48th WEFTA, Lisboa, Portugal, 15-18 October 2018

Nondestructive monitoring of thermal changes in Atlantic cod (*Gadus morhua*) using fluorescence hyperspectral imaging

Abdo Hassoun, Karsten Heia, Stein-Kato Lindberg, Heidi Nilsen, Martin H. Skjelvareid

Department of Seafood Industry, Nofima AS, P.O. Box 6122, 9291 Tromsø, Norway

In recent years, there has been an increasing demand for cooked and processed food products. Fish is very sensitive to thermal treatments and it is almost always cooked prior to consumption. Overheating is a commonly used strategy in food industry in order to ensure safety of cooked products. However, this practice is wasteful and can potentially also have a negative impact on nutritional quality, as some nutrients are lost under high thermal loads. Therefore, nondestructive determination of ideal temperatures needed during heating process would both reduce energy waste and maintain product quality. In this study, the potential of fluorescence hyperspectral imaging (fHSI) has been investigated for the analysis of changes induced by the application of different thermal treatments on Atlantic cod (*Gadus morhua*) fillets.

Fresh cod were purchased from a local market in Tromsø, Norway, and two fillets were obtained from each fish. The fillet loins were cut and used in this experiment. The loins were divided into several groups, vacuum packed and cooked at different three temperatures (30, 50, and 70 °C) using a bath of water of controlled temperature. After cooking, the fHSI measurements were performed using a pushbroom hyperspectral camera, mounted 1020 mm above a conveyor belt. The excitation was performed using a focused LED UV line light with a center wavelength of 365 nm and the emission spectra were obtained at wavelength longer than 400 nm. A group of fillets was also scanned and used as a control (raw fish without cooking).

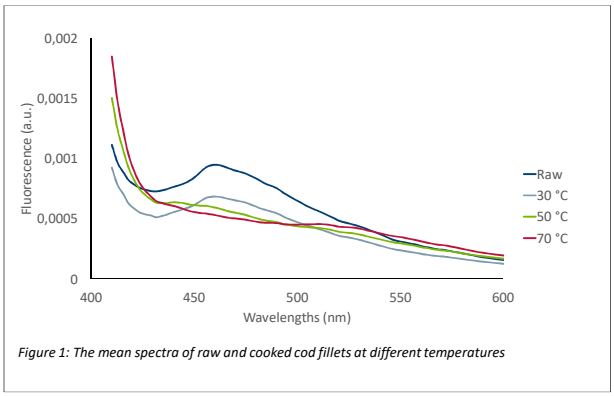

Figure 1: The mean spectra of raw and cooked cod fillets at different temperatures

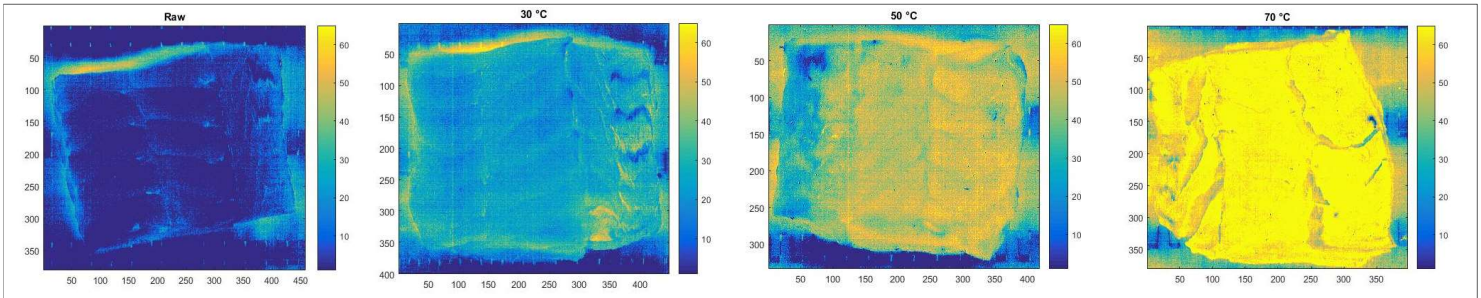

Figure 2: Examples of prediction images of cooking temperature, using partial least square regression (PLSR) model

As shown in Figure 1, the mean spectra of cod fillets have prominent peaks around 460 nm, while another less intensive peaks appear around 530 nm during cooking. The fluorescence around 530 nm is more remarkable when cooking temperature is increased, and these peaks are probably due to Maillard intermediate compounds and riboflavin. Application of factorial discriminant analysis on fluorescence data allowed a good discrimination of the fish fillets as a function of cooking temperatures.

A PLSR model (Figure 3) was built and used to predict cooking temperatures in each pixel of the spectral images. The resulting chemical images (Figure 2) are displayed with a linear color scale, varying from blue (low temperature) to yellow (high temperature). Although the temperature distribution was found to slightly vary between the different parts from the same fillets, it can be seen from the color scale that the estimated temperatures at pixel level corresponded quite well with the measured values.

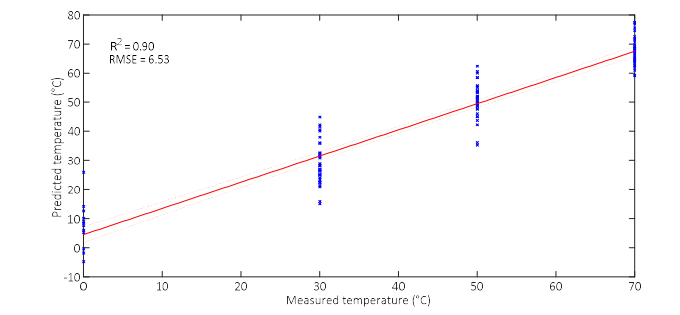

Figure 3: Measured and predicted cooking temperatures by PLSR models

- Fluorescence imaging enables a good discrimination of fish fillets as a function of cooking temperatures.
- The fHSI has a good performance in classification and visualisation of fish status during thermal processing.
- In future work, more measurements, such as protein oxidation, denaturation, lipid oxidation, and texture would be needed for better understanding of the complex reactions occurring during cooking.