



Original Article

A Comparison of Physical Properties Plain Khadi Cotton Fabric and Madder Dyed Khadi Cotton Fabric Using Alum as a Mordant

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Abstract

Plain khadi cotton fabric has less acceptance as compared with any dyed khadi cotton fabric. As synthetic dyes are more harmful to human skin. So, in this study application of madder is a natural dye which can be use with alum as mordant. After application of madder as dyes material on plain fabric it shows changes in their physical properties. The physical properties were tested and concluded in this research. The result was shown increase and decrease in values of different physical properties. In this way this research paper compared changes in physical properties of plain khadi cotton fabric and dyed khadi cotton fabric.

This study examines the comparative effects of natural dyeing using madder and alum as a mordant on the physical properties of plain khadi cotton fabric. As concerns about synthetic dyes grow due to their environmental and dermatological hazards, natural alternatives are gaining popularity. The experiment involved dyeing plain khadi cotton fabric with madder root extract using alum as a mordant and analyzing key physical properties such as elongation, tensile strength, tearing strength, bending length, and crease recovery. The findings reveal that dyeing alters these properties, with certain characteristics showing improvement—like crease recovery—while others, such as tensile and tearing strength, experienced slight reductions. The study highlights the suitability and sustainability of using natural dyes in textile applications, particularly for eco-conscious consumers and traditional textile revival efforts.

Keywords: Khadi cotton fabric, natural dyeing, madder root, alum mordant, physical properties, sustainable textiles, crease recovery, tensile strength, elongation

Introduction

The name "Khadi," which comes from the word "khaddar," refers to a hand-spun and woven natural fibre textile that was first employed by Mahatma Gandhi in 1918 during the Indian subcontinent's freedom struggle. The phrase is used in Bangladesh, Pakistan, and India. In 1917–18, the Sabarmati Ashram produced the first piece of the hand-woven fabric. Gandhi called it 'khadi' because of the coarseness of the fabric. Cotton is typically spun by hand and woven into the fabric. But it might also comprise wool or silk, which are all spun into yarn on a Charkha, a type of spinning wheel. This fabric is warm in the winter and cool in the summer. Khadi/khaddar is occasionally starched to give it a firmer feel and to enhance its appearance.

Khadi became a key component and symbol of the Swadeshi movement in the 1920s when Mahatma Gandhi started encouraging its spinning for rural self-employment and independence (as opposed to mill-made).

Colour substance derived from natural sources are known as natural dyes. Up until the middle of the nineteenth century, natural dyes were utilized to dyeing and printing many kinds of fabrics. The introduction of synthetic dyes, which were affordable and had superior fastness qualities, led to a decrease in the usage of natural dyes. Natural dyes are becoming more popular, nevertheless, as a result of stricter environmental regulations, global environmental concerns, and rising consumer awareness of the harmful effects of synthetic dyes.

Although plants are the primary source of natural dyes, these dyes are essentially components of natural resources and are often categorized as plant, animal, mineral, and microbial dyes according to their place of origin. Because they are biodegradable and renewable, natural dyes are sustainable.

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Natural dyes can be made from roots, leaves, fruits, flowers, and bark. Each component can produce a different colour; for example, sappan-wood tree pods produce red, bark produces brown, and roots produce yellow. Dye can be made from a variety of plant by products.

Madder is a red plant that is used to make natural dyes from a variety of *Rubia* species. The plant's roots are used to make the dye. Another common name for it is the "queen of natural dyes." Alizarin is the primary colouring agent found in European madder *Rubia tinctorum*. The colouring matter of *Rubia cordifolia*, also referred to as Indian madder, manjishth, or manjeet, is a blend of purpurin and munjistin. Apart from the roots, the plant's stems and other portions also contain dye. (Saxena Sujata).

In order to set (i.e., bind) dyes on textiles, a chemical known as a mordant or dye fixative forms a coordination complex with the dye, which subsequently adheres to the fabric (or tissue). It can be used to enhance stains in cell or tissue preparations or to dye textiles. Directs have generally replaced mordants in industry, however they are still used, particularly by small batch dyers.

