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Removal of methylene blue from aqueous solution by application of plant-based coagulants

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The 1st International Electronic Conference on Processes: Processes System Innovation

Session 2. Environmental and Green Processes

17 – 31 May 2022

Introduction

- Contributes to fulfilling the basic living (clothing) requirements of human life;
- The wastewater discharged from textile dyeing industry contains a total of 72 toxic chemicals, out of which 30 chemicals cannot be removed by waste treatment processes;
- Formation of many types of cancers of different organs such as bladder, spleen, liver and normal aberrations in model organisms and chromosomal deformities in mammalian cells;
- Textille dyes are characterized by high color density, high concentration of recalcitrante organics and pH and high turbidity.


Water Environment Federation

Textiles wastewater treatment technology: A review

Dongyang Deng[1,*], Mehdi Lamssali[1], Niroj Aryal[2], Andrea Ofori-Boadu[1], Manoj K. Jha[3], Raymond E. Samuel[4]


CRITICAL REVIEWS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY
2017, VOL. 47, NO. 19, 1836–1876
https://doi.org/10.1080/10643389.2017.1393263

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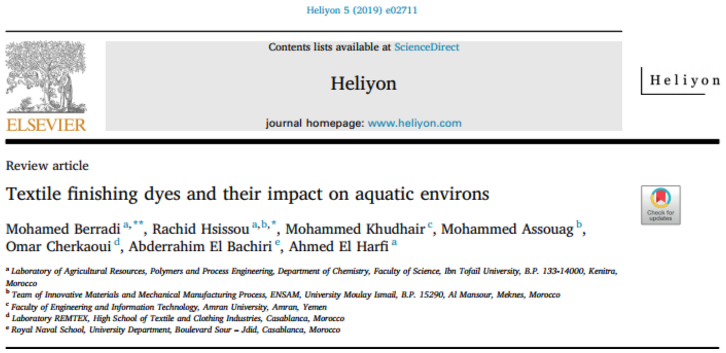
Check for updates

Biological methods for textile dye removal from wastewater: A review

Deepika Bhatia[a], Neeta Raj Sharma[a], Joginder Singh[a], and Rameshwar S. Kanwar[a,b]

[a]Department of Biotechnology, School of Bioengineering and Biosciences Lovely Professional University, Phagwara, Punjab, India; [b]Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa, USA


Heliyon 5 (2019) e02711

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Review article

Textile finishing dyes and their impact on aquatic environs

Mohamed Berradi[a,**], Rachid Hsissou[a,b,*], Mohammed Khudhair[c], Mohammed Assouag[b], Omar Cherkaoui[d], Abderrahim El Bachiri[e], Ahmed El Harfi[a]

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[b] *Team of Innovative Materials and Mechanical Manufacturing Process, ENSAM, University Moulay Ismail, B.P. 15290, Al Mansour, Meknes, Morocco*
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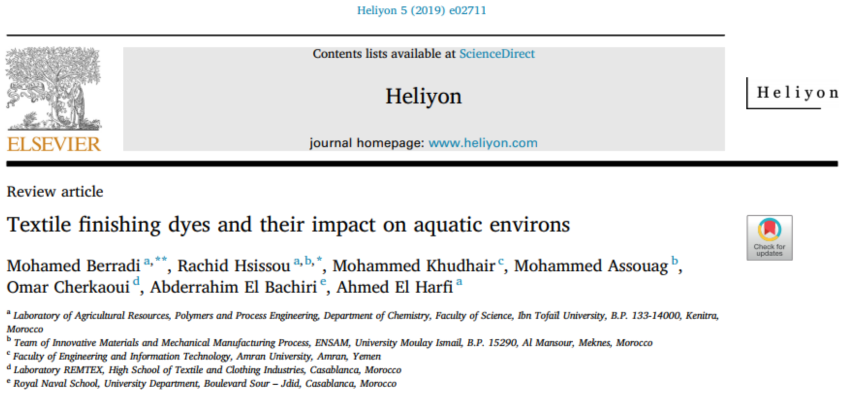
[e] *Royal Naval School, University Department, Boulevard Sour – Jdid, Casablanca, Morocco*


