PHOTOCATALYTIC DEGRADATION OF METHYLENE BLUE BY CQDs BASED COMPOSITE DERIVED FROM WATERMELON RINDS

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I hereby declare that I have checked this thesis, and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Pewarna terdiri daripada komponen yang toksik dan kompleks dan mempunyai kadar penguraian yang rendah. Dengan kehadiran pewarna, komponen pewarna merubah warna air yang membawa kesan yang negatif bukan sahaja dari segi nilai aestetik tetapi juga mengurangkan kadar penembusan cahaya matahari di dalam air. Bahan pewarna juga merbahaya kepada hidupan akuatik dan kesihatan manusia jika dialir secara terus. Usaha untuk membuang metilina biru daripada air sisa dilaporkan dengan pelbagai kaedah seperti rawatan fenton,ozonasi, tapisan membrane,pembekuan penyerapan proses ozonasi. Fotokatalisis telah dilaksana dalam beberapa kajian untuk merawat air sisa pewarna kerana ciri mineralisasi bahan organic yang lengkap. Disebalik itu, kaedah fotokatalisis semasa masih lagi terhad kerana kos yang tinggi dan sumber yang terhad.Sebaliknya, kulit buah tembikai (KBT) telah dilabel sebagai sisa dan dibuang tanpa dirawat. Maka, bagi menyelesaikan masalah alam sekitar, dalam kajian ini, KBT telah digunakan sebagai sumber karbon dalam sintesis Karbon Kuantum Dots (KKD) yang boleh digunakan sebagai fotokatalisis untuk merawat larutan metelina biru (MB). Tidak seperti bahan-bahan nano karbon yang lain seperti nanotiub karbon, graphene oxide dan graphene kuantum dots, KKD disintesis dengan mudah dan murah menggunakan sumber biojisim yang murah dan lestari. Oleh itu, objektif utama kajian ini adalah untuk menilai kebolehlaksanaan KBT yang digunakan dalam sintesis KKD untuk bertindak sebagai fotokatalis dalam menguraikan metelina biru. KKD digabungkan dengan titanium dioksida (TiO_2) untuk meningkatkan sifat kimia, fizikal dan optik TiO_2 untuk penilaian penguraian fotokatalitik di bawah penyinaran cahaya buatan. Semua serbuk fotokatalis dicirikan menggunakan difraktometer sinar-X (XRD). Mikroskop elektron transmisi resolusi tinggi (HRTEM), mikroskop elektron imbasan (SEM), spektroskopi sinar-X penyebaran tenaga (EDX), penganalisis kawasan permukaan Brunauer-Emmett-Teller (BET), spektroskopi fotoelektron sinar-X (XPS), UV spektrofotometer cahaya (UV-Vis) dan spektrum Photoluminescence (PL). Seterusnya, aktiviti fotokatalitik daripada fotokatalis dinilai dengan penguraian MB di bawah cahaya yang dapat dilihat dari lampu xenon (500W). Berdasarkan hasilnya, dapat disimpulkan bahawa sintesis KKD yang berasal dari KBT yang dapat digunakan sebagai fotokatalis dalam degradasi fotokatalitik metelina biru. Dalam hasilnya, didapati bahawa KKD dengan pemuatan pemangkin 0.1 g / L pada 5 mg/L mempunyai aktiviti fotokatalitik tertinggi dengan 73% penyingkiran MB berbanding TiO_2 dan CQDs- TiO_2 disebabkan oleh kadar permukaannye yang luas. Dari segi peratusan, penguraian MB adalah seperti berikut: CQD> CQD-TiO_2> TiO_2 masing-masing dengan 73%, 55% dan 27%. Hasil untuk kepekatan pH menunjukkan bahawa kecekapan penguraian meningkat dengan peningkatan pH. Pemangkin berfungsi lebih baik pada pH 9 kerana sifat kationik MB. Data kinetik degradasi metelina biru dilengkapi dengan model kinetik Langmuir-Hinshelwood dan parameter kinetic dapat diperoleh. Sebagai kesimpulan, kajian ini menunjukkan bahawa kepekatan metelina biru dapat dikurangkan dengan menggunakan KKD yang berasal daripada kulit buah tembikai (KBT).

ABSTRACT

Dyes comprise of toxic and complex components and has slow degradation rate. The presence of dyes components altered the colour of the water and bring negative effects not only from aesthetics value but also reducing the sunlight penetration into the waterbody. It also harmful to aquatic organism and human health if discharge directly to environment. The effort to remove the methylene blue (MB) from wastewater were reported using numerous methods such as Fenton treatment, ozonation, membrane filtration, coagulation, adsorption, and advanced oxidation process. Recently, photocatalysis has been conducted in several studies to treat dye wastewater because of the complete mineralization of organic compounds. Despite of that, the current photocatalysis method is still limited due to the high cost and limited source. On the contrary, watermelon rinds (WMR) have been discarded as waste and left untreated in the environment. Therefore, to tackle both environmental issues, this study employed the WMR as the carbon precursor in the synthesize of carbon quantum dots (CQDs) that can be used as photocatalyst to treat the MB solution. Unlike many other carbon nanomaterials such as carbon nanotubes, graphene oxide and graphene quantum dots, CQDs are easily and inexpensively synthesized using a cheap and sustainable source of biomass. Hence, the main objective of this study is to evaluate the feasibility of WMR used in the synthesize of CQDs to act as a photocatalyst in degrading the MB solution. CQDs was incorporated with titanium dioxide TiO_2 to enhance the chemical, physical and optical properties of TiO_2 for evaluation of photocatalytic degradation under artificial light irradiation. All photocatalysts powder were characterized using powder X-ray diffractometer (XRD), high resolution transmission electron microscope (HRTEM), scanning electron microscope (SEM), energy dispersive X-ray spectroscope (EDX), Brunauer-Emmett-Teller (BET) surface area analyzer, X-ray photoelectron spectroscope (XPS), UV-visible light spectrophotometer (UV-Vis) and Photoluminescence (PL) spectra. Next, photocatalytic activity of the prepared photocatalysts was evaluated by degrading MB under visible light from xenon lamp (500W). Based on the results, it is feasible to synthesize CQDs derived from WMR which can be used as solely photocatalyst in photocatalytic degradation of MB. In the results, it is found that CQDs with 0.1 g/L catalyst loading at 5 ppm has the highest photocatalytic activity with 73% of MB removal compared to TiO_2 and CQDs- TiO_2 due to its small surface area. In terms of the percentage, the MB degradation are as follows: CQD >CQD-TiO_2>TiO_2 with 73%, 55% and 27% respectively. The result for pH of concentration showing that the degradation efficiency increases with increasing of pH. The catalysts work better in pH 9 due to the cationic property of MB. The kinetic data of MB degradation were fitted with Langmuir- Hinshelwood kinetic model and kinetic parameters were obtained. In conclusion, this study suggested that the concentration of MB can be reduced by utilizing CQDs derived from WMR.

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