Preparation of Sugarcane Bagasse/Poly(Acrylic Acid-*co*-Acrylamide) Hydrogels and their Application

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In this work, sugarcane bagasse, being an abundant and renewable resource, was used as a raw material to prepare sugarcane bagasse-g-poly(acrylic acid-*co*-acrylamide) (SB/P(AA-*co*-AM)) hydrogels. The hydrogels were prepared by free radical graft copolymerization of SB with AA and AM using *N*,*N*-methylene-bis-acrylamide (MBA) as a crosslinker. The optimal synthesis conditions were determined by investigating the water absorbency of the hydrogels. The maximum water absorbency reached 269 g/g in deionized water, and the corresponding copper ions adsorption capacity was 265 mg/g. These grafted hydrogels showed a pH-sensitive swelling behavior. Furthermore, they also exhibited excellent water retention capacity, which reserved 92.7%, 81.7%, and 76.8% for 44 h, and 83.7%, 58.6%, and 47.1% for 116 h at 5 °C, 25 °C, and 35 °C, respectively. FTIR spectroscopy and SEM were used to reveal the chemical structure and the morphology of the hydrogels. SEM/EDS further confirmed the adsorption of the copper(II) on the resulting hydrogels. Therefore, SB/P(AA-*co*-AM) hydrogels could have promising applications as water retention agents and metal ions adsorbents in water treatment and agricultural industries.

Keywords: Sugarcane bagasse; pH-sensitive hydrogels; Water absorbency; Metal ions adsorption; Water retention capacity

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INTRODUCTION

Due to growing demand for agricultural production, especially in China, large amounts of agro industrial byproducts and residues such as sugarcane bagasse, wood, wheat straw, rice straw, maize straw, and off-cut residues from bamboo processing are generated every year. Most of these residues are disposed of in various ways. Burning of residues as one disposal method releases air pollutants. Only a small part of the available residue has been used in industry.

Sugarcane bagasse (SB), as the fibrous by-product remaining after sugar extraction from sugarcane, is one of the most important byproducts. About 54 million dry tons of SB are produced annually throughout the world (Ren *et al.* 2006). During a typical cane crushing season, about 50% of the SB is employed to generate heat and power to run the sugar milling process, while the remainder is stockpiled. The stockpiled SB is of low economic value and creates an environmental problem to sugar mills and surrounding districts.

Recently, there has been an increased interest in developing techniques for the conversion of lignocellulosic materials into environmentally friendly chemicals and biomaterials. A great deal of attention has been given to the production of bio-adsorbents from lignocellulosic byproducts such as wood sawdust (Rodrigues *et al.* 2006), crop milling waste (Saeed *et al.* 2005), sugarcane bagasse (Karnitz Jr. *et al.* 2007; Liang *et al.* 2013a; Pehlivan *et al.* 2013), bamboo lignocellulose (Wang *et al.* 2013), mulberry branches (Liang *et al.* 2013c), plant wastes (Ngah and Hanafiah 2008), and other lignocellulose (Bunhu and Tichagwa 2012; Hubbe *et al.* 2011; 2013; Roy *et al.* 2012; 2013; Shi *et al.* 2013). These bio-adsorbents prepared from lignocellulosic byproducts have potential application in the removal of heavy metal ions and methylene blue from wastewater. They can also be used in sugar decolorization, and in the sustained release of urea in agricultural and horticultural applications. The utilization of agricultural wastes as bio-adsorbents is currently receiving wide attention because of their abundant availability and low cost. Furthermore, they have a relatively high fixed carbon content and present a porous structure.

Hydrogels are a three-dimensional network of hydrophilic polymers crosslinked by chemical or physical interactions and are capable of imbibing large amounts of water or biological fluids. Hydrogels have received ever-increasing attention due to their many favorable properties such as hydrophilicity, soft tissue-mimicking consistency, high permeability to metabolites and oxygen, and resilience (Chen and Wang 2009; Hennink and van Nostrum 2012). These characteristics allow hydrogels to have a board range of applications in many fields such as in the food industry (as a thickening agent), pharmaceuticals (for controlled release preparations), agriculture and related fields (for controlled release of moisture, fertilizer, and pesticides), technical and electronic instruments (as protection from corrosion and short circuiting), biomedicine (as artificial organs), bioengineering (in bimolecular immobilization), veterinary, photographic technology, and as adsorbents for the removal of some unwanted agents in environmental application (Gulrez *et al.* 2011). There are various techniques adopted to prepare hydrogels, which contain physical cross-linking, chemical cross-linking, grafting polymerization, and radiation cross-linking. Such modifications can improve the mechanical properties and viscoelasticity for industrial application.