Textile dye factory


River polluted by textile dyes

Types of textille dyes

- Chemical classification
- Water soluble dyes
- Insoluble dyes in water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[b] Team of Innovative Materials and Mechanical Manufacturing Process, ENSAM, University Moulay Ismail, B.P. 15290, Al Mansour, Meknes, Morocco
[c] Faculty of Engineering and Information Technology, Amran University, Amran, Yemen
[d] Laboratory REMTEX, High School of Textile and Clothing Industries, Casablanca, Morocco
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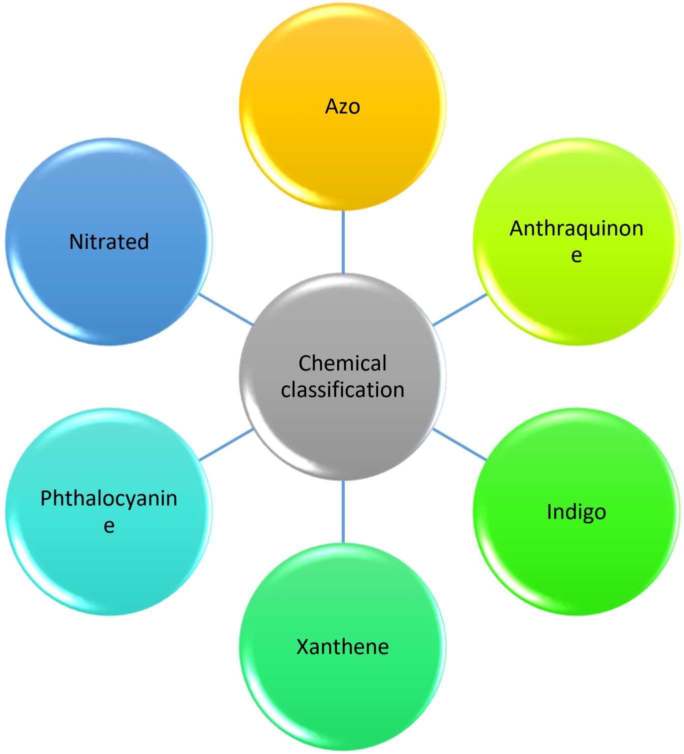
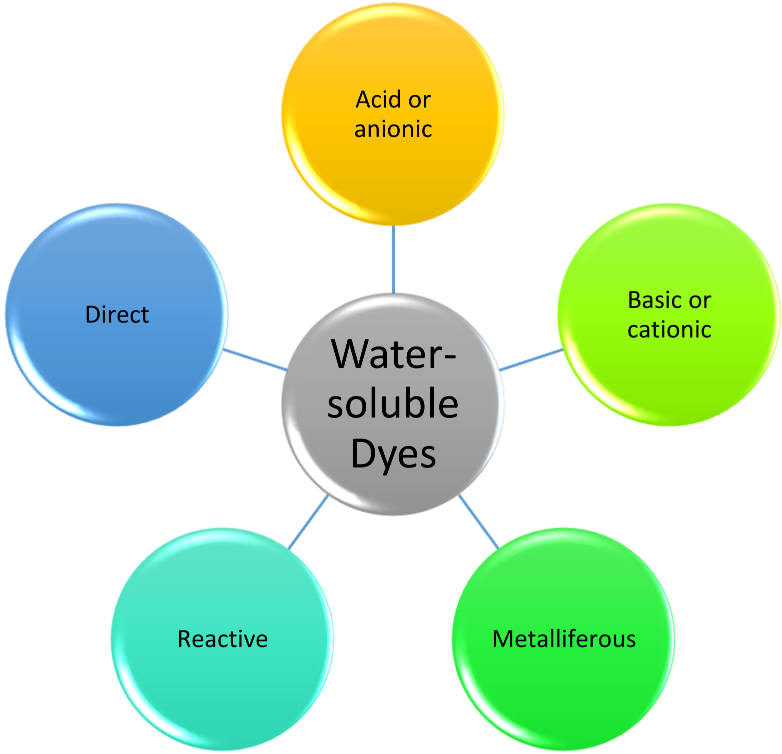
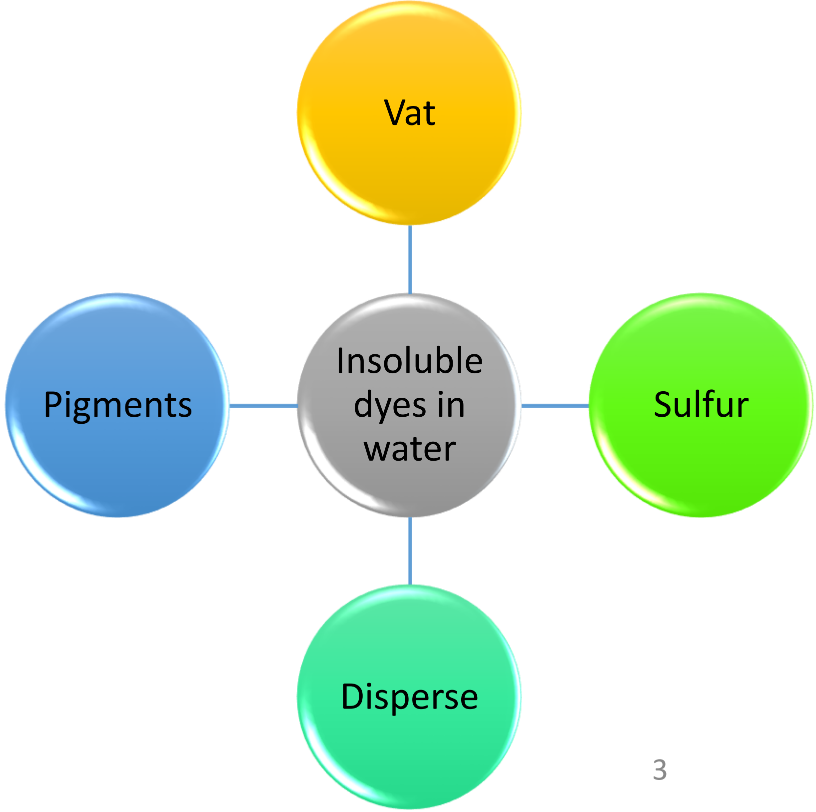
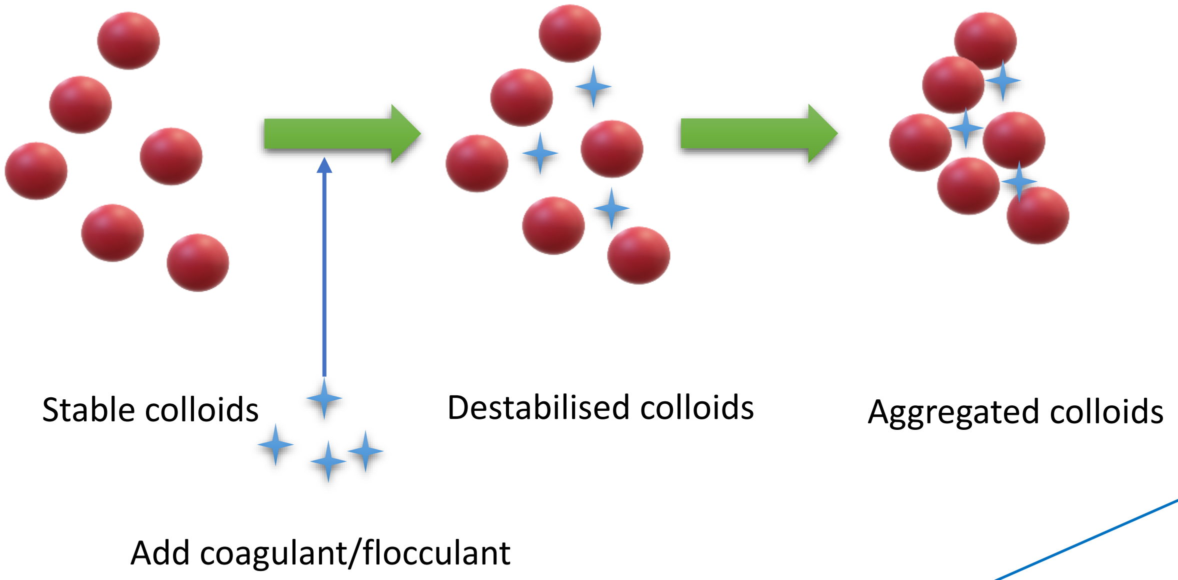






