**An Emerging Future Trend in Wastewater Treatment with its Innovative Product**

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**ABSTRACT**

Pollution is a serious world issue that causes varying levels of damage to the environment and life on earth. Recent years have seen a sharp increase in water scarcity, posing a challenge to humanity on a global scale, especially since the available water supplies are further constrained by various forms of pollution. The function of chicken Feather as a supposed adsorbent for eradicating of the dangerous synthetic organic dyes arising out of waste water is discussed in this chapter. It begins by outlining how crucially important clean water is for humanity and how crucial the adsorption technique is for removing dangerous pollutants from water over other physicochemical techniques. In the presence of thiourea, diluted alkaline solutions were used to partially hydrolyse hen feathers. After that, carbon disulfide treatment dithiocarbamylated the hen feathers. Polyvinyl alcohol was used with the product to create environmentally friendly films.Fourier Transform Infrared spectroscopy, powder XRD, scanning electron microscopy, and differential scanning calorimetry had been used to analyse these films. The adsorption technique had analysed by application of various kinetic and isotherm models. Extreme adsorption ability for methylene blue and crystal violet out of possession of aqueous solutions.

**KEYWORDS**: chicken feather, dithiocarbamylation, methylene blue, crystal violet, dye adsorption.

**I. INTRODUCTION**

The most limitless and plentiful resource on Earth, water has seen the most extravagant use by humans. This strange substance is also referred to as "the compound of life" because it has remarkable physical characteristics. It has an average abysm of 3000 meters and covering third quarters of the earth's exterior. In spite of so immensely of an accessible sum, as it were 1% of it is usable to us since 97% is salty seawater and 2% is solidified in ice sheets and polar ice caps. In this way, roughly 1% of the World’s water supply could be a valuable product essential for our survival [1–3]. Drinking water that is safe, healthy, and free of disease is a requirement for humanity's survival. It is subsequently not astounding that we have veracious watched the springs of water and over the centuries numerous clatters have taken put over water rights. Specialists have as of now cautioned of the prospect of a water emergency, which may be anticipated given the quick increment in populace. As a result, vigilant then appropriate organization also protection of usual water is indispensable on a global scale. Despite mother nature's amazing capability to reduce eco-friendly harm, the rising petition for water still want harnessing human skills to sustain the eminence along with the quantity. To meet all our desires for manufacturing, agronomy, electricity, irrigation, and further purposes necessary for the growth of civilization, we must treat water carefully. Because of nowadays water contamination has become one of the main environmental glitches then the control of water contamination is one of the major worries of the social order. Agriculture and food waste have been the most major economical way of living from decades. But every coin has its two sides likewise an enormous amount of agriculture and food waste are produced per annum. Some amount used in useful stuffs like for cattle feed but most of it thrown away or disposal producer that may cause crucial environmental pollution and harmful effect on human as well as animal health. Whatever that remains no longer usable also desires to be rid of is considered left-over. Additionally, garbage can remain categorized based on the kind of production it is and the location, such as agricultural, domestic, industrial, and mining. Large amounts of wastewater and solid waste are produced by the chicken business. The strong squander is made up of bedding fabric, excreta (fertilizer), bolster, plumes, shells, slime, abattoir squander (offal, blood quills, and fated cadavers), and transience. Incubation centre squander incorporates purge shells, barren eggs, dead embryos, and late hatchlings. Plant materials, which mostly comprise of ruffage components that may absorb heavyweight metallic cations in aqueous solution, are also made up of food waste and agricultural waste. Nature provides a variety of waste biomass sources whose adsorption capabilities have been described, including sawdust, rice rind, tea and coffee grounds, orange shell, peanut grenades, activated carbon, dry tree shrubberies, and bark [4].

