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# CHANGE IN pH AND CONDUCTIVITY DURING THE RINSING AND THE BIOSORPTION OF COPPER IONS ONTO PUMPKIN PEEL

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**ABSTRACT**

The changes in pH and conductivity during the rinsing of the pumpkin peel, and the biosorption of $Cu^{2+}$ ions, were the subject of this work. The obtained data showed that the pH value of the solutions increased during the rinsing of the biosorbent, as a result of the transfer of $H^+$ ions from the aqueous phase into the structure of the pumpkin peel. An increase in the conductivity value was observed in the initial period of rinsing the pumpkin peel, followed by a decrease. The increase in conductivity in the initial phase contributed to the self-leaching of the alkali and alkaline earth metal ions from the structure of the pumpkin peel, which were transferred into the aqueous phase. The further decrease in conductivity is a result of the dilution of the aqueous phase. The pH value decreased during the biosorption of $Cu^{2+}$ ions, as hydrogen ions were transferred from the pumpkin peel structure into the solution, and then exchanged with $Cu^{2+}$ ions. The conductivity value increased during the biosorption process, with a rapid increase in the initial period of 5 minutes, due to the transfer of alkali and alkaline earth metal ions into the solution.

**Keywords**: biosorption, pumpkin peel, pH, conductivity

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## 1. INTRODUCTION

Water pollution is one of the most significant problems facing the modern world. It is caused by the unselective discharge of various pollutants into bodies of water. One of the main causes of this problem is industry, which is responsible for the discharge of large quantities of toxic heavy metals into the environment. The rapidly growing development of industrial activities, including mining and metal processing industries, in the 21st century, has led to an increase in the amount of wastewater produced [1,2]. Heavy metals are treated on an industrial scale using conventional methods, such as chemical precipitation, cementation, ion exchange, solvent extraction, electro-extraction, reverse osmosis, etc [3]. However, these conventional methods also have disadvantages, such as: insufficient degree of metal removal, large amounts amounts of sludge and the need for further processing, high investment costs, etc. Biosorption has emerged as a potential alternative to conventional methods for wastewater treatment. Biosorption has been proven on the laboratory scale to be the most effective alternative to conventional methods of removing heavy metals from wastewater. It is an efficient and cost-effective alternative that allows the application of inexpensive and locally available biomaterials such as agricultural and industrial by-products, which have natural metal binding capabilities, as biosorbents. Biosorption can be described as the ability of the active sites present in the structure of biomaterials to bind heavy metals. The process of binding metal ions consists of many complex physicochemical processes, including ion exchange, complexation, electrostatic interactions, micro-deposition, and others [4,5].

## 2. EXPERIMENTAL

The pumpkin peel used as a biosorbent for the biosorption experiments was firstly ground and then sieved on a set of laboratory sieves. The fraction (-1+0.4) mm was used for further experiments. Before the biosorption experiments, the samples were rinsed with 400 mL of distilled water, to remove the physical impurities and free the active sites in the biosorbent structure.

The $Cu^{2+}$ solutions used for the biosorption experiments were prepared with $CuSO_4{\cdot}5H_2O$ (LACHEMA, Czech Republic). The pH and conductivity values were measured during the rinsing of the pumpkin peel samples.

The biosorption experiments were performed in a batch system. 1 g of the pumpkin peel sample was brought into contact with 50 mL $Cu^{2+}$ solutions, for different contact times. The pH and conductivity values were monitored during the biosorption process.

## 3. RESULTS AND DISCUSSION

### 3.1. Change in pH value during the rinsing of the pumpkin peel

Figure 1 shows the change in the pH of the aqueous phase during rinsing of the pumpkin peel sample. The sample was rinsed in 10 portions of 40 mL. The obtained results show that the pH value increases rapidly during rinsing with the first 80 mL, after which the increase continues, but at a slower rate. The increase in pH during rinsing of the biosorbent occurs due to the transfer of $H^+$ ions from the aqueous phase into the structure of the pumpkin peel sample, where they are exchanged with the alkali and alkaline earth metal ions. The $H^+$ concentrations were calculated from the obtained pH values, and the results showed that 0.00294 mmol $g^{-1}$ of $H^+$ ions were transferred into the pumpkin peel structure. This means that about 63 % of the $H^+$ ions were adsorbed during the rinsing of the pumpkin peel sample.

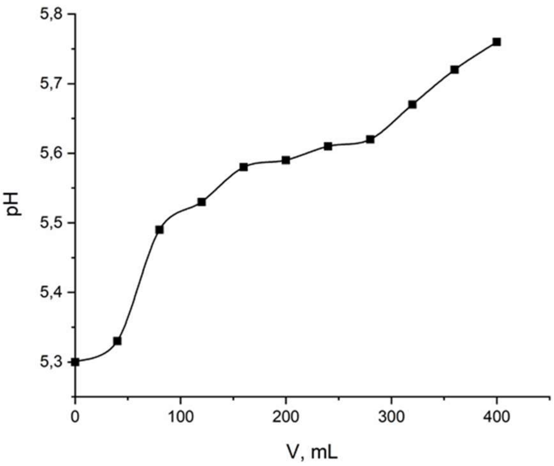


**Figure 1.** Change in pH value during the rinsing of the pumpkin peel sample

### 3.2. Change in conductivity during the rinsing of the pumpkin peel

The conductivity (k) of aqueous solutions indicates their ability to conduct electricity. The conductivity of aqueous solutions depends on the ions present, their concentration, mobility, and charge, as well as on the temperature at which it is determined [6].

