ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

EFFECT OF TEMPERATURE ON THE DYEING OF COTTON FABRIC WITH MONASCUS PURPUREUS DYE

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DOI: 10.5281/zenodo.203822

ABSTRACT

Textile industry is one of the most significant contributor to world economy and a major consumer of dyes. The nature provides rich and diverse source of dyes all the while being environmentally safe,

Nowadays, with the increasing awareness about health, wellness as well as environment among the general populace, there has been a renewed interest in natural sources of pigments for dyes. This is because naturally produced colors are not toxic nor carcinogenic to humans and are more environment friendly as they are easily biodegradable. The green movement that started in 1960s initiated the shift in preference of naturally sourced colors over synthetic colors and this prevalence has been increasing steadily. One of the major driving factors is the public discomfort in the usage of synthetic colors. Another factor is the leniency and flexibility provided by governments in the use of natural colors.

Plenty of literature can be found on various studies on microbial pigments, mostly focusing on production of specific pigments and their applications. As the interest towards natural and eco-friendly products among consumers is on the rise, microbes can be used to color textiles. The present paper deals with the effect of temperature on the dyeing of cotton fabric with microbe i.e Monascus purpureus dye.

KEYWORDS: Microbial pigment, Monascus purpureus, Bio-colorant, cotton dyeing, Textile dyeing.

INTRODUCTION

Humans have always been charmed by colors and thus the art of dyeing has been a very old one. The knowledge of dyeing with natural dyes has been confirmed by the evidences of dyed fabrics from several civilization's ruins. The skill and craftsmanship of dyeing with natural sources prolonged far and wide with the progression of civilization.

Since millennia, humans have sourced pigments from plants, insects, animals and ores. During 19th century, with the advent of industrial revolution, synthetic dyes replaced naturally sourced dyes and have been leading in this field to this day even though they are hazardous to the environment. But in recent year, there has been more awareness about the harmful effects some chemical dyes on humans and the environment. This has given rise to a renewed interest in pigments created from natural sources.

Natural dyes were primarily obtained from plants and their production requires agricultural land. There is scarcity of productive land for cultivation of dye yielding plants. Thus, it is difficult to meet the demand of dyes only with the plant dyes. There are other problems lack of standardization and seasonal availability of dye source, lack of reproducibility of shade, instability against light, heat or adverse pH.

To overcome this drawback, it is suggested to exploit the potential of microorganisms such as fungi, bacteria and algae that are fast growing and have the potential of being standardized commercially **(Sharma et al. 2012).** There are several microorganisms that can produce pigments, which are some of the important classes of secondary

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metabolites and are often referred to as biopigments. Microorganisms produce various pigments including carotenoids, melanins, flavins, quinones, prodigiosins and more specifically monascins, violacein or indigo **(Khanafari et al. 2006; Venil and Lakshmanaperumalsamy 2009).**

Microbial pigments provides an alternate source of pigments which is more environment friendly because of their enhanced biodegradability and better compatibility with environment. These qualities of microbial pigments open up exciting avenues in various applications including dyes in textiles industries. Microorganisms have easy and fast growth, are independent from environmental conditions and produce different shades of colours. Hence, microbial pigment production has now been one of the emerging fields of research to display its potential for a variety of industrial applications.

Cotton is produced in over 50 countries worldwide, averaging 20-24 million tons per year. India is one of the largest consumers of cotton, accounting for about 60% of the total consumption of cotton **(Furter *et al.*, 2007).** An effort was made to dye cotton fabric with monascus dye.

Keeping in view the above considerations, efforts were made in the present research work to analyze the effect of temperature on the dyeing of cotton fabric with microbe i.e *Monascus purpureus* dye.

MATERIAL AND METHODS

Preparation of Textile material

The cotton fabric was scoured to remove any kind of impurities like fats, oil and any other finishing treatment given to materials so that they do not react during dyeing process. The scouring was carried out at boil for 60 min with 2 gpl (gram per litre) detergent maintaining the material liquor ratio 1:50. The scoured fabric was thoroughly rinsed with water to ensure complete removal of soap and subsequently dried at room temperature.

