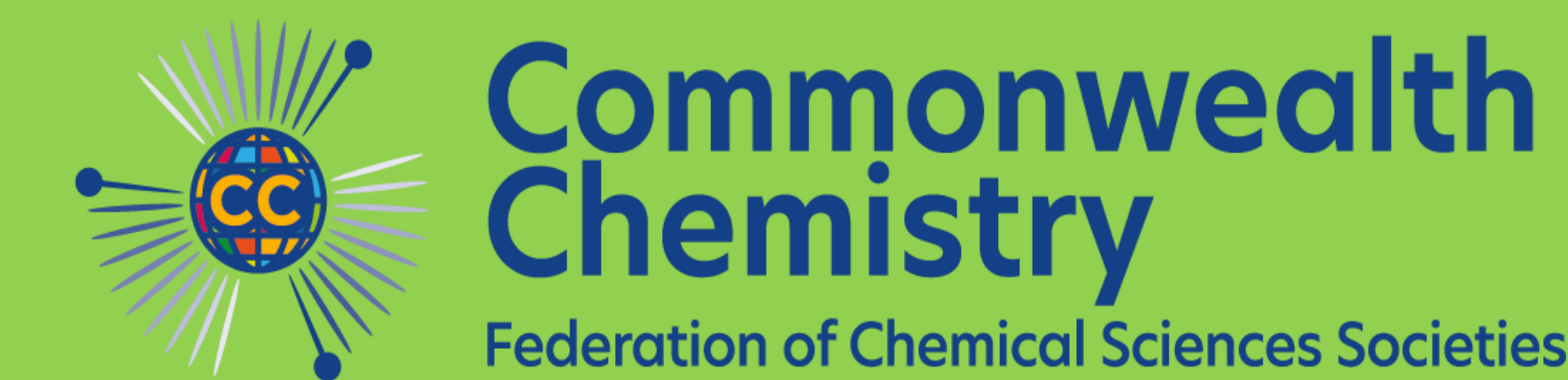




Electropolymerization of phenolic based compounds on carbon electrodes for the selective detection and determination of Hypoglycin A: Application to Food Safety

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Introduction



Figure 1: Ackee Fruit, delicacy of Jamaica and its wider diaspora.

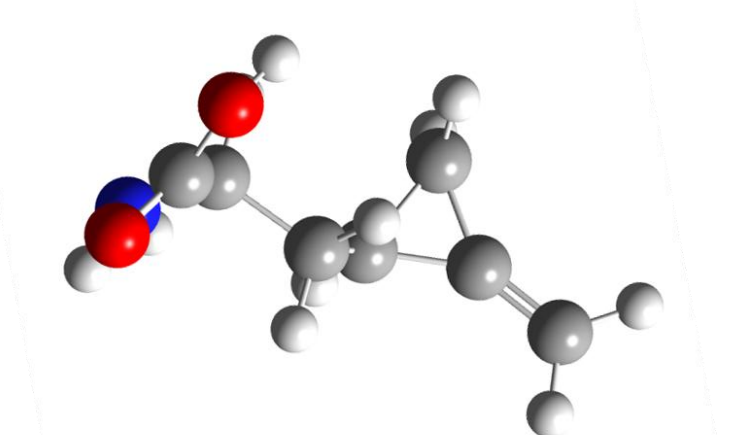


Figure 2: Hypoglycin A- Toxin present in the ackee fruit.

Ackee fruit is widely consumed throughout Jamaica as it is a major component of the culinary heritage. However, ackee is known to contain the toxin Hypoglycin A (**HGA**). This compound is a heat stable toxin that is present throughout the fruits life cycle. When the ackee fruit is immature, the Hypoglycin A concentration is alarmingly high and can lead to sickness if consumed. However, as the ackee fruits mature the toxin concentration decreases to a level that is safe for human consumption. Symptoms of Hypoglycin A toxicity include **vomiting, diarrhea, impaired consciousness** and in severe cases **death**. Hypoglycin A is also present in plants such as **Horse Chestnut, Maples, and lychee**.

