Non-destructive determination of chicken fillet adulteration by MicroNIRs

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RIKILT WAGENINGEN UR — VIAVI — FOOD INTEGRITY — Work Package 10 Integration

Chicken fillet - Background

Local production and import of chicken fillets in Europe/The Netherlands is a multimillion euro industry. Consumers are entitled to informed choices and should not be deceived, e.g. by:

- Thawed chicken fillets sold as fresh.
- Addition of non-labelled moisture and accompanying moisture retaining agents.

Figure 1. Obtaining NIR spectra of chicken filets with the MicroNIR™ 1700 equipped with rim.

Figure 2. The MicroNIR™ 1700 from Viavi Corporation.

MicroNIRs - Background

The MicroNIR™ 1700 was explored as a fast tool for on-site non-destructive authentication (Fig. 1). The equipment is USB powered, weighs 60 grams (45 x 42 mm) and measures in the spectral range of 950 – 1650 nm (Fig. 2). Analysis results can be directly displayed on a tablet or laptop (Fig. 5). A food inspector can therefore identify suspect samples to transfer to his laboratory facilities for more elaborate investigation
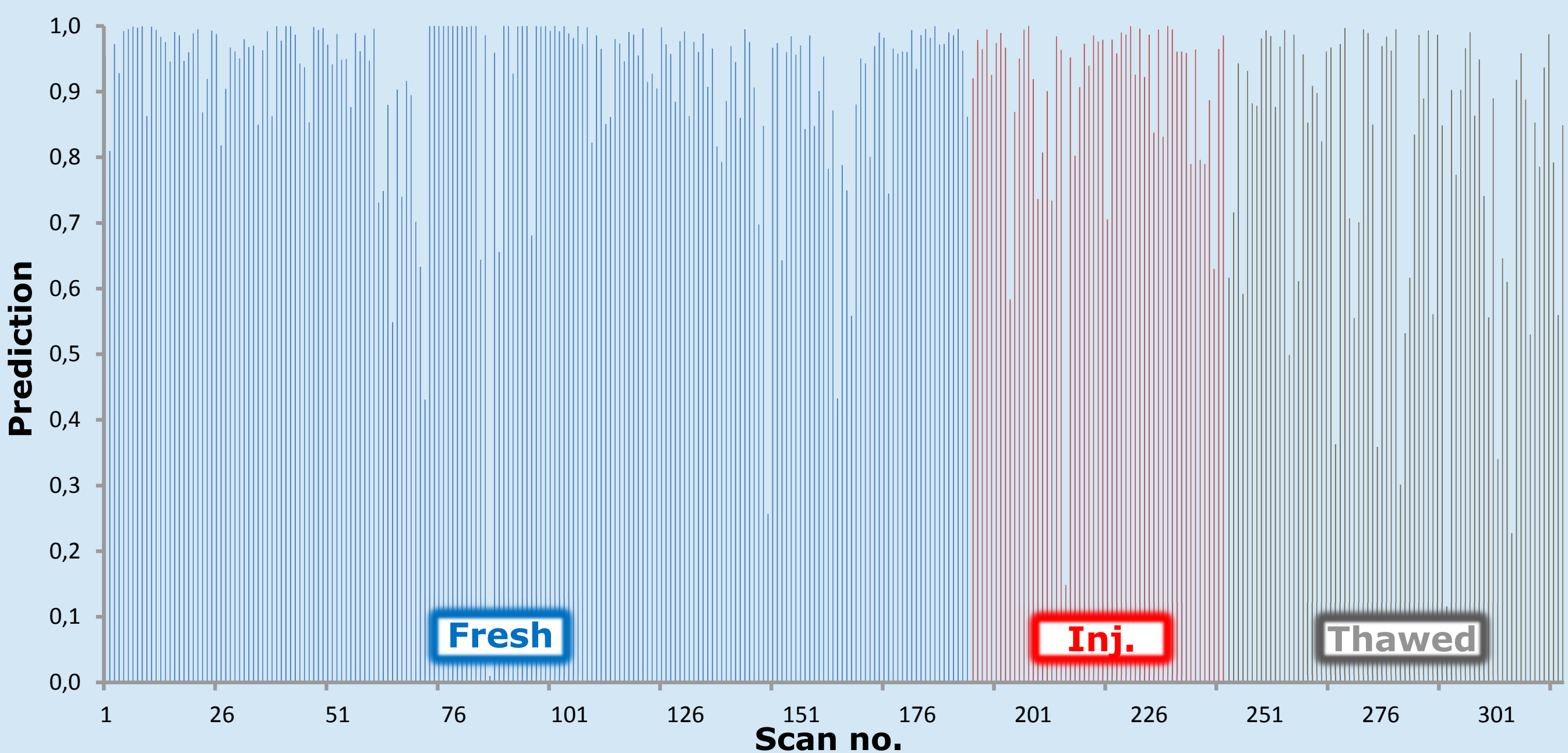
Classification: Fresh, Injected and Thawed filets

Figure 3. External validation (50/50% training/validation) of fresh, injected and thawed filets by linear C-SVM classification.

