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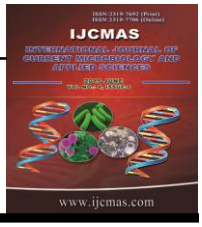


**Original Research Article**

# The antimicrobial activity of pretreated silk fabrics dyed with natural dye

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**Keywords**

Silk fabrics, *Moreinga olefera*, Dyeing, Microwave, Natural Dyes. Antimicrobial activity

**A B S T R A C T**

The antimicrobial activity of silk fabric pretreated with *Moreinga olefera* and dyed with natural coloring matter extracted from madder using microwave heating methods. Environmentally friendly pretreatment with *Moreinga olefera* were used instead of using mordant for enhancing the dyeability of Silk fabrics. Factors affecting the dyeing properties such as dye concentration and time of dyeing with microwave were studied. Color strength (K/S) was measured for dyed Silk fabric, the results indicate that Silk fabric pretreated with moreinga leads to high dye uptake than the untreated fabric. The antimicrobial activity with some kinds of Bacteria and Fungi were tested, and the results indicated that the samples pretreated exhibit higher inhibition percent than the untreated samples. Other additional features about microwaves heating are that they are cheaper, more economical (saving time and energy), eco-friendly, as compared to conventional techniques**.**

## Introduction

Natural dyes were used instead of synthetic dyes due to environmental conditions. Natural dyes are very important for textiles as well as to replace synthetic dyes, because of non-polluting, non-carcinogenic and eco-friendly. As synthetic dyes are causing water pollution and waste disposal problems, so they are broadly disparaged in the world. Natural dyes are environmental friendly, biodegradable and non-toxic. They are attracting the awareness of people (Bechtold, et al., 2006, Teli, et al., 2000).

It is known that textile materials and clothing are susceptible to microbial attack because they provide the basic requirements for microbial growth (Ali et al,, 2011). Natural fibres which are made of cellulose and protein, provide moisture, oxygen, nutrients and temperature for bacterial growth and multiplication. This often results in objectionable odour dermal infection, product deterioration allergic responses and often related diseases (Cardamone 2002).

Recently, many articles on natural dyes in textile coloration have been published. Dyes and pigments derived from natural sources such plants (leaves, stems, fruits, seeds, flower heads, bark, root, etc) animal (Lac, Cochineal and kermes) and mineral (prussion blue, red ochre and ultramarine

blue) for coloring materials have been used for centuries (Anasari, et al., 2000, Bechtold, et al., 2006).

**A** new area has developed in the realm of textile finishing with the advent of improved human life. The control of microorganisms, e.g., bacteria, mildews molds, yeasts and viruses on textile fabrics extends into diverse areas as hospital, environment and every day household. Neither natural nor synthetic fibres have resistance to microorganisms. Thus, various antimicrobial finishes and disinfection techniques have been developed for all types of textiles (Bechtold et al., 2003).

The consumers are aware of hygienic life style and there is a necessity of textile product with antimicrobial properties. Several antimicrobial agents as quarternay ammonium compounds and recently nano silver are available for textile finishing (Hebeish et al., 2011, Hebeish et al., 2014). The use of natural products such as chitosan (Shin, et al., 2010) and natural dyes (Singh et al., 2005) for antimicrobial finishing of textiles has been widely reported.

In order to obtain the greatest benefit, an ideal antimicrobial treatment of textile should satisfy a number of requirements (Williams, et al., 2005) of these treatments. The antimicrobial agent should be effective against broad spectrum of bacterial and fungal species but at the same time exhibits low toxicity to consumers, e.g., not cause toxicity, allergy or irritation to the user. Chitosan comes into focus and is advocated as an ideal antimicrobial agent (Hebeish et al., 2012).

*Moreinga olefera* contributes products of excellent nutritional quality mainly due to the wide variety of it, to its exceptional medicinal properties and to its use in human feeding. It is also used as flocculant in water treatment. In addition, it is utilized to produce biodiesel, ethanol, oil and gums; as well as in the control of vectors and infections caused by microorganisms and as biopesticide. Roots, flowers, bark, stem, leaves and seeds of *Moreinga olefera* possess antimicrobial properties (El-Mohamedy and Aboelfotouh, 2014 a,b)

In Egypt, the sowing and establishment of *Moreinga olefera* has increased remarkably, according to the scientific strategy followed at international level with such plant.

The aim of the present work is to study the effect of the pretreatment of silk fabric with natural product as *Moreinga olefera* on dyeing and antimicrobial activity. Silk fabric was dyed with madder dye using microwave heating method.

## Experimental

### Materials

### Silk Fabric

Silk fabric (53 g/m²), supplied by Akhmim Upper, Egypt, was treated with a solution containing 2 g/l anionic detergent and 2g/l sodium carbonate at 45ºC for 30 min, thoroughly washed and then air dried at room temperature.

