Glyphosate residue detection in selected pulse flour using FTIR spectroscopy

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Introduction

Glyphosate (N-(phosphonomethyl) glycine) is one of the most widely used broad-spectrum systemic herbicides for weed control spray. Irrespective of the application time in the field, glyphosate leaves significant residue in the harvested pulses at various levels. The conventional techniques used for pesticide detection are destructive in nature, time consuming and labour intensive. Hence, the research focused on the application of FTIR for glyphosate detection in pulse flour.

Objective

The objective of this research was to determine the feasibility of FTIR spectroscopy in detecting glyphosate residue in pulse flour. For this purpose, six pulse types (chickpea, yellow pea, red lentil, large green lentil, French green lentil, and black beluga lentil) at five glyphosate concentration levels (0 ppm (control), 5 ppm, 10 ppm, 15 ppm and 20 ppm) were evaluated.

Methodology

- Six types of organic pulses namely chickpea, yellow pea, red lentil, large green lentil, French green lentil, and black beluga lentil were procured for the experiment.
- The artificially spiked pulse samples (four glyphosate level) were made into flour.
- The flour samples were then evaluated with a commercially available glyphosate testing kit for the confirmation of spiked glyphosate level in pulse flours.
- FTIR spectra were recorded using an ATR-FTIR spectrometer (PerkinElmer, Waltham, MA, USA) with an instrument parameter of wavenumber from 200 to 4000 cm−1 at a resolution of 1 cm−1 by using a force gauge of 40.0 ± 5 N.
- The spectra was pre-processed using standard normal variation (SNV) analysis and then used for PLSR model development.
- The principal component analysis (PCA) was used to identify the interrelationships between the samples and the possible clusters of glyphosate treatment levels.
- The performance of the obtained PLSR models was evaluated considering the Root-Mean-Square Error of Cross-Validation (RMSECV), the correlate coefficient (R^2), the ratio of performance to deviation (RPD) and the range error ratio (RER).

Results & Discussion

- FTIR spectrum showed an increasing peak at wavenumber 1032 cm-1 with the increase in glyphosate concentration of pulse flours (Figure 1).
- For each glyphosate levels PCA formed distinct clusters (Figure 2).
- The R^2 value of PLSR model was 0.84 – 0.88 (Table 1).

