COLOUR DEVELOPMENT IN CURED NORMAL AND DFD-PORK BOSTON SHOULDERS

CROEGAERT TH. & VAN HOOF J.

Laboratory for Hygiene and Technology of Food from Animal Origin, Faculty of Veterinary Medicine, Wolterslaan 16, B 9000 Ghent, Belgium

INTRODUCTION

Fresh meat colour is considerably dependent upon the final pH of the muscle after slaughter. DFD-meat (pH>6.2) is characterized by a lower lightness, a lower degree of saturation and a stronger purple hue in comparison with meat showing a normal final pH (pH<5.8) (Dezeure-Wallays et al., 1988). This results in a pronounced darker colour (Dark, Firm, Dry), although the myoglobine content of DFD-meat can be lower than in normal pH meat.

During curing an important part of the myoglobine reacts with nitrite to produce nitroso-myoglobine, which is responsible for cured meat colour. When DFD-meat is cured, a slower salt diffusion can be observed: therefore, this meat is less suitable for curing (Wirth, 1978).

The aim of this comparative study was to determine to what extent the final pH in fresh meat determines colour development during curing and how it influences colour attributes in the final product. For that purpose, measurements were performed in the M. longissimus dorsi in pork boston shoulders.

Because nitroso-myoglobine formation is subject to the presence of reducing substances, among which sugars, and since DFD-meat has no residual glycogen and a low glucose content, the effect of supplementation of the brine with 1 % saccharose was examined at the same time.

MATERIALS AND METHODS

In this study 80 pork boston shoulders have been selected, among which 40 with a normal pH (<5.8: control group) and 40 with a DFD-character (pH>6.4), measured in the Mm. spinalis dorsi et cervicis (d0). Of each group 20 boston shoulders were injected for 10 % with a 10°Bé brine supplemented with 1 % saccharose; the other 20 were processed the same way without saccharose (d1). In this manner 4 groups of 20 boston shoulders were obtained:

group 1: control group without sacch.
group 2: control group with sacch.
group 3: DFD-group without sacch.
group 4: DFD-group with sacch.

The injected meat portions were transferred into 4 different curing tanks, filled with the same brine as used for the injection. Three days later (d4) the brine was decanted, while the boston shoulders remained in the tanks for maturation (4 days at 6-8°C). Then the pork was dried for 4 hours at 30°C, smoked for 16 hours at 41°C and further dried during 5 days (15°C; 78% RH). On day 14 the meat was cooled to 3°C and vacuum packed. The boston shoulders were further stored 1 month under refrigeration in vacuum packing. Measurements were performed on fresh meat (d0), after curing and maturation (d8), after smoking and drying (d14) and after 1 month of vacuum packing (d43). Each time 5 samples were taken from each group.

pH-Measurements were carried out on the Mm. spinalis dorsi et cervicis and on the M. longissimus dorsi. For this purpose, a combined glass-calomel electrode was used (Orion 91-63, Swiss made) connected with a digital pH-meter (Orion Research, model 701, Massachusetts, USA).

The amount of total haem-pigment and nitroso-haem-pigment in the M. longissimus dorsi was determined according to the method of Hornsey (1956), modified by Möhler (1958) and Gantner (1959). Lightness (L), hue (a/b) and saturation ($\sqrt{a^2+b^2}$) were evaluated with a HunterLab device (Model D25, Hunter Associates Laboratory, Fairfax, Virginia). Lightness was also measured with a GÖFO-Farb-Helligkeitsmesser (Göttingen, Western Germany).

