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Determination of Antimicrobial Activity of Cotton and silk Dyed Fabric Material by Using Natural Dye Sources

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Abstract

This Antimicrobial research work has determination of the antimicrobial activity of cotton and silk fabric material which dyed with the natural dyes. Some natural dye sources such as Turmeric, Logwood, Marigold, Madder and Basil were selected for dyeing of ecofriendly cotton and silk material. These dyes were extracted through aqueous medium before applied on clean cotton and silk fabric material by dyeing method. In this research the antimicrobial activity of cotton and silk dyed material against Escherichia coli (G-) & Staphylococcus aureus (G+) is evaluated. And for determination of this antimicrobial activity the well diffusion method was performed on both cotton and silk dyed material by using three different increasing volumes of solutions. The antimicrobial effect of these cotton and silk dyed material was also evaluated after repeated washing cycle through water medium. This work can provide the data towards creation of ecofriendly and antimicrobial fabric material as a development in textile industries. The natural dyes which were used for this work in the form of dyed cotton and silk fabric material gave good activity against harmful microbes.

Keywords: *Natural dyed fabric, Microbes, Antimicrobial activity*

Introduction

The textile industry presents challenges for research on textile production work. Interest in the technology is increasing to achieve good quality natural dyed materials with a maximum value of color fastness. The development of is essential in antimicrobial textile products that have direct and regular contact with parts of the animal body is essential [1]. Synthetic products have environmental and health effects owing to their toxicity and allergic characteristics. To overcome these effects, natural herbal products are also used by consumers. Some active antimicrobial compounds, such as ammonium and silver compounds, have textile and cosmetic applications [2]. The demand for hygienic and healthy lives can be fulfilled using antimicrobial products. Consumers are also aware of hygienic textile products, and the clothes used for medical purposes can be improved by antimicrobial agents. Antimicrobial products can have good hygiene, health, and medical applications [3]. Dermal infection is possible due to the growth of bacteria on cellulose fabric due to the availability of moisture and nutrients [4].

Natural dyes and dyed materials are used because they are nonpolluting, nontoxic, and biodegradable. The growth and attack of microbes on textile materials are possible. anti-microbial agents are used for the development of textile fabrics to obtain hygienic and eco-friendly products and to control the growth of microbes. Disinfection and antimicrobial techniques have been improved for textile products [5]. Microorganisms are very small and can grow on natural fabrics rather than synthetic fabrics. The Antimicrobial properties of the fabric material can enhance the quality of the fabric, and eco-friendly dyes that exhibit such antimicrobial activity are beneficial for dyeing fabrics and controlling the environmental effects of microbes. The use of textile and antimicrobial products in each area increases according to customer demand and lifestyle. This development is necessary for dyeing fabrics with antimicrobial agents.

Materials

Dyes from natural sources, such as turmeric, logwood, marigold, basil, and adder. Dye bath, Water, DMSO, Agar plates, soap, clean Cotton and Silk fabric material of 120 GSM

Method for Extraction of dye

The sources for Basil, Logwood, Turmeric Madder and Marigold dye were collected from the market. These sources can be obtained from any common market. The dye source was stored at room temperature. The dye source was converted into powder by crushing the source with a blender. This powder (10 g) was added to water (25 ml of water.

The solution was boiled for 30 min. After filtration, the solution was cooled and used for dyeing clean cotton and silk fabric.

Method for Dyeing of cotton and silk fabrics

Approximately 5 g of clean cotton and silk fabric material was used for this dyeing. This material was dyed in a dyeing machine using the selected dye sources at 1:20 liquor ratio. **dyeing** was performed for 40 min. at 50^{0}C and at an approximate PH range of 6. Theis's cotton- and silk-dyed material was washed with cold water and dried in air. Dyeing was carefully performed in a separate dye bath using the above **five types of natural dyes and water.** The dye concentrations were the same for each the **five types of** dyeing solutions. The dyed cotton and silk fabric material was then used to analyze the antimicrobial effect of the dyed fabric on **E. coli and St. aureus** microbes after air drying.