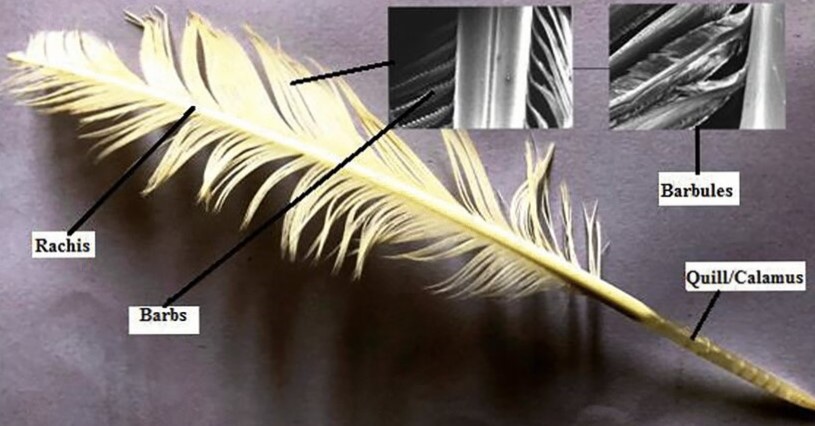
**II. EASE OF USE**

1. **Different ways obtain of waste from different type of industries:**

**Figure 1: types of waste from different industries**

Now Pollution is a serious world issue that causes varying levels of damage to the environment and life on earth. The carelessness of human actions is the real source of water contamination. It is convenient for many of us to dump rubbish into a brook or pond for discarding. The squander arranged of in expansive or little sums, dumped intentioned or incidentally, is carried absent by the water current, but will never vanish It’ll return downstream, now and then in a diverse shape, now and then fair weakened. [5-7]. Various physical methods for treatment, like as nanofiltration, diffusion, ion exchange, air stripping, and the rest, have also been used, and it has been discovered that these merely transference contaminants to additional stage rather than eliminating them. Some of the strategies outlined above have been shown to be quite effective, despite several flaws. The basic drawback of the advances talked about over is that they for the most part need the wide extend of treatment productivity required to evacuate all sorts of contaminants found in material wastewater. Be that as it may, when one approach does see promising, its capital costs or working costs frequently gotten to be restrictive when connected to the expansive water desires communal to at all industry. The need to treat wastewater in a way that is both affordable and environmentally sound has grown to be a serious issue. As a result, the adsorption procedure take confirmed to remain extremely effective method used for removing hazardous contaminants in the area of aquatic treatment. Adsorption is a technology that is quickly gaining popularity for treating textile effluents after wastewater treatment. Adsorption has been confirmed to be further advantageous used for reducing water pollution because it involves fewer initial expenditure then land-living. Second, the therapy apparatus is straightforwardly constructed and simple to use. There has been a extraordinary bargain of intrigued in embracing low-cost adsorbents for wastewater decolorization to lower working costs. These substances consist of chitosan, zeolite, fly ash, coal, oxides, agrarian wastes, wastes from legionellosis, etc. Animal waste materials like hairs, bones, etc. have been used as adsorbent in very little published work thus far.In specifically for the elimination of colours from wastewater using by Chicken Feathers as a possible adsorbent and reached extraordinarily good results. [8-17] Innovative ways to develop another energy sources and resources include certainly presented substitutes such as food and poultry waste [18**].** poultry wastes have been employed for a few decades in a variety of fields, including nanotechnology, to create new, essential composites. Almost half of all known compounds have been shown to be dissolved in natural water, and even a sparkling clear stream of water can contain complex mixtures of organic and inorganic elements [19] It increases downstream, sometimes in different forms, sometimes simply. Diluted Mother Nature has a excessive capability to breakdown leftover ingredients, but not in the quantities castoff by today’s culture. The excess that results, called contamination, ultimately puts the environment out of balance. Most of the time, community, agrarian, and manufacturing wastes contaminate our rivers, plus numerous dangerous artificial compounds that cannot be wrecked downcast by normal processes.Known as birds, warm-blooded vertebrates are distinguished by feathers, toothless beaks, hard-shelled eggs, fast metabolism, four-chambered hearts and strong but light skeletons. [20] Poultry waste may be useful in a variety of ways. Composite celluloses, proteins, fats, carbon-based acids, enzymes, and nutraceuticals make up food left-over [21] Although there has been much discussion on the definition of poultry waste for the purposes of this analysis, it is defined as any eatable or uneatable food that is vanished from the food source chain. The amassing of food wastelands poses ecological and economic problems. Food waste subsidizes more than 10-20% of the world's total releases of greenhouse gases (GHG), such as carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4). Food waste also harms the ecosystem by reducing land use and polluting groundwater near landfills. [22] Disposal of raw poultry compost without further processing is harmful, unsafe and causes serious environmental problems such as unpleasant odour, leaching of toxic elements such as heavy metals, methane emissions, eutrophication of water bodies, nutrient imbalance, phytotoxicity and spread of pathogens and weeds. The usual daily production of fresh compost per broiler is about 43 kg per 1000 kilograms of live weight. Poultry clutter production on a dry weight basis ranges from 0.8 to 2.1 tons per 1,000 broilers per flock. [23]

**Structure of feather**:Parts of feather –i) Rachis– the rachis is the stiff central shaft and Barbs constitute the softer portion of the feather. ii) The barbs are interconnected by hooked barbules called hamuli,iii)Calamus is the part of the shaft held in the feather follicle on the skin of the bird.[24]



**Figure 2: Structure of feather**

1. **How Birds Use Their Feathers**

As indicated by the different feather types described below Table

**Table 1: Different types of feather and their uses**

|  |  |  |  |
| --- | --- | --- | --- |
| **Feather type** | **Description** | **Barbule** | **Function** |
| Flight | long, stiff, asymmetrical | Hooked | flying |
| Contour | colorful, part still, part fluffy | Hooked and smooth | Protection |
| Down | soft, fluffy, small in size | smooth | Insulation |
| Semiplume | cross between contour and down feather | smooth | Insulation |
| Filoplume | Very small, sparse barbs at tip | Smooth | sensory |
| Bristle | short and stiff | smooth | Sensory |

