ETUDE 3

MEAT QUALITY IN RELATION TO BREED (BELGIAN BLUE vs HOLSTEIN) AND CONFORMATION (DOUBLE MUSCLED vs DUAL PURPOSE TYPE)

A. CLINQUART[1], C. VAN EENAEME[1], T. VAN VOOREN[2],
J. VAN HOOF[2], J.-L. HORNICK[1], L. ISTASSE[1]

[1] Université de Liège, Faculté de Médecine Vétérinaire, Nutrition Animale,
B43 Sart-Tilman, 4000 Liège, Belgium

[2] Rijksuniversiteit Gent, Faculteit van de Diergeneeskunde,
Hygiene en Technologie van Eetwaren van Dierlijke Oorsprong,
Wolterslaan, 9000 Gent, Belgium

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SUMMARY

Meat quality was assessed in four bulls from each of three biological types - Belgian Blue double muscled (BBdm), Belgian Blue dual purpose (BBdp) and Holstein (H) which were fattened and slaughtered in similar conditions and at the same live weight (overall mean 526 kg). The carcasses were electrically stimulated. BBdm bulls had heavier carcasses and a higher killing-out proportion than H, BBdp being intermediate. Carcass composition was estimated from dissection of the 7-9 rib joint. The muscle proportion in the carcass was highest and the adipose tissue proportion lowest in BBdm. Consequently large differences were observed in lean meat yield. The meat of the BBdm was paler than that from the BBdp and it contained less myoglobin. At 1h *post mortem*, pH was 5.60, 5.83 and 6.07 in BBdm, BBdp and H respectively. A trend to tougher meat was also observed in BBdm. There were no differences in water holding capacity measured 2 d *post mortem* between the 3 types but the cooking loss was significantly lower in the Belgian Blue groups.

KEY-WORDS : breed, conformation type, carcass composition, meat quality.

RESUME

La qualité de la viande a été déterminée dans 3 groupes : Blanc Bleu Belge de type culard, Blanc Bleu Belge de type mixte et Holstein. Les mêmes conditions d'engraissement et d'abattage ont été reproduites dans les 3 groupes. Les carcasses ont subi une stimulation électrique. Le poids des carcasses, le rendement de carcasse et la proportion de muscle dans la carcasse étaient les plus élevés chez les taureaux culards, les plus faibles chez les Holstein et intermédiaires chez les taureaux de type mixte, avec pour conséquence, des rendements en viande des carcasses très différents selon les races et les conformations. La viande des taureaux culards présentait une couleur plus pâle. Sa teneur en myoglobine était plus faible. Des valeurs de pH *post mortem* très faibles ont été observées dans ce groupe (pH 5,6 1h *post mortem*). La viande de ces taureaux avait tendance à être plus dure. La capacité de rétention d'eau mesurée 2 jours *post mortem* était semblable dans les 3 groupes. Par contre, les pertes à la cuisson ont été significativement plus faibles chez les Blanc Bleu Belge.

MOTS CLES : race, conformation, composition de la carcasse, qualité de la viande.

INTRODUCTION

Differences between breeds in meat quality characteristics are surprisingly generally small (PURCHAS *et al.*, 1993 , THONNEY *et al.*, 1991) and not significant (RENAND, 1990). Belgian Blue double muscled type and Holstein breeds are extreme in terms of muscle proportion (ISTASSE *et al.*, 1990). The present experiment was designed to investigate if large differences in carcass composition are associated with differences in meat composition and meat quality characteristics. Furthermore it was interesting to compare double muscled type with dual purpose type in the Belgian Blue breed and to assess the effect of conformation on meat quality characteristics.

MATERIAL AND METHODS

Animals and management

Four bulls of the three biological types with an initial weight of 340 kg were used in a fattening trial. They were given a diet based on dried sugar beet pulp supplemented with cereals, soyabean meal, linseed meal, minerals and vitamins. Their average daily gain was 1.40 kg per day for 145 days. The slaughter live weight was 526 kg. Within 45 min *post mortem* the carcasses were electrically stimulated with a 45 sec impulse (360 V, 50 Hz).

Measurements

Hot carcass weight was recorded. Rates of pH were measured directly on the carcass 1, 2.5 and 4 h *post mortem* in the Longissimus thoracis muscle (7-8-9 ribs). These 3 ribs were removed after 2 days and dissected in order to separate lean meat, fat and bones ; composition of the carcass was estimated according to MARTIN and TORREELE (1962). The *Longissimus thoracis* was taken for chemical analysis (dry matter, protein, ether extract and myoglobin content) and meat quality determination.

