CODEN (USA): IJPB07 ISSN: 2320-9267

Indian Journal of Pharmaceutical and Biological Research (IJPBR)
Journal homepage: www.ijpbr.in

Research Article DOI: https://doi.org/10.30750/ijpbr.6.4.9

Development of new Nanocomposite by using bagasse dust and polyaniline for removal of heavy metal ions from Pharma industry effluent

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ARTICLE INFO:
Article history:
Received: 17 September 2018
Received in revised form:
22 November 2018
Accepted: 24 November 2018
Available online: 31 December 2018
Keywords:
Nano-composites,polyaniline, heavy metals,FT-IR, SEM

Abstract
Nanotechnology has given the opportunity to the researcher for developing new nano-composites in all field including, pharmaceuticals, agriculture, electronics and other fields.
In this study agriculture waste material like bagasse dust has been combined with polyaniline to prepare new Nano composites. So formed Nano composite was characterised by using XRD, FTIR and SEM. SEM confirmed the Nanocomposite formation with size in the range of 100-130 nm. Such nanocomposites were used in the removal of dyes and heavy metals from industrial effluent. About 80-99% heavy metals could be removed through adsorption successfully.

Introduction

Nanocomposite is a multiphase solid framework in which one material is present in nanosize i.e. 1 to 200 nm. Nanoparticles are added to enhance a specific property of the material. The consequence of the addition of nanoparticles is a extreme improvement in physical as well other properties that can include adsorption, mechanical strength, toughness and electrical or thermal conductivity etc[1]. The effectiveness of the nanoparticles is such that the amount of material added is normally just in the vicinity 0.5% to 5% by weight[2]. Nanoparticles have an extremely high surface to volume ratio which significantly changes their wide sized equivalents. It likewise changes the manner by which the nanoparticles bond with the bulk material[3].

In this study, polyaniline nanocomposite was synthesized on the surface of bagasse and other agri-residues, which have shown very good adsorption of heavy metals.

Many industries like cosmetics, pharmaceuitcals, paper, food , textiles etc use dyes , metals and other compounds which create colour and pollution of the effluent[4]. Some of these dyes and their degradation and removal products like aromatic amines are extremely carcinogenic and dangerous for human health. The dyes and other compounds when discharged from the industries bearing waste water give adverse effect on aquatic environment owing to giving undesirable colour to water and reduce light penetration and photosynthesis[5].

Material and method

All necessary reagents of standard company like merck /rankem were used.Nanocomposite of bagasse dust (agri-residue waste) and polyaniline was prepared in acidic conditions. Polymerisation of aniline in aqueous acidic media can be performed using oxidizing agent $K_2S_2O_8$[7]. 2 g bagasse dust immersed in 25 mL of 0.20 M aniline in 1 M HCl solution for about 6 h before the polymerization. The excess of the monomer solution was removed by simple decantation. Semi molar $K_2S_2O_8$ used as an oxidant solution was added into the mixture slowly and slowly and the reaction was permitted to proceed at room temperature for about 3-4 hours. After that, the polymer coated bagasse dust (polyaniline nanocomposite) was filtered, washed with distilled water, dried in an oven at 60 ºC and sieved before use. The characteristics of the polyaniline nano composite were studied as per the standard procedures of XRD and the surface morphology was analyzed by scanning electron microscope (SEM).

Characterization of Adsorbent

The morphologies of the synthesized Polyaniline nanocomposite product were characterized using a scanning electron microscope (SEM). The synthesized samples were subjected to X-ray diffraction by a diffractometer (XRD, Bruker AXS company from IIT-R) equipped with the graphite mono chromatized CuKα radiation ($\lambda = 1.5406$ Å) in 2θ angles ranging from 5º to 50º with a step size of 0.05º and scanning rate 2º per minute. Absorbance was measured by the UV-Vis Double Beam Spectrophotometer built Systronics, Model no. AU-2701 (Department of Chemistry, Uttaranchal University).

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Result and discussion

Fig. 1. Polyaniline bagasse dust Nanocomposites sample

So formed nanocomposites have been shown in figure-1. And XRD is shown in figure-2 and sem analysis is shown in fig.3.