Table 1. Confusion matrix for a linear C-SVM classification of fresh, injected and thawed filets by external validation. False negatives are highlighted in red, false positives in orange.

Actual \ Predict.	Fresh	Injected	Thawed
Fresh	187	1	7
Injected	2	54	0
Thawed	1	0	70

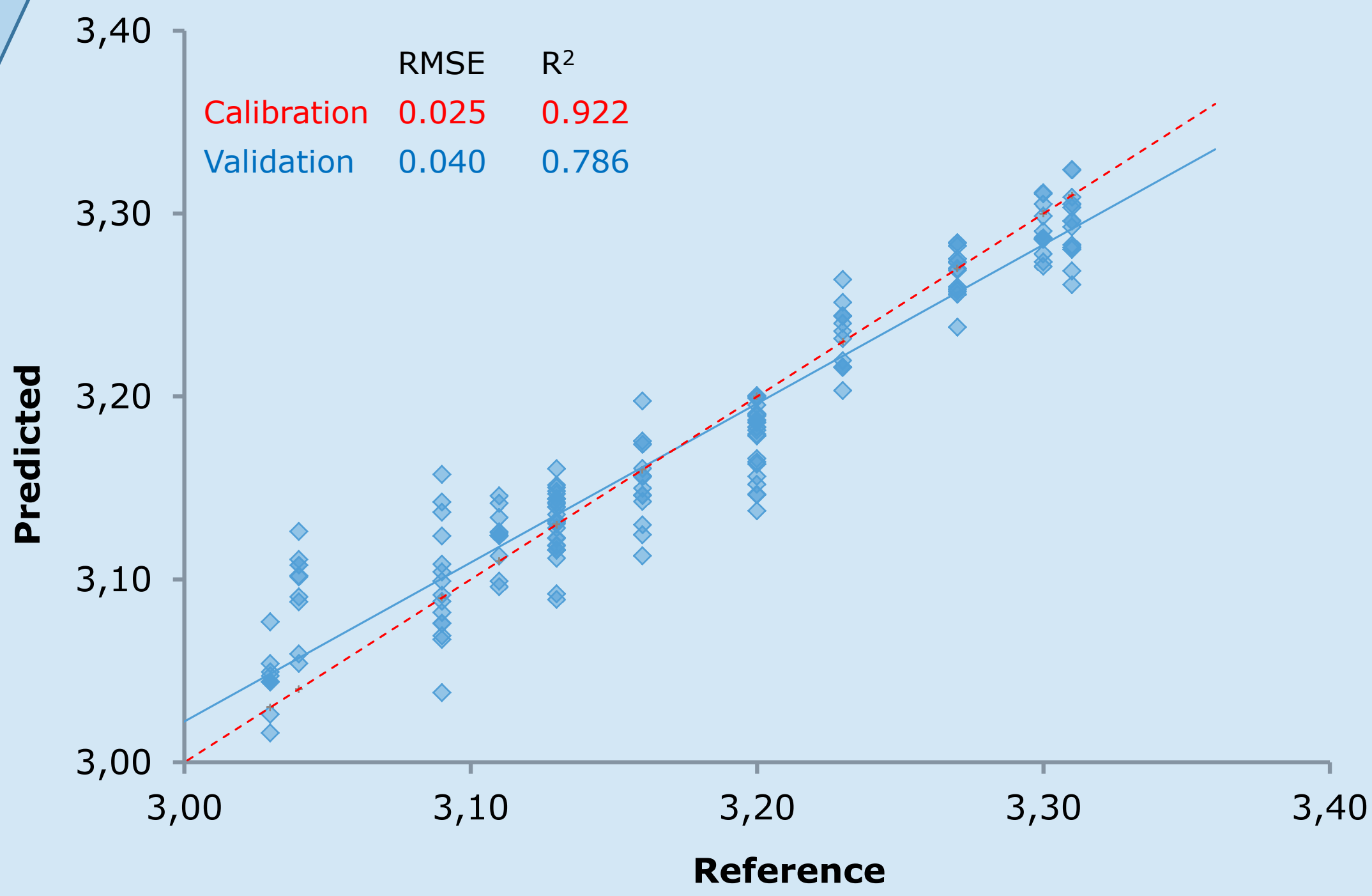|	RMSE	R²
Calibration	0.025	0.922
Validation	0.040	0.786

Figure 4. Regression of moisture-protein ratio using a radial base function epsilon-SVR model.

Table 2. External validation of moisture, protein and their ratio using a radial base function epsilon-SVR model.

