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Dates kernels utilization for green adsorbent preparation and rapid characterization technique for produced hydrochar

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Abstract

Dates kernels biowaste considered as an environmental problem due to its huge mass from dates industry. The global environmental aim to solve the environmental issues using green techniques. So, the idea to use dates kernels as an abundant and renewable organic source and ecofriendly solution for green adsorbent preparation. Hydrochar during the last few years attracted the researcher's attention as an excellent solution for environmental application. This work aimed to prepare hydrochar from dates kernels feedstocks and using the Fourier-transform infrared spectroscopy (FTIR) as rapid and precise method to characterize the functional groups of the hydrochar surface, which reflects the capability of hydrochar to be used as an adsorbent for different environmental pollutants. In This work dates kernels feedstock has been dried at 100 ˚ C for 200 min then 150 ˚ C for 60 min. Then, Hydrothermal Carbonization (HTC) process was done at 180 ˚C for 200 minutes for hydrochar preparation. Distilled water has been used as HTC medium. The density, yield and pH has been tested. FTIR spectra for dried dates kernels, hydrochar differs, which shows the changes that took place during the HTC process. The appeared function groups in most biomass feedstocks aliphatic hydroxyl, carboxyl, C-H, C=O, C=C. After the hydrothermal carbonization process, this peak reduced indicating that the lignin only decomposed partially under the studied condition. Also, it is indicating distortion of the C-H bonds in aromatic compounds. The study concludes that hydrochar from dates kernels feedstock can be used as an effective green adsorbent for water pollutants.

Keywords:

Dates kernels, Environmental applications, Hydrochar, Carbon, FTIR, Green adsorbent.

Dates kernels studies in different fields

The publications related to dates kernels in different fields such as chemistry, environment, etc. are shown a huge number of publications which reflects its importance as shown in Fig. (1). While the number of publications from year to year still significantly increase as shown in Fig. (2).

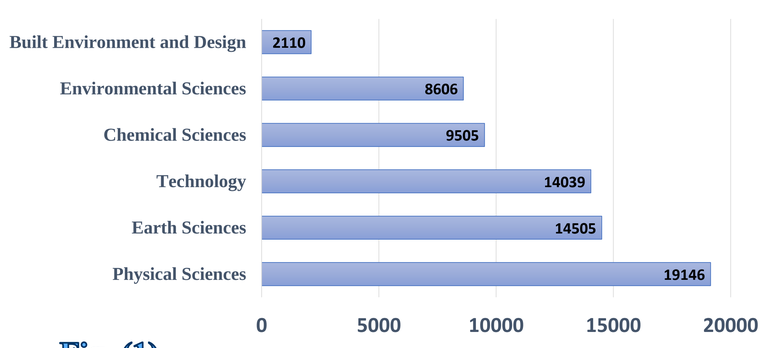

Fig. (1)

Publication related to dates kernels hydrochar

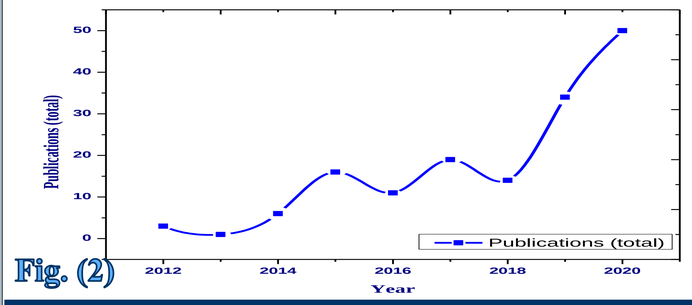

Fig. (2)

Research Problem

1- Huge Qty. of dates kernels wastes produced from dates industry.

2- Different water pollutants.

