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Development of Antimicrobial Textile Used to Dressing for Wound Healing

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KEYWORDS

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Silk fabric
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Ocimum basilicum plant extract

ABSTRACT

Ocimum basilicum plant has medicinal value and it has been used as a good source of ayurvedic medicine. This work presents the wound healing properties of dyed viscose and silk fabric with Ocimum basilicum plant extract by cold pad batch method. Cold pad batch dyeing technology was considered for incorporating antimicrobial properties that will support wound healing into viscose and silk fabric, whereas Ocimum basilicum plant extract was used as a natural antimicrobial agent. Both dyed antimicrobial textile dressings showed good wound healing properties, whereas silk dressing displayed better healing properties.

1. INTRODUCTION

Antimicrobial incorporated wound healing dressings are the most demanding medical textiles and create a significance for the successful wound healing treatment in medical sector [1]. Wound healing normally occurs in a predictable sequence, but for some wounds healing is prolonged or never achieved. The healing process is the consequence of a complex interaction between various issues during wound recovery, so the choosing of pertinent dressings and the accurate treatment plan of a skilled healthcare professionals [2]. Presently, different properties of wound dressings have been increased with contemporary materials and technologies for providing a moist environment during wound healing is the priority of these developments. Hence, the modern antimicrobial incorporated wound care textile dressings are based on the concept of providing optimum conditions to allow epithelial cells so as to move unimpeded for the treatment and healing of wounds. The different of wound care materials and wounded patient characters have resulted in a wide range of wound dressings [3]. Again, herbs contain antimicrobial property have been used as wound dressing as there have no allergic reaction on skin [4] . Therefore, different coating materials like aloe vera, curcumin and chitosan have been used into the base material to enhance wound healing applications and the wound healing efficacy has been analyzed by the in vivo method [5]. To improve antibacterial activity, neem oil, aloe vera, tulsi and different ingredients have been used for the treatment of textile wound care [6][7][8]. The present investigation focuses on developing antimicrobial properties on textile materials

using *Ocimum basilicum* plant extract that support wound healing property. Cold pad batch dyeing method was considered to develop antimicrobial properties on textiles. This dyeing method uniformly spread plant extract to fabrics during dyeing. This experimental work focused on the efficacy of antimicrobial textile materials with *Ocimum basilicum* plant extract that will support wound healing and could be used as a wound care textile material.

2. EXPERIMENTAL

2.1 Materials

2.1.1 Substrate

A pretreated viscose fabric and silk fabric were used in the experiment. Viscose fabric was sourced from Alliance Knit Composite Ltd, Zerabo, Ashulia, Savar, Bangladesh and silk fabric was purchased from the store of Sopura Silk Mills Ltd. Dhanmondi, Dhaka, Bangladesh. Table 1 represented the specification of fabrics.

Table 1: Specification of fabrics

Parameter	Viscose	Silk
Fiber composition	95% viscose 5% elastin (lycra)	degummed silk fiber
Weave structure	4x2 Rib	Plain weave
count	30 Ne 40D lycra	100
GSM	200	50

2.1.2 Dye

Ocimum basilicum plant was used as a natural dye source that was collected from Dhaka, Bangladesh.

2.1.3 Chemical

Methanol

2.2 Methods

2.2.1 Extraction

The solvent extraction method was employed for extracting coloring matters from the leaves of the *Ocimum basilicum* plant. At first, leaves were collected, washed, cleaned, and dried by sunlight then powered and measured weight. The extracted dye solution was prepared with 1:5 extraction ratio with 90 grams of dried powder and 450ml methanol. A 500 ml conical flask was used and it was sealed after pouring dried material and solvent and kept onto a shaker machine at 2 rpm for 48 hours (shaking 8 hours per day). Then, the seal of the conical flask was opened and it was let opened for 24 hours at room temperature for evaporation the methanol. Then, it was heated for the evaporation of solvent and filtered. The dry content, moisture percentage and pH of the extraction was measured. Fig.1 showed the extracted dye solution.

Fig. 1: Extracted dye solution

2.2.2 Dyeing

Samples were dyed by CPB (cold pad batch) method using the extracted dye. Padder pressure was set before dyeing as minimum pressure was set to achieve maximum pick up percentage. Then dyeing solutions were prepared according to following recipe presented in Table 2 and padded and squeezed fabric for 5 times to achieve shade on fabric. Usually in cold pad batch dyeing technique follows low liquor ratio but here considered 1:10 liquor ratio in the experiment for developing shade properly during dyeing. Then dyed samples were cold washed and dried for 100 ^{o}C temperature for 5 minutes.

Table 2: Recipe for cold pad batch dyeing [9]

Parameter	Quantity
Sample size	(3x3) inch
Extraction (Shade %)	5%
Padder pressure	0.12 Mpa
Pick up%	70%
Padding time	5
Liquor ratio	1:10

2.2.3 Sample labeling

Dyed samples were labeled according to fiber type like V1 and S1, whereas V1 denoted dyed viscose fabric and S1 denote dyed silk fabric.

