pH, COLOUR AND WATER HOLDING CAPACITY IN MUSCLES OF YOUNG BULLS DIFFERING FOR ETHNIC GROUP

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SUMMARY

46 young bulls (12 hypertrophied Piemontese, H; 12 normal Piemontese, P; 12 Friesian, F; 10 crosses H x F) were reared in the same conditions and slaughtered at 470 kg l.w. After 1 hr and then 24 hrs *post mortem* the pH was measured in *Longissimus thoracis* (LT), *Semitendinosus* (St), *Supraspinatus* (Ss) and *Pectoralis profundus* (PP). After 7 days of chilling, the pH, colour (L, a_L, b_L) and water holding capacity (WHC) were measured in samples taken from the same muscles.

The ethnic group did not influence the *post mortem* evolution of the pH. The muscles showed small differences and in some cases they interacted with the ethnic group. On the whole Ss showed a higher pH. The colour depended on ethnic group and, particularly, on muscle type, because L and b_L resulted higher in hypertrophied subjects (37.0; 10.6) and in St (41.8; 12.3).The differences of WHC among muscles were more remarkable compared to the differences among groups. Drip losses were lower in F (2.04%) and in PP (1.35%), higher in H (2.71%) and St (3.67%). Water bath losses resulted lower in hypertrophied subjects (H: 35.43%; H x F: 35.23%) *vs* normal subjects (N: 37.10%; F: 36.40%), whereas WHC, determined by means of filter paper press method (FPM) were slightly worse in F (8.66 cm^2) compared to all other groups. LT had a much better WHC (WBL: 33.o1%; FPM: 7.14 cm^2)than the other muscles, especially compared to SS (38.06%; 9.00 cm^2).

Introduction

Important parameters for the determination of the technological quality and the appearance of beef meat are the water holding capacity, the colour and the pH. The latter does not show any considerable variation among breeds, although the data available are not numerous (Monin, 1991).

The water holding capacity is widely recognized as important in relation to such characteristics as appearance, juiciness and tenderness. According to Monin and Ouali (1991), the water holding capacity and the increase in muscular development of the animals are negatively related. Lastly colour is a discriminant factor for breeds (Renerre, 1984) and, within the same breed, for hypertrophied animals. Their meat is of a paler colour as muscular hypertrophy causes a slower development and alters metabolic type of their muscular fibres.

The aim of this work was to study the pH, the water holding capacity and the colour of four muscles from young bulls of different ethnic groups.

Material and methods

A total of 46 young bulls, of which 12 hypertrophied (H) and 12 normal (N) Piemontese, 10 F_1 hypertrophied Piemontese x Friesian (H x F) and 12 Friesian (F), were reared in the same conditions in the Research Centre of Animal Science Department of Turin.

The animals were fed with mixed grass hay and concentrate in order to meet the nutritive requirement of 1 kg daily gain according to the feeding standards for late maturing cattle (INRA, 1988).The young bulls were slaughtered at an average live weight of 458 kg (H), 459 kg (N), 470 kg (H x F) and 479 kg (F) and the right sides were cooled at 2_C for 7 days. At 1 hour (pH1), at 24 hours (pH24) and at 7 days (pH7) after slaughtering the pH was measured in some muscles: *Longissimus thoracis* (LT), *Semitendinosus* (St), *Supraspinatus* (Ss) and *Pectoralis profundus* (PP), by means of a Hanna HI 9025 pHmeter with Ingold spear electrode and a temperature compensator.

On the 7th day after slaughtering some samples were taken from each right side and used to determine the colour and the water holding capacity (WHC). The samples were the part of LT between the 11th and 12th thoracic vertebra and some portions of St, Ss and PP. By means of a Minolta CR 331C chromameter, the

lightness, redness and yellowness of the Hunter system (Boccard et al., 1981) were measured three times for each sample and the average value was then calculated. The WHC was measured by means of three different methods: filter paper press (Graü and Hamm, 1957), drip losses and cooking losses. Drip losses, expressed as a percentage of the initial weight, were determined on a 1.5 cm thick steak cut across the long axis of the muscle, that was kept for 48 hours at 5_C inside a plastic container with a double bottom (Lundström and Malmfors, 1985). To determine cooking losses, 1.5 cm thick core of meat with a diameter of 3 cm, was sealed in poliethylene bag and placed for 30 minutes in a water bath at 70_C. The bags were cooled under running water and then the meat was dried with a soft cloth and weighted. Two replicate analyses were carried out for each muscle and the weight loss was calculated as a percentage of the initial weight.

The statistical analysis was performed by means of the SPSS package considering the ethinc group and the muscle as factors. As regard the pH, all subsequent measurements were considered separately.

