DETERMINATION OF THE AMOUNT OF INTRAMUSCULAR FAT IN BEEF - A COMPARISON OF TWO SPECTROSCOPIC TECHNIQUES.

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Introduction

The amount of intramuscular fat (IMF) is an important quality characteristics of meat as IMF affects both texture, taste and the nutrition value of meat. A high IMF content is unwanted in some societies. At the same time a too low IMF content is definitively undesirable. In this work we report on the feasibility of a less well exploited spectroscopic technique, namely using autofluorescence emission spectra (FE) for measuring IMF. The technique is compared with another spectroscopic technique, near infra red reflectance (NIRR) spectroscopy; a technique which is frequently used for its excellent capability for determining the fat content of, in particular, finely comminuted meat samples. The FE technique is known to be a very sensitive one, but lacks the signal stability and repeatability available in modern NIR equipment. A substantial improvement with respect to being able to handle such signal instability using modern software and information technology is, however, expected in the near future.

Materials and Methods

Non stimulated beef *longissimus dorsi* muscles were collected at a slaughterhouse and treated as described by Hildrum et al. (1994). The meat was frozen one day *post-mortem*, stored at - 40°C for approximately 4 weeks, then thawed overnight and measured by using the InfraAnalyzer 500 (Bran & Luebbe GmbH, Norderstedt, Germany) to obtain NIRR spectra, and an optical bench system for recording FE-spectra (Figure 1). The excitation was at 335 nm; this wavelength was not optimised for the determination of intramuscular fat content, but seemed like a feasible wavelength from various previous work on meat and dairy fat (unpublished). The spectroscopic measurements were performed at room temperature. The surface area measured by the NIRR technique was about 5 cm^2 and 80 cm^2 for the NIRR and FE techniques, respectively. The fat content was determined on the meat slices used for spectroscopic investigation, using an accredited procedure based on Foss-let.
Multivariate calibrations (partial least square regressions) were performed using the Unscrambler system (Camo A/S, Trondheim). All regression models were crossvalidated. The parameter root mean square error of prediction (RMSEP) was used to compare the two different methods.

Results and Discussion

While the technique of NIRR is rather well known for its feasibility to measure the fat content of in particular finely comminuted meat with high precision, i.e. up to an RMSEP of ± 0.21 (Isaksson et al., 1993) , it is less well known that the FE-signal could prove feasible for determining IMF. Figure 2 shows two emission spectra for a meat sample with 1% and 7.4% IMF. The two samples had the same amount of collagen, determined as hydroxyproline. Connective tissue is a another major meat component with a proved (Swatland, 1987) influence on the FE-signal from meat. Figure 2 shows that there is in particular a large difference between the high and the low fat sample at about 450-470 nm. The chemical compounds causing such differences in the emission spectra have only to a limited extent been investigated as chromophores accompanying fat tissues. However, the sensitivity of fluorescence for detecting fat tissues is appreciated by the fact that small laser sensors have been suggested as effective tools for in vivo detection of fat deposits inside human arterial walls (Verbunt et al., 1992).
Figure 3 shows the relation between predicted and measured IMF using FE spectra (left hand side), and between predicted and measured fat content using NIRR spectra (right hand side). The predictability of the two methods is

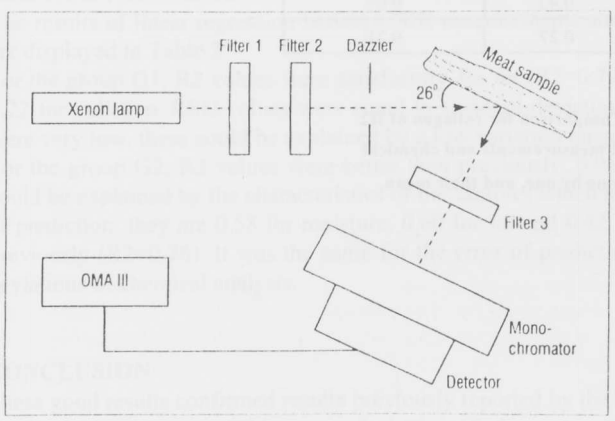

Figure 1. A schematic drawing of the optical bench used for FE- measurements.

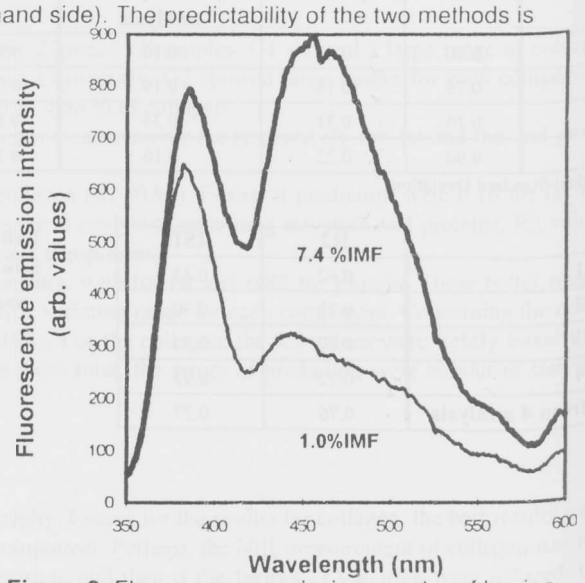

Figure 2. Fluorescence emission spectra of bovine *longissimus dorsi* muscles.