XRD Analysis:

In order to find out the structure and phase, XRD was carried out Powder X-ray Diffractometer (XRD) on D8 advance Bruker AXS. **Fig.2(a)** and **fig.(b)** show the XRD patterns of as prepared Polyaniline Nanocomposites. The sharp peaks are confirmation about the clusters having globular particle shape of bagasse dust-Polyaniline Nanocomposites. From figure, it is clear that no separate peaks occur while two broad humps was observed. These humps occur due to overlapping of the nearest peak. These peaks are very broad due very small particle size so that these cannot be separated by XRD. The first hump occur with the overlapping of the peaks of which are situated at nearly 21.57 to 23.49º. The average cluster size of the nanocomposites was calculated using Debye–Scherer formula:

$$D_{avg} = 0.9\lambda/\beta\cos\theta$$

Where λ is the X–ray wavelength, D is the crystalline size, θ is the Bragg's diffraction angle of peak and β is the full width of θ.

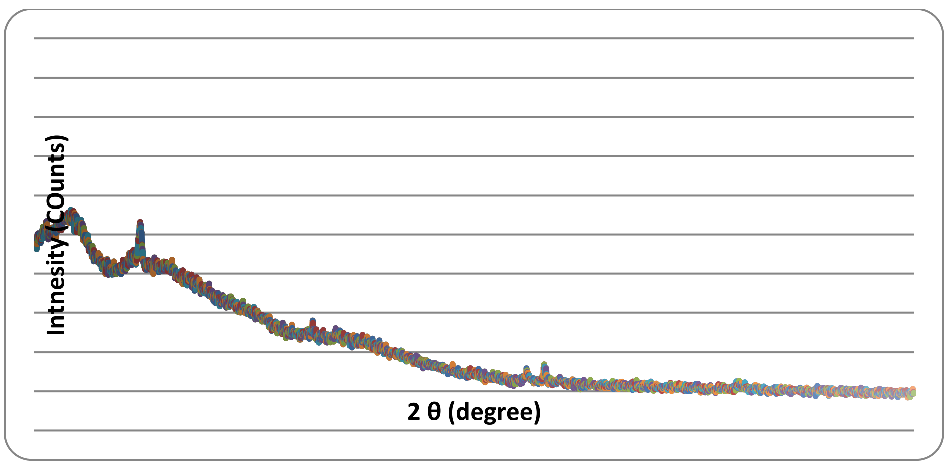

Fig.2.(a):XRD Analysis of Polyaniline nanocomposite sample

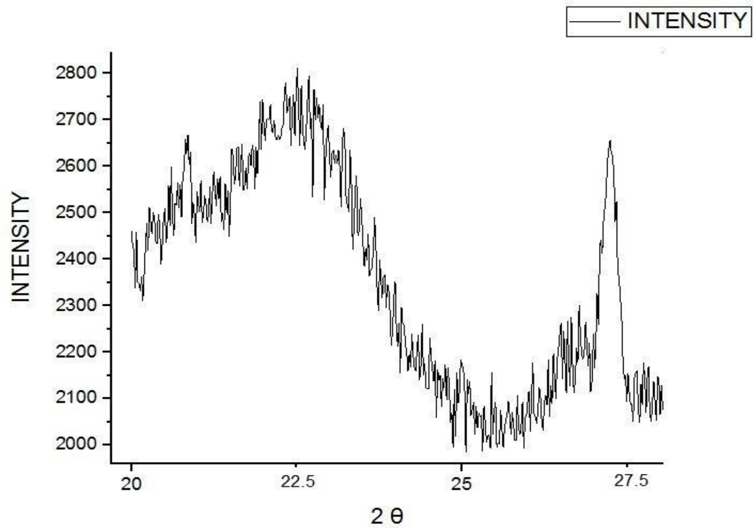

Fig. 2.b:Resolved XRD Analysis of bagasse dust-Polyaniline nanocomposite

SEM Analysis

The surface morphology studies of synthesized nanocomposite from scanning electron morphology (SEM). It is clear by the Fig that a cluster having globular particle shape like morphology was formed in the form of network, with diameter from 90 to 110 nm. In the polymer nanocomposite, the cluster having globular particle shape like morphology is less visible as the polymer coated dust (polyaniline nanocomposites). It is notable that, when HCl is used as a dopant, the aniline monomer was adsorbed onto the surface of sawdust through electrostatic attraction by the formation of weak charge transfer complexes between aniline monomer and sawdust.

