Exploring the adsorption efficiency of a novel cellulosic material for removal of food dye from water

Achyuta K Biswal[1], Pramila K. Misra[2]*

Centre of Studies in Surface Science and Technology, School of Chemistry
Sambalpur University, Jyoti Vihar-768019, Odisha, India.

INTRODUCTION

- In particular, the product synthesis using the underutilized and waste materials is exceedingly overarching to cross over the needs of the current high-density population around the globe and the hike in pollution thence because these materials are inexpensive and abundantly available.
- Many products have been derived from such waste materials for the potential utilization in the fields of bioengineering, environmental remediation, food technology, etc., in an eco-friendly manner
- Kendu (*Diospyros melanoxylon*) is an underutilized wild minor forest plant belonging to the *Ebenaceae* family, which is plentifully available across most of the South-East Asian Countries.
- Almost all parts of this plant, starting from the bark, leaves, and fruits to seeds, claim several commercial values. The leaves are used for making an improvised type of cigarette.
- Both unripe, as well as ripe fruits are used as folk medicines by tribal communities.
- The delicious and nutritious ripe fruit have good source s of nutrient and photochemical.
- In spite of these beneficial perspectives, a large number of Kendu fruits are wasted every year or utilized uneconomically due to the lack of proper processing techniques and awareness among the people.

OBJECTIVE OF WORK

- In continuation to our long-term motivation towards the product formulations using waste or underutilized materials for different technological applications, the present work aims at achieving CNCs from the coat of Kendu fruit.
- The waste Kendu fruit coat (KFC) was utilized for the fabrication of a novel cellulosic nano-adsorbent (KFCNCs) and exploration of its efficiency for the removal of food dye from water.

RESULTS AND DISCUSSION

Table 1: Chemical composition and Mineral analysis of KFC

Chemicals and minerals composition	Experimental value*
Moisture	42.28±0.21
Carbohydrate	19.36±1.21
Protein	8.10±1.31
Fat	0.87±0.05
Ash	0.68±0.11
Fiber	28.71 ±0.45
Minerals	
Calcium	201.05± 1.56
Magnesium	119.14±0.56
Sodium	134.24±1.26
Potassium	128.01±0.11
Aluminum	198.32±0.34
Phosphorous	18.20±1.02
Iron	11.39±0.64
Zinc	70.86±0.44
Copper	62.22±0.05

Characterization of KFC, KFCNCs 30 and 60

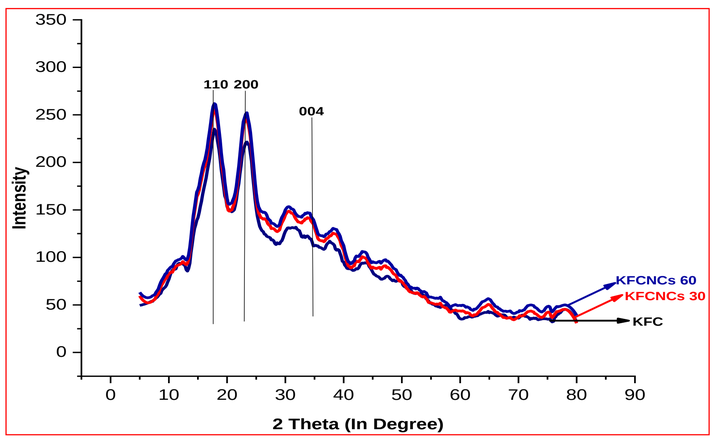


Figure 1: XRD patterns of KFC (A); KFCNCs after 30 min; (B) and 60 min(C) of sulfuric acid hydrolysis

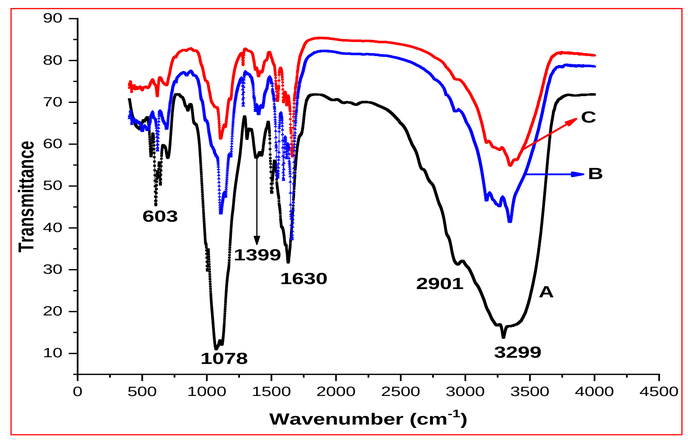


Figure 2: FTIR spectra of KFC (A), KFCNCs after 30 min (B) and 60 min (C) of sulfuric acid hydrolysis.

