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THE EFFECT OF POST MORTEM TEMPERATURE ON PORK COLOR AND WATERHOLDING CAPACITY

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INTRODUCTION

Fresh pork should be reddish-pink in color and slightly firm and moist in appearance. A pale, pinkish gray color is usually the result of a rapid increase in acidity immediately after slaughter. A dark color is most likely the result of little accumulation of lactic acid during post mortem conversion of muscle to meat. The rate of acid formation post mortem is influenced by numerous ante- and post-mortem factors.

Knowledge of factors that influence color and waterholding capacity as well as the relationship between these two characteristics will permit production of lean meat with satisfactory quality and provide industry with tools for more effective quality control. In general, there is a positive association between lighter color and lower water-holding capacities. However, the characteristics are not as closely associated as assumed and may vary independently (Warriss and Brown, 1987; van Laack et al. 1994).

There is good evidence that high drip loss and softness of PSE meat is caused by myosin denaturation. It is less clear which factors are responsible for the pale color of PSE meat. Offer and Knight (1988) suggested that color is mainly determined by denaturation of sarcoplasmic proteins (affecting the degree of reflection). However, results by Offer et al. (1989) indicated that myosin denaturation, influencing lateral spacing, is an important determinant of reflectance and absorbance, e.g. color. Protein denaturation is influenced by pH and temperature; low pH and high temperatures generally result in increased protein denaturation. Myosin denaturation is dependent on a third factor, rigor onset or the formation of actomyosin (Offer, 1989). Once myosin is bound to actin, myosin is protected against further denaturation. Denaturation of sarcoplasmic proteins is not expected to be influenced by rigor onset and will occur as long as pH is low and temperatures are high.

The purpose of this study was to assess the contribution of denaturation (resulting from high temperatures) of both myosin and sarcoplasmic proteins to color and drip loss (whc). Protein denaturation was 'manipulated' by pre-rigor and post-rigor temperatures.

MATERIALS AND METHODS

Loins from 7 pig carcasses (both sides) were excised within 45 min postmortem. Each loin was divided into 3 sections. For each carcass, three sections were incubated for 3 h at 40°C and three for 3 h at 15°C (=pre-rigor). After 3 h, one cut of each pre-rigor treatment was chilled at 5°C, one at 20°C and one at 30°C (=post-rigor). Subsequently, all cuts were chilled to 5°C, and 'drip loss' (Honikel, 1987), L-value (Minolta color meter), pH and solubility of sarcoplasmic proteins (0.03 M K-phosphate, pH 7.4) myosin (0.5 M KCl, 0.05 M K-phosphate, 10 mM tetrapyrophosphate, 1 mM $MgCl_2$, pH 6.5 - sarcoplasmic proteins) and total protein (0.55 M KI, 0.05 M K-phosphate, pH 7.4) were assessed. Sarcomere length and pigment concentration were assessed with the methods as described by Koolmees et al. (1986) and Hornsey (1956), respectively.

Data were analyzed using the GLM procedure (SAS, 1992) with the model consisting of pre- and post-rigor and pre- X post-rigor interaction treatments. Least square means were generated to assess the significant differences.

RESULTS AND DISCUSSION

Results are included in Table 1. Neither ultimate pH nor pigment level was affected by the treatments; these data are not presented.

Drip loss Pre-rigor treatment did not seem to affect the drip loss. The effect of post-rigor treatment was dependent on the pre-rigor treatment ($p<0.05$, interaction). When samples were kept at 40°C pre-rigor, drip losses from the 20 and 30°C samples were not significantly different from another but significantly different from 5°C. In contrast, an increase in post-rigor temperature resulted in an increase in drip losses ($p<0.001$) when samples were kept at 15°C pre-rigor. There was no significant correlation between drip loss and either 'myosin', total protein solubility or sarcomere length.

L-value L-value was affected by pre-rigor treatment as well as post-rigor treatment; higher temperatures resulted in higher L-values. However, the overall effect was rather small. Only meat incubated at 30°C post-rigor, approximated PSE quality. Correlation between L-value and

protein solubility was significant (r varied from 0.73 for myosin to 0.88 for total protein solubility). Although significant, the correlation between L-value and drip loss was low (r=0.46).

Protein denaturation Pre- as well as post-rigor temperatures affected solubility of various protein fractions. The effect of post-rigor treatment was not dependent on pre-rigor treatment. Higher incubation temperatures resulted in lower protein solubility, indicating increased protein denaturation. It was not possible to influence myosin and sarcoplasmic protein denaturation independently (r=0.63).

Table 1: The effect of pre- and post -rigor temperature on various quality attributes of pork longissimus muscle

Pre-rigor temp.	15			40			Significance	
Post-rigor temp.	5	20	30	5	20	30	Pre	Post
Drip (%)	2.2	5.4	7.5	3.9	5.8	6.0	NS*	p<0.001*
L-value	44.3	46.4	50.6	48.6	48.7	54.4	p<0.001	p<0.001
Sarc. proteins	81	82	72	77	78	65	p=0.003	p<0.001
"Myosin"	80	85	74	67	72	48	p<0.001	p<0.001
Total protein	207	209	171	179	185	130	p<0.001	p<0.001
Sarcomere length	1.69	1.66	1.69	1.62	1.56	1.66	p=0.002	p=0.045

* Pre- x post-rigor interaction (p<0.05) for drip loss

The purpose of this study was to determine the contribution of both sarcoplasmic proteins and myosin to color and drip losses. The assumption was that the pre-rigor treatment would affect myosin denaturation, whereas both pre- and post-rigor treatments would affect sarcoplasmic proteins. However, both pre- and post-rigor treatments affected sarcoplasmic proteins as well as myosin. Thus, it was not possible to determine the contribution of the various protein fractions to pork color.

The absence of a significant effect of pre-rigor treatment on drip losses was rather unexpected. Drip losses are presumed to be related to protein denaturation (Offer and Knight, 1988) and drip losses may be affected by sarcomere length (Honikel et al. 1986). Yet, despite the increased protein denaturation and shorter sarcomeres at higher pre-rigor temperatures, drip loss was not increased. Clearly, further studies on the mechanisms of drip loss and the contribution of protein denaturation are needed. Only when we understand the mechanisms of drip loss and factors responsible for color will we be able to explain the relationship between color and whc. Knowledge of this relationship is essential in the development of methods to predict and select a specific quality of meat.

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