USE OF ACTIVATED CARBON FROM SUGAR SORGHUM AS A SORBENT FOR WATER PURIFICATION FROM HEAVY METALS

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Introduction. Water resource pollution is a global environmental problem that requires the development of effective purification methods and technologies. Under the current conditions of active military operations in Ukraine, the issue of water contamination has become particularly urgent. Among pollutants, heavy metals deserve special attention, as their entry into the human body has a highly negative impact on health.

One of the most widely used approaches to water purification is sorption using various sorbents. Filters containing quartz, kaolin, zeolite, ion-exchange resins, and other materials are employed for this purpose [1]. The most popular sorbent is activated carbon, which remains an indispensable tool for purifying drinking water. It is also widely used for treating industrial wastewater and process water in various enterprises [2].

Many companies are actively developing new technologies for producing carbon sorbents with improved physicochemical properties. Particular attention is paid to natural, environmentally friendly, and economically feasible sorbents obtained from secondary agricultural raw materials. Their use addresses two problems simultaneously: wastewater purification and waste utilization [3].

The **aim** of this study was to determine the adsorption capacity of natural carbon sorbent produced from sugar sorghum press cake for removing heavy metal ions from water.

Materials and methods. Model experiments were carried out to assess the effectiveness of activated carbon from sugar sorghum press cake in removing Pb, Cd, Zn, and Mn ions from aqueous solutions. The raw material consisted of sugar sorghum stalk press cake left after juice extraction. The main structural components of the sorbent are cellulose and lignin, bound in biopolymer complexes.

Carbonization of the press cake was conducted at 800 °C in an inert argon atmosphere. To enhance adsorption capacity, the carbon was activated by oxidation in 25% nitric acid solution. This treatment increased the specific surface area to 2200 m^2/g, the pore volume to 1.12 cm^3/g, and resulted in an average pore size of 10.0 Å. These properties indicate a well-developed mesoporous structure with surface carboxyl and phenolic ionogenic groups (–COOH, –OH). Owing to its surface characteristics and ion-exchange functional groups, this sorbent is expected to be effective for binding high-molecular compounds and heavy metal ions [4].

The sorption properties were studied under static conditions. A portion of 0.1 g of sorbent was added to 100 ml of aqueous metal solutions with concentrations of 0.05, 0.5, and 1.0 mg/l. The suspensions were shaken for 2 h and left to stand for 24 h at 25 °C. The sorbent was then removed by filtration, and metal concentrations in the filtrate were determined at the start and after 24 h using inductively coupled plasma atomic emission spectroscopy (ICP-AES) with an Optima 2100 DV spectrometer (PerkinElmer, USA) [5].

Adsorption capacity was calculated using the formula (1) and sorption efficiency by the formula (2) :

$$q_e = \frac{(C_0 - C_e) \times V}{M} \ (1) \ \text{and} \ E = \frac{(C_0 - C_e) \times 100\%}{C_0} \ (2)$$

where:
q_e – adsorption capacity (mg/g);
E- sorption efficiency
C_0 and C_e – initial and equilibrium metal concentrations(mg/l);
V – solution volume(l);
M – sorbent mass(g).

Results. Analysis of metal concentrations before and after sorption showed that the adsorption capacity of sugar sorghum carbon varied for different metals. For Pb ions, the adsorption capacity was 0.03, 0.46, and 0.89 mg/g at initial concentrations of 0.05, 0.5, and 1.0 mg/l, respectively. For Zn, the corresponding values were 0.008, 0.32, and 0.63 mg/g; for Cd – 0.035, 0.20, and 0.39 mg/g; and for Mn – 0.015, 0.28, and 0.37 mg/g (Fig. 1).

