Feasibility of a near-infrared spectroscopy system to estimate the microbial load of seafood products

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Introduction

In the last decade, demand for seafood products has increased due to their flavor and nutritional properties. On the other hand, frauds involving this category also arise as their economic value is high. With frauds we refer to a wide category of illegal actions, regarding the sale of a food product which has characteristics that are different from the actual ones. A category in particular refers to the sale of a good that does not respect microbiological's standard of the market in which it is sold. This kind of fraud has severe effects on purchasers, as it affects both health and psyche. Quantifying microbiological load on seafood products requires a lot of time, human and economic resources; these procedures also have a great impact on the environment. Researchers and authorities of this field have been investigating valid alternatives to microbiological analyses, in order to reduce the economic and time burden that are required to test for good's quality that are to be introduced in the market. Spectroscopic data and statistical methods have so far demonstrated to be a reliable tool but, as accuracy requires to be as high as possible, studies are in progress in order to improve performances.

Aim

The aim of this study is to evaluate how spectroscopic data can be used to predict microbial load of *Pseudomonas spp.* as principal indicator among other SSO of spoilage in seafood products.

Methods and materials

A total of 81 cuttlefish samples (fresh, frozen-thawed, and frozen-thawed treated with peroxide hydrogen) were collected from a wholesale fish plant, and then stored at 0, 2 and 4 °C until rejection of sensory analysis. At 0, 3, 6, 9 and 12 days of storage, samples were evaluated through microbiological (Pseudomonas spp.), sensory (colour, odour, texture) and spectroscopic analyses by portable NIR (900-1680 nm) tools obtaining a total of 348 observations (Figure A). Spectra were pretreated and we kept the transformation which led to the best performance in terms of predictive error: standard normal variate, baseline removal, smoothing and second derivative were applied. Multivariate statistical models such as Principal Component Analysis and Partial Least Squares Regression were used to study relationship between variables and produce predictions.

