



# Natural Colouration and Antimicrobial Enhancement of Cotton and Linen Fabric using Mango Bark

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## ABSTRACT

The study of natural dyeing has been a focus within the textile industry, driven by rising environmental concerns and the increased demand for sustainable production processes. The application of synthetic colourants is a significant environmental issue and a major health concern. In this process, a natural colourant is to replace a synthetic colourant. The natural dyeing process uses a solution extracted from mango bark. One natural colouring molecule is tannin, derived from mango bark, an agricultural byproduct, which can give textiles a rich gold-brown to green hue. Plant-based dyes are green as opposed to synthetic dyes, as they are biodegradable, nontoxic, and environmentally friendly. This project involves extracting a natural dye from mango bark, which has been used to dye cotton and linen. Two dyeing processes involving the use of a mango bark on cotton and linen, with the use of mordant alum, plus a non-mordant process. Alum is more widely used in the natural dyeing process to improve fixation and colour stability. It indicates that the experiment was to compare the dye absorption, colour depth, and shade of the mordanted and the non-mordanted materials. Washing fastness tests and also rubbing were carried out. FTIR, antimicrobial, UV resistance, and Colourfastness tests have been conducted to investigate a natural dyeing process.

**Keywords:** Natural dyeing, Mango bark, Alum mordant, Sustainable textiles, and Eco-friendly dyeing.

## 1. INTRODUCTION

The textile industry is one of the largest sectors of the global economy and contributes significantly. Dyeing is a more significant process in textile production, since it provides colour and aesthetic value to the cloth. The traditional colouring of textiles involved natural dyes made from plants, minerals, insects, and barks. . Natural colorants are considered safer compared to synthetic dyes [1]. The application of natural dyes has been in rapid decline since the discovery of synthetic dyes in the nineteenth century, due to their benefits, including a wider colour palette, a broader range of hues, and faster application. Natural dyes are considered eco-friendly because they are derived from renewable sources and biodegrade naturally. Natural dyes are sustainable textile usages because they involve less use of harmful chemicals. Bark from trees is an important natural dye source due to tannin content [2]. The recovery of the dyeing process using natural dyes has cultural resonance, as it has been practised for over 100 years in traditional textile crafts. Plant material is the most used source of natural colours. Dye pigments are washed off various parts of the plants that contain leaves, flowers, fruits, seeds, bark, and roots.



One source of natural colouring substances is mango bark, which contains polyphenols and tannins that can be used to impart a uniform colour to textile fibres. Plant barks provide stable earthy tones in textile dyeing [3]. The mango tree is widely cultivated in tropical/subtropical regions, particularly in India. Its bark has natural tannins and colouring materials that can be used to make fabrics yellowish-green to brown. Mango trees are not uncommon; the trees can be used as a low-cost, sustainable source of natural dyes. The application of natural dyeing helps reduce waste from natural materials. Fibres such as cotton are natural and suitable for the natural dyeing process because they are absorbent and compatible with plant-based dyes. Natural dyeing is more reliant on mordants. Mordants are materials that help bind the dye to the fiber and enhance the strength and longevity of the colour.

## **2. MATERIALS AND METHODS**

### **MATERIALS**

Mango bark is chosen as a source of natural dyes; it contains tannins and other natural dyes, which give it a golden green to brown shade on cloth. To begin with, mango bark is collected locally and washed to remove dust and dirt. . Demonstrates effectiveness of plant-derived dyes on fabrics [4]. Experiments with dyeing are done on cotton and linen. The other two highly absorbent natural textile fibers that can be dyed with plant dyes are cotton and linen. The two textiles are cellulosic fibres and are common in studies on natural dyeing. In this experiment, alum was used as a mordant. The alum is commonly used in natural dyeing because it enhances the fixation of dyes and the development of colour in textile fibers. During this process, stainless-steel dyeing vessels, purified water, heating equipment, and measurement containers are involved.

