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# Non-invasive Analysis of Meat Quality using Fluorescence Spectroscopy

*Till now meat quality has been determined visually, with additional random controls along the production chain. Colour and pH value of the meat are the most common decisive parameters, in addition to microbiological analyses. The possibility of using non-invasive fluorescence spectroscopy to continuously measure the quality from slaughter to sale is evaluated here. Longterm tests with varying storage temperatures recorded the differences in fluorimetrical signals from the meat samples. The results were compared to conventional control methods of meat quality assessment.*

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Conventional methods to control meat quality from slaughter to sale include, besides visual inspections of every carcass half, also random microbiological analyses and measurements of colour and pH to detect DFD and PSE meat. In contrast optical methods offer the possibility to non-invasively monitor production processes along the entire production chain. Commercially available instruments which are reflectance-based can trace the main components of meat (water between 960 and 1010 nm, fat at 930 nm, proteins at 875 and 1025 nm and connective tissue at 908 nm) in the NIR-region [1]. Fluorescence spectroscopy is even more selective because not every molecule is able to emit fluorescence due to its chemical constitution. Furthermore, compared to absorption or reflectance spectroscopy, the fluorescence spectroscopy can detect small amounts of relevant substances to determine the quality of meat using relatively low energetic input.

The aim of the interdisciplinary research group "FreshScan" [2] is the development of a micro-detector system to control and optimise processes along meat production and processing. Within the scope of this project, the porcine *musculus longissimus dorsi* (MLD) was examined with fluorescence spectroscopy. MLD was removed from the carcass half one day post mortem (p.m.), cut in slices, packed each separately in PE bags and stored over 20 days at 5 or 12 °C. Meat samples were measured daily with the fluorescence spectrometer LS55 (Perkin Elmer, Rodgau-Jügesheim) at excitation wavelengths of 280, 340 and 420 nm in an emission range from 310 to 750 nm.

### Fluorescence spectrometric measurements at MLD

Fluorescence spectra of meat stored at 5 °C are shown in *Figure 1* exemplary for the 18th day p.m.. At a wavelength of 280 nm, mainly aromatic amino acids are excited. The intensity of their fluorescence emission in the meat is varying over storage time, but no time-dependent changes are observable. Aromatic amino acids seem to be therefore not suitable to serve as parameters for the determination of the age and ripening process of porcine meat.

An excitation wavelength of 340 nm causes a fluorescence of nicotinamide adenine dinucleotide (NADH) at 460 nm. With this energy-supplying coenzyme, ATP is gene-

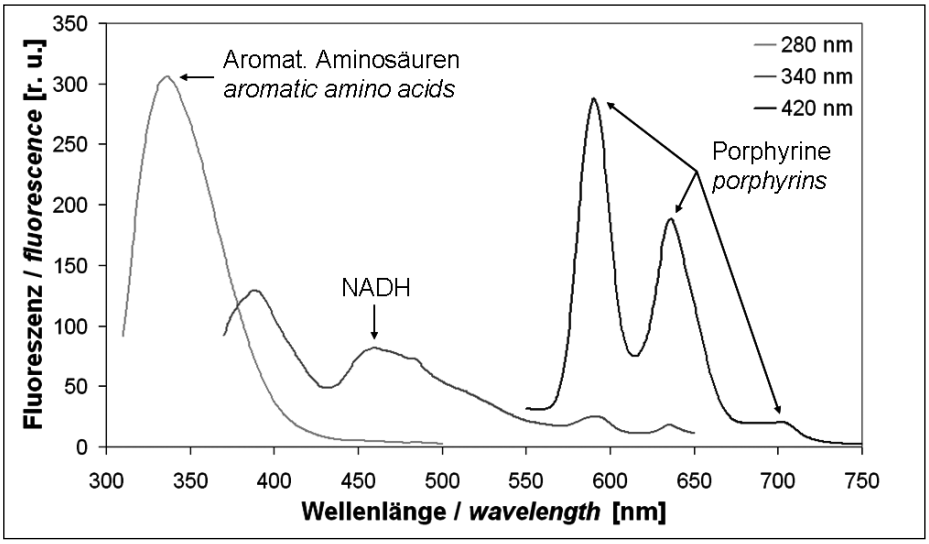


*Fig. 1: Fluorescence spectra ($\lambda_{ex}$ = 280, 340 and 420 nm) of porcine MLD at day 18 stored at 5 °C*

