Food Chemistry 230 (2017) 388–397

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Analytical Methods

Preconcentration and trace determination of copper (II) in Thai food recipes using Fe_3O_4@Chi–GQDs nanocomposites as a new magnetic adsorbent

Nunticha Limchoowong [a], Phitchan Sricharoen [a], Yonrapach Areerob [a], Prawit Nuengmatcha [a,b], Thitiya Sripakdee [a,c], Suchila Techawongstien [d], Saksit Chanthai [a,*]

[a] Materials Chemistry Research Center, Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand
[b] Department of Chemistry, Faculty of Science and Technology, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat 80280, Thailand
[c] Chemistry Program, Faculty of Science and Technology, Sakon Nakhon Rajabhat University, Sakon Nakhon 47000, Thailand
[d] Department of Plant Science and Agricultural Resources, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

ARTICLE INFO

Article history:
Received 20 September 2016
Received in revised form 17 February 2017
Accepted 11 March 2017
Available online 14 March 2017

Chemical compounds studied in this article:
Chitosan (Pubchem CID: 21896651)
Citric acid (Pubchem CID: 311)
Copper(II) chloride (Pubchem CID: 24014)
Ferric chloride hexahydrate (Pubchem CID: 24810)
Iron(II) sulphate heptahydrate (Pubchem CID: 62662)

Keywords:
Chitosan–graphene quantum dots
Magnetic nanocomposite
Copper
Food recipes

ABSTRACT

This study describes the preparation, characterization, and application of a new magnetic chitosan–graphene quantum dots (Fe_3O_4@Chi–GQDs) nanocomposite as an adsorbent for the preconcentration of Cu (II) in Thai food recipes or the so-called "Som Tam" (green papaya salad) prior to determination by inductively coupled plasma–optical emission spectrometry. The spectroscopic and magnetic properties along with the morphology and thermal property were analyzed using FTIR, EDX, XRD, TGA, VSM, and TEM. Preconcentration optimizations including pH, dosage of adsorbent, adsorption–desorption time, concentration and volume of elution solvent, sample volume and enrichment factor, and reusing time were investigated. Good linearity was obtained ranging from 0.05 to 1500 $\mu g\ L^{-1}$ with correlation coefficient of 0.999. Limit of detection was 0.015 $\mu g\ L^{-1}$. Relative recoveries of 85.4–107.5% were satisfactorily obtained. This Fe_3O_4@Chi–GQDs has high potential to be used as preconcentration method and can be reused 7 times with high extraction efficiency.

1. Introduction

Copper is a well-known inorganic element and possesses many biological characteristics as an essential element as well as a toxic substance. It is one of the most important heavy metals that is broadly used in industrial applications. It is also found as a residual contaminant in agricultural products (Rohani Moghadam, Poorakbarian Jahromi, & Darehkordi, 2016). Based on its widespread applications, Cu(II) can be leached out into the environment from several sources. As a result, it may directly or indirectly enter the food chains and in turn affects human health. Numerous serious diseases caused by its higher doses include an intestinal distress; bladder, brain, liver, and kidney damage; and Alzheimer's, Wilson's, and Menkes and Parkinson's diseases (Karadaş & Kara, 2017). Therefore, the determination of Cu(II) at trace concentration becomes increasingly essential because the heavy-metal contaminants in food products have posed a serious threat to public health and biological systems. The trace amount of Cu in food products must be controlled on a daily basis and the maximum allowable level of 30 $mg\ kg^{-1}$ Cu is recommended internationally (Sricharoen et al., 2017). Consequently, to ensure the public health, the preconcentration and determination of Cu(II) are required to meet its detection limit as well as the trace-to-ultratrace levels. Numerous techniques, such as solid phase extraction (SPE) (Yavuz, Tokalıoğlu, Şahan, &

* Corresponding author at: 123 Mittraphab Road, M. 16, T. Ni-Muang, A. Muang, Khon Kaen University, Department of Chemistry, Faculty of Science, Khon Kean 40002, Thailand.
E-mail address: sakcha2@kku.ac.th (S. Chanthai).

http://dx.doi.org/10.1016/j.foodchem.2017.03.066
0308-8146/