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Research Article

Influence of Natural Mordants in Coloration of Cotton Knitted Fabric with Mango Seed Kernel Extract Dyes

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Abstract

The sustainability of the environment is hampered day by day. People are more concern about environment and health including different types of goods e.g. textile goods. As a result, the researchers are interested to study environment friendly dyeing as natural dyeing. In this research bleached single jersey cotton knitted fabric (sample size: 7 inch × 7 inch) having areal density of 148 grams per square meter has been treated with some natural extract like pomagranate peel seeds, pomagranate peel bark, leaf of Thujaorientalis and leaf of Araucaria exelsa as mordanting agents. The treated samples have been dyed with natural dyes extracted from mango seed kernel (Mangiferaindica L.) and the dyeing performance was evaluated by several elementary parameters such as color strength (K/S value),color fastness to rubbing, color fastness to wash, color fastness to perspiration (acid & alkali). Mordanting was done at 95^{0}c temperature for 60 mins in exhaust method using lab sample dyeing machine. The dyeing was carried out at 100^{0}c temperature for 60 mins at same machine. The results illustrated that color strength (k/s value) increases in all cases. Pomagranate peel bark treated sample shows maximum (3.52) color strength (k/s value). Different natural mordants influenced the fastness properties of the dyed samples in different way. Araucaria exelsa treated fabric exhibited higher washing resistance in comparisons to other mordants.

Keywords: *Natural Mordants, Coloration, Mango seed, Dyeing properties*

1. Introduction

The use of natural dyes declined to a great extent with the advent of synthetic dyes which have moderate-to-excellent color fastness properties in 1865. During the decade of the 1990s, the textile and apparel industries, particularly the coloration industry, have been widely criticized for their role in polluting the environment. (K. Farizadeh *et al,* 2009) told that the use of carcinogenic dyes has been restricted and the use of natural dyes has increased. The use of synthetic dyestuffs during their application in the dyeing and printing industries has been criticized due to introduction of contaminants into the environment. The contemporary textile processing industry is getting more and more inquiries regarding "Dyeing with Natural Dyes" and therefore the subject of natural colors has assumed a great significance which was showed by (Yu-chan Chao *et al,* 2017). The mango is a very common and important tropical fruit which has been used as raw and ripened having excellent eating properties and nutrition composition. (Shilpa Yatnatti *et. al, 2014)* studied that processing of ripe mango fruit, generates its peel and seed as waste, which is approximately 40-50 % of the total fruit weight. Present study is undertaken to extract dyes from mango seed kernel and apply this dyes on cotton knitted fabric.

Natural dyes have many more technical advantages, though it has some limitations. (Hana Křížová, 2015) studied that natural dyes have a significantly lower affinity to fibres, which causes the lower dye-exhaustion from bath on fibres. The dose of dyes must be at least one order of one magnitude higher and the majority of natural dyes remain in bath after dyeing, especially when trying to obtain dark shades. This problem was tried to solve by mordanting studied by (P. A .G Wanyama *et. al*, 2010) & (Loum Janani *et.al*, 2014). The term mordant comes from the present participle of French "*mordre*", (to bite). Mordants cause the colour to 'bite' the fabric discussed by (H K Prabhu *et. al,* 2012). And the need to use mordants is another serious problem in the dyeing with natural dyes. This necessity arises from the fact that the molecular structure of most natural dyes is not ideal for interaction with fibres. The nature did not create them for this application of course. Tannic acids are considered as good natural mordant. It

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is applicable on different fibres, fabrics such as cotton or linen (vegetable fibers) or wool. Certain plant materials contain high concentrations of tannic acid, or tannin, which works well as a mordant to bond color to plant-based fiber. Tannin as a mordant, especially in combination with alum, can provide a greater color range with more successful results on most vegetable fibers. Certain tannin-bearing plant materials work especially well as mordants, such as horse chestnuts, pine bark, certain roots, some leaves, acorns, oak galls, pomegranate rind, and some fruits. (Sampath vasulingam, 2015) showed that pomegranate is a vital source of natural tannins. The powdered rind, or skin, of the pomegranate (*Punicagranatum*) can be used as a tannin mordant, as well as a dye to obtain peachy yellow with alum mordant, and to get grey to moss green with iron mordant. Pomegranate rind was also used as a color source for painting medieval illuminated manuscripts. The age of the fruit affects the color of the dye: the less ripe the fruit, the greener the yellow.

