Application Note – N°. 901/2025

Fish identification and authentication

Abstract: The ability to accurately identify fish species is essential for ensuring food authenticity, regulatory compliance, and consumer confidence. The ProxiScout™ handheld NIR scanner provides a rapid, cost-effective, and non-destructive solution for fish authentication, addressing challenges related to species mislabeling and substitution in the seafood industry.

1. Introduction

Seafood fraud is a widespread issue, with species mislabeling and substitution causing economic losses and potential health risks. Traditional fish identification methods, such as DNA analysis and chromatography, are costly, time-consuming, and require laboratory infrastructure. As a result, both suppliers and consumers often lack certainty about the authenticity of the fish they purchase or consume. Near-infrared (NIR) spectroscopy presents a rapid, non-destructive alternative for real-time species identification based on spectral fingerprinting. This study evaluates the effectiveness of ProxiScout™, a portable NIR scanner, in distinguishing fish species through their unique spectral signatures.

2. Equipment

The ProxiScout™ handheld NIR scanner was used to collect spectral data from fish samples. The introduction of handheld NIR scanners enables more inspectors to conduct on-site authentication in the field, on factory floors, and at ports, fish markets, warehouses, and restaurants, reducing the risk of fish mislabeling. Employees can easily operate ProxiScout™ with minimal training, using diffuse reflectance spectroscopy to capture unique spectral signatures and obtain instant, reliable results.

3. Samples

The team used two different pairs of fish, samlet and salmon trout, and sole and lemon sole, which represent species considered superior from a gourmet and price perspective (samlet, sole), and cheaper substitutes (salmon trout and lemon sole), see Figure 1.

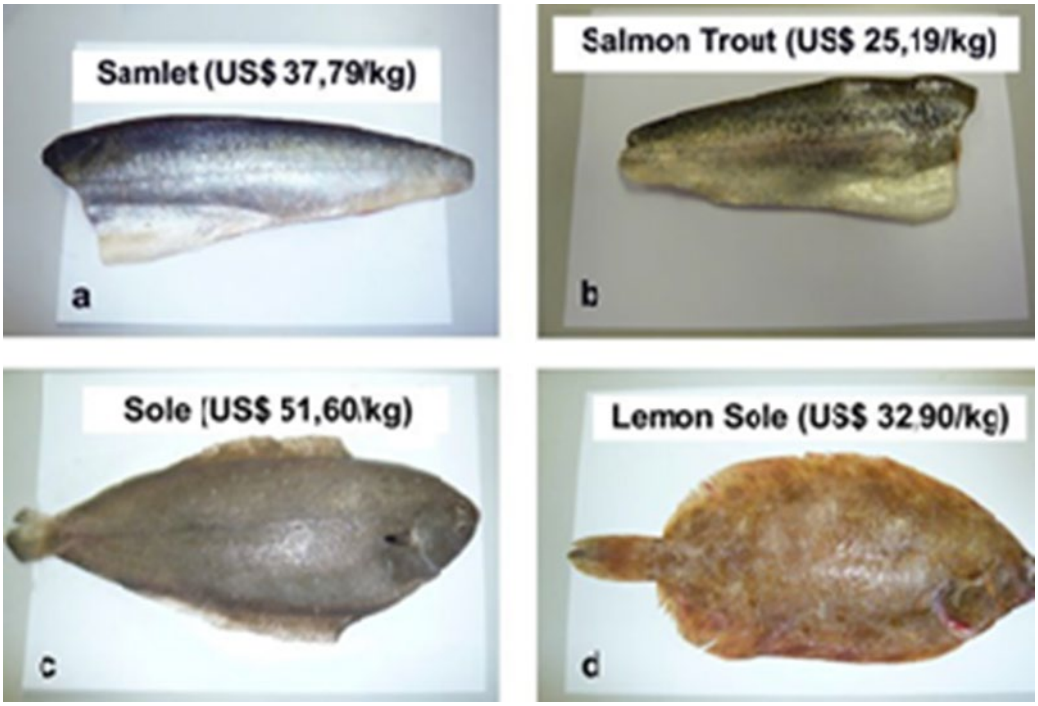

Figure 1: Filets of Samlet (a) and Salmon Trout (b) and whole fish of Sole (c) and Lemon Sole (d).

