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Fully chemical free garment dyeing

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Abstract

Despite the wide spread use of synthetic dyes, natural dyes are still exploited and used to enhance its inherent aesthetic qualities as a major material for beautification of the body. Centuries before the discovery of synthetic dyes, natural dyes were the only source of dye open to mankind. Dyes are extracted from plant -leaves, roots and barks, insect secretions, and minerals. However, research findings have made it clear that of all, plants- leaves, roots, barks or flowers are the most explored and exploited. During the normal processes, different types of chemicals are used for functional purpose & aesthetic issues. All the chemicals are produced through a series of reaction & have the minimal amount of side effects to our environment & human ecology. Without the use of dyes & chemicals, normally this is undesirable to get colored product. This paper investigates that dyeing can be carried out on bleached garment (T-Shirt) without using any chemicals & synthetic dyestuff & also able to impart Tie dyeing effect with maintaining the quality issues.

Keywords: gab fruit, eucalyptus bark & leaves, turmeric, chemical free

1. Introduction

The use of dye stuffs is as old as textiles themselves and pre-dates written history. Dyes are obtained from two main sources; the natural dyes and synthetic dyes. Natural dyes can be defined as those organic materials that have the ability to impart colour to any substrates which they must have had affinity for. Natural dyes are biodegradable and very compatible with the environment. They have beauty and depth of colour that cannot quite be obtained with synthetics. These dyes can be obtained either from plants, animals, and minerals. Until the mid 19th century, all dyestuffs were made from natural materials, mainly vegetables matter. Research findings have reported that synthetic dyes are harmful to the body and thus the increased search into the arrays of plants for natural dyes which is more environmental friendly. Most of these dyes are substantive and mordant are used to increase the colour and quality fabric. In this article work, no textile chemicals, auxiliaries & textile dyes were used & even the mordant is also natural. Everything was collected from nature & our surrounded area and the full dyeing process was completed by using this natural (chemical free) items.

2. Harmful effects of chemicals used in Textiles

Mills discharge millions of gallons of this effluent as hazardous toxic waste, full of color and organic chemicals from dyeing and finishing. Presence of sulphur, naphthol, vat dyes, nitrates, acetic acid, soaps, chromium compounds and heavy metals like copper, arsenic, lead, cadmium, mercury, nickel, and cobalt and certain auxiliary chemicals all collectively make the effluent highly toxic. Other harmful chemicals present in the water may be formaldehyde based dye fixing agents, hydro carbon based softeners and non-bio degradable dyeing chemicals. The mill effluent is also often of a high temperature and pH, both of which are extremely damaging. The amount of BOD, COD is more in effluent water which comes from different processes with chemicals. The colloidal matter present along with colors gives the water a bad appearance and foul smell. It prevents the penetration of sunlight necessary for the process of photosynthesis. This interferes with the Oxygen transfer mechanism at air water interface. Depletion of dissolved Oxygen in water is the most serious effect of textile waste as dissolved oxygen is very essential for marine life. In addition when this effluent is allowed to flow in the fields it clogs the pores of the soil resulting in loss of soil productivity. The texture of soil gets hardened and penetration of roots is prevented. Impurities in water affect the textile processing in many ways. In dyeing stage metallic ions present in water sometimes combine

with the dyes causing dullness in shades. Textile effluent is a cause of significant amount of environmental degradation and human illnesses. All the organic materials present in the wastewater from a textile industry are of great concern in water treatment because they react with many disinfectants especially chlorine. Chemicals evaporate into the air we breathe or are absorbed through our skin and show up as allergic reactions and may cause harm to children even before birth.

3. Chemical free dyeing

Dyes are used for coloring the fabrics. Dyes are molecules which absorb and reflect light at specific wavelengths to give human eyes the sense of color. Dyeing in textiles is a process in which color is transferred to a finished textile or textile material (like fibers and yarns) to add permanent and long-lasting color. It can be done by hand or by machine. Dyes can come as powders, crystals, pastes or liquid dispersions, and they dissolve completely in an aqueous solution like water. When the textile and the dye come into contact, the textile is completely saturated by the dye and colored. Some of the synthetic dyes contain metals too. The natural dyes are extracted from natural substances such as plants, animals, or minerals. Natural dyes come from sources like plants, minerals and animals. If the dyeing procedure with natural dyes is considered, different mordants are used. So, in dyeing there should be the presence of chemical & dyes whether it is synthetic or natural. Chemical free dyeing means where no chemical is used starting from the initiation stage of dyeing to termination. Here the dyeing is carried out by using natural dyes & natural catalyst with the use of no machine.