Figure 1: Pomegranate peel& bark, *Thujaorientalis, Araucaria exelsa*

Thuja orientalis is a genus of coniferous trees in the Cupressaceae (cypress family). There are five species in the genus, two native to North America and three native to eastern Asia. The genus is monophyletic and sister to Thujopsis. Members are commonly known as arborvitae (from Latin for tree of life) thujas or cedars. *Araucaria exelsa* is a genus of evergreen coniferous trees in the family Araucariaceae. *Araucaria* are mainly large trees with a massive erect stem, reaching a height of 5–80 metres (16–262 ft).

In this article work, no inorganic textile dyes were used & even the mordants are also natural. Everything was collected from nature & our surrounded area and the full dyeing process was completed by using these natural items. The whole dyeing process is easier process and also have satisfactory result on color fastness test. The aim of this work is to dye cotton knitted fabric without the use of chemicals with maintaining good physical quality of dyed fabric. The verdicts of this work provide a new space of utilization of large quantities of natural ingredients which are available in the surrounding environment for textile coloring purpose.

2. Material and fabric used

2.1Fabric description

Commercially 100% scoured and bleached single jersey knitted fabric (sample size, 7inch × 7 inch) was used in this experiment having areal density of 148 grams per square meter (GSM)and having geometrical properties: course per inch (CPI) = 47, Wales per inch (WPI) = 37, and yarn count 32^s.

2.2 Natural dyes

Mango seed kernel (*Mangiferaindica L.*) was used as natural dye source. Green mango collected from local market and mango seed kernel was separated from

green mango. Caustic soda was used as an alkali chemical to dyes extraction.

2.3 Natural mordanting agents

Following natural mordanting agents were used:

1) Pomagranate peel seeds: This types of natural mordanting agent was collected from local market of Santosh, Tangail.
2) Pomagranate peel bark: This types of natural mordanting agent was collected from local market of Santosh, Tangail.
3) *Thujaorientalis*: This types of natural mordanting agent was collected from in front of administrative buildings of MBSTU, Santosh, Tangail.
4) *Araucaria exelsa:* This types of natural mordanting agent was collected from in front of Medical Centre of MBSTU, Santosh, Tangail.

2.4 Soaping agent

ISO Standard Soap without optical brightener was used for removing the unfixed dye from dyed sample.

3. Methods

3.1 Mordanting process

Samples were treated with different natural sources leaf and bark powder as a mordanting agent in this experiment according to following curve.

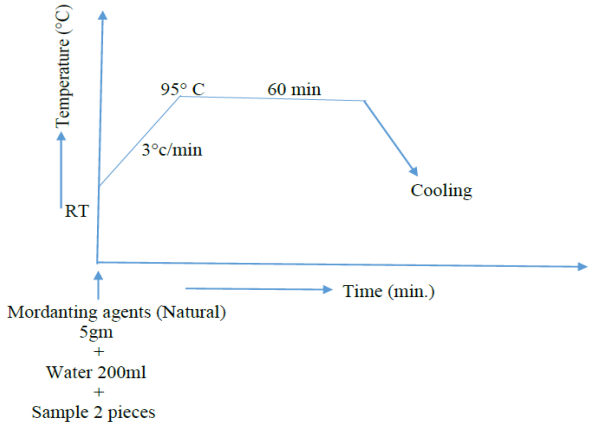

Figure 2: Process curve for mordanting with natural mordants

3.2 Dye extraction

Firstly, the green mango was collected from the local market. Secondly, mango seed kernel was separated from green mango by using knife. Thirdly, the raw seed kernel weighted in an electric balance. 4gm of Caustic soda (NaOH) pellets was dissolved into 800ml water and then added 50g raw mango seed kernel. Fourthly, boiled it at 95°c about 60 minutes and then cooled. Fifthly, it was filtered by a nylon strainer and the solution used as dye solution for preparing dyeing bath.

