

# A Multipurpose and Multilayered Microneedle Sensor for Redox Potential Monitoring in Diverse Food Analysis

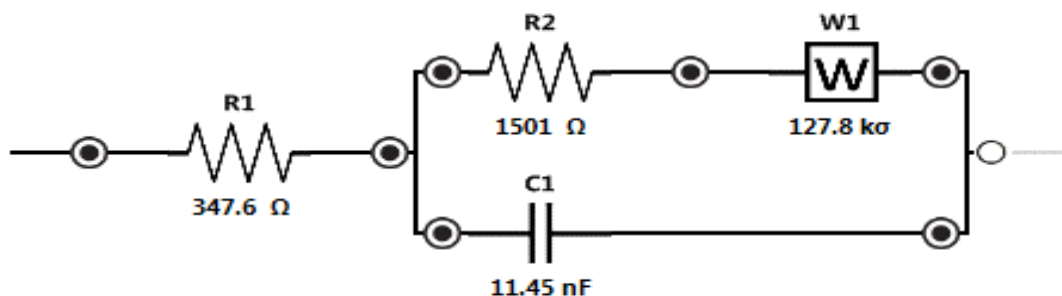
Samuel M. Mugo <sup>1\*</sup>, Dhanjai <sup>2\*</sup>, Weihao Lu <sup>1</sup> and Scott Robertson <sup>1</sup>

<sup>1</sup> Department of Physical Sciences, MacEwan University, Edmonton, AB T5J4S2, Canada

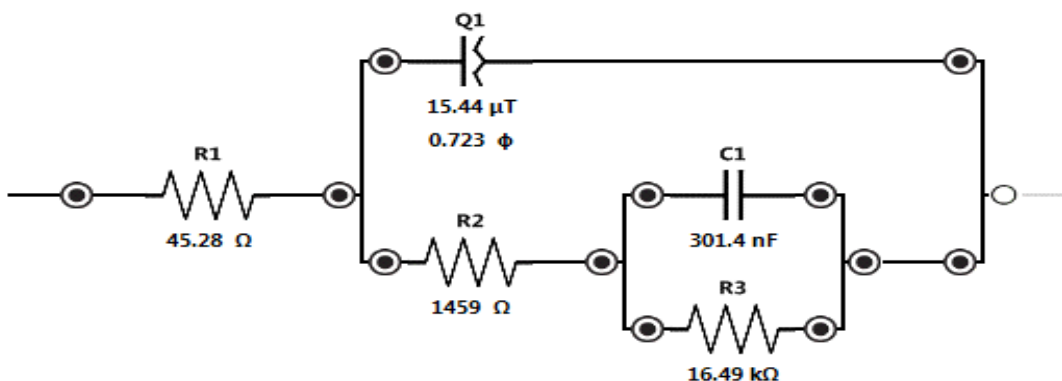
\*Correspondence: mugos@macewan.ca; dhanjai83@gmail.com

<sup>2</sup> Department of Chemistry, University of Allahabad, Prayagraj 211002, India

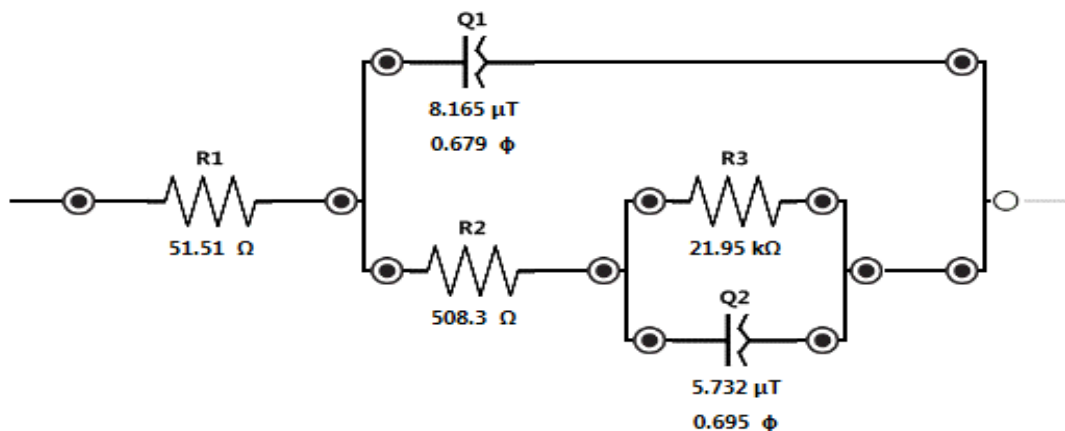
**Figure S1.** EIS equivalent circuit fittings for the MN redox sensor at different stages of development.



