

# STUDIES OF ADSORPTIVE INTERACTION BETWEEN *Aspergillus niger* AND THE REACTIVE AZO DYE PROCION BLUE MX-G

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■ **ABSTRACT:** *Aspergillus niger* on paramorphogenic form showed to be efficient adsorbent to reactive azo dye Procion Blue MX-G, where it has obtained rates of colour removal above 99% in acid pH, at 120 minutes of equilibrium time. Temperature did not exert expressive influence in the process, and the applicability of Freundlich's, isotherm suggest the occurrence of various molecules layers of adsorbed dye on the substratum surface.

■ **KEYWORDS:** *Aspergillus niger*; adsorption; dye; filamentous fungi.

## Introduction

Azo dyes are considered like the owners of great toxic potential for being degraded in residual chemical compounds of hard removal in industrial treatments of wastewater, <sup>1</sup> and to promote the appearance of aromatic amines in their degradation, considered of high carcinogenic and mutagenic potential. <sup>3,8</sup> The actual methods of treatment of these effluents do not seem to be enough efficient to impede the formation of toxic compounds like anilines, aromatic hydrocarbons, etc. <sup>4</sup> in process of activated sludge <sup>7,12</sup> interfering in the growth and respiratory rate of microorganisms; in chloration process, where it produces several degrees of toxicity for the aquatic fauna and flora, <sup>6,16</sup> still being very questioned in activated carbon process <sup>11,17</sup> in respect to resistant derivatives to biodegradation and levels of DBO.

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Recent tendencies show up the adsorption/absorption methods by microorganisms like commendable on removal treatments of toxics compounds of industrial effluents, since many searchers have recommended the utilization of fungic microorganisms, example: *Coriolus versicolor* Ps4a,<sup>14</sup> *Phanerochaete chrysosporium*,<sup>9</sup> *Saccharomyces uvarum*,<sup>13</sup> *Neurospora crassa*<sup>2</sup> and *Ramaria*, *Poria placenta* and *Gloeophyllum trabeum*<sup>5</sup> getting excellent results to aim at removing the dye of the aqueous medium in its integral form. In that work, were carried out studies of interaction with the fungus *Aspergillus niger*, intending to test its biosorptive potential with the reactive azo dye Procion Blue MX-G since that this type of dye is considered of low biosorptivity in activated sludge.<sup>15</sup>

## Experimental

*A. niger* culture maintained in 2% malt extract at 4°C was transferred to erlenmeyers containing growth medium for *Aspergillus* sp.<sup>10</sup> and 10 g of glass cylinders (with 6 mm of diameter and 2 mm of thickness). After that, they were put on a shaker at 250 rpm 30°C for 24 hours of cultivation, for lacerating the hiphae. From pre-inoculum thus obtained, were retreated aseptically aliquots of 4 mL and inoculated in erlenmeyers containing growth medium for *Aspergillus* sp. and placed on a shaker at 30°C and 250 rpm for 24 hours of cultivation. In this manner was obtained inocula with small and homogeneous mycelial pellets, mensuring around 0,5–1 mm of diameter,<sup>8</sup> which can offer greater active surface and more uniform in their entirety.

There was employed several aliquots of 1, 2, 4 and 6 mL of this inoculum (with posterior dry weight obtained at 105°C), in contact with the dye in the concentration of 100 µg/ml, and the final solution was tested during 120 min., with pH indices in 2.5, 4.5, 6.5 and 8.5 at 3 temperatures: 20, 30 and 44°C. The cultivations thus processed were centrifuged at 6.000 rpm to get the supernatant free of mycelia. The amount of remaining dye in the solution was determined by spectrophotometric readings in 375,4 nm (isobesthic point).

Obtained data were evaluated by Freundlich's equations, as follow:

$$\log (x/m): \log k + n \log Cr, \text{ where:}$$

x/m: mass of solute adsorbed per unit mass of adsorbent (mg/g)

Cr: solute concentration in solution (mg/L)

k: x/m when Cr is equal to 1 (mg/g)

n: slop

## Results and discussion

Procion Blue MX-G reactive dye showed considerable rates of adsorptivity in *A. niger*, contradicting the obtained results by Hitz et al. (1978) in Shaul et al.<sup>15</sup>, when they worked with activated sludge, remarking a low adsorptivity of the reactive dyes. The dye here studied showed excellent performance in pH indices at 2.5 and 4.5 (maximum values of colour removal at 99.82% with 6.3 mg of biomass - dry weight, and 94.25% with 8.4 mg at 30°C and 20°C respectively, as it has showed on Table 1. Neutral or alkaline pH made difficult the adsorptive process showing 49.6% in pH 6.5 at 40°C using 8.10 mg of biomass, while the pH 8.5 inhibited the process, obtaining maximum value of 2.69% (using 7.62 mg of biomass).

