

Appendix

Research Papers Published

1. **K.Vivithabharathi** and N. Muthulakshmi Andal, **A Comparison of Raw and Treated Plant Debris in the Chelation of Anion from Aqueous Media**, *Indian Journal of Environmental Protection*, 40(1), 64 - 68, **2020**
2. N.Shyamala Devi, N.Muthulakshmi Andal and **K.Vivithabharathi**, **Virtual Screening of Treated Pistachio vera shell Powder as a Potential sorbent Sequestering Ubiquitous Divalent Metal Ions from Aqueous Matrices**, *Oriental Journal of Chemistry*, 34(1), 1-10, **2018**
3. N.Shyamala Devi, N.Muthulakshmi Andal and **K.Vivithabharathi**, **Confiscation of Ni (II) from aqueous environs using treated bivalve shells**, *Advances in Applied Research*, 10(2), 76 – 81, **2018**
4. N.Shyamala Devi, N.Muthulakshmi Andal and **K.Vivithabharathi**, **Extensive Employment of Chemically Treated pod shells in Ni(II) Sorption Thermodynamic Analysis**, *Knowvel Publishers (Accepted)*
5. **K.Vivithabharathi** and N. Muthulakshmi Andal, **A Review on Removal of Phosphate from Aqueous solution/ Wastewaters Employing Biosorbents**, *Chemical Science Reviews and Letters (In press)*
6. **K.Vivithabharathi** and N. Muthulakshmi Andal, **Assimilation of Nitrate Ions from Aqueous Environs onto Surface Modified Biomaterial**, *Research Journal of Chemistry and Environment (communicated)*

Research Articles Presented at International Conferences

- 1. Potential Utilization of a Pod Shell for the Removal of Pb(II) Ions from Aqueous Solution**, International Seminar on “Nuance in Life Sciences” at Sri Ganesh College of Arts and Science, Salem on 9th February **2017**.
- 2. Optimization of adsorption Parameters for Anion – CSSD System from Aqueous Solutions**, International Conference on, “Advanced Materials and their Technological Applications” at PSGR Krishnammal College for Women, Coimbatore on 3 - 5 January **2018**.
- 3. Role of Magnetic Composite Beads of functionalized Biomaterial in the Anionic Chelation from Aqueous Environs**, International Conference on, “Impact of Innovations in Science and Technology for Societal Development – IISTSD - 2019”, at Kongunadu Arts and Science College on 19 – 21 September **2019**.
- 4. Comparative Efficacy of Plant Stems and Nut Shell in the Eviction of Phosphate Ions from Aqueous Matrices**, International Conference on, “Renewable Energy and Sustainable Environment”, at Dr. Mahalingam College of Engineering and Technology on 12 – 14 December **2019**.
- 5. Prediction of Breakthrough Curves and Modelling of Fixed – bed Column Mode for Anion Sorption using Eco – friendly Material**, International Conference on, “Chemical and Environmental Research”, at Jammal Mohamed College on 8th January **2020**.
- 6. Scrutiny of Greywaters from Laundry Units employing Plant based Material**, International Conference on, “Emerging Trends in Materials for Energy and Biological Applications”, at M. Kumarasamy College of Engineering on 7th March **2020**.
- 7. Assimilation of Nitrate Ions from Aqueous Environs onto Surface Modified Biomaterial**, International Conference on “Recent Innovations in Science, Engineering and Technology - ICRASET” at Jeppiaar Institute of Technology, Chennai on 24th & 25th July **2020**
- 8. Screening of Physio-chemical Parameters in laundry Discharges and Phosphate Sequestration employing Novel Biocomposite Beads**, International Virtual Conference on “New Strategies in Water Treatment and Desalination” SRM Institute of Science and Technology, Chennai on 21 – 23 March **2021**

