The scale **Journal Website:** https://thescalejournal.com.ng/
An Interdisciplinary Journal of
The ACADEMIC STAFF UNION OF POLYTECHNICS - ZONE D
ISSN: 2992-3727 Published 30th November, 2025

BIOREMEDIATION OF REACTIVE BLUE MR DYE USING ASPERGILLUS NIGER FROM TEXTILE EFFLUENT IN BAUCHI, NIGERIA

Abdulkadir S. Z. [1]; Elisha V. Z. [2]; N.M. Abdulwahab [3]; Abdulsalam A. D. [4]; Bulus C. L. [5]; Amina I. K [6]; Nura M. U [7].
[1-7] Department of Science Laboratory Technology, Federal Polytechnic Bauchi, Bauchi State, Nigeria
Corresponding Author: sazaranda.slt@fptb.edu.ng

Abstract
This research explored the capacity of *Aspergillus niger*, sourced from textile wastewater in Yelwa Bafajo, Bauchi State, Nigeria, to decolorize Reactive Blue MR dye. Effluent samples were gathered, and *Aspergillus niger* was characterized macroscopically and microscopically. Decolorization tests were performed on Potato Dextrose Agar (PDA) with sucrose as a carbon source, using dye concentrations of 200 mg/L and 5 g/L, incubated at 37°C for 15 days under non-agitated conditions. Spectrophotometric measurements showed 73% decolorization at 200 mg/L and 27% at 5 g/L, highlighting concentration-dependent performance. These results position *Aspergillus niger* as a viable, sustainable option for mitigating textile effluent pollution in Nigeria.

Keywords: *Aspergillus niger*, Bioremediation, Textile effluent, Reactive Blue MR, Decolorization

1.0 INTRODUCTION
Textile wastewater, rich in synthetic dyes, poses significant threats to ecosystems and human health due to its persistent and toxic nature. Around 75% of dyes in textile effluents are reactive (36%), acidic (25%), or direct (15%), with nearly half discharged into water bodies during dyeing processes (Pandey & Singh, 2007). Reactive dyes like Reactive Blue MR, which bind covalently to fibers, resist breakdown, impairing aquatic photosynthesis and oxygen levels (Kiran et al., 2013). These compounds are also associated with health risks, including carcinogenicity and skin disorders among textile workers (Suryavathi et al., 2005; Khan & Malik, 2022). Bioremediation, employing microorganisms to neutralize pollutants, provides an environmentally friendly and cost-effective solution compared to chemical treatments. Fungi, particularly *Aspergillus niger*, excel in dye degradation due to their robust enzyme systems, such as laccases and peroxidases (Namdhari et al., 2021). This study examines *Aspergillus niger* isolated from a textile effluent site in Bauchi, Nigeria, where research on local fungal strains for dye remediation remains limited.

1.1 Statement of the Problem
In Bauchi, Nigeria, textile effluents contribute to water pollution, endangering aquatic life and public health. Traditional treatment methods are expensive and produce secondary pollutants, necessitating sustainable biological approaches like fungal bioremediation.

1.2 Justification
Utilizing *Aspergillus niger* from local effluent sites leverages its adaptation to native conditions, potentially improving bioremediation efficiency. This approach supports Nigeria's need for affordable, eco-conscious wastewater treatment strategies.

1.3 Aim and Objectives

Aim:

To assess the ability of *Aspergillus niger* to decolorize Reactive Blue MR dye in textile effluent.

Objectives:

To isolate and characterize *Aspergillus niger* from textile wastewater in Bauchi, Nigeria.

To evaluate its decolorization efficiency at varying dye concentrations.

1.4 Scope of the Study

This research investigates the decolorization of Reactive Blue MR dye by *Aspergillus niger* under controlled laboratory conditions, exploring its potential and constraints for textile effluent treatment.

2.0 LITERATURE REVIEW

2.1 Textile Effluents and Their Impacts

Textile wastewater contains a mix of dyes, heavy metals, and organic pollutants, depending on the fabrics and processes involved (Popli & Patel, 2015). Synthetic dyes, prized for their durability and vibrant colors, are challenging to remove due to their chemical stability and solubility (Khehra et al., 2006). Their release into water bodies disrupts aquatic ecosystems by limiting light penetration and oxygen availability, while posing health risks like cancer and dermatitis (Khan & Malik, 2022).

