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GEOPOLYMER FROM METAKAOLIN AND BIOMASS ASH FOR Cu(II) IONS ADSORPTION FROM AQUEOUS SOLUTIONS: KINETICS AND ISOTHERM STUDIES

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Abstract

The utilizations of geopolymer as adsorbent in the treatment of wastewater containing heavy metal or dyes have shown encouraging results. In this paper, geopolymer synthesized from alkaline activation of metakaolin and biomass ash was utilized as adsorbent for Cu(II) ions from aqueous solutions. Adsorption of Cu(II) ions by geopolymer followed Langmuir isotherm model which adsorption occurred on geopolymer surface by forming monolayer of adsorbate molecule with maximum adsorption capacity of 58.824 mg g^{-1}. Furthermore, pseudo-second order kinetics model was more suitable to describe adsorption of Cu(II) ions by geopolymer.

Author keywords

adsorption; biomass ash; copper; geopolymer; metakaolin

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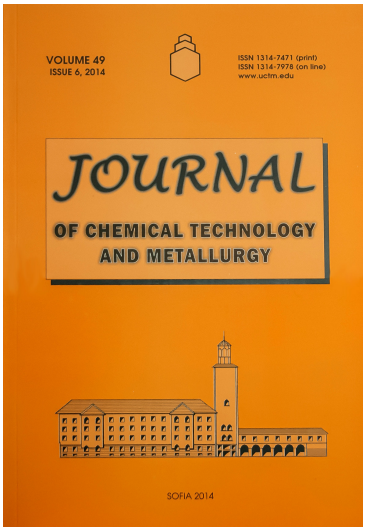

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GEOPOLYMER FROM METAKAOLIN AND BIOMASS ASH FOR Cu(II) IONS ADSORPTION FROM AQUEOUS SOLUTIONS: KINETICS AND ISOTHERM STUDIES

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ABSTRACT

The utilizations of geopolymer as adsorbent in the treatment of wastewater containing heavy metal or dyes have shown encouraging results. In this paper, geopolymer synthesized from alkaline activation of metakaolin and biomass ash was utilized as adsorbent for Cu(II) ions from aqueous solutions. Adsorption of Cu(II) ions by geopolymer followed Langmuir isotherm model which adsorption occurred on geopolymer surface by forming monolayer of adsorbate molecule with maximum adsorption capacity of 58.824 mg g^{-1}. Furthermore, pseudo-second order kinetics model was more suitable to describe adsorption of Cu(II) ions by geopolymer.

Keywords: adsorption, biomass ash, copper, geopolymer, metakaolin.

INTRODUCTION

Geopolymer is inorganic polymer with Si-O-Al bonds synthesized from alkaline activation of alumino-silicate materials at low temperature, generally below 100°C [1]. Metakaolin (Si_2O_5,Al_2O_2), obtained from calcination of kaolin ($Al_2O_3.2SiO_2.2H_2O$), is alumino-silicate material that has been widely used as geopolymer raw material [2]. Another source of alumino-silicate materials is solid waste from combustion such as fly ash and biomass ash. Biomass ash containing high silica, e.g. bamboo ash, can be used as geopolymer raw material [3].

Geopolymer having three dimensional porous structure has been applied for wastewater treatment as adsorbent of heavy metals [4, 5]. Adsorption has been widely used for heavy metal removal from wastewater because the process is simple, economical, and efficient [6, 7]. Applications of geopolymer from metakaolin as heavy metal adsorbent had been conducted on Cd, Cr, Cu, Pb [8]; Cs, Pb [9]; Zn, Ni [10]; and Pb [11]. Meanwhile, geopolymer from metakaolin and biomass ash had been applied as Pb adsorbent [12]. The use of geopolymer from biomass ash along with metakaolin as heavy metals adsorbent is interesting to study because it is one of the efforts to utilize solid waste to treat wastewater.

In this research, geopolymer was synthesized from alkaline activation of metakaolin and biomass ash and then applied as Cu(II) ions adsorbent. Copper is one of common heavy metals in industrial wastewater such as from electroplating, metal surface finishing, and fertilizer production, that are very toxic even at low concentration [13, 14]. Factors affecting adsorption process, namely adsorbent dosage, pH, initial concentrations, contact time, were studied in addition to kinetics and isotherm adsorption studies.

EXPERIMENTAL

Materials

Materials used in this study were metakaolin, biomass ash, commercial sodium hydroxide flakes (purity of 98 %), and commercial sodium silicate solution (SiO_2 = 30 %, Na_2O = 9 %, H_2O = 61 %). Metakaolin was obtained from calcination of commercial kaolin powder in electric furnace at 550°C for 3 hours, while biomass ash was obtained from combustion of bamboo (*Gigantochloa apus*). Metakaolin contained SiO_2 = 53.9 % and Al_2O_3 = 42.4 %, whereas the biomass ash contained SiO_2 = 58.6 % and Al_2O_3 = 0.7 %.