RESULTS

The pH-values measured in the Mm. spinalis dorsi et cervicis showed a high degree of correlation with the measurements carried out in the M. longissimus dorsi ($r=0.865$; $r^2=0.749$: fig.1) The amount of total haem-pigment (ppm haematin) measured in fresh pork, was higher ($p=0.055$) in normal pH pork

(56 ppm) than in DFD-meat (48 ppm: table 1).
In normal pH meat nitroso-haem-pigment formation was slower as compared with DFD-meat (fig.2), but the final amount of NO-pigment was very significantly higher (p=0.009: table 1). For both kinds of meat, supplementation of the brine with saccharose accelerated the formation of NO-pigment (fig.1); however, final amounts of NO-pigment in the end-product were not higher. These results appear also from calculation of the % reddening.
Normal pH meat showed a slower reddening as compared with DFD-meat (fig.3) During drying and ripening the reddening of normal pH meat increased further to a final value, which was very significantly (p=0.019) higher (81%) than in DFD-meat (44%). Curing with saccharose accelerated the reddening of normal and DFD-meat; this is most obvious on DFD-meat (fig.3). During further ripening of this meat the reddening decreased again.
The initial lightness (L) was higher in normal pH meat than in DFD-meat (table 1). The curing process induced a strong fall in lightness (fig.4). During ripening the lightness increased again. The highest value was obtained in normal pork cured without saccharose. Normal pH meat cured with 1% saccharose showed a lower final lightness-value.
A similar evolution of meat lightness during the curing process appeared from Göfo-measurements. A high degree of negative correlation was observed between Göfo-value and lightness (L): $r=-0.873$; $r^2=0.762$ (fig.5). However, no significant differences in Göfo-values could be detected between the final products of the different groups (fig.6).
The hue (a/b) of fresh meat was not different according to pH (fig.7). During curing and ripening the hue-value increased: this implicates a relative increase of the red component (a), a relative decrease of the yellow component (b) or a relative increase of the blue component (-b). The hue shifted to a more purple tint. The final hue of normal pH meat was very significantly lower than that of DFD-meat (p=0.0035: table 1). Curing with saccharose resulted in a significantly higher hue-value in normal pH meat (p=0.039). In DFD-meat no difference could be observed in hue, when saccharose was added to the brine.
The degree of saturation ($\sqrt{a^2+b^2}$) was initially equal in fresh normal and DFD-meat (table 1). During curing saturation increased considerably, decreased again during ripening and stabilized during vacuum storage. Final products made from normal pH meat showed a significantly lower degree of saturation (p=0.05). Addition of 1% saccharose into the brine did not result in a different saturation.

CONCLUSIONS

The pH measured in the Mm. spinalis dorsi et cervicis gives a good indication of the pH in the M. longissimus dorsi, which is more difficult to measure, due to the deep location of this muscle.
The amount of nitroso-haem-pigment showed a slower increase in normal pH meat than in DFD-meat, but resulted in a higher % reddening in the final product.
Cured boston shoulders processed from normal pH meat showed a higher lightness end-value as compared with DFD-meat. The hue developed to a more purple tint in DFD-meat than in normal pH meat. The degree of saturation of the M. longissimus dorsi was highest in the final product made from DFD-meat.
Supplementation of 1% saccharose to the brine accelerated the reddening, especially in DFD-meat, but resulted in a lower final value. Saccharose decreased lightness and increased the hue-value in normal pH-meat. In DFD-meat curing the addition of saccharose into the brine was of no significant influence.
Fresh boston shoulders with a normal pH (<5.8) differ significantly from DFD-boston shoulders according to colour. Even after curing and storage DFD-pork shows significant differences in colour attributes. Beside the lower keeping capacity and the slower salt diffusion in DFD-meat, also in regard to colour development DFD-meat is not suitable for production of raw cured meat. Addition of 1% saccharose

into the brine could not improve the final colour in DFD-meat.

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Table 1: Significance of colour measurements

