Detection of Paralytic Shellfish Toxins in *Homarus americanus* Through Alternative Non-Destructive Spectral Methods

Emily Blacklock
Dalhousie University, Halifax, NS

Background

- American lobster sequester saxitoxins which can cause paralytic shellfish poisoning[1]
- Saxitoxins are a concern for human health at high concentrations[1]
- The Japanese government has set import regulations for *Homarus americanus* shipped to Japan[2]
- The suggested maximum limit for the consumption of saxitoxin is 80 µg/100g STXeq[2]

- The standard methods for the detection and quantification of saxitoxin are:
  - Costly
  - Time consuming
  - Destructive in nature
  - Complex for industry use

- The use of spectral techniques would allow for a method which is:
  - Cost effective
  - Time efficient
  - Less invasive
  - Easy to implement

Raman Spectroscopy

- A laser projects light onto the sample at a set wavelength
- The laser causes molecules to excite and release various wavelengths of light
- The intensity of these wavelengths is measured and used to produce the Raman Spectrum

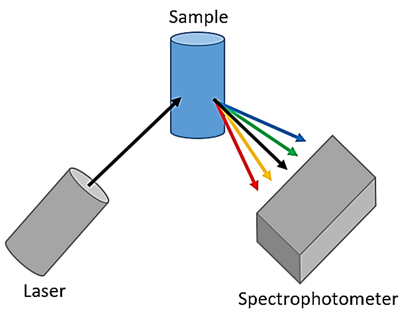

Figure 1 A diagram showing the process of Raman Spectroscopy. Diagram produced by Emily Blacklock.

Objective

To develop a non-invasive method to detect and quantify saxitoxin concentrations (STX) in American lobster (*Homarus americanus*).

Hypothesis

Saxitoxin concentrations in American lobster (*Homarus americanus*) hemolymph can be quantified through raman spectroscopy.

Methods

Lobster containing various amounts of saxitoxin, as determined by the enzyme-linked immunosorbent assay (ELISA), were examined with raman spectroscopy.

Raman Spectroscopy

Samples of lobster hemolymph were examined with a Nicolet NXR 9650 FT-Raman Spectrometer.

Specific peaks of interest were analysed with both Pearson and Spearman correlations.

Preparation of Hemolymph

Hemolymph was collected in 1mL amounts, diluted with water and frozen until measurements were taken.

Figure 2 The Nicolet NXR 9650 FT-Raman Spectrometer. Photograph by Michel Johnson.

Results

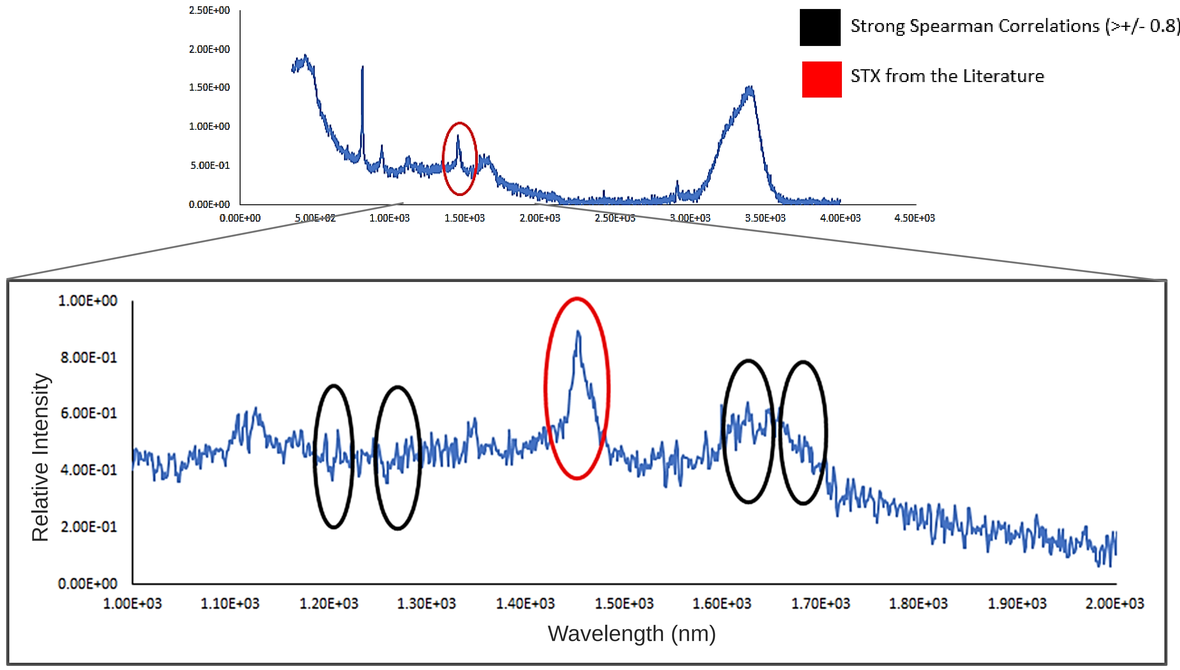

Figure 3 The raman spectra from the hemolymph of a *Homarus americanus,* with a STX concentration of 150.4 µg/100g STXeq, where significant peaks are circled.

- The peak identified by the literature to show the presence of saxitoxin was not observed to have a strong correlation (-0.49) as seen circled in red[3]
- Strong Spearman correlation coefficients (> +/- 0.6) were observed in 549 of the 4000 wavelengths examined
- 4 wavelengths showed significant negative Spearman correlation coefficients (> -0.8) as seen circled in black

Conclusion

- Raman spectroscopy shows promising results as a method for saxitoxin detection based on the strong correlations observed between the saxitoxin presence and raman peaks of lobster hemolymph

- Further research with both methods is needed to confirm their accuracy and data robustness for commercial application

Acknowledgements

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References

[1] Etheridge SM. 2010. Paralytic shellfish poisoning: seafood safety and human health perspective. Toxicon. 56: 108-122.
[2] Canadian Food Inspection Agency (2019) Export of Live Lobsters and Lobster Products Containing Tomalley Guidance Document.
[3] Olson TY, Schwartzberg AM, Liu JL, Zhang JZ. 2011. Raman and surface-enhanced raman detection of domoic acid and saxitoxin. Applied Spectroscopy. 65: 159-164.