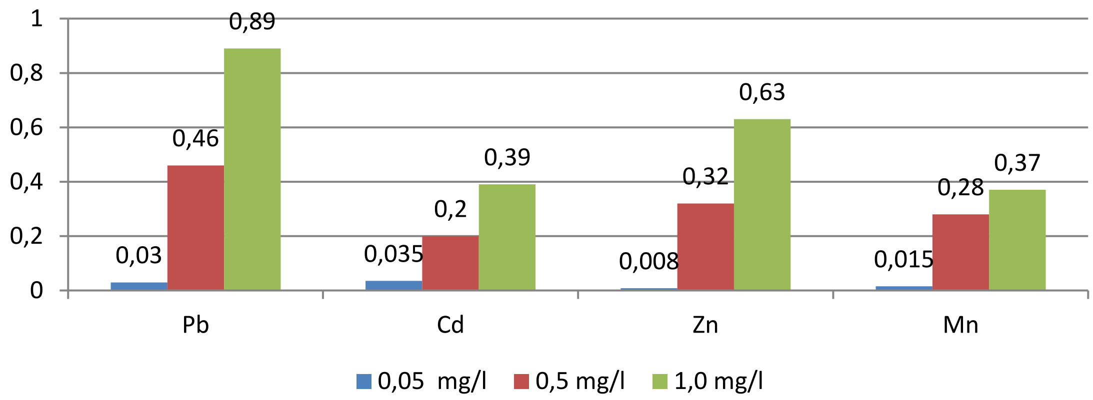

Fig. 1. Adsorption capacity (mg/g) of activated carbon from sugar sorghum press cake after 24 h incubation with metal solutions.

The calculated sorption efficiency of Pb ions was 72.0%, 79.3%, and 78.0% at the respective concentrations. For Cd ions, the efficiency was 53.8%, 36.4%, and 35.8%, while for Zn ions it reached 18.6%, 74.2%, and 54.3%. The lowest sorption efficiency was observed for Mn ions, amounting to 30.0%, 43.8%, and 30.0% (Fig. 2).

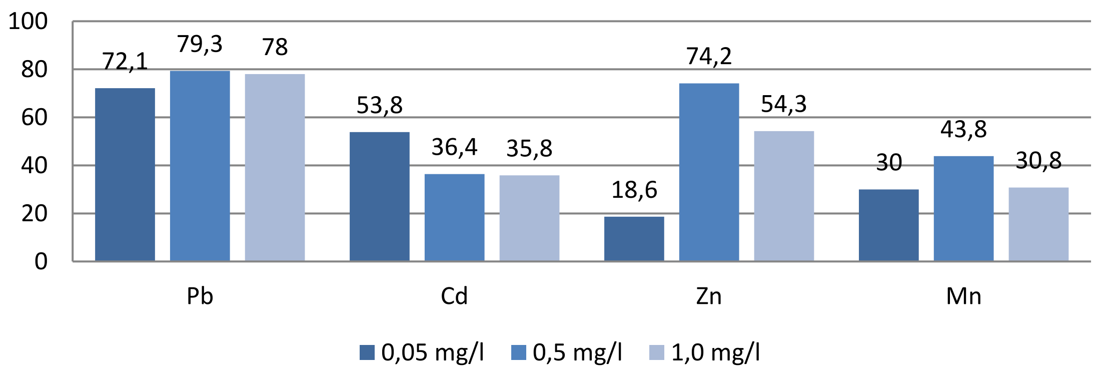

Fig.2. Adsorption efficiency of activated carbon from sugar sorghum press cake for metal ions after 24 h incubation

Conclusions. The results show that activated carbon produced from sugar sorghum press cake demonstrates the highest sorption activity toward Pb ions. This is explained by their stronger affinity for active surface groups (–OH, –COOH) compared to other metals. Considering that this sorbent is natural, environmentally safe, and simple to produce from agricultural waste, it represents a promising material for water purification from hazardous heavy metals, especially lead.

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CHANGES IN NITROGEN AND PHOSPHORUS CONTENTS IN THE WATERS OF LAKE PIASECZNO AS INDICATORS OF ANTHROPOPRESSURE ON THE AQUATIC ENVIRONMENT

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Nutrient pollution, primarily involving nitrate (V) and phosphate (V) ions and resulting from agricultural intensification, has become one of the main drivers of eutrophication in aquatic ecosystems. An imbalance often occurs between the influx of nutrients into aquatic systems and the resulting increase in biomass. This phenomenon is particularly evident in lakes, where limited water exchange and low flow rates promote eutrophic conditions. This leads to anaerobic decomposition processes, which disrupts biological activity in the aquatic environment. The aim of this study was to evaluate the degree of eutrophication in Lake Piaseczno (Łęczyńsko-Włodawskie Lake District, Eastern Poland) based on nitrate and phosphate concentrations in the littoral zone.

Lake Piaseczno, located in the southern part of the Łęczna-Włodawa Lake District in eastern Poland, covers approximately 84 hectares and has a maximum depth of about 39 meters. Its catchment area is relatively small and flat, encompassing around 240 hectares. The majority of the catchment is covered by podzolic soils composed of sand, which are characterized by low fertility and sorption capacity; peat soils have formed in the northern section, originating from fen habitats adjacent to the lake. Based on land use, the lake's basin is conventionally subdivided into three