# DETECTION OF PSE PORK UNDER FIELD CONDITIONS USING THE COLORMET® MEAT PROBE

ANDRÉ FORTIN

Animal Research Centre, Research Branch
Agriculture Canada, Ottawa, Ontario
Canada, K1A 0C6

## INTRODUCTION

The value of pork to a meat processor and the acceptability of pork to the consumer can be detrimentally influenced by the conditions known as PSE (pale, soft, exudative) and DFD (dark, firm and dry). These quality defects which are pH-dependent affect the aesthetic appearance as well as the industrial characteristics of pork meat.

It is generally agreed that the complete elimination of these pork quality defects can only be achieved through an integrated approach linking genetic selection and the improvement of pre- and post-slaughter management of the live animal and carcass, respectively (Jones et al., 1988; Warriss, 1987; Eikelenboom, 1985). In the meantime, there is a continuous need for the development of a rapid and accurate methodology for the detection of PSE/DFD pork under commercial abattoir conditions to allow the proper utilization of pork showing these quality defects and to enable the pork industry a better control of this quality problem.

During the seventies, MacDougall, at the Institute of Food Research - Bristol Laboratory, formally the Meat Research Institute, pioneered the use of fibre optics to gain access to the interior of a carcass in order to measure the internal reflectance of muscle/meat. The measurement of the internal reflectance of muscle/meat is now a widely used technique and a number of monochromatic instruments have been available commercially for a number of years (Fortin and Raymond, 1987; Barton-Gade and Olsen, 1984; MacDougall, 1984). These monochromatic instruments, however, have little flexibility as they are restricted to a single wavelength.

A new instrument, the Colormet® meat probe, which was developed for fish grading by Instrumar Ltd., St. John's, Newfoundland, Canada, and modified by Swatland (1986) for measuring muscle/meat colour, permits the simultaneous measurement of the internal reflectance of muscle/meat at 31 wavelengths over the visible spectrum. This portable photodiode array spectrophotometer is now available commercially, but on a limited basis.

The objective of this study was to evaluate, under commercial abattoir conditions, the capability of the Colormet® meat probe to identify colour and structure defects in pork carcasses using the internal reflectance spectrum of the longissimus dorsi (LD) muscle. Two probing times, time at grading (60 min postmortem) and 24 h postmortem (PM), were selected as only these two times represent time at which the detection of the two quality defects in pork (colour and structure) is commercially feasible under Canadian abattoir conditions.

## MATERIALS AND METHODS

All data used in this study were collected at a commercial abattoir (Table 1). Each carcass was probed on the left side at the last rib, 7 cm lateral to the exposed surface of the split carcass. The LD muscle was reached ventrally through the intercostal soft tissue to avoid any possible smearing of the recording window by the subcutaneous fat. Probing at 60 min PM was done on the slaughterline and probing at 24 h PM in the cooler.

Table 1. Distribution of loins (LD muscle) according to colour or structure[1]

| Score | Colour | Structure |
|---|---|---|
| 1 | 62 | 77 |
| 2 | 200 | 330 |
| 3 | 630 | 462 |
| 4 | 24 | 47 |

[1]Agriculture Canada Pork Quality Standards (1984).

Meat colour of the LD muscle was measured with a Colormet® meat probe (Instrumar Ltd., St. John's, Newfoundland, Canada). The probe was standardized by wrapping white teflon tape (Gore-Tex PTFE Tape, specification T-27730A) around the fibre-optic window. The data were transformed using a linear regression to estimate what the internal reflectance would have been if the Colormet® meat probe had been standardized on optical-quality barium sulfate (Swatland, 1988).

At 24 h PM, the boneless loins were assessed by two experienced evaluators using the Agriculture Canada Pork Quality Standards (Agriculture Canada, 1984). A five-point descriptive scale was used to describe colour: 1) extremely pale, 2) pale, 3) normal, 4) dark, and 5) extremely dark; and structure: 1) extremely soft and exudative, 2) soft and exudative, 3) normal, 4) firm and dry, and 5) extremely firm and dry. Although water holding capacity is the characteristic of PSE pork which is of major commercial concern, the visual assessments of colour and/or structure are generally used for determining the severity of PSE pork under commercial abattoir conditions. Colour on itself is also an important physical property of pork.

