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Original Research Article

Characteristic Analysis of Microencapsulated-cum-Cross linked Natural Dyed Fabrics

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ABSTRACT

The natural dyes with their potential application in several fields such as textile, cosmetics, food supplements etc, has been driven attention recently. The present study deals with the analysis of the dyeing of seven plants extract (*Curcuma longa*, *Azadirachta indica*, *Punica granatum*, *Aloe vera, Quercus infectoria*, *Thymus Vulgaris*, and *Bixa orellana*) to the cotton fabrics. The dyeing property of the plant extracts were incorporated to the fabrics by direct application and also by a modern method termed microencapsulation-cum-cross linking technology. The effectiveness of natural dyeing was comparatively analysed for normal standard dyed fabrics and fabrics dyed through microencapsulation-cum-cross linking technique. Both the dyed fabrics were analysed and studied for the surface morphological texture using SEM (Scanning Electron Microscope) analysis. The SEM study reveals that the novel dyed, microcapsule coatings-cum cross linked fabrics were very firmly attached to the fibrils by increasing the durability and smooth finished fabrics.

Keywords: Plant extract; *Curcuma longa*; *Azadirachta indica*; *Punica granatum*; *Aloe vera; Quercus infectoria*; *Thymus Vulgaris*; *Bixa orellana;* fabrics; dyeing; microencapsulation; cross linking; SEM

INTRODUCTION

Over from about 150 years ago, colouring agents were obtained from natural sources such as plants and animals. The biosphere is gifted as more than 500 plant species which yield natural dyes. Colouring agents of these plants are derived from leaves, roots, trunks, barks, or fruits. Natural dyes are environmental friendly, nontoxic, non-carcinogenic, non-allergic and Biodegradable substance, which have high regenerating, compatibility and renewable source. The replacement of natural dyes could happen until the introduction of synthetic dyes due to feasible variety of colouring property of natural dyes [1] &

[2]. Reports have been published on use of natural dyes over synthetic dyes on silk [3], [4], [5] and cotton [6]. At present there is a greater need to replenish the use of natural dye [7] and dyeing methods as an alternative to the harmful synthetic dyes.

A novel innovative natural dyeing method

As garments are subjected to washing, the wash durability of finishes is a major issue. Hence in this study a novel technology like microencapsulation and cross linking were used to fix the herbal extract on the fabric. It is the method in which textile finishing agents as microcapsules was used to enhance the durability of the dyed fabrics and controlled release of the extracts. Microencapsulation method is a rapidly expanding technology and finds greater applicability in textiles in recent years. Uniqueness of microencapsulation is the smallness of coated particles which provides a means of storing materials on microcapsules for later release under controlled conditions.

Added objectives and advantages of microencapsulated cum-cross linked technology

1. It increases the durability and fastening of the imparted colors.
2. Strengthens the antimicrobial property and anti-pathogenic property [11] of the dyed fabrics.
3. It gives a fine finished fabric product by quality, appearance, touch or feeling.
4. Natural plant source drive dyes are ecofriendly dye [8].
5. Since the selected plant extracts are possessing antimicrobial and antideterioration properties [11]. This property indirectly helps the person wearing the natural dyed fabrics inorder to protect them from the different harmful solar rays.

Scanning Electron Microscope (SEM) Analysis

The Scanning Electron Microscopic studies of the dyed fabric gives the surface morphology of the fabrics. It is a powerful technique in the examination of materials which can give a SEM image down to 25 Angstroms at high resolution. SEM analyzes the surface of materials by which it measures and evaluates surface pitting, characterization of dust, deposits, contaminants, particles, failure analysis, filter residues and other applications.

The present study analyses the surface morphology of the natural extract dyed fabric of both directly dyed and by using a novel technology termed *Microencapsulation-cum cross linking* technology for its property, durability, colour fastening, texture and study was made on its useful benefits.

MATERIALS AND METHODS

Collection of plant source and fabric material

The seven plants chosen for the study were rhizome of *Curcuma longa*, leaves of *Azadirachta indica*, fruit rind of *Punica granatum*, leaf sap of *Aloe vera,* seeds of *Quercus infectoria*, seeds of *Thymus Vulgaris*, and seeds of *Bixa orellana*. These plants were collected from the nearby areas of Coimbatore District. 100% woven cotton fabric with thread size of 14 was used for the study

Extraction of Dye from plant

The plant samples were shade dried at room temperature and powdered finely. Methanol was used as the extraction solvent with sample and solvent of 1:5. The extraction of the powdered samples was carried out in a soxhlet apparatus at 80-85ºC with repeated cycle of process to obtain the full extract from the plant source. Then the extract was filtered and stored for further use.

