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APPLICATION OF NATURAL DYES ON TEXTILE: A REVIEW

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Abstract:
This paper reviews the characterization and chemical/biochemical analysis of natural dyes. Extraction of colorants from different natural sources, effects of different mordents and application of binary mixture of natural dyes. Natural dyes are different sources such as plant dyes animal dyes mineral dyes etc. and characteristics of natural dyes such as chemical/biochemical analysis by using UV-visible spectroscopic and chromatographic analysis.

Keywords:
Natural dyes, colorants, toxicity, textiles.

1. INTRODUCTION

Natural dyes are known for their use in coloring of food substrate, leather as well as natural protein fibers like wool, silk and cotton as major areas of application since pre-historic times. The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes. However, worldwide the use of natural dyes for the coloration of textiles has mainly been confined to artisan / craftsman, small scale / cottage level dyers and printers as well as to small scale exporters and producers dealing with high-valued eco-friendly textile production and sales. Recently, a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes [1].

Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economical price and produce a wide variety of colors; these dyes however produce skin allergy, toxic wastes and other harmfulness to human body. For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without scarifying required quality of dyed textiles materials. Therefore, to obtain newer shades with acceptable color fastness behavior and reproducible color yield, appropriate scientific techniques or procedures need to be derived from scientific studies on dyeing methods, dyeing process variables, dyeing kinetics and compatibility of selective natural dyes. A need has also been felt to Samantha & agarwal: application of natural dyes on textiles reinvestigate and rebuild the traditional processes of natural dyeing to control each

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treatment and pre- dyeing process (preparation, mordanting) and dying process variables for producing uncommon shades with balanced color fastness and eco-performing textiles [2].

The present paper reports the studies carried out so far on the chemistry and application of natural dyes on textiles to understand the science of natural dyeing as well as to focus the problem areas, difficulty and probable measures to overcome them.

The main aim of this paper is therefore to study the application of natural dyes on textiles. To address the main objective the following specific objectives were included; such as identifying the source and types of natural dyes, understanding the application of natural dyes and identifying the possible extraction and purification methods.

2. NATURAL DYES

2.1. SOURCE OF NATURAL DYES

There are different sources of natural dyes. Natural dyes of plant, minerals and animal sources are fascinating beautiful and sometimes they challenge the wits of researchers and educators. Most of them produce very colorful effects that are so amazing to be hold. Natural colors are beautiful to be hold. Coloring matter extracted from the roots, stems, leaves or barriers and flowers of various plants have various expectations [3].

2.2. PLANT DYES

The roots, nuts and flowers of plant that grow in our back yards are all sources of coloring pigments and dyes. Most natural dyes come from such parts of plants that back berries, flowers, leaves and roots while the use of seeds fruits and young shoots as other source of natural dyes. The outer, inner bark and heart wood of trees also produce. The existence over 1000 sources of plants based dyes that were used across the word until the early 1900s included in these vast arrays of dyes yielding plants are the following. Henna (orange-red) - from leave of henna plants, Carechu (brown) - from resin (sticky substance from plant of acacia tree, Fustic (yellow)-from the wood of the fustic tree, Indigo ($C_{16}H_{10}N_2O_2$ (blue)-from leaves and stems of the indigo plant, Logwood (black)- from the core (heart) of the log wood tree, Turmeric (violet) -from the roots the turmeric plant and Saffron (yellow) - from stigmas of the common crocus are the common ones [4].