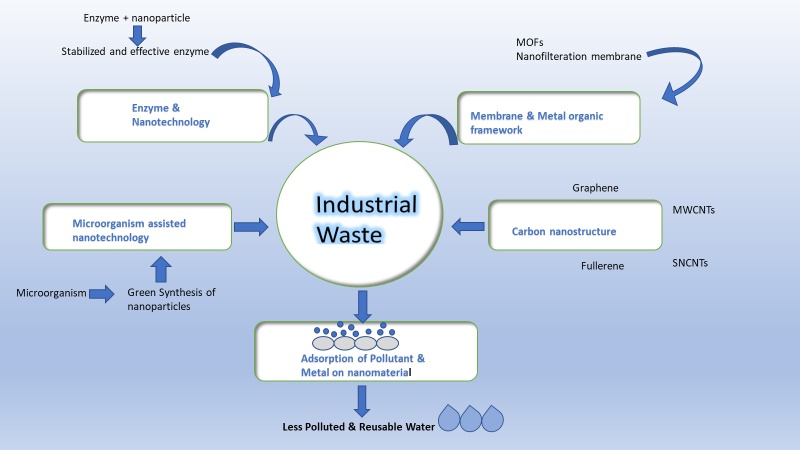
Avian feathers have a keratin content of about 90%. The global annual feat of offal production is around 8 \*105 tonnes. Processing feather waste to soluble keratin, which might be used to create innovative bioproducts, is an alternative technique of utilizing feather waste. [25]

**III. POULTRY SUB SECTOR REQUIREMENT**

Need Environment for policy development? Support and interventions are needed primarily for diseases surveillance, drug residues and quality control of drugs/vaccines, standardisation and quality control of feed ,poultry eggs and meat, apply HACCP( Hazard Analysis and Critical Control Points)and upright industrial observes to comply with WTO and CODEX standards and grading, value in addition, promote the brand and promote exports( approximately about Rs 532 crores in 2016-17)etc. (26)given below Table no. 2

**Table 2: Requirement of poultry sub sector**

**A. Ways of industrial wastewater**:



**Figure 3: Multi-stream Industrial Waste Water**

**IV. MATERIAL AND METHOD**

**MATERIAL**

1. **Adsorbate Material**

**A (i) Methylene blue** Is a vibrant organic salt molecule, is used as an adsorbate material. Swiss blue and methylthioninium chloride are other names for it. The most frequently used dye in the material manufacturing for finishing purposes is methylene blue (MB). This dye remains a highly oncogenic phenothiazine imitative that promotes hypertrophication and accordingly degrades marine media and wild life life circumstances. Skin aversions, nausea, nervous system sicknesses, cardiac injury, breathing difficulties, sickness, and gastrointestinal infection can all be caused by MB [27-29]. To evade the detrimental possessions of this dye on community fitness, MB must be removed from aqueous samples. [30]. A variability of methods for eradicating MB from bodies of water have been recognized. Photo-oxidation, organic decrease [31-33], adsorption [34], biotic treatment [35], film flotation [36], flocculation [37], and photocatalytic degradation [38,] are among the approaches documented.

**Table 3 Details of methylene blue**

|  |  |
| --- | --- |
| Chemical Formula | C16H18N3SCI |
| IUPAC NAME | 7−(dimethylamino)phenothiazin−3−ylidene - methyl azanium; chloride |
| Colour in Acid | Blue Colour |
| Colour in Base | Colour less |
| Molecular Weight | 319.85 g/mol. |
| Physical State | Solid, Dark Green Powder at room temperature |
| Order | Orderless |
| Melting Point | 100-110 0 C |
| Soluble/Insoluble | Soluble in Water/ Insoluble in Chloroform |
| Maximum Absorption | 665-670 nm |
| Specific Gravity | ~1.00 g/mL @200 C |
|  |  |

Methylene blue is represented by the formula C16H18N3SCI

It has 3,7-bis (dimethyl amino) phenothiazine - 5 – ium chloride as the counterion.

Its IUPAC name is 7−(dimethyl amino) phenothiazin−3−ylidene

7−(dimethyl amino) phenothiazin−3−ylidene - methyl azanium; chloride.

