Supporting Information for:

Removal of Heavy Metal Ions Using Modified Celluloses Prepared from Pineapple Leaf Fiber

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The determination of PAL composition using the TAPPI standard test methods was carried out using the following methods:

1) Extractive in ethanol + benzene

Ethanol and benzene solutions for 200 ml with a ratio of 1:2 were used mix with PAL (10 g) for the extraction. The mixture was refluxed in water bath for 5
hours. After that, the sample was filtrated and rinsed by 100 ml of ethanol before drying at 65 °C overnight. The % extractive was calculated using equation (1).

\[
% \text{ Extractive} = \frac{\text{initial weight of PAL} - \text{weight of PAL after extraction}}{\text{initial weight of PAL}} \times 100
\]  

(1)

2) Extractive in ethanol

95% of ethanol solution (150 ml) was mixed with all of the remaining extracted materials from step 1) (7.65 g) for the extraction. The mixture was refluxed in a water bath for 5 hours. After that, the sample was filtrated and rinsed by 100 ml of ethanol before drying at 65 °C overnight. The % extractive was calculated using equation (2).

\[
% \text{ Extractive} = \frac{\text{initial weight of extracted material} - \text{weight of PAL after extraction}}{\text{initial weight of PAL}} \times 100
\]  

(2)

3) Extractive in hot water
All of the remaining extracted material from step 2) (7.19 g) was mixed with DI water (500 ml). Then, the mixture was refluxed for 5 hours. After that, the sample was filtrated and rinsed by 100 ml of ethanol before drying at 65 °C overnight. The % extractive was calculated using equation (3).

\[
\% \text{ Extractive} = \left( \frac{\text{initial weight of PAL} - \text{weight of PAL after extraction}}{\text{initial weight of PAL}} \right) \times 100 \quad (3)
\]

4) **Holo-cellulose**

All of the extracted material from step 3) (6.48 g) in 250 ml was mixed with 0.5 ml of glacial acetic acid and 1.5 g of sodium chlorite, and then heated to 70-80 °C for 1 hour. Then, the same volumes of glacial acetic acid and sodium chlorite were added one more time and the mixture was continued at that condition for 1 hour. The mixture was then put in an ice bath until its temperature of the solution was lower than 10 °C. The remaining cellulose was filtrated and rinsed by acetone before drying at 65 °C for overnight. % of holo-cellulose was calculated using equation (4).

\[
\% \text{ holo-cellulose} = \left( \frac{\text{weight of holo-cellulose}}{\text{initial weight of PAL}} \right) \times 100 \quad (4)
\]
5) *α-cellulose*

1.5 g of holo-cellulose was mixed with 75 ml of 17.5%w/w NaOH and stirred at room temperature for 1 hour. Then, 25 ml of 17.5%w/w NaOH was added and the mixture was kept stirring for 30 min. Then, 100 ml of DI water was added and it was kept stirring for 30 min. filtrate and rinse by DI water before drying at 65 ºC for overnight. % of *α-cellulose* was calculated using equation (5).

\[
\text{% } \alpha \text{-cellulose} = \frac{\text{weight of } \alpha \text{-cellulose}}{\text{initial weight of PAL}} \times 100
\]  

(5)

6) *Hemicellulose*

Amount of hemicellulose was obtained using equation (6).

\[
\text{% hemicellulose} = (\text{% holo-cellulose}) - (\text{% } \alpha \text{-cellulose})
\]  

(6)

7) *Lignin*

15 ml of 72% H₂SO₄ in a beaker was put in an ice bath. The extracted material from step 3) (1.5 g) was added in the cold H₂SO₄ solution and the mixture
was stirred for 2 hours. The mixture was transferred into a round bottom flask and added 130 ml of DI water. It was refluxed for 4 hours, and then left to cool down to room temperature for overnight. The remaining sample was filtrated and rinsed using hot water before drying at 65 °C for overnight. The % lignin was calculated using equation (7).

\[
\text{% lignin} = \frac{\text{weight of lignin after extraction}}{\text{initial weight of PAL}} \times 100 \quad (7)
\]