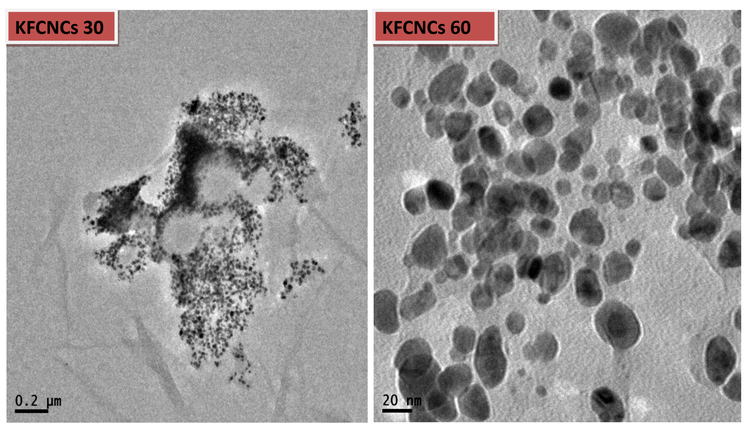


Figure 3: TEM images of KFCNCs after 30 min and 60 min (C) of suphuric acid hydrolysis.

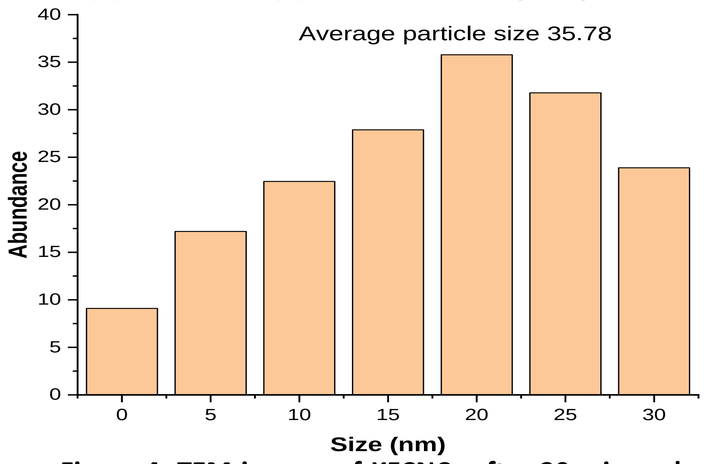
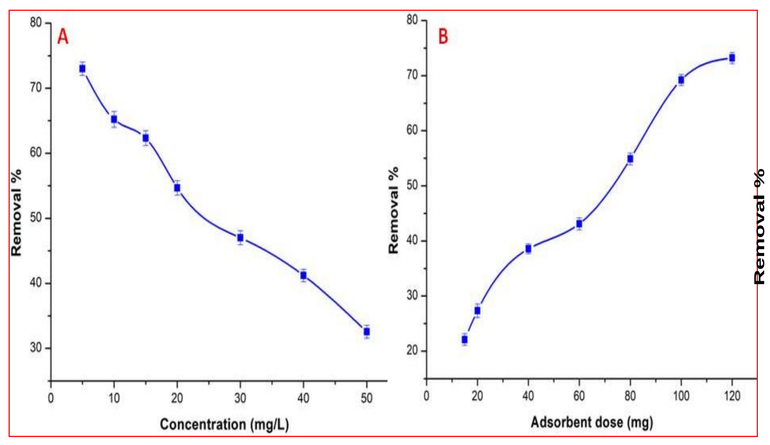


Figure 4: TEM images of KFCNCs after 30 min and 60 min (C) of suphuric acid hydrolysis.



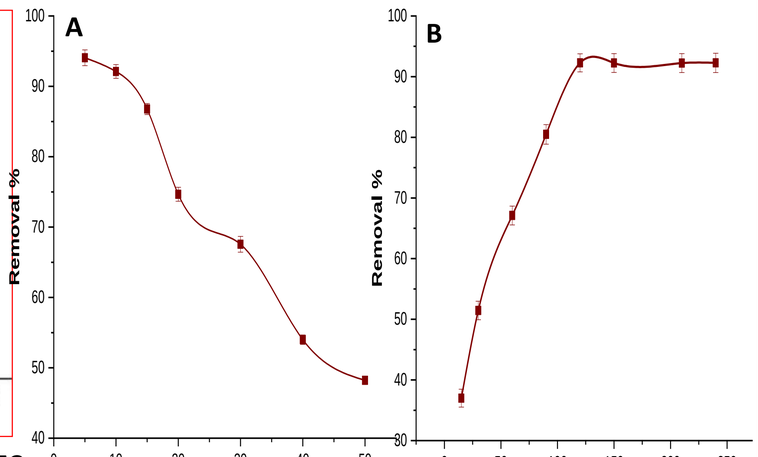


Figure 5: Removal percentage of tartrazine dye by virgin KFC powder: Plot of removal percentage as a function of: (A) initial concentration of the dye (pH= 6, Temp= 60 °C, adsorbent dose= 100mg); (B) adsorbent dose of KFC powder (pH= 6, Temp= 60 °C, Initial concentration of the dye= 10mg/L)

