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Powder Adsorption Characteristics of Antibacterial Bamboo Charcoal during Enhancing Activity against Bacteria Transmit

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Bacteria often floated in mid air, was inhaled in vivo, and could cause diseases. And adsorption properties of bamboo charcoal was not strong. Therefore, in order to enhanced adsorption and antibacterial effect, bamboo charcoal were pretreated by two silt and were analyzed by FT-IR. The results showed that VS's and IS's adsorption capacity were different for 0.5h, 1h, 1.5h, 2h, 2.5h, 3h, 3.5h, 4h, 4.5h, 5h, respectively. The optimal blast time were 2.5hof VS, and 0.5h of IS. Bamboo charcoal had the five characteristic absorption band during adsorption of VS and IS. S-S stretch, H_2O stretch, O H stretch, C=O or C=C stretch, N–O or C=C stretch were observed at 3850 cm^{-1}, 3730 cm^{-1}, 3430 cm^{-1}, 1660 cm^{-1}, 1520cm^{-1}, respectively. The transmissivity of IS's peaks at 3850 cm^{-1}, 3730 cm^{-1}, 1660 cm^{-1}, and 1520cm^{-1} achieved the maximum for 3.0h, and the transmissivity of the peaks at 3430cm^{-1} achieved the maximum for 1.0h. and the transmissivity of the VS's peaks at 3850 cm^{-1}, 3730 cm^{-1}, 1660 cm^{-1}, and 1520cm^{-1} achieved the maximum for 1.0h, and the transmissivity of the peaks at 3430cm^{-1} achieved the maximum for 4.5h. It provided the theory to enhance antibacterial activity od bamboo charcoal against bacteria transmit.

Key words: Antibacterial activity; Bamboo charcoal; Bacteria transmit; Industrial silt; Vital silt**.**

Bacteria, which were a large domain of prokaryotic microorganisms, were among the first life forms to appear on Earth, and were present in most of its habitats. Bacteria inhabited water, soil, radioactive waste, acidic hot springs, and the deep portions of Earth's crust[1]. Bacteria also lived in symbiotic and parasitic relationships with animals and plants. There were typically 40 million bacterial cells in a gram of soil, and a million bacterial cells in a milliliter of fresh water. Bacteria were vital in recycling nutrients, with many stages in nutrient cycles dependent on these organisms. Most bacteria hadn't yet been characterized, and only about half of the phyla of bacteria have species that could be grown in the laboratory[2]. There were about 10 times as many bacterial cells in the human flora as there were human cells in the body, with the largest number of the human flora being in the gut flora, and a large number on the skin[3]. The vast majority of bacteria in body were rendered harmless by the protective effects of immune system, and some are beneficial. However, several species of bacteria were pathogenic and cause infectious diseases, including cholera, anthrax, leprosy, syphilis, and bubonic plague. The most common fatal bacterial diseases were respiratory infections, with tuberculosis alone killing about 2,000,000 people per year, mostly in sub-Saharan Africa[4]. Bacteria often floated in mid air. If bacteria was inhaled in vivo, it could cause diseases.

Bamboo charcoal was created by heating bamboo at temperatures of 600-900ºC and then the charcoal itself was processed and mixed in with

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fabrics as part of the growing field of nanotechnology[5-16]. Bamboo charcoal had the many positive qualities[5-7]. The fabric inhibited bacterial metabolism causing fewer allergic skin reactions than other fibers sterilized with antimicrobial agents. Because the trait was due to the highly porous structure of the bamboo fabric, it could absorb sulfur-based compounds, nitrogen-based compounds and so on[6-12]. What's more, bamboo charcoal, which contained potassium, calcium and other minerals, could have adsorption and filtration of extractives, oil, other matters[17-28]. That was beneficial for people's health. However, adsorption properties of bamboo charcoal was not strong. Therefore, in order to enhanced adsorption and antibacterial effect, bamboo charcoal were pretreated by two silt and were analyzed by FT-IR.

MATERIALS AND METHODS

Bamboo charcoal was purchased from the market. The industrial silt (IS) was the waste water tank from the Industrial Park. The vital silt (VS) was the waste water tank in rural areas. IS and VS were dried and crushed into powder.