All data were analyzed using the Statistical Analysis System (SAS Institute, Inc., 1985).

RESULTS

Since a very small number of carcasses (n = 2) exhibiting extremely dark (score = 5) and/or extremely firm and dry (score = 5) characteristics were found during the course of this study, these carcasses were deleted from the analyses (Table 1).

The output of a Colormet® meat probe represents a fibre optic reflectance spectrum at 31 wavelengths (from 400 to 700 nm in 10 nm increments with a band width of 10 nm). In this study, the fibre optic internal reflectance spectra were first evaluated relative to the subjective colour assessment and then relative to the subjective structure assessment.

Figures 1, 2, 3, and 4 illustrate the average internal reflectance spectra at 60 min PM and 24 h PM for extremely pale, pale, normal, and dark loins (LD muscle), and extremely soft and exudative, soft and exudative, normal, and firm and dry loins (LD muscle), respectively.

At 60 min PM, only the mean internal reflectance spectra of loins exhibiting scores 1, 2 and 3 for colour and structure could be differentiated (t - statistic, P>0.01). The mean internal reflectance spectrum of loins exhibiting score 4 could not be differentiated (P≃0.3) from the mean internal reflectance of loins exhibiting score 3.

At 24 h PM, the divergence of the mean internal reflectance spectra between scores 1, 2, 3, and 4 for both colour and structure characteristics were significant at all wavelengths (t - statistic, P≥0.001).

The relationships of the colour

and structure scores with the internal reflectance were consistent with the mean internal reflectance spectra; loins with score 1 (colour or structure) had higher mean internal reflectance spectra than loins with score 2 or score 3 or score 4. The relationships with the subjective characteristics (colour and structure) were stronger at 24 h PM and at wavelengths 600 to 690 nm (Table 2). As a predictor of colour and structure determined at 24 hr PM (Agriculture Canada, 1984), the strongest relationship for a single wavelength was at 690 nm (60 min PM, colour: r = -0.52, structure: r = -0.43; 24 h PM, colour: r = -0.64, structure: r = -0.64).

Furthermore, at 24 h PM the relationship between internal reflectance and structure was as strong as the relationship with colour.

## CONCLUSIONS

The internal reflectance spectrum of the LD muscle measured by the Colormet® meat probe was assessed under commercial conditions (60 min and 24 h PM) for its ability to identify the colour and structure defects associated with PSE and DFD in pork.

The design of the Colormet® meat probe, a stainless steel shaft with a sharp conical tip mounted with a continuous ring of randomized out-going and in-going quartz optical fibres, makes it possible to obtain an internal reflectance measurement of muscle/meat directly from the carcass. In addition, the Colormet® meat probe, being a photodiode array spectrophotometer, is capable of simultaneously measuring a reflectance spectrum of 31 wavelengths from 400 to 700 nm in increments of 10 nm.

Based on the analysis of the individual wavelengths, the internal reflectance spectra between 600 and at 690 nm were identified as offering the most potential for the detection of quality defects in pork such as colour and structure. In this study, quality was defined in terms of subjectively assessed colour and structure. These two quality characteristics could be assessed from the internal reflectance spectrum to the same degree of accuracy particularly at 24 h PM.

At 60 min PM, despite a relatively low correlation (r ≃ -0.51, -0.52), the mean internal reflectance spectra from loins (LD muscle) showing quality assessed as 1 or 2 (extreme and slight) could be differentiated from loins showing normal and DFD (score 4) quality. At 24 h PM, it was possible to further differentiate loins exhibiting a normal score and score 4 (colour or structure).

The larger mean reflectance spectra and the larger correlation observed at 24 h PM illustrate very well the incomplete postmortem development of colour at 60 min PM. The additional differentiation of the mean internal reflectance spectra between quality scores (colour and structure) also illustrates the variation in the chromatic changes which take place over a 24 h period.

