Data Article

Adsorption of diclofenac onto different biochar microparticles: Dataset – Characterization and dosage of biochar

Linson Lonappan\textsuperscript{a}, Tarek Rouissi\textsuperscript{a}, Satinder Kaur Brar\textsuperscript{a,\ast}, Mausam Verma\textsuperscript{b}, Rao Y. Surampalli\textsuperscript{c}

\textsuperscript{a} INRS-ETE, Université du Québec, 490, Rue de la Couronne, Québec, Canada G1K 9A9
\textsuperscript{b} CO2 Solutions Inc., 2300, Rue Jean-Perrin, Québec, Canada G2C 1T9
\textsuperscript{c} Department of Civil Engineering, University of Nebraska-Lincoln, N104 SEC P.O. Box 886105, Lincoln, NE 68588-6105, United States

\section*{Article info}

\textbf{Article history:}
Received 11 October 2017
Accepted 17 October 2017
Available online 21 October 2017

\textbf{Keywords:}
Adsorption
Diclofenac
Biochar
Characterization

\section*{Abstract}

Due to its wide occurrence in water resources and toxicity, pharmaceuticals and personal care products are becoming an emerging concern throughout the world. Application of residual/waste materials for water remediation can be a good strategy in waste management as well as in waste valorization. Herein, this dataset provides information on biochar application for the removal of emerging contaminant, diclofenac from water matrices. The data presented here is an extension of the research article explaining the mechanisms of adsorption diclofenac on biochars (Lonappan et al., 2017 [1]). This data article provides general information on the surface features of pine wood and pig manure biochar with the help of SEM and FTIR data. This dataset also provides information on XRD profiles of pine wood and pig manure biochars. In addition, different amounts of biochars were used to study the removal of a fixed concentration of diclofenac and the data is provided with this data set.

\textcopyright 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
**Specifications Table**

| Subject area                          | Chemistry/Chemical engineering |
|---------------------------------------|---------------------------------|
| More specific subject area            | Adsorption, Surface Chemistry, Environmental Engineering |
| Type of data                          | Table, image (XRD, SEM), text file, figure(FTIR) |
| How data was acquired                 | SEM: Zeiss Evo®50 Smart SEM |
|                                       | FTIR: Perkin Elmer, Spectrum RXI, FT-IR instrument fitted with lithium tantalate (LiTaO₃) detector |
|                                       | XRD: Panalytical Empyrean XRD with monochromatized CuKα radiation (1.5418Å). |
|                                       | LDTD-MS/MS: Concentrations of diclofenac was measured using LDTD-APCI (atmospheric pressure chemical ionization) source (LDTD T-960, Phytronix Technologies, Quebec, Canada) mounted on a TSQ Quantum access triple quadruple mass spectrometer (Thermo Scientific, Mississauga, Ontario, Canada) |
| Data format                           | Pre-processed and analyzed |
| Experimental factors                  | Biochar samples (from pinewood and pig manure) were grounded to obtain microparticles and the data here is given is for characterization of biochar. Moreover, data for dosage effect of biochar on adsorption for diclofenac is given. |
| Experimental features                 | Characterization data of biochar microparticles obtained from SEM, XRD, and FTIR are given. Adsorption studies were carried out for the removal of diclofenac using biochar microparticles. Various biochar dosages ranging from 1 g L⁻¹ to 20 g L⁻¹ were tested. |
| Data source location                  | Bioprocessing and NanoEnzyme Formulation Facility (BANEFF), INRS-ETE, Université du Québec, 490, Rue de la Couronne, Québec, Canada G1K 9A9 |
| Data accessibility                    | Data presented in this article |
| Related research article              | The associated research article related to this data set is [1] |

**Value of the data**

- Characterization data for biochar derived from two different feedstock (pine wood and pig manure) are given.
- Dataset provides an insight to the surface features of biochar.
- Dataset gives information on the adsorption capacity of biochar for emerging contaminant diclofenac.
- Dataset would be useful to identify the dosage effect of biochar on the adsorption of diclofenac.

**1. Data**

The dataset comprises characterization as well as experimental data. Fig. 1 presents the scanning electron micrographs (SEM) of pine wood and pig manure biochar microparticles. Fig. 2. presents Fourier-transform infrared spectroscopy (FTIR) images of biochar microparticles. Fig. 3 presents X-ray Diffraction (XRD) images of biochar microparticles. Table 1 shows the effect of adsorbent dosage on the removal of diclofenac and removal efficiency.
2. Experimental design, materials and methods

2.1. Biochar microparticle preparation

Two types of biochars were prepared from pinewood and pig manure and named as BC-PW and BC-PM, respectively. Preparation of biochar and microparticles are explained elsewhere [1,2].

2.2. Characterization of biochar microparticles

Scanning electron micrographs of the biochar microparticles are recorded using Zeiss Evo®50 Smart SEM system. FTIR spectra of the adsorbents were recorded using Perkin Elmer, Spectrum RXI, FT-IR instrument fitted with lithium tantalate (LiTaO3) detector. XRD spectra of the adsorbents were recorded using Panalytical Empyrean XRD fitted with monochromatized CuK alfa radiation (1.5418A).