Dyeing of Fabrics with plant extract by standard method

For the fabrics to be dyed, it requires some pre-treatment by which the dye can be fixed. Scouring

of the fabrics is carried out initially to remove the starch present in it. The fabrics to be scoured were pre-weighed. Soda ash was used as the scouring agent. The salts were weighed (soda ash weighed about 2% of weight of the fabric and detergent as 5.5% of weight of fabric) and added to warm water with continuous stirring. The fabrics were added to the salt mixture and stirred for 20-30 mins at 85°C.

Scouring of fabric was followed by bleaching. The fabrics was bleached with 2gms of ascorbic acid and 3ml of sodium hypochlorite in 200ml of water and maintained at 90°C for 10mins. Then the fabrics were washed in sterile water and dried.

Mordanting of the fabrics was carried out to fix the dye to the fabrics. Alum acetate was used as the mordanting agent. Alum acetate was weighed equal to 5% of the weight of the fabric to be dyed at a liquor ratio of 1:40. The mordant mixture along with the fabrics was maintained at 30°C for 1hour with continuous stirring.

The pre-treated fabrics were dyed with the 5% extracts. The dye was dissolved in water with increasing temperature up to 30°C. The fabrics were added with a further increase in temperature to 80°C. The temperature was maintained with continuous stirring for about 45mins. Then the fabrics were removed from the dye bath and squeezed for the removal of excess dye and then washed gently in Sodium Lauryl Sulphate (SLS) for firm dye fixation. Finally the dyed fabrics were dried, scoured and stretched.

Dyeing the fabrics by novel Microencapsulation - cum cross linking technology

Initially the fabrics were treated with 100ml of resin and 2gms of $MgCl_2$. Then the fabrics were microencapsulated by using acacia gum as the wall material. 10 gms of acacia gum was allowed to swell for 15mins in 100ml of hot water. Again to this swelled gum, 50ml of hot water was added and stirred well to temperature 40ºC for 15mins. Then the plant extract was mixed with the wall material under stirring condition for 15mins and then 10ml of 20% sodium sulphate and 6% Citric acid were added. To form microcapsules, the mixture was freeze dried and then the cotton fabric was immersed in the microcapsule solution. The treated fabric was dried at 80°C and stretched.

Characterization of undyed, directly dyed and microencapsulation–cum-cross linked dyed fabrics

The SEM analysis is a characterization technique in which a beam of electrons scans the surface texture of the dyed fabrics and results in the three dimensional image of the fabrics.

In this study all the three types of fabrics ie., undyed, directly treated and microencapsulation–cross linked fabrics were analysed under SEM for the surface morphological study of the fabrics.

Since all the fabric are liable for washing, the water absorbency test to be carried out for the undyed, directly treated and microencapsulated- cum cross linked fabrics were carried out by the standard method as per AATCC 79-2000.

The quality of the treated fabrics was tested by analyzing the stiffness, crease recovery and tensil strength. The stiffness of the treated fabrics was measured as per the standard method ASTM D 1388-996. The crease recovery angles were measure as per AATCC 66-2003 test method. The tensil strength was evaluated as per ASTM D 5035-2006 test method.

RESULT AND DISCUSSION

Fabrics dyed with plant extract by standard method

The dyeing of the fabrics with the plant extract showed a wide range of colors which was fixed using the mordant of chemical origin which is nontoxic to the skin. Figure 1 showed the fabrics dyed directly with the plant extract.

Fabrics dyed with novel Microencapsulation - cum cross linking technology

The major drawback for the use of these natural extracts as dyeing agent is the poor wash fastness. To meet the problem of wash fastness, a modern technology called microencapsulation- cum cross linking was developed. With the application of this technology, the durability and the fastness property of the fabrics were increased. Figure 2 depicts the microencapsulated-cross linked dyed fabrics which clearly show the increase in the colour shading of the fabrics and also it increases the durability of the extract encapsulated fabrics.

The surface morphology of these dyed fabric were studied using Scanning Electron Microscope (SEM). Figure 3 shows the SEM image of the untreated fabrics. Figure 4 shows the SEM image of the directly treated fabrics at different resolution (100 µm, 50 µm, 10 µm & 5µm). It is clearly visible that the granular deposits on the fabrics were the plant extracted dye coating. These granular deposit were absent in the untreated fabrics.

Figure 5 shows the SEM image of the microencapsulated-cross linked dyed fabrics. It is clearly visible that the microcapsules were deposited on the fabric and the plant based dyes were fixed to the cotton fabrics.