Adsorption

Two silt powder were weighed 25g, respectively. These powder and 30g bamboo charcoal were put into the closed vessel, respectively. It was blasted in closed vessel for 0.5h, 1h, 1.5h, 2h, 2.5h, 3h, 3.5h, 4h, 4.5h, 5h, respectively. Each bamboo charcoal was removed, dried, weighed, respectively.

FT-IR spectra

FT-IR spectra of the above samples were obtained using a Thermo Scientific Nicolet iN10 FT-IR microscope as previously[29-32].

Result and Analysis

Based on the above test, the result of adsorption were obtained and listed in Table 1.

SC Effect

Based on Table 1, IS's adsorption capacity was 1.12 g/100g, 0.54 g/100g, 0.43 g/100g, 0.31 g/100g, 0.3 g/100g, 0.76 g/100g, 0.78 g/100g, 1.02 g/100g, 0.98 g/100g, 0.99 g/100g; VS's adsorption capacity was 0.55 g/100g, 0.38 g/100g, 0.52 g/100g, 0.39 g/100g, 1.57 g/100g, 0.43 g/100g, 1.45 g/100g, 0.76 g/100g, 1.01 g/100g, 1.16 g/100g for blast time of 0.5h, 1h, 1.5h, 2h, 2.5h, 3h, 3.5h, 4h, 4.5h, 5h, respectively. It showed that adsorption capacity changed at regularity difference. It might be because rapid stirring leaded to a small amount of silt on the surface of bamboo charcoal. The optimal blast time were 2.5hof VS, and 0.5h of IS.

FT-IR analysis

FT-IR spectra were recorded to investigate the functional groups of bamboo charcoal during adsorption of IS and VS. Spectra of the samples were shown in supporting information Figure 1. In the spectrum of adsorption, the S-S stretch, H_2O stretch, O H stretch, C=O or C=C stretch, N–O or C=C stretch were observed at 3850 cm^{1}, 3730 cm^{1}, 3430 cm^{1}, 1660 cm^{1}, 1520cm^{1}, respectively(listed in Table 2) [30-34]. Comprehensive comparison of the transmissivity of the peaks of VS and IS (Table 2), for the peak at

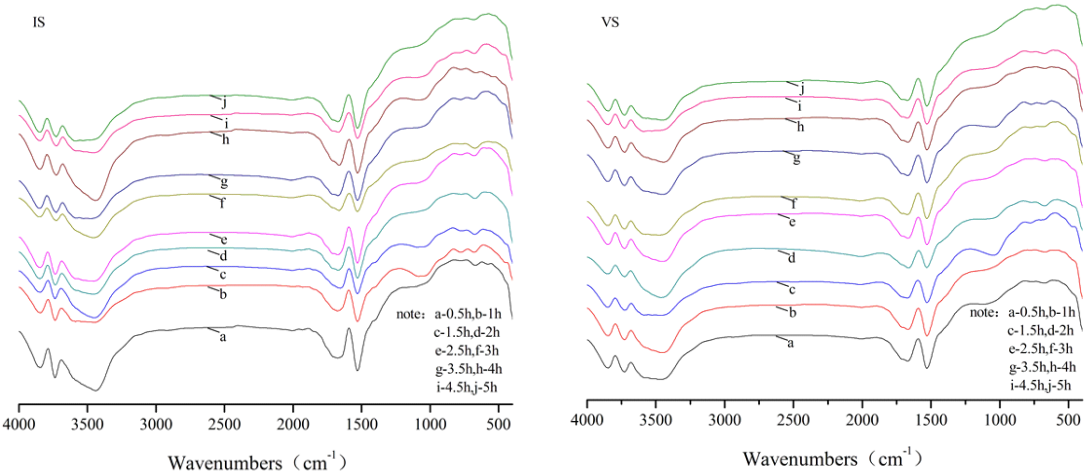

Fig. 2. FT-IR spectra of bamboo charcoal during adsorption of VS and IS

Table 1. Adsorption results

Blast time[h]	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
IS	1.12	0.54	0.43	0.31	0.3	0.76	0.78	1.02	0.98	0.99
VS	0.55	0.38	0.52	0.39	1.57	0.43	1.45	0.76	1.01	1.16

