USE OF PEROXIDASE EXTRACTS OF Ipomoea palmate Forssk FOR SUSTAINABLE REDUCTION OF SOLID FABRIC WASTE

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Abstract— Solid fabric wastes represent the highest percentage of wastes produced in the Apparel Industry. As it takes much longer time to degrade, the impact towards the environment is high. The current study was carried out to determine the concentration and the time needed to decolorize synthetic solid fabric waste using peroxidase extracts of *Ipomoea palmate* Forssk. The study was carried out for six months of time. The leaves of *I. palmate* were collected from home gardens in Kandy and Kurunegala District of Sri Lanka and the peroxidase from leaves was extracted using Three-Phase partitioning (TPP) on Butanol-Water solvent system. A titration with potassium permanganate was carried out to determine the concentration of the peroxidase extracts required to decolorize the polyester and cotton fabrics. It was revealed that for cotton fabrics, the highest decolorization capacity for *I. palmate* from Kurunegala district was 1.435 × 10-5 mol dm-3 of concentration and the minimum time was 11 days and for *I. palmate* from Kandy district, concentration was 1.6375 ×10^{-}5 mol dm-3 and the minimum time was 10 days. For polyester, the time taken for decolorization was 15 days *for I. palmate* from Kurunegala district and 12 days for *I. palmate* from Kandy district. The concentrations were same as for the cotton fabrics. The activity was measured using a standard colour matrix. Therefore *Ipomoea palmate* Forssk. is successful in decolorizing solid fabrics and can use as a sustainable cost effective way to minimize Solid Fabric Wastes.

Index Terms— Apparel industry, Color Matrix, Decolorization, Fabrics, *Ipomoea palmate* Forssk, Solid fabric wastes, Three phase partitioning

1 INTRODUCTION

The apparel industry in Sri Lanka, accounts for the highest percentage in the national gross income[1]. Lack of infrastructure facilities and disregard for proper industrial safeguard methodologies results in higher accumulation of industrial solid waste disposal . In which 56% of the total fabric wastes accounts for Solid Fabric Wastes[2]. Sri Lankan government has prohibited dumping or disposing of solid fabric wastes. At present, unwanted solid fabric wastes are being sent for incineration, however, the potential hazardous synthetic dye pigments enter into the atmosphere.

Peroxidase is a free radical enzyme which catalyzes many aromatic groups and has been used to decolorize color pigments[3]. *Ipomoea palmate* has been used as a natural herbal plant and contains high amounts of plant peroxidases in its leaves. Its pharmacological profile has been reported to be consisting of Antioxidant, Antimicrobial, Antibacterial, Anti-inflammatory and mosquito larvicidal activity. For the extraction of the plant peroxidases a novel method called Three Phase Partitioning was used[4].

The objective of this study was to determine the concentration and the time required to decolorize synthetic solid fabric waste using peroxidase extracts of *Ipomoea palmate*.

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2 MATERIAL AND METHODOLOGY

2.1 Preperation of crude extract

Leaves of *I. palmate* were collected from home gardens in Ampitiya area in Kandy District and Thulhiriya area in Kurunegala District of Sri Lanka. The mid rib of the leaf was removed and the remaining leaf parts were washed in running tap water and were dried in mild sunlight. Then they were cut into small parts of about 2-3 cm wide and were ground to fine powder. Weight of the powder was measured and the powder samples were mixed with 10 mM phosphate buffer on a shaker for 24 hours. The ratio of amount of powder to phosphate buffer was 1:1 (w/v).

2.2 Peroxidase extraction using Three Phase Partitioning (TPP)

The crude extracts obtained were filtered to remove all the cell debris and fiber traces and it was mixed with ammonium sulfate in the ratio of 1:1. TPP was carried out with this solution and butanol in a separation funnel in the volume ratio of 1:1 at 25°C for 30 minutes. After the two cycles of TPP the interface which includes peroxidase bio molecules were collected. The concentrations of peroxidases in the two extracts of I. palmate collected from two districts were determined by titrating 5 mL of each extract with 1× 10-4 moldm-3 of Potassium permanganate (KMnO4).