Recently, monomers with double-bonds such as acrylic acid (AA) and acrylamide (AM) have been grafted together on the backbone of nature's polymers such as cellulose, starch, and lignin under the function of a crosslinker to form hydrogels with some specific characteristics (Guo *et al.* 2013; Hubbe *et al.* 2013; Zhou *et al.* 2013; Wu *et al.* 2010). In addition, SB consisting of three main nature biopolymers (cellulose, hemicelluloses, and lignin) can be used as a skeletal material to be grafted with other functional groups. However, limited study has been focused on the preparation of hydrogels based on SB (Liang *et al.* 2013b). So the objective of this work was to use SB as a raw material to graft poly(acrylic acid and acrylamide) under the function of *N*, *N*-methylene-bis-acrylamide (MBA) as a cross-linker by free radical graft copolymerization for forming SB-g-P(AA-*co*-AM) hydrogels. The optimal copolymerization conditions were discussed by the water absorbency. And the water retention capacity of prepared hydrogels was investigated as well as the adsorption of prepared hydrogels for the copper(II) ions. The resultant hydrogels were characterized by Fourier transforms infrared (FTIR) spectroscopy and Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) together with energy-dispersive spectroscopy (EDS) (SEM/EDX).

EXPERIMENTAL

Materials

Sugarcane bagasse was obtained from Guangzhou Sugarcane Industry Research Institute. The SB was ball-milled to obtain powder between 0.15 mm and 0.074 mm in size, and the compositions of extractive-free SB were 45.0% cellulose, 22.2% lignin, 31.0% hemicelluloses, and 1.7% ash. MBA and ammonium persulfate (APS) were purchased from Shanghai Chemical Reagent Corp., China and were used without any further purification. AA (Xi'an Chemical Reagent Factory, China) was purified by distillation under reduced pressure to remove the inhibitor hydroquinone before use. AM was bought from Shanghai Chemical Reagent Corp., China. All other reagents used were of analytical grade and all solutions were prepared with distilled water.

Preparation of SB-g-P(AA-*co*-AM) Hydrogels

SB-g-P(AA-co-AM) hydrogels were prepared by free radical graft copolymerization of SB with AA and AM in the presence of a crosslinker (MBA) and an initiator (APS). The typical experimental procedure was carried out as follows. Firstly, 1.0 g of SB was dissolved in 20.0 mL of distilled water in a three-necked flask with a magnetic stirrer, a reflux condenser, and a nitrogen line at 70 °C. Simultaneously, oxygen-free nitrogen gas was bubbled into the solution for 30 min before adding the initiator. 0.1 g of APS (10% w/w, based on the dry SB weight) was dissolved in the distilled water and added to the mixture solution. The mixture was allowed to stir for 10 min to generate radicals in the nitrogen gas atmosphere. Thereafter, 1.0 g of AA (a neutralization degree of 70%, a 1.0 weight ratio of AA and SB) was added, and then 1.0 g of AM (a 1.0 weight ratio of AM and SB) and 0.025 g of MBA (2.5% w/w, based on dry SB weight) were subsequently added to the reaction mixture. The total volume of the solution in the reactor was controlled to 40 mL. After stirring for 30 min, the reaction proceeded for 2 h with no stirring. The hydrogels were carefully removed and washed thoroughly in distilled water for a few days to remove the unreacted monomers and homopolymers. During this period, the distilled water was replaced with fresh distilled water at least six times daily to leach out the unreacted chemicals. The hydrogels were then cut into regular small pieces (5×5×5 mm) and washed with ethanol four times. In succession, these small pieces were immersed in 1 M NaOH solution for 24 h, and were again carefully washed thoroughly in distilled water for 1 day and then dried to a constant mass at 50 °C.

