THE EFFECTIVENESS OF THE DANISH MQM PROBE TO EVALUATE POST-RIGOR PORK QUALITY

BORGGAARD C.*, ANDERSEN J.R.*, WARNER R.**, KAUFFMAN R.G.**, JOO S.T.**

* Danish Meat Research Institute, Roskilde, Denmark. ** University of Wisconsin-Madison, Muscle Biology Lab., Madison Wisconsin, USA.

S-IVB.23

SUMMARY

The objective of this study was to evaluate the ability of the Danish MQM (Meat Quality Marbling) invasive probe to assess meat quality in North American porcine carcasses 24 hours post slaughter.

A total of 190 pork loins were selected on a cutting line over 6 visits, to represent a range in quality. The loins were measured with the MQM reflectance probe. Each loin was cut at the last rib for visual inspection, surface measurement of lightness, exudate and ultimate pH. Quality scores were given to each loin for the attributes DFD, RFN (reddish pink, firm, exudative), RSE (reddish pink, soft, exudative) and PSE. Laboratory determination of drip loss (weight loss after suspension at 4°C for 48 hours), intramuscular fat (Soxhlet, ether extract) and total protein solubility (extracted with 1.1M KI/0.1M K_3PO_4; pH=7.2) was conducted.

The study has shown highly significant correlations between the unmodified MQM probe readings and the lightness, ultimate pH and drip loss of the meat. From the profile reflection measurement the intramuscular fat was predicted with R=0.5.

The data accumulated during this study was used to recalibrate the probe and a subsequent new study on 305 intact carcasses was performed. The results of this study showed a substantial improvement compared to the results obtained during the initial testing.

Instrumentation

The MQM-equipment is a manually operated insertion probe for measuring water holding capacity and marbling in pig carcasses 24h post-mortem (Borggaard and Andersen, 1989). When inserted into the carcass the device measures the reflection values at a single wavelength (950nm) for every 0.5 mm thus producing a reflection profile of the muscle along the line of insertion as shown in Figure 1. The probe readings are read into a portable computer for analysis. The calculations performed by the computer during this analysis fall into two separate stages. In the first stage the lean part of the profile is located. In stage two the lean part of the muscle is evaluated to give an indication of the muscle quality in terms of water holding capacity (total protein solubility) and marbling content.

Data

As a part of this study it was tested whether the MQM is useful in determining meat quality as defined by a chosen set of reference methods. The following objective reference methods were used. Lightness measured with a Minolta Chromameter CR200, ultimate pH (glass electrode) and drip loss determined either by loss of weight during suspension or with a filter paper test (weight of fluid absorbed after applying the filter paper to the freshly cut surface of the longissimus lumborum).

Initially 190 loins were selected from the cutting line over 6 visits to a packing plant. This selection was carried out by visual inspection in such a way that the quality groups PSE, RSE, RFN and DFD were approximately evenly represented, and at the same time a wide range in marbling was represented among the four groups. The 190 loins were measured with the MQM in the vicinity of the 13th rib. After being measured with the MQM, the loins were cut at the last rib and subjected to visual inspection for quality and surface measurements with Minolta and pH apparatuses. Each muscle was then subjected to laboratory determinations for ether extractable intramuscular fat, drip loss (loss of weight during suspension, 4°C, 48hrs) and total protein solubility.

This collection of data was used to recalibrate the MQM equipment. One problem observed was that since the MQM is designed to be used on whole carcasses it did a poor job in identifying where the lean started on the loins, as nearly all the backfat had been removed from these. Another problem was that the algorithm used in evaluating the profiles was developed on Danish slaughter pigs with an almost non existent DFD frequency and with very few individual carcasses showing severe PSE. This meant that the meat quality algorithm in many cases had to extrapolate from the pig population on which it originally had been developed,- often unsuccessfully.

Using partial least squares (PLS) (Martens and Naes, 1989), new MQM calibrations were developed for predicting Minolta-L values on a freshly cut surface, pH, drip loss and intramuscular fat. In Figures 2-5 the results on 157 loins after recalibration are shown for Minolta-L values on a freshly cut surface, pH, drip loss and intramuscular fat respectively (unfortunately MQM data on 33 of the loins was lost). Figures 2-5 were all produced using cross validation of the data. This means that all data points in the plots are true prediction results and not calibration results. The correlations between the various methods are seen in Table 1 with the standard error of prediction (SEP) given in parentheses.

Test results

After recalibrating, new data was collected by measuring 305 intact carcasses 24h post mortem over 3 visits to the packing plant. As the carcasses were not entirely split (as is the situation for Danish carcasses) it was rather difficult to perform the insertion with the MQM. Therefore MQM data from the first visit were discarded in the following analysis because the profiles from these measurements were made almost entirely in backfat. On the second and third visit, however, useful MQM data was collected. The test data thus consists of 224 individual carcasses. In order to save time and resources, the reference methods except Minolta-L and pH were changed from the initial data collection to this final trial. No laboratory test was performed for intramuscular fat or drip loss. Instead subjective scores were given for PSE, RSE, RFN, DFD, colour, firmness and marbling and the drip loss was assessed using the filter paper method (Kauffman et al, 1986).

In Table 2 are the correlations (and for the Minolta-L and pH readings the SEP, as only these two reference methods had remained unchanged from the initial testing of the MQM) between actual and estimated values.

In Figure 6 the test results on the Minolta-L v[illegible]re shown. When comparing this test result with the cross validation results on the calibration set, it sho[illegible]noted that the correlation is not so good on the test set. This is due to the smaller range for the Minolta-L readings in the test set. The standard error of prediction (which is the crucial parameter) is the same as for the test set. The profiles corresponding to the encircled datapoints in Figure 6 were investigated in order to see whether there were any reason why they were poorly predicted. It turned out that the instrument had not identified the lean part of these muscles very well. When the instrument was shown where to put the transition between backfat and lean and then asked to redo the prediction on these 5 individual carcasses, the SEP for the plot in Figure 6 fell to 2.38 (better than the original calibration data) and the correlation increased to R=0.83.

The MQM did not predict the marbling better in the final test than during the initial data acquisition as had been expected. However, it must be remembered that the reference method in the final test was a purely subjective evaluation (one judge) of the marbling using a scale from 1 (low) to 5 (high marbling). In a plot of these subjective ratings versus MQM there is a strong tendency that the MQM overestimates the marbling of the loins with high scores, so that the relationship is logarithmic. If the average is taken over the MQM measurements on loins with the same subjective ratings for each visit to the packing plant, the relationship between MQM and subjective ratings yields a correlation (R) of 0.9, and if one compensates for the logarithmic shape, the correlation increases to R=0.95. This clearly demonstrates that the MQM on the average is in good agreement with subjective ratings.

Conclusion

It has been shown that reflection measurements, (at a single wavelength in the infra-red region) using an insertion probe are highly correlated with the Minolta-L values. Also pH, drip loss and intramuscular fat can be estimated using this technique, although both pH and drip loss are highly correlated to the Minolta-L value. In certain carcasses the algorithm for finding the transition between backfat and lean muscle does not work well. If work is carried out to improve this part of the algorithm, the prediction results on muscle quality are also expected to improve.

References:

Borggaard C., Andersen J. R.: 1989, Proceedings of the 35th ICOMST meeting, Copenhagen, Denmark.

Martens H., Næs T.: Multivariate Calibration. 1989. John Wiley & Sons Ltd.

Kauffman, RG, Eikelenboom, G, Vand der Wal, P.G., Merkus, G. and Zaar, M.: 1986. The use of filter paper to estimate drip loss of porcine musculature. Meat Sci 18:191.