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Srpskog hemijskog društva**

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RADOVA  
KNJIGA RADOVA**

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## Adsorption of Congo Red as an indicator for the oxidized jute fabric's sorption properties

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This work aims to obtain jute fabrics with improved sorption properties that could be used as a novel solution for biodegraded land rehabilitation. For that purpose, raw jute fabric was oxidized with 0.4% sodium periodate ( $\text{NaIO}_4$ ), while the adsorption of textile dye Congo Red (CR) was used as an indicator for fabrics' sorption properties. The kinetic study revealed that fabric oxidized for 60 min reached equilibrium dye adsorption after 270 min, while in the case of jute oxidized for 120 min, the equilibrium was attained 30 min faster. This behavior is ascribed to the better availability and higher content of functional groups (capable of binding CR) within fabric oxidized for 120 min than within those oxidized for 60 min. The above-mentioned could be also used as an explanation for the 35 and 50% higher adsorption capacities of fabrics oxidized for 60 and 120 min compared to the raw fabric, respectively. With increasing the initial concentration of CR from 25 up to 100 mg  $\text{L}^{-1}$ , the equilibrium adsorption increased up to 2.6 times.

### Introduction

Over 40% of terrestrial ecosystems worldwide suffer from land degradation, a natural or human-influenced process that affects the functionality of the land. Biocrust carpet engineering has been proposed to fight land degradation and cyanobacteria as primary colonizers have been introduced as a potential solution. However, the rehabilitation takes a long time due to the lack of moisture during the initial phase. In this paper we prepared jute-based supports to provide the necessary water for the growth of the microbiota and to promote a sustainable relationship between microbiota and abiotic constituents in the degraded land surface. Namely, raw jute fabric was oxidized with 0.4% sodium periodate ( $\text{NaIO}_4$ ) for 60 or 120 min to improve fabric sorption properties, whereby the adsorption of CR was used as an indicator. This selective oxidation agent lead to the conversion of cellulose hydroxyl groups on C2 and C3 atoms to aldehydes, wherein the ring cleavage occurred and 2,3-dialdehyde cellulose was formed [1].

### Results and Discussion

#### Content of carboxyl (COOH) and aldehyde (CHO) groups in the jute fabrics

The oxidation of raw jute fabric with 0.4%  $\text{NaIO}_4$  for different times was performed to introduce new functional groups, and hence, to improve the fabric sorption properties. The

results listed in Table 1 indicated that oxidations for 60 and 120 min (fabrics JO60 and JO120) led to an increase in the aldehyde group content by 1.8 and 2.1 times, respectively. On the other hand, applied periodate oxidations did not affect the content of COOH groups, Table 1. Considering the increased total content of COOH and CHO groups after oxidations, it is reasonable to assume that oxidized jute fabrics have improved sorption properties. In light of that, adsorption of CR was used to evaluate the sorption properties of jute fabrics.

Table 1. Content of functional groups within the jute fabric

	RJ	JO60	JO120
COOH	0.169	0.171	0.173
CHO	0.185	0.326	0.397
COOH + CHO	0.354	0.497	0.570

### Effect of contact time on the adsorption of CR

A kinetic study was performed having in mind that, from the economic point of view, the contact time is the most important adsorption variable. According to the results presented in Figure 1, among all fabrics, RJ possessed the lowest adsorption capacity independently of the contact time, which is ascribed to the lowest availability and content of functional groups capable of binding CR, Table 1. After the oxidation with  $\text{NaIO}_4$ , the content of COOH and CHO groups increased, and therefore, the adsorption of CR increased. Fabric JO60 reached equilibrium adsorption of  $4.05 \text{ mg g}^{-1}$  after 270 min of contact time, while 30 min shorter adsorption time resulted in the highest adsorption ( $4.47 \text{ mg g}^{-1}$ ) of CR onto JO120.

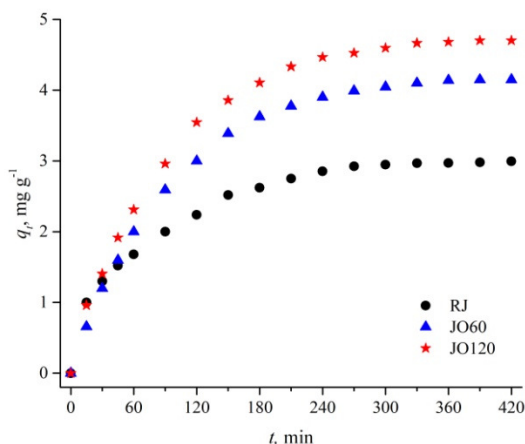


Figure 1. Effect of contact time on the CR adsorption onto jute fabric.