Water Absorbency of Hydrogels

Pre-weighed dry hydrogels (m_0) were immersed in excessive distilled water to reach a state of equilibrium swelling (about 5 h) at room temperature. The weight gain of the samples was monitored gravimetrically. The mass of the wet hydrogels (m_{eq}) was determined after removing the surface water by gently dabbing the hydrogels with filter paper. The water absorbency (Q_{eq}) was determined by the following equation:

$$Q_{eq} = (m_{eq} - m_0) / m_0 \qquad (1)$$

where m_0 (g) is the weight of the dry hydrogels and m_{eq} (g) is the weight of the swollen hydrogels. Q_{eq} (g/g) expresses the swelling ratio of the resulting hydrogels as grams of water per gram of sample. Data are representative of at least three experiments, and standard deviations are less than 5.0%.

FT-IR Analysis

FTIR analysis of the SB and SB-g-P(AA-*co*-AM) hydrogels was performed by a Nicolet 750 spectrophotometer within the frequency range of 400 to 4000 cm^{-1} by the method of transmission. The 1% finely ground samples were mixed with KBr to press a plate for measurement.

Morphology of Hydrogels

Surface morphology of the resulting hydrogels before and after the absorption of water was examined by SEM (Hitachi S3700). SEM/EDX analysis was used to investigate the morphology of prepared hydrogels after the adsorption of metal ions. Specimens were coated with gold for 30 s in a sputter coater.

Swelling Characterization at Various pH Values

Buffer solutions (KH_2PO_4, K_2HPO_4, and H_3PO_4), HCl, and NaOH were used to achieve the desired pH value. The measurement of water absorbency was calculated from Eq. 1.

Water Retention Measurement at Various Temperatures

The prepared SB/P(AA-*co*-AM) hydrogles were immersed in deionized water at room temperature to reach swelling equilibrium (about 5 h). The hydrogels were then weighed (M_0) after the water on the surface of the hydrogels was removed and placed at temperatures of 10, 25, and 45 °C. The samples were weighed for a few hours (M_i). The water retention capacity of the SB/P(AA-co-AM) hydrogels at various temperatures was determined by Eq. 2,

$$R_{iT} = M_i/M_0 \times 100\% \tag{2}$$

where M_0 (g) and M_i (g) are the mass of initial swollen hydrogels and the swollen hydrogels placed at different temperature in interval time, respectively. R_{iT} is the water retention capacity (g/g). The experiments were conducted in triplicate, and averaged values were reported.

Adsorption Experiments for Cu^{2+}

Batch experiments were carried out (at room temperature) by agitating 10 mg of dry adsorbent hydrogel particles in 50 mL of $CuSO_4$ solution (200 mg/L, pH=5.5) at 100 rpm to reach the adsorption equilibrium time (3 h), based on our previous work. At the end of the experiment, the mixture was centrifuged and filtered. The filtrate concentration was measured by Atomic Absorption Spectrometry (AAS). The amount of metal ions adsorbed on hydrogels (q_e) was calculated according to Eq. 3,

$$q_e = \frac{(C_0 - C_e) \times V}{W} \tag{3}$$

where C_0 and C_e are the initial and equilibrium metal ion concentrations (mg/L), V is the volume of the metal ion solution used in the adsorption experiment (L), and W is the weight of the hydrogel particles (g). The quantity q_e is the amount of metal ion adsorbed per gram of sample (mg/g).

RESULTS AND DISCUSSION

Mechanism of SB-g-P(AA-*co*-AM) Hydrogels Formation

The resultant hydrogels were prepared by graft copolymerization of acrylic acid and acrylamide onto sugarcane bagasse in the presence of APS as a free radical initiator and MBA as a hydrophilic crosslinker. The proposed mechanism for the chemical grafting and crosslinking reactions is shown in Fig. 1.

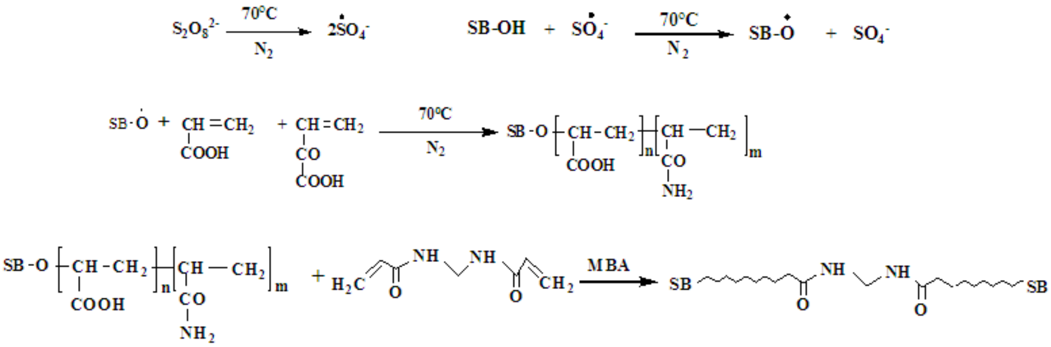

Fig. 1. Proposed reaction mechanism for the preparation of SB-g-P(AA-*co*-AM) hydrogels

