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STUDIUL ADSORBȚIEI BACTERIEI *BACILLUS SUBTILIS* ȘI A FUNGULUI *CANDIDA ALBICANS* PE ENTEROSORBENȚI DE ORIGINE VEGETALĂ DIFERITĂ

STUDY OF THE ADSORPTION OF *BACILLUS SUBTILIS* BACTERIA AND *CANDIDA ALBICANS* FUNGUS ON ENTEROSORBENTS OF DIFFERENT VEGETAL ORIGIN

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Rezumat. *Lucrarea prezintă rezultatele adsorbției bacteriei Bacillus subtilis și fungului Candida albicans pe enterosorbenți de diferită origine vegetală. Specia de bacterie a fost cultivată pe agar nutritiv și fungul pe agar Sabouraud pentru acumularea biomasei microbiene. În calitate de adsorbenți în experiențe au fost utilizate diferite fracții de: cărbune activ inițial din lemn de măr (630-800 μm), cărbune reactivat din lemn de măr (630-800 μm), cărbune activ din coji de caise (630-800 μm), cărbune din coji de nuc (800 μm - 2000 μm). Au fost stabilite curbe de calibrare pentru fiecare specie microbiană studiată. Soluțiile preparate au fost apoi puse în contact cu probe de cărbune activ cântărit în prealabil, aproximativ 100 mg fiecare. Densitățile optice ale probelor studiate au fost măsurate la o lungime de undă de 315 nm, ulterior fiind calculate concentrațiile de echilibru și valorile de adsorbție. Izotermele de adsorbție ale bacteriilor au fost măsurate după agitarea soluțiilor bacteriene de diferite concentrații inițiale cu adsorbanți carbonici timp de 2 ore la un agitator mecanic. Cele mai mari proprietăți de adsorbție au fost atestate pentru cărbunii activi din lemn de măr, valorile fiind în intervalul 1,25-1,5 McF*10^8/g, ceea ce poate fi explicat prin faptul că acest adsorbant carbonic conține o cantitate mai mare de macropori.*
Cuvinte-cheie: *bacterie, fung, adsorbție, cărbune active, curbe de calibrare, macropori*

Abstract. *The paper presents the results of the adsorption of Bacillus subtilis bacteria and Candida albicans fungus on enterosorbents of different vegetal origin. The bacterial specia was grown on nutrient agar and the fungus on the Sabouraud agar for the accumulation of the microbial biomass. As adsorbents in the experiments were used different fractions of: initial activated carbon from apple wood (630-800 μm), reactivated carbon from apple wood (630-800 μm), activated carbon from apricot husks (630-800 μm), charcoal from walnut shells(800 μm - 2000 μm). Calibration curves were established for each microbial species studied. The prepared solutions were then contacted with pre-weighed activated carbon, approximately 100 mg each. The optical densities of the studied samples were measured at a wavelength of 315 nm, subsequently calculated the equilibrium concentrations and the adsorption values. Adsorption isotherms of bacteria were measured after stirring the bacterial solutions of different initial concentrations with carbon adsorbents for 2 hours at a mechanical stirrer. The highest adsorption properties were attested for the activated carbons from apple wood, the values being in the range of 1,25-1,5 McF*10^8/g that can be explained due to the fact that this carbon adsorbent has a larger amount of macropores.*
Keywords. *bacteria, fungus, adsorption, activated carbon, calibration curves, macropores*

Introduction

Activated carbons are complex and heterogeneous material made of wood nutshells, coal, etc. with unique adsorptive characteristics mainly influenced by the porous structure surface area and chemical structure of the surface [5]. Granular activated carbon (GAC) has a very large amount of adsorption surface area; approximately one gram of carbon has a pore surface area of 800 – 2500 m²

and this massive surface area gives it an exceptional ability to adsorb gases, liquids and many kinds of materials on to its surface. This high surface area permits the accumulation of a large number of contaminant [1]. Activated carbon has a high efficiency of adsorption depends on the pore size, the small pore size increased surface area of activated carbon and thus will increase its efficiency of adsorption.