2.3 Characterization

2.3.1 Extraction

The dye extract from *Ocimum basilicum* plant was characterized by assessing optical density or absorbance through UV-Visible spectrophotometer. This works on Beer-lambert law (qualitative analysis) [10] where absorbance was measured against wavelength of 200-700 nm which determined maximum absorbance of dye extract at a particular wavelength.

2.3.2 Dyed fabric

Color Strength

Color strength of dyed sample was assessed by kubelka- Munk Eqn. (1) through data color in terms of K/S value [11].

$$\frac{K}{S} = \frac{(1-R)^2}{2R} \qquad (1)$$

Where R is the reflectance value of dyed fiber.

Wicking test

Wicking test of dyed fabrics was observed by JIS L1907 Section 7.1.5 - vertical wicking test method.

Antimicrobial

The antimicrobial property of dyed fabrics was assessed by AATCC TM 147 standard [12].

Wound healing

Two male cats of same species were used for wound healing observation. The wound place was wrapped with the dyed viscose and silk fabric individually and kept under observation by following the instructions of a registered local veterinarian [13]. The temperature of injured cats was measured after every 8 hours and also observed the infection of injured place. If there have not occurred any infection in the injured place then the measurement will be acceptable. After 6 days, the dressing of both fabrics were opened and made conclusion of the dressing effectiveness.

Odor Test

Odor assessment was done by laboratory sample method of EN 13725:2003 [14][15].

3 RESULTS AND DISCUSSIONS

3.1 Absorbance of dye extract

Fig. 2 showed the experimental data of dye extract in terms of optical density or absorbance against wavelength of 200-700 nm determined maximum absorbance or optical strength at a particular wavelength. Highest optical density or absorbance peak was found at 270 nm, 320 nm, and 380 nm and that was 3.74, 3.92, and 3.31 respectively. So, it could be said the dye extract will show maximum greenish hue at those wavelength.

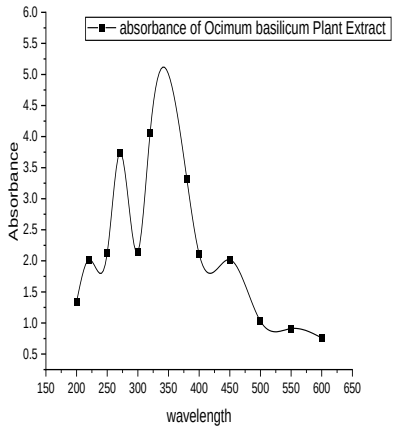

Fig. 2: Absorbance against wavelength of Ocimum basilicum pant extract

3.2 Color strength

Fig. 3 displayed color strength of viscose and cotton modal blend fabric result in term of K/S value respect to wavelength. Dyed viscose fabric, V1 showed maximum color strength of 11.02 at 270 nm where cotton modal blend fabric, CM1 had maximum color strength of 9.76 at 250 nm.

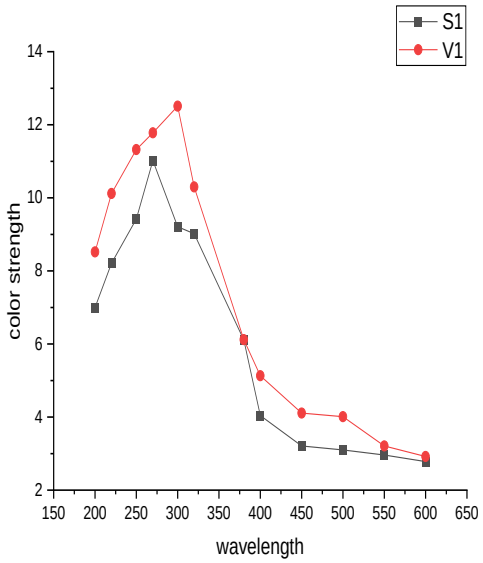

Fig. 3: Color strength of dyed fabrics

3.3 Wicking property

Fig. 4 showed the experimental data of wicking test of dyed fabrics. Silk fabric gave better wicking height (45 mm) whereas viscose fabric had wicking height in 42 mm. It express that silk has better absorbance property, so silk dressing will accelerate better wound healing compare to viscose fabric.

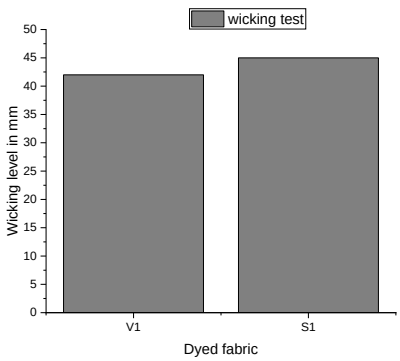

Fig. 4: Wicking test result of dyed fabrics

3.4 Antimicrobial property

Antimicrobial property of dyed fabric was assessed by agar disk method against gram negative bacteria, *E. coli* and gram positive bacteria, *S. aureus* showed in fig. 5. The experiment result revealed that antimicrobial activity against gram negative bacterial had better zone of inhibition diameter compare t gram positive bacteria.