3.3 Dyeing process

The mordanted samples were dyed with natural dye solution of mango seed kernel in IR dyer lab sample dyeing machine (XIAMEN RAPID, CHINA) by exhaust method. Samples were dyed with material to dye solution ratio about 1:22 at 100°c for 60 minutes and cooled at 60°- 70°c. After that samples were washed manually at room temperature and dried. The final washing was done at 70°c for 10 minutes for removing unfixed dye from the fabric surface by 2% stock solution of ISO standard detergent without optical brightener. The dyeing and washing process is shown in figure 3.

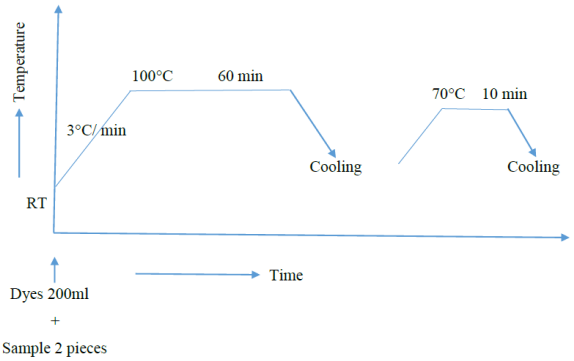

Figure 3: Process curve for dyeing with natural dyes

3.4 Determination of color strength (k/s)

The reflectance (%) value of dyed samples was measured by Data color 600 TM spectrophotometer for the wavelength of 400-700nm with 10nm intervals. The value of color strength (K/S) was measured of the treated samples by using the Kubelka - Munk's equation which are given below:

$$\text{Color strength (K/S)} = \frac{(1-R)\,2}{2R}$$

Here, R is Reflectance and S is the scattering.

3.5 Determination of color fastness properties

Color fastness to rubbing was done according to ISO 105 X 12
Color fastness to wash was done according to ISO 105 C05
Color fastness to perspiration was done according to ISO 105 E04

4. Results and discussions

4.1 Visual appearance of the dyed samples after treating with natural mordants

Figure 4 Illustrates the visual appearance of the shades of dyed cotton knitted fabrics after treated with pomagranate peel seeds, pomagranate peel bark, leaf of *Thujaorientalis* and leaf of *Araucaria exelsa.*

Pomegranate peel seed | Pomegranate peel bark | *Thujaorientalis* leaf | *Araucaria exelsa* leaf

Figure 4: Hues of the Dyed samples treated with various natural mordants

4.2Effect of natural mordants on color strength (k/s value)