Research Articles Presented At National Conferences

1. **A study on the Biosorption of Divalent Ion using a low-cost Material**, National Seminar on, “Emerging Trends and Future Challenges in Chemical Sciences” at PSGR Krishnammal College for Women, Coimbatore on 10th& 11th August **2017**.
2. **Utilization of Plant Waste Substantial for Trapping the Anion from Aqueous Medium**, National Conference on, “Recent Trends in Chemistry” at Sri Ramakrishna Mission Vidyalaya College of Arts and Science, Coimbatore on 2nd February **2018**.
3. **A Comparison of Raw and Treated Plant Debris in the chelation of Anion from Aqueous Media**, National Conference on, “Recent Advances in Materials Science and Technology” at Ethiraj College for Women, Chennai on 12 – 13 February **2018**.
4. **Effective Utilization of Green Materials in the Eviction of Phosphate ions: A Comparative Study**, National Conference on, “Chemistry of Advanced Materials and its Biomedical Applications”, at Kumaraguru College of Technology on 20 & 21 April **2018**.
5. **Anion Chelation in Aqueous Matrices Employing Ecofriendly Material**, National Seminar on, “Innovations in Chemical Science and Green Technology” at PSGR Krishnammal College for Women, Coimbatore on 6th & 7th September **2018**.
6. **Employment of modified *Camellia sinensis* stem in anion eviction from aqueous matrices**, National Conference on “Recent Trends in Chemistry – 2019 at Sri Ramakrishna Mission Vidyalaya College of Arts and Science, Coimbatore on 1st & 2nd February **2019**.
7. **Removal of toxic cation employing activated carbon/ carbon doped calcium alginate beads derived from *Gallus gallus domesticus* beaks**, National Conference on “Recent Trends in Chemistry – 2019 at Sri Ramakrishna Mission Vidyalaya College of Arts and Science, Coimbatore on 1st & 2nd February **2019**.
8. **Role of Activated Carbon/ Carbon Doped Calcium Alginate Beads derived from Animal waste in the uptake of Anions from Battery Wastewaters**, National Seminar on “Innovations in Recent Chemistry”, at Kongunadu Arts and Science College on 19 February **2019. (Best Paper Award)**

- 9. Extensive Employment of Chemically Treated Pod Shell in sequestration of Ni(II) ions : Thermodynamic Analysis**, National Conference on “Research Advances in Science and Technology”, at CSI College of Engineering, Ooty on 22nd February 2019.
- 10. Impregnation of Modified Biomaterial with Calcium Alginate Beads in the Eviction of Anion from Aqueous Matrix**, National Seminar on, “Nanotechnology – The Fascinating World of Science” at Anna Adarsh College for Women, Chennai on 22nd August **2019**.
- 11. Efficacy of Modified Biomaterial on the Adsorption of Nutrients from Aqueous Matrices – A Comparative Study**, National Seminar on, “Innovations in Chemical Science and Green Technology” at PSGR Krishnammal College for Women, Coimbatore on 16th & 17th September **2019**.
- 12. Facile Synthesis of Activated Carbon for Sequestration of Noxious Metal Ion from Battery Greywaters**, National Conference on, “Recent Trends in Chemistry of Materials (NCRTCM – 2019) at Bannari Amman Institute of Technology, Sathyamangalam on 11th & 12th October **2019**.
- 13. Anion Chelation from Aqueous Environs employing Biomaterial Functionalized Magnetite Beads**, E - Poster Competition on “Research Work – Chemistry” at Sri Devi Kumari Women’s College, Kuzhithurai on 21st June 2020

Publication

A Comparison Of Raw And Treated Plant Debris In The Chelation Of Anion From Aqueous Media