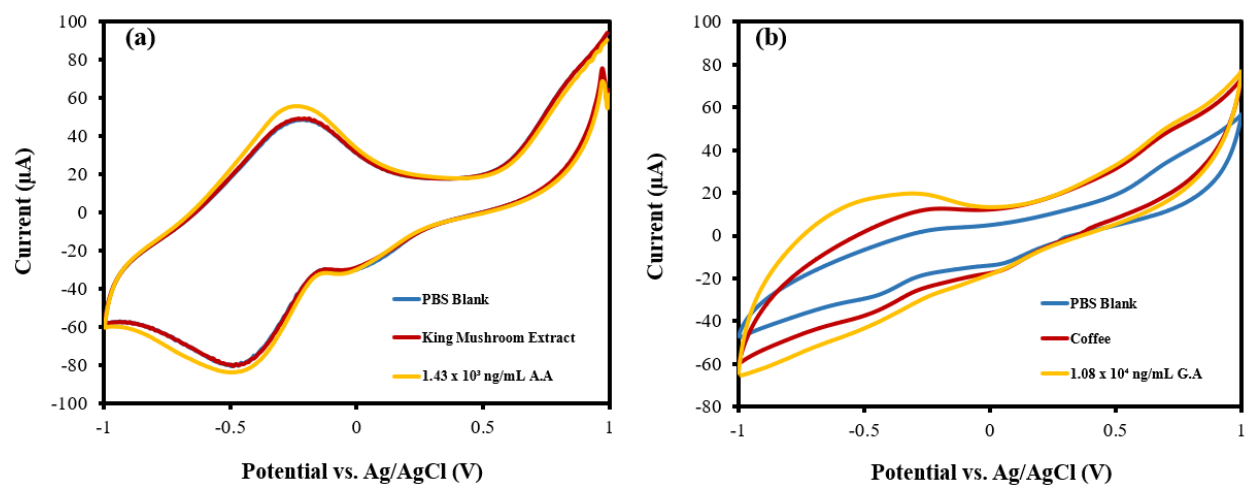
(a) CNT/CNC Microneedle



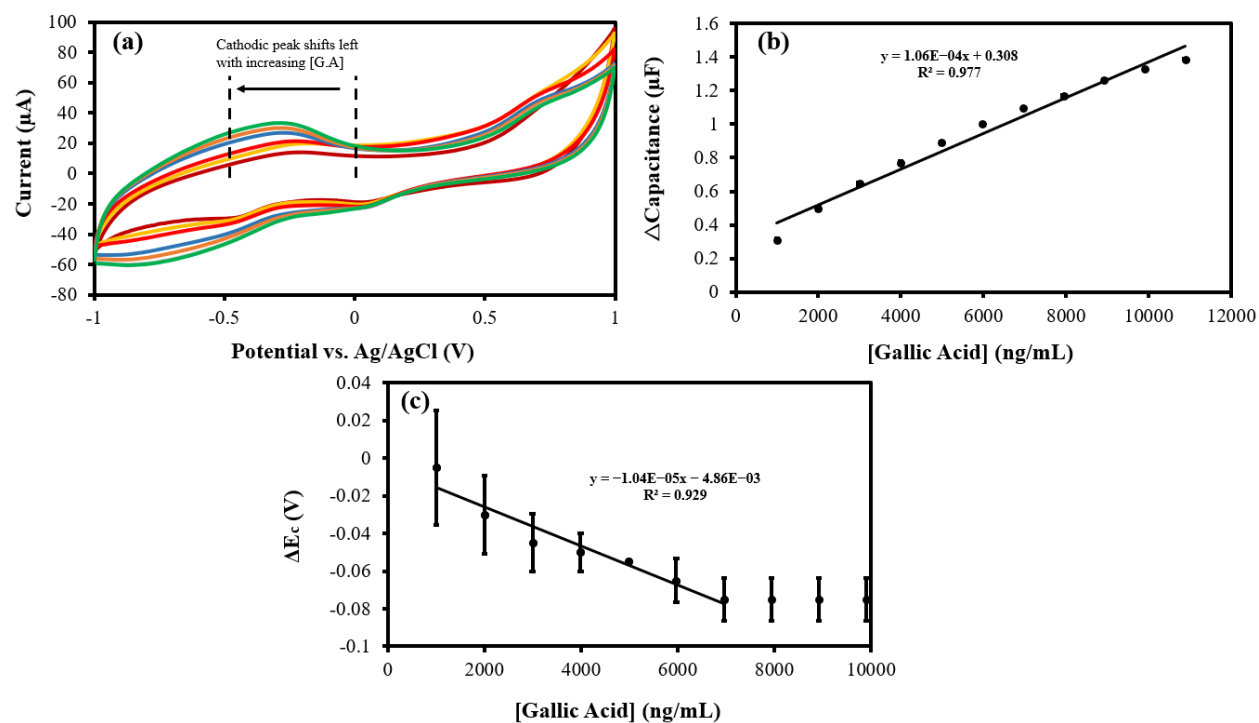
(b) PANI@CNT/CNC Microneedle



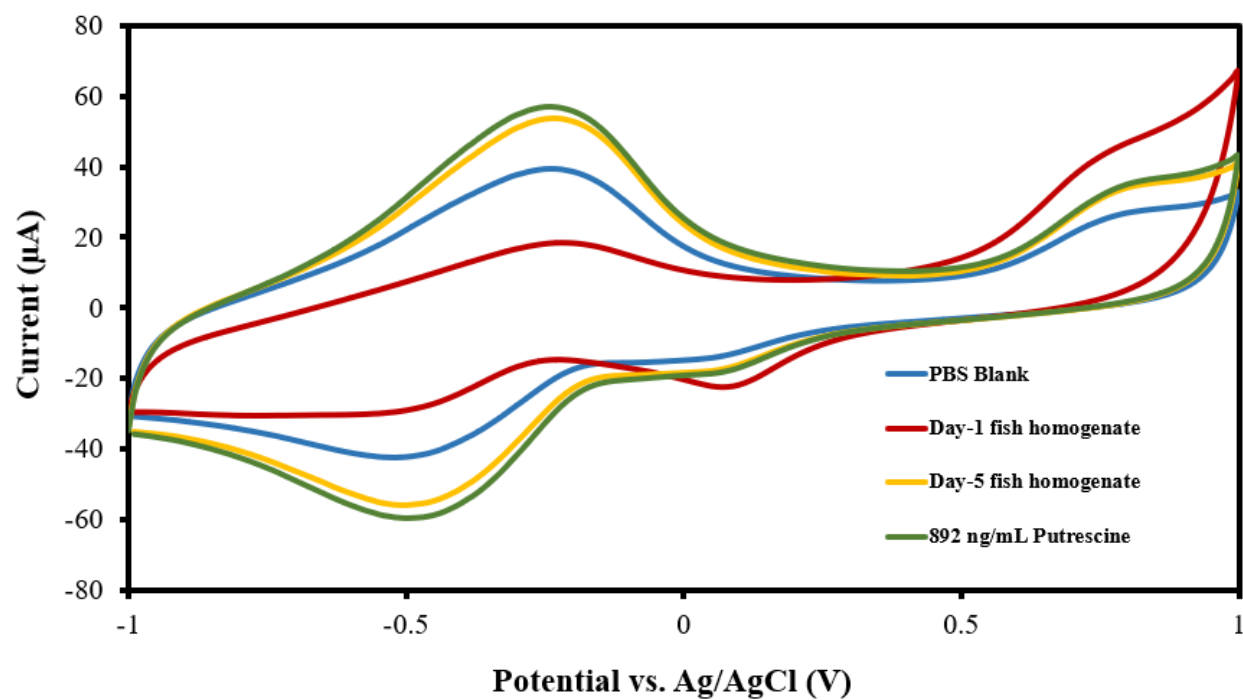
(c) MN redox sensor



**Figure S2.** Representative overlapped CVs showing the MN redox sensor electrochemical response to (a) PBS blank, king mushroom extract, and 1.43 x 10<sup>3</sup> ng/mL ascorbic acid (A.A); and (b) PBS blank, fresh brewed coffee, and 1.08 x 10<sup>4</sup> ng/mL gallic acid (G.A) during standard addition analysis.



**Figure S3.** (a) Representative overlapped CVs showing the MN redox sensor electrochemical response to  $999 - 1.09 \times 10^4$  ng/mL gallic acid, and resulting (b) cathodic  $\Delta$ capacitance; and (c)  $\Delta E_c$  vs. gallic acid concentration plots obtained using the MN redox sensor.



**Figure S4.** Representative overlapped CVs showing the MN redox sensor electrochemical response to PBS blank, day-1 fish homogenate, day-5 fish homogenate, and 892 ng/mL of putrescine during standard addition analysis.