### **METHODS**

Natural dyeing of cotton and linen fabric with mango bark, with and without mordant, was the experiment used in this study. The samples are scoured in warm water and mild detergent to remove contaminants such as dust, oil, and finishing chemicals, as these can affect dye absorption. The cloth was washed, rinsed, and dried. Mango bark is easy to dye: collect it, wash it, chop it into small pieces, and dye the fabric. The prepared bark was boiled in water, releasing the natural pigments, and a colour dye solution was obtained. The dye material is a mango bark, and the cloth is washed after dyeing. On dyed fabrics, a test is done to assess the colour fastness, absorption, and overall fastness. . The fabric is dyed by use of mango bark and cleaned after dyeing, a test is taken for the dyed fabrics to evaluate a colour fastness, absorption, fastness of the fabrics. Plant bark dyes contain phenolic compounds with antimicrobial properties [5].

### **MAKING OF MANGO BARK NATURAL DYE POWDER EXTRACT.**

Mango bark is a popular source of natural dyes because it is easy to find and can be easily ground into a powder. Mango bark is initially picked and washed with water to remove dust, soil, and other impurities. Having cut the bark into little pieces, turn it in the shade and leave it to dry there, until all the moisture is driven off. Dried bark was becoming brittle, making it easier to grind. After cleaned the barks that are chopped into small tiny pieces and left it into dry in the shade of few days until all of the moisture was completely removed. Similar extraction method applies to mango bark dye preparation [6]. The ground bark was then transformed into powder, which was passed through the sieve to remove coarse particles, resulting in a soft particle size. During the extraction of dye, one can take a certain amount of mango bark powder, add some water, and leave it to boil for a period of time to extract the natural pigments into the dye solution, then filter it and add it to the dye bath to dye the fabric.

### **PREPARATION OF FABRIC**

Before a dyeing procedure, the cotton and linen textiles were prepared by subjecting them to specific processes. Mango bark is suitable for sustainable dyeing applications [7]. The fabric was subjected to a scouring procedure to remove dust, contaminants, oil, waxes, and finishes. The fabric is washed in warm water with detergent and stirred for a while. The fabric was rinsed lightly in clean water to remove detergent residue, then dried at room temperature. Cotton and linen were chosen for the process because they have good absorbency.



## **MORDANTING WITH ALUM**

Natural dyeing, in practice, is aided by mordanting, which enhances dye uptake onto the textile. Alum is applied during the natural dyeing process to help cotton and linen fabrics absorb more of the dye used. Alum is widely used for cellulose fibers [8]. The required mordant solution was prepared by dissolving the required amount of alum in warm water. The sample of pre-washed fabric was already mordanted using an allum solution. The outcome of the process is a fabric that is pulled from the solution and thoroughly rinsed with clean water. Removed mordanted and then dried. It depicts how an alum mordant, which influenced colour intensity and a range of shade variation, the mordanted cloth is then stained with a mango bark dye.