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Utilization of tea plant stems, *Camellia sinensis* (CSS), discarded as litter, collected from Ooty was employed for phosphate removal. The material was broken into small pieces, washed, dried, pulverized into different mesh sizes using scientific test molecular sieves, labelled as raw *Camellia sinensis* dust (RCSSD). Sorption efficiency of the categorized sizes was tested by applying the batch verification technique, where 85 BSS exhibits better sorptive nature. The particle size of 85 BSS was determined (0.18 mm) using binocular microscope (Optika make), treated with 0.1 N H₂SO₄, washed, dried, named as treated *Camellia sinensis* dust (TCSSD). Characterization studies are supported by FTIR, SEM and EDAX methods. Sorption efficiency of TCSSD was experimentally verified under varying adsorption parameters. Absorbance values were recorded using UV/VIS spectrophotometer (LABINDIA[®]-UV3000⁺) by molybdenum blue complexation method for phosphate ions. Maximum removal was registered as 48.3% and 99.7% for RCSSD and TCSSD, respectively under optimized conditions of 0.18 mm particle size, 10 mg/L initial concentration, 9 min agitation time interval, 0.25 g dose, pH 5 at room temperature. Experimental data were validated using Langmuir and Freundlich isotherms wherein Freundlich plots recorded a better linear fit. Results imply that the selected material possesses excellent anion removal capability from aqueous media.

KEYWORDS

Adsorption, Phosphate, Plant waste, Batch process, Aqueous media, Isotherms

1. INTRODUCTION

Phosphate is an essential nutrient for the growth of microorganisms in most ecosystems but in excess plays a key role in causing eutrophication [1]. Eutrophication is the rapid growth of algae due to excess nutrients in the water, which covers the top of the water and prevents the availability of sunlight to reach aquatic plants. This leads to their death and results in a decline of dissolved oxygen levels. The source of excess phosphate leaching by the discharge of nutrient rich wastewater into the natural reservoirs. The point sources from which phosphate ion accumulate include natural sources (for example precipitation, dry fall, decomposition of organic materials, soil erosion) and artificial sources (for example use of fertilizers, detergents, human and animal wastes). Employment of biowaste materials to treat contamination with suitable modifications exhibit excellent adsorption capability than conventional treatment methods. The main objective of this work focusses on the assessment of phosphate removal from aqueous solutions using raw and treated tea plant stem.

2. MATERIAL AND METHOD

2.1 Collection of material

Tea plant stem of *Camellia sinensis* (CSS) discarded as litter during the winter season are collected from Ooty, were washed with distilled water in order to remove the impurities and sun dried for a period of nearly ten days. The dried material was then pulverized using an electrical mixer (RCSSD) and sieved to various mesh sizes, namely 85 BSS, 72 BSS, 52 BSS, 36 BSS and 22 BSS using scientific test molecular sieves. The sieved material was treated with 0.1 N H₂SO₄ for 3 hr, washed and dried (TCSSD). Figure 1 represents the cleaned tree stem, raw sieved material and its treated counterpart of 85 BSS mesh size.

2.2 Microscopic analysis

Particle size determination was carried out using a binocular microscope (Optika make) for the respective sieved mesh sizes and are shown in figure 2 for 0.18 mm particle size. Pore size diameter of TCSSD was observed to be mesoporous (13 nm) ensures better chelating property.

2.3 Preparation of sorbate

A stock solution of 1000 mg/L of phosphate ions was prepared by dissolving 1.4329 g of potassium

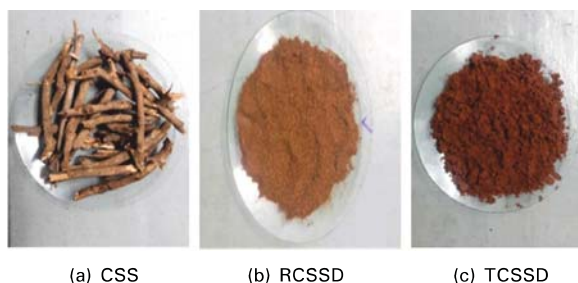


Figure 1. Clean tree stem, raw sieved material and its treated counterpart

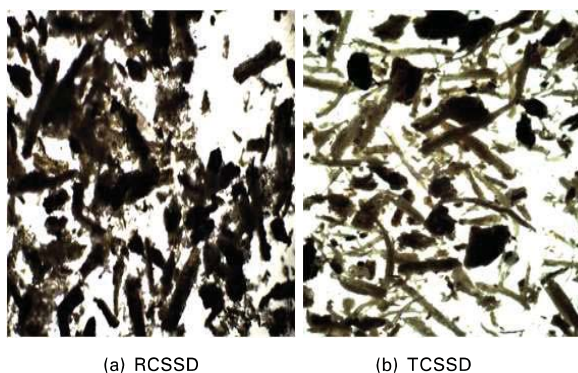


Figure 2. Sieved mesh sizes of RCSSD and TCSSD

dihydrogen phosphate. A standard of 100 mg/L was prepared from the stock solution and further dilutions were made as working aliquots as per the experimental requirements.

