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Preparation and Properties of Hydrogel Based on Bacterial Cellulose from Kombucha Bacteria

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Abstract

In order to obtain the cellulose based gel of kombucha bacteria with excellent strength, adsorbability, water absorption and water retention, this experiment determined the excellent process of gel preparation by controlling the single factor condition. Kombucha bacterial cellulose was added to the polyvinyl alcohol solution, and the kombucha bacterial cellulose gel was prepared by freeze-thaw cycle.The molding, properties and stability of hydrogels are closely related to the amount of polyvinyl alcohol added, the amount of cellulose added by kombucha bacteria, the mixing time of polyvinyl alcohol solution, the crushing time of cellulose by kombucha bacteria, the freezing time of gel, etc. The results showed that the gel was the best prepared by adding 20 % kombucha bacterial fiber into 9 g polyvinyl alcohol solution and repeatedly freezing and thawing it three times.

Keywords

Kombucha bacterial cellulose; PVA; Hydrogel.

1. INTRODUCTION

The economy is developing rapidly, but the natural resources such as oil and water are increasingly depleted, coupled with human not saving and a variety of pollution behavior. Non-renewable resources and renewable resources are facing the serious situation of lack, but also lead to environmental problems are increasingly serious, worthy of people's attention. In order to meet the needs of human social life and ease the tension in the shortage of resources, the use of biodegradable new natural materials or modification of polymer, synthetic polymer as the substrate of the hydrogel become the hot area of research, focus on research hotspot at home and abroad, is a water-soluble and biocompatibility of bacterial cellulose hydrogel, and should be widely research Natural polymer hydrogels prepared by starch [1], cellulose [2], sodium alginate [3], and chitosan [4] and their derivatives are characterized by water solubility and biocompatibility, so they have attracted extensive attention in the fields of medicine, pharmacy, agriculture, forestry, horticulture, environmental governance and bioengineering [5-7]

Kombucha bacteria also known as "haibao" was mixed strains with sugar, tea and water, after fermentation generated a kind of beneficial substances to human body, its itself is acid, can inhibit the growth of the other miscellaneous bacterium, maintain the best condition. So the vendors is a kind of excellent strains, and is helpful to human body health. For example, it has a good the rapeutic effect on atrophic gastritis and gastric ulcer. In addition, it can regulate blood pressure, improve sleep and prevent and treat various diseases. Kombucha is rich in many

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vitamins, such as vitamin C and vitamin B, and also contains beneficial microbial flora for human body, so it can regulate human physiological function, promote metabolism, help digestion, prevent arteriosclerosis, fight cancer, keep healthy and strengthen health, and become a popular health drink all over the world. Kombucha is a kind of thin film, which will produce a white transparent and hard film on the surface of the medium during fermentation. This film is called bacterial cellulose. Due to various advantages of kombucha, we have carried out in-depth research on kombucha, and a new height of application and research of kombucha has arisen at present.

Polyvinyl alcohol (PVA) is a water-soluble polymer, which is a molecule obtained by hydrolysis of polyvinyl acetate. The main chain is carbon chain, and there is a hydroxyl group on each repeating unit. Because of the small molecular weight and strong polarity of hydroxyl group, it is easy to form hydrogen bonds. Therefore, PVA has many advantages such as good water solubility, film formation, bonding and emulsification, good oil resistance and solvent resistance [8-10]. In addition to the performance of general hydrogels, hydrogels also have a high degree of compatibility with human tissues, non-toxic, no side effects, no degradation, stable chemical properties, excellent mechanical properties, high water content and easy molding. Therefore, the research on polyvinyl alcohol hydrogels is a field that people have compared [11-15].

The raw material of this test is red tea bacterial cellulose, and polyvinyl alcohol is used as the matrix. The hydrogel is prepared by repeated freezing-thawing method and its performance is tested. The properties of the hydrogel are mainly tested by mechanics and infrared spectrum, so as to determine the best preparation process of the hydrogel.

2. EXPERIMENT

2.1. Culture of Bacterial Cellulose from Kombucha

The liquid medium according to the following Table 1, after waiting for liquid medium cooling in conical flask to scale, seal it in the conical flask with high pressure steam sterilization pot and pipette for sterilization, sterilization after cooling to room temperature after the completion of vaccination, early open super clean workbench for ultraviolet disinfection, complete the vendors vaccination in ultra clean workbench, After inoculation, the inoculum was sealed and placed in a constant temperature incubator for 7-10 days.