Antimicrobial activity determination

The antimicrobial activity against Escherichia coli (G-) Staphylococcus aureus (G+) was evaluated for cotton- and silk-dyed materials. The antibacterial activity of cotton- and silk-dyed material against E. coli (G-) and St. aureus (G+) was determined by the inhibition zone. The antimicrobial effect of the dyed cotton and silk fabric material on E. coli and S. aureus was tested using diffusion agents. Cotton and silk fabrics are good natural materials and valuable materials for the textile industry. These materials have several applications. The toxic effect of dye absorption through the skin has been reported [6]. These toxic effects can be minimized by using the antimicrobial activity of the dyes. The LD50 (lethal dose) process was used to detect such toxicity. The antimicrobial effect of the selected dyed cotton and silk materials was evaluated by the diffusion method using agar plates. This is also known as the well-diffusion method. The standard procedure, as per the diffusion method, was performed for the evaluation of antimicrobial activity. The agar plate was used as a culture, and these plates were carefully inoculated with 1.7 x10^3 cfu per ml standardized inoculum of bacteria. This was spread using sterile swabs. About 6 mm sized well was prepared by inserting a sterile borer into the culture plates. The molten agar was selected as the medium to cover the lower part during the formation of the well. Cotton and silk materials that were dyed with the selected sources were carefully dissolved in H_2O and DMSO. Then, 20µl, 60µl &100µl solutions were taken as increasing volumes from the prepared stock solution. This volume was then added to each well. An antibiotic disc was used as a negative control. The plates were maintained at 30^0 C up to 15 min. for this diffusion. The plates were incubated for 20 h at 35^{0}C.

The inhibition zone was used to determine the antimicrobial activity of the selected dye material. This was measured in millimeters. The inhibition zone obtained using the above procedure was measured using a compass. Antimicrobial activity was considered when inhibitions had diameters greater than 8 mm. Weak or less antimicrobial activity was considered when the inhibition zone was in the range of 8–12 mm. good activity was considered when this inhibition was in the range of 13–18 mm in diameter. Very strong activity is considered when the diameter of the inhibition zone is greater than 18 mm [7]. Uninoculated sterile medium was selected as the blank. The antimicrobial activity of a dye depends on the composition of the dye molecule or the active group present in the dye molecules. This active group can control the growth of pathogenic microbes and exert antimicrobial activity. Some molecules exhibit antimicrobial activity against more than one microorganism. In this analysis, the antimicrobial effects of the selected natural dyes on the two types of bacteria were analyzed. The activity of turmeric is due to its phenolic and curcuminoid composition [8]. The anti-microbial activities of the dyes with dyed cotton and silk fabric materials are given in Table 1. a and 1.b.

Table 1.a: Antibacterial activity of the dyed cotton fabric material by diffusion method.

Dye source	Cotton fabric					
	E. coli (G-)			St.aureus (G+)		
	20 µl	60 µl	100µl	20 µl	60 µl	100µl
Turmeric	5	7	9	8	8	9
Logwood	9	10	11	11	12	14
Marigold	8	8	12	7	8	10
Madder	11	12	13	12	13	14
Basil	7	8	11	14	15	15

Table 1. b: Antibacterial activity of the dyed cotton fabric material by diffusion method.

Dye source	Silk fabric					
	E. coli (G-)			St.aureus (G+)		
	20 µl	60 µl	100µl	20 µl	60 µl	100µl
Turmeric	8	11	12	7	9	12
Logwood	4	5	7	8	10	11
Marigold	7	8	10	5	7	8
Madder	7	8	10	11	11	12
Basil	5	7	8	7	9	10

The Process of well diffusion was performed to determine the range of antimicrobial activity at different volume of solution of dyed fabric against E. coli and St. aureus. This activity is analyzed for one type of cotton and silk fabric material under five different types of ecofriendly dyes.

