Chapter

A Practical Guideline of Few Standardized Ready Made Shades of Natural Dyed Textiles

Anowar Hossain

Abstract

Marigold flower *Tagetes erecta* L., Arjuna Bark *Terminalia Arjuna*, Eucalyptus leaves *Eucalyptus Radiata*, Peach/Jam Leaves *Acacia acuminata*, Pecker leaves *Cinnamomum tamala*, Guava leaves *Psidium guajava*, Basil leaves *Ocimum basilicum*, Jackfruit wood *Artocarpus heterophyllus*, Catachu fruit *Senegalia Catechu*, Bohera fruit *Terminalia bellirica*, Betel nut fruit *Areca catechu*, Haritaki fruit *Terminalia chebula*, Mahogany fruit peel, Mahogany seed peel, and Mahogany seed *Swietenia macrophylla* are the common natural sources in Bangladesh, an Asian country which were experimented in terms of mordanting free natural coloration on cotton fabric under conceptual confirmation of referred journal where author has been picked the idea from the generation of available shade in his research laboratory and tested from different laboratories and it may be establish as mordant free natural dyeing for specific colorant on the basis of color fastness and shading behaviors. Fifteen standardized Ready Made Shade (RMS) has been presented with CIE color parameters, color fastness, wash fastness, and light fastness grading. A reproducing guideline for every Ready Made Shade (RMS) has been mentioned in this chapter.

Keywords: readymade shade (RMS), natural dyeing, eco-friendly dyes, natural extraction, mordant free dyeing

1. Introduction

A concept of readymade shade (RMS) has been developed by using numerous number of natural dyes which were collected from agri-production unit and different village sources in Bangladesh prepared and powdered in color processing unit, extracted with water solvent process, dyed and experimented the feasibility of coloration in textile chemistry laboratory to generate different hues of natural dyes after effective implementation on natural fiber based textiles which outcome of color may be beneficial for primary selection of color tone by the textile technologist of natural coloration cum customers for the decision-making of specific color tone both for product development and fashion concerns who are genuinely searching an eco-friendly dyes under the consideration of repeated hue without which the real output of natural coloration, sustainability of dyes and natural dyeing process as well as its actual production of different hue is being a challenged now as the textile technologists are habituated the essence of readymade shading behavior of synthetic dyes whereas toxicity is the main endangered for the human being.

2. Background

Environment pollution is the great challenge of color scientists in dyeing and finishing plant, so eco-friendly coloration is the key target of recent researchers and manufacturers. Natural coloration is being accepted by the environment scientist and related committee [1–3]. Researchers in the area of natural coloration have an immense intension to minimize pollution [4]. Focus on science and engineering on natural dyes based research, extractions, purifications, and implementations are rapidly climbing [5–9]. In this chapter, mordant free natural coloration and its feasibility was experimented to minimize environment pollution load which is not limited to synthetic dyeing but also natural dyeing in terms of mordant free coloration concepts for specific standardized shade. Author also experimented to establish an approach of green mordanting [10, 11] in natural coloration [12–16] although mordant [17] has an effect for the augmentation of fiber surface color and surface chemistry [18] and its appropriate affinity in terms of fastness properties [1, 19–24]. Light fastness [21–24] of natural dyed fabric is a critical issue for natural colorant if dyes sources and collection processes are not maintained accurately. There are many sources of natural colorant, using by the researcher as per availability of origin to origin in the world. Researchers are already invented and proposed like Jatropha flower [25], red sandal wood [26], wood of *Artocarpus heterophyllus* [27], Acalypha [28], areca nut [29], *Butea monosperma* [30], neem leaves [31, 32], Gomphrena globosa [33], Onosmaechiodes [34], *Nerium oleander* flower [35], Kesula flowers [36], Parijataka (Nyctanthes Arbor) flowers pigment [37], Hibiscus ovalifoliusand *Sesbania aegyptiaca* [38], Bark of Macaranga Peltata [39], Cutch, Ratanjot and Madder [40], Mesta Calyx [41], Kapila, Onion, Tesu [42], myrobalan, gallnut, pomegranate [43], Marigold flower [44, 45], *Areca Catechu* [46], Eucalyptus leaves [47], Eucalyptus bark [48, 49], Jackfruit wood [50], Peach [51], Arjuna [52, 53], Catechu [54] and others. Developments of natural indigo shade in comparison with synthetic dyes [55] are not only prime objects for coloration but also maximum natural dyes have medicinal value [56, 57], noncarcinogenic, production-friendly, and environment-friendly. Research and development of natural dyeing on cotton, jute, and silk fabric was done by Samanta and his researchers team at DJFT, University of Calcutta, India have an technical output, research impacts and motivation for future researchers, and manufacturing unit for the contributions of dyes selection, extraction, analysis, standardization, and commercialization [58–68]. Color matching [69] and reproducing of shade is another challenging issue for the manufacturing company and colorists when natural dye is compared with synthetic dyes but there are so many colorants of natural sources that can be possible to reproduce almost nearest shade. Tolerating percentage/acceptable range of color differences, ΔE value, and other properties can be standardized in a convincing way with local and foreign customer of any country as the real customer of any textile product is not going to sell the product after shade matching with spectrophotometer without enjoying its esthetic value, so a little bit lightness and darkness matter is not a trading challenge of dyer and manufacturing plant. Comparing to synthetic dyes, natural dyed fabric has a great market demand as the people who are concern about the intimidation of environment. Thus natural dyes have diverse applications and multi fiber based production options that are already available in literature for cotton [68], jute [66], wool [70], silk [34] based dyeing, processing in both laboratory stage and bulk production (**Figures 1–15**).