Traditional Methods for determining Hypoglycin A are costly, laborious and time consuming. This results in significant down time, loss of resources and revenue, therefore, alternative methods that are faster and cost effective are needed and are very crucial in the ackee and supporting industries. This study explores the developments of some polymer based sensors for the selective detection and quantification of Hypoglycin A.

Results

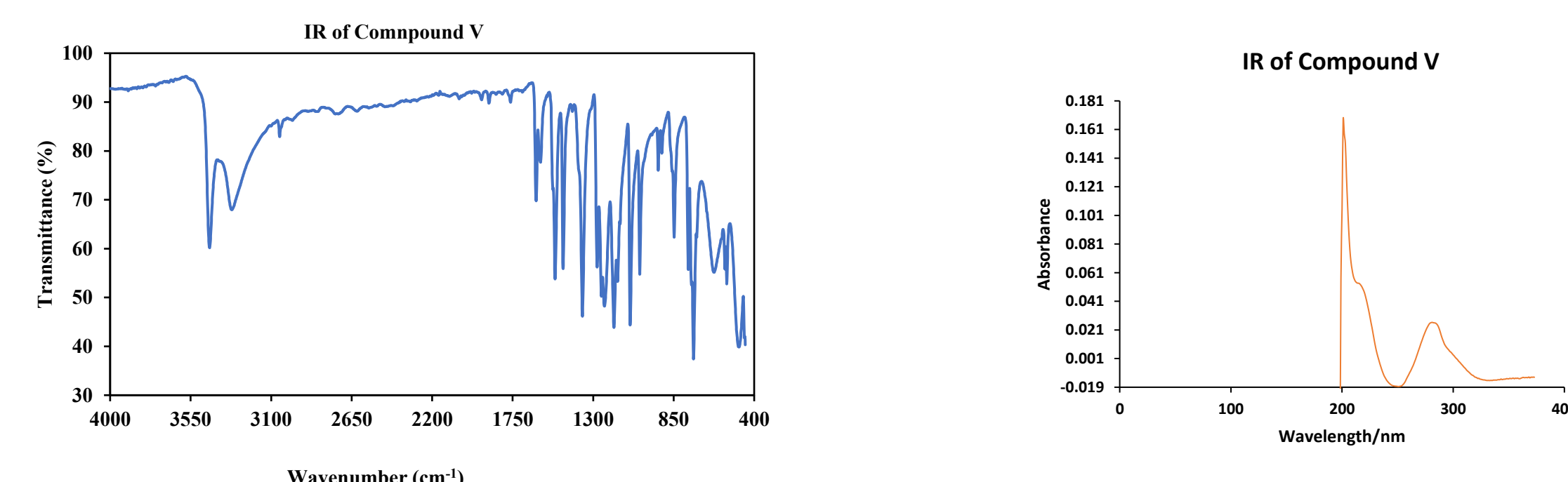


Figure 3. Characterization of Compound V using Spectroscopy techniques.

