DETERMINATION OF IODINE NUMBER OF HYDROCHAR FROM PLATANUS ORIENTALIS LEAVES USING ULTRAVIOLET–VISIBLE SPECTROSCOPY

Sultanov Bekhzad Sardorovich
PhD student, Fergana State Technical University
Assistant, Fergana Medical Institute of Public Health
bekhzodintil@mail.ru

Abstract: This study determined the iodine number of hydrochar from *Platanus orientalis* leaves via hydrothermal carbonization (HTC). Twelve samples were produced under varying conditions: 180-240°C in distilled water, 0.05 M, and 0.1 M citric acid solutions. Using a modified UV-Vis spectroscopy protocol (adapted from ASTM D4607-14) for rapid microporosity assessment, results show that higher HTC temperatures and increased citric acid concentrations enhanced the hydrochar's iodine number, indicating improved microporous structure and potential for water purification.

Keywords: Adsorption, hydrothermal carbonization, *Platanus orientalis*, biochar, iodine number, UV-Vis spectroscopy, microporosity.

Annotatsiya: Ushbu tadqiqotda *Platanus orientalis* barglaridan gidrotermal karbonizatsiya (HTC) orqali sintez qilingan gidroko'mirning yod soni aniqlandi. O'n ikki namuna turli sharoitlarda: 180-240°C haroratda distillangan suvda, 0.05 M va 0.1 M limon kislotasi eritmalarida ishlab chiqarildi. Mikrog'ovaklikni tezkor baholash uchun o'zgartirilgan UV-Vis spektroskopiya protokoli (ASTM D4607-14 dan moslashtirilgan) qo'llanildi. Natijalar shuni ko'rsatdiki, yuqori HTC haroratlari va limon kislotasi konsentratsiyasining oshishi gidroko'mirning yod sonini yaxshiladi, bu esa mikrog'ovaklik tuzilishining yaxshilanganini va suvni tozalash jarayonlarida qo'llash salohiyatini ko'rsatadi.

Kalit so‘zlar: Adsorbsiya, gidrotermal karbonizatsiya, *Platanus orientalis*, bioko'mir, yod soni, UV-Vis spektroskopiyasi, mikrog'ovaklik.

Аннотация: В данном исследовании определялось йодное число гидроугля, синтезированного из листьев *Platanus orientalis* методом гидротермальной карбонизации (ГТК). Двенадцать образцов были получены в различных условиях: при температурах 180-240°C в дистиллированной воде, а также в растворах лимонной кислоты концентрацией 0.05 М и 0.1 М. Используя модифицированный протокол УФ-Вид спектроскопии (адаптированный из ASTM D4607-14) для быстрой оценки микропористости, результаты показали, что повышение температур ГТК и увеличение концентрации лимонной кислоты улучшают йодное число гидроугля, что указывает на

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улучшение микропористой структуры и потенциал для применения в процессах очистки воды.

Ключевые слова: Адсорбция, гидротермальная карбонизация, *Platanus orientalis*, биоуголь, йодное число, УФ-Вид спектроскопия, микропористость.

Introduction. The growing interest in renewable and sustainable materials for water purification has sparked considerable research into biochar and hydrochar derived from biomass. One promising raw material is the leaf biomass of *Platanus orientalis*, a deciduous tree widely available in urban areas such as Fergana city, Uzbekistan. Leaf litter from this species, commonly considered waste, can be converted into value-added sorbents through hydrothermal carbonization (HTC) [1].

The efficiency of such carbon-based materials in adsorption applications is often assessed using the iodine number, which reflects micropore development and surface area [2]. Prior studies have shown that the type of biomass, processing temperature, and chemical activation conditions strongly affect the adsorption capacity [1,3-4]. Recent work highlights the value of agricultural waste utilization in energy and environmental applications, including biogas and water treatment [5]. In parallel, spectrophotometric methods such as UV–Vis spectroscopy offer precise and efficient alternatives for iodine quantification [6]. Moreover, understanding water quality parameters such as total dissolved solids is essential for correlating sorbent efficiency with environmental conditions [7].