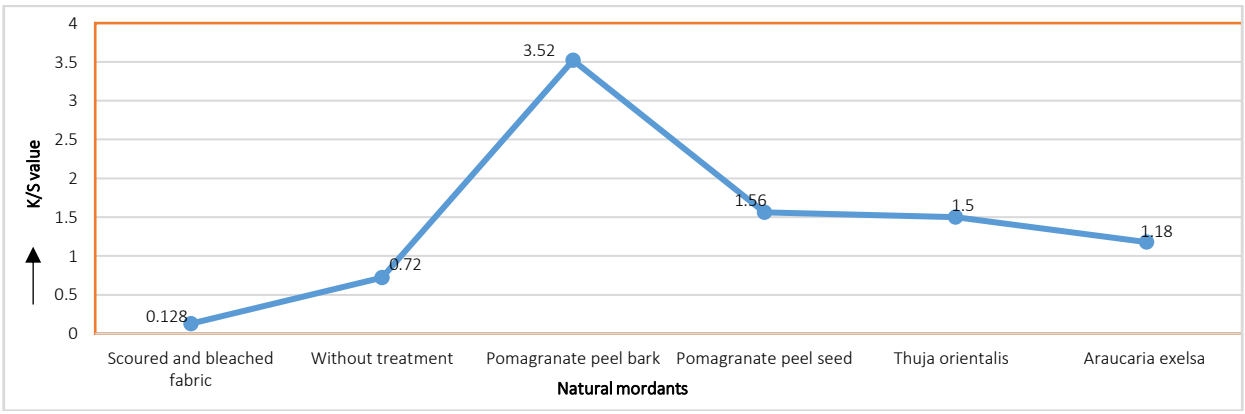

Figure 5: Color strength (k/s value) of natural mordants treated cotton fabric

Figure 5 explains the effect of natural mordants on the color strength (k/s value) on cotton knitted fabric. It is observed that natural mordants treated samples show more color strength (k/s value) than without treated sample that means every natural mordant increases the color strength (k/s value). Among the natural sources pomegranate peel bark treated sample shows maximum (3.52) color strength (k/s value).

4.3Effect of natural mordants on color fastness to rubbing

Table 1 it is observed that the samples show excellent results against color fastness to rubbing both dry and wet.

4.4Effect of natural mordants on color fastness to wash

Table 2 it is observed that in case of change in color samples show very poor results and in case of color staining its show good to excellent results.

Table 1: Color fastness to rubbing of natural mordants treated cotton fabric

Natural sources treated samples	Dry rubbing	Wet rubbing
Pomagranate peel bark	5	5
Pomagranate peel seeds	5	4-5
Thujaorientalis	5	5
Araucaria exelsa	5	5

Table 2: Color fastness to wash of natural mordants treated cotton fabric

Sample type	Change in color	Color staining					
		Diacetate	Cotton	Polyamide	Polyester	Acrylic	Wool
Pomagranate peel bark	1	5	3	5	5	5	5
Pomagranate peel seeds	1	5	4-5	5	5	5	5
Thujaorientalis	1-2	5	4	5	5	5	5
Araucaria exelsa	3	5	4-5	5	5	5	5

4.5Effect of natural mordants on color fastness to perspiration (alkali medium)

Table 3: Color fastness to perspiration (alkaline) of natural mordants treated cotton fabric

Sample type	Change in color	Color staining					
		Diacetate	Cotton	Polyamide	Polyester	Acrylic	Wool
Pomagranate peel bark	3	5	3-4	5	5	5	5
Pomagranate peel seeds	3-4	5	4-5	5	5	5	5
Thujaorientalis	3-4	5	4-5	5	5	5	5
Araucaria exelsa	3-4	5	4-5	5	5	5	5

4.6 Effect of natural mordants on color fastness to perspiration (acidic medium)

Table 4: Color fastness to perspiration (acidic) of natural mordants treated cotton fabric

Sample type	Change in color	Color staining					
		Diacetate	Cotton	Polyamide	Polyester	Acrylic	Wool
Pomagranate peel bark	2-3	5	3	5	5	5	3
Pomagranate peel seeds	3	5	4	5	5	5	4-5
Thujaorientalis	2-3	5	4	5	5	5	3-4
Araucaria exelsa	2-3	5	3-4	5	5	4-5	3

Table 3 and 4 explain the effects of natural mordants on the color fastness to perspiration (alkaline and acidic) on cotton knitted fabric dyed with mango seed kernel dyes. It is observed that color fastness to perspiration in alkali medium of the dyed samples show moderate results in case of color change but in case of color staining it shows excellent results with slight staining on cotton. It is also observed from table 4 that the samples show poor to moderate change in color with moderate staining on cotton and wool in case of color fastness to perspiration in acidic medium. In comparison, the samples show better results in alkali medium than acidic medium.

Conclusion

Different types of natural mordants have significant influence of the properties of cotton fabric dyed with mango seed kernel extracts. They have remarkable impact of color strength of the dyed fabric. Natural mordants can improve color fastness to rubbing and perspiration but the color fastness to wash was not satisfactory. An after treatment can be carried out for improving fastness properties as a part of further research.

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