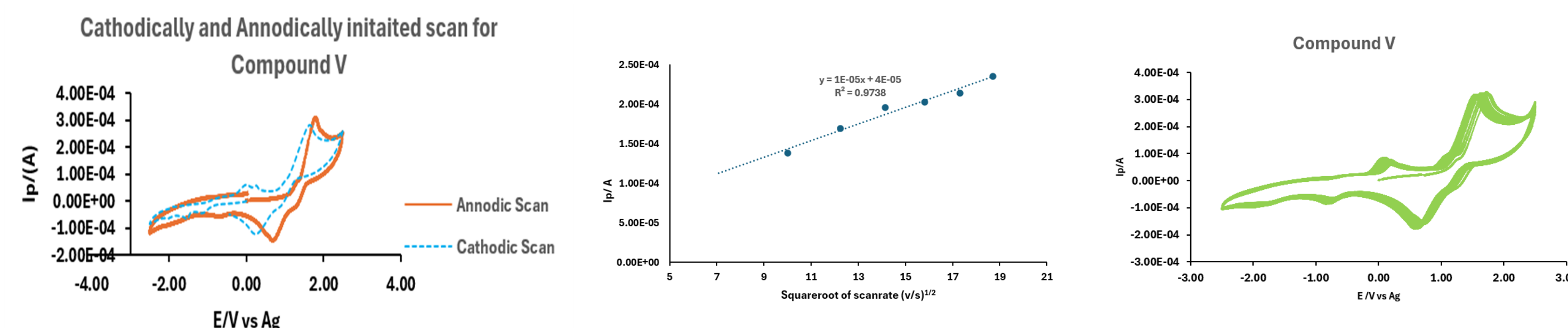


Figure 4 Characterization of Compound V using electrochemical techniques.

Table 1: Comparison of new surface area for compound V, W, X, Y and Z.

Investigation of New Surface Area formed at electrode's surface.	
Compound	New Surface Area / mol/cm ² x 10 ⁻¹¹
V	3.77
W	6.08
X	4.48
Y	4.45
Z	6.50

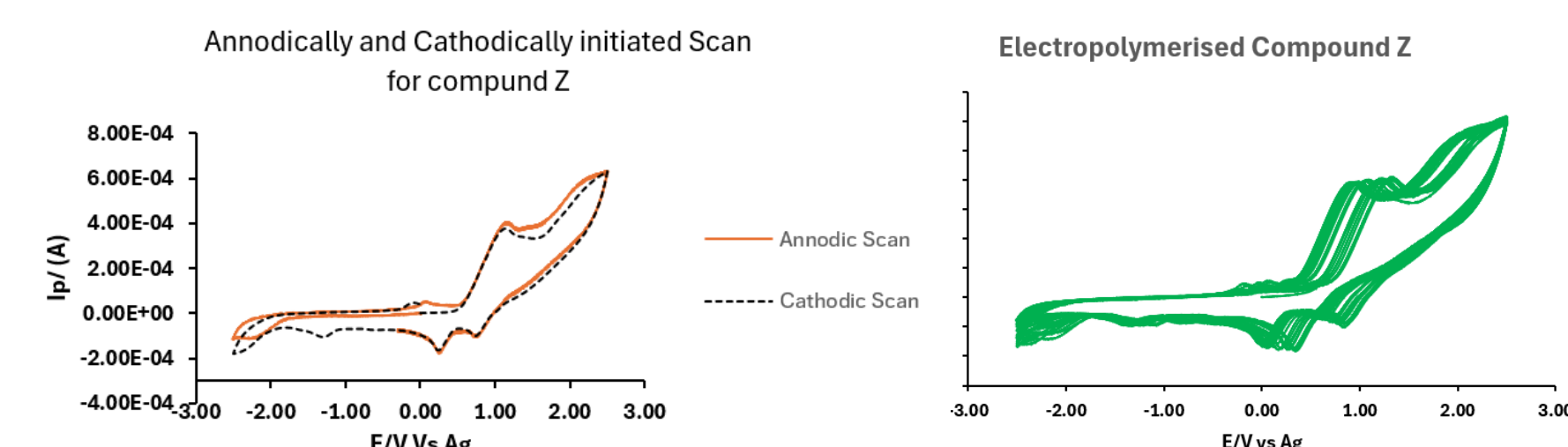


Figure 5: Cyclic Voltammogram of compound Z before and after Electropolymerization onto the electrodes surface.