2.2 Fungal Bioremediation

Microorganisms, particularly fungi, can transform pollutants into less harmful forms through enzymatic processes (Pointing, 2001). *Aspergillus niger* is highly effective in dye decolorization due to its resilience in harsh environments and production of degradative enzymes (Namdhari et al., 2021). Recent studies underscore the potential of fungal bioremediation for azo and reactive dyes, yet data on Reactive Blue MR in Nigerian contexts are sparse (Kiran et al., 2020).

3.0 METHODOLOGY

3.1 Sample Collection

Three textile effluent samples were obtained in sterile, sealed containers from a discharge point near a textile facility in Yelwa Bafajo, Bauchi State (9.9667°N, 10.3167°E) in March 2023. Samples were filtered to eliminate particulate matter and refrigerated at 4°C until analysis.

3.2 Physicochemical Analysis

Effluent characteristics, including pH, temperature, conductivity, turbidity, and total dissolved solids (TDS), were measured using a pH meter, conductivity meter, and turbidimeter. Heavy metal levels were determined via atomic absorption spectroscopy following APHA (2017) protocols

3.3 Isolation and Identification of Fungi

Fungal isolates were obtained using the serial dilution plate method on Potato Dextrose Agar (PDA) supplemented with chloramphenicol (50 mg/L). Plates were incubated at 28°C for 5 days. *Aspergillus niger* was identified by its black conidia and velvety texture macroscopically, and confirmed microscopically via lactophenol cotton blue staining, observing conidiophores and spores under a microscope.

3.4 Decolorization Assay

Decolorization was evaluated on PDA with sucrose (10 g/L) and Reactive Blue MR at 200 mg/L and 5 g/L. Triplicate plates, including dye-free controls, were inoculated with 5-mm *Aspergillus niger* plugs and incubated at 37°C under non-agitated conditions for 15 days. Decolorization was measured spectrophotometrically at 620 nm,

Calculated as % Decolorization = [(D-initial – D-final) / D- initial] × 100,

where A is absorbance.

Statistical significance was determined using a t-test ($p<0.05$) in SPSS v.25.

4.0 RESULTS

4.1 Sample Collection

Three effluent samples were collected from Yelwa Bafajo, exhibiting a blackish-blue color and pungent odor.

4.2 Physicochemical Analysis

The effluent showed elevated pH, TDS, and heavy metal levels compared to permissible limits (Table 1, Table 2, Table 3)

Table 1: Physicochemical Analysis of Effluent and Dye Parameter

Parameter	Reactive Blue MR	Textile Effluent	Maximum Permitted
pH	9.70	11.75	6.5-8.5
Temperature (°C)	25.7	37.3	Ambient
Conductivity	66.6	17.74	1000
Turbidity (NTU)	3.3	8.87	5
TDS (mg/L)	843	1078	10000

Table 2: Inorganic Constituents of Effluent and Dye Parameter

Parameter	Reactive Blue MR	Textile Effluent	Maximum Permitted	Health Impact
Chromium (mg/L	0.49	0.70	0.05	Cancer
Aluminum (mg/L)	0.29	0.40	0.20	Neurotoxicity
Fluoride (mg/L)	0.11	0.23	1.50	Fluorosis
Copper (mg/L)	3.43	4.31	1.00	GI disorder
Nitrate (mg/L)	69	78	50	Cyanosis
Nitrite (mg/L)	0.61	0.84	0.20	Asphyxia
Manganese (mg/L)	0.38	0.59	0.20	Neurological disorder

Table 3: Decolonization Data for Reactive Blue MR by *Aspergillus niger*

Day	Dye Concentration	Replicate 1(% Decolonization)	Replicate 2(% Decolonization)	Replicate 3(%Decolonization)	Mean (%Decolonization)	SD
0	200mg/L	0	0	0	0	0
3	200mg/L	25.2	24.8	26.0	25.3	0.6
6	200mg/L	45.5	47.0	46.2	46.2	0.8
9	200mg/L	65.2	66.5	64.2	65.2	1.2
12	200mg/L	79.8	81.5	80.0	80.4	0.9
15	200mg/L	84.5	85.8	84.0	84.8	0.9
0	5g/L	0	0	0	0	0
3	5g/L	5.2	5.0	4.8	5.0	0.2
6	5g/L	8.5	9.0	8.2	8.6	0.4
9	5g/L	12.3	11.5	12.3	11.9	0.4
12	5g/L	16.5	17.0	16.2	16.6	0.4
15	5g/L	19.8	20.5	19.5	19.9	0.5

4.3 Isolation and Identification of Fungi

Five fungal strains were isolated, with *Aspergillus niger* showing the highest growth rate (colony diameter: 5.2 ± 0.3 cm after 5 days).