1. **(ii)Crystal Violet**. : Also known as gentian violet, methyl violet 10B or hexamethylpararosaniline chloride. Crystal violet is used as an adsorbate material in our work Gentian Violet is a main dye utilize in the process of Gram stain. It is a triarylmethane dye that remains also referred to as CV. Although the name CV was originally intended to describe a mixture of methyl pararosaniline dyes (methyl violet), nowadays usually used interchangeably with Crystal Violet. It is not made from gentians or else violets, and its name mentions to the colour of its petals, which look like those of some gentian flowers. GV is an basic dye derived from carbon-based chloride salts of the triphenylmethane family. It has numerous biological and commercial applications, including fingerprinting, toner tinting, antifungal, antiseptic, anthelmintic agents, and histological discoloration. Gentian Violet is similarly identified as Basic Violet 3, Crystal Violet, Hexamethyipararosaline chloride, and Methyl Violet 10B. It is a dark green complex with a metal luster once powdered, but when melted in a solvent, it goes voilet. The dye's distinct hues are caused by the different charged states.

crystal Violet is an [aniline](https://pubchem.ncbi.nlm.nih.gov/compound/Aniline)-derived dye with the chemical formula of C25N3H30Cl

**Table 4 Details of Crystal Violet**

|  |  |
| --- | --- |
| Chemical Formula | C25H30CLN3 |
| IUPAC NAME | 3−(dimethylamino) Phenylmethyldimethylazanium |
| Colour in Acid | Yellowish- Green (Due to low pH) |
| Colour in Base | Bluish-Purple (Due to High pH) |
| Molecular Weight | 407.9 g/mol |
| Physical State | Solid |
| Order | Orderless |
| Melting Point | 2050 C |
| Soluble/Insoluble | Soluble in Water,Alcohol &Chloroform/ Insoluble in Ether & Xylene |
| Maximum Absorption | 592 nm |
| Specific Gravity | 1. /mL @200 C |

**B. Adsorbent material**

**Hen Feather:** Feather have beautiful and skilled structures. Figure 2 details the feather's component elements. According to a review of the literature, the usage of chicken feathers as a applicant aimed at a probable adsorbent for the elimination of harmful dyes remained a novel idea that was initially developed in a lab [8-17]. Prior to 2006, Al-Asheh and colleagues [39-41] were the leading researchers in the field of using chicken feathers as an adsorbent individual for the elimination of metal ions. Similar research was done [42] employing group adsorption techniques and chicken feathers as an adsorbent to remove dual arrangements of copper, zinc, and nickel ions. Teixeira et al. [43]. established a biotic approach aimed at through sorption of aqueous As (III) species over unused biomass derived from chicken feathers with a high fibrous protein content. Attempts have been undertaken in recent years to use chemically modified feathers to remove heavy metals (Zn2+) from polluted water [44].

**C. Production of Adsorbent Material**

As mentioned previously, chicken feathers typically have a lenient hook portion also a firm rachis. The poultry feathers remained roughly one centimetre long and filthy. The feathers were initial stirred in a wash of distilled water to remove filth, blood stains, and odour, and then they were repeatedly cleaned in particularly purified water. The cleaned feathers remained before dried out, their lenient hooks remained sliced into tiny parts with a sharp knife that were each about 0.1 mm long, and the central rachis were removed and thrown away. The resulting barbs were then exposed to 30% v/v hydrogen peroxide for around 24 periods to oxidize the carbon-based material adhering to the barbs. The substantial was then placed in an oven set at 100 C for 12 hours to remove the moisture, and the resulting activated adsorbent was held there in a vacuum desiccator until it was needed.

**Methodology**

Simple and affordable alkaline hydrolysis is used to hydrolyse HF. and after that, thiourea is used with NaOH as a reducing agent. Using CS2, partially hydrolysed HF is dithiocarbamylated. Different ratios of PVA, glycerol, glutaraldehyde, and HCl are mixed with DTCCF. PVA is used to aid in the development of films since it has a favourable tendency to do so.In addition to glutaraldehyde and HCl, glycerol also serves as a plasticizer and a cross-linker. The film was pigeonholed by scanning electron microscopy, Fourier transform infrared spectroscopy, X-ray diffraction analysis, differential scanning calorimetry and atomic force microscopy. This film remained used as an efficient adsorbent to eliminate methylene blue and crystal violet from their aqueous solutions.