The Hunter Lab device was used for objectively measuring CIE Lab brightness (L*) and colour (a* and b*). The method of GRAU and HAMM (1957) was applied to evaluate water holding capacity. *Post mortem* protein denaturation was estimated by transmission value (HART, 1962). Seven days later a 2.5 cm thick cut was used for cooking loss determination :

cuts were heated in open plastic bags in a waterbath at 75°C. After heating (for 50 minutes) they were cooled in cold tap water to room temperature, bags were drained and cuts were mopped gently dry with paper tissue. The difference between raw and heated weights was recorded as cooking loss, and expressed as a percentage of the raw weight. Warner Bratzler shear force was determined with an Instron 1140 perpendicular to the fibre direction on samples obtained from the heated cuts.

RESULTS

Mean values and standard deviations for live weight and carcass traits are given in *Tab.1*. The slaughter live weights were quite similar in the three breeds. The Belgian Blue double muscled bulls had heavier carcasses ($P < 0.05$) than the Hostein corresponding to a higher killing-out proportion ($P < 0.05$), the Belgian Blue dual purpose being intermediate. Large differences were also found in carcass composition : the muscle proportion was highest ($P < 0.001$) and the adipose tissue proportion was half that in the two other groups in double muscled carcasses ($P < 0.001$). Consequently the higher killing-out proportion and muscle proportion resulted in higher ($P < 0.001$) lean meat yield from the carcass : 244 kg, 189 kg and 159 kg in Belgian Blue double muscled, Belgian Blue dual purpose and Holstein groups respectively.

Longissimus thoracis of Belgian Blue dual purpose and Holstein bulls contained respectively 2.5 and 5 fold more fat than that of double muscled bulls (*Tab.2*).

The *post mortem* pH evolution is shown in *Fig.1*. In general the differences between biological types were not significant. A pH value of 5.6 was observed 1h *post mortem* in the Belgian Blue double muscled group but it did not fall to lower values during the next 3 hours. At this time the differences between groups were lower.

The meat quality characterisics of the *Longissimus thoracis* samples are given in *Tab.3*. Muscle from double muscled bulls was paler than in the two other groups as indicated by higher brightness and lower a*/b* index of hue. The differences were significant between the two Belgian Blue types ($P < 0.05$) but not between Belgian Blue double muscled type and Holstein.

The differences in meat color were associated with similar differences in myoglobin content which was significantly higher ($P < 0.05$) in the Belgian Blue dual purpose type. The fast pH drop in Belgian Blue double muscled group resulted in some protein denaturation as indicated by higher transmission values ($P < 0.05$) in this group. Higher Warner Bratzler peak shear force values were observed in the double muscled group. No difference was found in the water holding capacity measured 2 d *post mortem* by the filter-paper press method. By contrast the cooking loss measured 9 d *post mortem* was significantly ($P < 0.05$) lower in the Belgian Blue groups.

DISCUSSION AND CONCLUSIONS

The killing-out proportion values were quite low in the double muscled group as compared to previous results from ISTASSE *et al.* (1990) who observed 65.8% and 55.4% in Belgian Blue double muscled and Holstein with similar diets and live weights. In another experiment with Belgian Blue double muscled bulls alone (CLINQUART *et al.*, 1991) values close to 70% were observed. In the present experiment the large differences in carcass characteristics observed between breeds and conformation types were associated with differences in chemical composition of the *Longissimus thoracis* muscle ; similar trends were observed for fat content in the carcass and ether extract in meat.

These differences were also associated with differences in meat quality characteristics of the *Longissimus thoracis* samples. Since there were only 4 observations in each group, these differences must be interpreted with caution. The paler color in the double muscled group was associated with lower myoglobin content but could also be related to the low *post mortem* pH values and some protein denaturation. Such phenomena could be an indication of PSE-like meat characteristics. Furthermore the faster pH drop could be associated with electrical stimulation. There was however a trend to breed effect since the technique was applied to the 3 groups. The relationship with fatness was rather paradoxical : the fastest pH drop in the present experiment was observed in the group with the lowest fat content in the carcass ; such a finding is opposed to the results reported in many studies such as BOAKYE *et al.* (1993). In the present experiment electrical stimulation resulted in muscle fibre deterioration which impaired attempts to identify histologically fibres type ; therefore it was not possible to relate a faster glycolysis rate with a higher proportion of glycolytic muscle fibres. The highest protein denaturation could be also related to the lowest adipose content which did not protect muscle protein against the thermal effect of cooling (BOAKYE *et al.*, 1993).