3.1 Sample Collection

Two sets of fish species were analyzed:

- Set 1: Samlet vs. Salmon Trout.
- Set 2: Sole vs. Lemon Sole.

Samples were collected from different sources and analyzed under standardized conditions to ensure repeatability.

4. Procedure

For the samlet and salmon trout comparison, the researchers used 4 samlet and 6 salmon trout filets. The NIR spectra were collected by placing the ProxiScout™ scanner directly on fish samples. (Figure 2). A reference scan was conducted with Labsphere's 99% Spectralon™ reflection standard. 10 spectra with a scan time of 10 seconds were recorded in diffuse reflection from different positions on each fish filet. The team used Unscrambler™ software for the data pre-treatment and the development of PCA (Principal Component Analysis) and SIMCA (Soft Independent Modeling of Class Analogies) models.

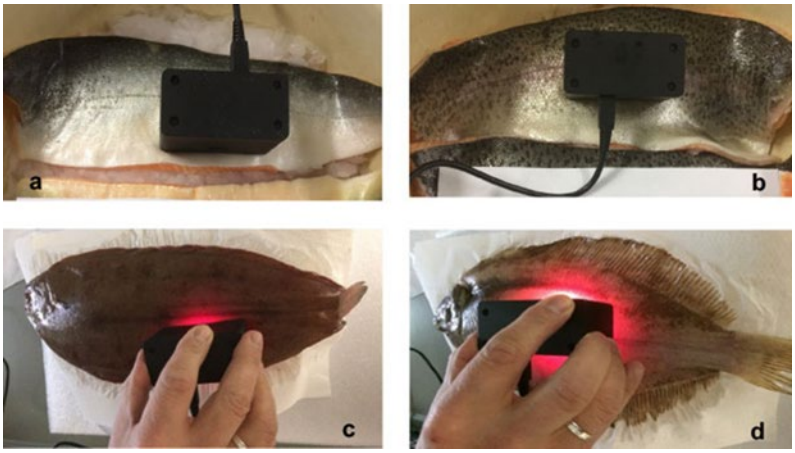

Figure 2: Sample presentation of Samlet (a), Salmon Trout (b), Sole (c), and Lemon Sole (d) for NIR spectra measurements with the sensor.

4.1 Data Analysis

Spectral data were pre-processed using Extended Multiplicative Scatter Correction (EMSC) before Principal Component Analysis (PCA) and Soft Independent Modeling of Class Analogies (SIMCA) were applied for classification.

5. Result

5.1 Samlet and Salmon Trout

The 100 spectra measurement are shown after pre-treatment in Figure 3. Using the PCA model the researchers were able to distinctly discriminate the two fish classes in a 2D score plot (Figure 4). Using the SIMCA classification based on the two PCA models for each fish class, the researchers were able to use a Coomans plot to ascertain to which class the spectra of an unknown fish belong, including a French salmon trout and a German salmon trout.

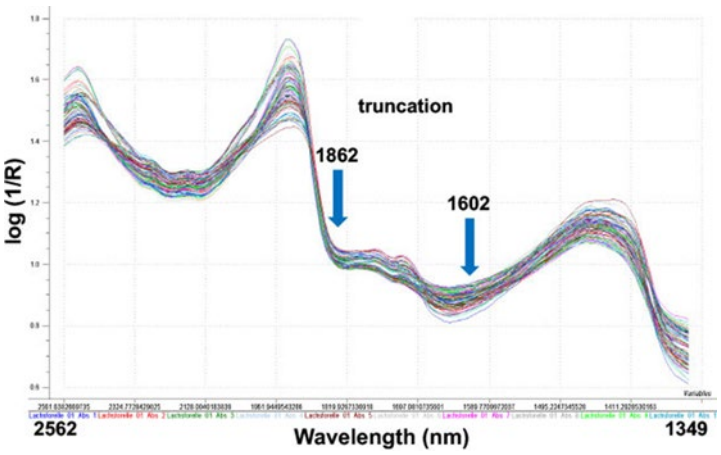

Figure 3: Comparison of NIR spectra measured with the sensor of all Samlet and Salmon Trout species after EMSC (including truncation range for PCA).