Coagulation-flocculation-decantation (CFD)



- Hydrolysable metal salts (mainly, **aluminum** and **iron**)

Most used on waster treatment

Disadvantages

Aluminum	Iron
Dialysis encephalopathy Alzheimer's disease	Generally corrosive Strongly dependent on the pH The leach cannot be recycled

Plant species colected during this work, for the development of **plant-based coagulants**

Tanacetum vulgare L. (seeds)

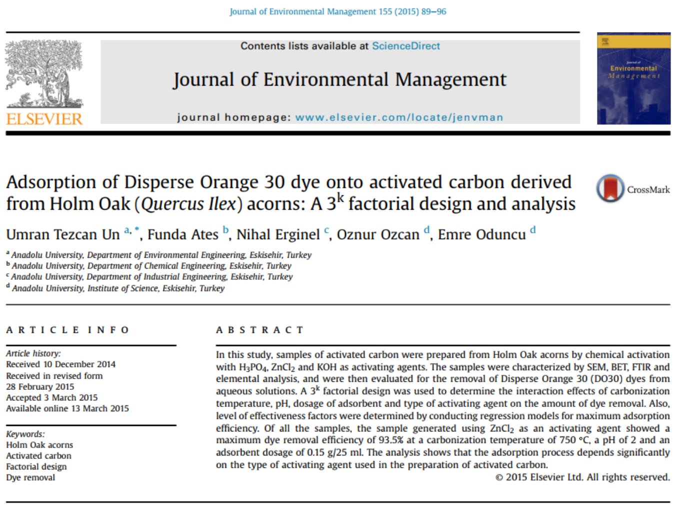
Chelidonium majus L. (seeds)

Dactylis glomerata L. (seeds)

Festuca ampla Hack. (seeds)

Vitis vinífera L. (rachis)

Works performed with plant-based coagulants



Journal of Environmental Management 155 (2015) 89–96

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Adsorption of Disperse Orange 30 dye onto activated carbon derived from Holm Oak (*Quercus Ilex*) acorns: A 3^k factorial design and analysis

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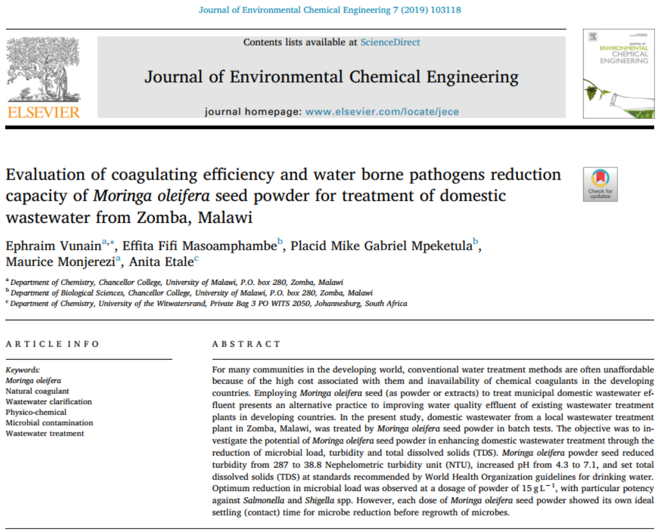
ABSTRACT