These data suggest that the Colormet® meat probe can be used to evaluate the effect of an experimental treatment (e.g., pre-slaughter management) on the colour and structure characteristic of the LD muscle particularly at 24 h PM. In addition, these data also suggest that the Colormet® meat probe can be used in a commercial environment to monitor the quality of pork meat.

## REFERENCES

Agriculture Canada (1984):
Pork Quality - A guide to understanding colour and structure of pork muscle. Agriculture Canada, Ottawa, Canada. Publ. 5180/B.

Barton-Gade, P. and Olsen, E.V. (1984):
The relationship between water holding capacity and measurements carried out with the automatic Danish Meat Quality Probe. In Biophysical PSE-Muscle Analysis (H. Pfutzner, ed.). Tech Univ. Vienna, Austria, p 192.

Eikelenboom, G. (1985):
Ways to improve meat quality in pigs. EAAP Publ. No. 33, p 68.

Fortin, A. and Raymond, D.P. (1987):
The use of electronic grading probes for the objective assessment of PSE and DFD in pork carcasses. Meat Sci. 21:159.

Jones, S.D.M., Murray, A.C., Sather, A.P., Jeremiah, L.E. and Greer, G.G. (1988):
Pork Quality, a technical review. Tech. Bull. 1988-11E, Research Branch, Agriculture Canada.

MacDougall, D.B. (1984):
Detection of PSE-meat by the MGQ fibre optic probe (FOP). Biophysical PSE-muscle Analysis (H. Pfutzner, ed.). Tech Univ. Vienna, Austria, p 162.

Statistical Analysis System Institute, Inc. (1985):
SAS users' guide, Version 5 Edition. SAS Institute, Inc., Cary, NC U.S.A.

Swatland, H.J. (1986):
Color measurements on pork and veal carcasses by fibre optic spectrophotometry. Can. Inst. Food Sci. Technol. J. 19:170.

Swatland, H.J. (1988):
Selection of wavelengths at which to measure paleness in pork by fibre-optic spectrophotometry. Can. Inst. Food Sci. Technol. 21:494.

Warriss, P.D. (1987):
Live animal effect on carcass and meat quality. Proc. Work Planning Meeting on Meat Quality. Winnipeg, Canada, p 7.

Table 2. Correlation coefficients between quality scores and internal reflectance of the loin (LD muscle) at each wavelength and measured at 60 min and 24 h PM.

| Wavelength | 60 min PM | | 24 h PM | |
|---|---|---|---|---|
| | Colour | Structure | Colour | Structure |
| 400 | -0.45 | -0.37 | -0.45 | -0.43 |
| 410 | -0.46 | -0.37 | -0.48 | -0.46 |
| 420 | -0.47 | -0.37 | -0.50 | -0.47 |
| 430 | -0.48 | -0.39 | -0.50 | -0.47 |
| 440 | -0.50 | -0.40 | -0.55 | -0.52 |
| 450 | -0.51 | -0.41 | -0.59 | -0.58 |
| 460 | -0.50 | -0.42 | -0.60 | -0.60 |
| 470 | -0.50 | -0.42 | -0.60 | -0.61 |
| 480 | -0.50 | -0.42 | -0.61 | -0.61 |
| 490 | -0.50 | -0.42 | -0.61 | -0.62 |
| 500 | -0.51 | -0.42 | -0.62 | -0.62 |
| 510 | -0.51 | -0.42 | -0.62 | -0.62 |
| 520 | -0.51 | -0.42 | -0.62 | -0.61 |
| 530 | -0.51 | -0.42 | -0.62 | -0.61 |
| 540 | -0.51 | -0.42 | -0.61 | -0.59 |
| 550 | -0.51 | -0.42 | -0.62 | -0.60 |
| 560 | -0.52 | -0.42 | -0.63 | -0.61 |
| 570 | -0.52 | -0.42 | -0.63 | -0.62 |
| 580 | -0.52. | -0.42 | -0.63 | -0.62 |
| 590 | -0.52 | -0.43 | -0.63 | -0.62 |
| 600 | -0.52 | -0.43 | -0.63 | -0.63 |
| 610 | -0.51 | -0.43 | -0.63 | -0.63 |
| 620 | -0.51 | -0.43 | -0.63 | -0.63 |
| 630 | -0.51 | -0.43 | -0.63 | -0.63 |
| 640 | -0.51 | -0.43 | -0.62 | -0.63 |
| 650 | -0.51 | -0.43 | -0.63 | -0.63 |
| 660 | -0.51 | -0.43 | -0.63 | -0.63 |
| 670 | -0.51 | -0.43 | -0.62 | -0.63 |
| 680 | -0.51 | -0.43 | -0.63 | -0.63 |
| 690 | -0.52 | -0.43 | -0.64 | -0.64 |
| 700 | -0.51 | -0.43 | -0.48 | -0.48 |

