Nitrogen-Doped Electrocatalyst from Tangerine Peels-Derived Biochar for Energy Storage and Conversion Applications

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Investigating effective and fairly cost electrodes with considerable energy efficiency and power density is important for electrochemical energy storage and conversion devices. Today, carbon-based materials such as activated carbon, graphene, and porous carbon, especially synthesized from wastes, stand out as electrode materials in energy storage and conversion applications due to their wide usability, economic applicability, high surfaces, and pore sizes.

Citrus fruits are one of the biocarbon material groups. Tangerine, which is a citrus fruit, is one of the most grown and consumed fruits in Turkey. Detailed production and consumption data for tangerines in Turkey can be found in Table 1 [1].

Table 1. Tangerine production/consumption data in Turkey

Year	Production (Tonne)	Consumption (Tonne)
2021/22	1.819,000	854.807
2020/21	1.585,629	699.033
2019/20	1.400,000	594.829

In this study, it was aimed to obtain activated porous carbon from tangerine peels. The peels of tangerines grown in Adana were used. Based on elemental analysis, the tangerine peel obtained from Adana was found to contain 45.8% carbon. As firstly, the tangerine peels were ground and pyrolyzed. Then, nitrogen-doped carbon electrocatalysts were synthesized from the tangerine peel powder by using NH_4OH via the hydrothermal carbonization (HTC) method. The products of different steps in this method were shown in Figure 1.

Figure 1. Synthesis of porous carbon from tangerine peels

The morphologies of the obtained activated porous carbon samples were analyzed using Field Emission Scanning Electron Microscopy (FE-SEM EDX) and Raman spectroscopy. FE-SEM EDX analysis showed that the nitrogen-doped carbon sample consists of 81.99% carbon, 12.92% oxygen, and 5.1% nitrogen. The porous structure of the sample also can be seen in Figure 2. In Figure 2, the FE-SEM images of the samples produced by HTC method were given. As seen in the FE-SEM results, the synthesized carbon materials have a porous structure.

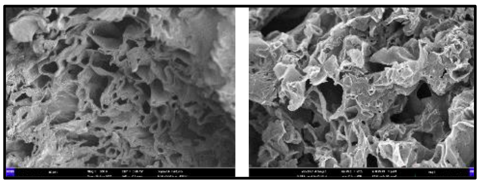

Figure 2. FE-SEM analysis of porous carbon from tangerine peels

As a result of the porous structure obtained, it is expected to obtain electrode applications with higher activity values to be used in energy conversion systems by increasing the active surface area of the material. According to the Raman analysis, the characteristic D and G bands of the obtained sample were seen at 1340 cm^{-1} and 1580 cm^{-1}, respectively, indicating the presence of carbon structures.

In conclusion, tangerine peel, which is a fruit waste with high waste potential, is an important biomass precursor to obtain nitrogen-doped carbon electrocatalysts with simple and cost-effectiveness. Moreover, the high electrochemical performance of the resulting carbon material renders it a suitable candidate for electrocatalysts in energy conversion and storage devices. In addition, this is an environmentally friendly alternative solution since as recycling tangerine production wastes can aid in mitigating environmental pollution.

References

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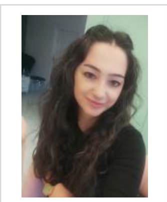

Hilal DOĞAN obtained her Bachelor's and Master's degrees in Chemistry from the Department of Chemistry at Erciyes University, Kayseri. She is continuing her doctorate at Erciyes University, Department of Energy Systems Engineering. Her research interests are centered on experimental investigations of biomass-derived carbon materials, renewable energy, Vanadium Redox Flow Batteries, PEM fuel cells, and hydrogen production.

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