4. Natural Catalyst used in chemical free dyeing

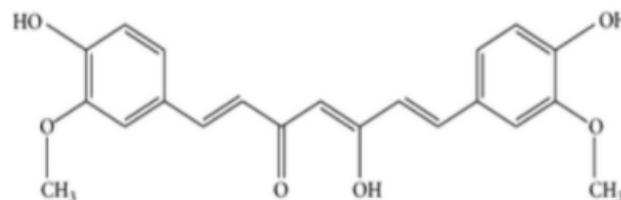
In chemical free dyeing natural catalysts were used instead of any chemical. Here the catalyst used in this chemicals free dyeing were collected only from nature. The dyes used in this process is natural dyes. The natural dyes which was used is turmeric and eucalyptus leaves. Eucalyptus bark and local gab fruits were used as natural mordant. Only these natural catalysts were used for chemical free dyeing. The list of substance is given below-

Name	Natural Catalyst
Dyes	Turmeric
	Eucalyptus leaves.
Natural Mordant	Eucalyptus bark
	Gab fruits

5. Chemical Structure of the Substance

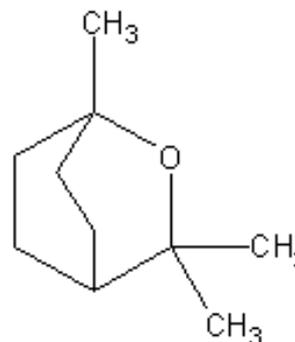
The Chemical structure of the substances used in this dyeing are given below

Turmeric-This can be in enol form or keto form. But the enol form is more energetically stable in the solid phase & also in solution.



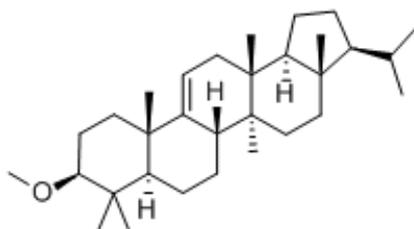
Structure of Turmeric in enol form.

Eucalyptus- In eucalyptus contain eucalyptol

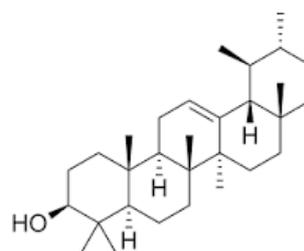


Structure of eucalyptol which contain ether group.

Gab fruit-Its contain Isoarborinol methyl ether which is also called cylindrin and also fatty esters of alpha and beta amyryn.



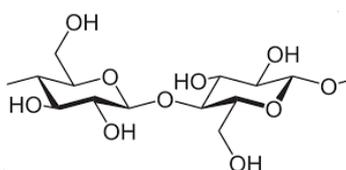
Cylindrin Structure.



Amyrin Structure

The structure of Cylindrin & Amyrin is almost the same which contain alcohol group. The structure of Amyrin was considered here for interaction of chemical.

Structure of cellulose



6. Procedure of chemical free dyeing

At first, 3 Bleached T-shirts were collected which will be dyed. For chemical free dyeing procedure in addition with Tie dyeing, different parts of the T-shirt was tied with tape. After that the T-shirt was immersed into water in a pot and kept it for one hour to increase the absorbency level of the fabric to a satisfactory limit. The natural dyes from turmeric and eucalyptus leaves were extracted. Also collected the sap from eucalyptus bark and gab fruits. Three trials were done.

Trial sample 1- First T- shirt was dyed with the natural dyes using only the natural mordant eucalyptus bark.



Picture under D65 light source - Front & back view of the trial sample 1 dyed with mordant eucalyptus bark.

