International Scientific Journal of Engineering and Management ISSN: 2583-6129
Volume: 03 Issue: 05 | May – 2024 DOI: 10.55041/ISJEM01606
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# Removal of reactive black dye color in textile effluent using Palmyra sprout and Moringa oleifera waste bio char

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**Abstract -** In this study treatment of the textile wastewater by colour removal using adsorbent (Palmyra sprout peel and Moringa oleifera peel) is done. This study collects information to discharge colour using adsorbent (Palmyra sprout peel and Moringa oleifera peel) which acts as an effective adsorbent. Both the adsorbent Palmyra sprout peel and Moringa oleifera peel are low cost adsorbent. Moringa oleifera peel is readily available for use, Palmyra sprout peel has seasonal availability. A series of batch experiment was carried out to determine the optimum dosage for colour removal using various adsorbent dosage (4 - 12g/lit), and optimum contact time 120 minutes. The efficiency of the colour removal was calculated by subtracting initial concentration and final concentration. The pH was varied from 10 to 2 and the colour removal rates was found to be from 25% to 93%. Lower pH conditions have increased colour removal rate for textile wastewater.

***Key Words*:** adsorption, Palmyra sprout peel, Moringa oleifera peel, Reactive black dye (RB5), and dye removal.

## 1.INTRODUCTION:

In recent decades, the textile industry has experienced exponential growth, catering to the ever-increasing demand for clothing worldwide. However, this expansion has brought along with it environmental concerns, particularly regarding the discharge of textile dye effluents into water bodies. Textile dye wastewater is notoriously difficult to treat due to its complex composition and high color intensity, posing a significant threat to aquatic ecosystems and human health.

Addressing this pressing issue requires innovative and sustainable solutions that not only effectively remove textile dyes but also mitigate the environmental impact of wastewater treatment processes. In this context, the utilization of natural and eco-friendly adsorbents has garnered considerable attention as an alternative to conventional treatment methods.

The aim is to explore the potential of two readily available agricultural by-products, namely Palmyra sprout peel and Moringa oleifera peel, as cost-effective and environmentally friendly adsorbents for the removal of textile dyes from wastewater. Palmyra sprout peel and Moringa oleifera peel are rich in bioactive compounds such as lignin, cellulose, and phenolic compounds, which possess inherent adsorption properties.

Moreover, the abundance and accessibility of Palmyra sprout peel and Moringa oleifera peel make them promising candidates for large-scale applications in textile dye wastewater treatment plants, particularly in regions where these resources are abundant.

Through a series of experiments, aims to evaluate the adsorption efficiency of Palmyra sprout peel and Moringa oleifera peel for various textile dyes commonly used in the industry. Factors such as adsorbent dosage, pH, contact time, and initial dye concentration will be systematically studied to optimize the adsorption process and maximize dye removal efficiency.

The findings of this study hold significant implications for the development of sustainable wastewater treatment technologies and the mitigation of environmental pollution caused by the textile industry. By harnessing the potential of agricultural by-products as adsorbents, this research contributes to the advancement of green chemistry principles and underscores the importance of leveraging natural resources for environmental remediation.

## 2. Materials and methods

### 2.1.1 PALMYRA SPROUT PEEL

Palmyra sprout peel, also known as "toddy palm" or "borassus flabellifer," is a natural material that holds promising potential for various applications, including wastewater treatment. It serves as an adsorbent for the removal of Reactive Black 5 dye from textile wastewater. Here's an explanation of its properties and potential benefits in this context:

1. **Abundant and Renewable**: Palmyra sprout peel is readily available in regions where the toddy palm tree grows abundantly. This makes it a sustainable and cost-effective option for use as an adsorbent in wastewater treatment, especially in areas where other conventional adsorbents may be scarce or expensive.
2. **High Surface Area**: The peel of the Palmyra sprout is characterized by its fibrous and porous structure, which provides a large surface area for adsorption. This structural feature enhances its capacity to adsorb dye molecules from wastewater effectively.
3. **Chemical Composition**: Palmyra sprout peel contains various functional groups such as hydroxyl (-OH), carboxyl (-COOH), and carbonyl (-C=O) groups on its surface. These functional groups can interact with dye molecules through mechanisms such as electrostatic attraction, hydrogen bonding, and $\pi$-$\pi$ interactions, facilitating the adsorption process.
4. **Biodegradability**: Unlike synthetic adsorbents, Palmyra sprout peel is biodegradable and poses minimal environmental risk. After adsorbing dye molecules, it can be easily disposed of or further treated without causing long-term harm to the environment.
5. **Potential Synergies with Other Treatments**: Palmyra sprout peel can potentially synergize with other treatment methods, such as coagulation-flocculation or microbial degradation. Its adsorption capacity can complement the removal efficiency of these processes, leading to more comprehensive and efficient wastewater treatment.

### 2.1.2. MORINGA OLEIFERA PEEL

Moringa oleifera, commonly referred to as the "drumstick tree" or "miracle tree," is known for its various medicinal, nutritional, and industrial applications. The peel of Moringa oleifera serves as an adsorbent for the removal of Reactive

Black 5 dye from textile wastewater. Here's an explanation of its properties and potential benefits in this context:

1. **Rich in Bioactive Compounds**: Moringa oleifera peel contains a plethora of bioactive compounds, including phenolic compounds, flavonoids, and alkaloids. These compounds possess functional groups such as hydroxyl (-OH) and amino (-NH2) groups, which can facilitate the adsorption of dye molecules through mechanisms such as hydrogen bonding and electrostatic interactions.
2. **High Adsorption Capacity**: The porous structure of Moringa oleifera peel, coupled with its rich bioactive composition, contributes to its high adsorption capacity for dye molecules. The large surface area and abundant functional groups provide numerous sites for the attachment of dye molecules, leading to efficient removal from wastewater.
3. **Antioxidant Properties**: The presence of antioxidant compounds in Moringa oleifera peel may enhance its adsorption capacity by preventing the degradation of adsorbed dye molecules. Antioxidants can scavenge free radicals and inhibit oxidative reactions, thereby maintaining the integrity of the adsorbent and prolonging its effectiveness in dye removal.
4. **Low Cost and Accessibility**: Moringa oleifera is widely cultivated in many tropical and subtropical regions, where it is valued for its nutritional and medicinal properties. As a result, Moringa oleifera peel is readily available and cost-effective, making it an attractive option for use as an adsorbent in wastewater treatment, particularly in resource-constrained settings.
5. **Environmental Friendliness**: Similar to Palmyra sprout peel, Moringa oleifera peel is biodegradable and poses minimal environmental risk. After adsorbing dye molecules, it can be safely disposed of or further processed without adverse effects on the environment, contributing to the sustainability of the treatment process.