**V. Comparative studies of low-cost adsorbent**

**Table 5 description and application of low-cost adsorbent**

|  |  |  |  |
| --- | --- | --- | --- |
| **Adsorbent**  **(Low cost)** | **Descriptive** | **Application** | **References** |
| Ostrich Feather | Isotherm Adsorption | Removal of Phenol from aqueous solution | 44 |
| Chicken Feather | Statically Physics Analysis | Physical Interpretation of the adsorption mechanism of heavy metals of ions (Pb+2,Ct+2,Ni+2) | 45 |
| Lignocellulosic base bio sorbent | Sustainable framework by emerging pollutant. | Adsorption of pharmaceutical and heavy metal pollutant in waste water. | 46 |
| Corn Stalk and Premna microphyll leaves | Bio aerogel | Oily water treatment | 47 |
| Azadirachta Indica (Neem Saw Dust) | Adsorptive elimination of cationic dyes | Removal of crystal violet from aqueous solution | 48 |
| Trypolyphosphate (TPP) | Chitosan based magnetic adsorbent and vanillin CMN | Synthesis surface modification characterization and application Cd+2,Co+2,Cu+2,Pb+2 ions removal from waste water. | 49 |
| Cinnamon Barc Biomass | Green Strategy | Removal of cationic methylene blue dye from waste water | 50 |
| Pigeon Feather | Kinetic and isotherm study | Kinetic and Isotherm studies of Congo red dye from aqueous solution. | 51 |
| Sugarcane bagasse | Kinetic and equilibrium isotherm | Removal of different petroleum hydrocarbon water pollutant | 52 |
| Rice Husk | Green Synthesis | Mitigating Waterborne Contaminant | 53 |

**IV. CONCLUSION**

The key aspects of this research were to progress a profitable, swift and versatile way for taking away the risky dyes (methylene blue and crystal violet) from wastewater and to apply waste material Chicken Feather as prospective adsorbent. The research displayed in this chapter certainly establishes that all Chicken Feather can be strongly engaged as adsorbent to take away the venomous dyes from wastewaters. The accessibility of waste material is ample and discarding this always been a challenge, the implementation of such a honest cause as expected to thrive efforts for the well-being of society. Outcome displayed in this chapter clearly recommends that the comprehensive research have been made right through the progression of the dye eradication process. So, to conclude that Chicken Feather react as an successful and environmentally safe adsorbent for the removal of risky organic pollutants– dyes from wastewater and the adsorption process emerges during the course of present investigations are effective, environmentally safe and profitable

**REFERENCES**

[1] B. M. Linde ‘‘Water on Earth’’ Bench Education Co. New York (2005).

[2] L. Hubbell ‘‘The Earth, National Science Teachers’’ Assoc., National Aeronautics andSpace Administration, USA (1964).**ERIC**

**Number:** ED021745

[3] D. McNab, N. D. W. Jig ‘‘Earth, Water, Air and Fire’’ Studies in Canadian EthnoHistory (1998). ISBN0889202974

[4] MohiniYadav, Vagish Dwivedi and SwatiSharmaNancyGeorge‘‘Biogenic silica nanoparticles from agro-waste: Properties,

mechanism extraction and applications inenvironmentalsustainability’’[2022]<https://doi.org/10.1016/j.jece.2022.108550>

[7] S. D. Kenneth and J. A. Day, Water: The Mirror of Science, Garden City, New YorkDouble Day, Anchor Book, p. 133 (1961).

[8] T. A. Ternes ‘‘Occurrence of rugs in German sewage treatment plants, river and water’’Research 32 (1998) 3245–3252.

<https://doi.org/10.1016/S0043-1354(98)00099-2>

[9] W. Kolpin, E. T. Furlong, M. T. Meyer, E. M. Thurman, S. D. Zaugg, L. B. Barber,AndH. T. Buxton, ‘‘Pharmaceuticals, hormones,

and another organicwastewatercontaminant’s’’ in U. S. streams, 1999–2000: A national reconnaissance.Environment.

2002, 36, 6, (1202–1211)<https://doi.org/10.1021/es011055j>

[10] A. Mittal, L. Kurup, and J. Mittal, ‘‘Freundlich and Langmuir adsorption isotherms andkinetics for the removal of Tartrazine from

aqueous solutions using hen feathers’’Journal of Hazardous Materials 146(1–2) (2007) 243–248.

<https://doi.org/10.1016/j.jhazmat.2006.12.012>

[11] A. Mittal, J. Mittal, and L. Kurup, ‘‘Utilization of hen feathers for the adsorption of ahazardous dye, Indigo Carmine from its simulated

effluent’’ Journal EnvironmentalProtection Science 1 (2007) 92–100. Hen Feather: A Remarkable Adsorbent for DyeRemoval 454

[12] V. K. Gupta, A. Mittal, L. Kurup, and J. Mittal, ‘‘Adsorption of a hazardous dye,Erythrosine, over hen feathers’’ Journal of Colloid &

Interface Science 304 (2006) 52-7.<https://doi.org/10.1016/j.jcis.2006.08.032>

[13] A. Mittal ‘‘Adsorption kinetics of removal of a toxic dye, Malachite Green, fromwastewater by using hen feathers’’ Journal of

Hazardous Materials 133(1–3) (2006) 196-202.<https://doi.org/10.1016/j.jhazmat.2005.10.017>

[14] A. Mittal ‘‘Use of hen feathers as potential adsorbent for the removal of a hazardousdye, Brilliant Blue FCF, from waste water’’

Journal of Hazardous Materials 128(2–3)(2006) 233–239. <https://doi.org/10.1016/j.jhazmat.2005.08.043>