RMS of Marigold (Figure 1): Waste Marigold flowers were collected from flower garden, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

3. Standardized Ready Made Shade (RMS) of natural dyed textiles

3.1 Natural coloration of cotton fabric with Marigold flower, types of dyes: natural, source of dyes: Marigold tree. scientific name: *Tagetes erecta*

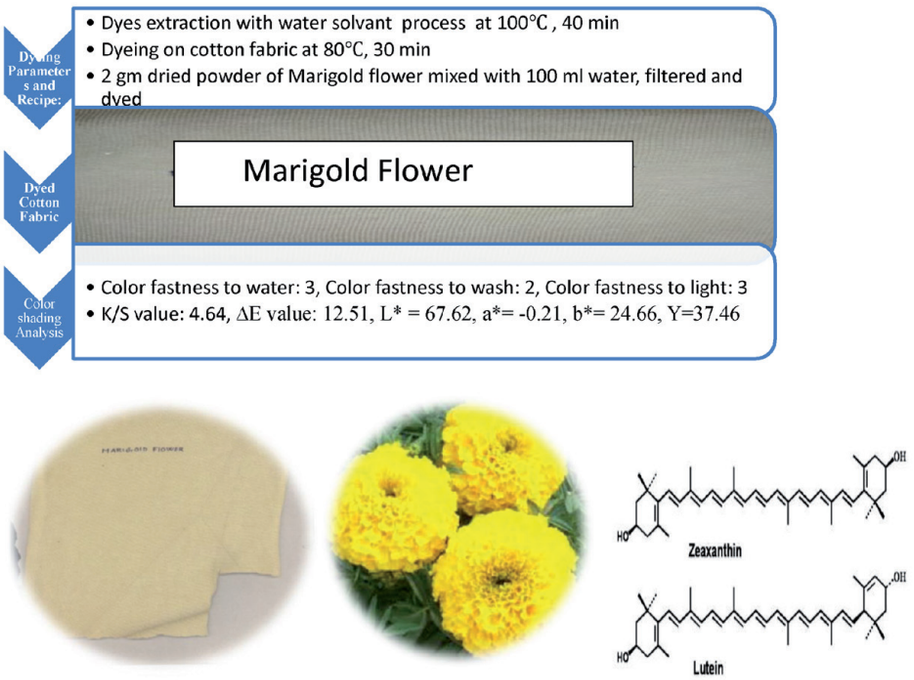


Figure 1.
RMS of Marigold.

3.2 Natural coloration of cotton fabric with Arjuna Bark, types of dyes: natural, source of dyes: Arjuna tree, Scientific name: *Terminalia arjuna*

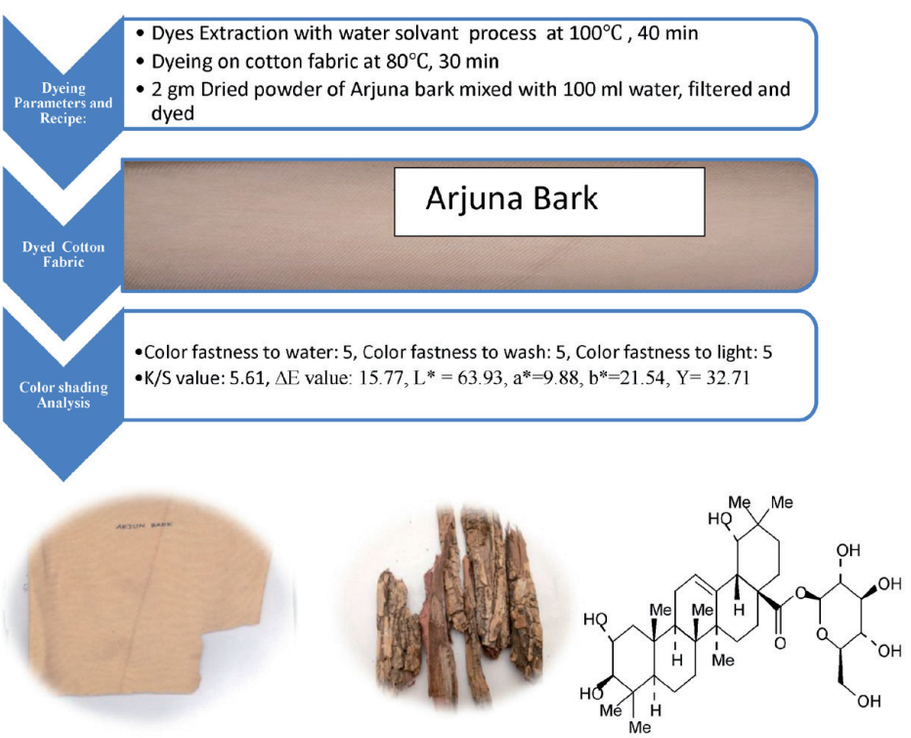


Figure 2.
RMS of Arjuna Bark.

3.3 Natural coloration of cotton fabric with Eucalyptus leaves, types of dyes: natural, source of dyes: scientific name: *Eucalyptus radiata*

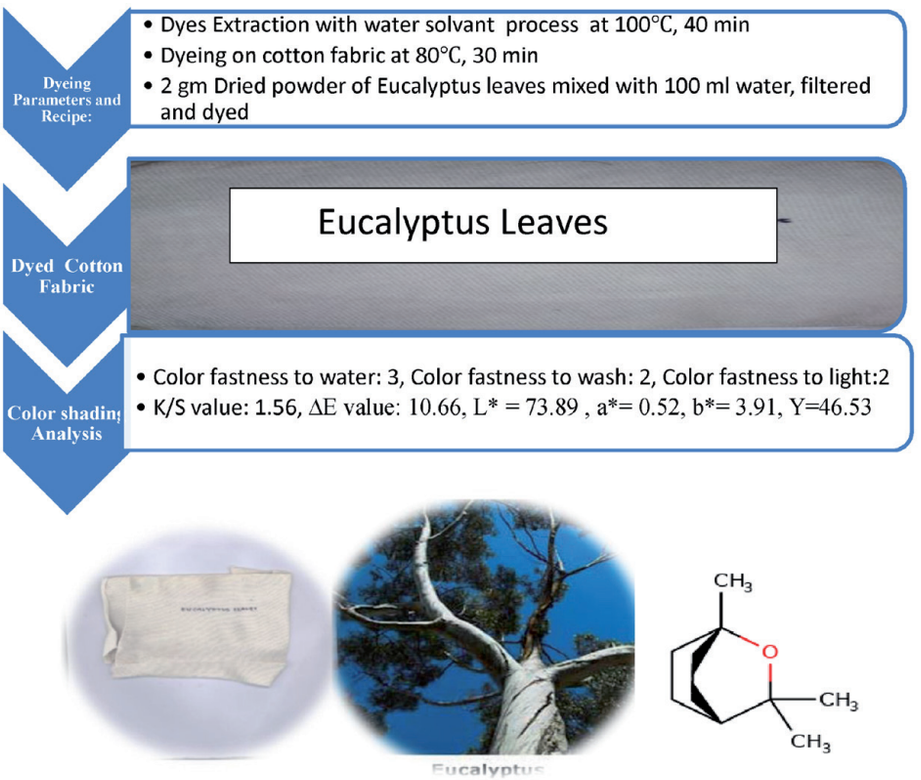


Figure 3.
RMS of Eucalyptus leaves.

