

Green Downscaling of Solvent Extractive Determination Employing Coconut Oil as Natural Solvent with Smartphone Colorimetric Detection: Demonstrating The Concept Via Cu(II) Assay Using 1,5-Diphenylcarbazine

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1. Properties of the Solvents

Table S1. Some properties of the solvents and spectrophotometric information of Cu(II)-DPC complexes in the solvents.

Solvent	Density (g mL ⁻¹)	Viscosity (cP)	Dielectric Constant	Hazard Rating	The Maximum Wavelength (nm)	Absorbance
Benzene	0.89 ^a	0.56 ^b	2.3 ^a	2 ^f	549	0.794
Toluene	0.87 ^a	0.52 ^b	2.4 ^a	2 ^g	549	0.977
Dichloromethane	1.34 ^a	0.41 ^c	9.1 ^a	2 ^h	545	0.279
1,2-Dichloroethane	1.26 ^a	0.72 ^b	10.4 ^a	3 ⁱ	545	0.551
Coconut oil	0.91 ^d	43.30 ^d	2.2 ^e	0 ^j	543	0.518

^a, ^b, ^c, ^d, ^e, ^f, ^g, ^h, ⁱ and ^j from references [32], [33], [34], [35], [36], [37], [38], [39], [40] and [41], respectively.