8) Ash

PAL (1.0 g) was put in a crucible and calcined at 525 °C for 6 hours. The % ash was calculated using equation (8).

\[
\text{% Ash} = \frac{\text{weight of dried ash}}{\text{initial weight of PAL}} \times 100 \quad (8)
\]
**Table S1.** Various modified cellulosic absorbents for adsorption studies for Pb\(^{2+}\) or Cd\(^{2+}\).

| Functional group/chelating agent | Raw material          | Metal ions     | \(q_m\) (mg g\(^{-1}\)) | Reference |
|----------------------------------|-----------------------|----------------|---------------------------|-----------|
| EDTA                             | Pineapple leaves      | Pb\(^{2+}\)   | 41.2                      | This work |
|                                  |                       | Cd\(^{2+}\)   | 33.2                      |           |
| Carboxymethyl                    | Pineapple leaves      | Pb\(^{2+}\)   | 63.4                      | This work |
|                                  |                       | Cd\(^{2+}\)   | 23.0                      |           |
| Polyglycidyl methacrylate        | Commercial cellulose  | Pb\(^{2+}\)   | 52.0                      | (1)       |
|                                  |                       | Cd\(^{2+}\)   | 53.4                      |           |
| acetate/polyvinylpyrrolidone      | Nanofiber membranes   | Pb\(^{2+}\)   | 30.96                     | (2)       |
| modified with thiol groups       |                       | Cd\(^{2+}\)   | 34.70                     |           |
| EDTA                             | Whatman grade 6 filter paper | Pb\(^{2+}\) | 227.3                     | (3)       |
|                                  |                       | Cd\(^{2+}\)   | 102.0                     |           |
| Guanyl-modified cellulose        | Commercial cellulose  | Pb\(^{2+}\)   | 52                        | (4)       |
|                                  |                       | Cd\(^{2+}\)   | 68                        |           |
| Oxidized pineapple fruit peel    | pineapple fruit peel  | Pb\(^{2+}\)   | 28.55                     | (5)       |
|                                  |                       | Cd\(^{2+}\)   | 42.10                     |           |
| Caboxylated cellulose            | Cellulose (3MM,       | Pb\(^{2+}\)   | 205.9                     | (6)       |
|                                  | Whatman)              |                | 86.0                      |           |
| Sulphur as anionic ligand        | Medical cotton        | Pb\(^{2+}\)   | 92                        | (7)       |
| (-SC(NH$_2$)$_2$) | Cellulose paper | Pb$^{2+}$ | Cd$^{2+}$ | | | | (8) |
| | Sugarcane bagasse | Pb$^{2+}$ | Cd$^{2+}$ | 232 | 112 | | |
| EDTA dianhydride | | 333 | 149 | | |
| | Succinylated mercerized cellulose | Pb$^{2+}$ | Cd$^{2+}$ | 192.3 | 87.0 | | |
| | (9) |
| | Sugarcane bagasse | Pb$^{2+}$ | Cd$^{2+}$ | 500.0 | 256.4 | | |
| Triethylenetetramine | | | | 10) |
| | Sugarcane bagasse | Pb$^{2+}$ | Cd$^{2+}$ | 313 | 313 | | |
| | (11) |
| | Rice husk | Pb$^{2+}$ | Cd$^{2+}$ | 374.32 | 268.98 | | |
| | (12) |

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Table S2. The total concentrations (gray color on the background) of Cd\(^{2+}\) + Pb\(^{2+}\) for the solutions that were used for studying the adsorption of binary system.

| Concentration of Pb\(^{2+}\) (mg L\(^{-1}\)) | 0  | 20 | 40 | 60 | 80 | 100 |
|---------------------------------------------|----|----|----|----|----|-----|
| 0                                           | 0  | 20 | 40 | 60 | 80 | 100 |
| 20                                          | 20 | 40 | 60 | 80 | 100| 120 |
| 40                                          | 40 | 60 | 80 | 100| 120| 140 |
| 60                                          | 60 | 80 | 100| 120| 140| 160 |
| 80                                          | 80 | 100| 120| 140| 160| 180 |
| 100                                         | 100| 120| 140| 160| 180| 200 |