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Applying Fourier Transform Mid Infrared Spectroscopy to Detect the Adulteration of *Salmo salar* with *Oncorhynchus mykiss*

Nuno Sousa [1] [ID], Maria João Moreira [1], Cristina Saraiva [1] [ID] and José M. M. M. de Almeida [2,3,*] [ID]

[1] School of Agrarian and Veterinary Sciences, CECAV, University of Trás-os-Montes e Alto Douro, Quinta de Prados, B. Laboratorial, B1.03, 5001-801 Vila Real, Portugal; nunofilipe_sousa@hotmail.com (N.S.); mjoaom24@hotmail.com (M.J.M.); crisarai@utad.pt (C.S.)

[2] Physics Department, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro, Quinta do Prados, 5001-801 Vila Real, Portugal

[3] CAP/INESC TEC—Technology and Science and FCUP-Faculty of Sciences, University of Porto, 4169-007 Porto, Portugal

* Correspondence: jmmma@utad.pt; Tel.: +351-259-350-000

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Abstract: The aim of this study was to evaluate the potential of Fourier transform infrared (FTIR) spectroscopy coupled with chemometric methods to detect fish adulteration. Muscles of Atlantic salmon (*Salmo salar*) (SS) and Salmon trout (*Onconrhynchus mykiss*) (OM) muscles were mixed in different percentages and transformed into mini-burgers. These were stored at 3 °C, then examined at 0, 72, 160, and 240 h for deteriorative microorganisms. Mini-burgers was submitted to Soxhlet extraction, following which lipid extracts were analyzed by FTIR. The principal component analysis (PCA) described the studied adulteration using four principal components with an explained variance of 95.60%. PCA showed that the absorbance in the spectral region from 721, 1097, 1370, 1464, 1655, 2805, to 2935, 3009 cm^{-1} may be attributed to biochemical fingerprints related to differences between SS and OM. The partial least squares regression (PLS-R) predicted the presence/absence of adulteration in fish samples of an external set with high accuracy. The proposed methods have the advantage of allowing quick measurements, despite the storage time of the adulterated fish. FTIR combined with chemometrics showed that a methodology to identify the adulteration of SS with OM can be established, even when stored for different periods of time.

Keywords: food fraud; food authentication; *Salmo salar* adulteration; FTIR spectroscopy; chemometrics methods

1. Introduction

Atlantic salmon (SS) is economically important in the daily life of consumers, since it is a good source of polyunsaturated fatty acids, specifically two important omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) [1,2]. They are composed of 5–10% red muscle and 90–95% white muscle [3]. The red/orange color is due to the presence of carotenoid pigment, named astaxanthin, which has antioxidant activity, leading to a high oxidative stability [4].

Salmon trout (*Onconrhynchus mykiss*) (OM) and SS are visually similar, namely in muscle color, as well as rich in EPA and DHA. They are the major species of European aquaculture because of the pressure on the wild fish population. Consequently, access to these species has become limited [5]. The pigmentation of OM is caused by the keto-carotenoids astaxanthin and canthaxanthin [6].

In the last decade, the issue of food safety has acquired increased importance, due to rapid changes in the agro-food system. Fraud is a major concern for the food industry. Fraud is defined as