Coloring components Zeaxanthin and Lutein structural group of marigold flower may be responsible for good color combination has OH group may be showed good color fastness properties with cellulosic fiber. Lutein ($C_{40}H_{56}O_2$) and Zeaxanthin ($C_{40}H_{56}O_2$) molecules may prevent UV damage for its strong antioxidant properties.

RMS of Arjuna Bark (Figure 2): Dried Arjuna bark were plucked from Arjuna tree, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

Ferrous ion of Arjuna Bark may be influencing the L*, a*, b*, Y value for providing outcome of deeper color and OH group is responsible for good fastness properties. Arjuna bark has phytosterol, lactones, flavonoids, phenolic compounds, and tannins, glycosides where tannin may be responsible for coloring agent.

RMS of Eucalyptus Leaves (Figure 3): Semi-dried leaves were plucked from Eucalyptus tree, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group of cellulose can easily make a bonding with dyes group of Eucalyptus. Eucalyptol is a colorless compound which is responsible for antibacterial properties but may be remaining pigment or other phytochemical compound is making color on the fabric surface.

3.4 Natural coloration of cotton fabric with Pecker leaves, types of dyes: natural, source of dyes: Pecker tree, scientific name: *Cinnamomum tamala*

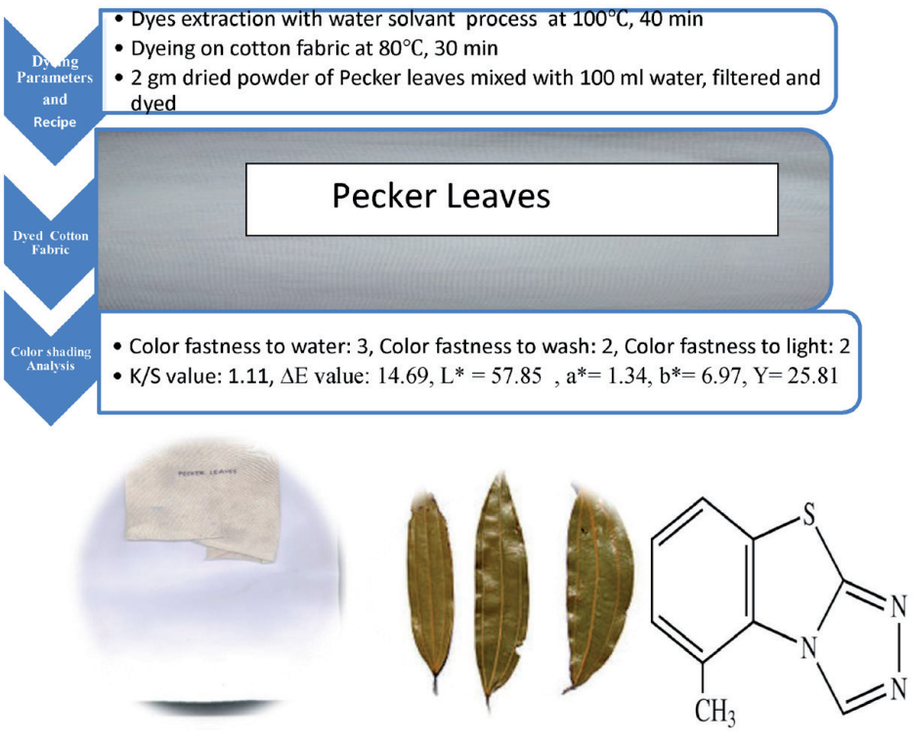


Figure 4.
RMS of Pecker leaves.

RMS of Pecker Leaves (Figure 4): Semi-dried leaves were plucked from pecker tree, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group of cellulose can easily make a bonding with dyes group of Pecker leaves. Eugenol is the main constituent of antimicrobial properties and other components like pinene, camphene, and limousine may be responsible for color formation.

RMS of Guava Leaves (Figure 5): Semi-dried leaves were plucked from tree, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group of dyes is responsible for good color fastness properties. Mixed components of flavonoid and tannin are highly responsible for bluish color of cotton fabric. Acidic pH and phenolic compound of guava leaves may generate flammable characteristics of guava leaves colored fabric.

RMS of Basil Leaves (Figure 6): Fresh and green Basil leaves were plucked from tree, washed and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

α terpineol remaining in dyes of Basil leaves may be responsible for dyeing of cotton fiber and OH group is making strong affinity with cellulose. Phytochemical constituents and medicinal properties of Tulsi leaves may create pathogen protective finish of cotton fabric like antimicrobial, COVID 19, and other viruses.

3.5 Natural coloration of cotton fabric with Guava leaves, types of dyes: natural, source of dyes: Guava tree, scientific name: *Psidium guajava*

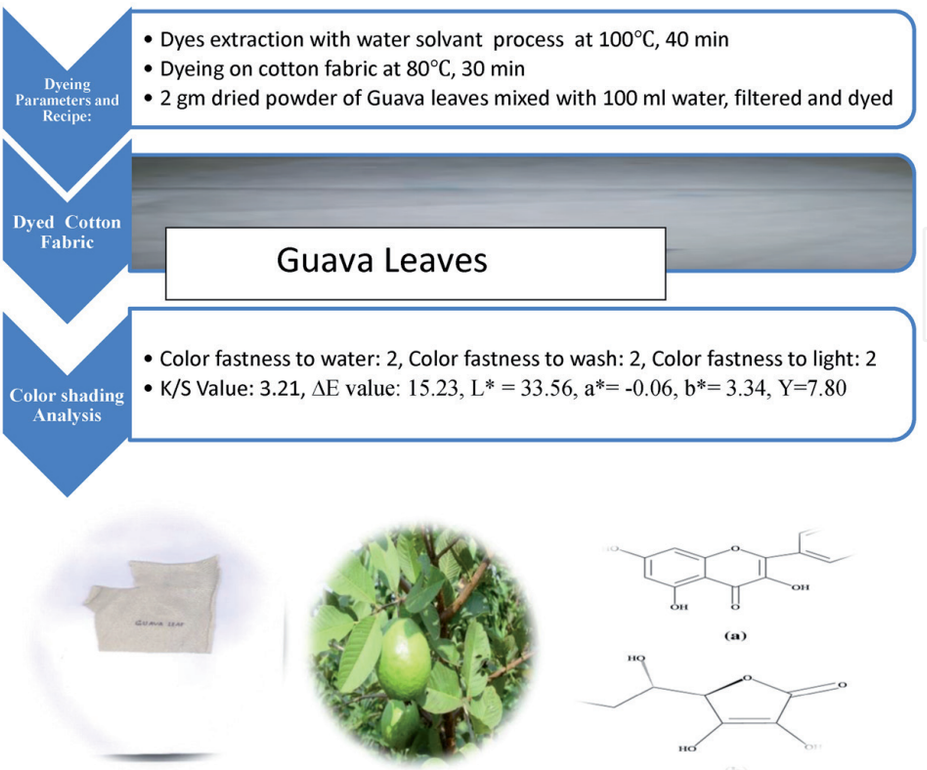


Figure 5.
RMS of Guava leaves.

