Pretreatment of Sesame straw by NaOH/Sulfuric acid for Enhancing Enzymatic Hydrolysis

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Abstract

Sesame straw is an agricultural waste that can be widely used as a potential raw material for biofuel production because of its adaptability. The composition analysis of the sesame straw collected from the local was carried out, and the alkali pretreatment process was found to be beneficial to the sesame straw by comparing the acid and alkali pretreatment. When the alkali concentration was 4%, the concentration of reducing sugar produced reached 7.9 g/L. Sesame straw can be used as one of the alternative raw materials for bioethanol production.

Keywords

Biofuel, Sesame straw, pretreatment.

1. Introduction

Sesame (ses-amum idicum), also known as sesame, is a genus of Lamalees and Pedaliaceae. It is one of the major oil crops in China, and is one of the four major oil crops. Because sesame has high application value and wide application, it is deeply loved by everyone. The sesame planting area is extensive, mainly planted in the temperate zone and tropical zone of China.

Straw is a kind of agricultural waste that is widely existed. The amount of sesame straw produced every year is also very large. It used to be treated by burning. After the annual harvest is completed, the government needs to arrange a large amount of manpower and material resources to treat the sesame straw. As we all know, this is a way of polluting the environment and wasting resources. Therefore, it is necessary to use sesame straw reasonably and effectively.

According to research, the content of cellulose in sesame straw is rich, so it can be considered whether it can be used to produce bioethanol. The production of bioethanol from lignocellulosic materials mainly includes the following three processes[1]: (1) physical, chemical or biological methods to destroy dense structures formed of cellulose, hemicellulose and lignin in lignocellulose[2]; (2) Cellulase and xylanase degrade organic macromolecular polymers in cellulose into oligosaccharides such as glucose, xylose and arabinose[3]; (3) use yeast to absorb small molecules of glucose under anaerobic conditions into ethanol[4]. The effective pretreatment of lignocellulose is an important prerequisite for the subsequent efficient enzymatic hydrolysis and fermentation. Sesame straw has the characteristics of high cellulose content, large yield and concentrated source[5]. It is a kind of high quality lignocellulosic raw material, which has important research significance and good application prospect in the field of fuel ethanol production and preparation[6].

This study determined the composition of sesame straw. The sesame straw was pretreated by acid/base chemical treatment to increase the relative content of cellulose[7]. As far as I know, this is the first time to measure the composition of sesame straw, and it is also the first time to use sesame straw for bioethanol production.

2. Materials and Methods

2.1 Sesame straw and Cellulase

Sesame straw is provided by Hengfeng Sesame Factory(Guangzhou, China). It was placed in an oven at 70°C and baked to constant weight over 24 h. The dried Sesame straw is then treated with a low

speed and high speed pulverizer, passed through a 100 mesh screen, and sealed and stored in a dry environment. Cellulase Ctec2 is provided by Novozymes (Denmark) and stored at 4°C.

2.2 Pretreatment

Sulfuric acid is used for acid pretreatment and sodium hydroxide for alkali pretreatment. A certain amount of Sesame straw was mixed at a solid-liquid ratio of 1:10.The chemical concentration (wt%) was set to added with 1,2,3,4% , and reacted at 121 °C for 1 hour.

After the acid/alkali pretreatment, the total reactants were transferred to a 50 mL centrifuge tube and spun at 6000 rpm for 10 minutes at room temperature. Then 2 mL of each supernatant was collected to measure the monosaccharide in the liquid. The solid residue is washed with deionized water in a centrifuge tube until the pH is neutral. The residue was dried at 75 ° C and used.

2.3 Enzymatic Hydrolysis

Sesame straw (0.5 ± 0.0005 g) was added to 25 mL of citric acid-trisodium citrate buffer (pH 4.8), CTec 2 (18 FPU). It was placed in an incubator at 50 °C and digested at 200 rpm for 84 h.The glucose concentration was measured by High Performance Liquid Chromatography (HPLC, Shimadzu, Japan), and the cellulose conversion rate was calculated according to the following formula.