Trial sample 2-Second T-shirt was dyed with the natural dyes using only the natural mordant gab fruit.



Picture under D65 light source - Front & back view of the trial sample 2 dyed with mordant gab fruit

Trial sample 3-Third T-Shirt was dyed with the natural dyes using both the natural mordant eucalyptus bark & gab fruit and the depth of shade is the darkest.



Picture under D65 light source- Front & back view of the trial sample 3 dyed with mordant gab fruit & eucalyptus bark.

Before started dyeing all of the liquids were filtered. The dyeing was carried out with the mixing of natural dyes & mordant at elevated temperature. After that the dye pot was kept to cool down. The T-shirt was then taken out from the pot and washed with normal water. After the completion of dyeing, the dyed T-shirts were washed with 3g/l detergent to make the water clean come out from the dyed product.

7. Findings and Results

The dyed samples were dried. After that the quality of dyeing was checked.

Quality of Levelness: the levelness of the dyed samples is really good.

Crease mark: the fabric quality of the T-shirt was single jersey but there is no crease mark after dyeing.

Dye Spot: no dye spot was noticeable.

Shade Variation: NO shade variation from the front and back part of the garments was found.

Tied Part Quality: the tied part of T-shirt really look nice and fashionable.

7.1 Fastness Result

The dry rubbing fastness of all three dyed sample was good 4-5

The wet rubbing fastness of trial dyed sample 1 which was dyed only using eucalyptus bark is 2-3.



Rubbing Fastness Test / ISO 105 -X12

The wet rubbing fastness of trial dyed sample 2 which was dyed only using gab fruit is 2.



Rubbing Fastness Test / ISO 105 -X12

The wet rubbing fastness of trial dyed sample 3 which was dyed using eucalyptus bark & gab fruit is 3-4



The color fastness to wash of trial dyed sample 1 & 2 was not satisfactory but on the other hand the color fastness of the trial dyed sample 3 (dyed with the combination of eucalyptus bark

& gab fruit) was fully satisfactory and the below result illustrates that.

Stained on Multifibre					
CT	CO	PA	PES	PAC	WO
4-5	4-5	4-5	4-5	4-5	4-5

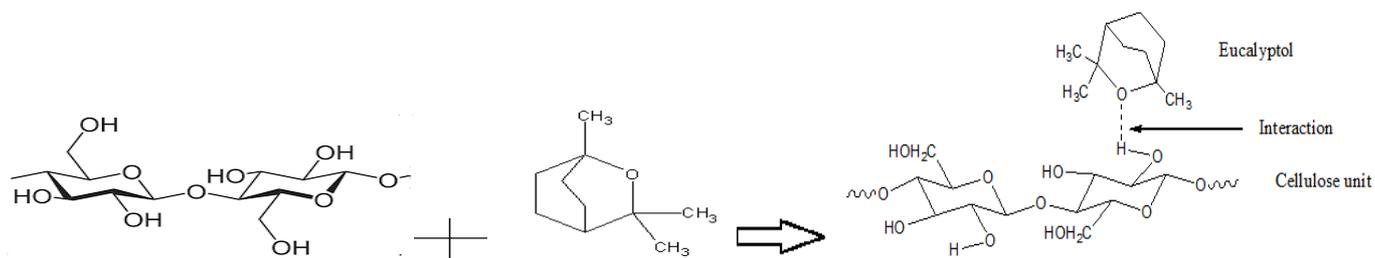
Washing Fastness Test / ISO 105 C06 C2S

Note- All the fastness testing was done in Archroma Bangladesh Limited.