In this study, samples of activated carbon were prepared from Holm Oak acorns by chemical activation with H_3PO_4, $ZnCl_2$ and KOH as activating agents. The samples were characterized by SEM, BET, FTIR and elemental analysis, and were then evaluated for the removal of Disperse Orange 30 (DO30) dyes from aqueous solutions. A 3^k factorial design was used to determine the interaction effects of carbonization temperature, pH, dosage of adsorbent and type of activating agent on the amount of dye removal. Also, level of effectiveness factors were determined by conducting regression models for maximum adsorption efficiency. Of all the samples, the sample generated using $ZnCl_2$ as an activating agent showed a maximum dye removal efficiency of 93.5% at a carbonization temperature of 750 °C, a pH of 2 and an adsorbent dosage of 0.15 g/25 ml. The analysis shows that the adsorption process depends significantly on the type of activating agent used in the preparation of activated carbon.



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Evaluation of coagulating efficiency and water borne pathogens reduction capacity of *Moringa oleifera* seed powder for treatment of domestic wastewater from Zomba, Malawi

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ARTICLE INFO

Keywords:
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ABSTRACT

For many communities in the developing world, conventional water treatment methods are often unaffordable because of the high cost associated with them and inavailability of chemical coagulants in the developing countries. Employing *Moringa oleifera* seed (as powder or extracts) to treat municipal domestic wastewater effluent presents an alternative practice to improving water quality effluent of existing wastewater treatment plants in developing countries. In the present study, domestic wastewater from a local wastewater treatment plant in Zomba, Malawi, was treated by *Moringa oleifera* seed powder in batch tests. The objective was to investigate the potential of *Moringa oleifera* seed powder in enhancing domestic wastewater treatment through the reduction of microbial load, turbidity and total dissolved solids (TDS). *Moringa oleifera* powder seed reduced turbidity from 287 to 38.8 Nephelometric turbidity unit (NTU), increased pH from 4.3 to 7.1, and set total dissolved solids (TDS) at standards recommended by World Health Organization guidelines for drinking water. Optimum reduction in microbial load was observed at a dosage of powder of $15\,g\,L^{-1}$, with particular potency against *Salmonella* and *Shigella* spp. However, each dose of *Moringa oleifera* seed powder showed its own ideal settling (contact) time for microbe reduction before regrowth of microbes.

Considering the necessity to perform treatment of textile wastewater by eco-friendly coagulants, the aim of this work is:

(1) To produce and characterize the plant-based coagulants

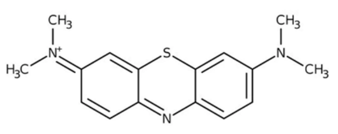
(2) To optimize the CFD process

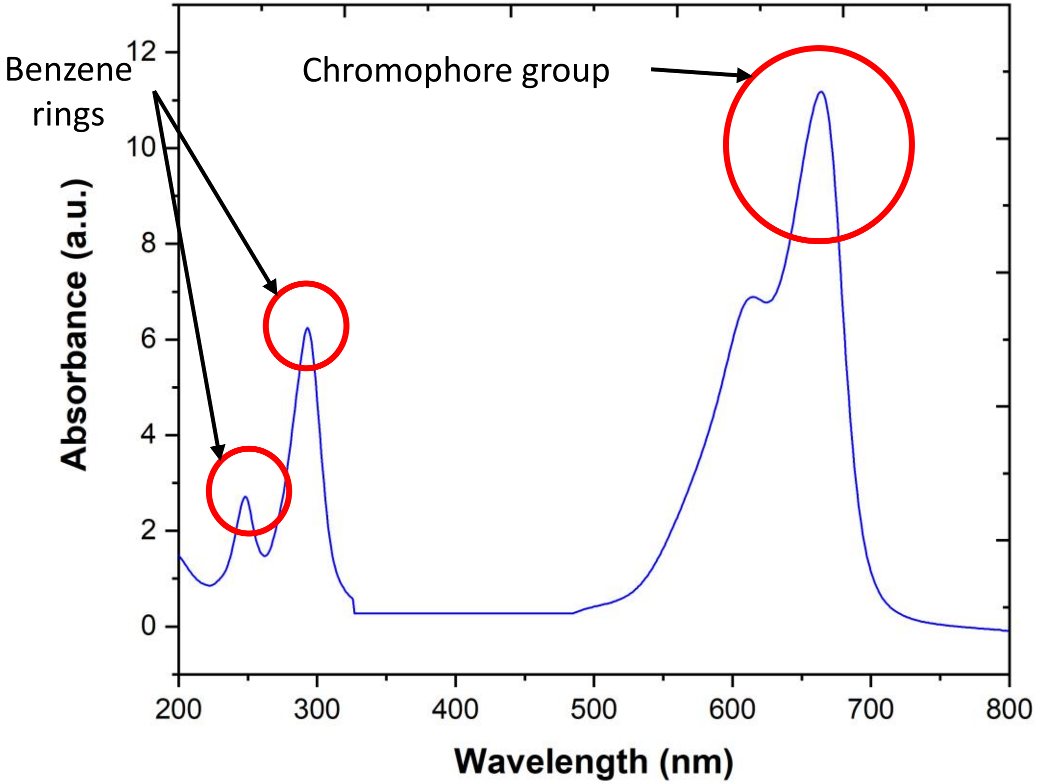
(3) To evaluate the application of bentonite as a flocculant agent