### 2.1.3 Effect of PH

The effect of pH on the adsorption of Reactive Black 5 dye by Palmyra sprout peel and Moringa oleifera peel is a crucial aspect. pH influences the adsorption process:

1. **Surface Charge of Adsorbents**: The pH of the solution affects the surface charge of the adsorbents. Palmyra sprout peel and Moringa oleifera peel contain functional groups such as hydroxyl (-OH) and carboxyl (-COOH) groups, which may be protonated or deprotonated depending on the pH of the solution. This can influence the electrostatic interactions between the adsorbents and the dye molecules.
2. **Dye Speciation**: The pH of the solution also influences the speciation of Reactive Black 5 dye. At different pH levels, the dye molecules may exist in different forms, such as the molecular form or various ionized forms (e.g., anionic or cationic). The speciation of the dye molecules can affect their adsorption behavior and affinity towards the adsorbents.
3. **Surface Chemistry**: Changes in pH can alter the surface chemistry of the adsorbents, affecting their surface charge, surface area, and functional groups ionization state. These changes may impact the adsorption capacity, and mechanism of the adsorption process.
4. **Competing Reactions**: In some cases, changes in pH may induce competing reactions, such as hydrolysis or dissolution of the adsorbents, which can influence the overall adsorption efficiency and stability of the system.

### 2.1.4 Effect of contact time

contact time influences the adsorption process by following mechanisms of action:

1. **Adsorption Kinetics**: Contact time refers to the duration for which the adsorbent and the dye solution are in contact during the adsorption process. During the initial stages of adsorption, there is a rapid uptake of dye molecules by the adsorbent due to the availability of vacant adsorption sites. As the contact time increases, the rate of adsorption gradually slows down, eventually reaching equilibrium where the rate of adsorption becomes equal to the rate of desorption.
2. **Equilibrium Attainment**: The contact time required to achieve equilibrium adsorption varies depending on factors such as the adsorbent's surface properties, the initial concentration of the dye solution, and the temperature. At shorter contact times, the adsorption process may not be complete, leading to lower removal efficiency. Extending the contact time allows for more dye molecules to interact with the adsorbent surface, eventually leading to higher dye removal efficiency.
3. **Pore Diffusion and Intraparticle Transport**: At the initial stages of adsorption, rapid adsorption occurs at the external surface of the adsorbent particles. As the contact time increases, diffusion of dye molecules into the internal pores of the adsorbent becomes significant. This intraparticle diffusion process may become the step, especially for adsorbents with a porous structure, and influence the overall adsorption kinetics.
4. **Optimization of Contact Time**: Studying the effect of contact time involves conducting adsorption experiments at different time intervals and analyzing the adsorption kinetics over time. By plotting adsorption kinetics curves and determining parameters such as the initial adsorption rate and the equilibrium adsorption capacity, identifying the optimal contact time required to achieve maximum dye removal efficiency.

### 2.1.5 Effect of Adsorbent dosage

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Varying the adsorbent dosage can significantly impact the adsorption efficiency of Reactive Black 5 dye by Palmyra sprout peel and Moringa oleifera peel.

By varying the adsorbent dosage and analyzing the resulting adsorption data, we can identify the optimal dosage that maximizes dye removal efficiency while minimizing the amount of adsorbent required. This involves balancing factors such as adsorption capacity, and cost-effectiveness.

## 2.2 EXPERIMENT PARAMETERS

The effect of pH on removal percentage was investigated over the range of 2-10. The pH was adjusted by the addition of 0.1 M HCL or NaOH. The adsorbent dosage was varied from (4-12g/litre).and the contact time was constant determined by varying 50ppm dye concentration at optimum pH 2. The calibration curve was plotted for concentration and absorbance The removal efficiency was calculated. The wavelength used for the detection of the reactive black 5 dye is 597nm which gives maximum absorbance.

## 2.3 UV SPECTROMETRY

The effectiveness of the dye removal process hinges on accurate monitoring and analysis of dye concentration throughout the treatment process. In this regard, UV (Ultraviolet) spectrometry emerges as a valuable analytical technique due to its sensitivity and versatility in quantifying the concentration of organic compounds, including dyes, in aqueous solutions.

UV spectrometry operates on the principle of measuring the absorbance of UV light by molecules in a sample, with absorbance being directly proportional to the concentration of the absorbing species. By UV spectrometry, to quantify the concentration of Reactive Black 5 dye in textile wastewater samples before and after treatment with Palmyra sprout peel and Moringa oleifera peel adsorbents.

UV spectrometry enables real-time monitoring of the adsorption kinetics and optimization of treatment conditions, facilitating the development of an efficient and sustainable dye removal process. By systematically analyzing the UV absorbance spectra of wastewater samples at different stages of treatment, insights into the effectiveness of the bio-based adsorbents and their potential for large-scale application can be gained.

**Table -1:** Calibration curve

| conc-ppm | absorbance in dye solution | | |
|---|---|---|---|
| 5ppm | 0.068 | | |
| 10ppm | 0.1 | | |
| 15ppm | 0.127 | | |
| 20ppm | 0.2 | | |
| 25ppm | 0.212 | | |
| 30ppm | 0.305 | | |
| 35ppm | 0.373 | | |
| | | | |

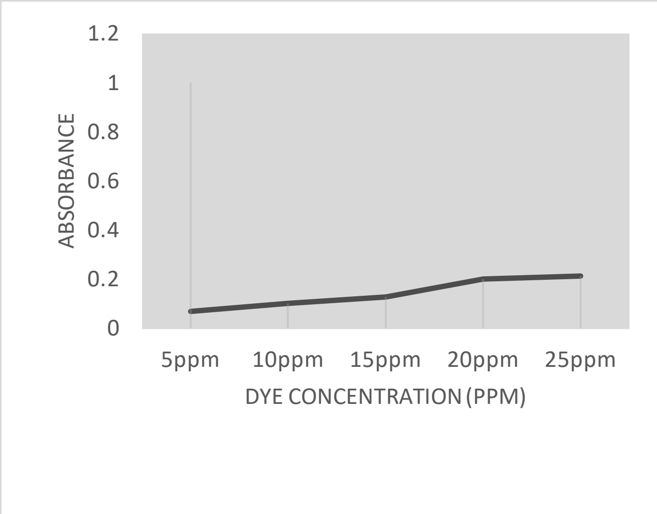


**Fig -1: Calibration curve**

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## 3.RESULTS AND DISCUSSION

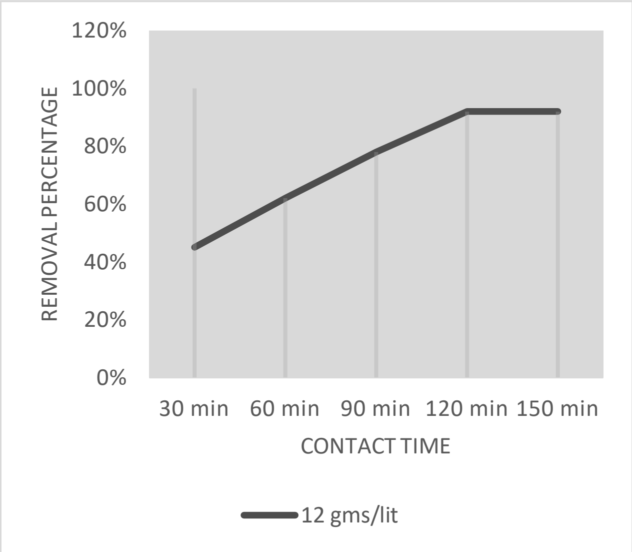


**Fig -2: Optimum contact time**

Optimum contact time was determined by varying contact time for 12gms/litre adsorbent dosage for 50 ppm dye concentration solution at optimum pH 2.