Table 1. Composition and ratio of liquid medium

Tea	Water	Agar	Glucose	Mannitol	Peptone	Yeast powder
1.5g	500ml	7.5g	11.25g	12.5g	1.5g	2.5g

2.2. Preparation of bacterial cellulose solution of Kombucha

Take out the bacterial cellulose of kombucha bacteria from the cultured conical flask, first wash it twice with distilled water, soak it in a beaker containing 1% sodium hydroxide solution, put the beaker in a constant temperature water bath at 75℃ for 2 h, wash it twice with distilled water after taking it out, and blot the water on the surface of the bacterial cellulose of kombucha bacteria with filter paper. Weigh a certain quality of saffellia bacterial cellulose into a 50 mL beaker, cut the saffellia bacterial cellulose into pieces with scissors, seal it, and then put it into the ultrasonic cell crusher for crushing, 1200 W for one hour. After taking out and cooling, the bacterial cellulose solution of kombucha fungus was obtained.

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2.3. Screening of Bacterial Cellulose Dosage of Kombucha

Add 10%, 20%, 40% kombucha bacterial cellulose to the PVA solution, put it in a magnetic stirrer heated at a constant temperature, stir it at 95℃ for 8 h, and then put it in a constant temperature water bath at 80℃ for 24 h. After taking it out, a uniform transparent solution with a concentration is formed into six holes formed in the cells in a petri dish of about 1.5 cm high level, after being ready and cooling puts cell cultures smoothly - 20℃ refrigerator frozen 8 h, is put in the freezer -4℃ after 6 hours, this is a cycle, repeat this cycle three times, namely get vendors bacterial cellulose hydrogel for testing.

2.4. Mechanical Testing and FTIR

Put 50 g on the top of the prepared hydrogel sample, observe its deformation state and resilience, and judge its strength and toughness. The advantages and disadvantages of hydrogels were analyzed and judged by macroscopic observation.

A certain amount of freeze-dried hydrogel samples and KBr powder were mixed and ground evenly in an agate mortar and then pressed into tablets. The infrared spectrum of the samples was obtained by FTIR infrared spectrum scanning. The scanning wavelength range is 400~4000 cm^{-1}.

3. RESULTS AND ANALYSIS

3.1. Effect of Bacterial Cellulose Content on Mechanical Properties of hydrogel

Different vendors join content of polyvinyl alcohol solution will also affect the preparation of hydrogels, see from Figure 1, preparation of hydrogel in 8 g PVA solution, after repeated freezing - thawing three times, add 10% vendors of the preparation of bacterial cellulose hydrogel has milk-white, a hard, elastic is not very strong, resilience is very weak; The hydrogel prepared by adding 20% kombucha bacterial cellulose was permeable, with strong texture and elasticity and strong resilience. The hydrogel prepared by adding 40% camellia bacterial cellulose is milky white, hard in texture, not very elastic, and the recovery elasticity is very weak.

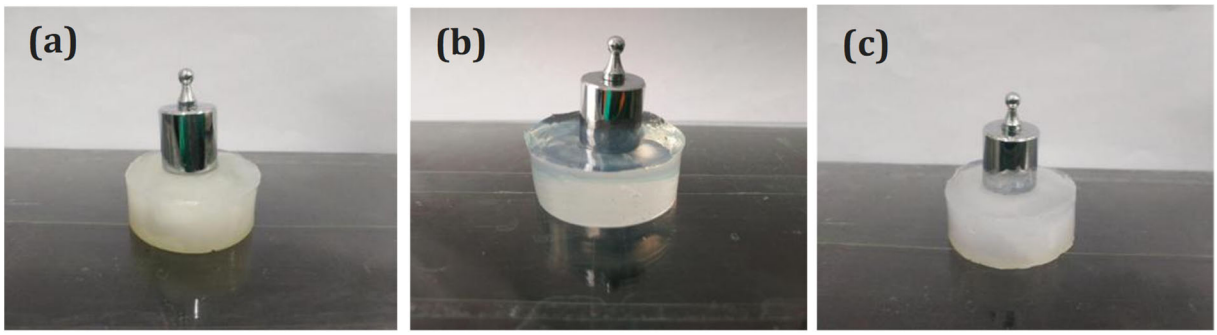

Figure 1. Mechanical properties of hydrogels prepared by adding 10% bacterial cellulose to solutions with different PVA content (a: 8 g PVA, b: 9 g PVA, and c: 10 g PVA)