Material and methods

Plant-based coagulants preparation

Name, chemical structure, maximum absorbance and molecular weight of MB

Name	Chemical structure	λ_{max} (nm)	Molecular weight (g/mol)
Methylene blue (azo dye)		665, 300 and 250 nm	319.85



Device used for CFD process

Jar-Test apparatus (ISCO JF-4)

Separation of seeds from plants

Washing and drying at 70ºC/ 24h

Crushing

Sieve

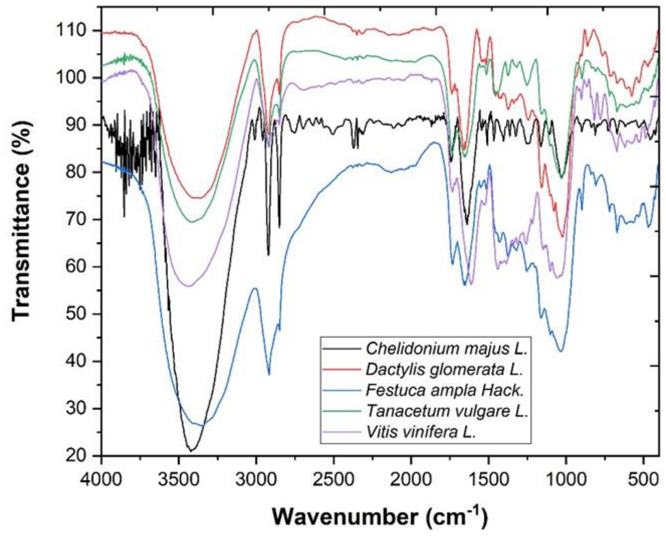
Drying at 70ºC/ 24 h

Laboratory incubator

Groundnut miller

Sieve (Mesh of 150 µm)

