Rapid assessment of chicken breast spoilage using Fourier transform infrared (FTIR) spectroscopy

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INTRODUCTION

Poultry is the most widely produced and consumed meat (36 % of global production). Poultry's rapid spoilage caused by microbial activity leads to significant economic losses for the poultry industry. Hence, the rapid assessment of spoilage is of paramount importance. Fourier transform infrared (FTIR) spectroscopy is considered a rapid and non-invasive method that has already been applied in quality assessment of raw and processed meat products[1,2]. The aim of this study was to correlate spectral data obtained by FTIR measurements to microbiological data from spoilage experiments in chicken breast, as an attempt to assess the level of *TVC* and *Pseudomonas* spp. on the surface of chicken breast fillet.

MATERIALS AND METHODS

A) Microbiological analysis and Fourier transform infrared spectroscopy acquirement
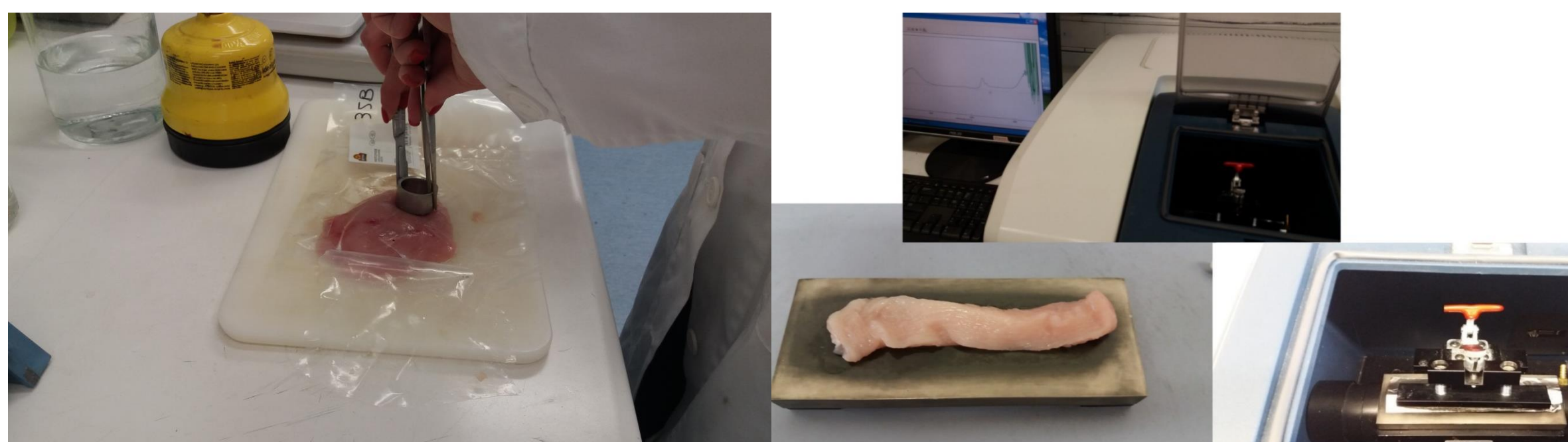
Chicken breast fillets (n= 216) stored aerobically at four isothermal conditions (0, 5, 10, 15 °C) for 518 hours, were **analyzed microbiologically** (enumeration of *TVC*, *Pseudomonas* spp.) and simultaneously **FTIR spectra were obtained** (FTIR-6200 JASCO spectrometer (Jasco Corp., Tokyo, Japan)/ ZnSe 45_HATR crystal (Horizontal Attenuated Total Reflectance).
The experimental procedure was performed twice (n= 4).

RESULTS

Table 1: Kinetic parameters of Baranyi and Roberts primary models for *TVC* and *Pseudomonas* spp.

Storage temperature (°C)	Microorganism	λ (lag phase) (h)	μ_{max} (h⁻¹)	R^2
0	TVC	92.6	0.0382	0.826- 0.879
	Pseudomonas spp.	72.2	0.0356	0.826-0.877
5	TVC	52.8	0.0570	0.875-0.937
	Pseudomonas spp.	17.5	0.0610	0.866-0.955
10	TVC	22.7	0.0903	0.894-0.964
	Pseudomonas spp.	-	0.0991	0.899-0.979
15	TVC	10.2	0.2141	0.879-0.982
	Pseudomonas spp.	8.8	0.2409	0.941-0.978

- According to microbiological analysis, the dominant microbial group on the surface of chicken breast were *Pseudomonas* spp.
- Low temperatures indicated an inhibitory impact on chicken's breast spoilage (*Table 1*).
- Comparison between fresh to spoiled spectral data demonstrated difference to the absorbance at the range of 1400 to 1900 cm⁻¹ (*Figure 1*).
- PLS-R models for the determination of TVC and *Pseudomonas* spp., showed satisfactory performance (*Figure 2*).
- For TVC estimation, RMSE and r (correlation coefficient) values were 0.907 and 0.755, respectively, while *Pseudomonas* spp. population was effectively estimated as well (RMSE and r were 0.967 and 0.763, respectively).