It can be seen from Figure 2 that the hydrogel prepared in 9g PVA solution is milky white, soft in texture, weak in elasticity and weak in rebound force after three times of repeated freezing and thawing, and the hydrogel prepared by adding 10% kombulea bacterial cellulose is weak in elasticity. The weight will sag greatly when put on it. The hydrogel prepared by adding 20% kombucha bacterial cellulose was milky white, with strong texture and elasticity, and strong resilience. The hydrogel prepared by adding 40% kombucha bacterial cellulose is milky white, hard in texture, not very elastic, and the recovery elasticity is very weak.

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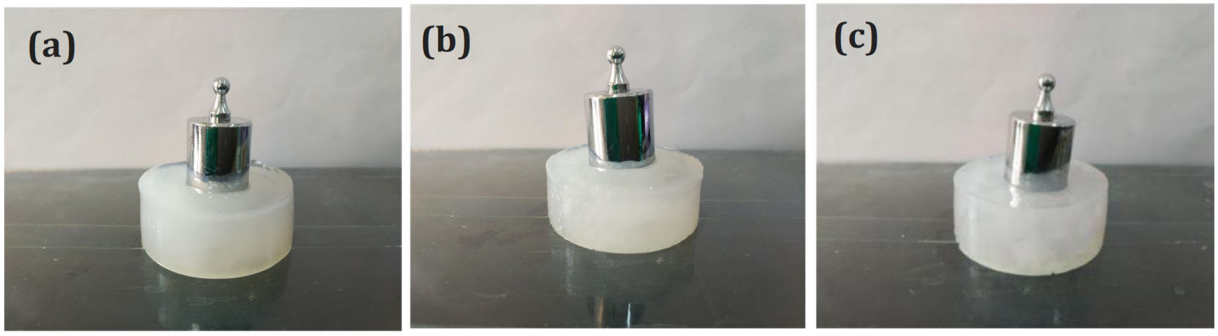

Figure 2. Mechanical properties of hydrogels prepared by adding 20% bacterial cellulose to solutions with different PVA content (a: 8 g PVA, b: 9 g PVA, and c: 10 g PVA)

It can be seen from Figure 3 that the hydrogel prepared in 10 g PVA solution is transparent, hard in texture, not very elastic and weak in resilience after repeated freeze-thawing for three times by adding 10% kombucamilla bacterial cellulose. The hydrogel prepared by adding 20% kombucha bacterial cellulose was transparent, with weak texture and elasticity, and not very strong resilience. The hydrogel prepared by adding 40% kombucha bacterial cellulose is transparent, hard in texture, not very elastic, and the recovery elasticity is very weak. Therefore, it can be seen that the gel prepared by adding 20% kombucha bacterial cellulose in 9g polyvinyl alcohol solution has certain strength, elasticity and transparency.