This antimicrobial activity of selected ecofriendly dyed fabric material is also determined after washing in water by following different washing cycles (4, 8 and 12 washing cycle). This antimicrobial effect after the washing cycle was performed for a 100µl solution. The antibacterial activity remained almost constant after washing the material. The durability of dyes on cotton and silk substrates can be increased using mordents such as alum and other mordanting agents. In this process of washing, the antimicrobial effect of selected dyed cotton and silk fabric was analyzed after decreasing the amount of dye due to washing of these fabrics many times in the water. The bonding of the dye molecules to the fabric was considered during this washing cycle. These five different types of natural dye molecules have good bonding with cotton and silk fabric materials. During the washing cycle, the availability of these dyes on selected cotton and silk fabrics was possible because of the required bonding between the dye molecule and fabric material. The required bonding between the dye molecule and the selected fabric material can be increased by using mordents during the dyeing process.

The washing cycle was performed in distilled water. The Washing cycle is performed by taking extra clean and commonly used water to minimize the cost of washing and by considering the availability of water during washing. The sources for the dye gave good shade of color to the fabric along with antimicrobial activity. This color shade and antimicrobial activity increases the appearance and quality of the fabric material. Some extra and different good color shades can be produced from these five types of dyes using mordants. The antimicrobial activity of the dyed fabric was achieved by natural sources that do not produce harmful side effects when using this fabric. Washing the fabric minimizes its dye content. However, the effect of the antimicrobial activity of the dye on microbes is given by the dyed fabric even after a number of washings. The antimicrobial activity of the given examples of dyes was carefully determined using two types of bacteria. These bacteria are gram- positive and gram-negative. These dyes are active against both types of microbes.

The values obtained for the antimicrobial activity after washing were recorded. The dye sources analyzed in this study showed positive antimicrobial activities against both **E. coli and St. aureus bacteria.** The washing cycle was performed in water. After washing, the antimicrobial effect of the dyed sample on E. coli and S. aureus was evaluated using three readings. The antibacterial activity of the selected dyed cotton and silk materials after four, eight, and twelve washing cycles is given in Table 2. a and table2.b

Table2.a: Antibacterial activity of the dyed cotton material after washing cycle (W: washing cycle)

Dye source	Cotton fabric					
	E.coli (G-)			St.aureus (G+)		
	4 W	8 W	12 W	4 W	8 W	12 W
Turmeric	9	9	8	10	8	8
Logwood	11	11	10	13	14	14
Marigold	8	6	5	7	6	4
Madder	9	8	8	11	13	14
Basil	7	7	5	8	9	11

Table2. b: Antibacterial activity of the dyed silk material after washing cycle
(W: washing cycle)

Dye source	Silk fabric					
	E.coli (G-)			St.aureus (G+)		
	4 W	8 W	12 W	4 W	8 W	12 W
Turmeric	10	9	9	12	11	10
Logwood	8	7	7	11	10	8
Marigold	7	7	6	7	7	6
Madder	7	6	5	8	7	5
Basil	5	4	4	6	5	4

Conclusion

This antimicrobial research work focuses on dyed cotton and silk fabric materials, which provide good antimicrobial activity against selected bacteria. The antimicrobial dyeing process on cotton and silk materials will be beneficial for minimizing the effects of pathogenic microbes and avoiding allergic conditions due to microbial growth on fabric materials. The dyed cotton and silk fabric samples for this determination were active against both Escherichia coli and Staphylococcus aureus. The strong bonding between the dye molecule and the selected fabric molecule showed good results, even after the washing cycles. The samples dyed with the selected dye sources exhibited greater inhibition than the undyed fabric material. The logwood and madder dyed material were more active against Staphylococcus aureus than against E. coli. This antibacterial activity on cotton and silk dyed fabric substrates increased with increasing concentration of the dye solution. This selected cotton and silk fabric material, which is dyed using natural and antimicrobial dye sources, can increase the quality of the fabric material.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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