CONCLUSION

PLS-R models in tandem with FTIR analysis could efficiently estimate the level of spoilage microorganisms in chicken breast fillets. Consequently, these findings could be exploited by poultry industries to predict meat products' quality and in parallel diminish food waste.

B) Data processing

- Kinetic parameter (lag phase, μmax) estimation by Baranyi and Roberts growth model (TVC and *Pseudomonas* spp.)
- Partial Least squares regression (PLS- R) → development of quantitative models assessing TVC and *Pseudomonas* spp. on chicken breast
- Spectral data were used as independent variables and log (CFU/cm²) was the dependent one, for both models
- Raw data were subjected to smoothing pre-processing using Savitzky-Golay numerical algorithm with a second-order polynomial and a 9-point window
- Calibration model and Leave-one-out-Full-cross validation was comprised of data from the first experiment (n= 116). Data from the second experiment were used as external validation (n= 100)
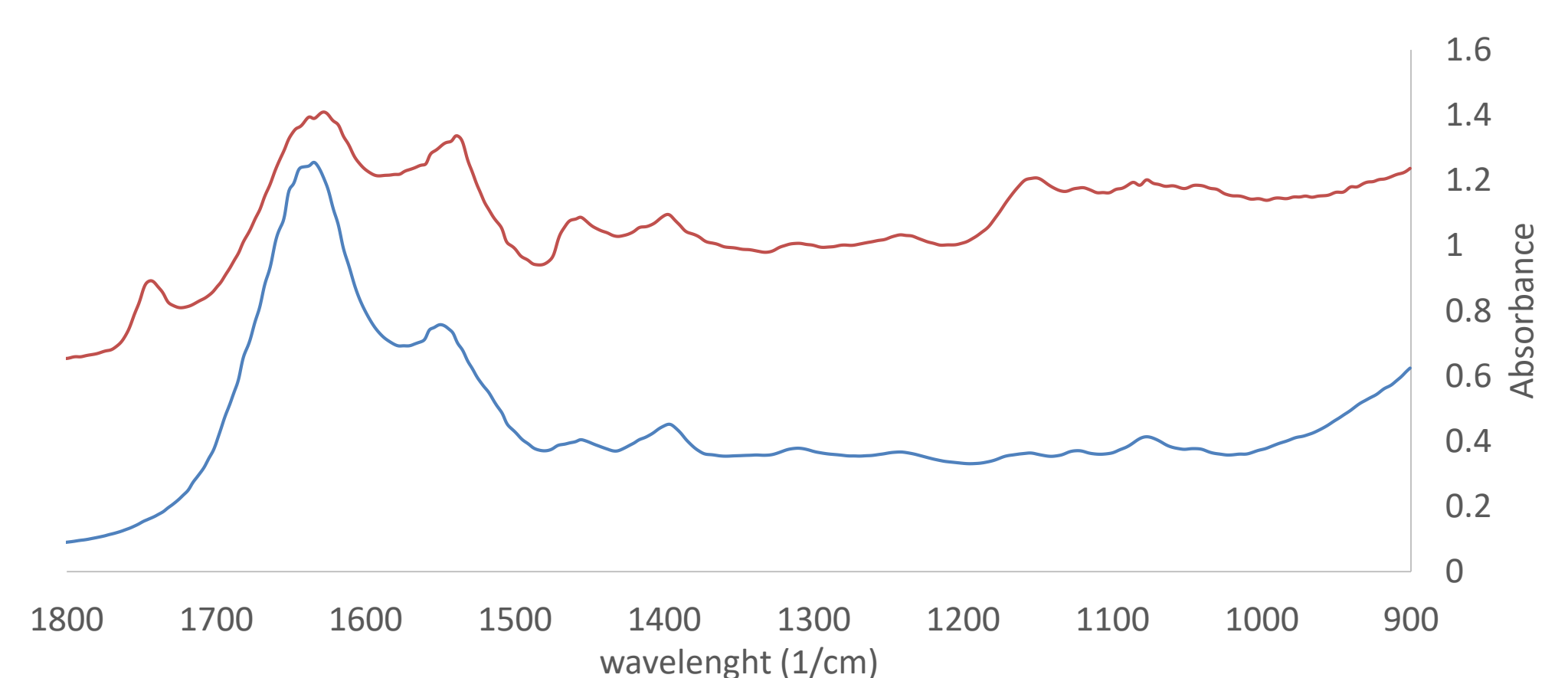