3.6 Natural coloration of cotton fabric with Basil leaves, types of dyes: natural, source of dyes: Basil tree, scientific name: *Ocimum basificum*

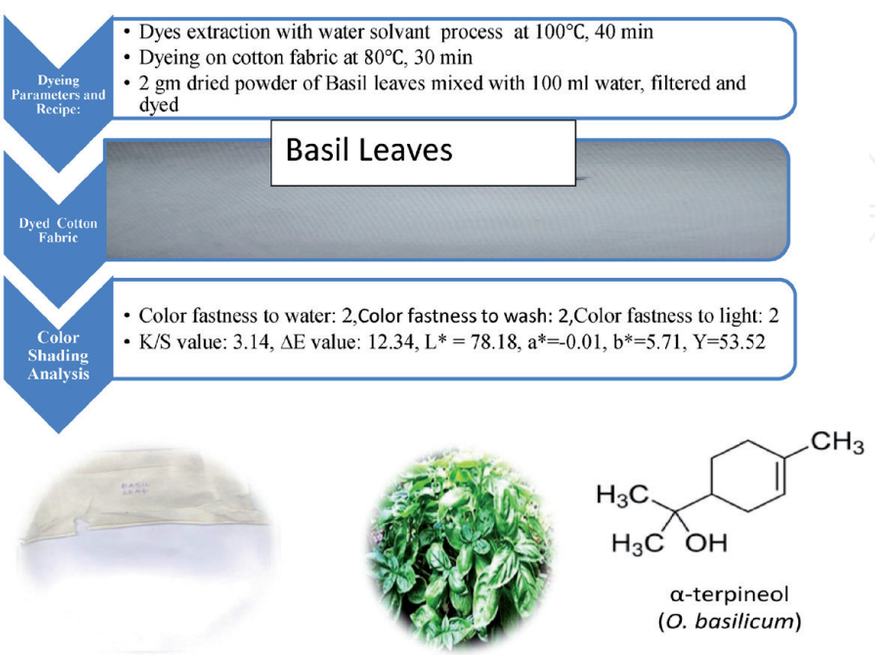


Figure 6.
RMS of Basil leaves.

3.7 Natural coloration of cotton fabric with Jackfruit wood, types of dyes: natural, source of dyes: Jackfruit tree, scientific name: *Artocarpus heterophyllus*

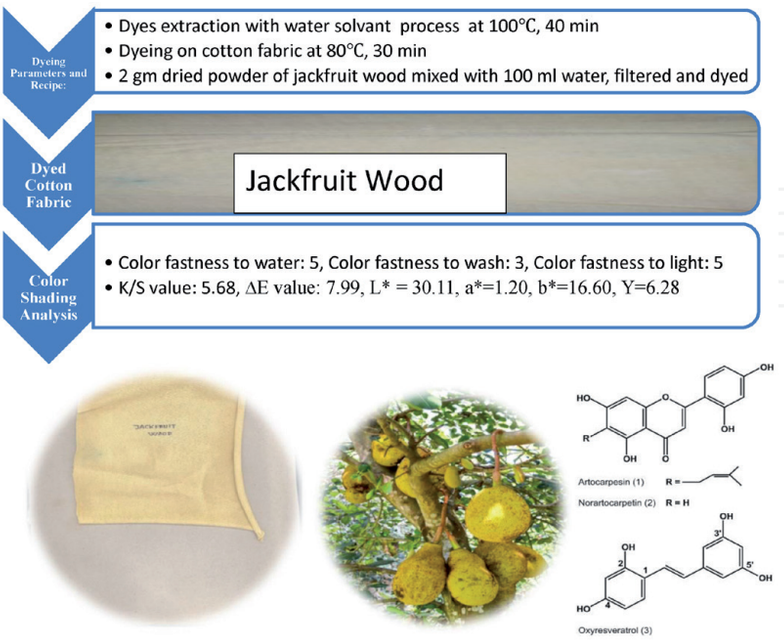


Figure 7.
RMS of Jackfruit wood.

3.8 Natural coloration of cotton fabric with Catechu fruit peel, types of dyes: natural, source of dyes: Catechu tree, scientific name: *Senegalia catechu*

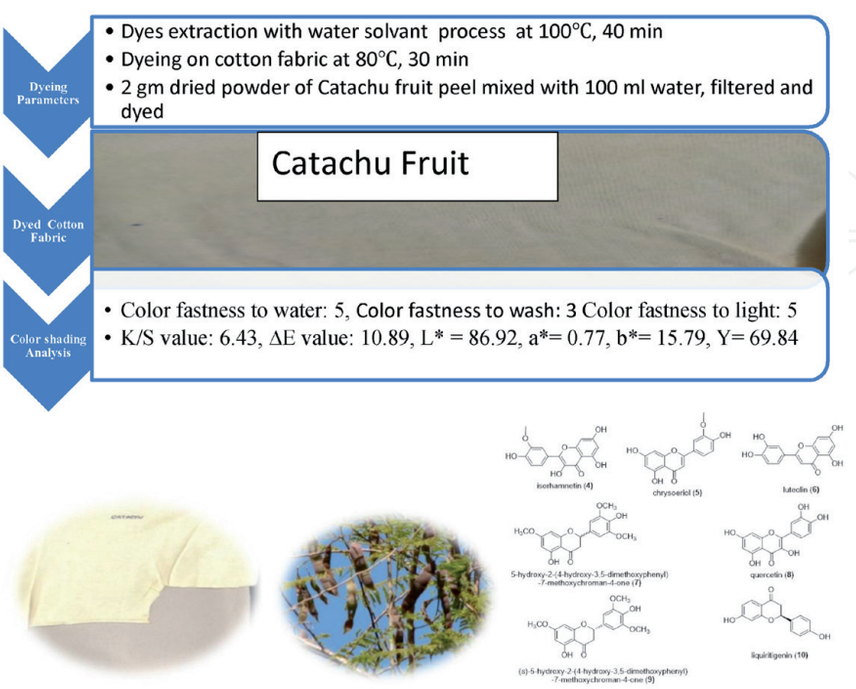


Figure 8.
RMS of Catachu fruit.