It was observed that fabrics treated by microencapsulation cum cross linking process showed a pinch of yellow shade [10]. It is due to the natural resin, which is used in cross linking method. It also gave a pleasant smell due to the presence of natural terpenes, thymol and volatile compounds. Microencapsulation cum cross linking fabrics was given fine finishes to the textile fabrics and smoothness and texture was also improved when compared to normal standard dyeing method. However due to colouration, odour, texture and physico-chemical properties won't affect the acceptability quality of the textile fabrics [11]. Microencapsulation cum cross linking fabrics possess antimicrobial activity, anti-pathogenic activity and also it prevent the cross infecting pathogens due to its above said properties.

Water Absorbency of the fabrics

Based on the water absorbency analysis for untreated and treated fabrics under various techniques (table 1), the values indicated for untreated fabrics were uniform and constant in all the cases (not altered), whereas in direct dyed fabrics, water absorbency was at the higher rate. Among the plant extract treated fabrics *Azadirachta indica, Punica granatum* and *Aloe vera* extracts shown higher absorbency, *Curcuma longa* treated fabrics shown a moderate absorbance and the extract driven from the seeds of *Quercus infectoria*, *Thymus vulgaris* and *Bixa orellana* were shown lesser absorbency due to the presence of hydrophobic substances in the seed material. Then in the case of microencapsulation cum cross linking technique, the water absorbency was almost lower among all other techniques. Here also the dye extract from plant seed source showed comparatively lesser absorbency than that of direct dyeing method. These results were on par with Sathianarayanan M. P. et al. [10]. The crease recovery angle and tensile strength of the fabrics were given in figure 6. It is observed that there is no significant change between undyed and directly dyed fabrics. But in the case of microencapsulated cum cross linked fabrics, there is slight increase in the crease recovery angle and no much loss in the tensile strength.

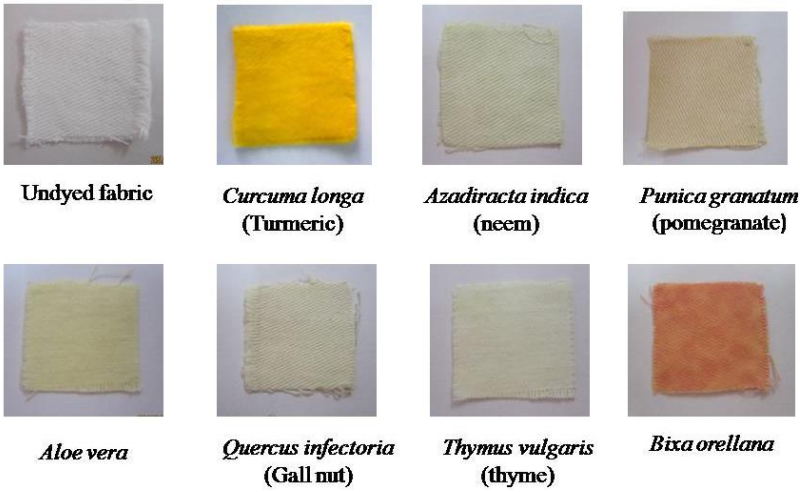

Fig. 1: Fabrics dye with plant extracts directly

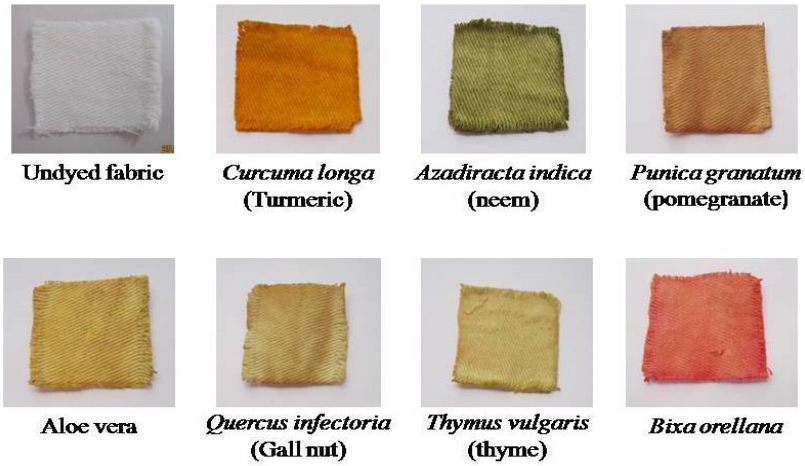

Fig. 2 : Fabrics dyed with plant extracts by Microencapsulated-Cross linked technology