2.3 Sampling of the crude extract

Extracts from each district (Kandy and Kurunegala) were diluted three times to make 4 replicates (×1, ×10, ×100, ×1000). Thus at the end, a total of 8 replicates were tested

2.4 Determination of the concentration of the decolorization

Decolorizing capacity of each sample was checked using synthetic polyester fabrics and cotton fabrics. About 6 drops from each sample were added to the fabrics and was compared with a standard color matrix.Color matrix was made for each color of the fabric material where No 1 was given to the highest contrast and No 10 was given to the white color. After every 30 minutes, color change of the fabric material was checked using the color matrix and the grade was recorded until the fabric was completely decolorized.

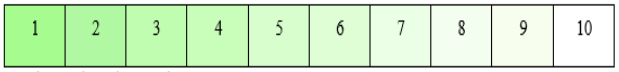

Fig. 1. The color matrix

2.5 Determining the time taken for decolorization

The concentrations of peroxidase extracts from the two plants in both districts which gave the highest color index value within the shortest period of time were selected. 6 drops each from the selected peroxidase extracts *of I. palmate* from both districts were added to the synthetic polyester fabric and the cotton fabric. The time taken for fabrics to come up to the color index value of 10 was observed and recorded.

3 Results and Discussion

3.1 Extraction of plant peroxidases using Three Phase Partitioning

The peroxidase volumes obtained from each extract of *I. palamate* from both districts were as follows. The highest yield is from Kandy districts.

Type of Plant and Area	Extracted volume per unit weight/ mL g-1
Ipomea palmate from Kurunegala District	2.25
Ipomea palmate from Kandy District	2.41

Table 1. The Volume of extract collected per weight of the plant material

3.2 Determination of decolorizing capacity of Ipomea palmate Forrsk.

There is a significant drop of the decolorizing capacity of the extracts when the concentration of replicates decreases. The trends of each sample set were observed the same way. When the peroxide contents per unit volume become low, the amount of free radicals per unit volume decreases. This is could be the reason behind the above observation

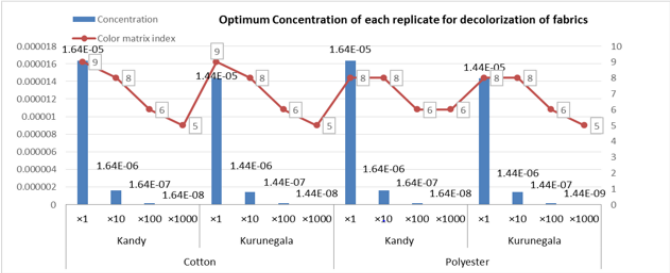

Fig. 2. The optimum concentration of each replicate for decolorization of fabrics

3.3 Determination of time required for decolorization.

Peroxidase mother extracts from both districts were selected to test for the time required to decolorize the fabrics as they gave the best concentration of peroxidase which gave the highest color index value for both types of fabric materials

Plant	Treated Fabric material	Area	Concentration/ moldm-3	No of days
Ipomoea palmate Forrssk.	Cotton	Kandy	0.0000035	10
		Kurunegala	0.0000035	11
	Polyester	Kandy	0.0000035	12
		Kurunegala	0.0000035	15

Table 2. The Concentration for each sample

4 Conclusion ad Recommendations

This preliminary study revealed that I. palmate leaves were successful in decolorizing fabric materials. The highest decolorization capacity was from the peroxidase extracts obtained from *I. palmate* leaves from Kandy district. Mother extracts of the plants from both districts had a higher concentration of peroxidases than the diluted solutions. When cotton fabrics were compared with polyester fabrics, it showed that the tendency of cotton to de-color is higher than the polyester fabrics. In conclusion it could be seen that the peroxidase extracts of *I. palmate* has a potential to be used as a decolorizing agent in sustainable solid fabric waste management.

Other than Three Phase Partitioning (TPP) more sophisticated partitioning techniques such as fractionation of acetone along with gel filtration, aqueous two phase extraction with ultra-filtration, combination of TPP into the affinity chromatography and a TPP with ion exchange chromatography techniques produce higher yields and purification.

In this study, the peroxide contents were tested only for the leaves of *Ipomoea palmate* Forrssk but further investigation into amount of peroxide contents in the shoots, flowers, roots and other plant parts could lead to a different direction.

ACKNOWLEDGMENT

The authors wish to thank University of Sri Jayewardenepura.

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