Valorisation of Moringaoleifera waste: treatment and reuse of textile dye effluents

M. Vilaseca, V. López-Grimau, C. Gutiérrez-Bouzán
Institute of Textile Research (INTEXTER), UniversitatPolitècnica de Catalunya (UPC)-Barcelona Tech, Terrassa, 08222, Spain
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Presenting author email: vilaseca@intexter.upc.edu

Abstract

This work is focused on the valorisation of an agricultural waste as natural coagulant to treat wastewater from the textile industry. In this paper, the waste of Moringaoleifera oil extraction is used as coagulant to remove five reactive dyes from synthetic textile effluents. Moringaoleifera shows better results for dye removal than conventional treatment of coagulation-flocculation with $FeCl_3$ and polyelectrolyte. Treated water can be reused in new dyeing processes of cotton fabrics with high quality results.

Keywords: Moringaoleifera; natural coagulant; dye removal; textile wastewater; water reuse

1. Introduction

The dyestuff industry is one of largest in the world and the implications for economic and social conditions in many countries, especially India and China, are of high importance (1). Depending on various factors such as fibre class, colour or industrial process, there are a number of dye substances which could be highly polluting if released into the environment.

For many years researches have been working on several ways of removing dyes from wastewater and different procedures have been developed. A possible source of low-cost materials that could provide a successful solution is natural raw materials (2). In this sense, Moringaoleifera seeds contain about 40% of highly valued oil and about 60% of waste with a high protein content. A fraction of this protein content of the seeds, around 1%, is constituted by active proteins neutralizing precipitate colloids and water, as do industrial coagulants but at lower cost (3).

Currently due to insufficient water, the need to protect the environment and benefit economically wastewater has promoted the controlled reuse of effluents. The reuse of treated wastewater is many and varied depending on the level and treatment technology to that which will determine effluent quality achieved (4).In this sense, we propose to study the treatment of textile dyeing effluents with reactive dyes using Moringa as a coagulant-flocculant agent. Moringa is one of the most useful tropical trees. The relative ease way which it propagates through both sexual and asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy.

This work is focused on the use of the waste of oil extraction from Moringaoleifera seeds to eliminate five azo reactive dyes from synthetic effluents. The efficiency of dye removal with

Moringaoleifera waste is compared with the use of the chemical coagulation-flocculation. Finally, the feasibility of reusing the treated water to carry out new dyeing of cotton fabrics is verified.

2. Experimental

Moringaoleifera seeds were supplied by the Centre National de SemencesForestières of Burkina Faso. Shells were removed manually and kernels were reduced to powder using a domestic grinder (Moulinex).

1g of M. oleifera crushed seeds fed to a Soxhlet extractor. The extraction was run for 2 hours in triplicate (n=3) with 100 mL of ethanol (Sharlab).

Suspension of coagulant solution of 5 g/L (w/v) in water, stirring for 2 hours was prepared.

Five azo reactive dyes widely used on cotton dyeing industries were selected in this study. They were supplied by DyStar. The commercial name and the Colour Index name of the five studied dyes are shown in Table 1.

Table 1. Commercial name and Colour Index name of the studied dyes

Commercial name	**C.I. name**
Remazol**Black** B-133	Reactive Black 5
Procion**Blue** H-EXL	Reactive Blue 198
Procion**Crimson** H-EXL	Reactive Red 231
Procion**Navy** H-EXL	Not available
Procion**Orange** MX-2R	Reactive Orange 4

Simulated dye baths were prepared at a dye concentration of 0.1 g/L in decalcified water. In the textile industry the dyeing process with reactive dyes is carried out with the addition of salt as electrolyte and at alkaline pH. This procedure generates alkaline and saline residual dye baths which contain the reactive dye in its hydrolysed form.

The effectiveness of the seeds was determined as coagulant in Jar test assays at different concentrations of solutions Moringa seeds, different pH and NaCl content. Conventional coagulation/flocculation tests were also carried out in Jar Test with at the same concentration chosen for the moringa of Iron (III) chloride solution (10%) and 1mg/L polyelectrolyte TS140 (Deripol) solution (1g/L) as coagulant and flocculant respectively to compare treatment whit the Moringa seeds.

Samples of treated water were used for the dyeing of cotton fabrics (referred hereafter as reused dyeings) with the five selected dyes and one thrichromie (a mixture of of Blue, Crimson and Orange). Reference dyeings with decalcified tap water were also carried out. Dyeing tests were carried out at a liquor ratio (LR) 1/10 (fibre weight/ water volume) in a laboratory batch dyeing machine, Ti-Color OTX 200, equipped with twelve stainless steel drums of 100 mL,method “all in” was selected (5), 70% of reused water, decolorized with Moringa, and 30% decalcified tap water.