Parameter	Sacchar.	Time	Mean	St. Dev.	n	signif (p)
Tot. pigm. (pH < 5.8)	-	d0	56	10	10	0.055
Tot. pigm. (pH > 6.4)	-	d0	48	10	10	
NO-pigm. (pH < 5.8)	-	d43	46	17	5	0.009
NO-pigm. (pH > 6.4)	-	d43	21	6	5	
% redden. (pH < 5.8)	-	d43	81	31	5	0.019
% redden. (pH > 6.4)	-	d43	44	13	5	
Lightness (pH < 5.8)	-	d0	56	3	10	0.123
Lightness (pH > 6.4)	-	d0	54.2	2.8	10	
Lightness (pH < 5.8)	-	d43	52.0	2.2	5	0.041
Lightness (pH > 6.4)	-	d43	49.4	1.8	5	
Hue (pH < 5.8)	-	d0	0.73	0.14	10	0.175
Hue (pH > 6.4)	-	d0	0.79	0.14	10	
Hue (pH < 5.8)	-	d43	1.32	0.18	5	0.039
Hue (pH < 5.8)	+	d43	1.64	0.31	5	
Hue (pH < 5.8)	-	d43	1.32	0.18	5	0.0035
Hue (pH > 6.4)	-	d43	1.68	0.13	5	
Saturation (pH < 5.8)	-	d0	11.5	0.7	10	0.95
Saturation (pH > 6.4)	-	d0	11.4	0.8	10	
Saturation (pH < 5.8)	-	d43	12.8	0.9	5	0.05
Saturation (pH > 6.4)	-	d43	13.6	0.5	5	

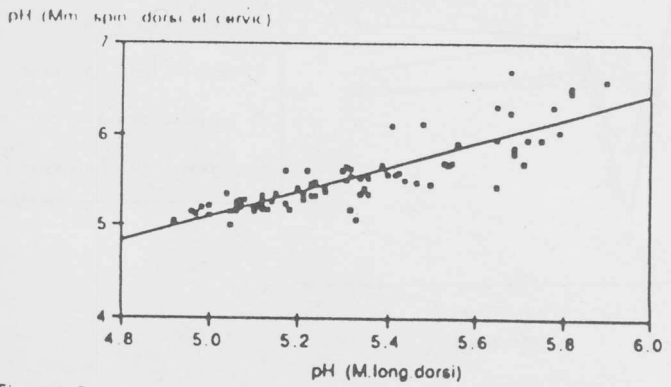

Figure 1: Correlation between $pH_{(M.\ long.\ dorsi)}$ and $pH_{(M.\ spinalis\ dorsi\ et\ cervicis)}$ ($r = 0.865$; $r^2 = 0.749$; $Y = 1.341\ X - 1.611$)

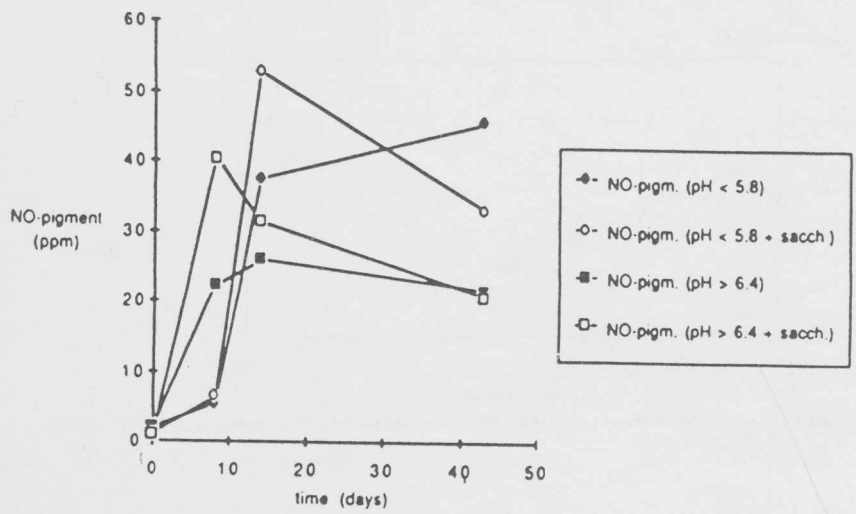

Figure 2: NO-pigment (ppm) development in M. long. dorsi during curing of boston shoulders

