Dyeing of polyester fabric with natural colorants extracted from mahogany (Swietenia mahagoni) seed pods

Md. Abdullah Al Mamun
Department of Chemistry
Jahangirnagar University
Savar, Dhaka-1342
mamun416174@gmail.com

Mubarak Ahmad Khan
Bangladesh Jute Mills Corporation, Dhaka
makhan.inst@gmail.com

Mohammad Mamun Hossain
Department of Chemistry
Jahangirnagar University
Savar, Dhaka-1342
chemmamun2@yahoo.com

Abstract
The natural colorants were extracted from mahogany seed pods using the acid boiling method. For that, 50g mahogany seed pods powder and 1cc hydrochloric acid were boiled in 1000cc water for 60 minutes. The filtered solution was then used as the dye solution to dye 100% polyester bleached fabric. 10g fabric was dyed in 200cc extracted solution at 130°C for 60 minutes. The dyed fabric was then neutralized with 2g/l soda ash at 50°C for 10 minutes. The unfixed dyes were removed by washing with 2g/l ISO reference detergent at 95°C for 15 minutes. The dyeing traits of the dyed materials were judged in terms of their color strength and fastness properties. All testes were carried out following the ISO standards. From the results, it is lucid that the dyed fabric showed acceptable colorfastness properties in case of all fastness except color fastness to light. It is observed that dyeing time had profound influence on the color strength (k/s value) of the dyed material. The k/s value increases with the increase of dyeing period up to 120 minutes. The maximum color strength (0.76) was noted for the fabric. The shorter dyeing period produces brighter sample and the longer dyeing period produced colorful samples.

Keywords— Natural colorants, polyester fabric, chromaticity, color strength, color fastness

1. INTRODUCTION
The milieu is a natural gift and well-thought-out as the key aimed at existence for life on the earth [1]. But there is severe climate change for global warming, extreme pollution [2, 3] from many sources, industrial development etc. which destroy the ecosystems and the extinction of wildlife too [4]. The environment and its conservation have been of worldwide concern since the dawn of humanity’s modern evolution. The global changes and human factors are surely altering the course of the earth’s long-term sustainability including stream as well [5, 6]. Recently, environmental apprehensions about environment friendly natural dyes are increasing than the synthetic ones [7, 8, 9]. Traditionally, synthetic dyes have a wide range of hazardous effects: toxic or fatal, corrosive (destructive to living tissues), irritant (induces local inflammatory reaction in living tissues), contamination (representing a potential source of the spread of diseases to humans, domestic animals and wild life), radioactive and so on [10, 11]. But the natural dyes are non-carcinogenic, produce soothing and fashionable colors to the textiles, have better biodegradability and higher compatibility with the environment [12, 13, 14]. But the uses of natural dyes declined to a great extent with the advent of synthetic ones in 1865, which have moderate to excellent color fastness properties. During the era of 1990s, the textile and apparel industries, predominantly the coloration industry, have been widely disapproved for their environmental pollution. So, the uses of carcinogenic dyes have been restricted while the uses of natural dyes have been amplified [15]. The uses of synthetic dyestuffs during their application in the dyeing and printing industries have been criticized due to the introduction of pollutants in the environment. This has led to the desire
to turn to the more natural way of life (i.e. biological/organic farming, natural food etc.). In line with this trend, now there is an ever-increasing lobby to use natural colorants for both natural and synthetic textiles [16]. The contemporary textile processing industries are getting more and more inquiries regarding “Dyeing with Natural Dyes” and, thus, the subject of natural colors has been assumed a great consequence [17]. The plant kingdom has a vast source of natural dyes or colorants that can be extracted from many parts of plant such as leaves, fruits, wood, heartwood, roots, flowers, seeds and barks. Bangladesh has an abundance of plant species with dye yielding properties. The rural people extract dyes from leaves, fruits, wood, heartwood, roots, flowers, seeds and barks of some plant species generally by boiling, scraping, powdering and mixing with other materials to get the desired color. There is huge number of mahogany trees in Bangladesh which grow plenty of seed every year. These seeds some medicinal uses but their seed pods have no food or industrial uses in the growing areas and is, therefore, tons of tons seed pods are simply wasted. Oppositely, the scientific uses of these seed pods in fabric dyeing purposes may be an effective way to reduce the problem of such waste disposal and at the same time economic utilization in dyeing industries. But such study is lacking. So, the present experiment under report will be taken to explore its possibilities in textile coloration industries.

2. EXPERIMENTAL:
   A. Fabric:
The fabric used includes commercially scoured-bleached 100% polyester woven fabric with the specification 110 gsm, Plain woven, EPI=136, PPI=74, Warp count=75 Denier, Weft count=150 Denier, Fabric width= 56 inches.

   B. Dyes and Chemicals:
Mahogany seed pods were used as the natural colorants and were collected from Mawlana Bhashani Science and Technology University campus, Santosh, Tangail-1902. Laboratory grade hydrochloric acid was used for extraction of colorants. ISO standard soap without optical brightener was used to remove the unfixed dye from the dyed samples.

   C. Process Curve for extraction of colorants:

Fig. 1: Flow chart for the natural colorants extraction
Fig. 2: Line graph showing the process curve for the polyester dyeing dyeing with the natural colorants.

Fig. 3: Line graph showing the process curve for neutralization and soaping.

3. RESULTS AND DISCUSSION:

A. Color fastness properties of the dyed material.

| Color fastness to     | Color-change ratting (Grey scale/blue wool) |
|-----------------------|---------------------------------------------|
| Wash                  | 3-4                                         |
| Alkaline perspiration | 4                                           |
| Acidic perspiration   | 3-4                                         |
| Dry rubbing           | 4                                           |
| Wet rubbing           | 4                                           |
| Light                 | 2-3                                         |

Table 1: Color fastness properties of dyed fabric

The dyed fabric showed excellent resistance to color straining on multi fibre fabric ratting 4-5 in all cases. The color fastness to dry rubbing, wet rubbing and alkaline perspiration of the dyed fabric are good ratting 4 on the grey scale. On the contrary color fastness to wash and acidic perspiration are moderate ratting 3-4. The dyed material showed poor color fastness to light ratting 2-3 on blue wool.

B. Effect of dyeing time on the color strength (k/s value):
Fig. 4: Bar diagram showing the effect of dyeing period on the color strength of dyed fabric. It is observed that dyeing time had profound influence on the color strength (k/s value) of the dyed material. The k/s value increases with the increase of dyeing period upto 120 minutes. The maximum color strength (0.76) was noted for the fabric.

C. *Effect of dyeing period on brightness of the dyed fabric.*

Fig. 5: Bar diagram showing the effect of dyeing period on the brightness of dyed fabric. It is noticed that dyeing time had profound influence on the brightness of the dyed material. The brightness followed a decreasing trend in most of the cases. The maximum brightness (84.056) was noted for the fabric dyed for 15 minutes.

D. *Effect of dyeing period on chromaticity of the dyed material*

Fig. 6: Bar diagram showing the effect of dyeing period on chromaticity. It is noticed that dyeing time had remarkable influence on the chromaticity of the dyed material. The chromaticity followed a decreasing trend in most of the cases. The maximum chromatic value (12.212) was noted for the fabric dyed for 135 minutes.

4. **CONCLUSION:**
Dyeing of polyester fabric with natural dyes extracted from mahogany seed pods is a new approach in textile coloration. The fastness properties of the dyed material are good enough except color fastness to light. In future, studies of some chemical treatments may be carried out for the enhancement of the light fastness properties.

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