The most often used mordant is alum. There are two kinds of this naturally occurring metallic mordant: aluminum potassium sulfate and aluminum ammonia sulfate. Potassium aluminum sulfate is inexpensive, accessible, and secure. Colour is unaffected. It enhances and intensifies the finished color. Textiles with more alum seem harsh and sticky. Cream of tartar, which aids in evenness and somewhat brightens, is typically added with it.

Materials and Methods

Material

Fabric

100% pure Khadi Cotton fabric was selected. Fabric was purchased from Gram Sewa Mandal, Gopuri Wardha.

Metal Mordant: Alum (Aluminium sulphate)

Natural Dye: Madder Dye (*Rubia tinctorum*)

Chemicals: Sodium chloride (NaCl) and Acetic Acid (CH_3COOH)

Method

The dyeing of khadi cotton fabric was basically done in four stages, pre-treatment, extraction of dyes from root powder, mordanting and dyeing. The entire process of dyeing was done through control method.

Preparation of raw Material

1. Scouring of Khadi cotton fabric

The starch present in khadi cotton fabric was eliminated by scouring. Fabric to be scoured was pre-weighed. Ratio of material to liquor 1:20 Fabric was dipped normal water for 30 minutes. Then heated the water and salt was added and thoroughly mixed. After adding the soaked cloth, the temperature was maintained at 80°C for approximately 30 minutes while being agitated. After giving the material a thorough water treatment, it was allowed to air dry at room temperature.

2. Pre-mordanting

Mordanting of the fabric performed using alum 15% of weight of the fabric and material to liquor ratio 1:20. The mordant bath was maintained at a temperature of 80°C for the about half an hour along with constantly stirred serves as the firm fixative agent.

3. Extraction of dye

Concentration of Madder root powder 20% mixed with filter water and kept the mixture for an hour. Dye Material to Liquor ratio was maintained 1:30 and temperature 60°C for extraction of dye. Temperature was maintained with constantly stirred for about 30 minutes. Throughout the process, extraction was carried out to get optimum colour of the solution. The solution was filtered to get clear extraction. Some drops added acetic acid for maintained pH value. pH value was 5.

4. Dyeing

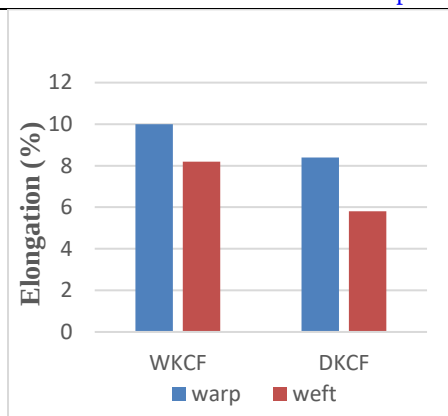
Khadi cotton fabric was dyeing with extract keeping material to liquor ratio was 1:30. The maintained pH value 5. Water that was heated to 40°C was used to dissolve the dye. Salt was added 10 gm per lit. The fabric was added with a further rise in temperature to 80°C. The temperature was kept constant by constant stirring for about 30 min. Then the fabric was taken from the dye bath and soaked in regular water. washed gently in non-ionic soap solution (easy) and then dyed fabric was dried at room temperature.

Results and Discussion

Results of Fabric Tests

Elongation

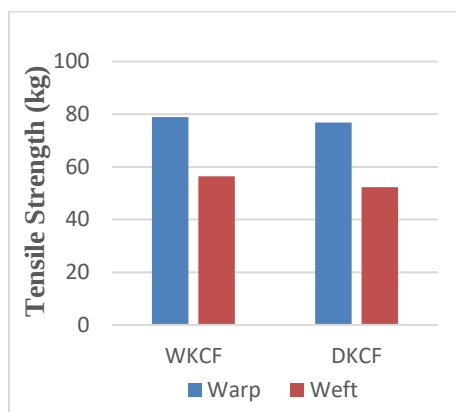
IS 1969:1985 test method was selected for the assessment of elongation of plain khadi cotton fabric. As sample was dyed with madder using alum as a mordant it shown changes in their physical properties as per graph, I show that elongation of sample before dye i.e. white khadi cotton fabric was 10.0% as warp and 8.2% as weft. But when the same sample was dyed with madder using alum as mordant their warp becomes 8.4% and weft become 5.8%.