Materials and Methods

The dates kernels were collected, dried at 100 ˚ C for 200 min then 150 ˚ C for 60 min, next milled to particle sizes to be less than 1 mm and added into the HTC reactor. Deionized (DI) water was added to be 10 X the weight of the feedstock. The HTC reactor was heated in an oven to 180 °C for 200 minutes. The HTC reactor was then allowed to cool to room temperature. The resulting hydrochar was then isolated by filtration using 0.45 µm filter paper (Whatman), washed by DI water for 30 min to remove water-soluble volatile matter, then dried for 2 h at 100 °C.

Physical Parameters

Dates kernels feedstock:

Moisture content : 16.7%

Bulk density gm./ cm^3 0.74

Dates Kernels Hydrochar:

Hydrochar yield : 78%

Chemical Structure of hydrochar

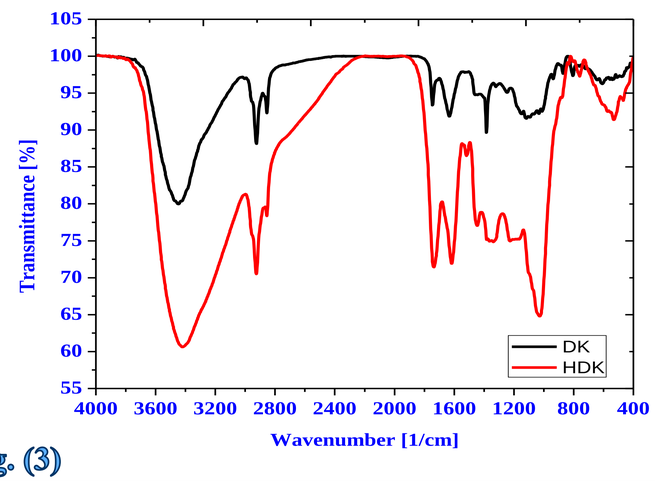

Fig. (3)

FTIR Spectrum analysis

FTIR spectra in Fig. (3) presents the dates kernel's feedstock, hydrochar produced by conventional method differs, which shows the changes that took place during the hydrothermal carbonization process. The strong and broad peak observed in Section 1 (3600-3000 cm^{-1}) is due to the aliphatic OH stretching vibration of hydroxyl and carboxyl functional groups. While the peaks in Section 2 (3000- 2800 cm^{-1}) are due to the C-H stretching vibration. Additionally, the peak in Section 3 (1800-1600 cm^{-1}) corresponds to the stretching vibration of C=O bonds in esters, carboxylic acids or aldehydes from cellulose. While the peak in Section 4 (1600-1500 cm^{-1}) corresponds to the C=C vibrations of the aromatic rings in lignin. After the hydrothermal carbonization process, this peak reduced indicating that the lignin only decomposed partially under the studied condition, while those in Section 5 (1450- 1200 cm^{-1}) corresponds to the C-H bending vibration of aliphatic carbons, methylene, and methyl groups, which shows that aliphatic structures are present. Section 6 (1200-1000 cm^{-1}) represents the stretching vibration of C-O groups from esters, phenols and aliphatic alcohols. The peak in section 7 (< 1000 cm^{-1}) is results from the distortion of the C-H bonds in aromatic compounds

Discussion

Effective hydrolysis and dehydration process of dates kernels convert it to the hydrochar with rich oxygenated functional groups (C-O, COO-, C=O, etc.). So, the hydrochar can be utilized as adsorbents for heavy metals and cationic dyes from water. The content of oxygenated functional groups mainly depends on the process conditions. The HTC of saccharides as glucose, starch, sucrose, and dehydrated dates kernels can lead to the formation of hydrochar with rich oxygenated functional groups.

Recommendation

The study recommended that dates kernels an economic candidate for hydrochar production, which will be a promising eco-friendly, low-cost adsorbent for cationic dyes and heavy metals.

Biography

Before joining Suez Canal University for PhD obtaining, Ahmed obtained his M. Sc. in environmental chemistry from Ain Shams University. Since joining the University of Suez Canal, Ahmed has been involved with studies related to environmental application using both green and nanotechnology.

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