The trend for a tougher meat in the Belgian Blue double muscled group is very surprising since these bulls are known for their tender meat (BOCCARD, 1981 , OUALI, 1991 , RENAND, 1990). The toughness in the present experiment can be associated with an excessively rapid glycolysis during the first hours *post mortem*. In an experiment with various glycolysis rates PIKE *et al.* (1993) observed tougher meat at a pH3 of 5.6 or less. They recommended for optimum tenderness that electrical stimulation should be utilized to produce an intermediate glycolysis rate (pH3 of 6.0). The altered tenderness could also be related to chilling rate and sarcomere length variation (PURCHAS *et al.*, 1993). Those were not measured in the present experiment but cold shortening is unlikely since muscle shortens to a very low extent if its pH is below about 6.0 (MARSH *et al.*, 1987). The same author observed that low pH and temperature cause greater toughening in the absence of cold shortening. Other factors such as the extent of proteolytic breakdown could also be involved in the higher shear values. The calcium dependent proteases, which play a major role in tenderizing as compared to lysosomal cathepsins (KOOHMARAIE *et al.*, 1988), show a reduced activity at this pH level.

The relationship between water binding, fat content and pH drop was not clear. The protein denaturation in the double muscled group did not result in an altered water binding. It has to be noted that the filter-paper press and cooking loss methods used in this experiment cannot differentiate with complete certainty between normal and PSE meat (HONIKEL, 1987).

In conclusion, the colour of meat was affected by breed or by conformation type. The effect on water binding was not clear. Differences in fat content were probably not responsible for the tenderness differences. This altered characteristic associated with a faster pH drop in the double muscled group could possibly be related to detrimental effects of electrical stimulation.

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TABLE 1.- *Means and standard deviations of live weights and carcass traits in bulls from the Belgian Blue double muscled type (BBdm), the Belgian Blue dual purpose type (BBdp) and the Holstein (H.)*

items	Bbdm	Bbdp	H.
Number	4	4	4
Slaughter characteristics			
Slaughter live weight (kg)	523.6±7.9	523.9±9.3	529.8±8.7
Killing-out proportion (%)	62.5±0.9[a]	59.0±1.0[b]	51.5±0.9[c]
Carcass weight (kg)	326.7±7.4[a]	308.9±8.6[a]	274.9±8.1[b]
Carcass composition			
Muscle proportion (%)	74.7±0.6[a]	61.2±0.7[b]	57.6±0.7[c]
Adipose tissue proportion (%)	11.6±0.8[a]	24.2±0.9[b]	25.2±0.8[b]
Bone proportion (%)	13.7±0.6[a]	14.4±0.8[a]	17.2±0.7[b]

[a,b,c]Means without a common letter in their superscripts differ significantly ($P < 0.05$)

TABLE 2.- *Means and standard deviations of chemical characteristics (in dry matter) of the Longissimus thoracis muscle in bulls from the Belgian Blue double muscled type (BBdm), the Belgian Blue dual purpose type (BBdp) and the Holstein (H.)*

items	Bbdm	Bbdp	H.
Number	4	4	4
Dry matter (g/kg)	249± 5[a]	263± 8[b]	270±12[b]
Crude protein (g/kg DM)	881±18[a]	817±21[b]	764±32[b]
Ether extract (g/kg DM)	30± 6[a]	84±31[b]	172±64[b]

[a,b,c]Means without a common letter in their superscripts differ significantly ($P < 0.05$)

TABLE 3.- *Means and standard deviations of meat quality characteristics of the Longissimus Thoracis muscle in bulls from the Belgian Blue double muscled type (BBdm), the Belgian Blue dual purpose type (BBdp) and the Holstein (H.)*

items	Bbdm	Bbdp	H.
Number	4	4	4
Brightness L* (%)	41.5 ± 0.8^{a}	37.9 ± 2.8^{b}	37.7 ± 3.8^{ab}
Hue a*/b*	1.4 ± 0.1^{a}	1.7 ± 0.2^{b}	1.7 ± 0.3^{ab}
Myoglobin content (mg/g meat)	2.2 ± 0.1^{a}	3.2 ± 0.5^{b}	2.4 ± 0.3^{a}
WB peak shear force (N)	40.9±4.3	31.9±5.8	31.7±4.6
Transmission (%)	90.3 ± 0.8^{a}	58.9 ± 29.9^{ab}	21.9 ± 6.0^{b}
Loose water value (%)	41.0±2.0	42.5±3.9	43.3±5.0
Cooking loss (%)	18.3 ± 2.2^{a}	21.8 ± 4.2^{a}	30.7 ± 3.6^{b}

^{a,b,c}Means without a common letter in their superscripts differ significantly ($P < 0.05$)

FIGURE 1.- *Post mortem pH evolution in Longissimus thoracis in bulls from the Belgian Blue double muscled type (BBdm), the Belgian Blue dual purpose type (BBdp) and the Holstein (H.)*