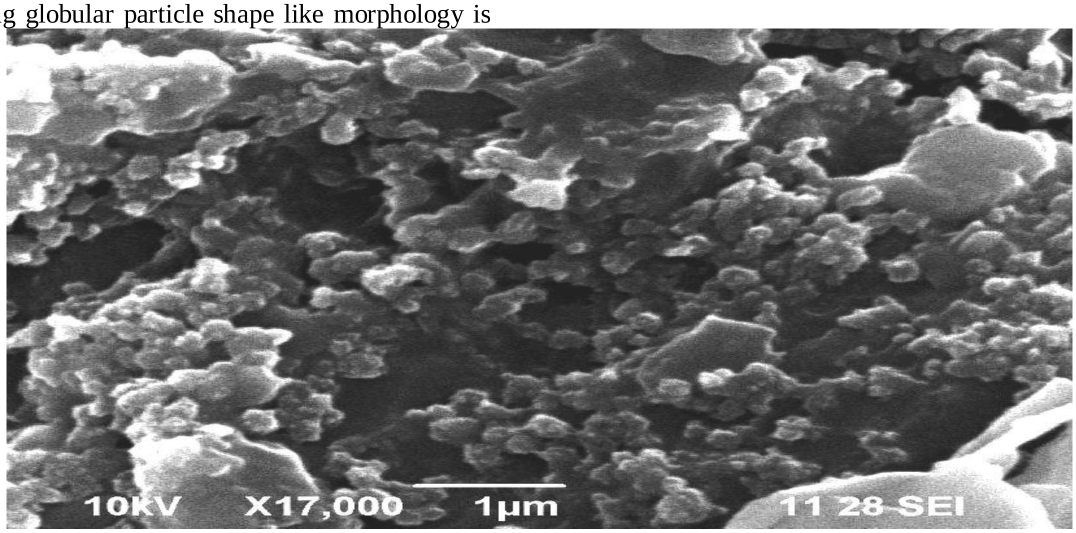

Fig.3: Scanning electron microscope (SEM) of polyaniline nanocomposite

Heavy metals and dye removal

So formed nanocomposites was used in different industrial effluent like paper, cosmetics, pharma and other industry effluents. We observed that on addition of amounts of nanocomposite in effluent increases the removal of pollution load specially heavy metals from effluent.We observed removal of heavy metals ffrom 80 to 95 %, by adsorption phenomenon on increasing the concentration of so formed nanocomposites. Different experiments were also set for removal of dyes from aqueous solution and effect of time temperature and concentration were studied and we observed that lower PH favored the removal of colored dyes and results are shown in figure- 4

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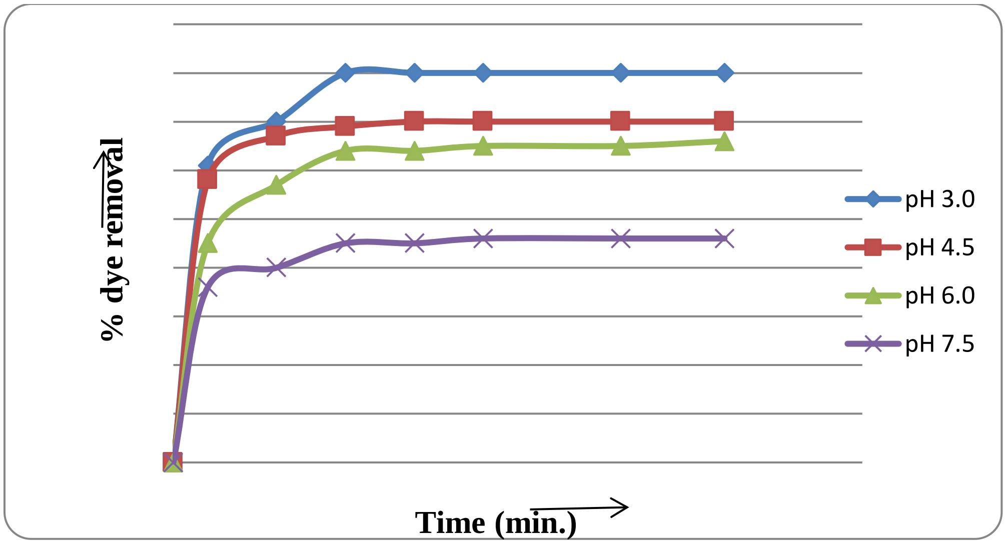