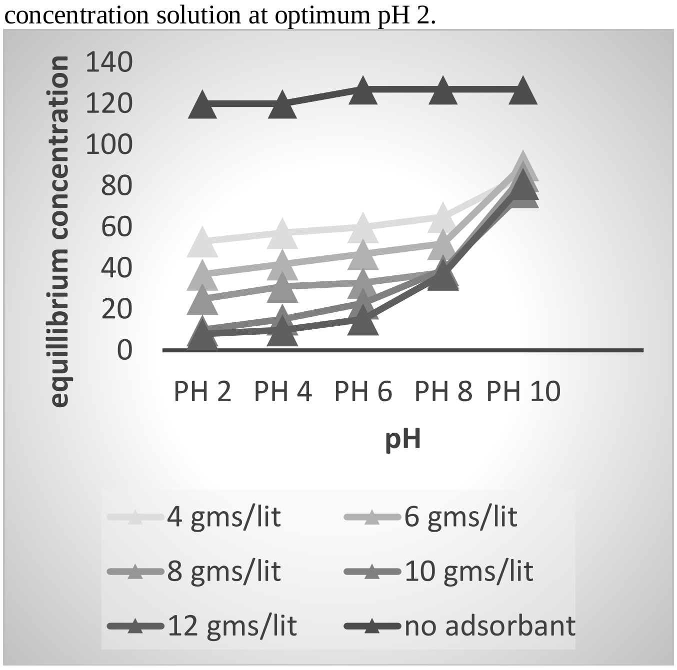


**Fig -3: Palmyra sprout Adsorption efficiency for 12.5 ppm concentration**

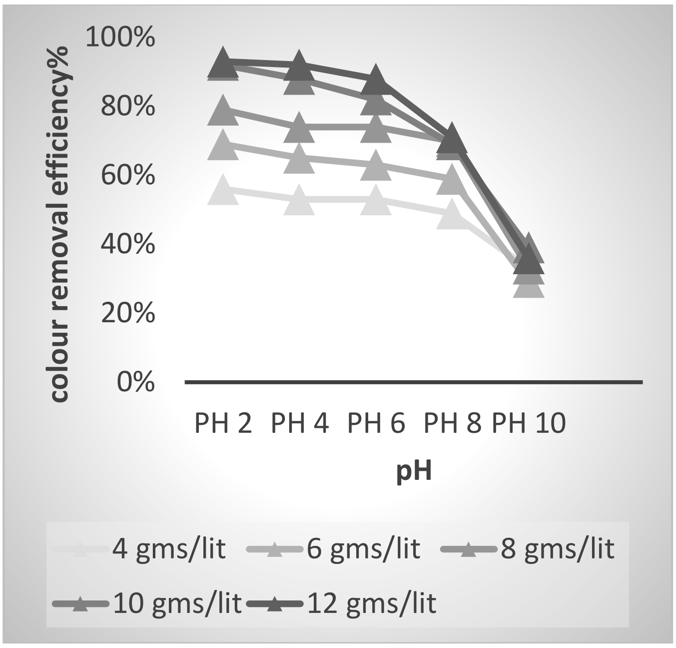


**Fig -4: Palmyra sprout Removal efficiency for 12.5 ppm concentration**

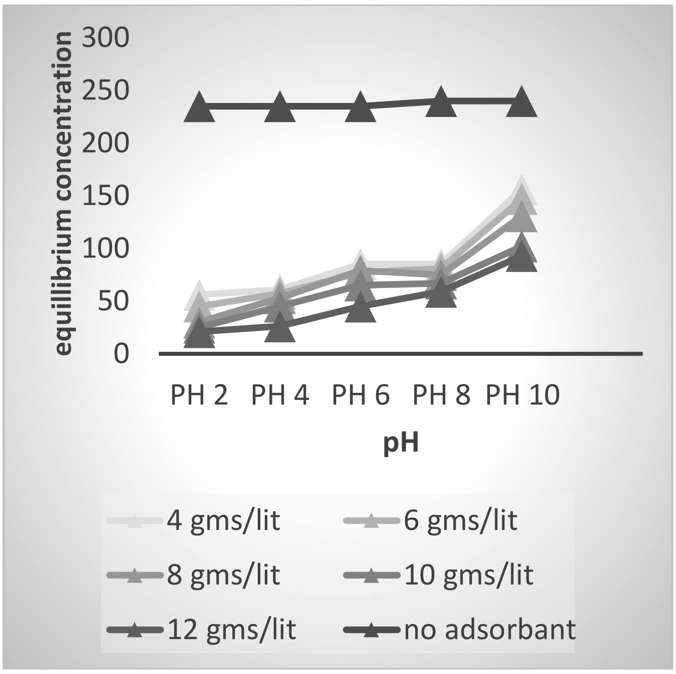


**Fig -5: Palmyra sprout Adsorption efficiency for 25 ppm concentration**

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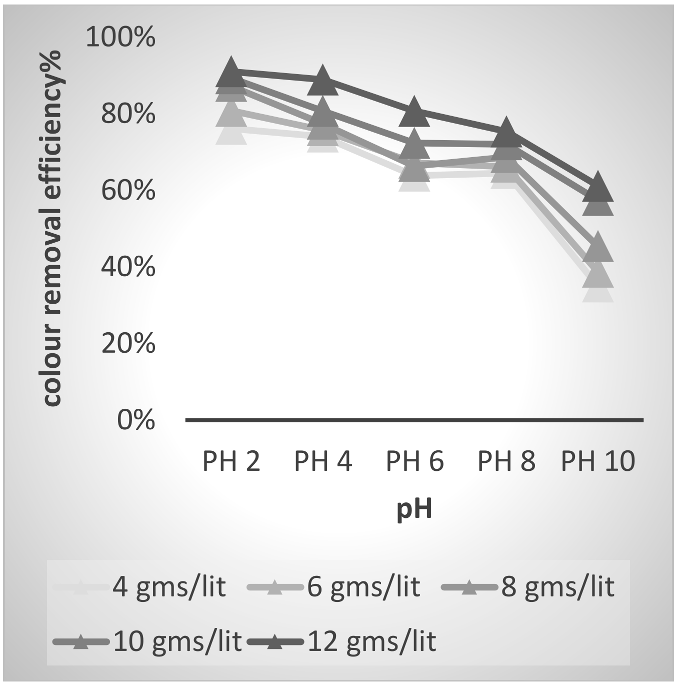


