IMPROVING THE EFFICIENCY OF NATURAL DYES ON COTTON FABRIC

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ABSTRACT
Concerns about the environmental effect of synthetic dye creation and usage have once again piqued the public's interest in natural colors. In this study, we used natural herbal dyes to color cotton garments. Herbal natural colours were employed for this project, including turmeric, aloe vera, neem, beetroot, pomegranate, and onion. There has been an increase in both colorfastness and dye absorption efficiency thanks to the usage of edible gum and cow urine. It will be especially useful in lowering rates of skin allergy and infection-related disorders.
Keywords: Cotton, microwave radiation, mordants, natural dyes, tea leaves
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INTRODUCTION

When it comes to textiles, cotton is by far the most important natural fiber. Cellulose, a polymer made of glucose monomers, makes up its structural backbone. Cotton can only be dyed at pH levels over 4, since doing so would cause the cellulose to hydrolyze if heated in an acidic medium. Cellulose chains undergo partial oxidation, changing the pendant hydroxymethyl groups into carboxyl groups, as the plant develops and is processed. Cotton's surface gains a negative charge from these carboxyl groups after being immersed in the dye. Surface negative charge is greatly enhanced at pH levels over 8, when hydroxyl groups on the side chains become ionized.

As a result of charge repulsion, cotton has a limited affinity for anionic dyes and absorbs few of them. It has been suggested that pretreatment with synthetic cationic fixing agents in the form of secondary, tertiary, and quaternary amine compounds might increase the fabric's receptivity to anionic dyes.

In order to attach colors to cotton in a more environmentally friendly manner, biopolymers containing amino groups like chitosan and proteins from natural sources have been discovered; The acidic pH of these compounds' cationic sites makes them attractive to anionic dyes.

Because they don't permanently stain cotton without mordants, natural dyes are sometimes known as mordant dyes. In order to facilitate the chemical fixing of natural dyes on cloth, mordants are used to neutralize the acidic or basic characteristics of the dyes. However, in recent decades, the textile industry has been pushed to utilize natural dyes without utilizing hazardous mordants in the dyeing process due to the rising awareness of eco-friendly fabrics. There have been significant breakthroughs in this area in recent years. The textile processing industry was able to decrease its effluent waste generation by transitioning to biodegradable organic salts and green chemical auxiliaries.

One of the biggest problems for human and environmental health is the large amount of waste caused by the repeated introduction of synthetic dyes into the water system. The urgency of the situation has pushed the worldwide community to focus more on environmentally friendly goods. Using plant, animal, and mineral-based natural colors in textiles, food, cosmetics, flavors, etc. is currently considered an example of "green chemistry." This is due to the fact that unlike synthetic dyes, natural dyes may be safely disposed of, are extracted under "low" circumstances, and have several therapeutic applications. In today's modern world, natural colorants are employed in a broad variety of industries, and more than a thousand distinct species serve as sources of these pigments. Interest in natural dye and its uses has increased with growing concern for the environment.

It's easy to get and doesn't break the bank to use synthetic colours. With its widespread availability, natural coloring has lost some of its luster. Specialty goods requiring decentralization have highlighted the need of both synthetic and natural colors. Natural colours are safe alternatives to synthetic ones since they are not harmful and do not cause allergic reactions. Natural dyeing, on the other hand, is a sustainable practice that doesn't harm the environment because to the biodegradability of the natural colorants used.

LITERATURE AND REVIEW

Samanta (2020) In this chapter, we cover the history of natural dye research and its application to the textile industry. The revival of environmentally friendly goods and processes, such as dying fabrics with natural dyes, is especially significant today because of the increased environmental awareness of customers. This paper therefore elaborates on the renaissance of the use of natural dyes in textiles and provides an overview of previous studies that have sought to standardize its technique of extraction, mordanting, dyeing process factors, etc. Natural dye characteristics, as well as the dyeing chemistry, are rigorously examined here. Because of this, this section has become the one and only complete ready-to-use chapter on the chemistry and textile applications of natural dyes and their revitalization method.

