Light scattering properties of pork at 45 minutes compared with those at 24 hours post mortem

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Introduction

The Fibre Optic Probe (FOP), that was developed to detect PSE and DFD 24 h post mortem, can also be used for the prediction of pork quality at 45 min post mortem, as could be deduced from the significant correlation between panel scores for meat quality and FOP-measurements (Somers and Tarrant, 1984). This was in agreement with studies on slaughter pigs in The Netherlands (Van der Wal et al., 1985a). This relationship, however, has limitations when there is less variation in meat quality in the carcasses that are measured. This not only pertains to the FOP, but also for equipment for carcass grading, such as the Fat-o-Meat'er (FOM) and the Hennessy Grading Probe (HGP), that is used to measure the light scattering properties of pork at 45 min post mortem (Van der Wal et al., 1985b). It was found that only a portion of the PSE carcasses could be detected at the time of slaughter by using the higher reflectance classes. As a part of a study on the use of grading equipment in fresh and chilled carcasses, this study included additional measurements about the scatter of light at 45 min and at 24 h post mortem to obtain information about changes in reflectance values that occur overnight in a chilling room.

Material and methods

Measurements of light scattering were performed on 154 pig carcasses in a commercial slaughterhouse at 45 min post mortem and after storage overnight in a chilling room at 24 h post mortem. The equipment that was used was:
a. FOM (Fat-o-Meat'er; SFK, DK 2650 Hvidovre, Denmark),
b. HGP (Hennessy Grading Probe (GP2); Hennessy and Chong Ltd., Auckland, New Zealand),
c. FOP (Fibre Optic Probe; TBL-Fibres Ltd., Leeds LS10 1AU, England).
The measurements were carried out in the longissimus of the left side between the 3rd and 4th lumbar vertebrae (3/4LV) 8 cm from the dorsal midline (FOP-1), at the last rib (LR) 8 cm from the dorsal midline (FOP-2; HGP-1) and between the 3rd- and 4th-from-last ribs (3/4LR) 6 cm from the dorsal midline (FOP-3; HGP-2; FOM-2). Although the measurements for carcass grading with the FOM were performed at two positions (3/4LV, 3/4LR), light scattering was only determined in the thoracic part of the longissimus (FOM-2). Besides the two reflectance values given by the HGP, this apparatus automatically registrates an overall reflectance value (HGP-0) from both individual measurements. The positions of the measurements are indicated in Fig. 1. Mean values and standard deviations of the variables were calculated. The corresponding variables were compared within carcasses with a paired t-test (two-tailed test). Simple correlation coefficients among all variables were determined.

Results and discussion

It was found that all reflectance values increased significantly during the period of storage overnight in a chilling room (Table 1). This implied that the longissimus became more pale during storage.

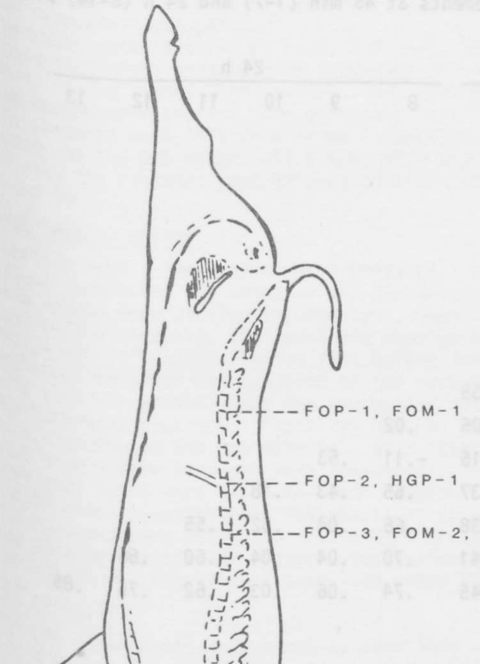

Fig. 1. The anatomical positions of the measurements of light scattering.
FOP-1, FOM-1: between the 3rd and 4th lumbar vertebrae (3/4 LV) 8 cm from the dorsal midline,
FOP-2, HGP-1: at the last rib (LR) 8 cm from the dorsal midline,
FOP-3, FOM-2, HGP-2: between the 3rd- and 4th-from-last ribs (3/4 LR) 6 cm from the dorsal midline.

Table 1. Reflectance values of FOM, HGP and FOP at 45 min and 24 h post mortem.

time post mortem:		45 min		24 h	
variable [1]	n	x	SD	x	SD [2]
FOM-2	154	31.7	4.5	57.4	11.3
HGP-1	153	38.8	9.0	52.8	21.7
HGP-2	153	37.2	5.9	60.8	17.4
HGP-0	154	9.0	2.6	19.5	6.8
FOP-1	153	111.3	5.9	139.2	15.6
FOP-2	154	110.0	6.5	137.2	15.5
FOP-3	154	108.5	5.0	139.0	13.3

1) see Fig. 1 for identification of anatomical position.