Colour differences between reused and reference dyeings were measured to evaluate the viability of reusing the treated effluent. With this purpose, the final dyed fabric colour was measured by a spectrophotometer Macbeth Color Eye 7000, with illuminant D65 and 10º of standard observer. The instrument evaluates the chromatic coordinates of each dyed fabric. These coordinates are defined by three parameters (Lightness Lcmc; Chroma Ccmc, and Hue Hcmc). According to the standard UNE-EN ISO 105-J03: 1997 [6], the colour difference between two samples is calculated with the formula DE CMC(2:1), represented in the equation 1:

$$DE_{CMC\ (2:1)} = [(\Delta L^*/2S_L)^2 + (\Delta C^*_{ab}/S_c)^2 + (\Delta H^*_{ab}/S_H)^2]^{1/2}$$

3. Results

Dye removal results obtained with Moringaoleifera and with $FeCl_3$ are presented in Figure 1. Optimal conditions of treatment were chosen according to the results obtained in previous studies. Experimental conditions were: Concentration of Moringa seeds without oil suspension: 750 mg/L, solution unfiltered, pH=9, NaCl concentration=60 g/L, dye 0,1 g/L.

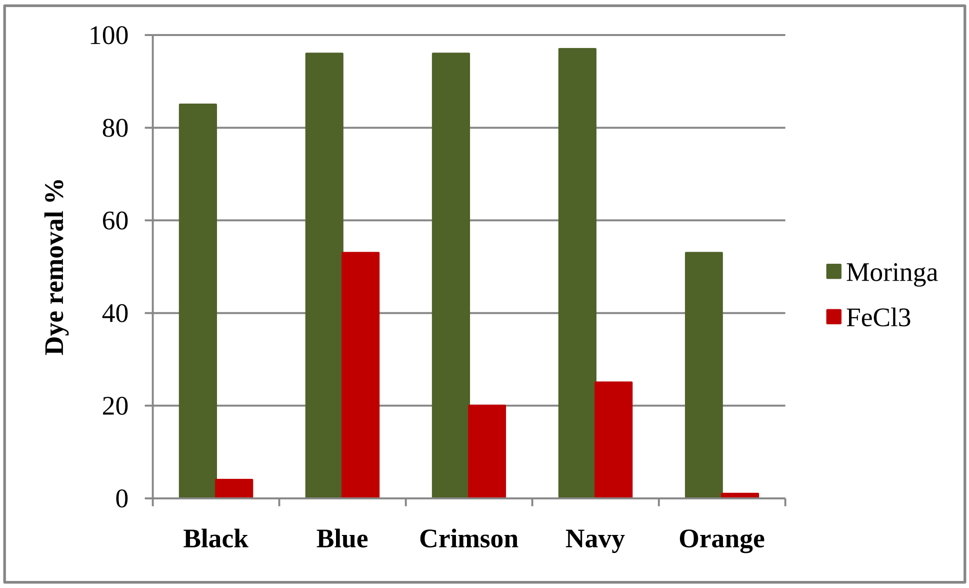

Figure 1. Comparison of dye removal withMoringaoleifera versus ferric chloride

As can be seen in Figure 1, Moringaoleifera waste is much more efficient on dye removal than the conventional coagulation/flocculation treatment with $FeCl_3$ and polyelectrolyte.

Treated water with Moringaoleifera was reused to carry out new dyeings of cotton fabrics in order to evaluate the feasibility in reusing these high salt content effluents. Colour differences of new dyeings with respect to reference dyeings are shown in Figure 2.

