Abstract
Automated quality control of salmon fillets

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Introduction

Producers of smoked salmon fillets experience problems with the product quality due to embedded blood and melanin spots. If embedded, these spots are not detectable by visual inspection, but after processing and slicing they appear as dark spots in the product. In this work the potential of using imaging spectroscopy for quality grading of fresh salmon fillets to sort out fillets with blood and melanin spots was studied.

Materials and methods

Twenty salmon fillets were used in this experiment. Some of these had embedded and surface blood spots, while others had melanin spots. They were all imaged as fresh fillets, using an imaging spectroscopy instrumentation developed at Nofima Marine, Norway. In some of the fillets blood spots were injected into the muscle to study the performance with respect to deeply embedded blood spots. Other fillets were salted and smoked after measurement and then measured once more to see if it was possible to detect blood and melanin spots in the final products. The fillets were presented for the imaging system on a conveyer belt, with a belt speed of 400 mm s^{-1}. Two parallel light lines were projected onto the fillets and the measurement line was in the middle between the two light lines, and on the same side of the fillet. By proper shielding no light enters directly into the measurement area. Therefore the measured light was forced to propagate some distance within the fillet before entering the detector unit. The imaging system has a spatial resolution of 0.5 mm × 1.0 mm, and a spectral resolution of approximately 10 nm, covering the range from 400 nm to 1000 nm. The imaging spectroscopy data were calibrated using a custom made Teflon reference. The performance of the technique was evaluated by visual inspection of raw and smoked fillets. To see embedded spots the fillets were sliced and then the visual impression was compared with the results of imaging spectroscopy analysis.

Results and discussion

With salmon it is difficult to use the strongest blood absorption wavelengths in the analysis, because the colour pigment astaxanthin absorbs strongly in the same region. Therefore higher wavelengths were applied. Melanin, on the other hand, is known to absorb over a wide wavelength range. To separate blood and melanin spots spectral data from different wavelength regions were applied. Both blood spots and melanin spots can be detected and distinguished from one another, even when embedded. Controlled blood injections showed that blood spots embedded as deeply as 10 mm can be detected. In Figure 1 one example of blood detection is shown.

The bottom image is the result of the analysis and the top image is a digital image of the same fillet. Blood spots can be detected in both fresh and smoked fillets. In Figure 2 an example of melanin detection is showed.

The top image is an artificial colour image generated from the imaging spectroscopy data, while the lower image is the result of the analysis. As with blood spots, the melanin spots could also be detected when embedded as deeply as 10 mm.

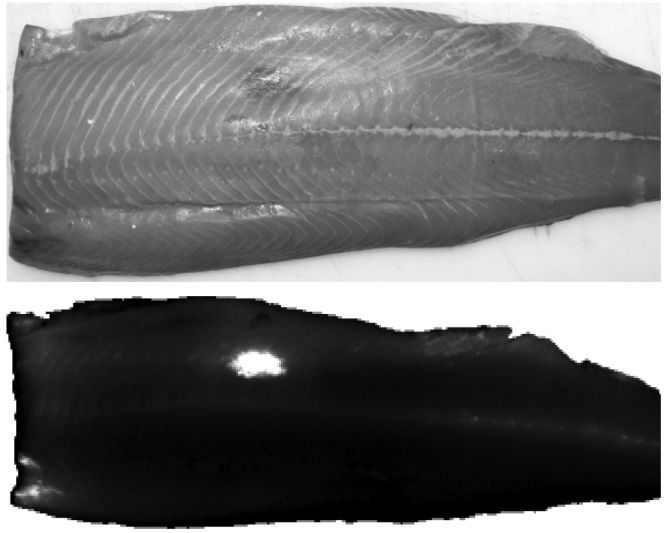

Figure 1. Salmon fillet with several blood spots. The top image is a digital image of the fillet as smoked, while the lower image is the blood analysis result based on Imaging Spectroscopy data from the fresh fillet.

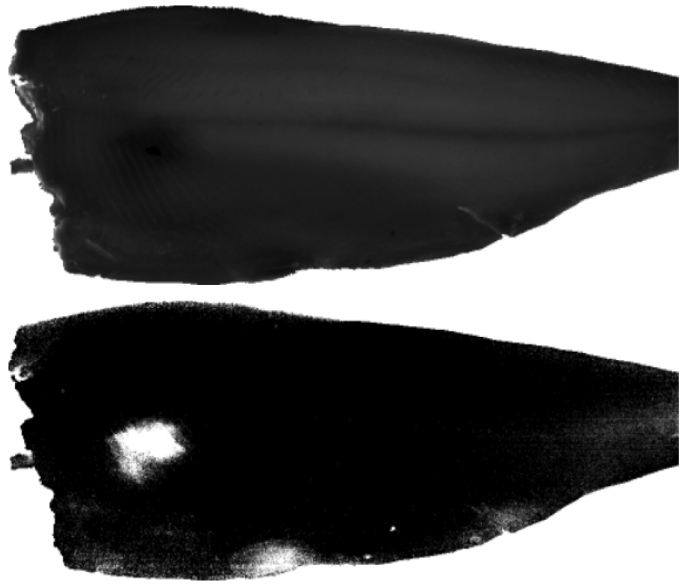

Figure 2. Salmon fillet with several melanin spots. The top image is an artificial colour image of the fillet generated from the Imaging Spectroscopy data, and the lower is the result of the melanin analysis.