2. Characterization of Coconut Oil

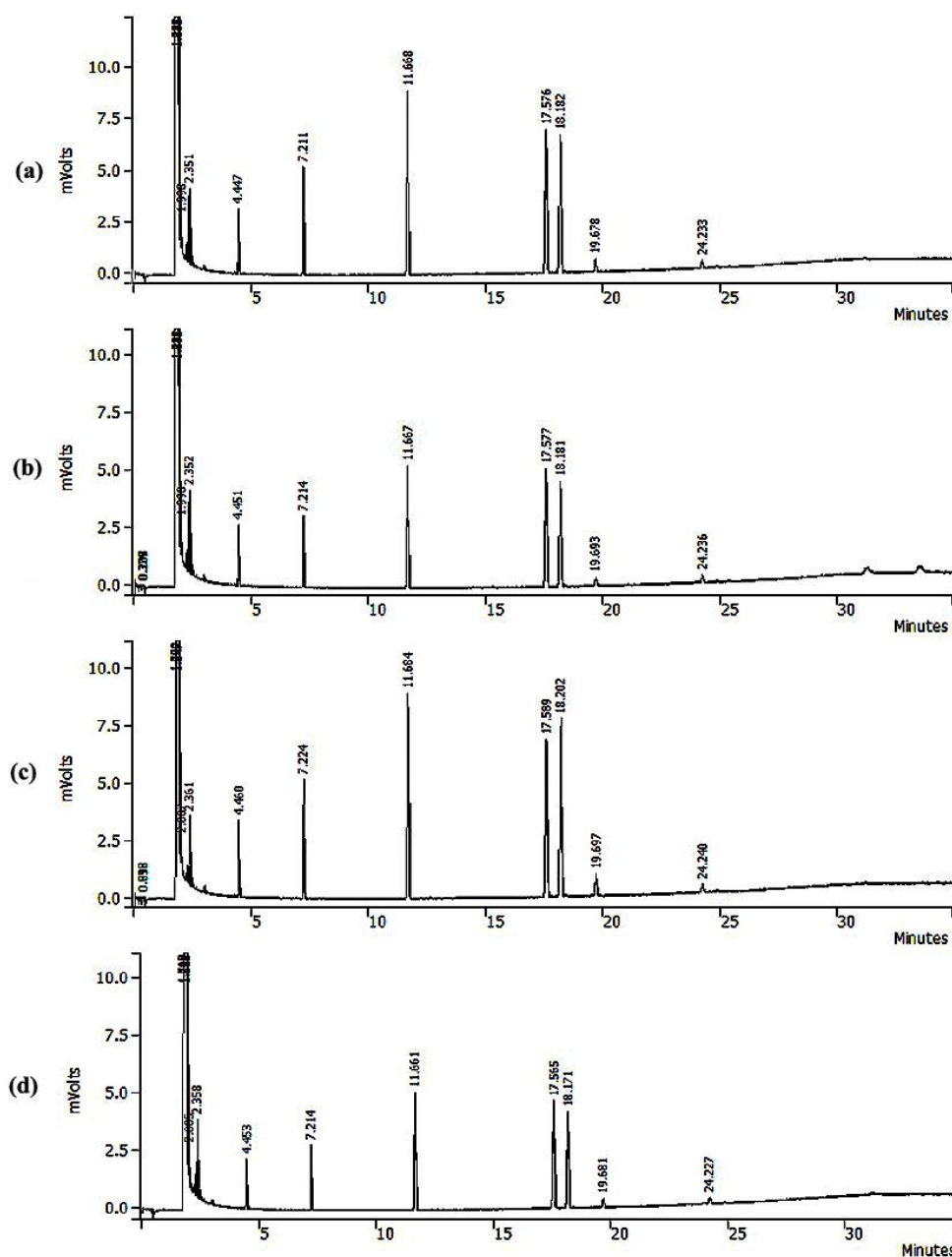


Figure S1. Chromatographic chromatograms of different coconut oils: (a) CHAOKOH brand lot1 (manufacture date February 2020), (b) CHAOKOH brand lot2 (manufacture date August 2020), (c) COCOLOVE brand, and (d) KING ISLAND brand.

Conditions

The coconut oil was characterized by gas chromatograph based on the base-catalyzed derivatization of fatty acid method [42]. Briefly, an exact amount of coconut oil (about 60 mg) was weighed into a small vial. Then, 1 mL of hexane, and 4 M potassium hydroxide in methanol were added and heated (50 °C) with magnetic stirring (100 rpm) for 30 min. The mixture was cooled to room temperature. DI water was vigorously added. An aliquot of the organic layer, after phase separation, was taken for the analysis using a gas chromatograph (Varian, CP-3800, USA) fitted with FID detector, with a polar capillary column CP-Wax52, injection temperature of 200 °C, the initial temperature of 150 °C with

temperature increasing rate $2\text{ }^{\circ}\text{C min}^{-1}$ until $210\text{ }^{\circ}\text{C}$. Chromatograms of different coconut oils are illustrated in Figure S1.

3. Downscaling Solvent Extraction of Cu(II) Employing DPC

3.1. Using a Small Vial

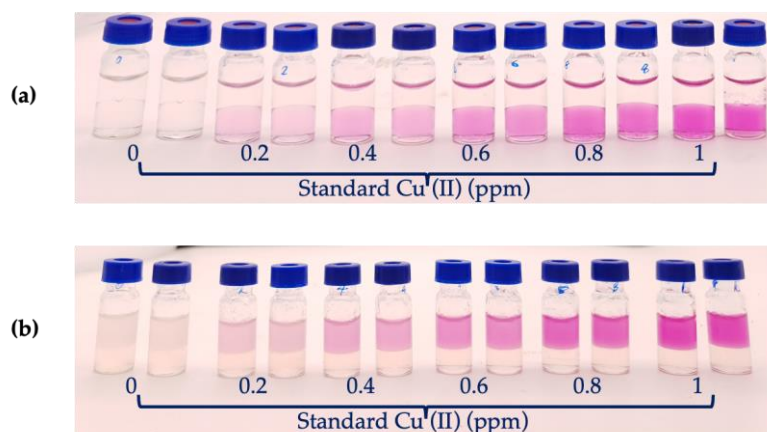


Figure S2. Extraction of Cu(II) via vial procedures using (a) DCE solvent and (b) coconut oil solvent.

3.2. Using a Well Plate

3.2.1. Investigation for Detection Condition by Using a Smartphone Camera

Investigation for detection condition by using a smartphone camera was made by placing $240\text{ }\mu\text{L}$ of a dye solution (rose pink, $1/500$ of original concentration) into the 96 wells of the plate. The well plate was put in a light control box for photographing as set up illustrated in Figure 3b in the Materials and Methods section. An empty well plate was also photographed. The photographs were processed for G intensity. It was observed that not all of the 96 wells hosted a homogeneous brightness, as indicated in Figure S3a. For further experiments, only 32 wells would be deployed (as indicated in Figure S3b). The G intensity of each of 32 wells was laid in the mean G intensity \pm standard deviation and the G intensity of the well would be evaluated by subtracting the G intensity of the empty well by the G intensity of the well with solution.