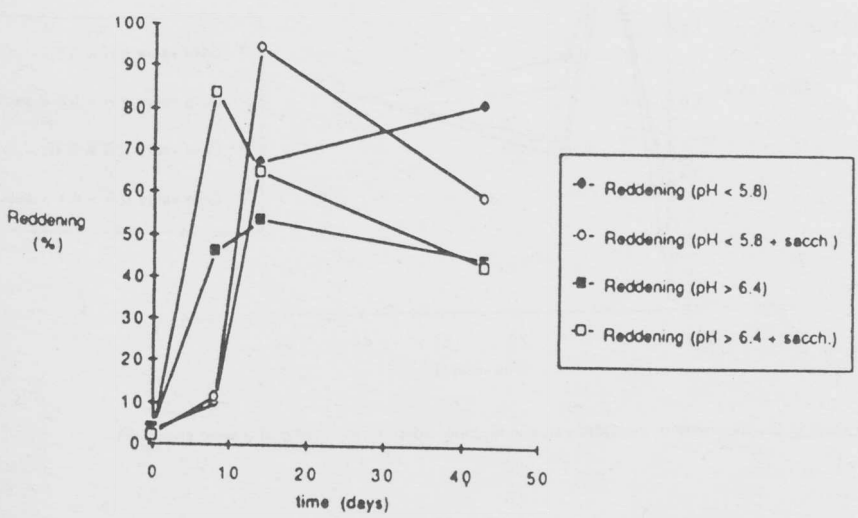

Figure 3: Development of the reddening (%) in M. long. dorsi during curing of boston shoulders

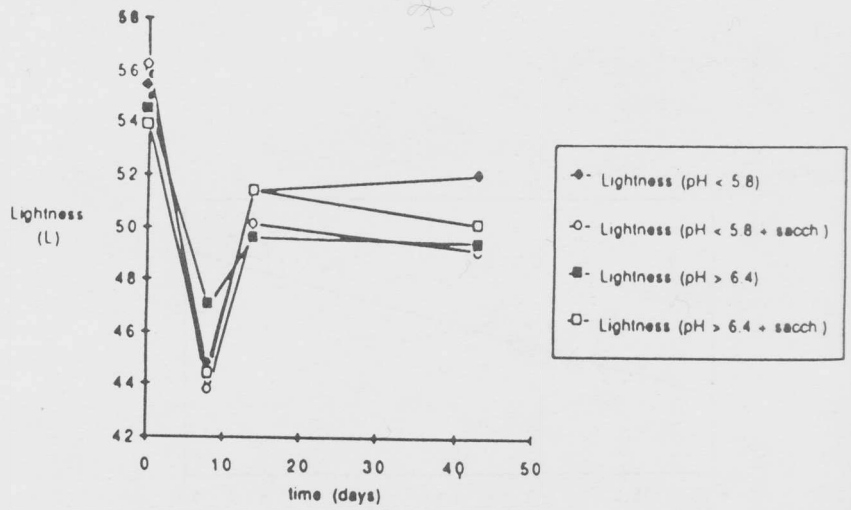

Figure 4: Development of the lightness (L) in M. long. dorsi during curing of boston shoulders

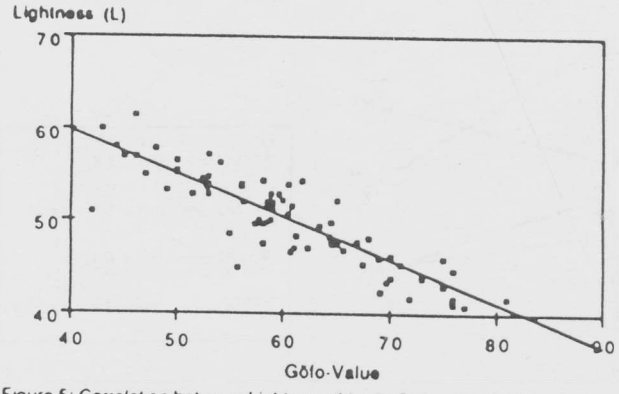

Figure 5: Correlation between Lightness (L) and Gõfo-value in M. long. dorsi ($r = -0.873$; $r^2 = 0.762$; $Y = -0.463\ X + 78.115$)