Fig.5 Effect of pH on percentage removal of color(dye) on Polyaniline nanocomposite

Also we studied the agitation time, agitation time of about 3 hours was most favorable for removal of maximum dyes and heavy metals. Results showm in fig.5

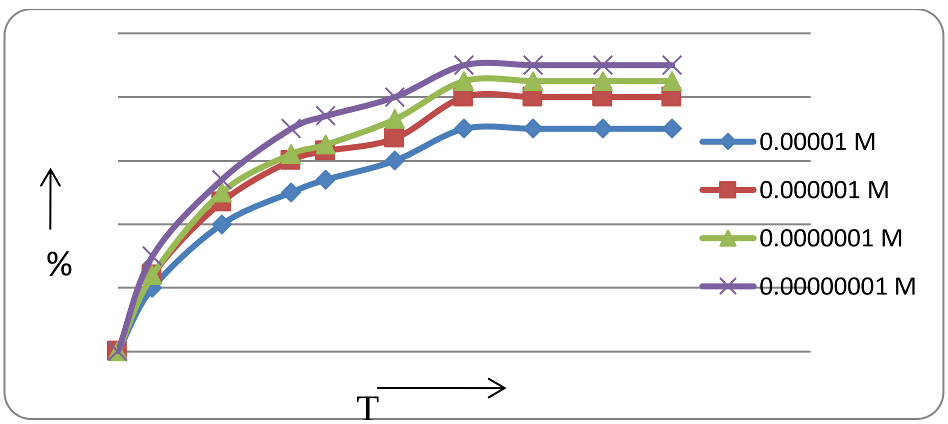

Fig.5: Effect of agitation time(T) on the percentage removal (%) of reactive dye on polyaniline nanocomposite at 30°C (adsorbent dosage 100 mg at pH 4)

Removal of heavy metals due to adsorption was observed. Such formed Polyaniline –bagasse dust nanocomposite has sites and these are fixed positively charged which are balanced with the anions starting from monomer. The small size dopant anions can be exchanged with other anionic species in treated solutions which have stronger interactions with the polymer. Adsorption is an effective treatment technique that's wide used for the removal of contaminants from water and wastewater[8]. Activated carbon is that the most commonly used adsorbent owing to its high adsorption capability. However the high cost of activated carbon restricts its use mostly in developing countries. This has led several researchers to search for the use of low cost and efficient alternative materials like coal, sludge, magnetically improved brewer's yeast, soil, fly ash, rice husk, neem (Azadirachta indica) leaf powder, baggasse pith, date pits, fruit stones and nutshells[9]. They were used for the removal of dyes from artificial dyehouse effluents by many researchers[10-12].

Overall it can be concluded that such formed nano-composites by using agricultural waste like bagasse dust or coconut or wheat straw many nano-composites can be prepared along with polyaniline and other compounds which can be used in removal of heavy and other metals ions from waste water or effluent and it can be best optimized economical and environment friendly method.

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Cite this article: **Ajay Singh, Gurmeet Singh, Asheesh Kumar Gupta.**Development of new Nanocomposite by using bagasse dust and polyaniline for removal of heavy metal ions from Pharma industry effluent. **Indian J. Pharm. Biol. Res.2018; 6(4):43-47.**