Table 1 - Parameters obtained for the adsorption of Procion Blue MX-G on *Aspergillus niger* according Freundlich's isotherm

pH	Temperature (°C)	Intercept	Slop	Correlation index	Adsorbed dye (%)
2.5	20	1.1250	0.2594	0.6282	96.66
	30	1.3492	0.2156	0.8991	99.82
	40	1.2999	0.2183	0.9137	99.82
4.5	20	0.8963	0.2892	0.9183	94.25
	30	0.9753	0.3013	0.9551	93.11
	40	0.6832	0.4299	0.9771	90.59
6.5	20	1.4119	-0.3644	-0.7554	44.68
	30	0.4914	0.5296	0.9868	47.08
	40	-1.3034	1.2432	0.9466	49.61
8.5	20	-10.509	5.0343	0.1354	2.69
	30	There was no mensurable adsorption			
40	There was no mensurable adsorption				

Temperature did not exert expressive influence in the process, and the applicability of Freundlich's equation seems to be sufficient in the demonstration of the adsorptive process suggesting the occurrence of various molecules layers of adsorbed dye on the substractum surface.

## Conclusion

*Aspergillus niger*, a filamentous fungus shows very effective on the removal of the removal of the azo dye Procion Blue MX-G from aqueous medium, mainly in acids pH, obtaining above 90% of adsorption. Near of neutral pHs (6.5) this fungus presented levels around 47% of removal dye. According increase of pH (alkaline), there was observed a reduction of the interaction between the biomass and dye, remaining more quantities of its in the aqueous medium.

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■ **RESUMO:** As mais recentes tendências de tratamento de efluentes têxteis apresentam processos biosorvivos (adsorção/absorção) em substratos alternativos como microrganismos, já que a maioria dos métodos existentes (carvão ativado, lodo biológico, processos químicos etc.), através da degradação dos corantes, dão origem a compostos químicos recalcitrantes, de difícil remoção. Entre tais compostos podem-se incluir as aminas aromáticas, consideradas potencialmente carcinogênicas e mutagênicas, além de anilinas, hidrocarbonetos aromáticos, substâncias tensoativas e metais pesados. Dentre os vários microrganismos testados, o fungo filamentoso *A. niger* tem sido considerado de grande potencial biosorvivo para metais pesados, corantes e substâncias tóxicas, tendo sido testado visando à total remoção destes compostos do meio aquoso. O presente trabalho mostra o desempenho de *A. niger* ante o corante azóico reativo Procion Blue MX-G, e os resultados demonstram que variações na temperatura (20, 30 e 40°C) não exercem influência expressiva no processo adsorvivo. O mesmo já não ocorreu com os valores de pH, sendo que os ácidos (2,5 e 4,5) foram os que mais favoreceram o processo adsorvivo, apresentando níveis acima de 90% de remoção de corante, decaindo em torno de 47% em pH próximo ao neutro (6,5) e sendo praticamente nulo em pH alcalino (8,5). A análise dos resultados pela isoterma de Freundlich foi adequada para sugerir a ocorrência de várias camadas de moléculas de corante adsorvido na superfície do substrato.

■ **PALAVRAS-CHAVE:** *Aspergillus niger*; adsorção; corantes; fungos filamentosos.

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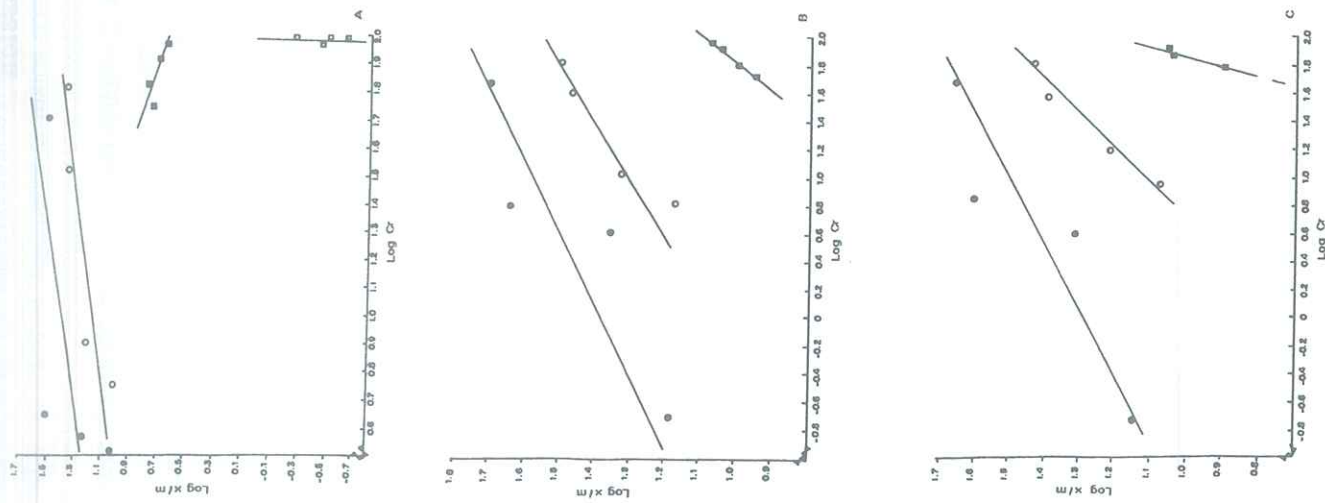


FIGURE 1 - Graphic demonstration of obtained data for the adsorption of Procion Blue MX-G on *Aspergillus niger* micelia according to Freundlich's isotherm. Graph. A: 20°C; B: 30°C; C: 40°C. There was assayed the pH values: 2.5 (●), 4.5 (○), 6.5 (■) and 8.5 (◻).

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