2.3. Adsorption studies

Adsorption studies were carried out using 50 mg (1 g L\(^{-1}\)), 0.1 g (2 g L\(^{-1}\)), 0.3 g (6 g L\(^{-1}\)), 0.5 g (10 g L\(^{-1}\)), 0.7 g (14 g L\(^{-1}\)) and 1 g (20 g L\(^{-1}\)) of biochar samples with 50 mL of 500 µg L\(^{-1}\) of diclofenac (DCF). Batch adsorption studies were carried out in an INFORS HT – multitron standard shaking incubator (INFORS, Mississauga, Canada). Experimental conditions are as follows – shaking speed: 200 rpm; temperature: 25 ± 1 °C, pH: 6.5, centrifugation (after adsorption studies): at 11,600×g for 10 min in a MiniSpin® plus centrifuge. The supernatant was analyzed for remaining DCF using LDTD-MS/MS [3].

It was observed that for both BC-PW and BC-PM, increasing the adsorbent dosage considerably enhanced the removal efficiency. BC-PM possessed better adsorbent properties than BC-PW and showed higher potential for the removal of DCF compared to BC-PW. With a dosage of 2 g L\(^{-1}\), BC-PM achieved a removal efficiency of 95.87% and above 2 g L\(^{-1}\) dosage level, BC-PM always achieved nearly 100% removal efficiency. For BC-PW, removal efficiency increased from 43% to 98.8% with a dosage varying from 2 to 20 g L\(^{-1}\). However, the adsorption amount (µg g\(^{-1}\)) on biochar decreased with increase in adsorbent dosage. This observation can be explained as a consequence of partial agglomeration of biochar at higher concentrations of biochar which will decrease the active sites on the surface of biochar [4,5]. Adsorbent dosage experiment was carried out at equilibrium time and samples were drawn. In the case of BC-PW, the complete removal might have been obtained during any time of the adsorption. Therefore, adsorption amount cannot be considered as the equilibrium adsorption capacity of the biochar BC-PM. As shown in Fig. 1, porous structure of biochars probably
Fig. 2. Fourier transform infra-red spectra and of biochar; BC-PW: pine wood biochar, BC-PM: pig manure biochar.
had a positive effect on the adsorption of DCF [6]. Moreover, as shown in Fig. 2, both biochars are rich in surface functional groups which in turn can facilitate the adsorption.

Acknowledgements

The authors are sincerely thankful to the Natural Sciences and Engineering Research Council of Canada (Discovery Grant 355254 and NSERC Strategic Grant) and Ministère des Relations Internationales du Québec (coopération Québec-Catalunya 2012–2014; project 07.302). We would like to thank Prof. Christian Roy (Pyrovac Inc., Quebec) and Dr. Stéphane Godbout (IRDA, Quebec) for providing biochar samples. We would like to acknowledge Dr. Kshipra Misra (Defense Institute of Physiology and Allied Sciences (DIPAS), India) for analytical supports.

References

[1] L. Lonappan, T. Rouissi, S.K. Brar, M. Verma, R.Y. Surampalli, An insight into the adsorption of diclofenac on different biochars: mechanisms, surface chemistry and thermodynamics, Bioresour. Technol. (2017).
[2] L. Lonappan, T. Rouissi, R.K. Das, S.K. Brar, A.A. Ramirez, M. Verma, R.Y. Surampalli, J.R. Valero, Adsorption of methylene blue on biochar microparticles derived from different waste materials, Waste Manag. 49 (2016) 537–544.
[3] L. Lonappan, R. Pulicharla, T. Rouissi, S.K. Brar, M. Verma, R.Y. Surampalli, J.R. Valero, Diclofenac in municipal wastewater treatment plant: quantification using laser diode thermal desorption—atmospheric pressure chemical ionization—tandem mass spectrometry method, J. Chromatogr. A 1433 (2016) 106–113.
[4] M.A. Hanif, R. Nadeem, H.N. Bhatti, N.R. Ahmad, T.M. Ansari, Ni(II) biosorption by Cassia fistula (Golden Shower) biomass, J. Hazard. Mater. 139 (2) (2007) 345–355.

Table 1

| Adsorbent dosage (g L⁻¹) | Removal efficiency (%) | Adsorption amount on biochar (µg g⁻¹) |
|-------------------------|-------------------------|--------------------------------------|
|                         | BC-PW | BC-PM | BC-PW | BC-PM |
| 2                       | 42.99 | 95.87 | 107.49 | 239.69 |
| 6                       | 83.16 | 100   | 69.30  | – |
| 10                      | 93.67 | 100   | 46.83  | – |
| 14                      | 96.52 | 100   | 34.47  | – |
| 20                      | 98.81 | 100   | 24.70  | – |

*BC-PW: Pinewood biochar microparticles, BC-PM: Pig manure biochar microparticles.*
[5] H. Hu, B. Jiang, J. Zhang, X. Chen, Adsorption of perrhenate ion by bio-char produced from Acidosasa edulis shoot shell in aqueous solution, RSC Adv. 5 (127) (2015) 104769–104778.

[6] C. Jung, L.K. Boateng, J.R.V. Flora, J. Oh, M.C. Braswell, A. Son, Y. Yoon, Competitive adsorption of selected non-steroidal anti-inflammatory drugs on activated biochars: experimental and molecular modeling study, Chem. Eng. J. 264 (2015) 1–9.