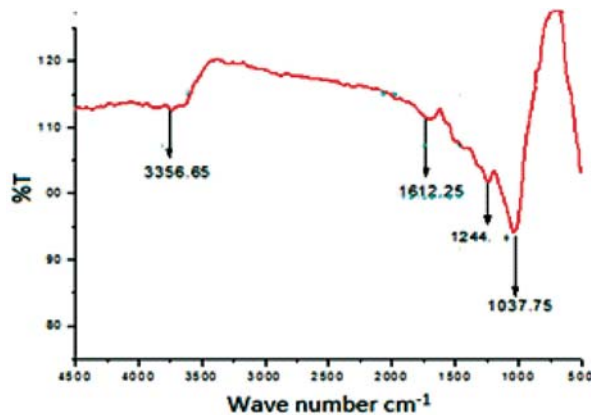
2.4 Batch experimental studies

Adsorption experiments were carried out varying the particle size (0.18, 0.21, 0.30, 0.42 and 0.71 mm), agitation time intervals (3-30 min), initial phosphate concentration (2, 4, 6, 8, 10, 12 and 14 mg/L), dosage (100, 150, 200, 250 and 300 mg), pH of the medium and co-ions (10 mg/L for NO_3^- , SO_4^{2-} , F^- and Cl^-) to optimize the best suitable condition for maximum removal by RCSSD and TCSSD. 50 mL of phosphate samples were added into the 250 mL Erlenmeyer flasks, with respective doses and particle size of raw and treated sample. The contents of the flasks were agitated in a mechanical shaker at a speed of 140 rpm. Absorbance values of initial and final readings were analyzed using UV/VIS spectrophotometer by molybdenum blue complexation method [2].

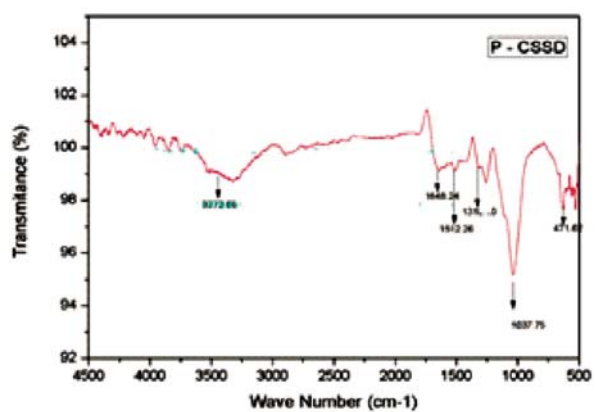
3. RESULT AND DISCUSSION

3.1 FTIR spectral studies

FTIR spectra corresponding to TCSSD and its loaded



(a) Unloaded CSSD



(b) Loaded CSSD

Figure 3. FTIR images of unloaded and loaded TCSSD

sample recorded a shift in wave number of prominent peaks. These significant shifts in the wavelength may attribute to the phosphate binding action occurring on the material surface, 1648/cm and 3372.66/cm corresponds to carboxyl and carbonyl group (Figure 3) [3].

3.2 SEM / EDAX analysis

Porous nature exhibited by TCSSD is supported by the surface morphological changes as depicted in the SEM images being confirmed by the EDAX spectral peak at 1.73 keV (Figures 4 and 5).

3.3 Effect of particle size

The sorption capacity of any sorbent material is suggested as a function of particle size, probably indicating a better surface sorption phenomenon. The bar chart is indicative of almost 100% phosphate removal by TCSSD against RCSSD for 0.18 mm particle size, being the most significant, is fixed for the forthcoming