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ON-LINE ASSESSMENT OF THE PROXIMAL COMPOSITION OF GROUND MEAT BY NIR AND OTHER INSTRUMENTAL TECHNIQUES

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Introduction

The variation in composition of meat raw materials intended for industrial processing is a considerable problem for the meat industry. This is mainly due to variability in individual carcass composition and causes reduced stability in the following manufacturing processes. In turn the customer is exposed to unwanted variation in product quality in the stores. Standardisation of raw material composition is usually based on off-line analyses on small samples from large batches of ground meat, which is a procedure prone to high sampling errors. A range of instrumentation has in recent years been developed for on-line meat process analysis. These make it possible to continuously measure the flow of ground meat, which gives a better representation of the proximal composition of the whole batch and reduces the problems regarding sampling.

Objectives

An on–line instrumentation should be tested under the same conditions it is to be used later. The aim of this project was to test different commercially available instrumentations for on-line analyses of fat, water and protein contents of ground beef under industry conditions.

Methodology

The instrument sensors were either mounted at the outlet of a meat grinder, on a conveyer belt or in a pipeline with moving ground meat. The 60 batches ranged between 150-500kg, and the grinding sizes were 18 or 40mm. The following instruments were selected for testing;

- Reflectance diode array NIR, Corona 45 (Zeiss)
- Reflectance NIR, MM710 (NDC-IE)
- X-ray AVS Raytech (Safeline)

In addition, a microwave instrument assembled and operated by the Danish Meat Research Institute was included in the testing. Much emphasis was placed on obtaining representative samples for the following reference analysis;

- Total fat (extraction and acid hydrolysis) - ASN 3121
- Water (drying overnight at 102-105°C for 16-18hrs) - NMKL 23 (1991)
- Protein (Kjeldahl) – AOAC 981.10 (1983)

Results & Discussion

There is known to be a close, inverse relationship between fat and water in meat. Plotting the content of fat against the contents of water and protein in the cuts showed high correlations. The sums of the components for each sample were checked to trace any outliers. The information in the strong relationships between the components is obviously used in the calibrations.

As both the 2 NIR instruments and the X-ray instrument performed well, they can be recommended for implementation in meat processes for the analysis of fat and water (Figure 1). The X-ray instrument yielded the best prediction results, with a standard error down to 0.5 % for the best model. The coarseness of the ground meat did not seem to have a large effect on the performance of the analysis. The largest contributor to the overall error in the analyses was evidently the sampling error. An on-line instrument for a specific meat application should be selected on the basis of the particular process and monitoring site in that process.

Conclusions

1. Prediction results for fat or water in ground meat for all 3 instruments were in general promising with explained variances in the range 89-99%. Prediction of protein by the NIR instruments was not satisfactory with explained variances as low as 71-75%.
2. Coarsely ground meat (40mm) was as well predicted as finer ground meat (18mm).
3. The non-contact microwave instrument did not perform satisfactory in this test due to various interferences and needs to be developed further.

Tables and Figures

Figure 1. On line analysis of fat by 3 different commercially available instrumentations.