Deepti Pargai et al (2019) Natural dyes have been gaining popularity as a solution to climate change and other environmental problems. The visual attraction of natural dyes alone is not enough to capture customers' attention in today's highly technical society. Products that combine attractive design with practical benefits are more likely to find buyers. In light of this practical consideration, several studies are being conducted to uncover natural dyes' untapped potential. Although there are many synthetic agents that may be used to obtain the desired colors and other functional features, it would be useful and important to investigate additional functional properties of natural dyes. To protect humans from environmental hazards like ultraviolet radiation, microorganisms, and insects, In this chapter, we'll look at how natural dyes may be used to provide fabrics useful features like antimicrobial protection, UV resistance, insect repellency, and more. This chapter will not only discuss the tools we have at our disposal to analyze natural dyes for their functional qualities, but it will also delve into the motivations behind those properties.

P. Pisitsak et al (2016) To enhance the dyeability of cotton fabrics when using a tannin-rich natural dye extracted from Xylocarpus granatum bark, a pretreatment with whey protein isolate (WPI) was carried out. Dyeability, color fastness, physical characteristics, and UV protection are all topics that have received much study. Each sample has been colored a deep crimson brown, but the pretreatment samples showed a significant increase in color strength (K/S). As a result of their interactions through hydrogen bonding and hydrophobic forces, WPI and tannin form an insoluble mixture that causes this phenomenon. Dyeing at higher temperatures for longer periods of time produced more vibrant hues. Because tannin forms compounds with proteins most effectively at the protein isoelectric point, acidic pH levels are conducive to dye absorption, with a pH of 5 resulting in the strongest color intensity. Cotton padded with WPI at a solid content of only 0.35 percent resulted in colored textiles with a K/S value around 50 percent higher than untreated materials. Under the same dyeing circumstances, the WPI-treated cotton had a more intense color than the soy protein isolate (SPI)-treated cotton. Except for color fastness to light and crocking, protein-treated cotton textiles were rated as adequate to extraordinary for their fastness attributes. Textiles that have been pretreated with proteins have lower tensile and tearing strengths and somewhat higher stiffness. Fabrics treated with natural dye or WPI had a higher UPF, indicating improved protection against UV rays.

Adekunle Olusegun Adeoye et al (2015) Using hydrolyzed cassava peel media, five local strains of Aspergillus niger were screened in order to increase citric acid synthesis through UV-radiation-induced mutation and optimum medium conditions. Central Composite Design (CCD) of Response Surface Methodology was used to improve the physicochemical parameters involved in citric acid synthesis from mutant strains. Input parameters have substantial interaction effects on citric acid production, as seen by the response surface graphs. The research confirmed that UV-mutation and medium optimization may increase citric acid production. This research shows that it is possible to increase citric acid output from agricultural waste, such cassava peels, by employing mutant strains of A. niger in conjunction with the right set of optimum operating settings.

F. Kabir et al (2019) It is required to modify the light-absorbing characteristics of organic dye such that it has a maximal response throughout the visible and near infra-red spectrum in order to boost the performance of DSSCs. The purpose of this research was to discover whether or not the use of natural red (Red spinach) and yellow (Turmeric) dyes as sensitizers for semiconductor TiO2 as electron conductor may boost the efficiency of DSSC. Natural dye combinations with well selected agents showed greater photovoltaic effects than those of single dye sensitization, leading to more solar light absorption and more efficient use of photon energy. The efficiency with which natural yellow dye converted electricity was 0.378%, whereas that of natural red dye was just 0.134%. The most efficient sensitized DSSC had a maximum efficiency of 1.078%, an open circuit voltage of 499.3 mV, and a short circuit current-density of 4.264 mA cm2. Compared to the efficiency of using either yellow or just red dyes, the combined efficiency is around 2.85 and 8.04 times greater, respectively.

MATERIALS AND METHODS

Figure 1 100% Cotton woven fabric.