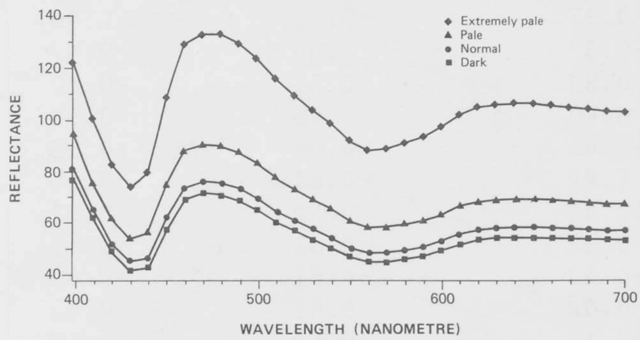


Figure 1. Mean internal reflectance spectra of carcasses exhibiting various colour scores (Agriculture Canada, 1984). Colormet® meat probe measurements were made at 60 min PM.

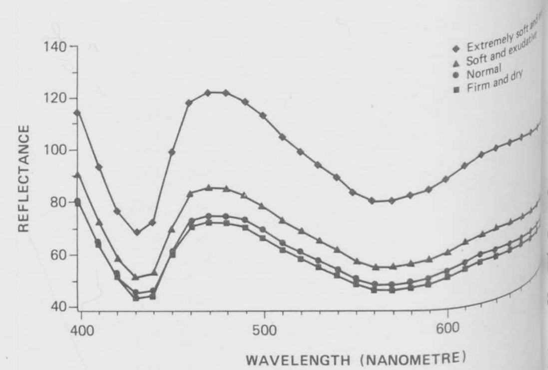


Figure 3. Mean internal reflectance spectra of carcasses exhibiting various structure scores (Agriculture Canada, 1984). Colormet® meat probe measurements were made at 60 min PM.

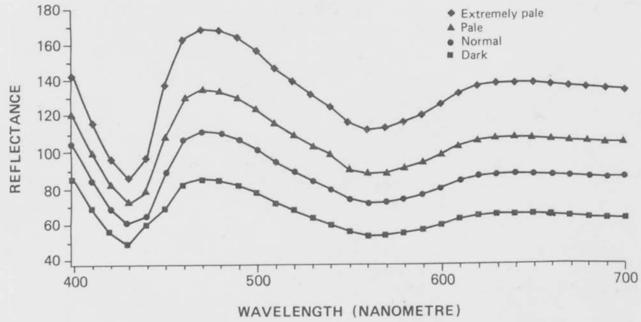


Figure 2. Mean internal reflectance spectra of carcasses exhibiting various colour scores (Agriculture Canada, 1984). Colormet® meat probe measurements were made at 24 h PM.

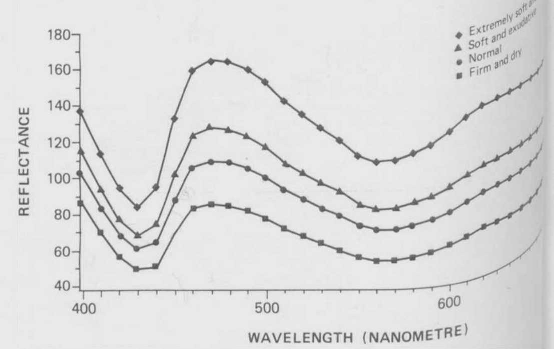


Figure 4. Mean internal reflectance spectra of carcasses exhibiting various structure scores (Agriculture Canada, 1984). Colormet® meat probe measurements were made at 24 h PM.