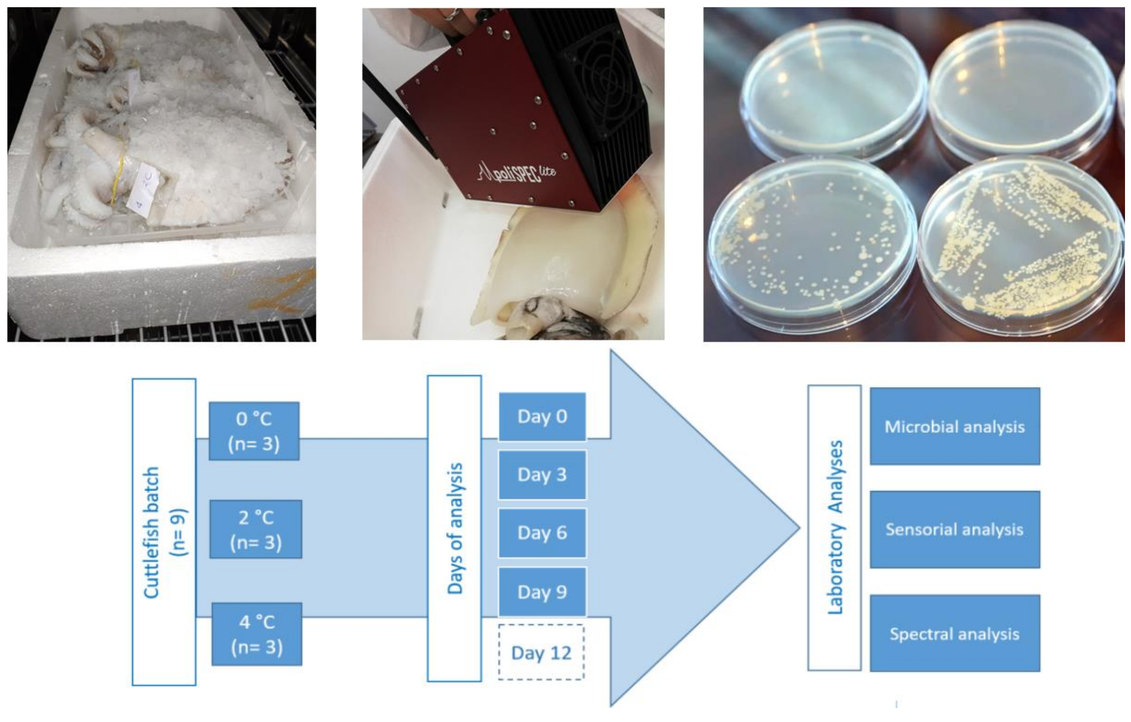

Figure A. Laboratory activities

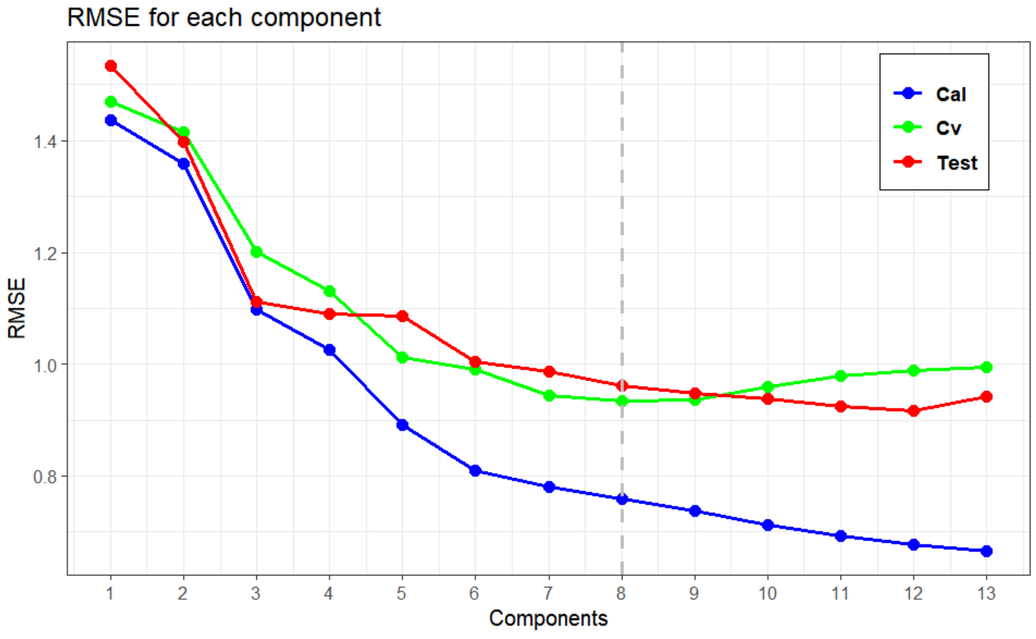

Figure B. *Performances of the model in calibration, cross-validation and testing.*