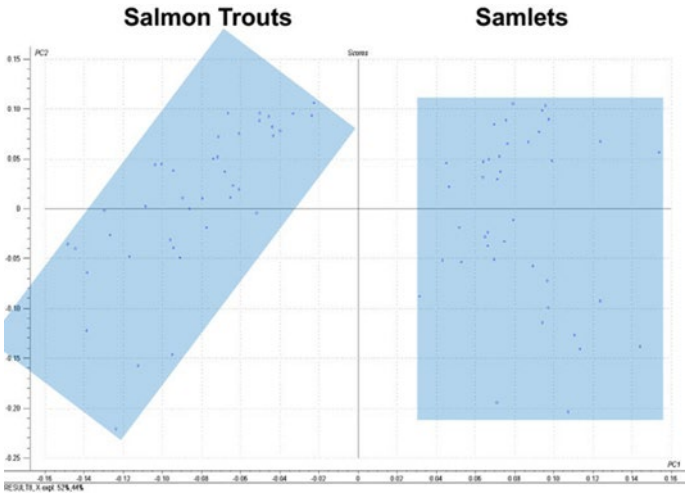

Figure 4: 2D (PC1/PC2) score plot based on the PCA of 40 calibration spectra for each of the investigated Samlets and Salmon Touts.

5.2 Sole and Lemon Sole

For the sole and lemon sole comparison, similar methods were used. In this case the two species could be distinctly identified even from the initial wavelength graph (Figure 5). The fish species were also distinguishable from each other in the 2D score plot, while unknown species could be identified from the Coomans plot.

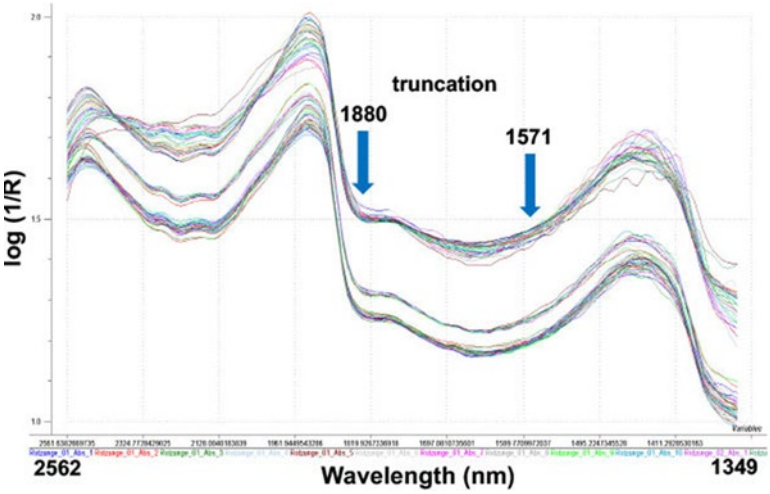

Figure 5: NIR spectra measured with the sensor of all Sole and Lemon Sole species after EMSC (including truncation range for PCA).

6. Conclusion

Comparison to Standard Methods:

- PCA score plots demonstrated clear separation between species groups.
- SIMCA classification correctly assigned unknown samples to their respective species with high accuracy.
- ProxiScout's results correlated well with traditional laboratory methods, confirming its capability as a rapid fish authentication tool.

The study demonstrated that, based on NIR-based diffuse reflection spectra, the ProxiScout™ scanner effectively distinguishes between visually similar fish species, providing an on-site, non-destructive solution for seafood authentication. Its portability and ease of use make it an ideal tool for regulatory agencies, seafood suppliers, and quality control labs. Equally significant, unknown fish within the two studied classes were accurately classified using SIMCA analysis, further validating ProxiScout™ reliability in species identification.

7. References

[1] Global Seafood Market Valuation (2017): Source: Allied Market Research

[2] Oceana. (2013). National seafood fraud testing results: Final report. Oceana. Retrieved from https://oceana.org/wp-content/uploads/sites/18/National_Seafood_Fraud_Testing_Results_FINAL.pdf

[3] Gautam, R., Jayaprakasha, G. K., & Patil, B. S. (2023). Handheld near-infrared spectroscopy: State-of-the-art instrumentation and applications in material identification, food authentication, and environmental investigations. Retrieved from https://www.researchgate.net/publication/370511228_Handheld_Near-Infrared_Spectroscopy_State-of-the-Art_Instrumentation_and_Applications_in_Material_Identification_Food_Authentication_and_Environmental_Investigations