Characterization of plant-based coagulants



FTIR analysis of plant-based coagulants

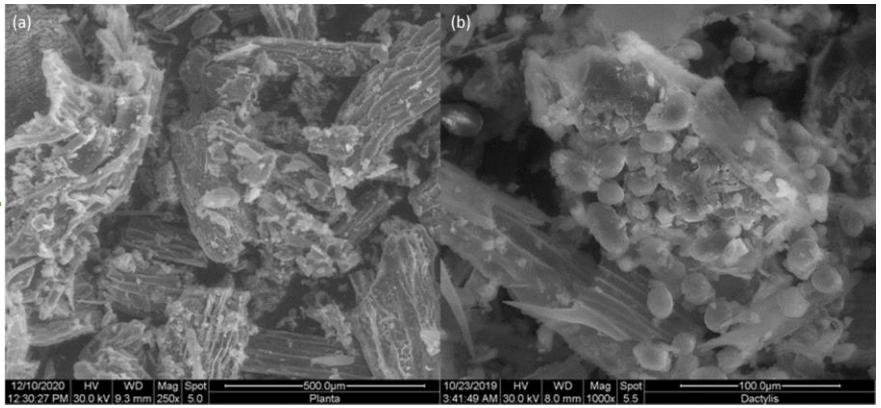
Vibration bands (cm^{-1})	Compounds
3421.72	Stretching vibrations of OH groups (from water, alcohols, phenols, carbohydrates, peroxides) as well as amides
2920.23 and 2850.79	C-H stretching vibrations specific to CH_3 and CH_2 from lipids, metoxy derivatives, C-H (aldehydes), including cis double bonds
898.83 – 1253.73	C–O–C, C–C, and C–O stretching vibrations from carbohydrates

B.E.T. analysis of the plant-based coagulants

Coagulants	S_{BET} (m^2/g)	$V_{total\ pore}$ (cm^3/g)	Particle size (nm)
C. Majus	0.05	n.q.	n.q.
D. Glomerata	0.06	n.q.	n.q.
F. Ampla	0.18	n.q.	n.q.
T. Vulgare	0.03	n.q.	n.q.
V. vinifera	0.50	n.q.	n.q.

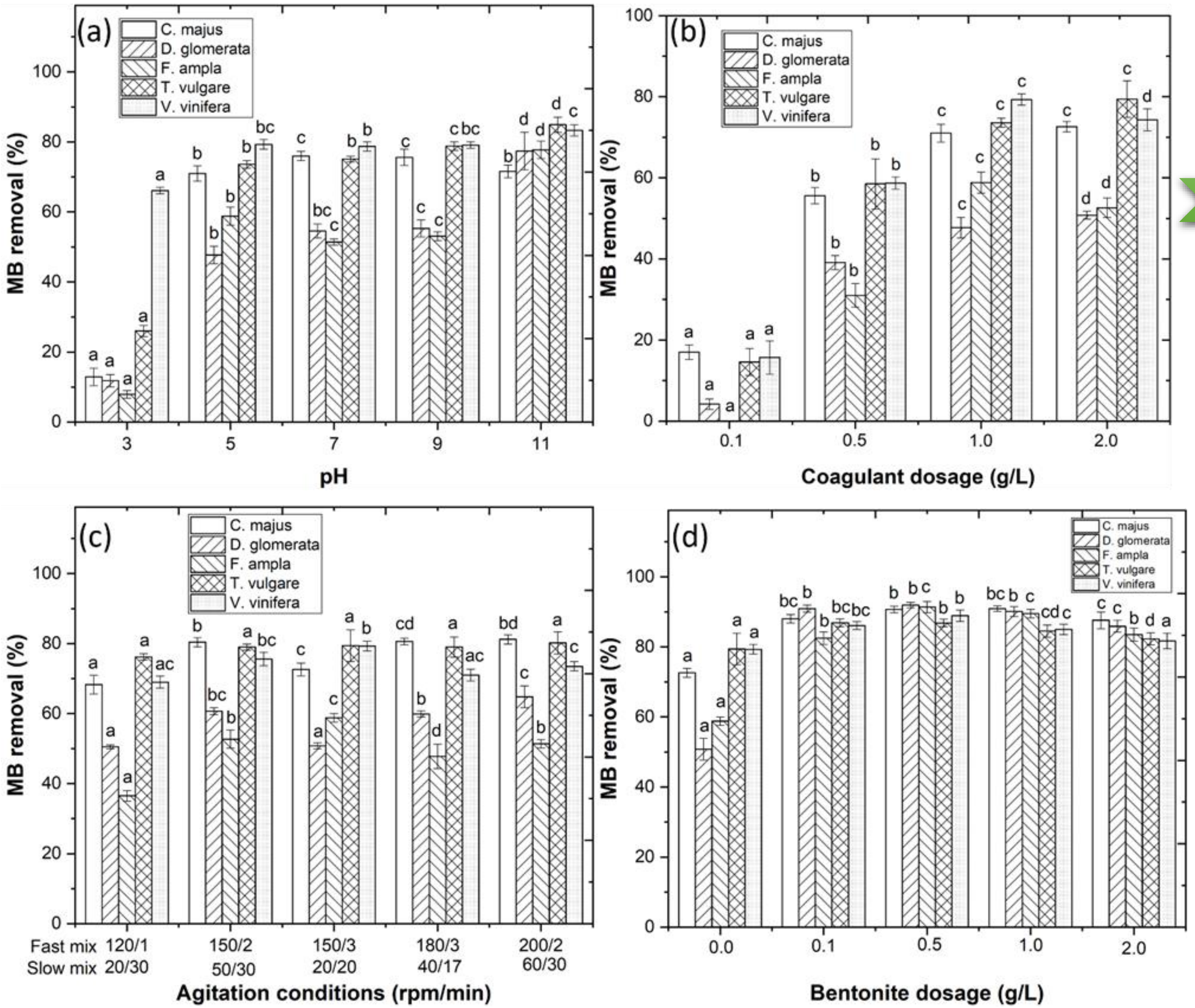
The BET analysis showed that all plant-based coagulants had a low BET surface area. The shape of its N_2 adsorption-desorption isotherm was of type I isotherm, typical of microporous solids having relatively small external surfaces as de-fined by the International Union of Pure and Applied Chemistry (IUPAC) classification