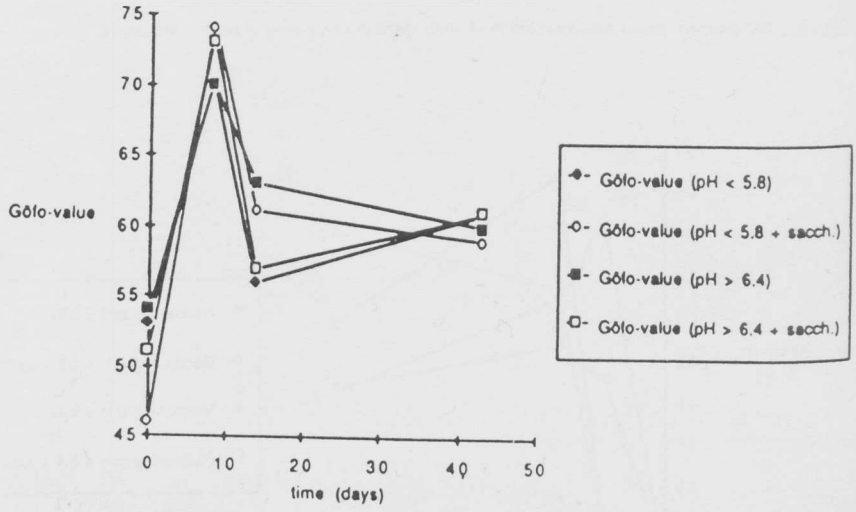

Figure 6: Development of the Gõfo-value in M. long. dorsi during curing of boston shoulders

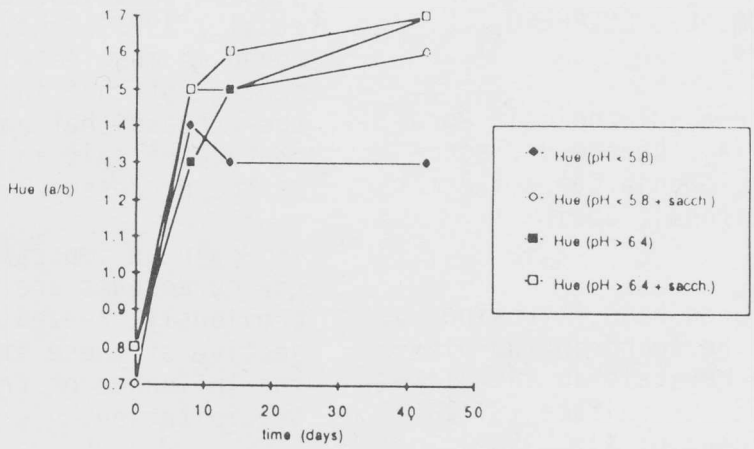

Figure 7: Development of the hue (a/b) in M. long. dorsi during curing of boston shoulders

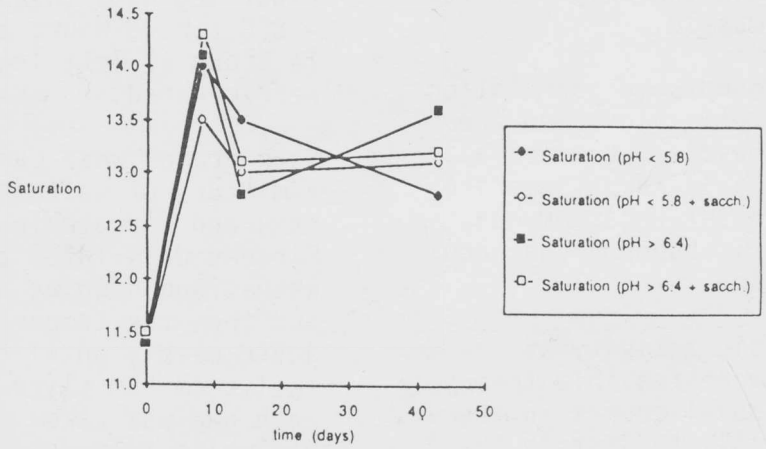

Figure 8: Development of the saturation ($\sqrt{a^2 + b^2}$) in M. long. dorsi during curing of boston shoulders