Reason to choose natural dyes

Natural dyes have a low economic value. Neem, aloe Vera, turmeric, onions, and pomegranates may all learn from them. Water contamination, soil pollution, and the death of soil microorganism due to the chemical dye's poisonous nature all have a negative impact on agricultural output. Toxic chemicals from synthetic dyes in clothes are absorbed via the skin, the body's biggest organ, over time. Absorption has been linked to serious health problems, such an increase in tumors. Allergies to textile dye include contact dermatitis, lung illness, allergic reactions of the eyes, skin, and mucous membranes, and skin irritation. Because they spend their days in close proximity to the chemical, those working with the dye are disproportionately affected. However, natural dyes may be harvested from the wild. It is naturally dyed, meaning no chemicals are used. Natural dyes provide protection against a wide range of skin illnesses without causing any harm to the human body.

Dyeing process

Cotton fabric was dyed with neem, aloe Vera, turmeric, onion, beet root, and pomegranate extracts in a liquid ratio of 1:40 at 100 C for 60 minutes. The stainless steel vessel was used for the dying process. The cotton cloth was dyed in a 30 C water bath, and then soaked in rose water for 10-20 minutes to set the color.

Colour fastness to light test

The primary goal of a colour fastness to light test is to ascertain how the color of a cloth will change when exposed to sunlight. ISO 105 B02 compliant laboratory equipment model TF422 was discovered. When it comes to the light-processing of colors, this is the universally accepted worldwide standard. Half of the sample should be covered with blue wool and the other half left open to serve. A score of 1 to 8 is shown in blue. The light-fastness scale goes from extremely low (1) to very high (8).

Figure 2 Light fastness tester.

Laboratory equipment of type DZ-307 launder - O- meter was used to launder the dyed sample in accordance with ISO 105 C06 A2S. The ability of a textile's color to withstand regular washing with a detergent is evaluated in this test. The wash bath contains 4(g/l) ECE phosphate and 1(gm/l) sodium perborate, and the specimen measured 40mm x 100mm. The water volume was 150 ml, the water temperature was 40 C, and the washing duration was 40 seconds. In order to facilitate washing, ten stainless steel balls are placed into each bath. The samples are washed, squeezed with cold water, dried at an air temperature of no more than 600 degrees Celsius, and then their staining and color change are measured on a grayscale.

Figure 3 Colour fastness to washing tester.

Rub-on colorfastness tests quantify how much of the original color remains after being rubbed. When determining how much dye will transfer from a garment to another surface by rubbing, the crock meter is a standard and straightforward rub tester. The EN ISO 150X12 standard calls for testing the rub fastness of the dyed sample using a table crock meter of the type 418 type used in a laboratory. The sample size was 20mm by 100mm, the arm was weighted to maintain a 9N load, and a mechanical counter kept track of the number of cycles that had been run. When the rubbing sample is dry, it is evaluated for color staining using the AATCC grey scale (ISO 105-A03).

Figure 4 Rubbing fastness tester.

A spectrophotometer is a tool for capturing and analyzing color samples. The most widely used spectrophotometer, the spectra flas 600 plus CT (data color) detects light reflected at a set angle to the sample, often 45 degrees. The equation is used to get the k/s value.

$K/S=(1-R)/2R$

R = scattering times K = absorption times s = reflectance.

Edible gum and cow urine are used to make coloured cotton samples more resistant to fading after exposure to light, washing, and rubbing. The results of the sample's colorfastness test to light treatment are in. The blue wool scale goes from 0 to 8. Lightfastness scales from 1 (extremely low) to 8 (very high). Grading is used to display the majority of the sample. The samples seem decent (4), and the washing fastness rating is good.