[15] A. Mittal ‘‘Removal of the dye Amaranth from waste water using hen feathers apotential adsorbent’’ Electronic Journal of

Environmental, Agricultural and FoodChemistry5(2) (2006) 1296–1305. ISSN: 1579-4377

[16] J. Mittal, V. Thakur, H. Vardhan, and A. Mittal. ‘‘Batch removal of hazardous azo dyeBismark Brown R using waste material hen

feather’’ Ecological Engineering volume 60 (2013)249-253<https://doi.org/10.1016/j.ecoleng.2013.07.025>

[17] A. Mittal, V. Thakur, J. Mittal, and H. Vardhan ‘‘Process development for the removal of hazardous anionic azo dye Congo-red from

wastewater by using hen feather aspotentialadsorbent. Desalination and Water Treatment’’10.1080/19443994.2013.785030

Pages 227-237 (2013)<https://doi.org/10.1080/19443994.2013.785030>

[18] A. Mittal, V. Thakur, and V. Gajbe ‘‘Adsorptive removal of toxic azo dye Amide Black10B by hen feather’’ Environmental Science

and Pollution Research 20 (2013) 260–269.

[19] A. Mittal, V. Thakur, and V. Gajbe ‘‘Evaluation of adsorption characteristics of andanionic azo dye Brilliant Yellow onto hen feathers

in aqueous solutions’’ EnvironmentalScience & Pollution Res. 19 (2012) 2438–244

[20] B. Halling-Sorensen, S. N. Nielsen, P. F. Lanzky, F. Ingerslev, H. C. Holten Outshootand S. E. Jorgensen, Occurrence, fate and effects

of pharmaceutical substances in theenvironment – A review. Chemosphere 36 (1998) 357–393

[21] Bird. Available at <https://en.wikipedia.org/wiki/Bir>B. N. Publication House. Israel. 2022.

[22] RajeevRavindran and Amit K.Jaiswal ‘‘Exploitation of food industry waste for high-Value’’ 1198 productsTrends in Biotechnology

34, 58-69<https://doi.org/10.1016/j.tibtech.2015.10.008>

[23] FAO (2011) "Energy-smart" food for people and climate: issue paper [Online]. Food and1021 Agriculture Organization of the United

Nations. Availablehttp://www.fao.org/3/a1022 i2454epdf [Accessed 15/4/2020]

[24] P Singh · 2018 · Cited by 24

[25] Grazziotin, A., Pimentel, F.A., De Jong, E.V., Brandelli, ‘‘ANutritional improvement offeather protein by treatment with microbial

keratinase’’Animal Feed Science Technology **1261**,135–144 (2006).<https://doi.org/10.1016/j.anifeedsci.2005.06.002>

[26] R. Begum, J. Najeeb, A. Sattar et al., “Chemical reduction of methylene blue in the presence of Nano catalysts: a critical review,”

Reviews in Chemical Engineering, vol. 36, no. 6, pp. 749–770, 2020.<https://doi.org/10.1515/revce-2018-0047>

[27] M. I. Din, J. Najeeb, Z. Hussain, R. Khalid, and G. Ahmad, “Biogenic scale upsynthesis of ZnO Nano-flowers with superior Nano-

photocatalytic performance,” Inorganic and Nano-Metal Chemistry, vol. 50, no. 8, pp. 613–619, 2020.

<https://doi.org/10.1080/24701556.2020.1723026>

[28] M. F. Shakir, A. Tariq, Z. A. Rehan et al., “Effect of Nickel Spinal-Ferrites on EMIshielding properties of polystyrene/ polyaniline

blend,” SN Applied Sciences, vol. 2,no. 4,pp. 706–713, 2020.

[29] H. F. Shakir, M. Shahzad, H. R. Aziz et al., “In-situ polymerization and EMI shielding property of barium hexaferrite/ pyrrole

nanocomposite,” Journal of Alloys andCompounds. vol. 902, Article ID 163847, 2022.

<https://doi.org/10.1016/j.jallcom.2022.163847>

[30] C. M. B. Neves, O. M. Filipe and N. Mota ,Sónia A.O. Santos, Armando J.D. Silvestre , Eduarda B.H. Santos , M. Graça

P.M.S. Neves , [Mário M.Q. Simões](https://www.sciencedirect.com/author/7102405728/mario-m-q-simoes)[a](https://www.sciencedirect.com/author/7102405728/mario-m-q-simoes)Photodegradation of metoprolol usinga porphyrin as photosensitizer under

homogeneous and heterogeneous conditions,”Journal of Hazardous Materials, vol. 370, pp. 13–23, 2019

<https://doi.org/10.1016/j.jhazmat.2018.11.055>

[31] A. Nasri, B. Jaleh, Z. Nezafat et al., “Fabrication of g-C3N4/Au nanocomposite usinglaser ablation and its application as an effective

catalyst in the reduction of organicpollutant in water,” Ceramics International, vol. 47, no. 3, pp. 3565–3572, 2021

<https://doi.org/10.1016/j.ceramint.2020.09.204>.

