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Research Article

Synthesis of Carbon Dots from Orange Carrot Juice

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Abstract

In this research. scanning Electron Microscopy (SEM) image confirmed that CDs are almost spherical in shape and the size is around 6.40 – 25.76 nm. The energy-dispersive X-ray (EDX) spectrum showed the existence of carbon in the samples. The Fourier-transform infrared (FTIR) spectrum of carrot extract (CE) and CDs is explained that the -C=O peak was found in 1740 and 1650 cm−1 in the CE, but it is completely lost in CDs. This result indicates that the carbonyl group has undergone carbonization and producing luminescent CDs.

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1. Introduction

The carbon dots can be defined as luminescent carbon nanomaterials with sizes below 10 nm and they have perfect chemical and optical properties [1,2]. Carbon dots (CDs) were recognized since 2004 through the cleansing of Single Walled Carbon Nanotubes (SWCNTs) through preparative electrophoresis [3-4]. They can be defined as fluorescent small carbon nanoparticles and their sizes are less than 10 nm. The CDs have several applications such as bioimaging, biosensing, drug delivery, disease detection, materials science, and synthetic chemistry [5–8]. These materials are low production costs, water-soluble, photo-chemically, and physiochemically stable. Recently, the applications, production, and of CDs have maintained the attention of many scientists because it is essential to develop different morphologies, sizes, and specific CDs for future research. In addition, CDs were used to develop fluorometric tests regarding enzymes such as β-galactosidase [9–12]. In the last decade, several procedures were used to synthesize CDs for example laser ablation, pyrolysis, acidic treatment, hydrothermal treatments, electrochemical exfoliation, alkaline oxidation, microwave heating, and arc discharge [13–17]. The use of natural bio-resources to produce CDs has several advantages such as being cost-effective, appropriate, and easily available in natural environments such as banana and orange peel. A hydrothermal route was the most popular in the green synthesis of CDs [18–25]. The aim of this study is to prepare the CDs from carrot.

2. Materials and methods

2.1 Materials

The edible carrots were obtained from a supermarket in Karbala. Chemical materials such as Na_3PO_4 (TSP).

2.2 Preparation of carbon dots

In this method, 5 grams of carrot were placed in a flask, then 25 mL of 100 mM Na_3PO_4 (TSP) solution which was added to this flask. The solution was refluxed by fitting a condenser on a round bottom flask, then placed on a magnetic stirrer hot plate. After two hours of heating at 60 ± 5 °C, the solution color was changed from colorless to brown at the end. This result indicates that carbonization yields CDs.

2.3 Instrumentations

Fourier-transform infrared spectroscopy (FTIR) (Shimadzu- 8000); and Scanning Electron Microscopy (SEM were used in this research.

3. Results

The main functional groups of Carbon dots (CDs) were determined by FTIR and compared with those reported for the carrot extract (CE). A scanning electron microscope (SEM) was used to produce images of CDs samples by scanning the surface with a focused beam of electrons. These electrons will interact with atoms in the CDs sample, producing various signals that contain information about the surface topography and composition of the sample.

4. Discussion

4.1 FT-IR analysis

The results of CDs and CE obtained from orange carrots are shown in Figures 2 (a and b). The peaks corresponding to -OH (broad) and -NH (stretching) were seen at 3236 and 3259 cm^{-1}, respectively. The peaks associated with -CH (stretching) were found at 2916, 2850 $cm^{-1,}$ and 2924 cm^{-1}. On the other hand, the peaks associated with bending vibrations of -CH were found at 1396 and 1400 cm^{-1}. The peaks corresponding to the pyranose form of sugar were found at 1045 and 1072 cm^{-1}. The peaks at 1566 and 1585 cm^{-1} are associated with C=C (vibrations). The results indicate that CDs have a sharp peak at 1566 cm^{-1} in comparison to CE. On the other hand, there are two peaks, namely 1728 and 1647 cm^{-1} were found to correspond to -C=O in the carrot extract, while these peaks were lost in CDs. This result indicates that the carbonyl group-including phytonutrients suffer carbonization and produce more sp^2 hybridized carbon.

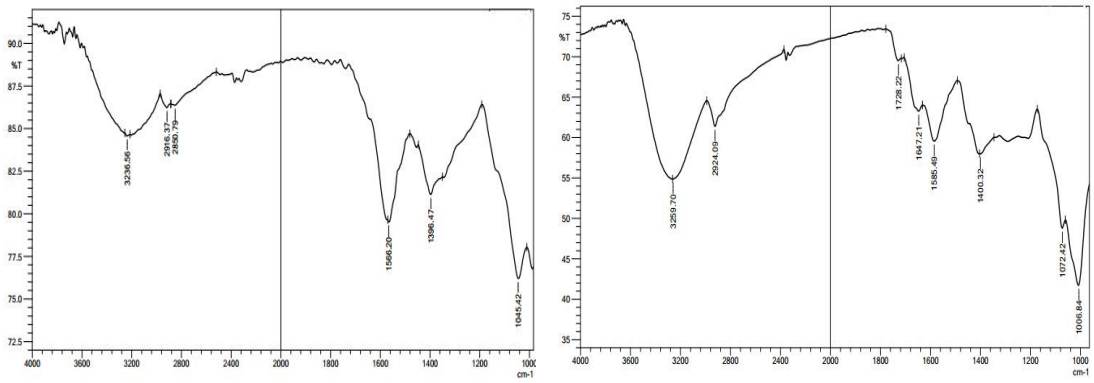

Figure 2. FTIR spectra of (a) carbon dots (CDs) and (b) orange carrot extract (CE).

4.2 SEM analysis

The Scanning electron microscope (SEM) of pure carbon dots (CDs) is shown in Figure 3. The results confirm that the size of CDs obtained from carrot was found in the range of 6.40 – 25.76 nm.

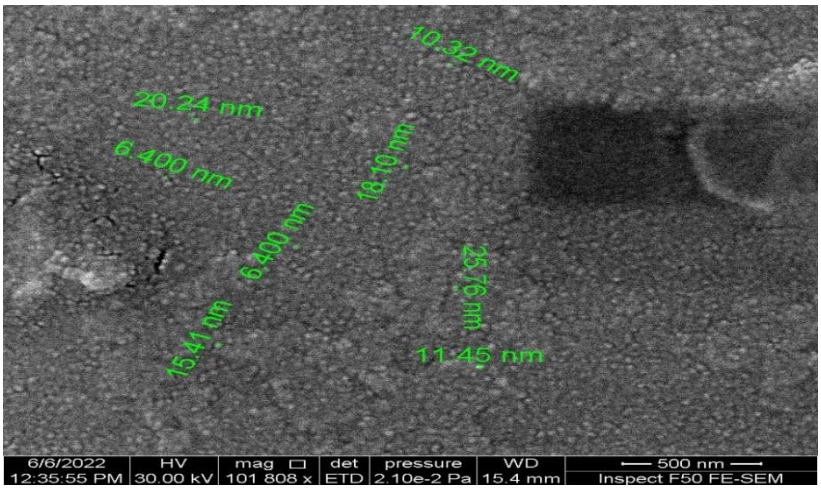

Figure 3. SEM images of CDs

5. Conclusions

An appropriate procedure to synthesize CDs from Iraqi edible carrots was studied by using obtainable chemicals and labware. SEM, and FTIR were used to evaluate the characteristics of prepared CDs.

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