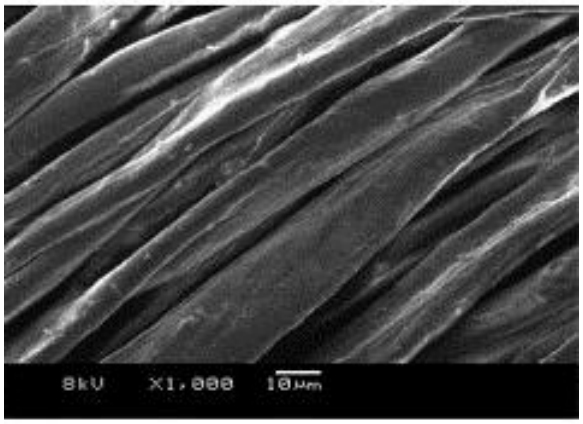

Fig. 3: SEM image of undyed fabric

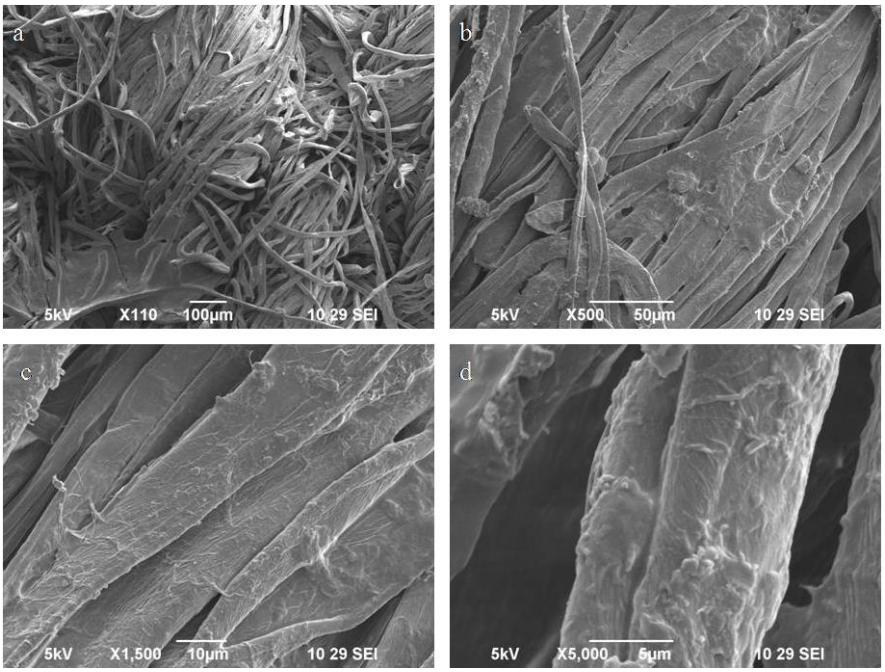

Fig.4: SEM image of directly dye treated fabric at resolutions a) 100 µm, b) 50 µm, c) 10 µm & d) 5µm

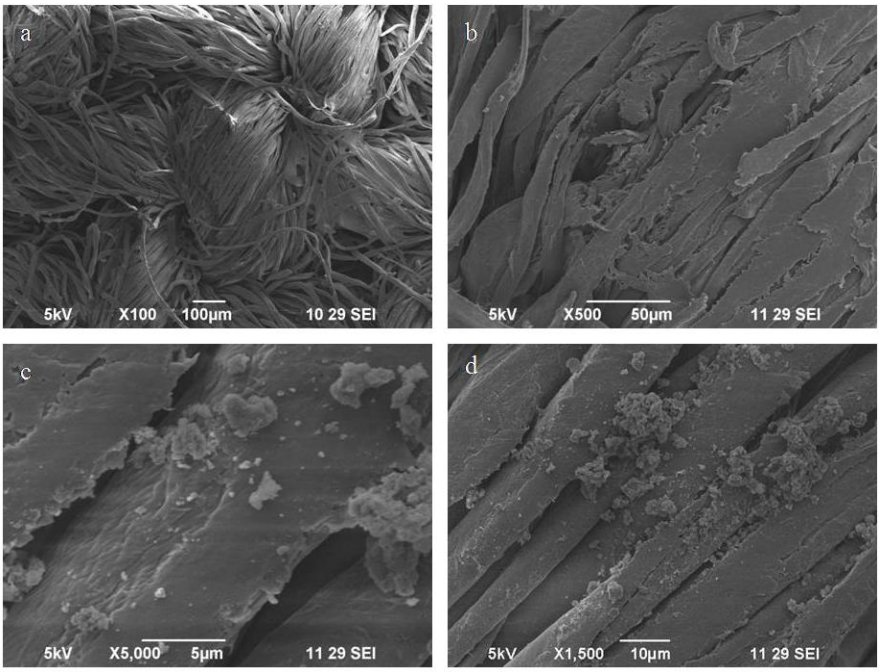

Fig. 5: SEM image of microencapsulated-cross linked dye treated fabric at resolutions a) 100 µm, b) 50 µm, c) 10 µm & d) 5µm