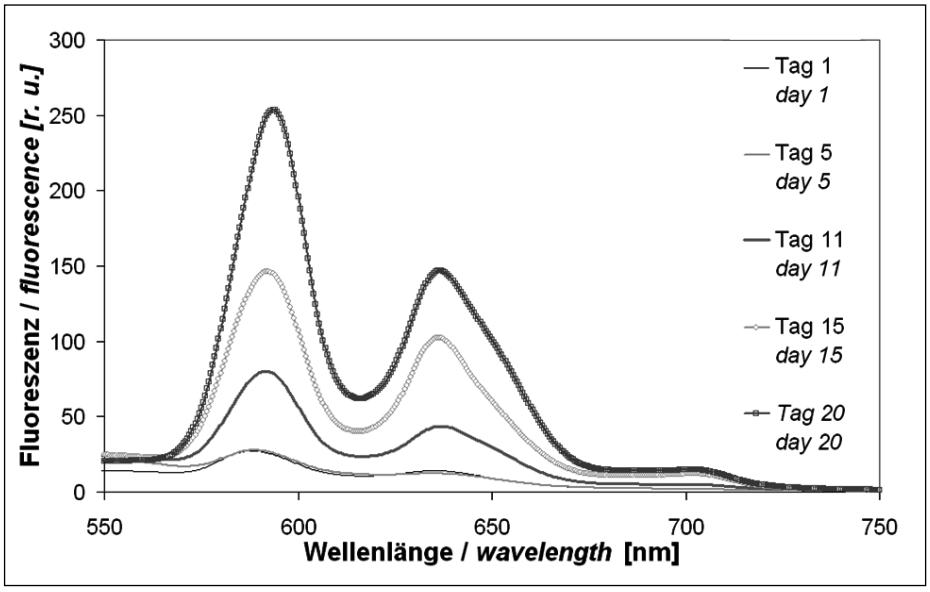


*Fig. 2: Development of fluorescence signals ($\lambda_{ex}$ = 420 nm) during storage of porcine MLD at 5 °C*

rated in the respiratory chain. After death, cell functions were initially maintained while decomposing the available NADH. As a result, a maximum at 460 nm is observable in the first days p.m., which is decreasing during ageing. The increase of the NADH fluorescence at approx. day 18 p.m., when the meat is already subjected to decomposition processes, could be traced back to the production of NADH from microorganisms.

At 420 nm different porphyrins occurring natively in meat were excited, which fluoresce between 585 and 710 nm. Protoporphyrin IX shows maximum fluorescence emission intensity in a range from 630 to 640 nm and 700 to 710 nm, whereas zinc protoporphyrin IX fluoresces mainly in a range from 585 to 595 nm and 640 to 650 nm. Protoporphyrin IX is a precursor of haeme, which builds in combination with proteins the red blood pigment haemoglobin. In zinc protoporphyrin IX the central atom consists of zinc instead of iron. In homogenised and vacuum packed pork meat both substances were detected at storage over seven days [3]. Besides enzymatic catalysis the formation of zinc protoporphyrin IX can also be generated through microorganisms [4], which could give inference about the microbial quality of the meat.

Regarding the fluorescence spectra at storage temperature of 5 °C over the whole storage time (*Fig. 2*) a distinct forming can be presented from approx. day 11 p.m.. Storage at 12 °C leads at approx. day 6 p.m. to a clear intensity increase of a twofold higher level. This faster increase of intensity at higher storage temperatures can be used for example as indicator for an undesirable interruption of the cooling chain.

### Correlation with reference analyses

Besides fluorescence spectroscopic measurements the already established analyses for meat quality were performed. Therefore the values of internal pH and surface colour (with Hunter Lab system) of every slice were recorded with respect to a possible correlation of the spectral data. The colour values of L (brightness) and b (blue/yellow) showed no distinct trend. Values of a (green/red) increased at the beginning of storage because of oxygenation of myoglobin to bright red oxymyoglobin and decreased afterwards due to formation of brown metmyoglobin. Values of pH remained relative constant over the whole storage time and increased initially at day 18 p.m. due to an increasing amount of microorganisms. No correlations between fluorescence spectra and values of pH or colour could be determined.

### Conclusion

With help of non-invasive fluorescence spectroscopy it is possible to identify indirect quality indicators for constitution of pork meat, which could be used for controlling and optimising the processing chain. Fluorescence signals of NADH as well as protoporphyrin IX and zinc protoporphyrin IX could be consulted as indicators of decomposition processes. Transferring the results of this study into a micro-detector system, these parameters would be of high advantage for producers, traders and consumers to quickly detect differing processing conditions.

## Literature

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