Plant-based coagulants exhibited a heterogeneous and relatively porous morphology. The spaces available (represented in dark) may facilitate adsorption of the MB contaminant.



SEM images of (a) C. majus and (b) D. glomerata

Coagulation-flocculation-decantation process optimization



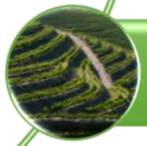
Best operational conditions

Coagulants	pH	Coagulant dosage	Fast mix	Slow mix	[Bentonite]
		(g/L)	(rpm/min)	(rpm/min)	(g/L)
C. majus	5.0	2.0	200/2	60/30	1.0
D. glomerata	5.0	2.0	200/2	60/30	0.5
F. ampla	5.0	1.0	150/3	20/20	0.5
T. vulgare	5.0	2.0	150/3	20/20	0.1
V. vinifera	5.0	1.0	150/3	20/20	0.5

The pH was varied from 3.0 to 11.0 and the results showed a MB removal of 71.0, 47.7, 58.8, 73.6 and 79.3%, respectively

The coagulant dosage was varied (0.1 – 2.0 g/l) and results showed a MB removal of 72.6, 50.8, 58.8, 79.4 and 79.3%, respectively

The effect of mixing conditions was also considered in this work and results showed a MB removal of 81.2, 64.8, 58.8, 79.4 and 79.3%, respectively



Bentonite was added as a flocculant aid and results showed a MB removal of 90.9, 91.9, 91.4, 86.9 and 88.9%, respectively

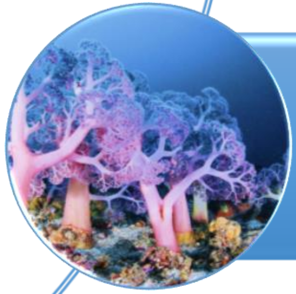
Optimization of CFD process with variation of (a) pH (3.0 – 11.0), (b) coagulant dosage (0.1 – 2.0 g/L), (c) agitation conditions and (d) bentonite dosage (0.0 – 2.0 g/L), with sedimentation time = 30 min. Means in bars with different letters represent differences ($p <$ 0.05) within each coagulant (C. majus, D. glomerata, F. ampla, T. vulgare and V. vinifera) by comparing wastewaters

Conclusions

Based in the results, it is concluded:

(1) The plant-based coagulants are carbon-based materials with porous structures that can adsorb the contaminants

(2) Under the best operational conditions, the plant-based coagulants achieve a high removal of MB from aqueous solution



(3) The addition of bentonite significantly increase the efficiency of the CFD process

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Thank you for your attention