According to the scheme in Fig. 1, APS is decomposed under heating to generate sulfate anion-radicals. The radicals extract hydrogen from the hydroxyl groups of SB to form more active groups (macro-radicals). Then, the active centers on SB attack the monomer molecules (AA and AM) to propagate a polymeric chain and thereafter become free radical donors to neighboring molecules to grow the grafted chain. During chain propagation, the polymeric chains can react simultaneously with the vinyl groups of MBA and a crosslinked structure is formed. The formation mechanism of hydrogels is similar with those proposed in the literature (Pourjavadi *et al.* 2007; Rashidzadeh *et al.* 2014).

The Effects of Reaction Conditions on the Water Absorbency

Figure 2 shows the effects of the reaction conditions on the water absorbency. Experiments of graft copolymerization were carried out at 70 °C by varying the amounts of APS, MAB, and monomers to obtain different structures of SB/P(AA-*co*-AM), which correspondingly resulted in different water-swelling capacities. The water absorbency as a function of the initiator (APS) amount (4%, 6%, 10%, 15%, and 20%, based on the dry weight of SB) is displayed in Fig. 2a. The water absorbency increased with an increment in the APS amount from 4% to 10%. The maximum water absorbency of 261 g/g was obtained at 10% of APS. Further increasing the amount of APS, the water absorbency decreased. This trend was in accordance with other literature (Cheng *et al.* 2013). They mentioned that there was a characterized relationship between average chain length and the initiator concentration during polymerization. So the APS amount had a remarkable effect on the structure of hydrogels, thereby affected the water absorbency. The enhancement of water absorbency was due to the sufficient grafting polymerization by more macro-radicals caused by the increase of APS amount. Consequently, more available sites on the polysaccharide backbone reacted with AA and AM to propagate a polymeric chain; however, the excess APS generated more free radicals to accelerate the chain termination reaction, forming more homopolymers and thereby decreasing the absorbency. A similar phenomenon was also reported by Wu *et al.* (2012).

The function of the crosslinking reagent is to endow hydrogels with network structure to enhance the gel strength. Crosslinking reaction leads to a formation of hydrogels with a permanent network structure. In crosslinked hydrogels, polymeric chains are interconnected by crosslinkers, resulting in the formation of a 3D network. The properties of crosslinked hydrogels depend mainly on the crosslinking density, namely the molar ratio of crosslinking agent to polymer repeating units (Peppas 1986). So, the crosslinker has an important impact on the properties of hydrogels. Figure 2b illustrates the effects of the crosslinker (MBA) on the water absorbency of prepared hydrogels. The water absorbency decreased when the MBA amount increased from 2.5% to 10% based on the dry SB weight. The decrease in the water absorbency with increasing cosslinking reagent amount was due to the higher crosslinking density, which led to a decrease in the spaces between the copolymer chains, and consequently the resulting structure was less expanded and failed to expand upon fluid exposure, thus retaining little water (Mahdavinia *et al.* 2004; Pourjavadi *et al.* 2004). Thus, SB/P(AA-*co*-AM) hydrogels with moderately crosslinked hydrophilic polymer networks could absorb the large amount of distilled water.