The change in conductivity during rinsing of the biosorbent is shown in Figure 2. It can be seen that the conductivity increases in the first period, up to about 50 mL of passed distilled water, after which there is a decrease. The increase in conductivity in the first period occurs due to the transfer of alkali and alkaline earth metal ions from the pumpkin peel structure into the aqueous phase. The subsequent decrease in conductivity after the first period is the result of the decrease in the concentrations of alkali and alkaline earth metal ions, as the rinsate is diluted.

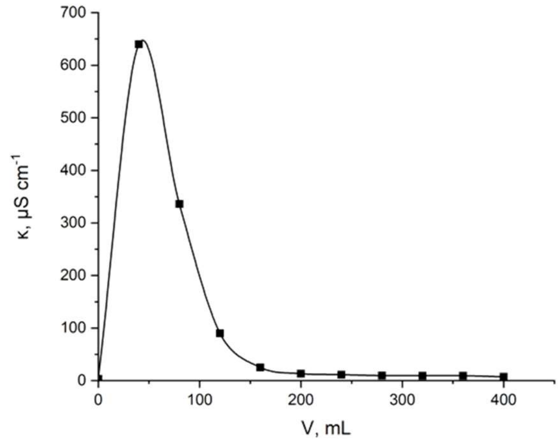


**Figure 2.** Change in conductivity during the rinsing of the pumpkin peel sample

### 3.3. Change in pH during the biosorption of $Cu^{2+}$ ions onto pumpkin peel

The change in pH of the solution during the biosorption of $Cu^{2+}$ ions using pumpkin peel as a biosorbent is shown in Figure 3. As can be seen, the pH of the solution decreases during the biosorption process, in contrast to the change of the same parameter during the rinsing of the biosorbent. It is hypothesised that the decrease in pH is observed due to the deprotonation of the functional groups in the pumpkin peel sample and the transfer of $H^+$ ions from the sample structure into the solution where they are exchanged with $Cu^{2+}$ ions.

### 3.4. Change in conductivity during the biosorption of Cu2+ ions onto pumpkin peel

Figure 4 shows the change in conductivity during the biosorption of copper ions using pumpkin peel as a biosorbent. It can be seen that the conductivity of the solution increases during the biosorption process. The rapid increase in conductivity is observed in the initial phase (first 5 minutes). This increase occurs due to the transfer of alkali and alkaline earth metal ions from the pumpkin peel structure into the aqueous phase.

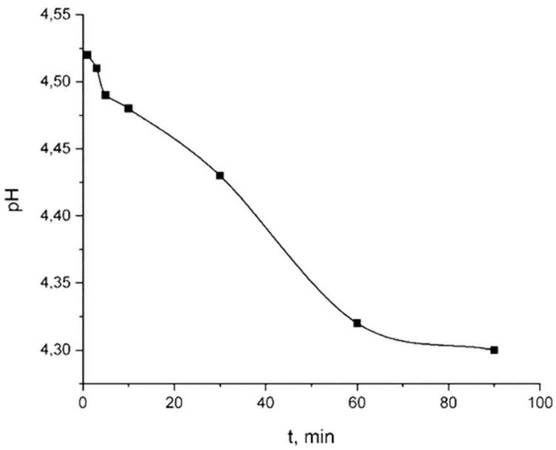


**Figure 3.** Change in pH value during the biosorption process

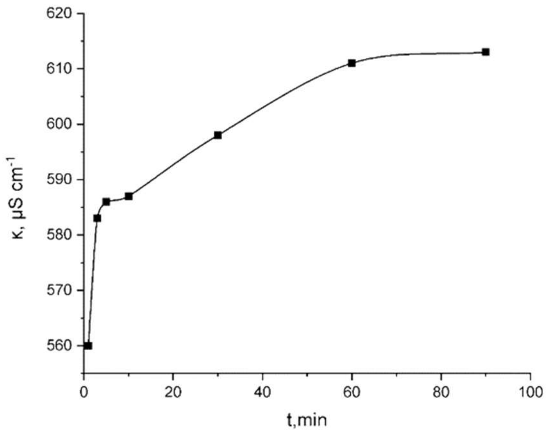


**Figure 4.** Change in conductivity during the biosorption process

## 4. CONCLUSIONS

The changes in pH and conductivity during the rinsing of the pumpkin peel and the biosorption of copper ions were monitored and presented in this paper. During the rinsing of the biosorbent, the pH of the solution increases due to the transfer of $H^+$ ions from the aqueous phase into the structure of the pumpkin peel. The conductivity of the solution initially increases until about 50 mL of distilled water has passed, where it reaches its maximum value. Further rinsing leads to a decrease in the conductivity of the solution. The increase in conductivity occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are transferred from the pumpkin peel structure to the aqueous phase. With further rinsing, the conductivity decreases as the concentration of these ions decreases due to the dilution of the solution. During the biosorption experiments, the pH decreases due to the deprotonation of the functional groups present in the pumpkin peel structure and the transfer of $H^+$ ions into the solution, where they are exchanged with copper ions. The conductivity of the solution increases during the biosorption process. This increase occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are exchanged with copper ions during the biosorption process.

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**Conflicts of Interest**
The authors declare no conflict of interest.

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