3.2.2. Design for Using the Well Positions in Downscaling Solvent Extraction

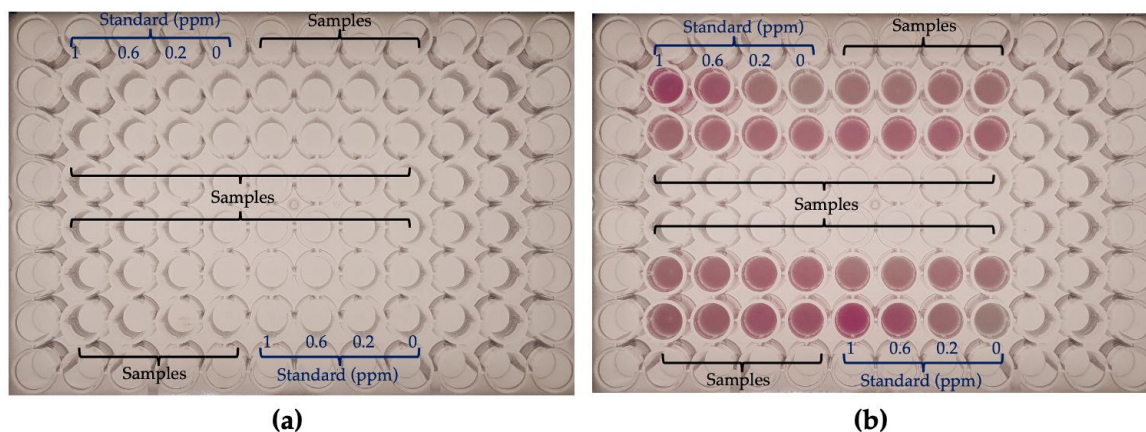


Figure S3. The well plate used for the extraction, (a) the empty well plate; (b) the well plate after extraction indicating with labels of standards and samples.



Figure S4. DCE extract observed to be more viscous as function of time (extraction of aqueous Cu(II)-DPC into DCE in a polystyrene well plate).

4. Evaluating the Developed Procedure by Green Analytical Procedure Index (GAPI) Approach

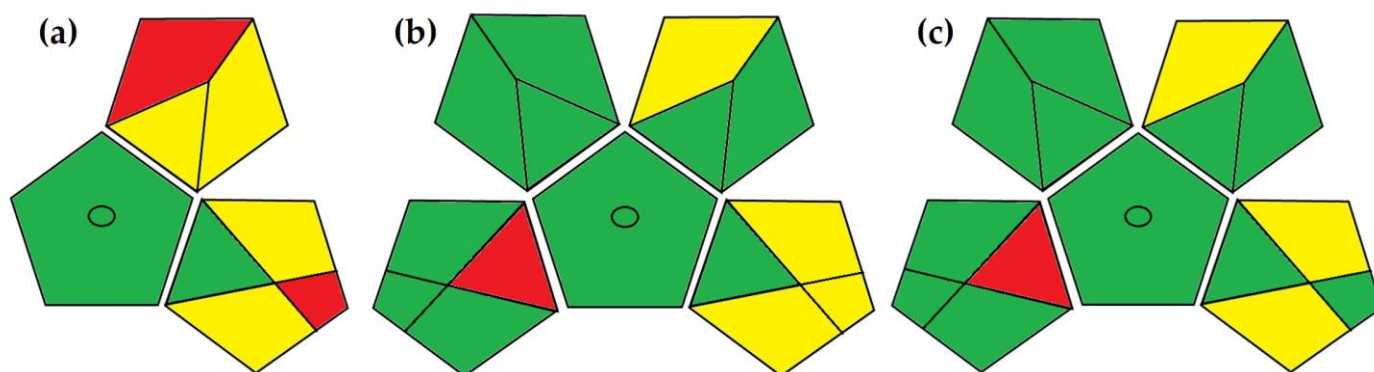


Figure S5. Evaluating the developed procedures by GAPI: (a) traditional [2]; (b) the developed procedure using vial with DCE; (c) the developed procedure using well plate with coconut oil.