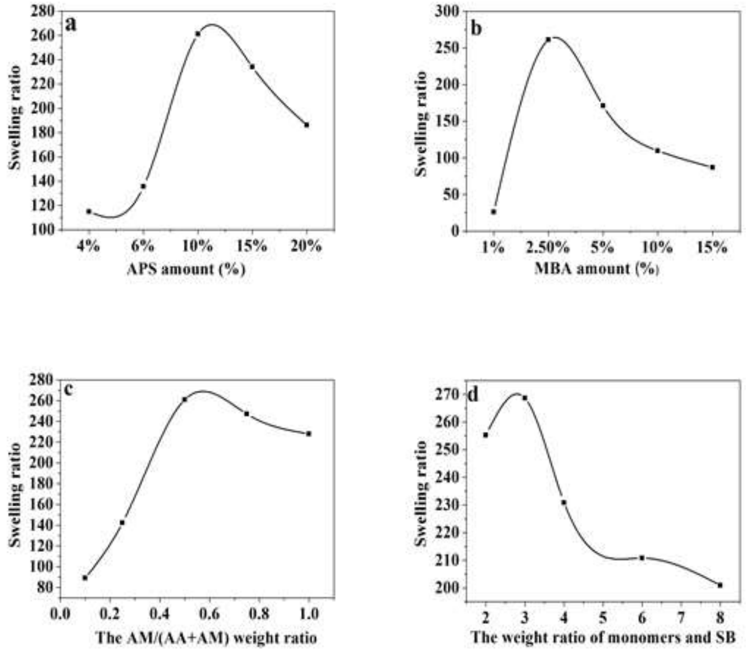

Fig. 2. The effects of reaction conditions on water absorbency

Figure 2c shows the effects of various AM/(AA+AM) weight ratios on the water absorbency. The results indicated that the absorbency for water remarkably increased when the weight ratio was below 0.5. When this ratio was further increased, the water absorbency decreased, which was likely due to ionization effects. The -COONa group may be ionized into –COO$^-$ in water, producing a hydrophilicity of –COO$^-$ superior to that of –$CONH_2$ (Cheng *et al.* 2013).

AA and AM as the hydrophilic groups were grafted onto the backbone of lignocellulose for enhancement of the hydrophilicity. Figure 2d displays the effects of the total monomer amounts (AA+AM) on the water absorbency. Obviously, the absorbency firstly increased and then decreased sharply with an increase in the monomers/SB weight ratios from 2.0 to 8.0. The maximum water absorption capacity value was 268 g/g. The increased monomer amount promoted the monomer molecules to accumulate close to the backbone of the lignocellulose, resulting in high grafting efficiency. The excess amount of monomers caused preferential homopolymerization rather than graft copolymerization, and also enhanced the chance of chain transfer to the monomer molecules (Pourjavadi *et al.* 2008). So the optimized weight ratio of the total monomer to sugarcanes bagasse was 3.0.

Characterization of SB/P(AA-co-AM) Hydrogels

Figure 3 illustrates the FTIR spectra of the SB (spectrum a) and SB/P(AA-*co*-AM) (AM/(AA+AM)=0.5, spectrum b; AM/(AA+AM)=1.0, spectrum c). In spectrum a, the band at 3411 cm^{-1} is attributed to the stretching vibration of the hydroxyl groups on SB. The bands at 2925 cm^{-1} originate from the C-H stretching of methyl and methylene groups. Aromatic skeleton vibrations in the lignin are assigned at 1603, 1508, and 1421 cm^{-1} (Sun *et al.* 2001). The bands at 1325 and 1265 cm^{-1} relate to ring breathing with C-O stretching. The prominent absorption at 1052 cm^{-1} is attributed to the glycosidic linkage v(C-O-C) contributions, and the small sharp band at 900 cm^{-1} is due to the *β*-glycosidic linkage between xylose units in hemicelluloses and glucose units in cellulose (Sun *et al.* 1996).

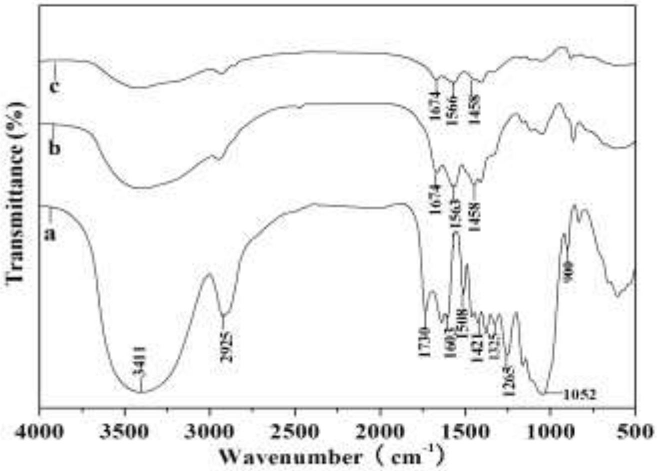

Fig. 3. FT-IR spectra of SB (a) and hydrogels (AM/(AA+AM)=0.5, b; AM/(AA+AM)=1.0, c)

Compared to spectrum a, new bands are present in spectra b and c. A band at 1674 cm^{-1} is a shift of C=O stretching vibration, caused by the superposition of C=O in the amide I and C=O in COO$^-$ (Wu *et al.* 2012). The new band at 1566 cm^{-1} corresponds to the asymmetric –COO$^-$ stretching vibration. The band at 1458 cm^{-1} is assigned to the C-N bonding (Rashidzadeh *et al.* 2014). The region from 3100 to 3500 cm^{-1} corresponds to the absorption of hydrogen bonds caused by O–H and N–H. These findings were indicative of the introduction of P(AA-*co*-AM) on the backbone of the SB lignocellulose.