Preparation of geopolymer

Geopolymer powder for Cu(II) ions adsorption was obtained from geopolymer paste preparing from metakaolin, biomass ash, and alkaline activator. The weight ratio of metakaolin to biomass ash was 4:1. Alkaline activator used was mixture of 10 N sodium hydroxide

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DETERMINATION OF SOME PROHIBITED SUBSTANCES IN FOOD SUPPLEMENTS USING HPLC WITH MS OR UV DETECTION – VIEW ON CURRENT DEVELOPMENT

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ABSTRACT

Nowadays bioanalytical techniques including liquid and gas chromatography combined with different types of detectors are largely introduced in a practice. They are largely used for detection and control of substances and for monitoring of the whole production process. The type of detector depends on necessary levels of detection, but also on the matrix where aimed compounds have to be determined.

Herein are summarized data from the last ten years related to determination of six main prohibited substances sildenafil, tadalafil, vardenafil, dapoxetine, yohimbine and sibutramine as well as their derivatives in food supplements using high performance liquid chromatography combined with mass spectrometric or UV detection. All these compounds are in a large interest because they are introduced often in products freely distributed in the internet market.

Keywords: sildenafil, tadalafil, vardenafil, dapoxetine, yohimbine, sibutramine, HPLC/MS, HPLC/UV.

INTRODUCTION

Bioanalytical techniques such as chromatographic methods, electrophoresis, biosensors, etc. are largely used in modern industries. They are part of the process of analysis and control of substrates and final products for the market as well as the monitoring of the whole process of aim product production. Today bioanalytical methods have reached very high levels of sensitivity. Some types of detectors allow determining femto and attograms of substances. Thanks to new developments in the field of these techniques today more than 10 components with a complex structure can be separated and analyzed for a short time for example in a modern ultra-performance liquid chromatography (UPLC) and capillary electrophoresis techniques. However, the different problems still arise related to the needs for analysis of more complex matrices. So the sample preparation process occupies an increasing and key share of the analytical process. In addition development of analytical technics for selective detection of target components of a mixture remains on the agenda.

Food supplements, especially those based on herbal extracts, have been gaining ground in the pharmaceutical market in recent years. They are used to support the prevention and treatment of various diseases and organism needs such as immune response [1, 2], sexual potency [3], the process of weight losing in overweight and obese people [4], antioxidants [5], etc. [6, 7]. The development of internet based platforms for trading of such kind of substances strongly arises over the last decade. Unfortunately, the control of the content and quality of a many of these substances offered on the internet is greatly reduced or non-existent. This market also is characterized by lack of adequate information of potential hazards [8, 9]. Thus, the number of poor quality food supplements containing traces or significant quantities of active substances in the internet market is increasing sharply [10 - 12]. Hence, the safety of such kind food supplements is really questionable [13]. Moreover, they can cause significant side effect on human organism depending on their quantity and secondary interactions with another medical drugs

INORGANIC SALT MEDIATION FOR IMPROVED ISOLATION OF ESSENTIAL OIL FROM THE CINNAMON BARK

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ABSTRACT

An aqueous solution has an ability to alter the rate of essential oil extraction for the essential oil in positive direction by affecting the cell structure. In the present study, various inorganic salts have been employed with different methods like hydrodistillation, sonohydrodistillation and microwave assisted extraction for isolating the essential oil from cinnamon (Cinnamomum zeylanicum) bark. Various salts with different cation, anion and valency have been studied to select the best salt. The maximum yield (4.47 %, w/w) of cinnamon oil was obtained in microwave assistant extraction with 5 % KCl solution with the highest fraction of cinnamaldehyde (0.97). This salt additive method has reduced the extraction time, energy and environmental burden when compared with the conventional method and provided a greener path. This salt additive method can emerge as a sustainable approach for a higher scale application.

Keywords: cinnamaldehyde, cinnamon oil, inorganic salts, microwave assistant extraction, sustainable technique.

INTRODUCTION

The essential oil obtained from the bark of cinnamon (*Cinnamomum zeylanicum* L.) is always known for its flavor, aroma, medical and other properties. The essential oil is widely used as a flavoring agent, in baking, cold drinks and sauces [1]. It was also well liked by ancient people for various medical conditions such as blood circulation and disturbances [2]. Having such admiration, cinnamon plants are mainly cultivated in Southeast Asia, mainly in Vietnam, Seychelles, Malaysia, China, India, and Srilanka [3]. The essential oil extracted from the bark contains cinnamaldehyde (CA) as the principle compound [4]. In a food industry for preservation of the food product, synthetic chemicals have been used. However, these chemicals have toxic effect in a longer period [5]. The cinnamon oil is an alternative to these types of chemicals and has considerable use in the food industries. Due to distinctive properties essential oil is used as an additive in pharmaceutical industry [1, 6 - 8].

For extraction of cinnamon oil, maceration [6], steam distillation [7] and hydrodistillation [8] have been used. Most of the industries adopt conventional approach for extraction which is an easier and law capital investment process as well as the complete extraction of essential oil can be obtained. However, the conventional methods require more energy and have negative impact on ecology. These extraction methods need a longer time for operation and consume utility in a higher amount which ultimately leads to increased environmental burden [9]. There is also a need to modify the conventional technique so that the benefit of low capital investment would remain along with alleviated energy and environment concern. One such alternative for improving the conventional technique is to incorporate salts as an additive.

The present study was aimed to decrease the envi-