GRAPH I Elongation

Tensile Strength

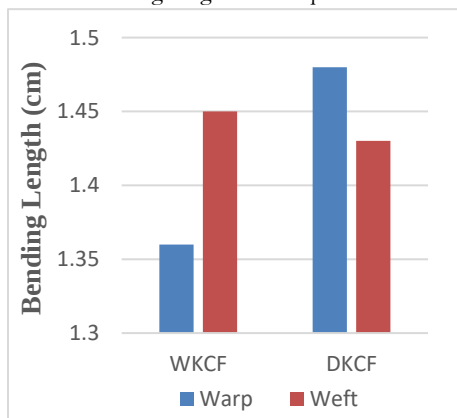
IS 1969-1989 test method was selected for assessment of tensile strength in kg plain and dyed khadi cotton fabric. When applied tensile strength test on same white khadi cotton fabric. Tensile strength as per graph II its warp was 78.89kg and tensile strength of weft was 56.46kg. Then after application of dye tensile strength of same dyed sample become 76.84kg on warp and 52.34kg on weft.



GRAPH II Tensile Strength

Bending Length

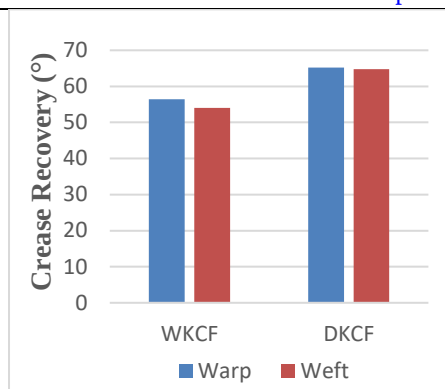
IS 6490:1971 test method was selected for assessment of bending length in cm for plain khadi cotton fabric and dyed khadi cotton fabric. Graph III shows that bending length of plain khadi cotton fabric for warp was 1.36 cm and for weft was 1.45 cm. When it was dyed with madder using alum as mordant its bending length for warp becomes 1.48 cm and for weft become 1.43 cm.



GRAPH III Bending Length

Crease Recovery

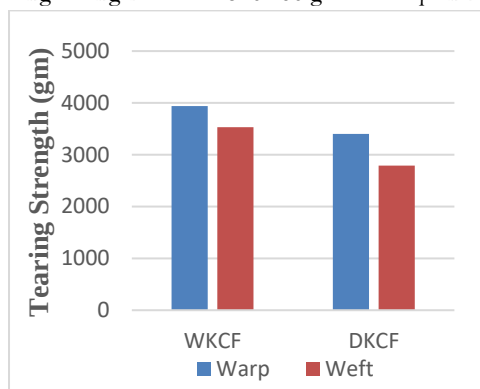
IS 4681:1981 test method for assessment of crease recovery was selected for plain and dyed khadi cotton fabric. As per graph IV it shows that crease recovery of plain khadi cotton fabric was 56.40° for warp and 54.00° for weft. When the same plain fabric was dyed with madder using alum as mordant its crease recovery becomes 65.20° for warp and 64.80° for weft.



GRAPH IV Crease Recovery

Tearing Strength

IS 6489:1993 test method for assessment of tearing strength was selected for plain and dyed khadi cotton fabric. As per graph V tearing strength of plain khadi cotton fabric was 3942.40 gm for its warp and 3532.80 gm for its weft. When same sample dyed with madder using alum as mordant its tearing strength become 3404.80 gm for warp and 2790.4 gm for weft.



GRAPH V Tearing Strength

Conclusion

Different physical properties were tested on plain khadi cotton fabric and dyed khadi cotton fabric. Combinedly result of all tests show different way of variation.

Elongation of dyed khadi cotton fabric was reduced when it dyed with madder and used alum as mordant. Tensile strength is also an important physical property due to dyeing of plain khadi cotton fabric it shows reduction in tensile strength. Tearing strength of the fabric was observed in grams. Results of tearing strength test shows it decreased in tearing strength as compared plain khadi cotton fabric with dyed khadi cotton fabric. Bending length of both the samples were tested it shown increase in bending length as compared warp of plain khadi cotton fabric with warp of dyed khadi cotton fabric. But bending length of weft of plain khadi cotton was decreased when it dyed. Crease recovery of both fabrics was tested with specific tests to observe its change. It shows that crease recovery angle of plain khadi cotton fabric was increased when it dyed.

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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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