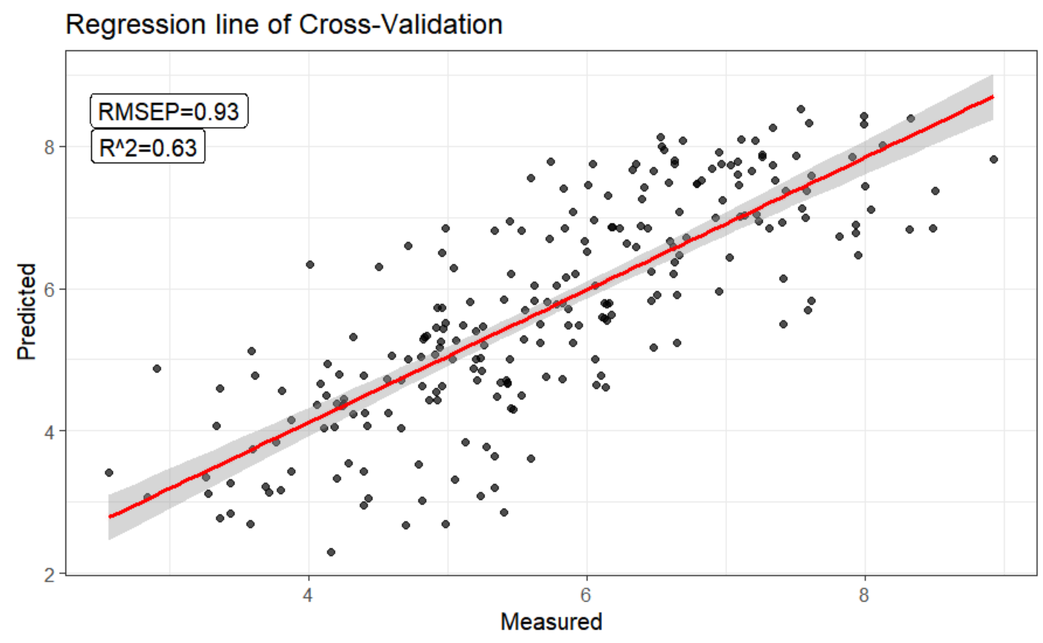

Figure C. *Regression line obtained from the Leave-One-Out Cross-Validation*

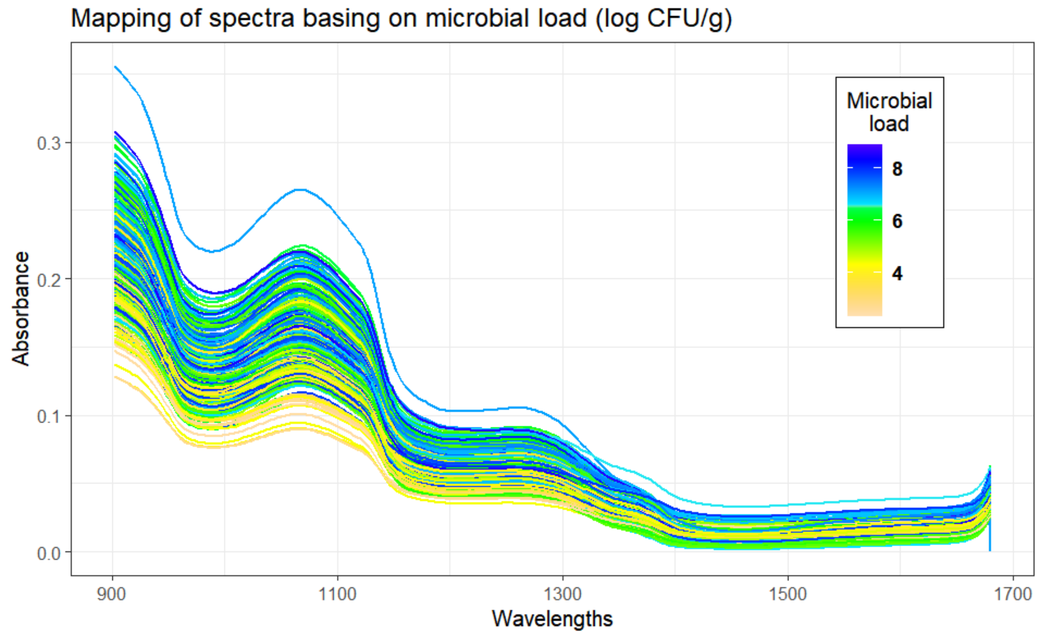

Figure D. *Spectra colored basing on microbial load of Pseudomonas spp. in each sample.*

Results and discussion

An exploratory analysis was carried out using PCA, and was found that:

- **Storing days** had an important effect on determining clusters.
- **Temperature** and **treatment** had less impact on microbial and sensorial scores.

NIR results showed:

- No clear clusters were highlighted.
- **Storing days** was the only variable that showed impact on values of absorbance, as we can see from ***Figure A***.

The matrix used with PLS was composed by:

- **X-Block:** Spectroscopic and sensorial data
- **Y-Block:** *Pseudomonas spp.*

The model chosen had eight component had eight components and:

- Captured 87% of variance of the X-block and 75% of the Y-block.
- Is close to results found by other studies, which demonstrate spectra's promising capacity for this kind of applications.

Conclusions

Frauds associated with seafood continue to pose challenges within the industry, and researchers in this field are dedicated to identifying viable and environmentally sustainable solutions. Significant advancements have been made; however, further progress is necessary. The outcomes of our experiment demonstrated that the integration of spectroscopic data with multivariate statistical methods holds promise as a means of estimating the microbial load of seafood products. Nonetheless, improvements in accuracy are required before Near Infrared Spectroscopy can be deemed a valid tool for reducing the use of classical microbiological analyses.

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