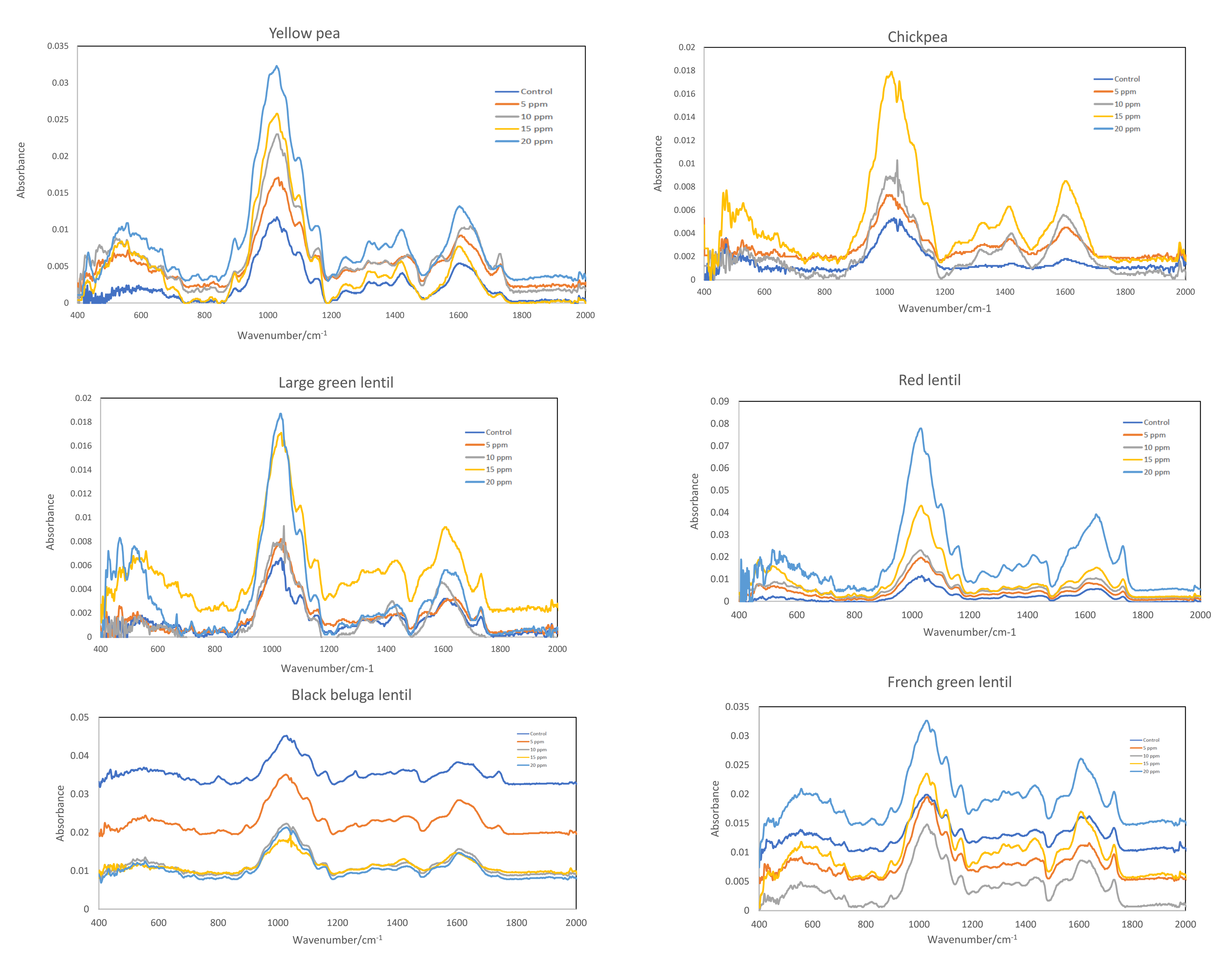

Figure 1 – FTIR spectra of six different pulse flours

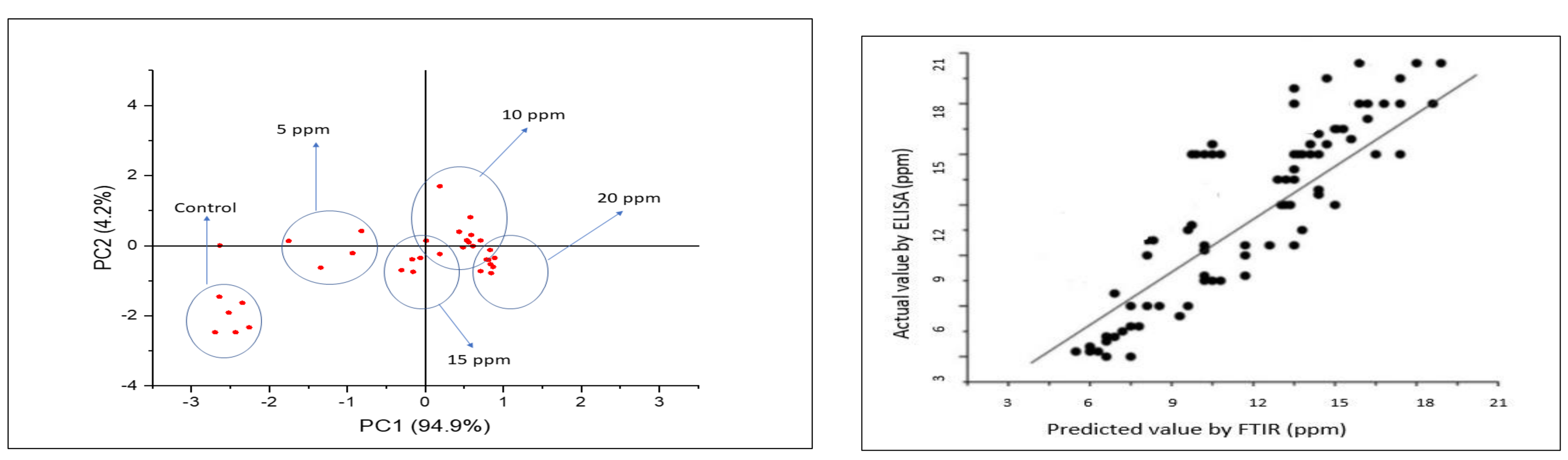

Figure 2 – PCA and PLSR of pulse flours

Table 1 – PLS calibration parameters of the FTIR for intact pulse and pulse flour

Sample type	Number of variables	RMSEcv	R²
Pulse flour	7	0.82-0.88	84-88

Conclusion

FTIR technique has potential for detecting glyphosate residues in pulse flours and implement in processing facilities. PCA was used successfully in lowering the dimensionality of data, allowing for the identification of the distinctive behaviour of pulse samples relating to glyphosate concentration. The PLSR model yielded strong predictive accuracy for determining glyphosate level in pulse flours.

References

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