8. Reason of fastness result & visual look variation among the dyed samples

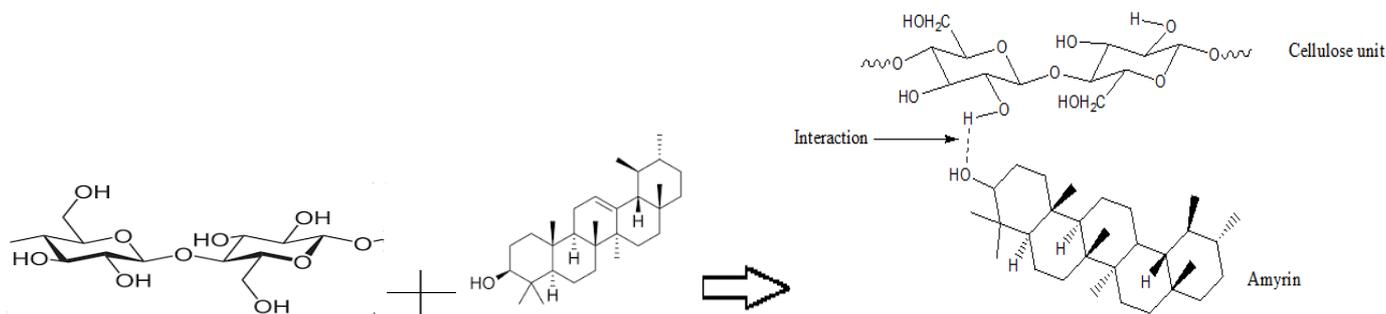
The depth of sample 3 is darker than that of the other 2 samples.

During dyeing, the dye liquor was entered into the fiber. When the eucalyptus bark was only used as mordant for trial sample -1, the interaction with the Cellulose fiber is as below

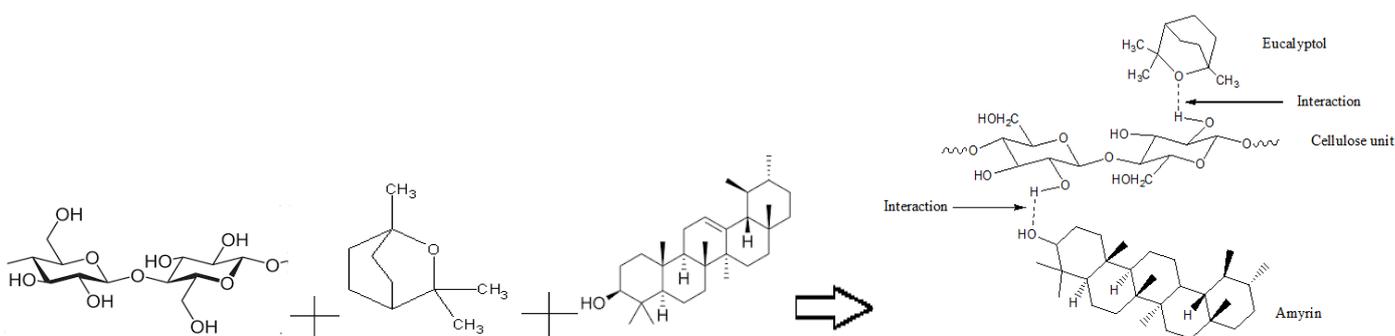


In this chemical reaction, the eucalyptol only interact with the C-2 of cellulose unit.

The Chemical reaction is as below when the cellulose of trial sample -2 interact with only the amyirin of Gab fruit extract



When eucalyptol & Amyrin interact with the cellulose of trial sample -3, the reaction is as below



In every reaction, the interaction happens with C-2 of cellulose. Another cellulose unit will join with C-4 by beta linkge. So, not possible to interact with C-4. This is not possible with C-3 also due to steris repulsion. This is not possible to interact with C-6 because another cellulose unit attached with amyirin need space to join with

other cellulose. Another reason is the electro negativity of C-6 is less than that of C-2. That's why C-6 don't participate in interaction.

Interaction with amyirin & eucalyptol illustrates that the side arrangement is more spacious than that of individual interaction with amyirin & eucalyptol. Due to the strong

interaction with combine amyridin & eucalyptol, the depth of dyed sample 3 is more than that of the other two sample and the color fastness of to wash of dyed sample 3 is also better.



Picture-Depth variation of the dyed sample under D65 light source.

9. Conclusion

Chemical free dyeing which is without any use of chemical is a new concept in textile dyeing. The result of this study has revealed that fully chemical free dyeing is possible & the combination of gab fruit & euclyptus bark is a better natural mordant. In addition, the result of this experiment will add a bust to environmentally conscious consumers with growing need for organic clothing.

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