### *Moreinga olefera*

*Moreinga olefera oleifera* Lamarck (*Moreinga olefera* ) family *Moreinga olefera* ceae constitutes one of the multipurpose trees most demanded by the world population in recent years (figure 1).

### Dyestuff

**Madder dye:** It is a natural coloring matter. Coloring substance used was extracted from Madder(figure 2).

## Methods

### Extraction of natural coloring matter

Madder were crushed to the powder form, and then the coloring matter was extracted using (10 g of the powder in 100 ml water) at the boiling for one hour. At the end, the solution was filtered off and left to cool down.

### Preparation of coagulant

The husk covering the *Moreinga oleifera* seeds were manually removed, good quality seeds were selected, and the kernel was ground to a fine powder using an ordinary electric blender. The active component from coagulant was extracted using sodium chloride (NaCl) or potassium chloride (KCl) salt solution. A concentration of 4% (4 g of powder in 100ml salt solution) was used throughout the study after several trials. The whole mixture was stirred for 30 min at room temperature using a magnetic stirrer. The suspension was filtered using whatman filter paper. The resultant filtrate solution was used as a coagulant.

### Pretreatment with *Moreinga olefera*

Silk fabric was immersed in the freshly prepared *Moreinga oleifera* coagulant solution and then subjected to microwave for 3 min at a liquor ratio 50:1. Then washed in distilled water and finally dried at ambient conditions.

### Dyeing

### Microwave Equipment

The microwave equipment used in this experiment was the Samsung M 245 with an n output of 1,550 watts operating at 2450 MHz.

### Dyeing Procedure

In a dye bath containing different concentrations (0.2- 1 g/l) of madder dye with a liquor ratio 1:100, the silk fabric was dyed by microwave heating at pH (5) for different time periods(1-5 minutes).The dyed samples were rinsed by warm water and then cold water, washed in a bath containing 5g/l non-ionic detergent at 50ºC for 30 minutes, then rinsed and dried in air at room temperature.

### Measurements

### Color strength (K/S value)

An Ultra Scan PRO spectrophotometer was used to measure the reflectance of the samples and hence, the K/S was measured spectrophotometrically at wave length 500 nm. The K/S of untreated and pretreated silk fabrics with *Moreinga olefera* was evaluated.

### Fastness properties

The dyed samples were washed-off using 2 g/l nonionic detergent at 80°C for 30 minutes, and tested according to ISO standard methods. The specific tests were ISO 105-X12 (1987), ISO 105-C02 (1989), ISO 105-E04 (1989), and ISO 105-B02 (1989), corresponding to colour fastness to rubbing, washing, perspiration and light, respectively. The color changes of the samples were assessed against an accurate Gray scale.

### Antimicrobial activity

Antimicrobial activity of silk fabric pretreated with *Moreing olefera* seed extract was tested according to Rajni *et al*.,(2005) as follow: PDA potatoes dextrose agar (20.0 g dextrose, 200 g potatoes, 20.0 g agar ) and Nutrient agar medium (g/L: peptone 5.09

beef extract 1.5; yeast extract 1.5; NaCl 5.0, agar 20.0; pH 7.5) were prepared and autoclaved at 121°C for 20 min. sterilized Petri plates were supplemented with an equal thickness of PDA or nutrient agar medium. *Escherichia coli and Staphylococcus aureus* bacteria cultures grown over night at 32°C, 120 rpm in 10 ml nutrient broth, this broth was used for seeding the nutrient agar plates. Dices (05 mm in diam.) of *Aspergillus niger* isolate No. 3 taken from culture 7-day –old were seeded in the center of plates supplemented with PDA media. A small discs of silk fabric pretreated with *Moreing olefera* seed extract and dyed with madder placed at four corners of the prepared previous plates. After 72 h of incubation at 32°C, the zones of inhibition of each tested microbe were measured then the reduction % of inhibition were calculated (Avadi et al., 2004).

## Results and Discussion

### Effect of conc. of dye on dyeing by microwave

Figure 3 shows that as the concentration of the dye increase the color strength (K/S) increase. It is also shows that the values of K/S for treated samples are higher than the untreated. These referred to the ability of *Moreinga olefera* to form true covalent bonds with silk fabrics leads to high penetration of the dye within the fabric. The highest K/S was obtained at 1 g/L dye concentration. Silk fabrics treated with moreinga olefera and dyed with madder natural dye display high penetration of the dye because the hydroxyl groups of moreinga olefera seed extract afford dyeing sites for the dye.