Table 1. Water Absorbency of the fabrics

Fabric	Water Absorbency						
	Curcuma longa	*Azadirachta indica*	*Punica granatum*	*Aloe vera*	*Quercus infectoria*	*Thymus vulgaris*	*Bixa orellana*
Untreated	2	2	2	2	2	2	2
Directly dyed	18	19	20	20	16	12	11
Microencapsulated cum cross linked	6	7	5	9	5	4	4

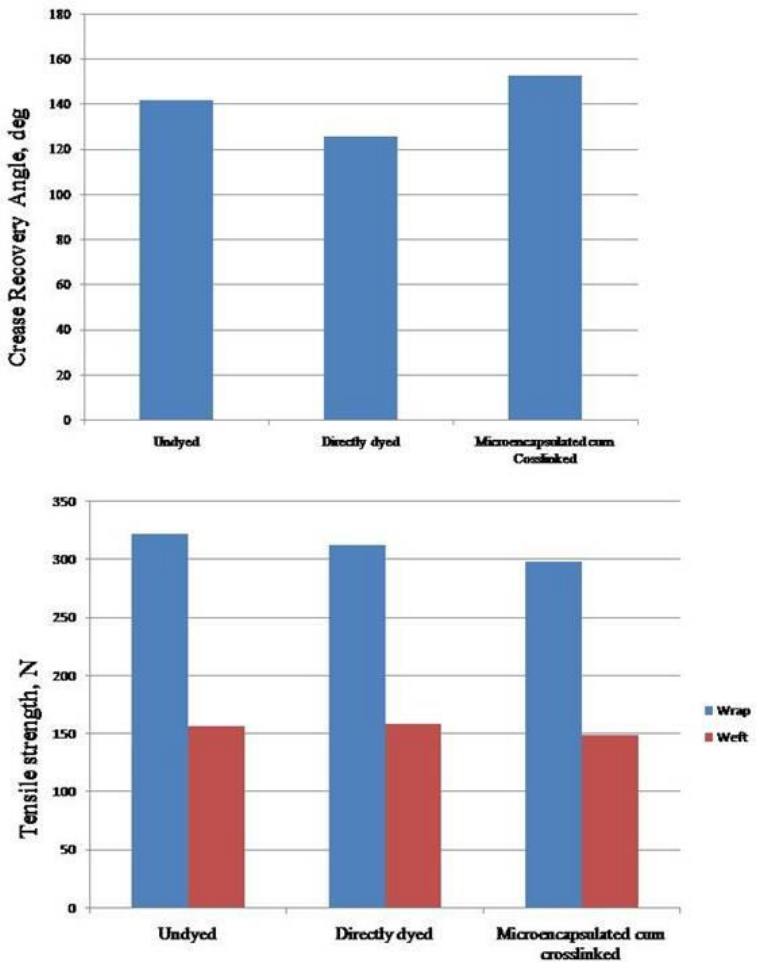

Fig. 6: Crease recovery angle and Tensile strength of the treated fabrics

CONCLUSION

The normal standard dyeing method indicates that direct dye treatment is only a superficial coating on textile fabrics surface and it can easily be washed off by three or five washes. Since this kind of fabrics recommended for one time usage for example it is

used in dispersible fabric categories. Textile fabrics treated with microencapsulation-cum cross linking method showed little bit stiffness and less crease recover property and gave fine finished texture. Observation were made on the wash durability up to 13-15 washes, it reveals that there is no fastening of colour and it never losses the tensile strength. The surface morphological study also indicated that microencapsulated cum cross linked technique make the fabric stiff and imparts good crease recovery property. Moreover the novel method of dyeing increases the antimicrobial property, eco-friendly textile material which improves the economy of the state/nation. Apart from all the above, it is one of the healthy textile product in order to keep away all type of pathogenic diseases caused by communicable pathogens, prevent the skin cancers to a certain extent, protection from harmful solar rays etc,. The aim and scope of implementation and commercialization for the growth of the global economy, this novel idea of dye imparted fabrics can be recommended in the finished product of the textile industries.

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