Fingerprinting Meat Quality through Spectroscopy - On-Line

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Abstract

Most chemical components in meat can be rapidly determined by spectroscopic methods. Light is transmitted via optical fibers in combination with an insertion probe into the carcass. Here the constituents of the meat absorb light at various wavelengths. Some of the attenuated light is reflected and transmitted through other optical fibers to a spectrometer. The spectra are treated by multivariate data analysis in order to correlate them to meat quality parameters such as pigment and protein contents.

We have developed an equipment able to measure the intrinsic colour (pigment) of meat utilising spectrometry in the visual wavelength range. A method for determining protein using near infrared light is under development.

The correlation regarding determination of pigment (sum of myoglobin and haemoglobin) between the laboratory method and the above mentioned method is 0.98. At the moment the correlation for protein is 0.85.

Introduction

In our efforts to maintain high meat quality we are developing equipments with capabilities to measure specific components in meat. The common goal for the methods used is to characterise meat for higher degree of sorting according to product type, i.e. to ensure optimal use of the raw material. In addition, it is the intention to report back to the producer about the result of the measurement. With this knowledge the farmer can raise pigs more efficiently. Furthermore, with more specified sorting procedures it is easier to make meat products that fulfill requests from consumers.

To accomplish the goals it is necessary to have fast measuring techniques that give reliable results early on the slaughter line. Therefore, the methods have to function on-line. The techniques we are focusing on are optical methods harnessing the information from attenuated light. The quality parameters first dealt with are pigment and protein contents.

Procedure

The essential technique is the combination of spectroscopy and multivariate data analysis. Light is directed via optical fibers and an insertion probe into the carcass. In the meat attenuated light is reflected to other optical fibers and transmitted to a spectrometer. The spectrum is a unique fingerprint of the meat composition, due to the fact that some of the light is absorbed by components in the meat. To use this method one must first determine the wavelength range where the specific component has an optimum for absorbing light. These wavelength ranges are for pigment visual light 400 - 600 nm, and for protein near infrared light 800 - 2500 nm. In the near infrared region there is information about water and fat content too.

When using such spectroscopic techniques in combination with optical insertion probes, information about the meat is received very fast. But there are complications, because information is retrieved from a small volume which cannot represent the whole bulk of meat. Therefore, mathematical and statistical treatments are essential. We are using all information in the spectrum from the region in question. This spectrum is treated with multivariate

techniques such as Partial Least Squares, Principal Components Analysis and Neural Networks. Hereby we obtain calibration models which are related to the laboratory test result for the actual species. The method requires very large sets of corresponding reference and spectral data to ensure a reliable calibration model.

When building a new model, slaughter line spectra from different muscles are required. We choose the muscles of greatest interest for the parameter we want to investigate e.g. m. longissimus dorsi and m. biceps femoris. From the measured muscles samples are taken for laboratory analysis. Approximately 50 carcasses are selected originating from a wide range of producers. Using this concept the model covers the greatest possible variability, although it is a limited model. This first generation model can then be used to select new spectra to mature the model; *i.e.* making it more robust in terms of variability.

Results

We have developed a manual equipment for experimental use able to measure pigment content in fresh pork. With a trained technician it is possible to follow the Danish slaughter line velocity of 6 pigs per minute. The correlation coefficient between laboratory and spectral results is 0.98 on an independent test set of samples.

We are in the process of developing an equipment which can determine protein content in fresh pork. Lots of problems in getting optical fibers and probes have been experienced, due to the fact that materials used for producing them absorb light in the near infrared area. Nevertehless, an equipment for experimental use now exists. The model is not yet as rapid as wanted. The correlation between laboratory and spectral results on an independent test set of samples is 0.85.

Conclusion

It is possible to analyze the meat quality characteristics rapidly using spectroscopy and multivariate calibration. The above-mentioned methods are examples; the number of parameters may be increased. Our experience tells us to be patient because many of the devices needed are not yet fully developed. In the near future a test version of an automatic pigment analyzer for on-line measurements will be implemented on a slaughter line.

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