This study investigates the iodine number of hydrochar synthesized from Platanus orientalis leaves via HTC at different temperatures and media. It also demonstrates the feasibility of UV–Vis spectroscopy in quantifying iodine adsorption in accordance with ASTM D4607-14 guidelines..

Materials and Methods.

Feedstock Preparation. Dried leaves of *P. orientalis* were collected from Fergana City. The leaves were ground to a fine powder and thoroughly washed with distilled water to remove decomposed organic residues. After washing, they were oven-dried at 105 °C for 12 hours. A 5 g portion of this raw material (not hydrothermally treated) yielded an iodine number of 205 mg/g, serving as a baseline for comparison..

Hydrothermal Treatment. Biochar samples were synthesized at 180 °C, 200 °C, 220 °C, and 240 °C in a polypropiolactone-lined stainless-steel autoclave. For each temperature, three reaction media were used: Medium A: 20 mL distilled water, Medium B: 10 mL water + 10 mL of 0.05 M citric acid, and Medium C: 10 mL water + 10 mL of 0.1 M citric acid. Each reaction was run for 6 hours. After

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cooling, the biochar was separated by filtration, thoroughly washed with distilled water, and oven-dried at 105 °C for 12 hours. The HTC method was adapted based on carbonization protocols outlined in regional biomass valorization studies [5,6].

Iodine number determination. The iodine number was determined following ASTM D4607-14 with modifications for UV–Vis analysis. A standard 0.1 N iodine solution was prepared using resublimed iodine and potassium iodide. Due to the low adsorption capacity of the biochar, 1.75–2.5 g of biochar was mixed with 100 mL of the iodine solution and stirred for 60 minutes in each test to ensure the residual iodine concentration in the filtrate fell within the specified range (0.008–0.040 N). After filtration, 50 mL of the filtrate was titrated spectrophotometrically at 352 nm against a sodium thiosulfate standard curve (Du et al., 2021).

Results and discussion. Table 1 summarizes the iodine numbers for all twelve samples. A monotonic increase in iodine number with temperature is observed across all media. At a given temperature, samples treated with higher citric acid concentration exhibit greater iodine numbers, confirming the activating role of citric acid in enhancing microporosity.

The data reveal that both HTC temperature and citric acid concentration positively influence the iodine number. This trend is attributed to increased degradation of lignocellulosic material and enhanced carbonization, leading to the formation of more micropores at higher temperatures and acidic conditions. Citric acid likely aids in partial hydrolysis of cellulose and hemicellulose, producing porous structures during HTC.

The iodine number of the raw, dried powder (205 mg/g) is lower than all samples treated at ≥200 °C in acidified media, confirming that HTC enhances the microporous surface area of the biomass. The maximum increase (408 mg/g at 240 °C in 0.1 M citric acid) reflects just above 200% improvement over the untreated raw powder. UV–Vis spectroscopy proved effective in quantifying iodine concentrations and offers a modern alternative to titrimetric methods, providing rapid, reliable results with minimal sample handling (Du et al., 2021).

Table 1. Iodine numbers of *P. orientalis* biochar synthesized by HTC under various conditions.

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Sample No.	Temperature (°C)	Medium	Iodine Number (mg/g)
Raw Material	—	—	205
1	180	Water	212
2	180	0.05 M Citric Acid	234
3	180	0.1 M Citric Acid	252
4	200	Water	246
5	200	0.05 M Citric Acid	278
6	200	0.1 M Citric Acid	305
7	220	Water	276
8	220	0.05 M Citric Acid	312
9	220	0.1 M Citric Acid	347
10	240	Water	315
11	240	0.05 M Citric Acid	357
12	240	0.1 M Citric Acid	408

Conclusion. Biochar synthesized from *Platanus orientalis* leaves through hydrothermal treatment demonstrates significantly enhanced iodine adsorption capacity with increasing temperature and citric acid concentration. The optimal condition (240 °C, 0.1 M citric acid) yielded a high iodine number of 408 mg/g, indicating considerable microporosity. UV–Vis spectroscopy provides a reliable method for iodine number determination, supporting broader applications in biochar quality control and water purification. These findings suggest that modified hydrothermal conditions can be tailored to produce efficient biochar adsorbents from local biomass waste in Fergana City, contributing to sustainable environmental management.

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