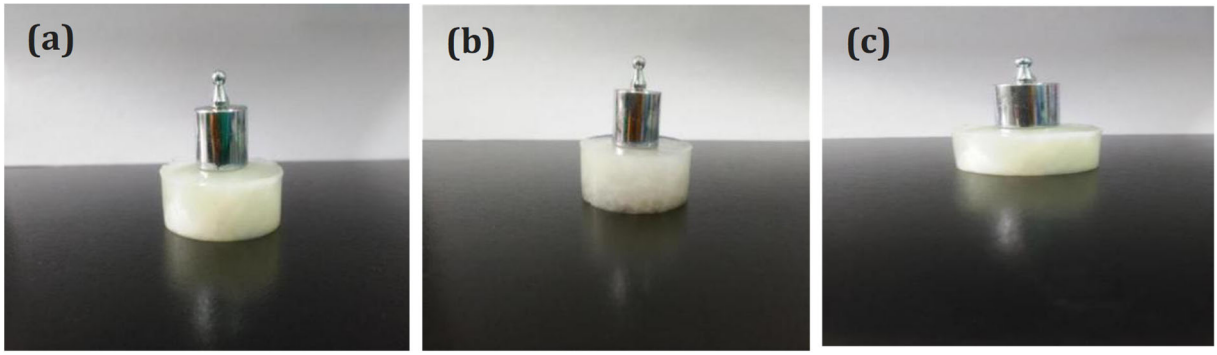

Figure 3. Mechanical properties of hydrogels prepared by adding 40% bacterial cellulose to solutions with different PVA content (a: 8 g PVA, b: 9 g PVA, and c: 10 g PVA)

When the bacterial cellulose of kombucha bacteria is added too little, the prepared hydrogel may be soft in texture and not good in molding, or the prepared hydrogel may be hard in texture and not good in elasticity. When the bacterial cellulose of komcha bacteria is added too much, the hydrogel prepared is hard and has poor elastic properties. Therefore, it can be concluded that when the number of freezing-thawing times of the PVA content is the same, the hydrogel prepared by adding 20% bacterial cellulose of Komcha bacteria has the best properties and texture.

3.2. FTIR of Hydrogel Based on Bacterial Cellulose from Kombucha Bacteria

The spectral lines in Figure 4 are respectively FTIR of PVA, bacteria cellulose powder, bacteria cellulose hydrogel. In the pure PVA solid spectral line, the wave number 3300 cm^{-1} corresponds to the hydroxyl asymmetric stretching vibration peak 1130 cm^{-1}. There are C-H stretching and bending vibration peaks at 1422 cm^{-1} and 2938cm^{-1}, and the double absorption band is generated at 1422cm^{-1}.

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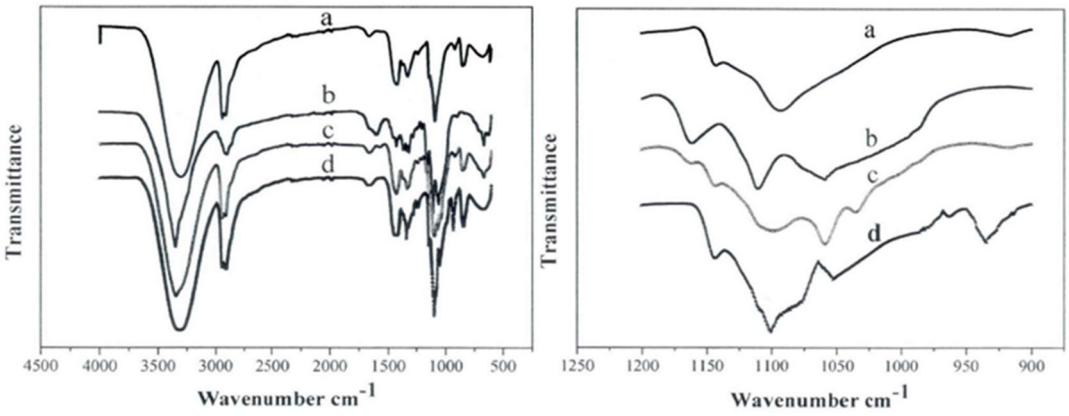

Figure 4. FTIR Spectrogram of PVA (a), bacteria cellulose powder (b), and aerogel prepared with different PVA content (c: 8 g PVA and d: 10 g PVA)

As shown in Figure 4-a, the wave number 3300cm^{-1} in the solid spectral line of pure polyvinyl alcohol corresponds to the asymmetric stretching vibration peak of hydroxyl group. There are C-H stretching and bending vibration peaks at 1130 cm^{-1}, 1422 cm^{-1} and 2938 cm^{-1}, and the double absorption band is generated at 1422 cm^{-1}.

4. CONCLUSION

1) The gel prepared when the content of PVA is too high has poor elasticity and poor resilience.

2) The hydrogel prepared by adding 20% kombucha bacterial cellulose is permeable, with strong texture and elasticity and strong resilience.

3) The best condition of preparation process as follows: 9 g PVA of adding 20% bacterial cellulose. In this under the optimum process conditions, the hydrogel has a good elastic performance and good strength properties.

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