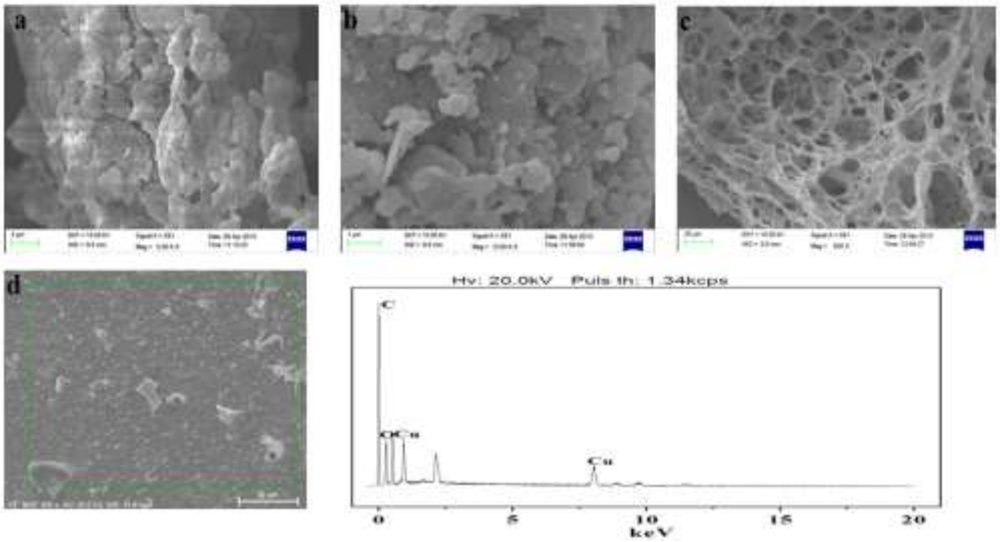

Fig. 4. SEM images of SB (a), SB/P(AA-*co*-AM) (AM/(AA+AM)=1.0 before (b) and after the water absorption (c) and copper(II) ions adsorption (d)

SEM images of SB, as well as SB-g-P(AA-*co*-AM) hydrogels before and after the water absorption are shown in Fig. 4a-c. The ground SB had a coarse and loose surface. For dry SB-g-P(AA-*co*-AM) hydrogels had smooth, compact, and porous structure (Fig. 4b). The pore structure contributed to water diffusion in the polymeric network, thereby producing high swelling capacity in the final hydrogels (Cheng *et al.* 2013). Hydrogels after the water absorption displayed an expanded network structure. Also, the pores were below 20 µm. These pores are understood to be the regions of water permeation and interaction sites of external stimuli with the hydrophilic groups of the graft copolymers. The formation of pores was due to the dehydration with water and the drying process.

Water Absorbency at Different pH Values

Figure 5 shows the effects of pH value in the aqueous medium on the water absorbency of hydrogels, keeping the absorption time of 5 h. The water absorbency was increased with increasing pH from 2.0 to 4.0, and then changed to be stable in pH region of 4 to 10.0. Further enhancing of the pH value caused a sharp reduction in water absorbency. The high water absorbency was ascribed to the high repulsion of $–NH_3^+$ groups in the acidic media, and $–COO^-$ groups in the basic media. Under acidic conditions (pH<4.0), most $–COO^-$ groups were protonated into –COOH groups. The protonation of COO^- groups resulted in a decrease of the electrostatic repulsion among negatively charged COO^- groups and an increase in the hydrogen bonding interaction among COOH groups; additionally, the anion-anion repulsive forces were eliminated, and as a result, the water absorbency remarkably decreased (Yin *et al.* 2008). Moreover, the charge-screening effect of the Cl^- counterions in the swelling medium shielded the ammonium cations and prevented an efficient repulsion (Pourjavadi *et al.* 2007). At a pH greater than 4.0, ionization of COOH groups occurred, and the water absorbency was enhanced at the higher pH value.