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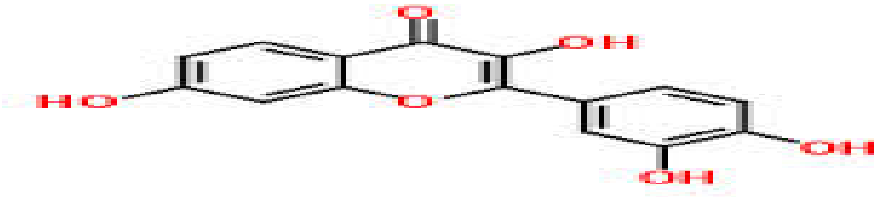

Figure1: structural formula for fustic yellow ($C_{15}H_8O_6$)

2.3. ANIMAL DYES

Red animal dyes derived from certain species of tiny scale insects known as co-chi-near that fed on red cactus berries. The insects can be gathered by hand and ground in to pigment. Major sources of animal dyes are: Cochineal (red) - from bodies of cochineal insects and Tyriam purple or crimson-from the bodies of same textile of marine snails [5].

2.4. MINERAL DYES

Derive from colored clays and earth oxide; Chrom green-from a compound of chromium and oxygen, Chrom red -from from a compound of chromium and lead, Chrom yellow-from a compound of chromic acid and lead and Prussion blue-from a compound of iron and cyanide [6].

3. CHARACTERIZATION OF NATURAL DYES

3.1. MACRO AND MICRO CHEMICAL ANALYSIS

Macro chemical analysis is used to identify the natural dyes chemical composition. Chemical based classification of natural dyes gives the classes of dyes like; anthroquinone(madder), alphanapthoquinones (henna),flavones (weld) , indigoids (indigo and tyrian puple), carotenoids chemical nature of such colorants [4].

I. Madder dyes -are hydroxyl-anthraquinones which are extracted from the root bark of various rubiaceae.

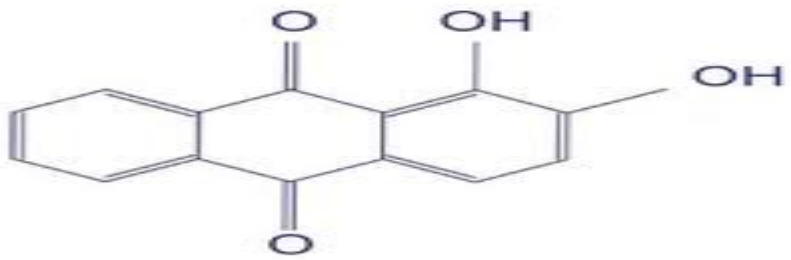

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Figure2: structural formula for quercetin ($C_{14}H_6O_4$)

3.2. UV-VISIBLE SPECTROSCOPIC STUDY

UV-visible spectra of any colorants /dye show its own peaks at predominating wave length, indicating main color. For natural dyes, the spectra specially indicate different peaks for mixed colorants available in their extract in both UV and visible region. UV-visible spectroscopic studies of different natural dyes were carried out by using different solvents for extraction. Some of the studied dyes are; (i) Neem bark colorants – shows two absorption maxima it 275 and 374 nm while beet sugar shows three absorption bands at 220,280,530 nm, (ii) Red sandal wood shows a strong absorption peak at 288nm and the maximum absorption at 504 and 474nm at pH 10 in methanol solution and (iii) Gomphrena globosa flower colorants shows one major peak at 533nm. This dye does not show much difference in the visible spectrum at ph 4 and 7.how ever the peak shifted towards 554nm. These studies are although too scientific in nature, but are useful in understanding the UV absorbance criteria ,as these are indicative of many application information like possible fading and absorbance behavior under UV-light ,sun-light, etc hence these reports are also important [7].

3.3. CHROMATOGRAPHIC ANALYSIS

Chromatography is very important in chemistry. It is used to analyze unknown compound. Thin layer chromatography (TLC) is applicable to identify different color components in natural dyes to be applied on textiles. Dyes detected were insect dyes, and vegetable dyes. Non-destructive – identifying faded dyes on fabrics through examination of their emission and absorption spectra and analyzed quantitatively the red dyes, such as alizarin, purpurin carminic acid, etc. A linear gradient elution method is used for the analysis of plant and scale insect as well as for the red anthraquinonoid mordant, molluscan blue, red, purples and indigoid vat dyes. The method enables the use of the same elution program for the determination of different chemical class of dyes [8].

