# Two-toned colour in the biceps femoris muscle in relation to post mortem pH and temperature fall in Belgian Blue beef

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**Abstract**

Beef from double-muscled Belgian Blue cattle is characterized by fast glycolysis and slow temperature fall post mortem (pm), which may affect meat quality in deeper muscles resulting in e.g. two-toning. In this study, the inner biceps femoris (IBF) muscle at 10 cm depth and the outer biceps femoris (OBF) muscle at 2 cm depth was studied in 8 cows of this breed. In one carcass side, the quadriceps muscle was partially cut early pm to allow faster cooling of the IBF, whereas the other carcass side was left intact. The IBF but not the OBF underwent heat shortening for approximately 3 hours (pH<6 and temperature>35°C). A significantly higher protein denaturation, higher L* value and shorter sarcomere length was also found for the IBF compared to the OBF. Starting from similar a* values, the decline in a* values and increase in metmyoglobin formation after 9 days of cooled display under light was much larger for the IBF than for the OBF showing lower colour stability. Partial cutting resulted in lower L* values in the OBF but had only a marginal effect on colour stability. It is concluded that heat shortening is at least partly responsible for two-toning in deeper muscles of Belgian Blue beef.

## Introduction

Meat quality of double-muscled Belgian Blue cattle differs in many aspects from meat of conventional breeds (Clinquart et al., 1998; De Smet, 2004). The more glycolytic fibre type in combination with the larger muscle mass of these animals results in faster glycolysis and slower cooling post mortem (pm) compared to carcasses of non double-muscled and lighter animals. Particularly in the deeper muscles of the hindquarter this may provoke heat shortening and protein denaturation leading to inferior meat quality, i.e. pale colour and reduced colour stability may be observed. The pH and temperature gradient within these muscles may also result in unwanted two-toning.

Sammel et al. (2002) have previously compared characteristics of beef inside and outside semimembranosus muscle in response to differences in chilling rate. They applied partial hot boning of the semimembranosus muscle for faster chilling. Whereas cold-boned steaks were two-toned in colour, hot-boned inside and outside semimembranosus muscle samples had a more uniform and stable colour. The objectives of the present study were to assess the rate of pH and temperature fall pm and colour and colour stability in the inner and outer part of the biceps femoris (BF) muscle in double-muscled Belgian Blue cattle, and to examine whether partial cutting of the quadriceps muscle allowed to improve colour uniformity and stability in the BF muscle.

## Material and methods

In this study, 8 double-muscled Belgian Blue cows from the same farm were slaughtered in two abattoirs. The age and carcass weight at slaughter varied between 68 and 97 months and 480 and 556 kg respectively. The carcasses were classified in class S (except one E carcass) for conformation and in class 2 for fat cover according to the SEUROP carcass classification system. Within 2 hours after slaughter, the quadriceps muscle and the tensor fasciae latae of the left carcass side was partially cut to allow faster cooling of the inside muscles of the round, whereas the right carcass side was left intact and served as control.

Temperature and pH were measured at 1, 2, 3, 4, 5 and 72 hours pm in the longissimus (LD) muscle at 8 cm depth, in the inner biceps femoris (IBF) at 10 cm depth and the outer biceps femoris (OBF) at 2 cm depth. At 5 days after slaughter, samples of the IBF and OBF were taken, wrapped in oxygen permeable foil and displayed at 4°C under fluorescent light (approximately 1200 lux). Colour parameters were measured with a Hunterlab Miniscan colour meter (D65 light source, 10° standard observer, 45°/0° geometry, 1-inch light surface, white standard) at 0 and 4 hours and 1, 2, 5, 6, 7, 8 and 9 days of display to assess colour stability (AMSA, 1991). In addition, protein solubility and sarcomere length were determined.

**Results and discussion**

In Figure 1, the pH versus temperature fall is presented. It is clear that the LD and the IBF but not the OBF muscle underwent heat shortening (pH<6 and temperature>35°C; Thompson, 2002). The average duration of heat shortening was estimated to be approximately 1,5 hours for the LD and 3 hours for the IBF muscle (Figure 2). The pH fall was extremely fast with values as low as 5,6 at 3 hours pm in the LD and at 4 hours pm in the IBF with temperature values still above 35°C at these times. On the other hand, average pH and temperature at 5 hours pm was 6,23 and 23°C respectively in the OBF. Data are shown here as average values for both carcass sides (partial cutting versus control), since there was no significant effect of the partial cutting treatment on the pH and temperature fall. The sarcomere length was significantly higher for the OBF versus the IBF muscle (1,10 versus 1,01 µm) with also no effect of the partial cutting treatment.

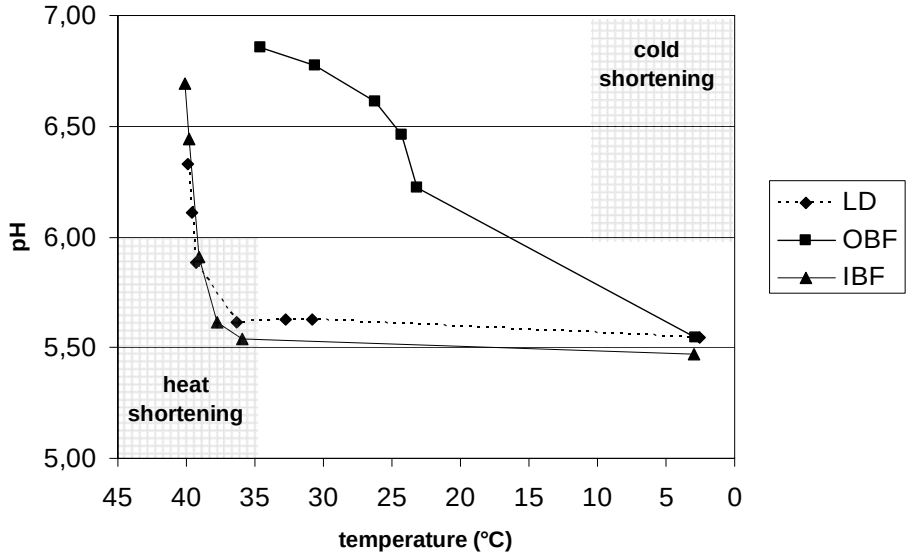


**Figure 1.** pH versus temperature relationship for the longissimus (LD) and inner and outer biceps femoris (IBF and OBF) muscle.