**Fig -6: Palmyra sprout Removal efficiency for 25 ppm concentration**

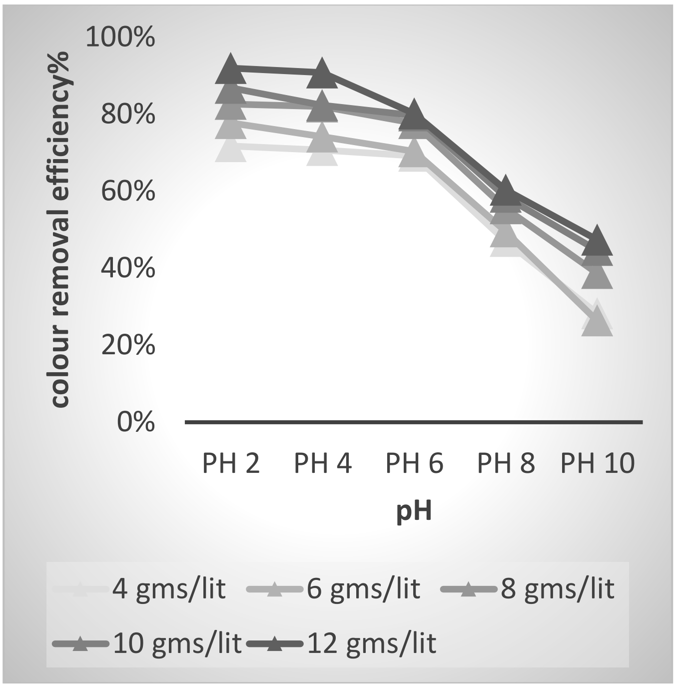


**Fig -8: Palmyra sprout Removal efficiency for 50 ppm concentration**

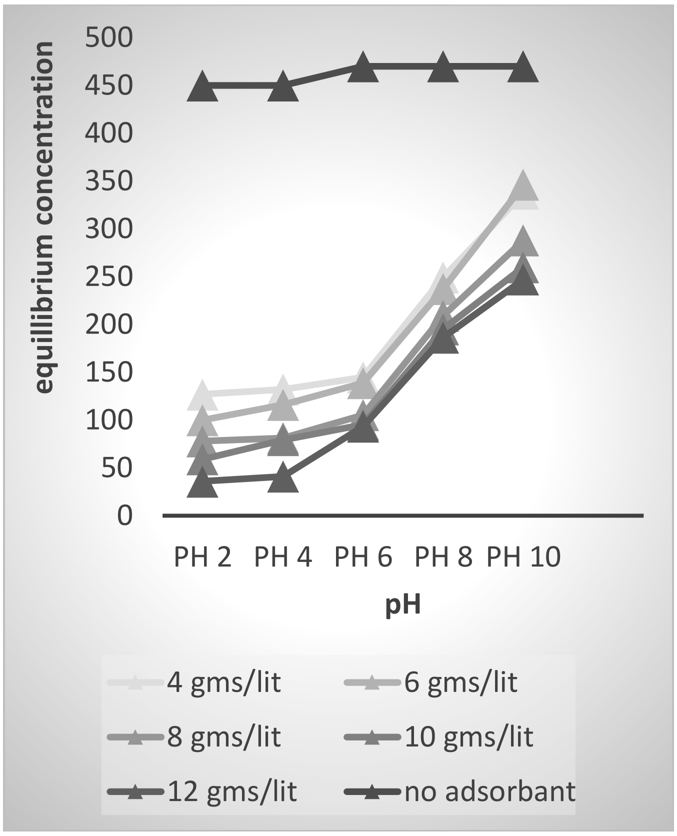


**Fig -7: Palmyra sprout Adsorption efficiency for 50 ppm concentration**

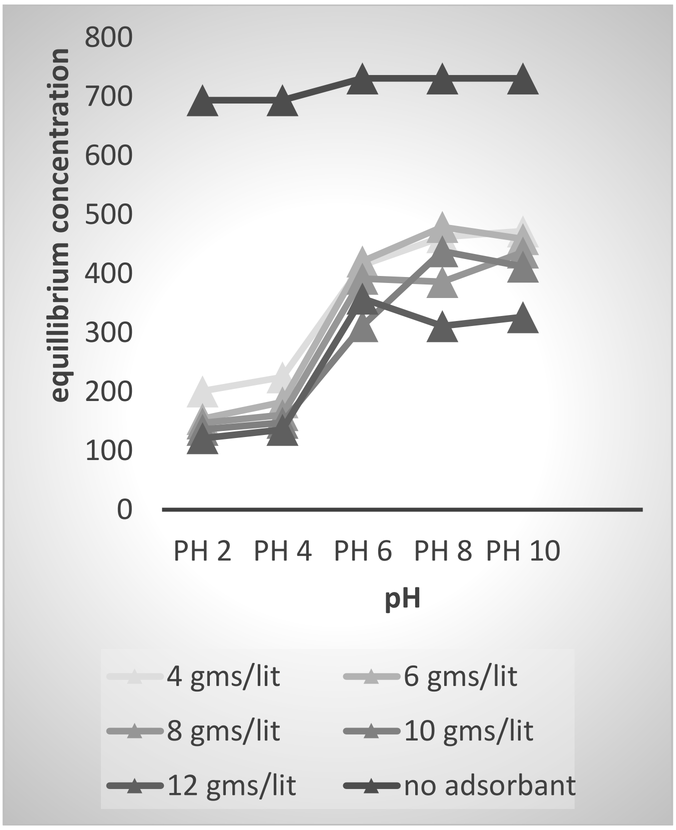


**Fig -9: Palmyra sprout Adsorption efficiency for 75 ppm concentration**

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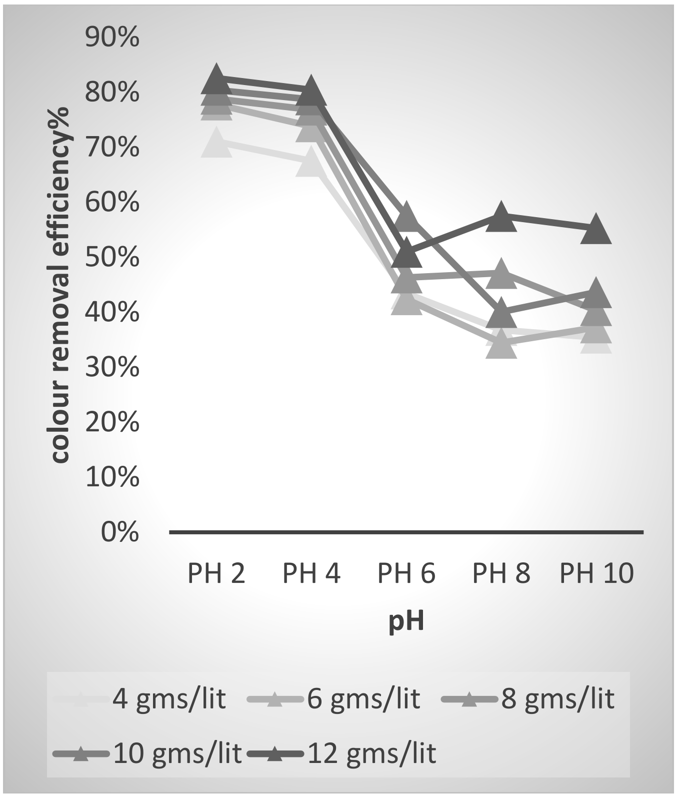