## **DYEING OF FABRIC**

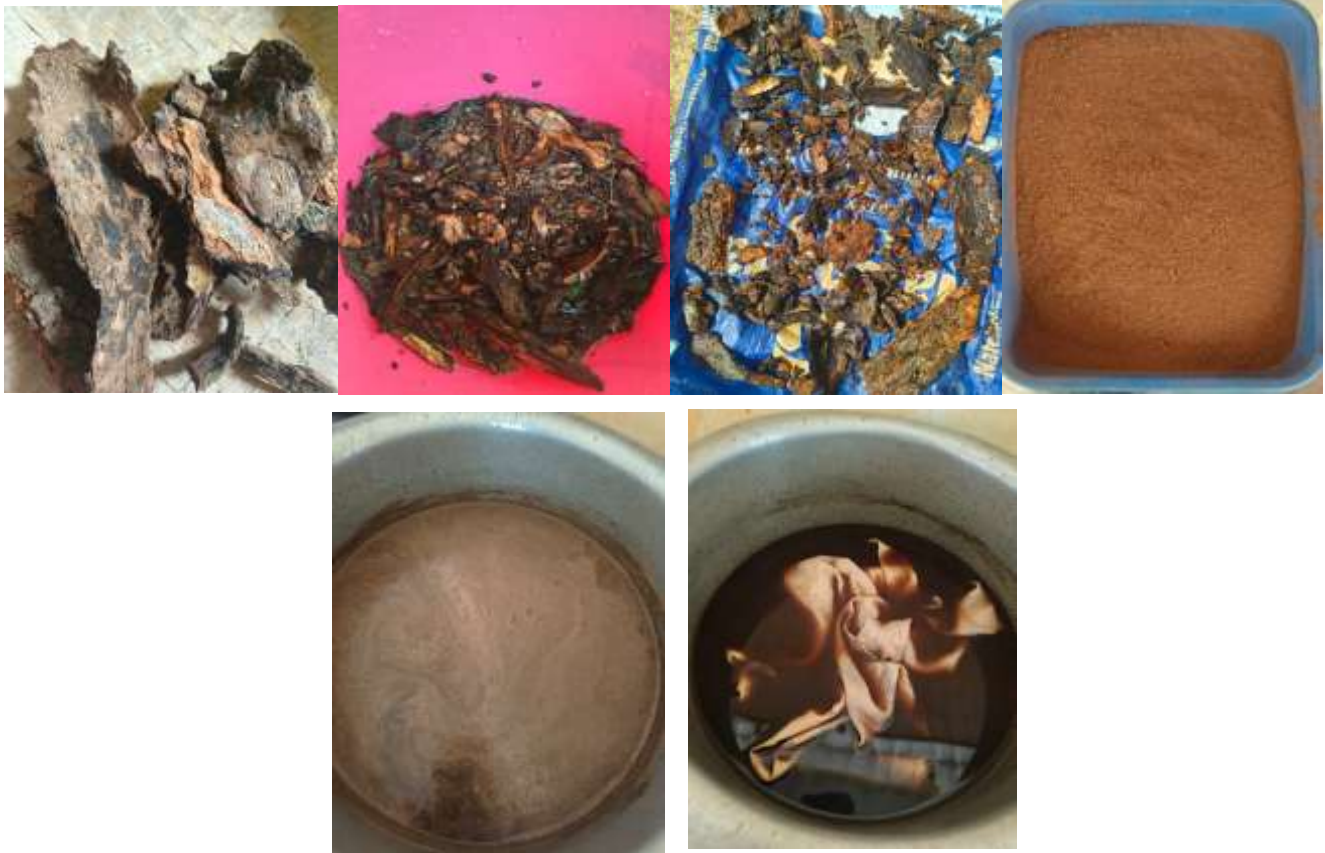
The process of dyeing is carried out on both mordanted and non-mordanted cotton and linen fabric, using alums. To prepare a solution for the dyeing process, one uses vessels heated to a specific temperature. After placing the fabric sample in the dye bath and exposing it for the required time, allow for dye absorption. The dyes are added to the fabric and stirred for a given interval of time, long enough to dye up. The dye molecule can be introduced into the structure of clothes through the heating process. Once that bit is dyed into a piece of clothing, it is taken out and rinsed with water, then dried at room temperature. Through the application of both mordant and non-mordant to the fabrics of both cotton and linen. The alum mordant that is applied to the fabrics is usually made darker, richer, and more intense in colour with the effect of shade changes. The mordant enhances the absorption of colour by enhancing the fibre, the fabric dyed in the absence of mordant produces a comparatively light colour. Textiles made of cotton and linen were compared to examine the reactions of different cellulosic fibres to similar dyeing conditions. To remove a mordant and then dried. Mordanting improves wash fastness and shade depth [9]. Cotton is a more absorbent and less tough fibre than linen; its cellulosic structure has a slight influence on the permeability of dye fibres.

## **DRYING AND SHADE EVALUATION**

The cotton and linen fabric were removed from the dye bath and rinsed with water. Fabric washing is significant in natural dyeing, as it helps remove excess dye and prevent staining and an imbalanced hue on the garment. It is then rolled in the fabric to squeeze out excess water without twisting the material, as too many handles can destroy the fibre structure. A Natural dyeing process are made from plant material that are biodegradable and less environment damages than the synthetic dyes which it contains hazardous chemical and less toxic elements. By use of a synthetic dyeing process, it releases a chemical effluent into a water bodies, causing pollution and affects an environment. The fabric samples are dried in the shade at room temperature. A visual examination of the dyed samples was performed to determine the colour obtained by the material after complete drying of the mango bark dye. It assesses hue vividness, shade tone, and colour intensity. Comparison between those without mordant and those treated with alum mordant is given special attention. The colour-stained obsession with cloth is observed, in which mordanted cloth with alum produced deeper, richer, and more consistent colours. Eco-friendly dyeing can be achieved using mango bark [10]. Both cotton and linen are cellulosic fibres that tend to vary slightly in shade development, and these differences are due to differences in fibre structure and dye absorption. Results are used to determine how natural dyes react with textile fibres and which mordants will determine the ultimate look of the dyed fabrics. A textile ecofriendly natural dyeing was used before an introduction of a synthetic dye. Nowadays again started the process of a natural dyes due to ecofriendly and environmentally safe the fashion and textile production have followed the traditional dyeing process. As a result, by using of mango bark as a natural dye source it is environmentally friendly and sustainable textile production it produceing dyes by natural process. Mango bark dye can be more environmentally friendly textile practices by a lowering pollution, making effective use of natural resource and ecofriendly production techniques.