	Moisture (%)	Protein (%)	Moisture/Protein (-)
Ext. val. set	Abs. average difference of actual and predicted values		
1	0.50	0.42	0.07
2	0.36	0.50	0.09
3	0.32	0.41	0.07
Average	**0.39**	**0.44**	**0.08**

Results & Discussion

Due to the inhomogeneity of the samples, 'classical' principal component classification and regression methods show little correlation with the laboratory values. Therefore, machine learning algorithms were employed. In this case, support vector machine (SVM) classification and support vector regression (SVR) gave accurate results (Fig. 3 – 4 and Tab. 1 -2). Low number of false negatives for classification and low deviations from the actual ISO values were found.
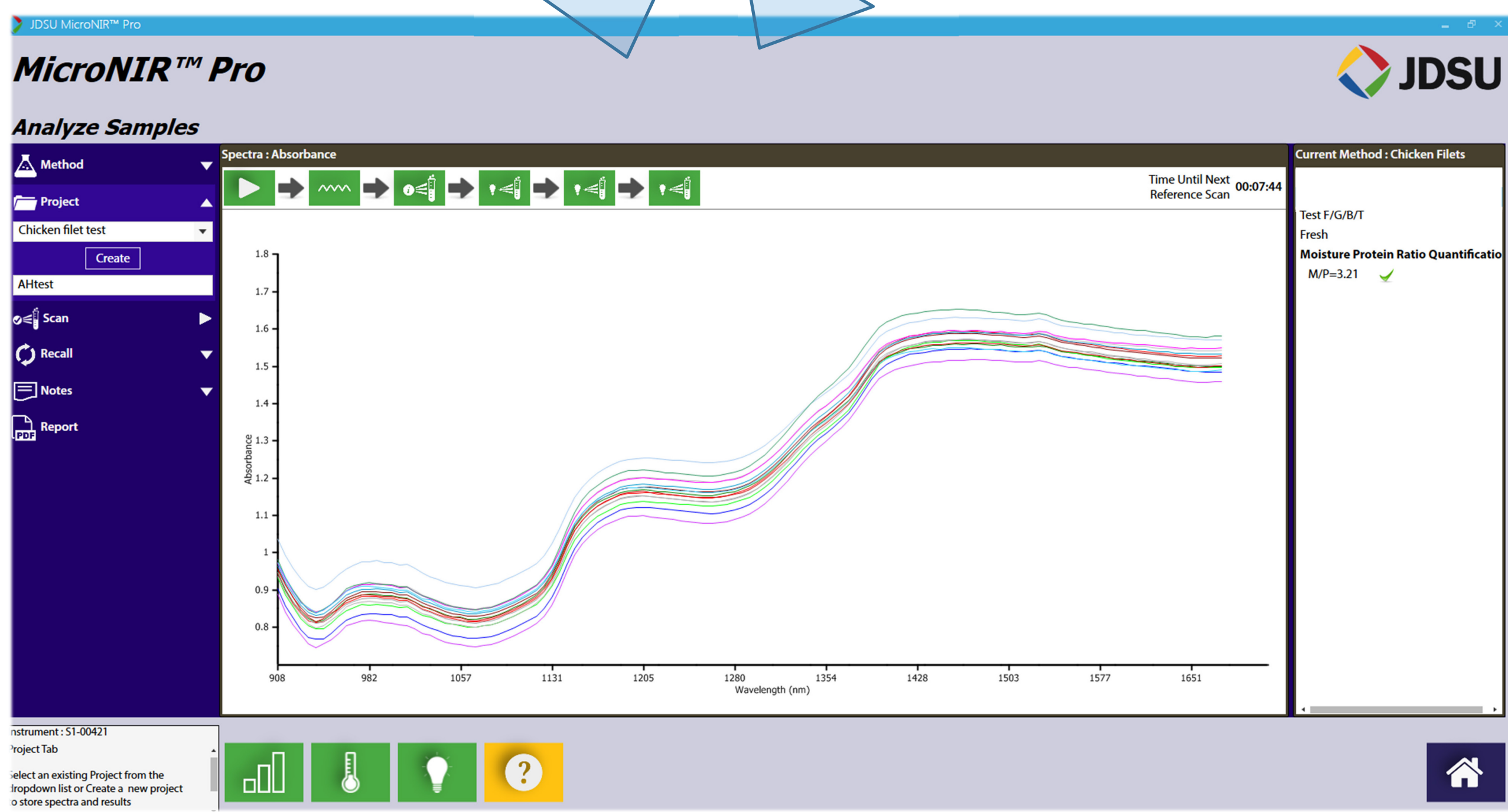

Figure 5. Example of a MicroNIR™ user interface for the prediction of new chicken fillet samples. This can be performed on-site.

Conclusions

Chicken fillet can be authenticated on-site and non-destructively by portable MicroNIR spectroscopy.

Methods

- Five MicroNIRs spectra per filet (63 pc.), 950-1650 nm range, reflectance, 17.2 ms integration time, 100 scan count, rim applied.
- Chemometrics: Unscrambler X 10.3.
- Freeze/Thawing: 24h/24h.
- Up to 1% (w/w) brine or porcine gelatine solution added.
- Moisture: NEN-ISO 1442:1997; Protein: NEN-ISO 937:1992.