**Fig -10: Palmyra sprout Removal efficiency for 75 ppm concentration**

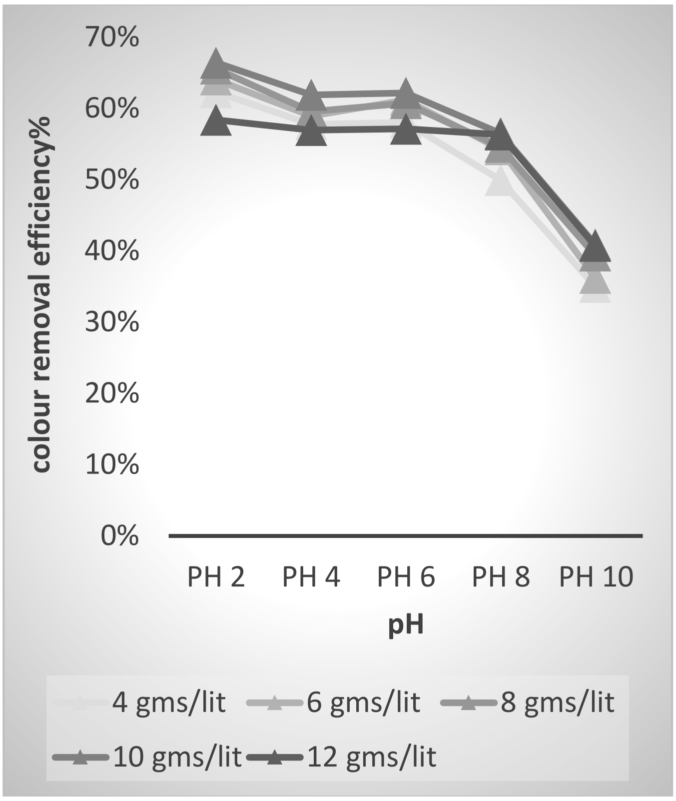


**Fig -12: Palmyra sprout Removal efficiency for 100 ppm concentration**

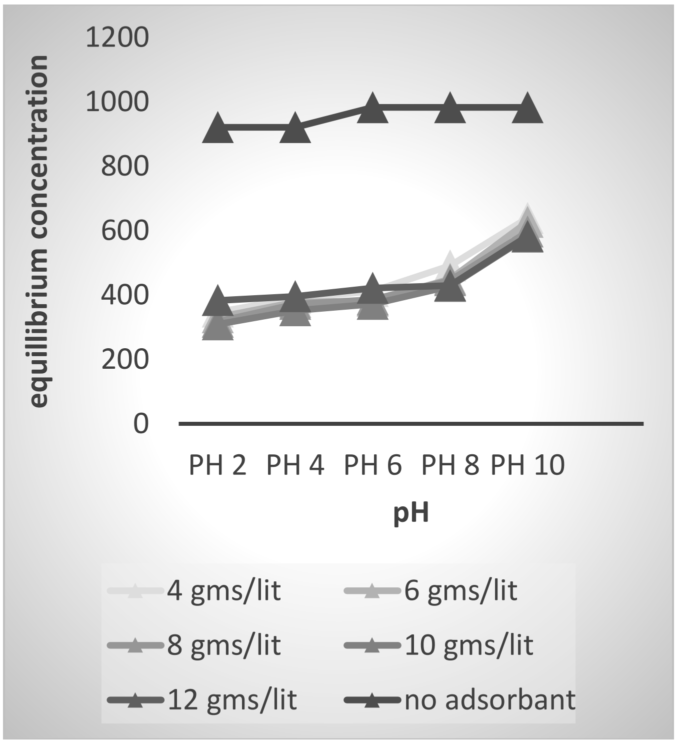


**Fig -11: Palmyra sprout Adsorption efficiency for 100 ppm concentration**

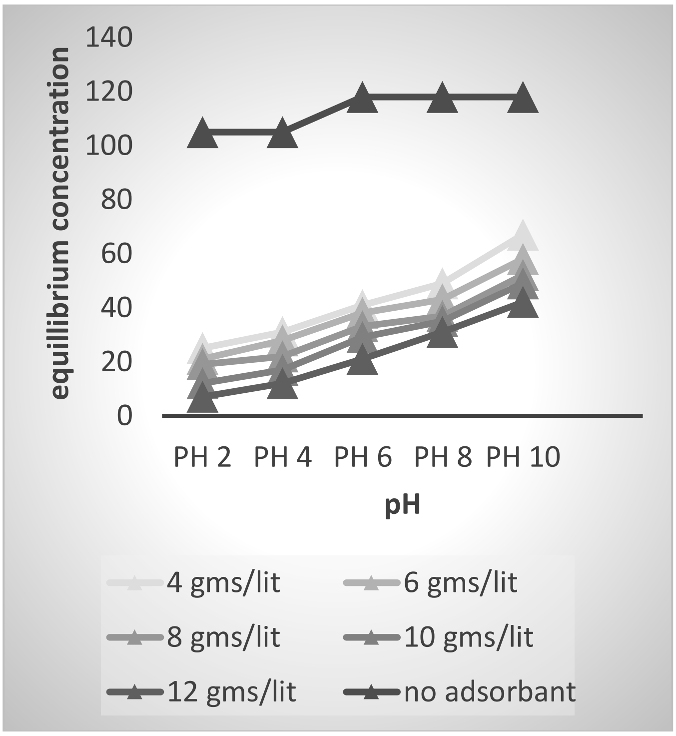


**Fig -13: Moringa oleifera Adsorption efficiency for 12.5 ppm concentration**

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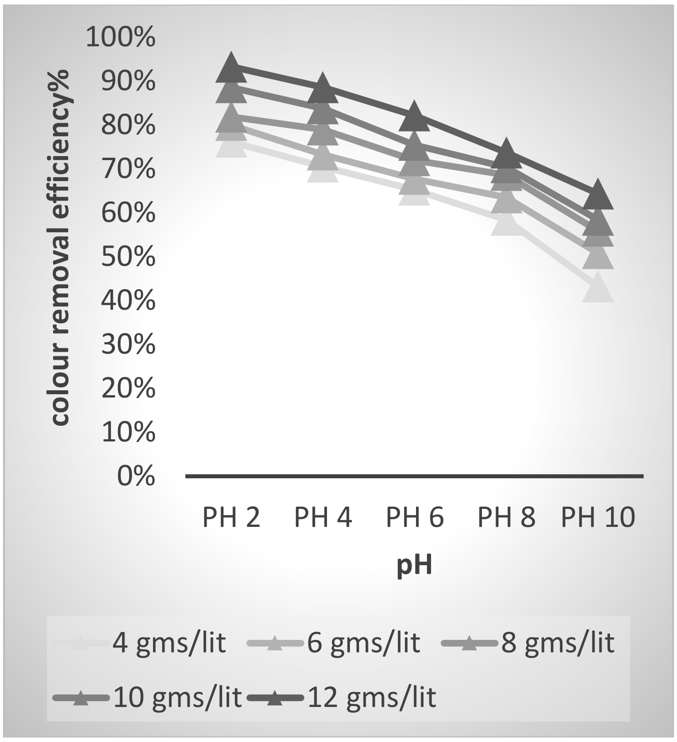