3.9 Natural coloration of cotton fabric with Bohera fruit peel, types of dyes: natural, source of dyes: Bohera tree, scientific name: *Terminalia bellirica*

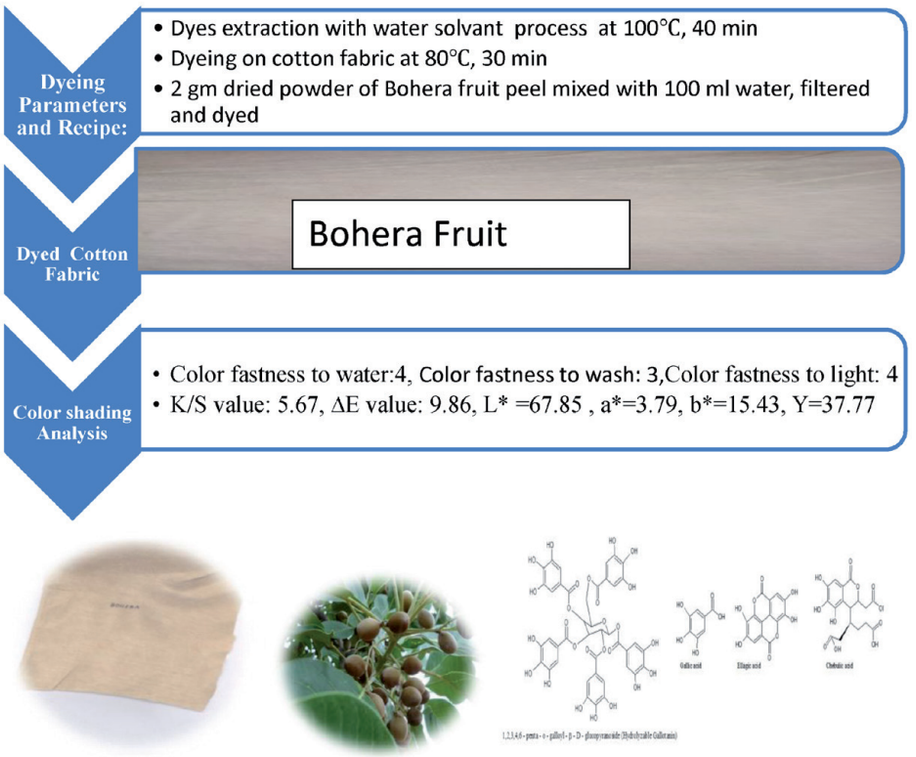


Figure 9.
RMS of Bohera fruit.

RMS of Jackfruit Wood (Figure 7): Powder of Jackfruit wood were collected from saw mill, filtered and 5 days dried with summer sun light. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

Artocarpesin and Norartocarpetin group of golden yellow color jackfruit tree wood has phenolic compounds, apigenin, curcumin may be responsible for making a yellow color having an optimum value of L*, a*, b*, Y as well as OH group is improving color fastness properties.

RMS of Catachu Fruit (Figure 8): Semidried Catachu fruit were plucked from tree, washed, fruit peel were cut into small piece, 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

Catachu is making off white color with soft hand feel and may be remaining natural pigment in the chemical components is responsible for dyeing without mordanting. Coloring component in the catechu is catechin having molecular formula $C_{15}H_{14}O_6$.

RMS of Bohera Fruit (Figure 9): Bohera fruit powder was purchased from herbal medicine shop, Tongi, Dhaka, Bangladesh. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

3.10 Natural coloration of cotton fabric with Mahogany seed, types of dyes: natural, source of dyes: Mahogany tree, scientific name: *Swietenia macrophylla*

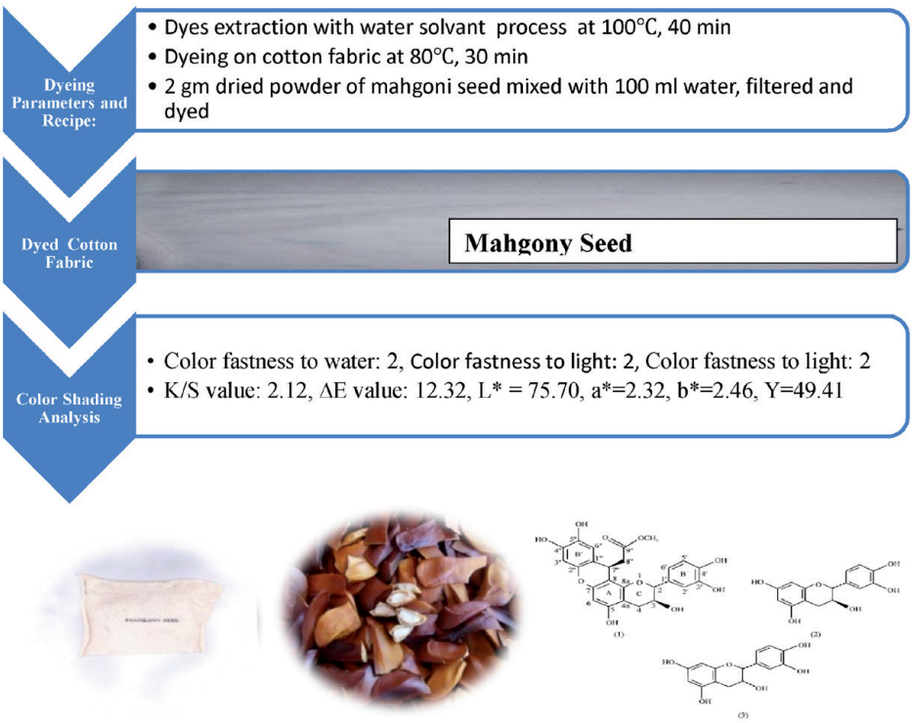


Figure 10.
RMS of Mahogany fruit, seed.