[32] P. T. Ahmad, B. Jaleh, M. Nasrollahzadeh, and Z. Issaabadi, “Efficient reduction ofwaste water pollution using GO/ cMnO2/Pd

nanocomposite as a highly stable andrecoverable catalyst,” Separation and Purification Technology, vol. 225, pp. 33–40,

2019.<https://doi.org/10.1016/j.seppur.2019.05.062>

[33] M. Nasrollahzadeh, M. Sajjadi, H. R. Dasmeh, and S. M. Sajadi, “Green synthesis of the Cu/sodium borosilicate nanocomposite and

investigation of its catalytic activity,” Journal of Alloys and Compounds, vol. 763, pp. 1024–1034, 2018.

<https://doi.org/10.1016/j.jallcom.2018.05.012>

[34] K. Naseem, Z. H. Farooqi and M. Z. Ur Rehman “A systematic study for removal heavy metals from aqueous media using Sorghum

bicolor: an efficientbio sorbent,”Water Science and Technology, vol. 77, no. 10, pp. 2355–2368, 2018.

[35] S. Saghaf, A. Ebrahimi, N. Mehrdadi, and G. N. Bidhendy, “Evaluation of aerobic/anaerobic industrial wastewater treatment

processes: the application of multi-criteria decision analysis,” Environmental Progress and Sustainable Energy, vol. 38,

no.5, Article ID 13166, 2019 [**https://doi.org/10.1002/ep.13166**](https://doi.org/10.1002/ep.13166)

[36] W. Pronk, A. Ding, E. Morgenroth et al., “Gravity-driven membrane filtration for water and wastewater treatment: a review,” Water

Research, vol. 149, pp. 553–565, 2019.<https://doi.org/10.1016/j.watres.2018.11.062>

[37] T.-H. Ang, K. Kiatkittipong, W. Kiatkittipong et al., “Insight on extraction andcharacterisation of biopolymers as the green coagulants

for microalgae harvesting,”Water, vol. 12, no. 5, p. 1388, 2020. [**https://doi.org/10.3390/w12051388**](https://doi.org/10.3390/w12051388)

[38] M. I. Din, R. Khalid, J. Najeeb, and Z. Hussain, “Fundamentals and photocatalysis ofmethylene blue dye using various noncatalytic

assemblies-a critical review,” Journal of Cleaner Production, vol. 298, Article ID 126567, 2021.

<https://doi.org/10.1016/j.jclepro.2021.126567>

[39] M. Nasrollahzadeh, Z. Nezafat, M. G. Gorab, and M. Sajjadi, “Recent progresses ingraphene-based (photo) catalysts for reduction of

nitro compounds,” MolecularCatalysis,vol. 484, Article ID 110758, 2020.

<https://doi.org/10.1016/j.mcat.2019.110758>

[40] S. Al-Asheh, P. Banat, and D. Al-Rousan, ‘‘Beneficial reuse of chicken feathers in removal of heavymetals from wastewater’’ Journal

of Cleaner Production 11 (2003) 321–326.<https://doi.org/10.1016/S0959-6526(02)00045-8>

[41] F. Banat, S. Al-Asheh, and D. Al-Rousan ‘‘Comparison between different keratin- composed bio sorbents for the removal of heavy

metal ions from aqueous solutions’’ Adsorption Science and Technology 20 (2002) 393–416

<https://doi.org/10.1260/02636170260295579>

[42] S. Al-Asheh, P. Banat, and D. Al-Rousan ‘‘Adsorption of copper, zinc and nickel ions from single and binary metal ion mixtures on to

chicken feathers’’ Adsorption Science and Technology 20 (2002) 849–864 456 Green Chemistry for Dyes Removal from Wastewater.

<https://doi.org/10.1260/02636170260555778>

[43] M. C. Teixeira and V. S. T. Ciminelli ‘‘Development of a bio sorbent for arseniteStructural modelling based on x-ray spectroscopy’’

Environmental Science and Technology 39(3) (2005) vol. 895–900.<https://doi.org/10.1021/es049513m>

[44] C. Yang, L. Guan, Y. Zhao, Z. Su, and T. Cai ‘‘Adsorption of Zn (II) on TA-modified feather. Lizi Jiaohuan Yu Xifu/Ion Exchange

and Adsorption 23(3) (2007) 259–266. 71.