**Fig -14: Moringa oleifera Removal efficiency for 12.5 ppm concentration**

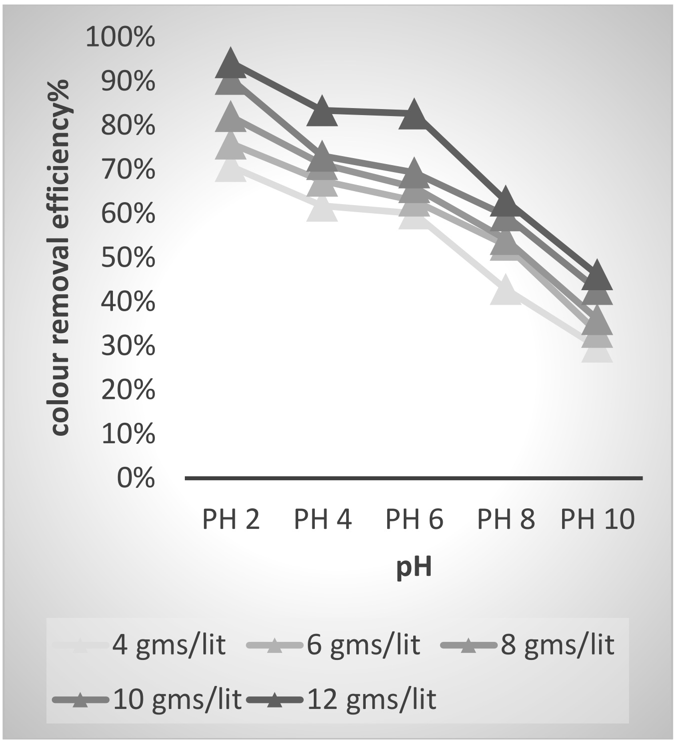


**Fig -16: Moringa oleifera Removal efficiency for 25 ppm concentration**

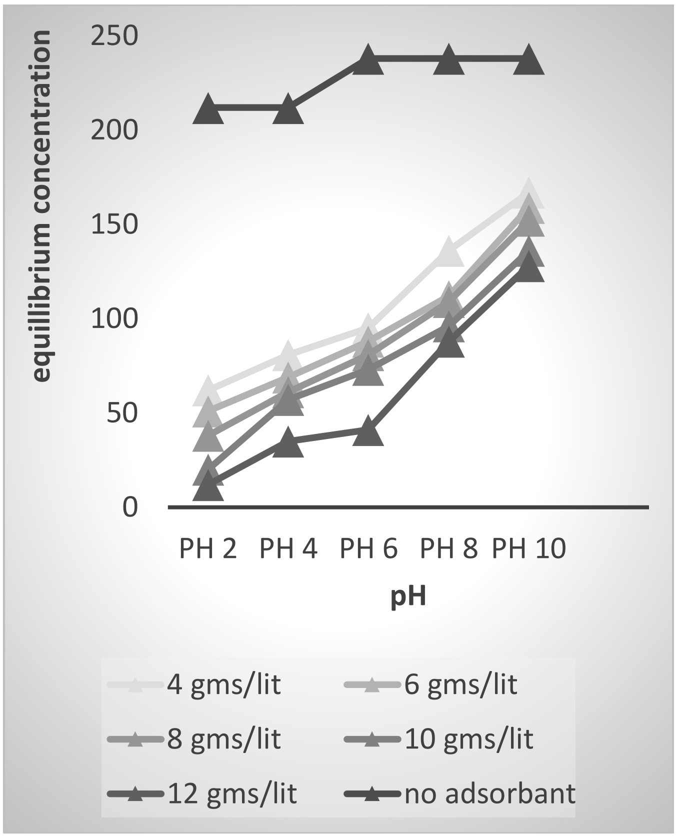


**Fig -15: Moringa oleifera Adsorption efficiency for 25 ppm concentration**

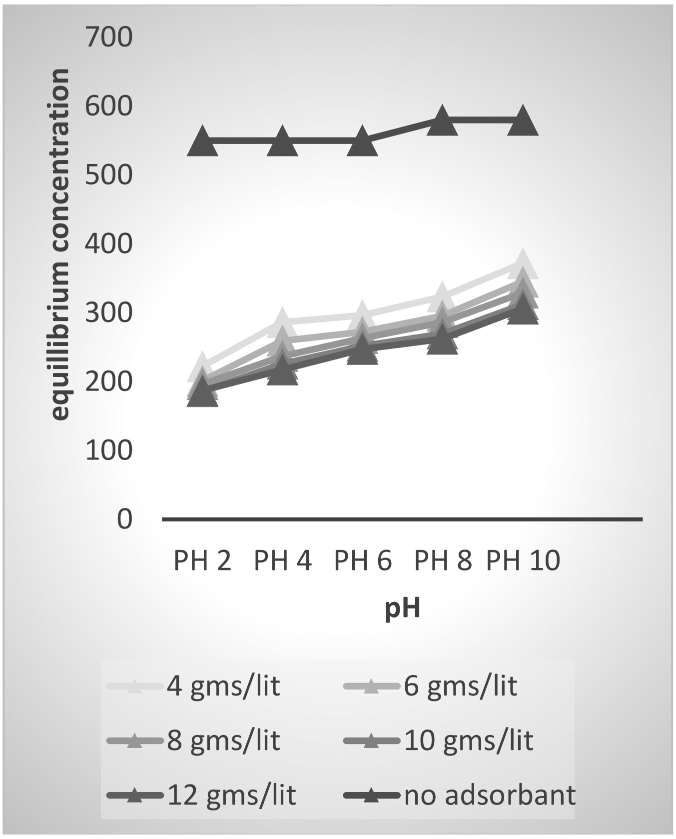


**Fig -17: Moringa oleifera Adsorption efficiency for 50 ppm concentration**

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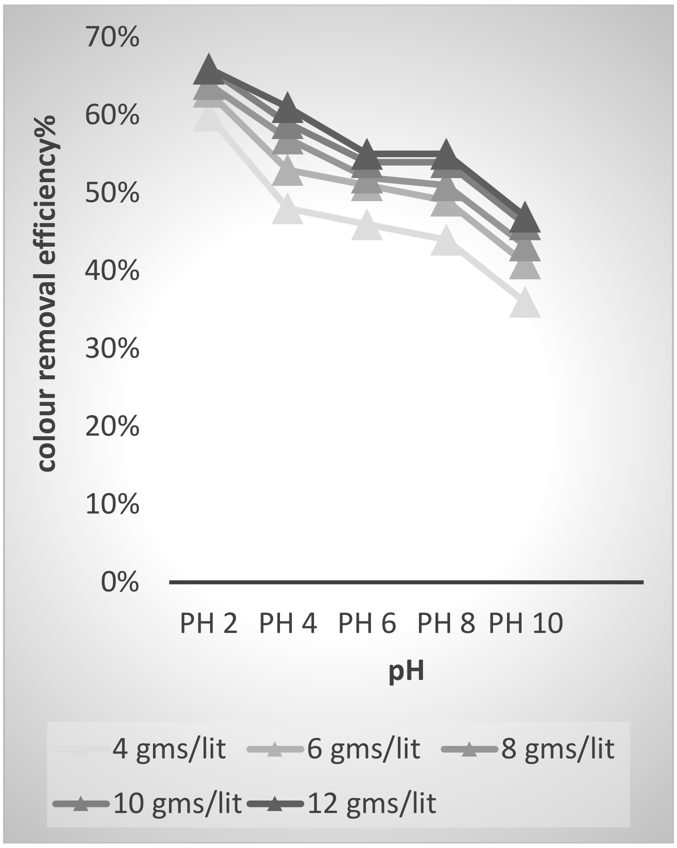