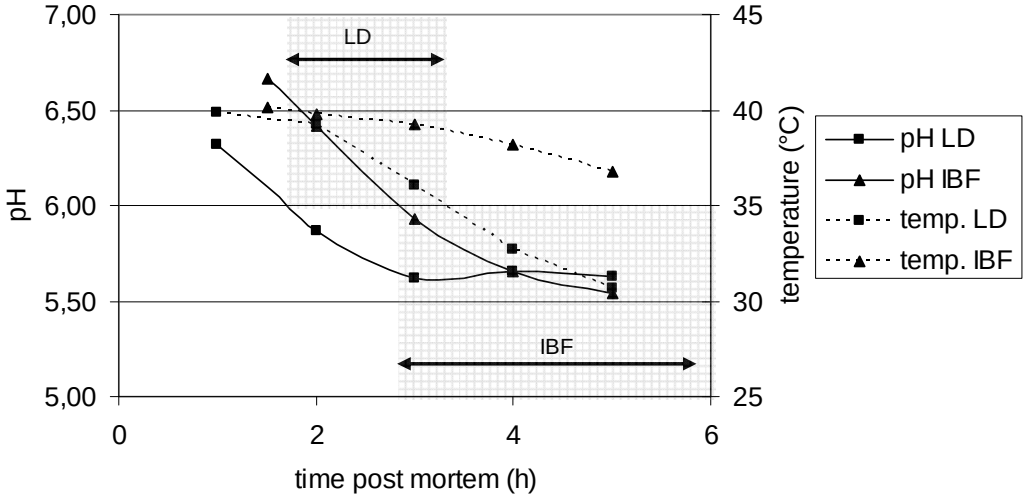


**Figure 2.** pH and temperature fall for the longissimus (LD) and inner biceps femoris (IBF) muscle.

The average L* value was significantly higher in the IBF compared to the OBF muscle in the intact carcass side (42,4 versus 33,4). The partial cutting treatment resulted in a decrease in the L* value in the IBF muscle to 37,1. The protein solubility was significantly higher in the OBF compared to the IBF muscle (71 versus 59 mg/g meat), pointing to lower protein denaturation. The partial cutting treatment resulted also in slightly higher protein denaturation.

Starting from similar a* values, the decline in a* values and increase in metmyoglobin formation after 9 days of cooled display under light was much larger for the IBF than for the OBF showing lower colour stability. In figure 3, the metmyoglobin formation is shown for samples of IBF and OBF muscle and according to the partial cutting treatment versus the control treatment. Metmyoglobin formation was significantly higher for the IBF muscle compared to the faster cooling and slower glycolysing OBF muscle. The metmyoglobin formation and the a* values were only slightly affected by making the partial cuts. Hence, the colour stability was not improved due to this treatment. In a similar experiment, Sammel et al. (2002b) found an improvement of the colour stability of the semimembranosus muscle by partial hot-boning this muscle. However, it should be mentioned that the cuts made in the present study did not allow to increase the cooling rate of the deeper laying biceps femoris muscle. Nevertheless, the difference in colour and colour stability between the IBF and OBF muscle demonstrates that the rate of cooling and glycolysis has a great impact on colour traits.

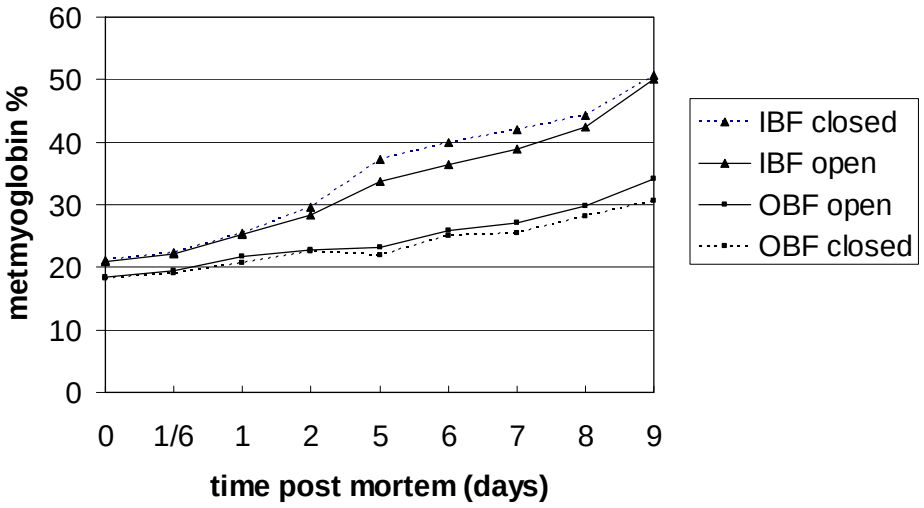


**Figure 3.** Metmyoglobin formation in the inner and outer biceps femoris (IBF, OBF) for the treatment 'partial cut' (open) versus control (closed).

**Conclusion**

It is concluded that heat shortening is at least partly responsible for two-toning in deeper muscles of Belgian Blue beef.

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