[45] [Mohammad Manshouri](https://www.tandfonline.com/author/Manshouri%2C+Mohammad),[Hasti Daraei](https://www.tandfonline.com/author/Daraei%2C+Hasti)&[Ahmad Reza Yazdanbakhsh](https://www.tandfonline.com/author/Yazdanbakhsh%2C+Ahmad+Reza)Pages 179-185 | Received 06 Jul 2011, Accepted 08

Jan 2012, Published online: 29 Mar 2012<https://doi.org/10.1080/19443994.2012.664712>

[46] Fatma Dhaouadi a, Lotfi Sellaoui a, Michael Badawi b, Hilda Elizabeth Reynel-Ávila c d, Didilia Ileana Mendoza-Castillo c d, José

Enrique Jaime-Leal c, Adrián Bonilla-Petriciolet c, Abdelmottaleb Ben Lamine a<https://doi.org/10.1016/j.molliq.2020.114168>

[Volume 319](https://www.sciencedirect.com/journal/journal-of-molecular-liquids/vol/319/suppl/C), 1 December 2020, 114168

[47] Rongchuan Ye , Huosheng Li , Jianyou Long , Yaxuan Wang , Dan Peng ‘‘Bio-aerogels derived from corn stalk and Premna

Microphylla leaves as eco-friendly sorbents for oily water treatment’’ The role of microstructure in adsorption performance

[Volume 403](Volume%20%20%20403), 1 June 2023, 136720 <https://doi.org/10.1016/j.jclepro.2023.136720>

# [48] Mohd Ashraf Dar, Mohammad Anas, Kumari Kajal, Sandeep Kumar, Garima Kaushik ‘‘Adsorptive removal of crystal violet dye

# by Azadirachta indica (neem) sawdust: A low-cost bio-sorbent’’ (2023) <https://doi.org/10.1016/j.chnaes.2023.02.011>

# [49][Dipesh Chandra](https://www.nature.com/articles/s41598-023-32847-3#auth-Dipesh-Chandra-Aff1), [Md. Tamzid Hossain Molla](https://www.nature.com/articles/s41598-023-32847-3#auth-Md__Tamzid_Hossain-Molla-Aff1), [Md. Abul Bashar](https://www.nature.com/articles/s41598-023-32847-3#auth-Md__Abul-Bashar-Aff1), [Md. Suman Islam](https://www.nature.com/articles/s41598-023-32847-3#auth-Md__Suman-Islam-Aff1) & [Md. Shameem Ahsan](https://www.nature.com/articles/s41598-023-32847-3#auth-Md__Shameem-Ahsan-Aff1) ‘‘Chitosan-based nano-

# sorbents: synthesis, surface modification, characterisation and application in Cd (II), Co (II), Cu (II) and Pb (II) ions removal from

# wastewater’’**volume 13**, Article number: 6050 (2023)

# [50] Batuhan Yardımcı a, Nergiz Kanmaz An effective-green strategy of methylene blue adsorption: Sustainable and low-cost waste

# cinnamon bark biomass enhanced via MnO2<https://doi.org/10.1016/j.jece.2023.110254>[Volume 11, Issue 3](https://www.sciencedirect.com/journal/journal-of-environmental-chemical-engineering/vol/11/issue/3), June 2023, 110254

[51] HARPREET KAUR\* , SWATI and RAJVIR KAUR ‘‘Kinetic and Isotherm Studies of Congo Red Adsorption from Aqueous

Solution by Biowaste Material’’ Chemical Science Transactions DOI:10.7598/cst2014.922 2014, 3(4), 1300-1309

[52] [Nour Sh. El-Gendy](https://www.tandfonline.com/author/El-Gendy%2C+Nour+Sh) , [Hussein N. Nassar](https://www.tandfonline.com/author/Nassar%2C+Hussein+N)‘‘Study on the effectiveness of spent waste sugarcane bagasse for adsorption of different

petroleum hydrocarbons water pollutants: kinetic and equilibrium isotherm’’Pages 5514-5528 Published online: 03 Feb

2015<https://doi.org/10.1080/19443994.2015.1004598>

[53] Evidence Akhayere ,DogaKavaz and Ashok Vaseashta Efficacy Studies of Silica Nanoparticles Synthesized Using Agricultural

Waste for Mitigating Waterborne Contaminants Appl. Sci. 2022, 12, 9279 https:// doi.org/10.3390/app12189279

The key aspects of this research were to progressaprofitable, swift and versatile way for taking away the risky dyes (methylene blue and crystal violet) from wastewater and to apply waste material Hen Feather as prospective adsorbent. The research displayed in this chapter certainly establishes that all Hen Feather can be strongly engaged as adsorbent to take away thevenomous dyes from wastewaters. The accessibilityof waste material isampleand discarding this always been a challenge, theimplementationof such ahonest cause as expectedto thriveefforts for the well-being of society. Outcome displayed in this chapter clearlyrecommends that the comprehensiveresearch have been made right through the progression of the dye eradication process. So, to conclude that Hen Featherreact as an successful and environmentally safe adsorbent for the removal of risky organic pollutants– dyes from wastewater and the adsorption process emerges during the course of present investigations are effective, environmentally safe and profitable.