Table 2 Colour fastness to light test

Sr. No.	Dye name	Grade
1	Turmeric	4
2	Neem	3
3	Aloe Vera	3
4	Onion	4
5	Beet root	4
6	Pomegranate	4

Table 3 Colour fastness to washing fastness test

Sr. No.	Dye name	Grade
1	Turmeric	4
2	Neem	3
3	Aloe Vera	3
4	Onion	3
5	Beet root	4
6	Pomegranate	4

Table 4 Rubbing fastness

Sr. No.	Dye name	Dry rubbing fastness	Wet rubbing fastness
1	Turmeric	2	4
2	Neem	4	2
3	Aloe Vera	4	4
4	Onion	2	4
5	Beet root	2	4
6	Pomegranate	4	4

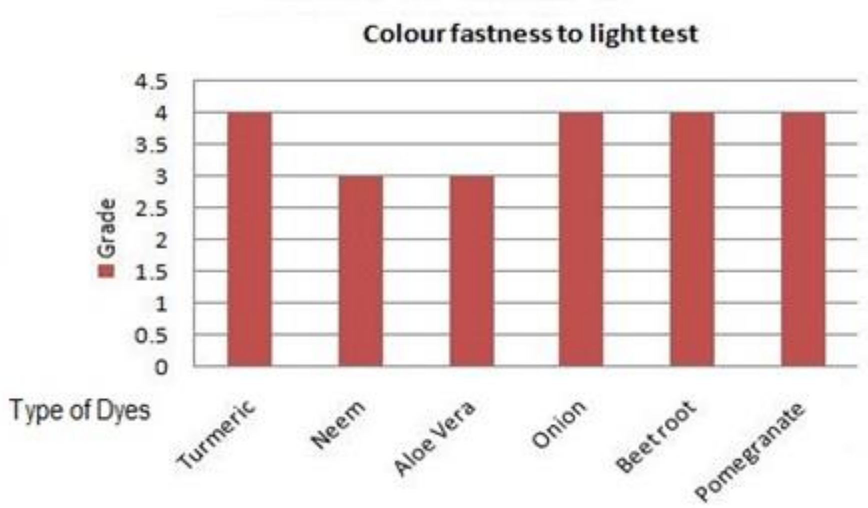

Figure 5 Natural dyes effect on colour fastness to light test.

All of the samples are almost the same in terms of how their colors shift when rubbed dry and wet. However, both the dry and wet (2) grades are of a high caliber. All of the treated samples had washing fastness scores between 3 and 4.5, indicating excellent to very high resistance to fading in the wash. It has been discovered that dye made from leves, aloe Vera, turmeric, pomegranate, onion, and beet root, when extracted and applied directly to cotton cloth, produces beautiful results. These results may be used in the textile industry and other laboratories to determine how well a material washes, rubs, and resists fading when exposed to light.

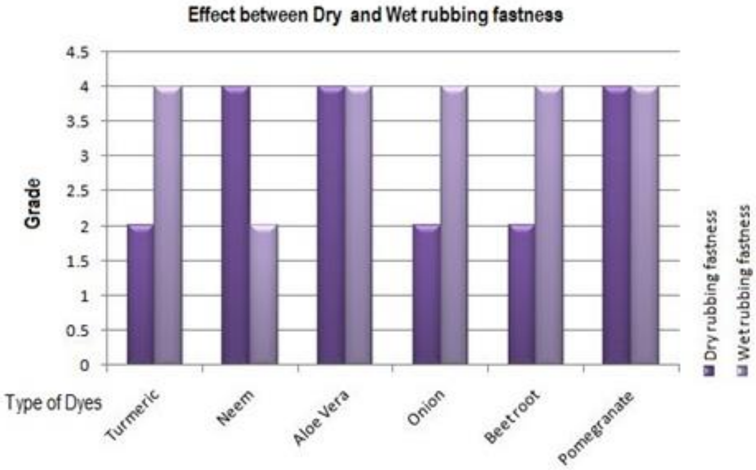

Figure 6 Variation in dry and wet rubbing fastness due to the use of natural dyes.

CONCLUSION

Insufficient scientific research and comprehensive reporting on natural dyeing of textiles have been identified. There are a ton of untapped natural resources. Although the use of natural dyes in handmade goods, paintings, and handloom textiles dates back centuries, there has only recently been an uptick in interest in the chemistry of interaction between such colorants and textile materials for the purpose of creating environmentally friendly textiles. The goal is to make cotton more absorbent and more resistant to fading from natural herbal dyes. Herbal dyes on cotton cloth have been shown to have excellent fastness against both dry and wet rubbing.

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