d in group '-') were imposed to twelve Belgian Blue bulls from dual purpose type during 202 d. They were then fattened until 600 kg liveweight. In group '-', bulls produced more fat as indicated by a higher adipose tissue proportion in the carcass (31.1 vs 26.4%, P<0.05) and a higher ether extract content in the *longissimus thoracis* muscle (8.7 vs 6.8% in dry matter, P<0.05). These changes were associated with slight effects in meat quality e.g. a significantly higher water holding capacity (drip loss : 7.0 vs 9.5%, P<0.05 ; cooking loss : 31.1 vs 33.3%, P<0.05) and a trend for darker and tougher meat. These changes could be related to the severity of food restriction during the growing period and to a longer fattening period in group '-'.

Introduction

The degree to which growth patterns are modified in cattle after a period of food restriction affects the composition of the carcasses and the physical properties of meat (Fishell et al., 1985 ; Carstens et al., 1991). In numerous studies, the compensatory growth exhibited by beef cattle after a restriction period is often compared with a continuous growth pattern. In Belgium beef meat is mainly produced from growing-fattening bulls. In conventional practice the average daily gain is about 1.0 kg/d during the growing period and about 1.4-1.5 kg/d during the fattening period (Clinquart et al., 1991). The objective of the present experiment was to compare carcass composition and meat quality in bulls produced by either the conventional technique or by a technique including a severely restricted growth rate (<0.4 kg/d) during the growing period.

Material and methods

Animals and Management

Twelve Belgian Blue bulls from the dual purpose type weighing 233 kg were offered two different planes of nutrition during the growing period which lasted for 202 days. Six bulls (group '+') received *ad libitum* a conventional growing diet made of 80% growing concentrate and 20% hay. The concentrate was based on dried sugar beet pulp, dried alfalfa, cereals, soya-bean meal and molasses. The average daily gain was 1.13 kg/d. Six other bulls (group '-') were given a restricted diet made of 20% of growing concentrate, 60% straw pellets and 20% hay. The average daily gain was reduced to 0.34 kg/d in this group. Then both groups were fattened with a similar diet made of 86% of a fattening concentrate and 14% of hay given *ad libitum*. The concentrate was based on dried sugar beet pulp, cereals, soya-bean meal, linseed meal and molasses. Both groups were slaughtered when the liveweight was close to 600 kg so that the fattening period lasted for 82 and 194 d and the average daily gain was 1.44 and 1.46 kg/d in the groups '+' and '-' respectively.

Measurements

Hot carcass weight was recorded at slaughter. pH was measured directly on the carcass 1h *post mortem* in the *longissimus thoracis* muscle (7-8-9 ribs). These 3 ribs were removed after 2 days and dissected to separate lean meat, fat and bones ; composition of the carcass was estimated according to Martin and Torreele (1962). The *longissimus thoracis* muscle was taken for chemical analysis (dry matter, protein, ether extract and myoglobin content) and meat quality determination. The Hunter Lab device was used 48h *post mortem* for objectively measuring CIE Lab brightness (L*) and colour (a* and b*), the a*/b* ratio being used as an index of hue. *Post mortem* protein denaturation was estimated by transmission value (Hart, 1962). The filter paper press method of Grau and Hamm (1957) was applied to measure the expressible juice. Drip loss was determined as the percentage weight loss of a 2.5 cm thick cut after 5 days in a plastic bag at 4°C. Then this cut was used for cooking loss determination (50 min at 75°C) according to Boccard et al. (1981). Warner Bratzler peak shear force was determined with an Instron 1140 device perpendicular to the fibre direction on 1.25 cm diameter cores obtained from the heated cuts.

Statistical analyses

One-way analysis of variance was used according to the method described by Dagnelie (1975).