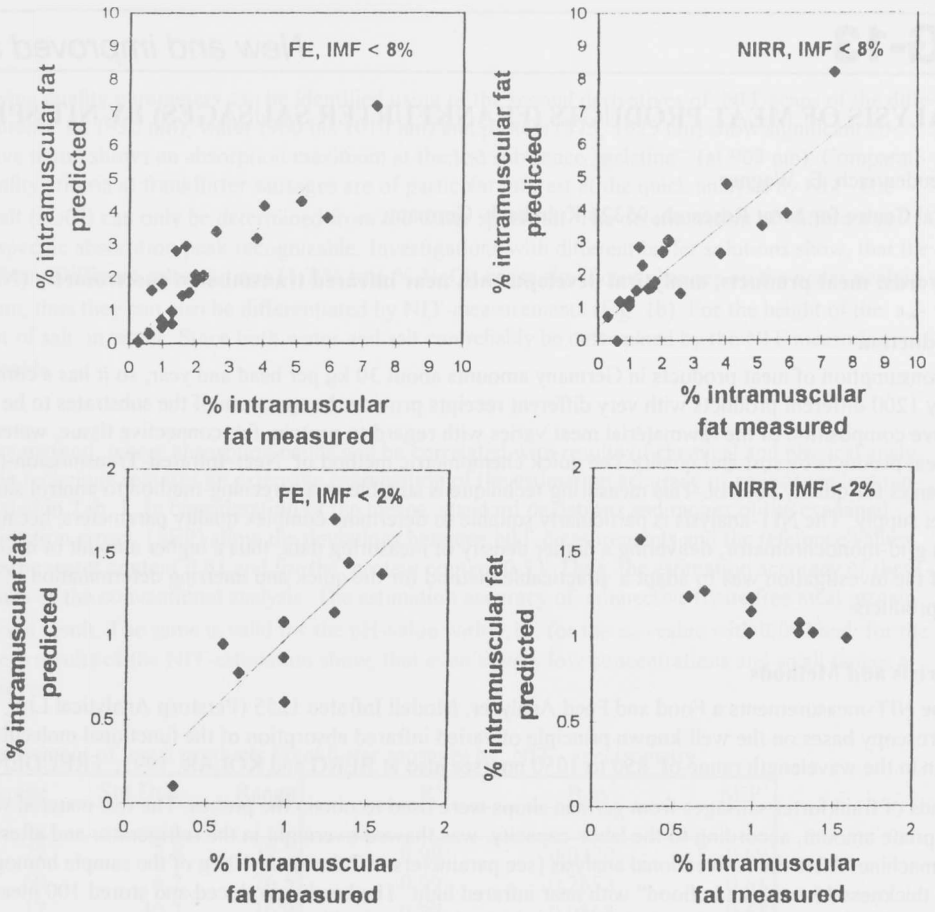

Figure 3. The relationship between measured and predicted amount of intramuscular fat (IMF) using fluorescence emission (FE) spectroscopy (left figures) and near infrared reflectance (NIRR) measurements (right figures). Upper figures IMF < 8%; lower curves < 2%.

comparable, i.e. 0.90% and 0.77%, respectively. To understand the relatively high prediction error for the more well known NIRR method, attention should be given to the fact that intact meat was used here, while more often the prediction error of finely comminuted meat samples is reported in the literature. The effect of comminution on the NIRR prediction error in the on-line analysis of fat content is also reported elsewhere at this conference (Tøgersen et al., 1996). However, a larger difference between the two spectroscopic techniques was observed when only meat samples of low (≤ 1.6%) IMF content were evaluated. In that case it was possible to obtain a good estimate (RMSEP = 0.24) for IMF from FE measurements (Figure 3, lower left) while no model could be established from the NIRR measurements (Figure 3, lower right). The feasibility of FE and NIRR to predict IMF seems good compared with ultrasonic frequency methods too as Park et al. (1994) reported a prediction error of 1.17% for fat levels from 1.49% to 10.5%. The study reported here only encompasses 22 samples of unaged beef. However, we have performed two more studies on 38 other unaged animals using modifications of the equipment shown in Figure 1, as well as commercial instrumentation, and obtained RMSEP of 0.71 and 0.88, respectively. However, in the latter two studies the IMF range was more narrow and therefore somewhat less suited to demonstrate the difference between the two techniques at low levels of IMF.
An accuracy of 0.24% is regarded as being very close to that of the reference method, i.e. the FE-technique cannot be expected to give much more accurate predictions for IMF.

Conclusions

The preliminary work performed here suggests that the technique of FE could have the same analytical accuracy for determining the amount of intramuscular fat as NIRR when the amount of IMF is above 2%. However, for lower levels of IMF the technique of fluorescence seems superior.

Acknowledgements

The technicians at the Meat Analysis Lab., MATFORSK, are thanked for performing the fat measurements.

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