Dyes are substantive or adjective. Substantive dyes are absorbed and fixed by chemical bonds within the fibers without further chemical treatment. However, most natural dyes are adjective dyes and need the use of mordents to help their absorption and fixing on fibers. Metal salts act as chemical bonds between the dye molecules and the functional groups of the fibers, and generally change the color produced by the dye. The pretreatment of silk fabric with *Moreinga olefera* can bind to the fabric. It may make chemical links either to the terminal -NH2 or -COOH groups of the polypeptide chain or to the functional groups present in the side chains of the component amino acids.

### Effect of time of dyeing by microwave

Dyeing of silk fabric was carried out by microwave at period of time (1-5 min).

Figure 4 shows that the highest value of K/S obtained at 3 min. This refers to using microwave indicate saving time.

**Table.1** Fastness properties for untreated and pretreated silk fabric with moreinga olefera seed extract dyed with madder dye

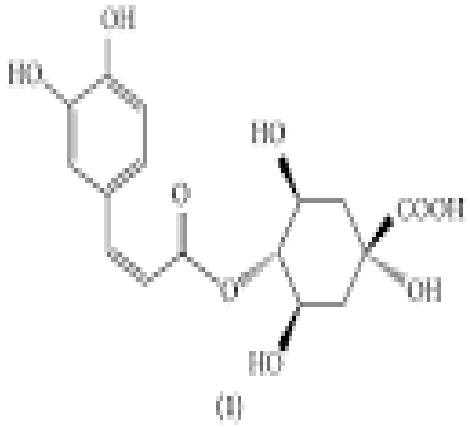
| Dyed silk fabric | Washing | | | Rubbing | | Perspiration | | | | | | Light fastness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | A | | | b | | | |
| | A | C | W | Rd | RW | A | C | W | A | C | W | |
| Untreated | 3 | 2-3 | 3 | 3 | 3 | 2-3 | 3 | 3 | 3 | 3 | 3 | 6 |
| Pretreated | 4 | 4 | 5 | 4 | 4 | 5 | 4 | 4 | 4 | 4-5 | 5 | 7-8 |

A = change in color, C = staining on cotton, W = staining on wool, Rd = dry rubbing, Rw = wet rubbing, a = acidic, b = alkaline

**Table.2** Antimicrobial activity of untreated and pretreated dyed silk fabric with madder dye at different concentrations of *Moreinga olefera* seed extract

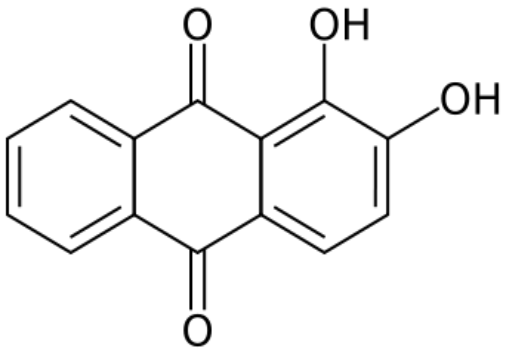
| Microbes | % Growth reduction of the tested microbes | | | | | |
|---|---|---|---|---|---|---|
| | Concentrations of moreinga olefera seed extract | | | | | |
| | **0** | **0.2** | **0.4** | **0.6** | **0.8** | **1** |
| ***Escherichia coli*** | **14** | **16** | **35** | **45** | **65** | **94** |
| ***Stophyloccus aureus*** | **12** | **14** | **30** | **39** | **50** | **90** |
| ***Aspergillus niger 1*** | **7** | **10** | **25** | **30** | **40.0** | **80** |
| ***Aspergillus niger 2*** | **5** | **7** | **20** | **25** | **35** | **70** |
| ***Aspergillus niger 3*** | **6** | **8** | **23** | **30** | **40.0** | **84** |

