### Supplementary information

#### to main article

# Electrochemical Detection and Quantification of Gingerol species in Ginger (*Zingiber officinale*) using Multiwalled Carbon Nanotube Modified Electrodes.

Korbua Chaisiwamongkhol, Kamonwad Ngamchuea, Christopher Batchelor-McAuley, Richard G. Compton\*

## **S1** Estimated surface area of MWCNT on the modified electrode

In order to estimate the geometric surface area of MWCNT, we first calculated the volume of MWCNT dropped on the BPPG electrode. The bamboo-like multiwalled carbon nanotubes possess the diameter of *ca*. 30 nm and density of *ca*. 1.4 g cm<sup>-3</sup> (purchased from NanoLab, USA). To modify the BPPG electrode, we used 20  $\mu$ L of the 1 mg/mL MWCNT solution. Therefore, we had 20 x 10<sup>-3</sup> mg of MWCNT on the bare BPPG electrode.

## According to

$$Density = \frac{Mass}{Volume}$$
(1)  
$$Volume = \frac{20 \times 10^{-6} g}{1.4 g \text{ cm}^{-3}}$$
(2)

The total volume of MWCNT on the BPPG electrode was  $1.43 \times 10^{-5} \text{ cm}^3$ .

MWCNT has cylindrical shape, thus we can calculate surface area from  $2\pi rh$  and volume from  $\pi r^2h$ .

$$\frac{Surface\ area}{Volume} = \frac{2\pi rh}{\pi r^2 h}$$
(3)

So, 
$$Surface area = \frac{2(volume)}{r}$$
 (4)

Surface area = 
$$\frac{2(1.46 \times 10^{-5} \text{ cm}^3)}{15 \times 10^{-7} \text{ cm}}$$
(5)

Surface area 
$$\approx 20 \ cm^2$$
 (6)

The estimated surface area of MWCNT we used on the modified electrode is  $20\ cm^2$ 

#### **S2** Langmuir isotherm equation

$$\theta = \frac{B[C]}{1 + B[C]} \tag{1}$$

where  $\boldsymbol{\theta}$  is the fractional occupancy of the adsorption sites, B is the equilibrium constant

which is  $\overline{k_{des}}$  where  $k_{ads}$  and  $k_{des}$  are rate constant of adsorption and desorption respectively, and [C] is the concentration of 6-gingerol.

$$\theta = \frac{Q}{Q_{max}} \tag{2}$$

where Q is the voltammetrically measured charge transferred during oxidation of the species at the concentration studied and  $Q_{max}$  is maximum charge transfer at saturation of the surface with gingerol.

Substituting equation (2) in (1) produces

$$\frac{Q}{Q_{max}} = \frac{B[C]}{1 + B[C]}$$

$$\frac{Q_{max}}{Q} = \frac{1}{B[C]} + 1$$

$$\frac{1}{Q} = \left(\frac{1}{BQ_{max}}\right) \left(\frac{1}{[C]}\right) + \frac{1}{Q_{max}}$$
(5)
(4)

**S3** Extraction efficiency



**Figure S1** The comparison of gingerol related species ( $\mu$ mol g<sup>-1</sup>) in ginger sample of the first extraction and multiple re-extractions of extracted ginger sample from 2 sets of extraction experiments.

In order to assess the extraction efficiency of the extraction method, two sets of the experiments were performed as described next. 1.0 g of sample was weighed and placed into a 15 mL centrifuge tube. 5 mL of ethanol was added as a solvent and the sample was

vigorously shaken by a vortex mixer for 1 min. The tube was then centrifuged at 4000 rpm for 10 min to remove solids. The supernatant was diluted (the dilution factors used was 100) and the voltammetric analysis was performed to quantify the concentration of gingerol related species. The extracted sample was re-extracted and quantified using the same procedure as described above. Re-extraction was conducted until the signal of sample was not observed. From the result, we calculated the extraction efficiency of the first extraction. The values obtained from the two repeated experiments were 85% and 80% extraction efficiency respectively.