3. Results and Discussion

3.1 Sesame straw compositions

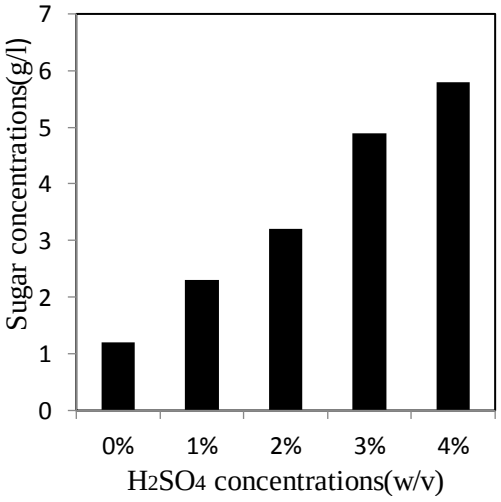
Our results indicate that the composition of the dried Sesame straw as follows: 38 wt % cellulose,15.2wt% hemicellulose,32.9wt% lignin, 9.3wt% ash, 4.6wt% uncharacterized residue,as shown in Fig. 1.

cellulose	hemicellulose	lignin	ash	uncharacterized remnant
38.00%	15.20%	32.90%	9.30%	4 .60%

Fig. 1. Sesame straw compositions

3.2 Release of sugar from sesame straw after acid pretreatment

After pretreatment of sesame straw with acid, the content of glucose produced by enzymatic hydrolysis for 84 hours is shown in Fig. 2. Different concentrations of glucose were obtained after pretreatment with different concentrations of sulfuric acid[8]. The concentration of glucose increased with increasing sulfuric acid concentration, reaching a maximum of 4.8 g/L.

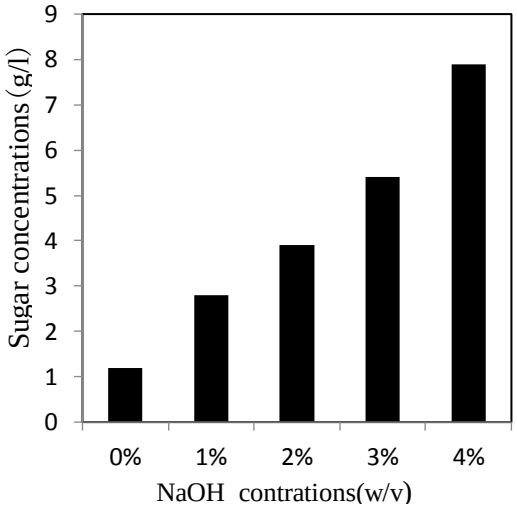


Figer.2 Effects of different H2SO4 concentrations on the suger concentrations

3.3 Release of sugar from sesame straw after NaOH pretreatment

After pretreatment of sesame straw with alkali, the content of glucose produced by enzymatic hydrolysis for 84 hours is shown in Fig.3.For the pretreatment of sodium hydroxide, the glucose concentration increased with the increase of alkali concentration, reaching a maximum of 7.9 g/L. It

can be seen from the figure that the alkali pretreatment effect is better than the acid pretreatment for the same concentration of acid and alkali. In the alkaline pretreatment method in which the sesame straw is soaked in an alkaline solution and then heated for a certain period of time, the voids can be swollen, thereby increasing the internal surface area of the raw material and lowering the degree of crystallinity and polymerization[9]. Usually, most of the lignin and some hemicellulose will dissolve in this process, promoting the binding area of cellulase to cellulose[10].



Figer.3 Effects of different NaOH concentrations on the suger concentrations

4. Conclusion

The composition of the sesame straw component was 38% by weight cellulose, 15.2% by weight hemicellulose, 32.9 wt% lignin, 9.3 wt% ash, and 4.6 wt% uncharacterized residue. The sesame straw was pretreated with different concentrations of acid/base. The results showed that the alkali pretreatment method obtained higher reducing sugar, reaching a maximum of 7.9 g/L. Sesame straw is one of the alternative raw materials used to produce bioethanol.

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