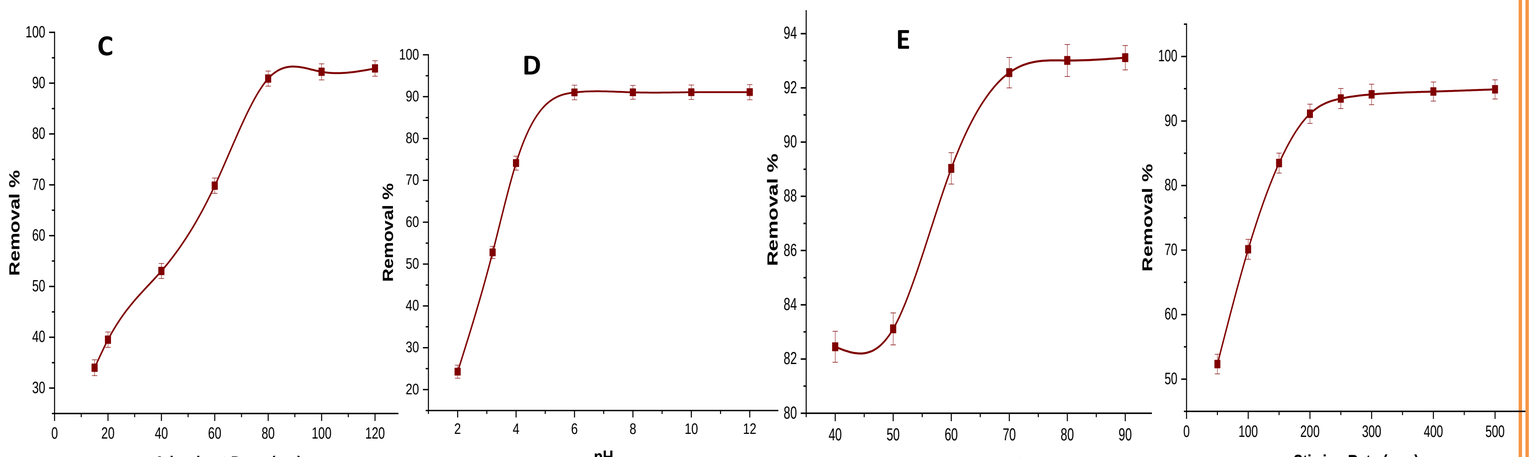


Figure 5:Removal percentage of tartrazine dye by KFCNs: Plot of removal percentage as a function of; Initial concentration(A), Adsorbent doses (B), time(C), pH(D), temperature(E) and stirring rate(F) of KFCNCs tartazine dye removal. (Initial concentration=10 mg/L, pH=6, Adsorbent dose=100 mg, Time=120 min, Temperature=60°C and stirring rate= 200 rpm)

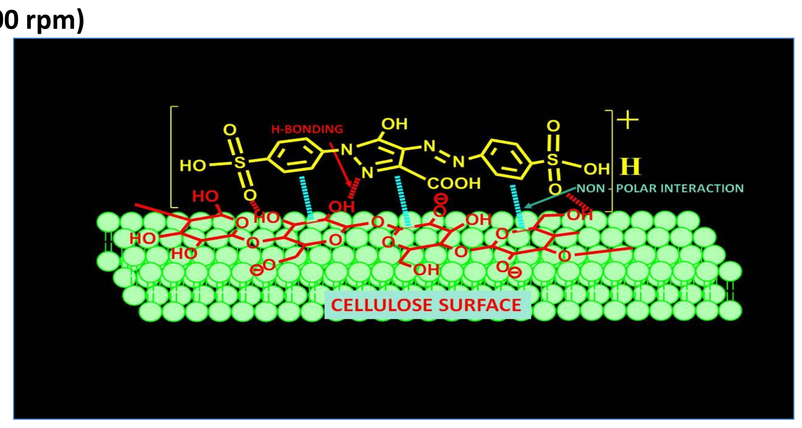


Figure 6: Schematic diagram of adsorbed layer at KFCNC-water interface holding the protonated tartrazine dye through the electrostatic interaction (charged sites due to protonation), hydrophobic interactions (nonpolar sites due to aromatic rings and –CH groups of KFCNCs), polar sites hydrogen bonding interactions (due to acidic groups of dye and –OH group of KFCNCs).

CONCLUSION

- A novel cellulose-based nanocrystal(KFCNCs) was developed from Kendu fruit coat.
- The nanocrystal was characterized by XRD, TEM, and FTIR techniques.
- The optimal batch adsorption factors of tartrazine dye onto nanocrystal were established.
- The mechanism of adsorption at KFCNCs-water interface was proposed.
- The fabricated nanocellulose crystal could be a better option for the removal of tartrazine dye due to the plentiful availability, efficiency, and cost-effectiveness