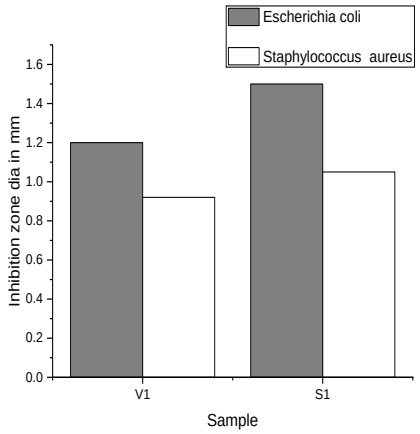

Fig. 5: Agar diffusion test result

On the other hand dyed silk fabric showed better antimicrobial property against dyed viscose fabric. The Zone of inhibition diameter of dyed silk fabric was 1.5 mm whereas dyed viscose sample has 1.2 mm zone of inhibition diameter against *E. coli*. The Zone of inhibition diameter of dyed silk fabric was 1.05 mm whereas dyed viscose sample has 0.92 mm zone of inhibition diameter against *S. aureus*.

3.4 Wound healing property

Normal body temperature for cat is 38.3 to 39.2°C (101.0 to 102.5°F). Few cats maintain a baseline temperature a little above or below the average, but if the cat's temperature rises above 40.0°C (104°F) or falls below 37.2°C (99°F), need to consultant with an animal specialist. Table 3 denoted test results of wound healing observation. Both samples have better healing property. According to test result silk fabric showed faster healing recovery against viscose sample as silk sample has antimicrobial resistance properties itself. After six day

observations, there would not occur any infection in the injured portion of both cats. Again, the cat bandaged with silk dressing recovered faster compare to viscose dressing cat.

Figure 6 showed the body temperature of cat with silk and viscose dressing according to days of wound. The body temperature of cat with silk and viscose dressing was nearly same at first day. The body temperature of cat with silk dressing was 38 ^{o}C after six day whereas the body temperature of cat with viscose dressing was 38.3 ^{o}C that considered normal body temperature of cat and the injured portion recovered and there grow tissues also.

Table 3: Test results of wound healing observation considering body temperature

Day	Time	Temperature (^{o}C) V1	Temperature (^{o}C) S1	Avg. temperature (^{o}C) V1	Avg. temperature (^{o}C) S1
1	5.00 am	40	39.5	39.8	39.8
	1.00pm	39.5	40		
	9.00pm	40	40		
2	5.00 am	40.5	40	40.1	39.9
	1.00pm	40	40		
	9.00pm	40	39.7		
3	5.00 am	39.7	39.5	39.6	39.5
	1.00pm	39.5	39.5		
	9.00pm	39.5	39.4		
4	5.00 am	39.4	39.4	39.2	39.1
	1.00pm	39.1	39.1		
	9.00pm	39.1	38.8		
5	5.00 am	38.8	38.6	38.7	38.4
	1.00pm	38.8	38.3		
	9.00pm	38.6	38.3		
6	5.00 am	38.3	38	38.3	38
	1.00pm	38.3	38		
	9.00pm	38.3	38		

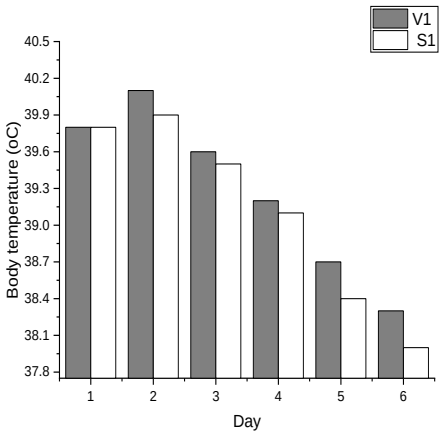

Fig. 6: Observation of cat's body temperature in respect to day

3.5 Odor test result

Both samples had weak odor as *Ocimum basilicum* plant extract was used for developing antimicrobial and wound healing property. Again, *Ocimum basilicum* plant have aromatic pleasant fragrance also. Table 4 displayed intensity scale rating of odor.

Table 4: Odor test rating of dyed samples.

Sample	Grade	Intensity scale
V1	2	weak odor
S1	2	weak odor

4. CONCLUSION

This empirical study demonstrated that *Ocimum basilicum* plant extract could be used as a prospective source of natural dye for developing antimicrobial properties to textile materials and the antimicrobial textile support wound healing when used as a surgical bandage. Test results illustrated that both dyed samples showed good antimicrobial activity against gram positive and gram negative bacteria. Dyed Viscose fabric showed 1.2 mm ZOI diameter and dyed viscose fabric showed 1.5 mm ZOI diameter. The experiment result of wound healing observation on cats revealed that both samples have better healing power in injured portion and helps to grow issue without any harm. Dyed silk has a better healing property against viscose fabric. Fabric with *Ocimum basilicum* plant extract. Further study of this research would be the efficacy of those properties after several wash cycles. In a nutshell, sample dyed with *Ocimum basilicum* plant extract could be considered as a safe substitute of synthetic wound healing dressing and could be commercialized in medical textile sector.

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CONFLICT OF INTEREST

All authors declared that there is no conflict of interest with this work.

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