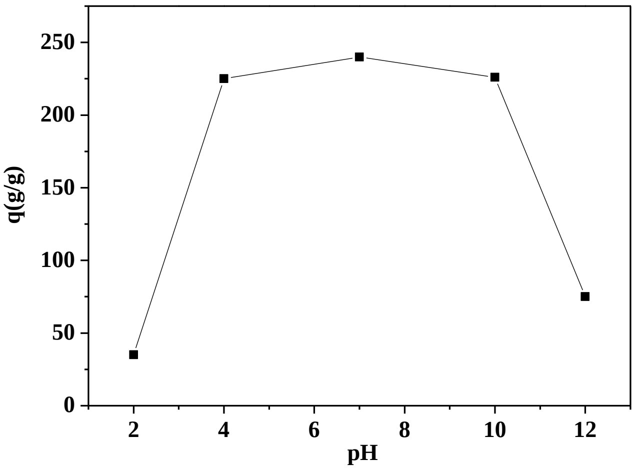

Fig. 5. Effects of pH on the water absorbency of the absorbent (AM/(AA+AM) weight ratio of 0.75)

The presence of COO^- groups was favored to form strong electrostatic repulsion, leading to an expanded network, consequently resulting in a high water swelling ratio. While in highly alkaline solutions (pH>11.0), the screening effect of the Na^+ counterions in the swelling medium led to the decrease of water absorbency. Thus, the prepared hydrogels were pH sensitive. Furthermore, the hydrogels had a high water absorbency at the appropriate medium (pH of 4 to 10), indicating that the products could have a promising application in agricultural and horticultural industries as a water retention agent.

Water Retention Measurement

Water retention capacity is an important property for an absorbent. The water retention test of the SB-g-P(AA-*co*-AM) hydrogels was determined at various temperatures, as seen in Fig. 6.

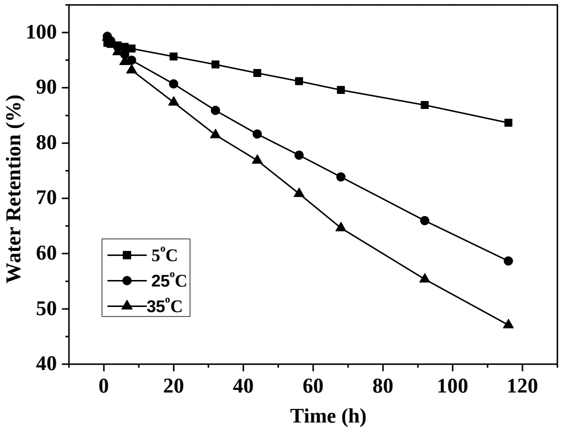

Fig. 6. Water retention capacity of SB-g-P(AA-*co*-AM) hydrogels at various temperatures ((AA+AM)/SB weight ratio of 3.0)

The results indicated that the water retention of the SB-g-P(AA-*co*-AM) hydrogels decreased with increasing time. Also, a high temperature caused a decrease in the corresponding water retention capacity. The hydrogels at 5 °C, 25 °C, and 35 °C reserved 97.1%, 95.0%, and 93.2% of the absorbed water for 8 h, 92.7%, 81.7%, and 76.8% for 44 h, and 83.7%, 58.6%, and 47.1% for 116 h, respectively. The decrease in water retention capacity at the higher temperature was explained by the fact that the hydrogen bonds that capture water molecules in the polymeric chains were destroyed (Roy *et al.* 2009). These results indicated that these absorbent hydrogels prepared could be applied as water retention agents in the agricultural and horticultural industries.

Metal Ions Adsorption

The metal ions adsorption capacity of the prepared adsorbent hydrogels is shown in Table 1. Clearly, these adsorbents had a relatively high adsorption capacity for Cu^{2+}. The maximum adsorption achieved was 265 mg/g. Increasing the APS amount led to the increment of Cu^{2+} adsorption capacity, indicating that sufficient grafting copolymerization occurred on the SB, creating more adsorption groups and thus enhancing the metal ions adsorption. With an increase of total monomer amount, the adsorption firstly increased and then decreased. The excess monomer amount caused an increasing chance of homopolymerization, and consequently, the adsorption for Cu^{2+} decreased.