3.11 Natural coloration of cotton fabric with Mahogany fruit (outer peel), types of dyes: natural, source of dyes: Mahogany tree, scientific name: *Swietenia macrophylla*

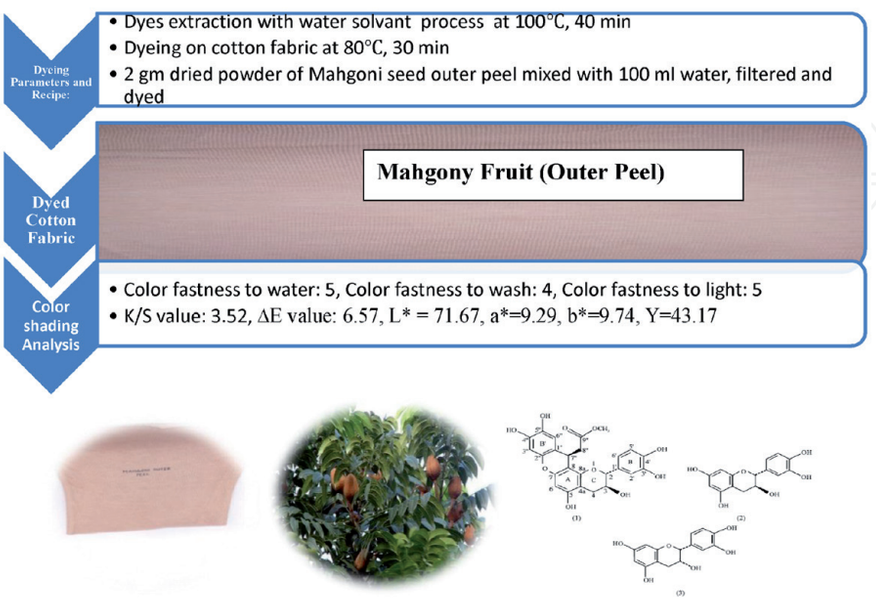


Figure 11.
RMS of Mahogany fruit, outer peel.

3.12 Natural coloration of cotton fabric with Mahogany seed (outer peel), types of dyes: natural, source of dyes: Mahogany tree, scientific name: *Swietenia macrophylla*

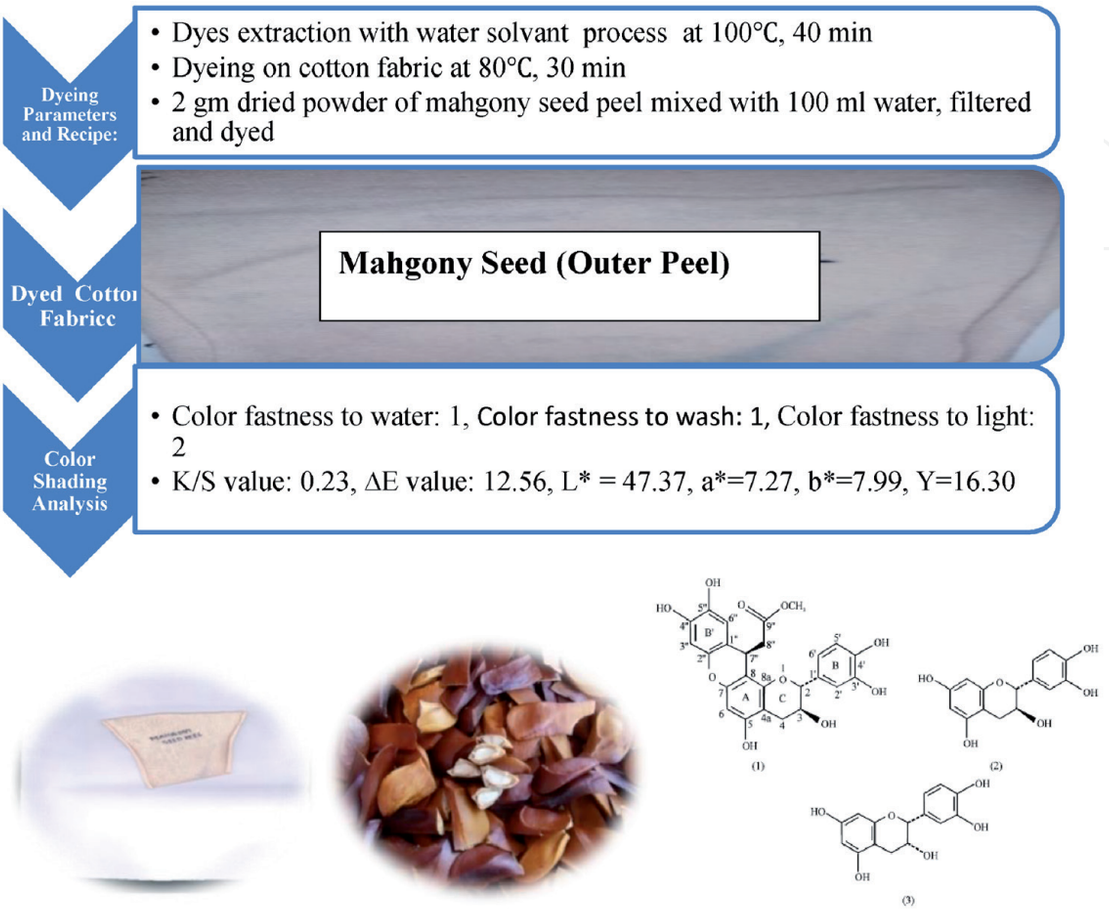


Figure 12.
RMS of Mahogany fruit, outer peel of seed.

OH group and its tannin constituent may be created a natural shading environment on the surface of cotton fiber and its medicinal properties may create the dyed fabric antimicrobial. Flavonoid and falvins constituent of Bohera fruit may have adaptive capabilities of viruses and microorganisms.

RMS of Mahgony Fruit, Seed (Figure 10): Semi-riped Mahogany fruits were plucked from tree, washed, seeds were separated with sharp knife, cut into small pieces and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group may be responsible for good dye-absorption and ferrous ion may be responsible for dyeing. Phytochemical constituents and other medicinal properties may have a good source protective clothing like insect repellent, antimicrobial, COVID19, and other viruses.