Results and discussion

Liveweight at the slaughterhouse was 581.4 and 581.7 kg and hot carcass weight 377.0 and 370.2 kg so that the killing-out proportion was 64.8 and 63.6% in groups '+' and '-' respectively (Table 2). The carcass composition was altered the group '-' as indicated by lower lean meat (55.6 vs 58.1%, $p>0.05$) and higher adipose tissue proportion (31.1 vs 26.4%, $p<0.05$). Similar trends were observed in the *longissimus thoracis* muscle composition : 80.2 vs 86.9% ($p<0.05$) for crude protein content in dry matter and 8.7 vs 6.8% ($p<0.05$) for ether extract content in dry matter in groups '-' and '+' respectively (Table 3). Thus the bulls deposited more fat in group '-' than in group '+'. Carstens et al. (1991) apparently found an opposite trend with steers submitted to a similar severe growth restriction (0.4 kg/d from 245 to 325 kg) followed by a 1.59 kg/d gain from 325 kg to 500 kg but in their experiment 'control' steers gained 1.51 kg/d from 245 to 325 kg and only 1.16 kg/d from 325 to 500 kg. In the present experiment, as opposed to the 'control' bulls of Carstens et al. (1991), the bulls of group '+' were also submitted to a growth restriction during the first period and they exhibited compensatory growth during the second. Therefore these results are in accordance with the assumption of Carstens et al. (1991) who concluded from their own and other results that, as the severity of growth restriction increases, there is a tendency for lean tissue growth to be reduced and fat tissue growth to be increased during the compensation period.

The quality characteristics of the *longissimus thoracis* muscle are presented in Table 4. The *post mortem* pH evolution was similar in both groups. There was a tendency for a darker meat in group '-' as indicated by a lower L* value (34.4 vs 36.1%, $p>0.05$) and a higher a*/b* hue value (1.85 vs 1.80, $p>0.05$). This trend was associated with a higher myoglobin content (4.4 vs 3.8 mg/g of fresh meat, $p>0.05$) and could be related to age of these animals which were slaughtered about 4 months later. Water holding capacity was significantly improved in group '-' : drip loss and cooking loss being lower (7.0 vs 9.5%, $p<0.05$; 31.1 vs 33.3%, $p<0.05$). In contrast, no difference was observed by the filter paper press method, since the expressible fluid was similar in both groups (34.0 vs 33.4%). The lower water holding capacity in group '+' could not be related to a higher *post mortem* protein denaturation since the transmission value was similar in the two groups. There was no pH effect. Therefore the lower drip and cooking loss in group '-' could be partly explained by a higher intramuscular fat content. A trend for higher Warner-Bratzler peak shear force was found in group '-' (40.8 vs 36.9 N, $p>0.05$) suggesting tougher meat in this group. The higher growth rate during the first month of the fattening period in this group did not improve tenderness. Aberle et al. (1981) changed groups of steers from a low to a high energy diet ; an improved tenderness was observed only in the group which was slaughtered after the first 70 days. This improvement of tenderness could be related to a higher newly synthetized collagen content and a higher extent of myofibril fragmentation. The higher tenderness observed in group '+' is consistent with these results. This effect could have been lost in group '-' because of the longer fattening period (194 d). Nevertheless, the observed trend for a tougher meat could be related to the *post mortem* tenderisation process. As reported by Van Eenaeme et al. (1994), calpain I activity 1h *post mortem* was lower in group '-' (5.6 vs 13.1 units/g/min , $p<0.05$) while calpain II activity was higher 1h (37.2 vs 25.3 units/g/min, $p<0.05$) and 24h *post mortem* (36.1 vs 25.0 units/g/min, $p<0.05$) in this group. Calpastatin activity was not altered. Since most of the tenderisation process in beef *longissimus thoracis* muscle is caused by calpain I and occurs before 24h (Dransfield, 1994), the trend for a tougher meat in the present experiment could have been associated with an altered tenderisation process. In contrast the relationship between this trend and fat content of meat is paradoxal and not consistent with the results from Bruce et al. (1991) who observed with Charolais-crossbred steers that meat tenderness was affected primarily by dietary energy and its relationship to intramuscular fat deposition. The trend to darker and tougher meat could also be related to altered muscle fiber characteristics due to a lower energy or protein level during growth ; but according to Seideman and Crouse (1986) muscle fiber characteristics do not relate to tenderness in bulls.

In conclusion, a restriction of feeding during the growing period produced fatter carcasses and fatter meat with altered quality characteristics : higher water holding capacity and a trend to a darker colour and tougher texture. These changes appear to be related to the severity of restriction and duration of fattening period.

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