The active carbon pores are classified into 4 classes depending on their size. Micropores have a diameter smaller than 0,6-0,7 nm, supermicropores have a diameter between 0,6-0,7 nm and 1,5-1,6 nm, mesopores have a diameter between 1,5-1,6 nm and 100-200 nm, macropores are larger than 100-200 nm in diameter [6]. Granular activated carbon filters are used as a final polishing step in drinking water treatment to remove compounds that are usually present in the water at high concentrations (algae toxins, microorganisms, pesticides, taste, odors and industrial micro pollutants) [2]. The use of activated carbon to remove pollutants from waters is widely extended, because of their high surface area micro porous character and the chemical nature of their surface [7]. The bacterial specia used in the study is a representative of gram-positive group. It occur naturally in soils, at a concentration of up to one million per gram, and are therefore some of the most common bacteria that can be grown in the soil. Also, because of the structure similarity with bacteria from other groups these specia can be used as test-models for the evaluation of the adsorptive properties of the activated carbon for bacteria from different specia [4]. The fungus specia used is one of the most common fungal pathogens of humans and causative agents of superficial and invasive candidiasis. Candida colonization is also associated with several intestinal diseases, including Crohn's disease and ulcerative colitis, and reducing the amount of the fungus reduces the severity of the disease. In addition, Candida species is an increasing problem in immunocompromised patients [3].

Thus, the aim of our studies was to investigate the adsorption processes of these microorganisms on activated carbons obtained from different raw materials.

Materials and methods

The study used 1 representative of the gram-positive bacteria such as: *Bacillus subtilis* and the fungus *Candida albicans*. The diameter of the bacteria and fungus studied in this work is between 1000-6000 nm. Based on this fact, we can state that the adsorption of bacteria and fungi will only take place in the macropores of carbonic adsorbents. The bacterial specia was grown on nutrient agar and the fungus on the Sabouraud agar for the accumulation of the microbial biomass.

In order to carry out research for microbial adsorption on activated carbons, solutions of these microorganisms with an optical density of 0,48 were prepared, in a tub with the length of 10 mm recorded on the КФК-2-УХЛ photo colorimeter 4,2 or 1,9 according to the McFarland index, determined by the DEN-1 densimeter (BIOSAN). 5, 10, 15, 50 ml of prepared microbial solution were placed in 10 vials, to which 45, 40, 35,5 ml of distilled water were added to dilute the initial prepared solutions. Subsequently, calibration curves were established for each microbial species studied. The prepared solutions were then contacted with pre-weighed activated carbon samples, approximately 100 mg each. After 90-120 min of contact, the optical densities were measured at a wavelength of 315 nm, of the studied samples, subsequently calculated the equilibrium concentrations and the adsorption values.

As adsorbents in the experiments were used different fractions of: initial activated carbon from apple wood (630-800 μm), reactivated carbon from apple wood (630-800 μm), activated carbon from apricot husks (630-800 μm), charcoal from walnut shells(800 μm - 2000 μm). 2.3. Adsorption

isotherms of bacteria were measured after stirring the bacterial solutions of different initial concentrations with carbon adsorbents for 1-2 hours at a mechanical stirrer with 150 rot/min. For this, 100 mg of adsorbent were passed into flasks of 150 mL. A 50 mL solution of bacteria of different initial concentrations was passed into each flask.The adsorption capacity values for the bacteria were determined by the expression: $a = (C_0 - C_e) \times V / m$ (1) where: a- represents the adsorption capacity of the adsorbent (McF*10^8/g); C_0 represents the initial concentration of the adsorbate (McF*10^8/L); C_e is the equilibrium concentration of the adsorbate (McF*10^8/L); V is the volume of the contact solution (L); m is the mass of the adsorbent (g).

Results and Discussion

The obtained results are presented in the table bellow:

Table 1. The adsorption of the studied microorganisms on different samples of activated carbons

Samples	Microorganisms/Adsorption values					
	B. subtilis			*C. albicans*		
	60 min	90 min	120 min	60 min	90 min	120 min
Initial activated carbon from apple wood (fraction 630-800 mkm)	0,39	0,45	0,5	0,52	0,57	0,6
Reactivated carbon from apple wood (fraction 630-800 mkm)	1,1	1,18	1,25	1,4	1,46	1,5
Activated carbon from apricot husks	0,4	0,5	0,48	0,9	0,96	1,07
Charcoal from walnut shells	0,75	0,8	0,9	0,63	0,74	0,85

As it can be seen from the table above for the bacteria *B. subtilis* the biggest adsorption properties presented the reactivated carbon from apple wood followed by the charcoals from walnut shells. The initial carbon from apple wood had the lowest adsorption properties. Regarding the *C.albicans* the highest adsorption properties also were attested for the reactivated carbon from apple wood, followed by activated carbon from apricot husks and the charcoals from walnut shells.

The highest adsorption properties attested for the charcoals from apple wood probably are due to the fact that this carbon adsorbent has a larger amount of macropores.

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