Bioresource Technology 128 (2013) 36–43

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Uptake of gold (III) from waste gold solution onto biomass-based adsorbents organophosphonic acid functionalized spent buckwheat hulls

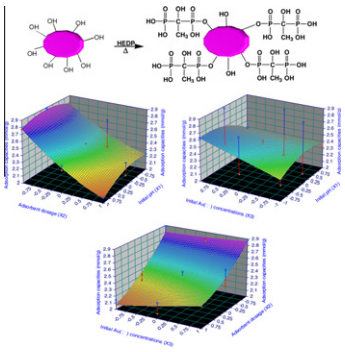
Ping Yin *, Mingyu Xu, Rongjun Qu *, Hou Chen, Xiguang Liu, Jiang Zhang, Qiang Xu

School of Chemistry and Materials Science, Ludong University, Yantai 264025, PR China

HIGHLIGHTS

- Feasibility of novel functionalized buckwheat hulls OPA-BH for gold uptake was confirmed.
- The low-cost biosorbent had very high adsorption capacity for Au(III).
- The biosorption process optimization was performed using response surface methodology.
- Desorption and regeneration studies were conducted to evaluate this adsorbent efficiency.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 29 July 2012
Received in revised form 9 October 2012
Accepted 11 October 2012
Available online 23 October 2012

Keywords:
Biomass-based adsorbent
Buckwheat hulls
Organophosphonic acid
Functionalization
Au(III) uptake

ABSTRACT

Novel biomass-based adsorbents organophosphonic acid functionalized spent buckwheat hulls (OPA-BH) with 60 mesh were successfully employed to adsorb Au(III) ions from simulated wastewater. The adsorption kinetics and isotherms both in unary ion system and in ternary ions system were investigated, and the applicability of the Langmuir, Freundlich and extended Langmuir isotherm models has been tested for the equilibrium. The process optimization was also conducted by using response surface methodology (RSM), and the maximum adsorption capacities reached 2.84 ± 0.01 mmol/g under the optimum process conditions. Furthermore, the regeneration capacities of OPA-BH were investigated by using the eluent solutions of 0.0–5.0% thiourea in 0.1 mmol/L HCl, and the results showed that the adsorption capabilities for OPA-BH were ranged between 0.77 mmol/g and 0.85 mmol/g after three cycles of adsorption–desorption processes. The research results showed that OPA-BH was favorable and useful for gold adsorption, and the high adsorption capacity and good reproducibility make it a good promising material for the precious metal uptake.

1. Introduction

The demand for gold, one of the precious metals used as a global currency, has shown an increasing trend because of its increasing uses in industry. The unique chemical and physical properties offered by gold are increasingly being sought for use in a growing number of industrial and medical applications. Therefore, it is very necessary to recover gold from industrial scraps and wastewater (for example, the scraps from electronic devices containing gold, such as cellular phones and personal computers). Then, the effluents from these scrap industry containing precious metal gold have attracted considerable attention not only because it is a precious metal and a conducting material but also because of its use in various chemical and electrochemical applications (Fujiwara et al., 2007; Nguyen et al., 2010).

More attentions have been focused on the methods for recovery and reuse of metal ions. Adsorption is highly effective, economical and a widely used method for metals ions uptake from different aqueous solutions (Stafiej and Pyrzynska, 2007; Feng and Aldrich, 2004). Recently, the search for low-cost biomass-based adsorbents that have metal-binding capacities has been intensified. Agricultural

* Corresponding authors. Tel.: +86 535 6696162; fax: +86 535 6697667.
E-mail addresses: yinping426@163.com (P. Yin), rongjunqu@sohu.com (R. Qu).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.10.048