**Figure.1** Chemical structure of the active component of seed extract from *Moreinga olefera* Olefera plant




**Chemical structure of seed extract of *Moreinga olefera* Olefera** ***Moreinga olefera* Olefera plant**

**Figure.2** Chemical structure of Madder dye




Chemical structure of Madder dye Madder dye

**Fig.3** Effect of conc. of dye on dyeing by microwave

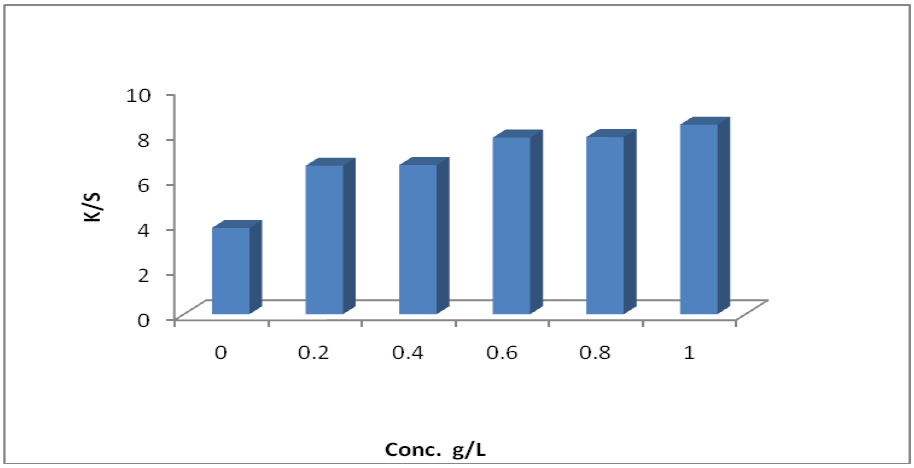
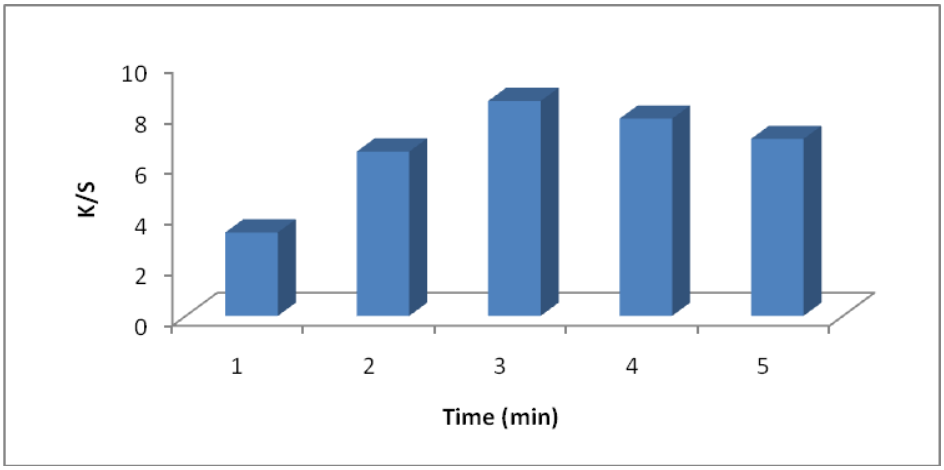



**Fig.4** Effect of time of dyeing by microwave




## The fastness properties

The fastness properties of the investigated dye on silk fabric are given (Table 1). The dye revealed higher results of fastness properties for the treated samples than the untreated. The high ratings of fastness properties could be referred to the covalent binding linkages between the dye and the fiber.

## Antimicrobial activity

Antimicrobial activity of silk fabric pretreated with *Moreinga olefera* seed extract and dyed with madder dye was evaluated and the results in Table (2). Results show that all concentration of *Moreinga olefera* seed extracts enhances the antimicrobial properties of silk fabric against all tested microbes. Antimicrobial activity of silk fabric is tested in accordance to diffusion agents, test organisms such as *Escherichia coli*, *Staphylococcus aureus* and *Aspergillus niger* 1, 2,3 were used and the results indicate that the samples pretreated with *Moreinga olefera* seed extract exhibit higher inhibition percent than the untreated samples. Table (2) shows that the antimicrobial properties against E. coli (G-) was found to be greater than that of

*Staphylococcus aureus* (G +) which can be attributed to the differences in the structure between the two types of bacteria. The antimicrobial properties of the treated samples can be attributed to treatment by *Moreinga olefera*. The ability of this matter to form true covalent bonds with silk fabrics leads to the improvements of the antimicrobial properties. Antimicrobial activity, expressed as growth reduction of the microorganisms, could be explained as follows: The hydroxyl groups in *Moreinga olefera* interfere with the bacterial metabolism by stacking at the cell surface and binding with DNA to inhibit m-RNA synthesis (Purwar, et al., 2004). The increasing of concentration of *Moreinga olefera* shows more tendencies to deposit on the surface of the fabrics, resulting in hydroxyl groups more easily accessible to microorganisms (Hebeish et al., 2012). Silk fabrics treated with *Moreinga olefera* and dyed with the madder natural dye display high growth reduction of microbes.

In conclusion, environmentally friendly pretreatment of silk fabrics with *Moreinga olefera* seed extract instead of using mordant improved the color strength and the fastness properties. Factors such as dye concentration and dyeing time using microwave indicate probable saving time and energy. Other additional features about microwaves are that they are cheaper, more economical, eco-friendly, and produce a high dye uptake. Silk fabrics pretreated with *Moreinga olefera* seed extract and dyed with madder natural dye display high growth reduction of microbes (bacteria and fungi) compared to untreated.

This research proves the feasibility of high quality pretreatment and dyeing with natural dye extracted from madder, thus creating new opportunities for both the environment and the fabric industry to catch up with the current consumer trends towards more aesthetic fabrics with natural products.

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