# 5-P7

## DEVELOPMENT OF A NIR FILTER BASED INSTRUMENT FOR ON-LINE MEASUREMENTS OF FAT QUALITY IN PORK

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### Background

The quality of subcutaneous fat in pork is important for the processing characteristics of the carcasses. Back fat which is soft and has a high iodine value is not well suited for many products. For fresh cuts the slicing quality is poor and for dried meat products a high iodine value will cause rancidity problems. At many slaughterhouses and processing plants fat quality is therefore evaluated either by expert classifiers as being soft, normal or firm or by an expensive and time consuming iodine number determination using GC-analysis. Mitsubishi Rayon Engineering, Food Engineering Division (MRE) in Japan and the Danish Meat Research Institute (DMRI) have with the support of the Japan Meat Technology Institute (JAMTI) therefore developed a near infrared based measuring system for detecting soft fat problems in pork carcasses.

### Objective

The objective of this work was to develop a rapid method for determining fat quality in porcine carcasses. The method should be capable of classifying the subcutaneous fat of carcasses as being soft, normal or firm. Initial studies showed that near infrared reflectance (NIR) spectroscopy was capable of detecting differences in spectra between carcasses with high iodine numbers and carcasses with low iodine numbers. As near infrared spectrometers for laboratory use are expensive, quite slow and not well suited for the rough conditions at slaughterhouses, it was decided to build a small and robust hand held NIR instrument that could be used anywhere on the slaughter line.

### The instrument

In Figure 1 is shown a schematic view of the instrument. A 6W halogen light source is used for illuminating the fat surface on the carcass. Three optical fibre bundles guide light from the lamp to the point of measurement where the sample is illuminated at an angle of 45 degrees to the carcass surface. Twelve individual fibre bundles collect light that has been reflected from the surface of the fat, guides it to twelve individual silicon and germanium light sensitive diodes for detection. In front of each detector is placed a narrow band filter acting as a monochromator. In this way the spectrum of the fat surface is sampled at 12 different wavelengths in the region from 400nm to 1800nm. A 13th detector is built into the instrument for monitoring the output from the lamp. This renders it possible to compensate measurements for small changes in luminosity.

### Test results

The NIR filter instrument was calibrated and tested for 8 working days during a two week period in March 1998 at the Nanchiku Slaughterhouse on Kyushu Island, Japan. Each day 160 dehided carcasses were taken off the slaughterline just before they were conveyed into the chilling room. The carcasses were measured with two instruments and by two operators. Measurements were performed on the subcutaneous fat at the thickest part of the hind leg.
After measuring, the carcasses were conveyed into the chilling room and stored there till the next morning when the fat was evaluated by the slaughterhouse expert classifiers as being either firm, normal or soft.

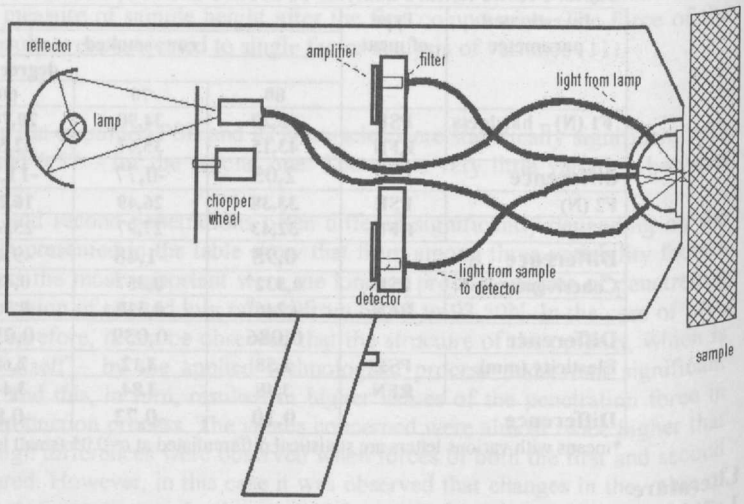


**Figure 1**: Schematic view of the NIR instrument. Only a few of the fibre bundles are shown.

Measurements done during the first 4 working days (Monday to Thursday) were only used to calibrate the instrument. The following 4 days (Monday to Thursday of the following week) measurements were used for both calibration and testing. Based on the data collected during the first week, the instruments were recalibrated to give a prediction of the fat quality of each carcass. The

prediction results were noted together with the carcass ID and the following day these results were compared with the expert classifiers evaluations.