3.13 Natural coloration of cotton natural coloration of cotton fabric with Haritaki fruit peel, types of dyes: natural, source of dyes: Haritaki tree, scientific name: *Terminalia chebula*

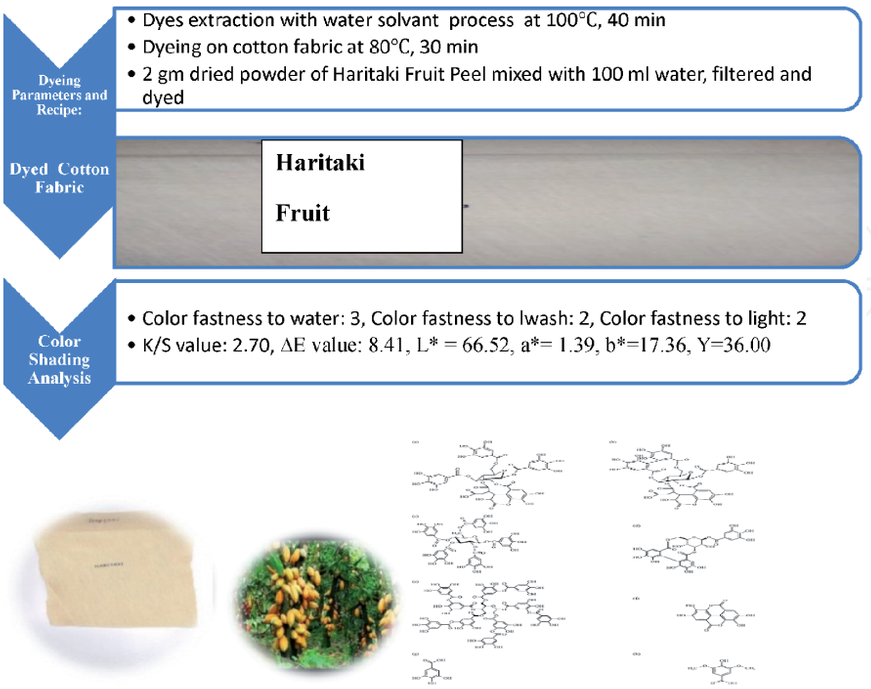


Figure 13.
RMS of Haritaki fruit.

3.14 Natural coloration of cotton fabric with Betel nut, types of dyes: natural, source of dyes: Betel nut tree, scientific name: *Areca catechu*

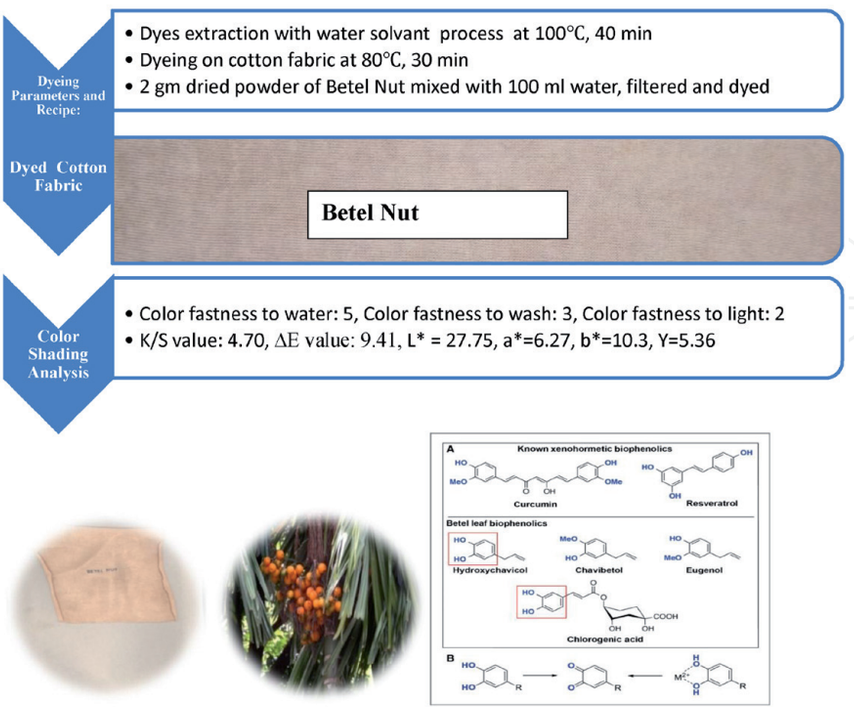


Figure 14.
RMS of Betel nut.

3.15 Natural coloration of cotton fabric with Peach leaves, types of dyes: natural, source of dyes: Peach leaves, scientific name: *Acacia acuminata*

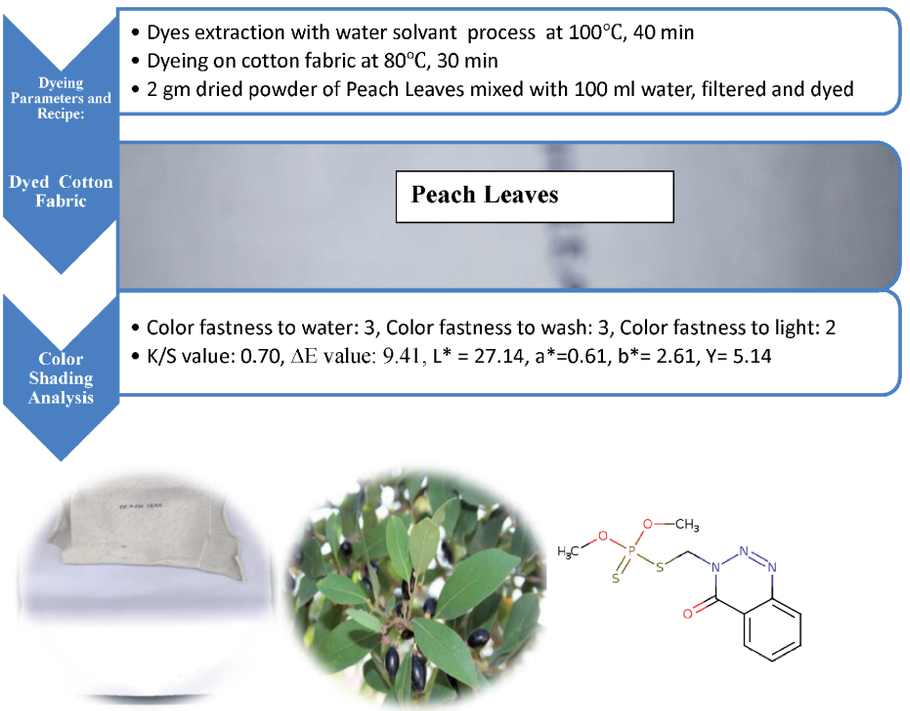


Figure 15.
RMS of Peach leaves.

RMS of Mahgony Fruit, Outer peel (Figure 11): Semi-riped Mahogany fruit were plucked from tree, washed, fruit peels were separated with sharp knife, cut into small pieces and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group and ferrous ion may be responsible for good dye-fiber bonding phytochemical constituents and other medicinal properties may have a good source protective clothing like insect repellent, antimicrobial, COVID19, and other viruses.