**Fig -18: Moringa oleifera Removal efficiency for 50 ppm concentration**

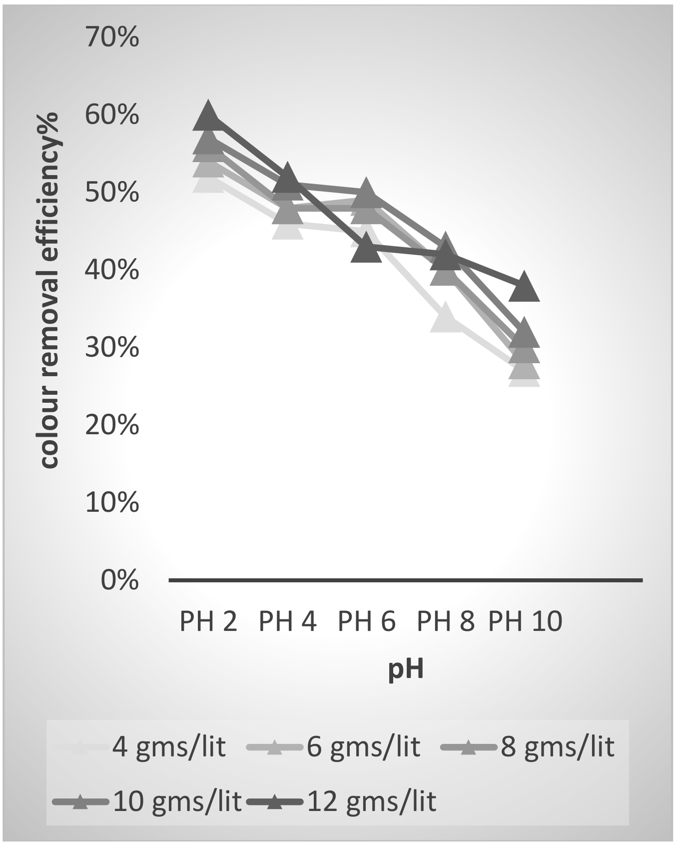


**Fig -20: Moringa oleifera Removal efficiency for 75 ppm concentration**

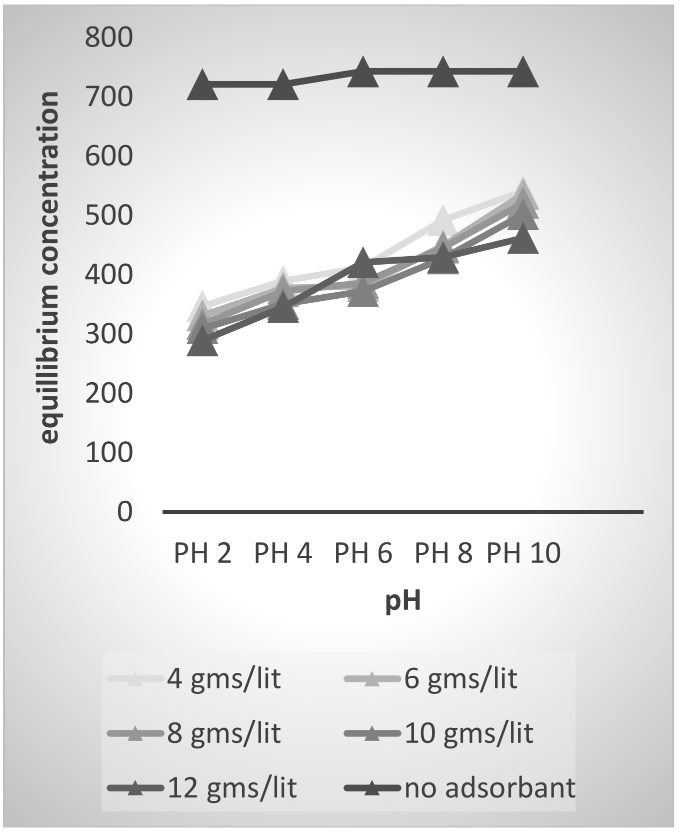


**Fig -19: Moringa oleifera Adsorption efficiency for 75 ppm concentration**

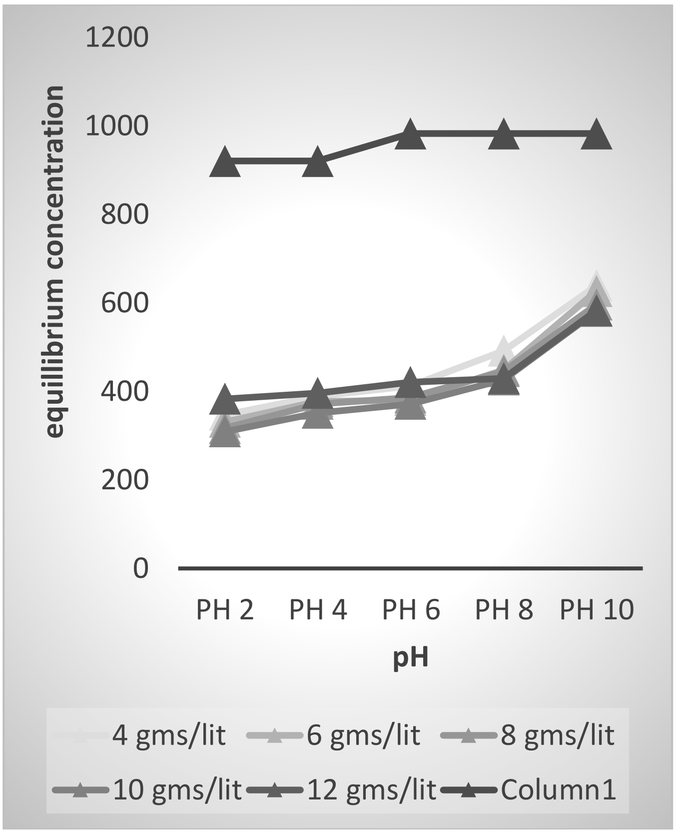


**Fig -21: Moringa oleifera Adsorption efficiency for 100 ppm concentration**

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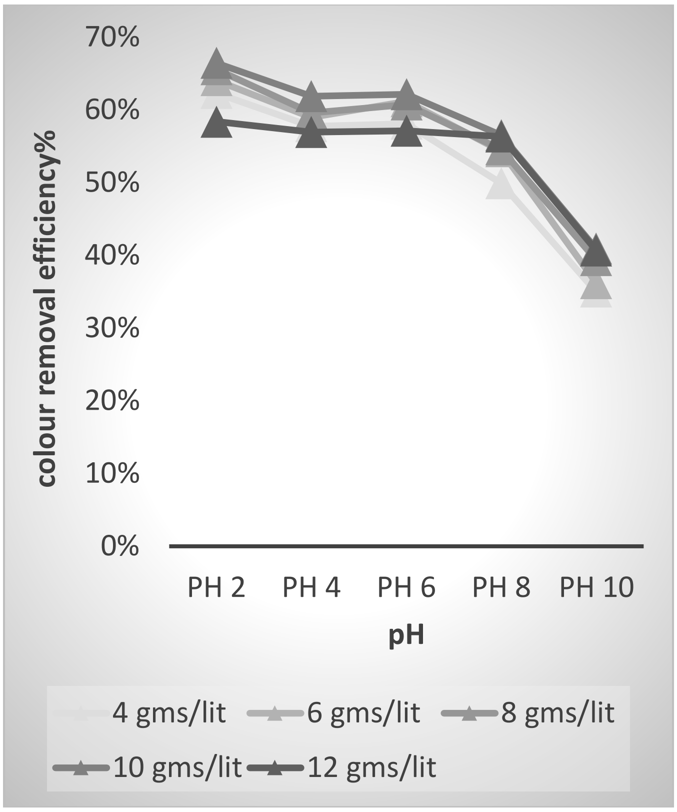


**Fig -22: Moringa oleifera Removal efficiency for 100 ppm concentration**

The color removal efficiency plotted in the graph shows that acidic conditions favor removal of textile dye color in wastewater. Higher adsorbent dose gives higher textile dye color removal efficiency.

## 5. CONCLUSION

The study revealed that the maximum dye removal efficiency was achieved at pH 2, indicating acidic conditions favor the adsorption process. Furthermore, an adsorbent dosage of 12 grams per litre was found to be optimal, providing sufficient adsorption sites for dye molecules. The optimum contact time of 120 minutes allowed for adequate interaction between the adsorbents and the dye solution, leading to efficient dye removal. Both Palmyra sprout peel and Moringa oleifera peel demonstrated remarkable adsorption capacities under the identified optimal conditions. The adsorbents exhibited high affinity towards Reactive Black 5 dye, effectively removing a significant proportion of dye molecules from the wastewater solution. The utilization of Palmyra sprout peel and Moringa oleifera peel as natural adsorbents presents promising environmental and economic benefits. These adsorbents are abundant, renewable, and biodegradable, offering a cost-effective and eco-friendly solution for textile wastewater treatment.

The study aims to investigate the feasibility of utilizing natural adsorbents, specifically Palmyra sprout peel and Moringa oleifera peel, for the removal of Reactive Black 5 dye from textile wastewater. Reactive Black 5 is a commonly used dye in the textile industry, known for its persistence and potential environmental hazards. By exploring eco-friendly alternatives to conventional treatment methods, the study seeks to address the pressing need for sustainable wastewater treatment solutions. Adsorption experiments are conducted to evaluate the performance of Palmyra sprout peel and Moringa oleifera peel in removing Reactive Black 5 dye from aqueous solutions under various conditions, such as pH, temperature, and initial dye concentration.

## REFERENCES


- Effective colour removal in textile waste water using natural adsorbent (Ms N.U.Yuvasri , Dr J B Veeramalini, Madesh K ,Siddharth , Vignesh)
- (Mehedi Hasan, Mir Tanvir Al Biruni, Simanta Azad & Tanvir Ahmed ) Adsorptive removal of dye from textile wastewater employing moringa oleifera leaves biochar As a natural biosorbant.