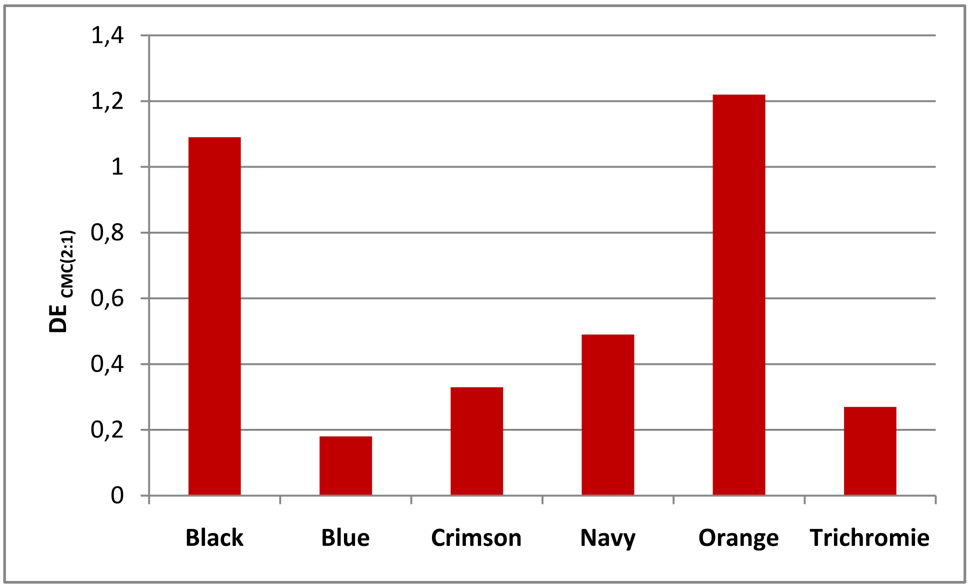

Figure 2. Colour differences of dyeings performed with decolorized water with respect to the corresponding references dyeing.

As can be seen in Figure 2, colour differences ($DE_{CMC(2:1)}$) below 0.5 were obtained in dyeings with Blue, Crimson and Navy dyes, as well as for the trichromie, which is an excellent result. In opposite, for Black and Orange dyes colour differences were slightly above the limit established in quality dyeing control ($DE_{CMC(2:1)}$) ≤ 1. Cotton samples dyed with decolorised water and reference dyeing are shown in Figure 3.

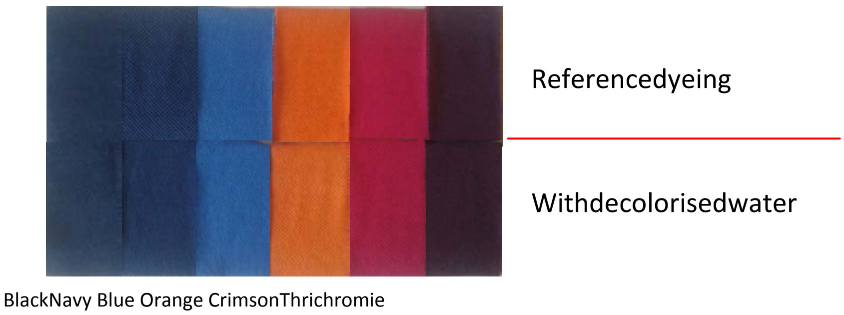

Figure 3. Comparison of dyeing samples obtained with decolorised water with respect to reference dyeings.

4. Conclusions

Moringaoleifera wastes can be valorised as coagulant solutions for the removal of reactive dyes from textile wastewater. Better dye removal results were obtained with Moringaoleifera than those obtained with conventional coagulation/flocculation treatment with $FeCl_3$ and polyelectrolyte.

The feasibility of reusing decolorised water in new dyeing processes with reactive dyes was demonstrated. The reuse of decolorized dye baths not only entails water saving but also NaCl saving and the reduction of salinity in the discharged wastewater.

Acknowledgments

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References

[1] Beltrán-Heredia, J., Sánchez-Martín, J. (2008) Azo dye removal by *Moringaoleífera* seed extract coagulation. Color. Technol., 124, 310-317.

[2]Beltrán-Heredia, J., Sánchez-Martín, J., Delgado-Regalado, A., Jurado-Bustos, C. (2009) Removal of Alizarin Violet 3R (anthraquinonic dye) from aqueous solutions by natural coagulants. Journal of Hazardous Materials, 170, 43-50.

[3] Foidl, N., Makkar, H., Becker, K. (2001) The potential of Moringaoleifera for agricultural and industrial uses. In: miracle tree. The multiple attributes of moringa. L. J. Furglie (Ed). Church World Service, Dakar, Senegal, 45-76.

[4] Mas y Rubí, M., Carraquero, S., Martínez, D., Gabriel Mejías, D., Vargas, L. (2013) Eficiencia de lassemillasMoringaoleíferacomocoagulanteorgánicoen la remoción de metalesenaguas de bajaturbiedad. Rev. Tecnocientífica URU, 5, 27-37.

[5] DyStar, Inc. Work procedures. Industrial Washing Procedure, Excel Washing, 36.

[6] AENOR (1997). UNE-EN ISO105-J03: 1997. Textiles. Ensayos de solidezdelcolor: Cálculo de lasdiferencias de color. Madrid: Asociación Española de Normalización y Certificación.