## The influence of initial CR concentration on the fabric adsorption efficiency

The initial dye concentration in the solution plays an important role in the content of dye adsorbed per gram adsorbent. The adsorption capacity of differently treated fabric samples for CR present at different initial concentrations (25-100 mg L<sup>-1</sup>) was investigated after a contact time of 270 min. From the results presented in Figure 2, it is evident that with increasing the initial concentration of CR from 25 to 100 mg L<sup>-1</sup>, the equilibrium adsorption ( $q_e$ ) increased by maximum of 2.6 times (JO120).

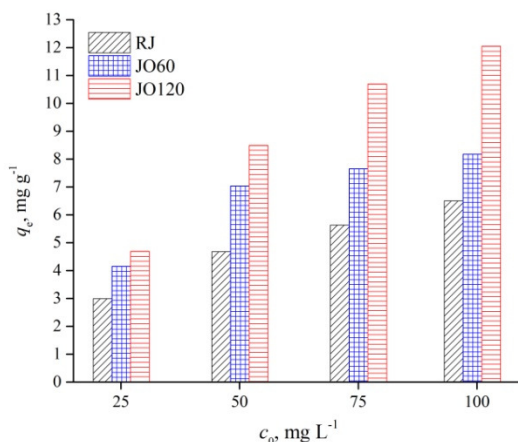


Figure 2. Effect of initial CR concentration on its adsorption onto jute fabrics.

## Experimental Part

### Adsorbents' Preparation and Characterization

The raw jute fabric (RJ) was oxidized with 0.4% sodium periodate (NaIO<sub>4</sub>) solution for 60 or 120 min (oxidized fabrics' codes: JO60 and JO120, respectively) according to the procedure given in the literature [1]. The content of carboxyl (COOH) and aldehyde groups (CHO) was determined using the calcium-acetate method previously described by Ivanovska et al. [2].

### Adsorption of CR

The adsorption experiments were carried out at a pH of 10.00 by varying the contact time and initial dye concentration at room temperature. A specimen of jute fabric (0.5 g) was immersed in 100 ml of CR solution containing 15 g L<sup>-1</sup> NaCl and constantly shaken. The concentration of CR in aqueous solution was determined based on the UV-Vis (Shimadzu 1700 spectrophotometer) absorbance spectra at  $\lambda_{\max} = 486$  nm.

## Adsorpcija Kongo crvenog kao indikatora sorpcionih svojstava oksidisane tkanine od jute

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Cilj ovog rada je dobijanje tkanine od jute sa poboljšanim sorpcionim svojstvima koja će se koristiti za rehabilitaciju degradiranog zemljišta. U tu svrhu, sirova tkanina jute oksidisana je 0,4% rastvora natrijum-perjodata ( $\text{NaIO}_4$ ), dok je adsorpcija tekstilne boje Kongo crvenog (CR) korišćena kao indikator sorpcionih svojstava. Kinetička istraživanja pokazala su da je tkanina oksidisana tokom 60 minuta dostigla ravnotežnu adsorpciju boje nakon 270 minuta, dok je u slučaju tkanine od jute oksidisane tokom 120 minuta ravnoteža postignuta 30 minuta brže. Ovakvo ponašanje posledica je bolje dostupnosti i većeg sadržaja funkcionalnih grupa (sposobnih da vežu CR) unutar tkanine oksidisane tokom 120 minuta u odnosu na tkaninu oksidisanu tokom 60 minuta. Navedeno bi se moglo koristiti i kao objašnjenje za 35 i 50% veće adsorpcione kapacitete uzoraka tkanine oksidisanih tokom 60 i 120 minuta u poređenju sa sirovom tkaninom, redosledno. Sa povećanjem početne koncentracije CR sa 25 na 100  $\text{mg L}^{-1}$ , ravnotežna adsorpcija se povećava do 2,6 puta.

1. A. Kramar, A. Ivanovska, M. Kostić, *Fiber Polym.* **2021**, 22, 2177.

2. A. Ivanovska, L. Pavun, B. Dojčinović, M. Kostić, *J Serb Chem Soc.* **2021**, 86, 885.

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