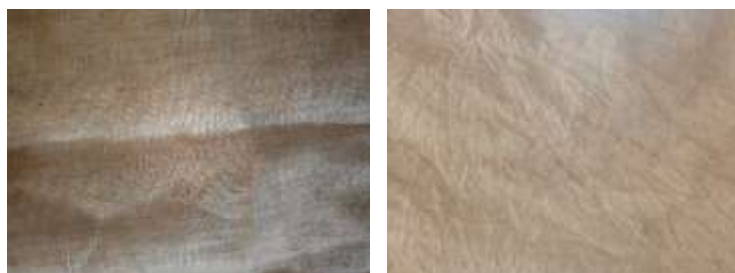
## DYEING PROCESS



## COTTON AND LINEN WITH MORDANT ALUM



## COTTON AND LINEN WITHOUT MORDANT





## ANTIMICROBIAL TEST

Antimicrobial testing aims to assess the resistance of microorganisms to growth on the surface of stained fabric. The purpose of antimicrobial test is to determine to evaluate to resist the growth of microorganisms in the ability of dyed fabric. Bioactive chemicals like tannins and phenolic compound that have an antibacterial quality that's are frequently found in natural colours derived from plant sources. These substances are present in mango bark; the dyed textile is showing how well the growth of microorganisms. After the dyeing process the antibacterial activity of the cotton and linen fabrics was evaluated for this study.

### WITHOUT MORDANT

LINEN

#### Sample-1



#### Sample-2

COTTON



### WITH MORDANT

LINEN

#### Sample-3





**Sample-4**

COTTON



**Sample-1**

Organisms Concentration	<i>E.Coli</i>	<i>Strephylococcus aureus</i>
Sample	3.5 mm	2.5 mm
Standard	5 mm	5 mm

**Sample-2**

Organisms Concentration	<i>E.Coli</i>	<i>Strephylococcus aureus</i>
Sample	3.0 mm	2 mm
Standard	5 mm	5 mm

**Sample-3**

Organisms Concentration	<i>E.Coli</i>	<i>Strephylococcus aureus</i>
Sample	3.0 mm	2.5 mm
Standard	5 mm	5 mm

**Sample-4**

Organisms Concentration	<i>E.Coli</i>	<i>Strephylococcus aureus</i>
Sample	2 mm	4 mm
Standard	4 mm	4 mm



## RESULT AND DISCUSSION

Mango bark extract was successfully used as a natural dye for both cotton and linen fabrics, with and without an alum mordant. The dyed samples were evaluated for shade development and antimicrobial activity. The results showed that mango bark produced a natural, earthy brown shade on both fabrics. However, cotton samples treated with alum mordant exhibited deeper and more uniform coloration compared to un-mordanted cotton, indicating improved dye fixation. Linen, with its finer and less coarse fibers, also absorbed the dye effectively when mordanted, though the colour intensity was slightly lighter than that of cotton.

Mordanting clearly enhanced dye uptake and improved overall color strength, especially in samples that would otherwise show lighter shades without treatment.

Antimicrobial activity was assessed using the agar disc diffusion method against *Escherichia coli* and *Staphylococcus aureus*. The dyed fabric samples demonstrated moderate antibacterial properties. Sample 1 showed inhibition zones of 3.5 mm against *E. coli* and 2.5 mm against *S. aureus*, while Sample 4 exhibited the highest inhibition (4.0 mm), particularly against *S. aureus*. Although these values were slightly lower than the standard range (4–5 mm), the results still indicate appreciable antimicrobial activity.

This antibacterial effect may be attributed to the presence of tannins and phenolic compounds in mango bark, which are known to inhibit bacterial growth. Overall, the study confirms that mango bark is an effective natural dye and, when combined with mordanting, enhances both color quality and functional properties, making it suitable for eco-friendly textile applications.

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