Results and discussion

The ethnic group did not influence in a significant way pH1 (table 1). As regard muscles the value of PP (5.53) was lower ($P < 0.01$) than the value of LT (6.66) and of Ss (6.71), while the value of St (6.57) was lower than that of Ss. The interaction ethnic group x muscle was significant ($P < 0.05$) for pH24 (table 2), as LT in H x F and in F had a lower value than the other muscles (5.40 in H x F, 5.41 in F), as opposed to the other two groups. Also for pH7 (table 3) this interaction was significant ($P < 0.05$), as the value of Ss was higher in F than in the other three groups (5.63 vs 5.51). The average value of the pH was 5.46. Taking into consideration the ethnic group variations are negligible, whereas regarding muscles variability, included between 5.41 (LT and St) and 5.54 (Ss), was more important (5.41 in LT and St, 5.54 in Ss

Colour. Lightness (table 4) was higher ($P < 0.01$) in H (36.90) and H x F (36.77) than in N (34.23) and F (34.47), and also in St (41.78) compared to the other three muscles, the value of PP (32.19) being lower than that of Ss (34.11) and of LT (34.08). Relevant for redness (table 5) was the interaction ($P < 0.01$) ethnic group x muscle, because within each group the sequence of muscles was different. In particular St had the lowest redness in H (15.48) and H x F (16.23), whereas LT had the highest in H x F (19.30) and F (18.50). The same differences among groups and muscles observed for lightness were found for yellowness (table 6): the value of b_L was higher in H (10.58) and in H x F (10.59) that in N (10.05) and F (9.73), lower in PP (9.17) and higher in St (12.26) compared to the other muscles.

Water holding capacity. As regard drip losses (table 7), F (2.04%) differed ($P < 0.01$) from N (2.44%) and H (2.71%). The latter reported higher losses than H x F. In muscles losses are observed to be increasing from PP (1.35%) to Ss, to LT and to St (3.67%).The interaction ethnic group x muscle was significant ($P < 0.01$) for water bath losses (table 8), as the value of PP was higher than that of St in H x F and than that of LT in F. Compared to the general mean (36.08%) the lowest loss was in H (35.43%) and the highest in N (37.10%). The values of muscles ranged from 33.01% (LT) to 38.06% (Ss).The filter paper press method (table 9) allowed us to observe significant differences ($P < 0.01$) between the F group (8.66 cm^2) and the H x F (8.00 cm^2) and N groups (8.27 cm^2). LT (7.14 cm^2) differed ($P < 0.01$) from the other three muscles, whereas the value of Ss (9.00 cm^2) was higher than that of PP (8.45 cm^2).

A general examination of the data gathered on the pH shows that, as regard pH1, the *post mortem* falls was slower in the *Longissimus thoracis* of Piemontese animals, no matter whether they were hypertrophied or not. Also in *Supraspinatus* of crossbreed H x F the fall was slow, whereas, on the contrary, in *Pectoralis profundus* of Friesian the fall was much faster. This result is in accordance with the statement of Monin (1991) when talking about the variability among muscles in relation to the *post mortem* fall of the pH and to the onset of the *rigor*. On the other hand, the different behaviour of the *Longissimus thoracis* of the Piemontese breed seems peculiar. The evolution of the pH from the 1st to the 24th hour *post mortem* developed regularly even in hypertrophied animals , in accordance with Bouton et al. (1979) and Monin (1981), who did not find differences between normal and hypertrophied subjects.The pH fall between 24 hours and 7 days was negligible, with the exception of *Pectoralis profundus* that showed a higher decrease in Friesian bulls.

As regard colour, the effect of hypertrophy on lightness and yellowness was evident in all muscles. Muscular hypertrophy also influenced the redness in *Semitendinosus*, that showed lower values in hypertrophied Piemontese and crossbreed groups than in normal Piemontese and Friesian groups. The meat of hypertrophied animals was of a paler colour, in accordance with Boccard (1981) statement.

When talking about water holding capacity it is necessary to take into consideration the different methods used. Compared to the crosses and Friesian subjects, Piemontese young bulls had higher drip losses in particular in *Semitendinosus* but not in *Pectoralis profundus*. Considering water bath losses, the muscular hypertrophy brought about in the *Semitendinosus*, the *Supraspinatus* and especially the *Longissimus thoracis* a

lower weight loss compared to normal Piemontese and Friesian bulls. As regard the paper press method, in hypertrophied Piemontese and in Friesian animals the difference in WHC among the four muscles was more evident, mostly because of the higher values of the *Supraspinatus*.

Conclusions

The ethnic group and the presence of muscular hypertrophy affected the examined parameters to a different extent.

The effect of the ethnic group was greater on the initial pH fall of the *Longissimus thoracis* and on the drip losses. Muscular hypertrophy influenced lightness and yellowness, the redness of the *Supraspinatus* and the cooking losses in all muscles with the exception of the *Pectoralis profundus*.

Lastly, the variability due to the muscle emphasizes the importance of using different muscles when studying meat quality.

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