Table 1. Cu^{2+} Adsorption Capacities of the Hydrogels with Different Structures

The APS amount	The ratio[a]	The ratio[b]	Cu^{2+} adsorption (mg/g)
4%	0.5	2	115
6%	0.5	2	136
10%	0.5	2	261
10%	0.25	2	136
10%	0.5	2	258
10%	0.75	2	160
10%	0.5	2	258
10%	0.5	3	265
10%	0.5	4	226

[a] The AM/(AA+AM) weight ratio
[b] The (AA+AM)/SB weigh ratio

A similar trend was present for the water absorbency discussed in Fig. 2. The OH, $CONH_2$, and COO^- groups on the backbone of the SB lignocellulose had a great adsorption ability for metal ions, which gives the potential application in the removal of meal ions in wastewater treatment. At pH 5.5, all acid groups became ionized, and the electrostatic repulsive forces between anions led to a marked increase of swelling, and therefore, adsorption of metal ions. On the other hand, amino groups were not ionized, so the effect of the electrostatic repulsion of the negatively charged COO^- groups had a dominant effect on the high adsorption of metal ions (Krusic *et al.* 2012).

FTIR spectra were obtained for hydrogels before and after the adsorption of Cu^{2+} ions, as shown in Fig. 7. Obviously, the intensity of the bands around 3405 cm^{-1} became weak upon adsorption of Cu^{2+}, which indicated that these –OH and $–NH_2$ groups were possibly involved in the adsorption of metal ions. The bands around 1668 and 1579 cm^{-1}

(spectrum a) shifted to 1674 cm^{-1} and 1566 cm^{-1} (spectrum b), which indicated the interaction between Cu^{2+} ions with $–COO^-$ and $–CONH_2$ groups. So the changes in FTIR spectra of hydrogels before and after the adsorption of metal ions further confirmed that all $–OH$, $–NH_2$, and $–COO^-$ groups were involved in the Cu^{2+} ions adsorption.

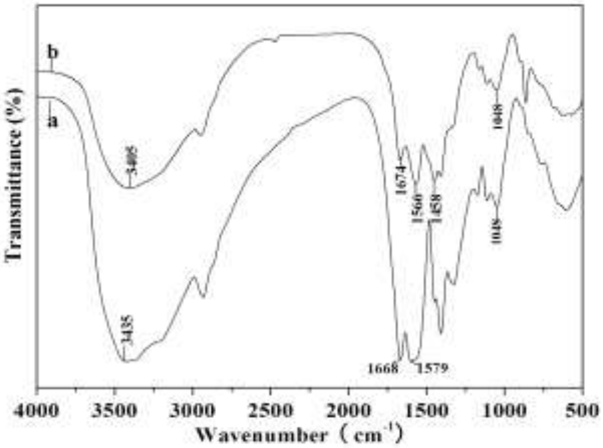

Fig. 7. FT-IR spectra of hydrogels before adsorption (a) and after adsorbing Cu^{2+} (b)

In order to verify the presence of Cu^{2+} ions on the resultant hydrogels, an EDX spectrum of hydrogels loaded by Cu^{2+} is illustrated in Fig. 4d. The EDX spectrum showed the copper peaks, which verified that the existence of copper(II) ions on SB-g-P(AA-*co*-AM) hydrogels.

CONCLUSIONS

1. New sugarcane bagasse (SB)-based hydrogels were prepared by grafting acrylic acid (AA) and acrylamide (AM) onto the backbone of SB in the presence of a crosslinker *N*,*N*-methylene-bis-acrylamide (MBA) using free radical graft copolymerization. They displayed pH sensitivity.
2. The optimal synthesis conditions for the water absorbency were an ammonium persulfate (APS) amount of 10% (based on SB weight), a MBA amount of 2.5% (based on SB weight), and an AM/(AA+AM) weight ratio of 0.5. With monomers/SB weight ratio of 3.0, the corresponding maximum reached to 269 g/g for the water absorbency and 265 mg/g for copper ions adsorption capacity.
3. These prepared hydrogels also had excellent water retention capacities. The absorbents at 5 °C, 25 °C, and 35 °C reserved 92.7%, 81.7%, and 76.8% for 44 h, and 83.7%, 58.6%, and 47.1% for 116 h, respectively.
4. Further studies can focus on the kinetic studies for the metal ions adsorption and the fertilizer release, which will provide the useful information for the waste treatment and agricultural and horticultural industries.

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