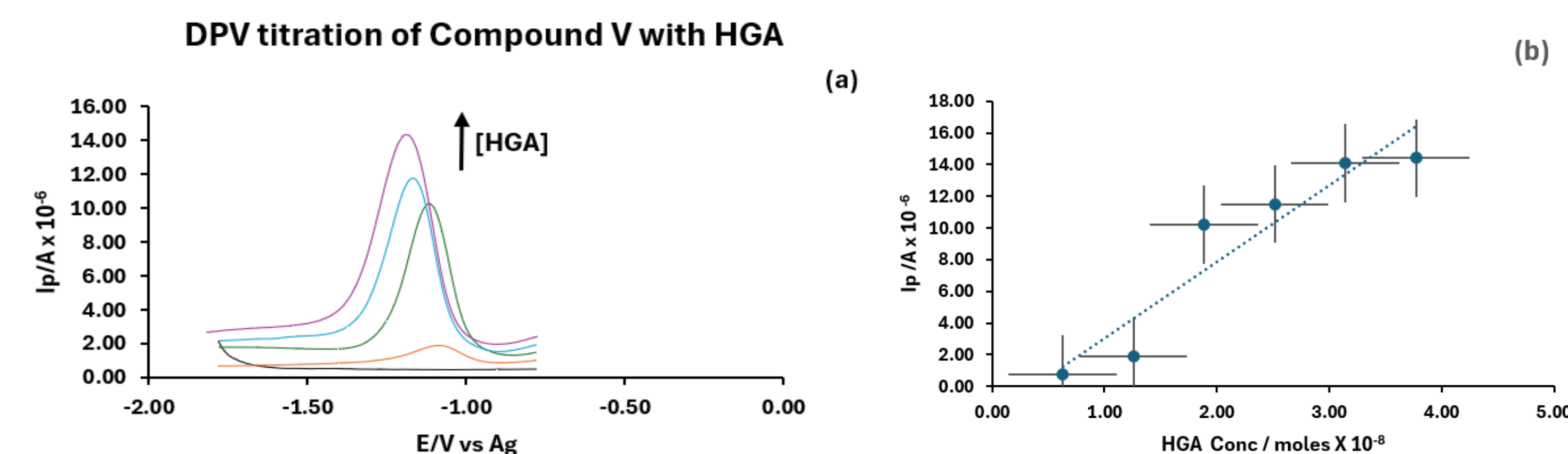


Figure 6. a) Preliminary Differential Pulse Voltammetry scans at different HGA concentrations b) Potential Calibration for HGA derived from the Differential Pulse Voltammetry with compound V

Discussion



Electrochemical Studies and Spectroscopic techniques have allowed successful characterization of the phenolic compounds utilized in this study. Compounds V through Z, showed clear oxidation and reduction peaks indicating their redox activity. Some compounds exhibited quasi-reversible electronic processes, whereas others showed irreversible oxidation processes, due to coupled electron transfer-chemical processes: EC mechanism. The effects of scan rate on peak current was also investigated and after applying the Randles-Ševčík's equation, the process was found to be diffusion controlled (Fig 4).

Electropolymerization of said compounds, through repeated voltametric scans, indicated clear signs of interaction of the phenolic compounds to the electrode's surface. Investigations into the new surface area formed at the electrode's surface revealed that Compound Z had the most significant change (Table 1).

Differential Pulse Voltammetry was used to determine the relationship between the concentration of HGA and the corresponding current response. A **linear** relationship was observed, and this will be further used to model the analytical parameters of the polyphenolic sensor.

Conclusions

Electrochemical techniques have become increasingly popular for the rapid detection of various molecules. The results of this study, though preliminary, indicates that electropolymerized phenolic compounds can be applied for the detection and quantification of hypoglycin A.

Future Work

Interference studies with amino acids.
Development of electrochemical sensor prototype.
In-the-field testing and comparison of the results to traditional methods.

Contribution to the UN Sustainable Development Goals (SDGs)

3 Good Health and Wellbeing— *Early and reliable detection of this toxin can improve food safety monitoring and reduce the risk of exposure to the toxin. The development of the electrochemical sensor can equip individuals with the ability to conduct routine screening of food samples, thereby preventing illness and protecting the consumer.*

References

- Bowen-Forbes C.; Minott-Kates, D. Magn. Reson. Chem. **2009**, 47, 1004–1006
- Mohammad, R. et al. Sensors and Actuators B. **2017**, 241 174–181
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Methods

Computational Analysis

- DFT Calculations were performed using a Gaussian software,
 - Electron exchange and correlations functions investigated.

Electrochemical Studies

- Cyclic Voltammetry, Differential Pulse Voltammetry and Electrochemical Impedance Spectroscopy.

UV Spectroscopy