2) means for each row were compared with a paired t-test and are highly significant ($P < .001$)

The reflectance values determined with carcass grading equipment and the FOP at 45 min post mortem were highly correlated ($P < .001$) as shown in Table 2. The highest correlations were between the FOP measurements at the three different positions, i.e. 3/4LV, LR and 3/4LR. The lowest ones occurred between the reflectance values that were determined at the position LR with the HGP (HGP-1) with those measurements made with the other equipment. However, these correlations were mostly all highly significant too. This was valid for the FOM-2 (LR), followed by the FOP at the positions LR (FOP-2) and 3/4LR (FOP-3), the calculated HGP value (HGP-0) and the FOP at position 3/4LV (FOP-1). The two measurements with the HGP at both positions (LR and 3/4LR) were not significantly related.
Comparable results were obtained when the HGP reflectance values at both positions were compared with the other FOM en FOP values. It was found that all these correlations were rather low and very often not significant. Despite these low correlation coefficients with the HGP, it has to be noted that the calculated HGP reflectance value scored much higher; the correlation coefficients were of about the same magnitude as those of the FOM, which were both related to the FOP. One possible explanation for the differences between the HGP and the FOM might be due to the different detection systems used to measure the amount of scattered light. The highest peak response for FOM is in the region of the spectrum at the near infrared light (Andersen, 1984). This is comparable to the FOP that was designed to measure light scatter with a minimal interference from light absorption by myoglobin (McDougall and Jones, 1975). The FOP's photodetector has a peak response at 900 nm, i.e. the region

Table 2. Correlation coefficients among all FOM, HGP and FOP measurements at 45 min (1-7) and 24 h (8-14) post mortem (n = 154).

			45 min							24 h					
			1	2	3	4	5	6	7	8	9	10	11	12	13
	1.	FOM-2 [1]													
	2.	HGP-1	.40												
	3.	HGP-2	.64	.52											
45	4.	HGP-0	.58	.85	.85										
min	5.	FOP-1	.52	.36	.48	.48									
	6.	FOP-2	.56	.49	.61	.59	.71								
	7.	FOP-3	.61	.49	.68	.65	.74	.82							
	8.	FOM-2	.52	.49	.56	.60	.37	.49	.55						
	9.	HGP-1	.04	.05	.01	.05	-.04	-.09	-.06	.02					
	10.	HGP-2	-.11	-.12	-.08	-.09	-.14	-.18	-.15	-.11	.53				
24 h	11.	HGP-0	.31	.35	.43	.46	.24	.31	.37	.65	.43	.18			
	12.	FOP-1	.44	.42	.46	.48	.31	.46	.38	.65	.04	.02	.55		
	13.	FOP-2	.47	.47	.49	.53	.30	.50	.41	.70	.04	.04	.60	.86	
	14.	FOP-3	.47	.51	.54	.60	.33	.47	.45	.74	.06	.03	.62	.76	.85

$r = .18$: $P < .05$

$r = .23$: $P < .01$

$r = .29$: $P < .001$

1) see Fig. 1 for identification of anatomical position.

of the spectrum where the absorption of haem pigment is minimal (McDougall, 1984). On the contrary the HGP has a maximum peak response in the visible region of the spectrum at about 570 nm (Lundström et al., 1985). This wave length is nearly indentical to that at which several haem pigments (haemoglobin, myoglobin) have a maximum absorption. This suggests that the HGP detemines muscular pigments rather than the changes in physical properties that are the result of denaturation of proteins. The determination of pork colour can be conceived as a quality determination via an indirect way. An aberrant pork quality like PSE is characterized by the precipitation of sarcoplasmic proteins. These precipitated proteins mask the colour of myoglobin, possibly caused by the adsorption of the muscle pigment on the precipitated portein (McLoughlin and Goldspink, 1963), which would result in higher scattering properties of the muscle.

Based on pork quality determinations with the FOP, it was concluded that carcass grading equipment can be used for the estimation of pork quality at 45 min post mortem. This is true for the FOM as well as the HGP, with the understanding that the HGP measurements at the position of LR were not satisfactory. For quality measurements on chilled carcasses at 24 h post mortem, the HGP measurements at two different positions in the carcass are not suitable when compared to the calculated HGP value (HGP-0) which is similar to the FOM (FOM-2) value. As the values of light scattering measurements for predicting pork quality are limited, they should be combined with others that are based on different principles. However, we have to bear in mind that carcasses behaving quite normally at 45 min post slaughter, may have a very low ultimate pH, together with a pale colour and a decreased water holding capacity. This phenomenon concerns pork of the 'hampshire type' as described by Monin and Sellier (1985).

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