Dyeing of cotton:

Cotton fabric samples were dyed at different temperatures ranging from 60, 70, 80, 90 and 100^0C. During the dyeing experminets. Experiments were conducted to assess the effect of temperature on dyeing of cotton fabric with *Monascus purpureus* dye. Dyeing was carried out at material to liquor ratio of 1:100. After the dyeing the fabric was allowed to dry and analysed as follows:

A. Analysis of colour values of dyed cotton samples

The principle behind the analysis of color value involves the measurement of reflected light from a sample when a specific light is projected through it. The instrument consists of an optical sensor and a signal processor. The optical sensor measures the sample reflectance at varying wavelength. The reflected light that is reflected gets converted to photocurrent and is then passed to signal processor to achieve colour values **(Mehta and Bhardwaj, 1998)**. The Kubelka Munk theory helps in predicting the color value. The formula is given below.

$$K/S = \{1-R\}^2/2R$$

Where, K = a constant about the light absorption of the dyed fabric
S = a constant about the light scattering of the dyed fabric
R = reflectance of the dyed fabric, expressed in fractional form

The K/S values were determined using "Colorscan spectrophotometer". The samples were placed at sample holder and light was projected onto it. The computer screen directly gives the reflectance. The orientation of the sample was changed thrice and readings were taken. The K/S values and color coordinates (CIELAB) L∗, a∗, b∗ C and h^o were recorded directly from the computer.

B. Subjective evaluation through visual evaluation

A proforma was prepared for visual evaluation which includes various attributes viz. luster of dye, depth of shade, evenness of dye and overall appearance. A panel of respondents were selected for evaluation through random sampling. Maximum five marks were allotted to each attribute and there were total four attributes therefore, total marks allotted were 20. Percentage of marks obtained through visual evaluation was calculated by using following formula.

$$\% \text{ of marks} = \frac{\text{Marks obtained}}{\text{Total marks allotted}} \times 100$$

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RESULTS AND DISCUSSION

Experiments were conducted to assess the effect of temperature on dyeing of cotton fabric with *Monascus purpureus* dye. Dyeing was carried out at different temperatures i.e 60, 70, 80, 90 and 100^{0}C. The results of color strength and visual evaluation are given in Table 1 and Table 2 respectively.

The cotton fabric was dyed with *Monascus purpureus* dye, and was assessed for color strength and visually evaluation. When dyeing was done at 60^{0}C, color strength value of 3.78 was recorded, followed by 4.06 at 70^{0}C. When dyeing was done at 80^{0}C, color strength value of 4.39 was recorded (table 1). However, with the increase in temperature of dyeing, there was no further increase in color strength of the dyed samples.

Table 1: Color strength obtained by cotton fabric dyed at different dyeing temperature with Monascus

Temperature (^{0}C)	**K/S**
60^{0}C	3.78
70^{0}C	4.06
80^{0}C	4.39*****
90^{0}C	4.34
100^{0}C	4.23

purpureus **dye**

***** maximum value

When dyeing was done at 60^{0}C, percent color strength value of 3.78 was recorded, followed by 4.06 at 70^{0}C

The highest percentage of marks were also scored at 80^{0}C (Table 2). However, with the increase in temperature of dyeing, the samples received lesser marks when evaluated visually. Therefore, 80^{0}C was selected as optimum temperature for dyeing during further experiments.

Table 2: Percentage of marks obtained by cotton fabric dyed at different dyeing temperature with Monascus purpureus dye

Temperature (^{0}C)		**% marks**
60^{0}C		69.68
70^{0}C		80.32
80^{0}C		80.34*****
90^{0}C		71.86
100^{0}C		69.92

***** maximum value

The results are in accordance with **Sudha et al (2016)** who stated that when dyeing was done with *Penicillium minioluteum*, color depth and dye exhaustion was found to be maximum at the dyeing of 80 °C temperature. Dyeing temperature of 80 °C was also used by **Alihosseini et al. (2008)** in dyeing machine who also obtained accepted colors on multifiber fabric at this temperature when dyeing was done using red color extracted from *Vibrio* sp.

Bhargava (2012) dyed cotton samples with *Pseudomonas fluorescens* dye. Dyed cotton samples showed highest percent absorption when dyed at 80^{0}C temperature. In case of *Pseudomonas aeruginosa* dye also, 80^{0}C was selected as the optimum dyeing temperature for the dyeing of both the samples as it exhibited better results. **Selvi et al. (2011)** had also stated that the pigment extract of *Roseomonas fauriae* were applied on cotton fabric using pad-dry cure method at minutes at 80°C.

CONCLUSION

At higher temperature, due to the thermal energy from outside the aggregation of dye particles in solution became non-aggregated and the number of fiber pores as well as their diameter increased. Thus, more dye particles penetrated easily into the cotton fiber pores at higher temperature. **(Mondal and Razzaque**, **2007)**

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It can be concluded from the results that temperature play a key role in the dyeing process of cotton fabric with *Monascus purpureus* dye. Results further suggests that dyeing of cotton with *Monascus purpureus* dye can be done successfully at the dyeing temperature of 80^0C.

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