RMS of Mahgony Fruit, Outer peel of Seed (Figure 12): Semi-riped Mahogany fruit were plucked from tree, washed, seed peels were separated with sharp knife, cut into small pieces and 5 days dried with summer sun light, and made it crispy and fine powdered with grinding machine. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group and ferrous ion may be responsible for good dye-fiber bonding. Phytochemical constituents and other medicinal properties may have a good source protective clothing like insect repellent, antimicrobial, COVID19, and other viruses.

RMS of Haritaki Fruit (Figure 13): Haritaki fruit powder was purchased from herbal medicine shop Tongi, Dhaka, Bangladesh. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

OH group and ferrous ion may be responsible for good dye-fiber bonding. The plant is constituted of Glucoside, Tannins, Gallic acid, Ethyl gallate, and Chebulinic acid where tannin may be responsible for coloring the cotton fiber.

RMS of Betel Nut (Figure 14): Ripe Betel nut were purchased from local village shop, separated the peels, and grinded to make it powder form. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

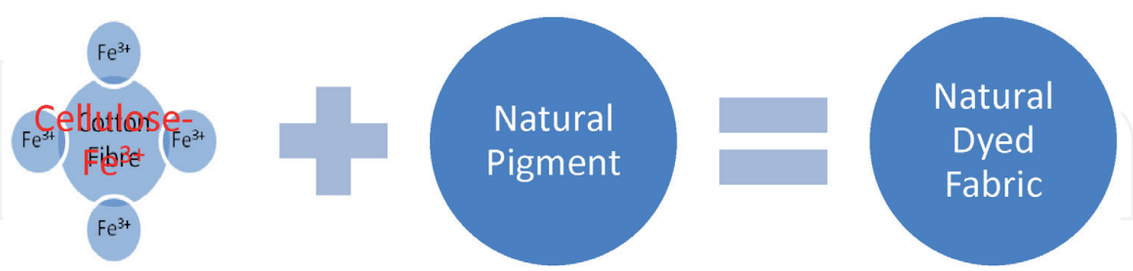
OH group can create a bond between dye and fiber and remaining curcumin may be responsible for coloration and dyed fabric may be slightly flammable due to having hydroxychavicol in the chemical constituent of betel nut.

RMS of Peach Leaves (Figure 15): Semi-dried Peach leaves were plucked from Peach tree garden. Two gram powder was mixed with 100 ml water, heated at boiling temperature for 40 min, and filtered properly. The dyes solution was used for cotton fabric dyeing in open bath medium for 30 min at 80°C.

Minimum color strength is found but fastness is lightly higher, increasing dye percentage may improve the color on the fiber surface. Remaining ferrous, copper, and zinc may be responsible for coloring the cotton fiber. As per chemical constituent, antimicrobial and anti-inflammatory can be found.

4. Method of natural fixing for mordant free dyeing

Maximum natural dyes sources from natural tree leaves, roots or fruits have ferrous ion, tannin, curcumin, catechin, OH group, and other known and unknown phytochemical constituent. Ferrous ion, tannin, curcumin, and catechin are making various color formations, and OH group is creating affinity with cellulosic fiber as well as the fastness properties may be increased if the dyes have natural pigment which may influence the capability of remaining dyes on the fiber surface after washing. Drying/curing with higher temperature may impact the color making duller or brighter. So specific dye-fiber system of natural fixing for mordant free dyeing is also possible but exact curing/drying temperature should be fixed for getting expected outcome of shading. So expected mechanism of mordant free natural coloration may be proposed as below although dyes and fiber substances may create changing of it.



5. Testing process

5.1 Color fastness to wash method

ISO 105-C06:2010, color fastness to water method: ISO 105-E01 and color fastness to light was tested by AATCC TM16 inQ-SUN XE-2 Xenon Test chamber.

5.2 Machine used for color parameters

Color parameters (L^*, a^*, b^*, Y) were measured by Hunter Lab Spectrophotometer, machine name: ColorFlex EZ, Model 45/0 LAV, Geometry

Figure 16.
Color Flex EZ, Spectrophotometer.

45°/0°, viewing area: large, visible spectrum (400–700 nm), testing condition: $D_{65/10°}$, room temperature of testing lab: 18°C (**Figure 16**).

6. Representation of dyed fabric and picture of dyes sources

All dyed shades were scanned with HUAWEI Smart Phone, Camera-13 MP, distance between fabric sample and camera position: 12–16 inch. So there is a possibility of having difference with actual shade. Picture of actual dye-fiber system was also scanned with HP Scanjet 4890 Photo Scanner. All sources of dyes pictures have been mentioned on the basis of grown trees in Asian Countries, specially in Bangladesh and scientific name was used accordingly. All the pictures of chemical structure mentioned here indicate the group of tree, not exactly indicating the chemical structure of specific parts of trees which one is extracted and dyed on cotton fabric.

6.1 Overcoming contradiction of natural dyeing

A huge number of researchers are working on natural dyes, still have a challenging for uneven dyeing, appropriate mordanting and dyes availabilities, shade matching where I can put a logic to protect our environment and human life as well.

6.2 Uneven dyeing

Automation in extraction and dyeing process.

6.3 Appropriate mordanting and dyes availability

Selection of specific dyes for commercial production and/or wastage can be used as dyes sources.

6.4 Shade matching

Customers are not always asking for shade matching when they are shopping although some natural dyes have attractive shading and repeated shading also possible.

7. Conclusion

Mordanting free coloration was practiced establishing the feasibility of environment friendly natural coloration which is the ongoing research of author and a part

of his research has been included here. Shade variation of natural dyed fabric may influence the uncontrollable factors for the collection of natural dyes sources on the basis of season to season, region to region and a same source but different parts of same dye sample source. So it is very tough to make a specific declaration of shading behaviors by the textile technologist but specific expertise in natural dyes extraction and natural dyeing may minimize the problem whereas expertise in dyeing with synthetic dyes and dyeing with natural dyes are not same for bulk production.

Following directions for the real shade development mentioned above:

1. Fabric should be well scoured and bleached.

2. Dyes materials should be clean, dried and powdered properly, improper drying and inappropriate powder formation may be responsible for unexpected shading and uneven dyeing.

3. Extraction time, dyes percentage may be maximized or minimized if the actual color is not observed.

4. Improper filtration of dyes may create uneven dyeing.

5. Dyes should not be powdered in wet or sticky condition which may effect the changing of light fastness and color shading.

6. Insect affected dyes source may create the changing of shade.

7. Synthetic mordanting and chemical medium dyes extraction may improve the shade but the concern of chemical and cost.

8. For open bath dyeing, liquor ratio should be higher, and stirred continuously to reduce color mark on the dyed fabric.

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