- (Mst. Nazmin Zaman Khan, Kallol Paul, Md. Abul Hashem*, Husne-Al-Jabeen, Sofia Payel)
  Dye removal from tannery wastewater by adsorption-coagulation using Moringa oleifera bark charcoal.
- (Nancy Jotham Marobhe, Fredrick Salukele, Shadrack Mwita Saba) Potential of Moringa oleifera seeds and fuel wood ash as adsorbent of dye and organic matter in wastewater from batik producing enterprises
- (Sunitha ranote, Ghanshyam S chuahan,, Veena joshi) Etherified *Moringa oleifera* gum as rapid and effective dye adsorbents
- (Xiao Mi,Zhenya Shang,Chunbao Du,Guoting Li,Ting Su,Xinying Chang,Ruiming Li,**Zhihong Zheng**,and **Jingxi Tie)** Adsorption of an Anionic Azo Dye Using *Moringa oleifera* Seed Protein-Montmorillonite Composite
- (Elkammah, Mai & Elkhatib, Elsayed & Gouveia, Susana & Cameselle, Claudio & Aboukila, Emad) Enhanced removal of Indigo Carmine dye from textile effluent using green cost-efficient nanomaterial: Adsorption, kinetics, thermodynamics and mechanisms
- (Reza Marandi, Seyedeh Marjan , Bakhtiar, sepehr) Removal of Orange 7 Dye from Wastewater Used by Natural Adsorbent of Moringa Oleifera Seeds
- (Hridoy roy, Md shahinoor islam) Chitosan-ZnO decorated *Moringa oleifera* seed biochar for sequestration of methylene blue: Isotherms, kinetics, and response surface analysis
- (Syieluing Wong, Nawal Abd Ghafar, Norzita Ngadi, Fatin Amirah Razmi, Ibrahim Mohammed Inuwa, Ramli Mat & Nor Aishah Saidina Amin.) Effective removal of anionic textile dyes using adsorbent synthesized from coffee waste
- (Maimuna Akter, Fahim Bin Abdur Rahman, M. Zainal Abedin and S M Fijul Kabir) Adsorption Characteristics of Banana Peel in the Removal of Dyes from Textile Effluent
- Saha, S., Sarkar, S., & Pal, A. (2018). Adsorptive removal of reactive black 5 dye from wastewater using bio-char as an adsorbent. Journal of Environmental Chemical Engineering.
- Garg, V. K., Amita, M., Kumar, R., Gupta, R., & Yadav, A. B. (2003). Adsorption of basic dye on high-surface-area activated carbon prepared from

coconut husk: Equilibrium, kinetic and thermodynamic studies. Journal of Colloid and Interface Science,

- Mittal, H., Rani, U., Mittal, J., & Mittal, A. K. (2015). Removal of reactive black-5 dye from aqueous solutions using Moringa oleifera bark: Equilibrium and kinetic studies. Journal of Molecular Liquids.
- Ncibi, M. C., Mahjoub, B., Seffen, M., & Gaspard, S. (2016). Moringa oleifera seeds for water pollution treatment: Journal of Environmental Management.
- Siddique, M. A., Rahman, M. M., Rashid, M. H., & Yusof, A. M. (2014). Utilization of waste product of palmyra palm (Borassus flabellifer L.) seeds as low-cost adsorbent for removal of heavy metals from wastewater: A review. Journal of Environmental Management.
- Removal of Reactive Black 5 from Waste Waters by Adsorption: A Comprehensive Review Mohammad Reza Jalali Sarvestani1 and Zohreh Doroudi.