Figure 1: Absorbance for frequencies 1000- 1800 cm⁻¹ after the FTIR measurements for fresh sample of chicken breast (blue line, zero time) and for spoiled sample (red line, 518 h storage).
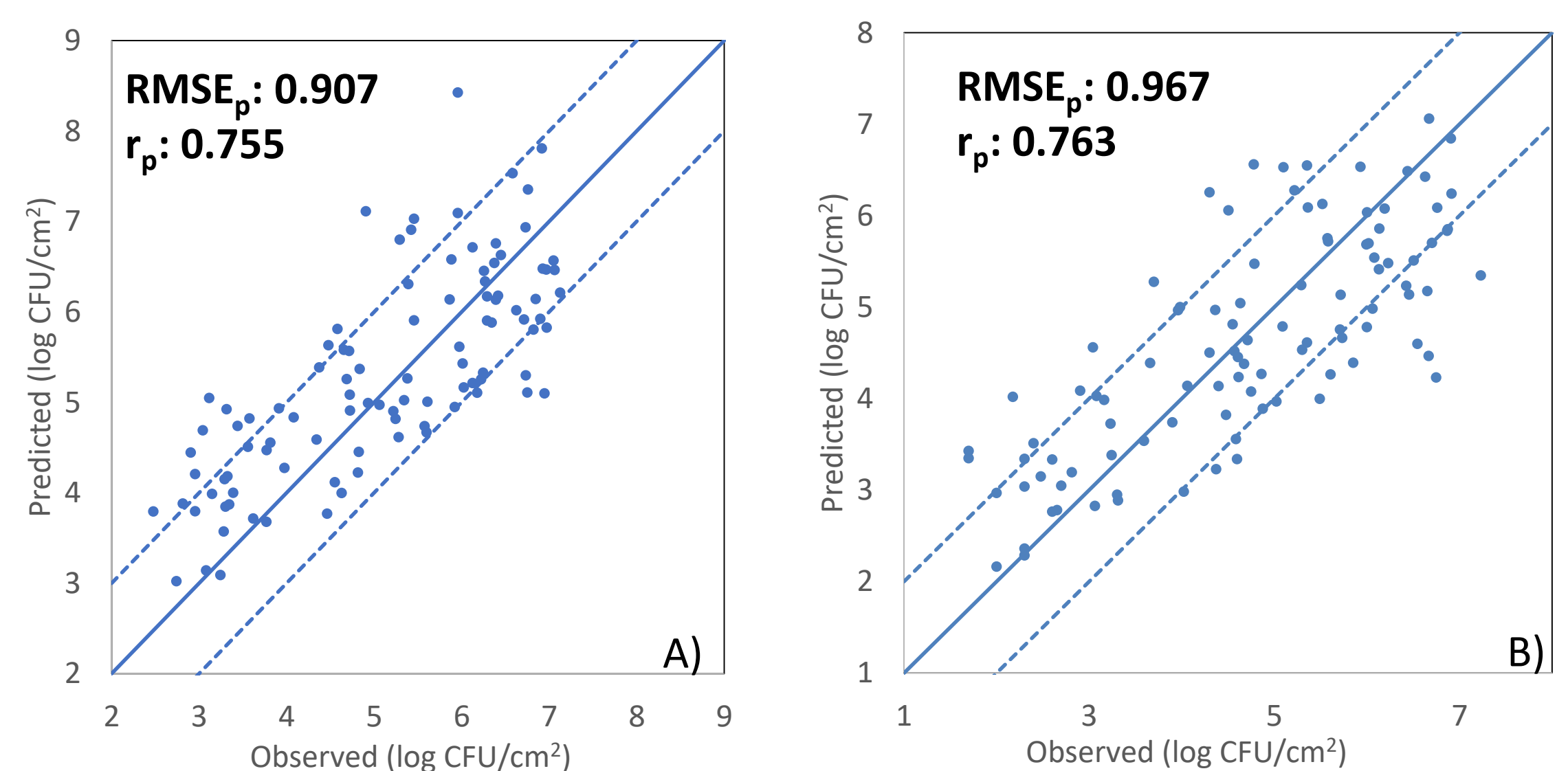

Figure 2: Comparison of observed to predicted values (log CFU/cm²) extracted by PLS- R models for TVC (A) and *Pseudomonas* spp. (B), where solid line: the ideal y= x line; dashed lines: the 1 log unit area.

REFERENCES

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