Table 2. Group attribution of bamboo charcoal during adsorption of VS and IS (%)

Kind	Peak (cm^{-1})	Adsorption time (%)										Group
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	
IS	1520	78.1	79.6	83.2	82.1	81.9	85.8	83.8	77.9	82.7	81.4	N–O or C=C
	1660	81.7	82.6	84.6	84.2	84.2	85.7	84.7	79.6	84.1	82.7	C=O or C=C
	3430	71.7	79.2	75.6	77.0	76.2	77.6	78.2	69.1	78.1	77.7	OH stretch
	3730	75.2	79.3	81.2	79.3	77.6	82.9	80.0	77.3	80.4	78.6	H_2O
	3850	78.5	81.9	83.2	81.8	80.4	83.7	80.8	78.5	81.6	79.5	S-S stretch
VS	1520	79.3	91.5	83.3	86.0	79.5	83.5	79.5	78.7	81.3	81.4	N–O or C=C
	1660	81.2	89.8	84.5	85.2	81.2	84.2	81.5	81.0	83.0	82.9	C=O or C=C
	3430	74.9	77.3	78.3	74.6	73.0	77.2	74.8	73.8	78.9	75.8	OH stretch
	3730	77.8	89.7	80.6	82.4	78.0	79.3	78.3	77.8	79.7	77.8	H_2O
	3850	78.8	89.5	80.9	83.0	79.1	80.1	79.4	78.9	80.6	79.0	S-S stretch

1520cm^{-1}, the transmissivity of IS were lower for 0.5h, 1h, 1.5h, 2h, and 4h; for the peak at 1660cm^{-1}, the transmissivity of IS were lower for 1h, 2h, 4h and 5h; for the peak at 3430cm^{-1}, the transmissivity of IS were lower for 0.5h, 1.5h, 4.5h, and 4h; for the peak at 3730cm^{-1}, the transmissivity of IS were lower for 0.5h, 1h, 2h, 2.5h, and 4h; for the peak at 1520cm^{-1}, the transmissivity of IS were lower for 0.5h, 1h, 2h, and 4h. For FT-IR spectra of IS, the transmissivity of the peaks at 3850 cm^{1}, 3730 cm^{1}, 1660 cm^{1}, and 1520cm^{1} achieved the maximum for 3.0h, and the transmissivity of the peaks at 3430cm^{1} achieved the maximum for 1.0h. For FT-IR spectra of VS, the transmissivity of the peaks at 3850 cm^{1}, 3730 cm^{1}, 1660 cm^{1}, and 1520cm^{1} achieved the maximum for 1.0h, and the transmissivity of the peaks at 3430cm^{1} achieved the maximum for 4.5h.

VS's and IS's adsorption capacity were different for blast time of 0.5h, 1h, 1.5h, 2h, 2.5h, 3h, 3.5h, 4h, 4.5h, 5h, respectively. The optimal blast time were 2.5hof VS, and 0.5h of IS.

FT-IR spectra showed that bamboo charcoal had the five characteristic absorption band. And the S-S stretch, H_2O stretch, O H stretch, C=O or C=C stretch, N–O or C=C stretch were observed at 3850 cm^{1}, 3730 cm^{1}, 3430 cm^{1}, 1660 cm^{1}, 1520cm^{1}, respectively. For FT-IR spectra of IS, the transmissivity of the peaks at 3850 cm^{1}, 3730 cm^{1}, 1660 cm^{1}, and 1520cm^{1} achieved the maximum for 3.0h, and the transmissivity of the peaks at 3430cm^{1} achieved the maximum for 1.0h. For FT-IR spectra of VS, the transmissivity of the peaks at 3850 cm^{1}, 3730 cm^{1}, 1660 cm^{1}, and 1520cm^{1} achieved the maximum for 1.0h, and the transmissivity of the peaks at 3430cm^{1} achieved the maximum for 4.5h.

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