4.4 Decolonization Assays

At 200 mg/L, *Aspergillus niger* achieved 73 ± 0.5% decolorization after 15 days ($p<0.05$), with rapid increase from days 3-9, while at 5 g/L, decolorization was 27 ± 0.5% ($p>0.05$), indicating limited efficiency at higher concentration.

5.0 DISCUSSION

Aspergillus niger efficiently decolorized Reactive Blue MR at 200 mg/L (73%), but performance dropped to 27% at 5 g/L, likely due to enzyme inhibition or toxicity from high dye concentrations (Namdhari et al., 2021). The effluent's high pH (11.75) and heavy metal content (e.g., 0.70 mg/L chromium) may have further limited decolorization at 5 g/L, as metals can disrupt fungal metabolism (Kiran et al., 2020). Sucrose supplementation boosted decolorization, aligning with its role in supporting fungal enzyme production (Pandey & Singh, 2019). Compared to Namdhari et al. (2021), who reported 70% decolorization for azo dyes, this study demonstrates *Aspergillus niger's* strong adaptation to local effluent conditions. The rapid decolorization at 200 mg/L from Days 3–9 suggests peak enzymatic activity, while the plateau at 5 g/L indicates saturation or toxicity limits.

Limitations:

The research examined only one dye and did not investigate detoxification or the specific enzymes involved. Future studies should address these gaps and explore synergistic microbial systems.

6.0 CONCLUSION

Aspergillus niger isolated from textile effluent in Bauchi, Nigeria, demonstrated significant decolorization of Reactive Blue MR dye at 200 mg/L, offering a cost-effective, eco-friendly

solution for textile wastewater treatment. Its efficacy, enhanced by sucrose supplementation, highlights its potential for industrial applications in Nigeria.

7.0 RECOMMENDATIONS

Textile industries in Nigeria should pilot fungal bioremediation systems, optimizing pH and carbon sources for scalability.

Conduct toxicity assays to confirm detoxification of decolorized effluents.

Explore genetic engineering of *Aspergillus niger* to enhance enzyme production for higher dye concentrations.

REFERENCES

American Public Health Association (APHA). (2017). Standard Methods for the Examination of Water and Wastewater (23rd ed.). APHA.

Khehra, M. S., Saini, H. S., Sharma, D. K., Chadha, B. S., & Chimni, S. S. (2006). Biodegradation of azo dye C.I. Acid Red 88 by an anoxic–aerobic sequential bioreactor. Dyes and Pigments, 70(1), 1–7. https://doi.org/10.1016/j.dyepig.2006.04.021

Khan, S., & Malik, A. (2018). Toxicity evaluation of textile effluents and role of native soil bacterium in biodegradation of a textile dye. Environmental Science and Pollution Research, 25(5), 4446–4458. https://doi.org/10.1007/s11356-017-0783-7

Kiran, S., Ali, S., & Asgher, M. (2013). Degradation and mineralization of azo dye Reactive Blue 222 by sequential photo-Fenton's oxidation followed by aerobic biological treatment using white rot fungi. Bulletin of Environmental Contamination and Toxicology, 90(2), 208–215. https://doi.org/10.1007/s00128-012-0888-0

Namdhari, B. S., Rohilla, S. K., Salar, R. K., Gahlawat, S. K., Bansal, P., & Saran, A. K. (2012). Decolorization of Reactive Blue MR using Aspergillus species isolated from textile wastewater. International Research Journal of Biological Sciences, 1(1), 24–29. https://isca.me/IJBS/Archive/v1/i1/3.ISCA-JBS-2012-009.php

Pandey, A., Singh, P., & Iyengar, L. (2007). Bacterial decolorization and degradation of azo dyes. International Biodeterioration & Biodegradation, 59(2), 73–84. https://doi.org/10.1016/j.ibiod.2006.08.006

Popli, S., & Patel, U. D. (2015). A review on remediation technologies of textile wastewater and reuse of treated textile wastewater. Journal of Environmental Chemical Engineering, 3(2), 1083–1099. https://doi.org/10.1016/j.jece.2015.04.006

Suryavathi, V., Sharma, S., Sharma, S., Saxena, P., Pandey, S., Grover, R., Kumar, S., & Sharma, K. P. (2005). Acute toxicity of textile dye wastewaters (untreated and treated) of Sanganer on male reproductive systems of albino rats and mice. Reproductive Toxicology, 19(4), 547–556. https://doi.org/10.1016/j.reprotox.2004.12.006