In Figure 2 the results of a reproducibility test is shown. The predictions of the two instruments (and two operators) are compared on 160 carcassed measured during a single day. Firm, normal and soft samples have been given the arbitrary reference values 1, 2 and 3 respectivly. Samples predicted below 1.5 are classified as being firm and samples predicted above 2.5 are classified as being soft.

In Table 1 the predictions given by the instruments are compared with the fat quality evaluations of the expert classifier in a confusion table. For the last 4 days of the test period the expert classifier was asked to evaluate the carcasses twice in order to establish the repeatability of the reference method. Out of 160 carcasses tested per day typically 20 carcasses were evaluated differently in the two evaluation rounds. Hardly any carcasses were misclassified more than a single softness class by the expert. However, the expert classifier did point out that he had a bias problem from day to day, meaning that he had difficulty in classifying at the same level each day. As the carcasses could not be kept in cold storage more than approximately 16 hours, we were not able to quantify this bias problem. This day to day reference bias did indeed create some very challenging problems for developing a mathematical method for predicting the softness class. In the table it is seen that 14 carcasses out of a total of 580 (2.4%) are misclassified more than a single softness class by the instrument.

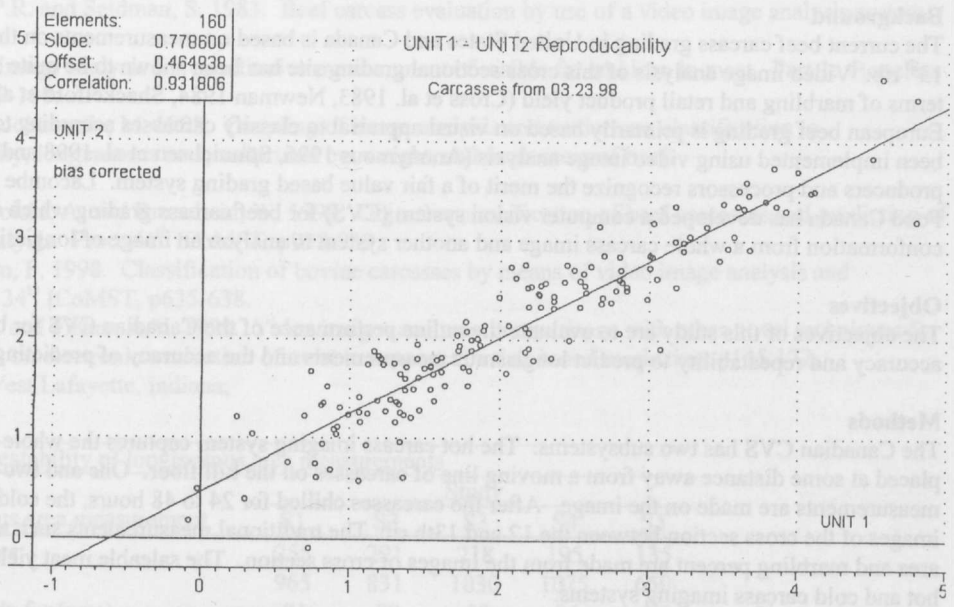


**Figure 2**: Comparison between two instruments.

| Table 1 | | Expert classifier | | | |
|---|---|---|---|---|---|
| | | Firm | Normal | Soft | Total |
| NIR Predictions | Firm | 71 | 57 | 10 | 138 |
| | Normal | 49 | 180 | 53 | 282 |
| | Soft | 4 | 59 | 97 | 160 |
| | Total | 124 | 296 | 160 | 580 |

**Conclusion**

In a collaborative effort between MRE, JAMTI and DMRI an inexpensive, hand-held NIR-spectrometer capable of grading pork carcasses according to the softness of their fat was constructed and tested. Of a total of 580 carcasses only 14 were misclassified with more than one softness class (out of three) as compared with an expert classifier.

The instrument will be marketed by SFK-Technology (Denmark) in the near future.