3.4. TEST OF TOXICITY

The toxicity data sheet for natural dye provides evidence about the possibility of any adverse effect to human being. The irritation effects to skin and eye and the sensitization potential are the primary concern. Furthermore possible long term effects such as mutagenic, carcinogenic or reproductive toxicity effects are also to be tested for any material /natural dye before its use [9].

The lethal dose (ld-50) is the best known toxicity rating it describes the lethal dose for 50% of the test animals which is the amount of substance in kg/kg of body weight that kills half of the animals. The crude methanolic extracts of stem, root, leave, fruit, seeds of artocarpus hetrophylus and their subsequent pertaining with petrol, dichloromethane, ethyl acetate and butanol fractions exhibited abroad spectrum of antibacterial activity [10].

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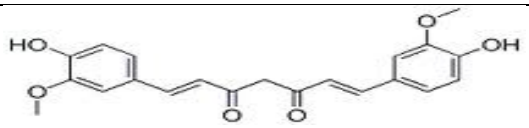
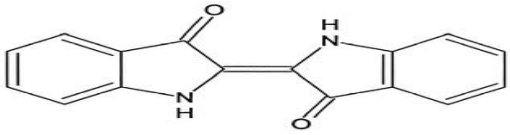
UV-visible and IR spectroscopy, TLC, HPLC, eco-toxicity (ld-50) and bio-assay, are the common methods of identification of vegetable dyes on cellulose fibers, animal fibers and man-made fibers. There are however, exclusive but not exhaustive and many further analyses of color components of natural dyes are possible by other modern techniques like FTIR (Fourier transform, infrared spectroscopy, NMR, nuclear magnetic resonance), AAS (atomic absorption spectrometric), TGA (thermo gravimetric analysis) and elemental analysis of natural dyes /colorants to study the chemical functional nature, presence of different elements for understanding the chemistry of natural dyes components [8].

3.5. EXTRACTION OF COLORANTS FROM NATURAL DYES

The extraction efficiency of colorants component present in natural plant, animal, mineral, sources depends on the media type like aqueous, organic solvent, acid, alkali, PH of the media and condition of extraction, such as temperature, time, and material to liquor ratio particle size of the substrate [9].

Table 1: Examples of natural dyes extracted from plants.

Major component of color	**Name of plant**	**Chemical structure**
Curcumin ($C_{19}H_{15}O_6$) yellow	Curcmalagal(turmeric)	
Indigo ($(C_{16}H_{10}N_2O_2)$)	Indigoferatinctori(indigo)	

Extracted colorants from the leaves of eucalyptus hybrid, seeds of cassia tora and grewia optiva by using aqueous medium, from biomass products indicates yellow red zone. Dyes uptake increased with increase in mordant concentration. Aqueous extraction of saffron yields a yellow dye with medium wash fastness on wool and poor wash fastness on cotton. The wash fastness can be improved by treatment with metal salts before dying. Extraction of dye from food was best achieved with ethanol 40 m/oxalic acid mixture. A process developed for the extraction of natural dye from the leaves of teak plant has been carried out using aqueous methanol. Extraction of

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euphoria leaves under acidic pH by adding hydrochloric acid, under alkaline pH using NaCO3 can also be possible [11].

4. APPLICATION OF NATURAL DYES ON TEXTILE

4.1. COLOR FASTNESS PROPERTIES OF NATURAL DYED TEXTILES

Color fastness is the resistance of a material to change any of its color characteristics or extent of transfer of its colorants to adjacent white materials in touch. The color fastness is usually rated either by loss of depth of color in original sample or it is also expressed by discoloration scale, i.e., the accompanying, white material gets tinted or stained by the colour of the original fabric. However among all types of color fastness, light fastness, wash fastness and rub fastness are considered specifically for apparels only [12].

4.2. AS LIGHT FASTNESS

Light fastnesses of many natural dyes particularly which are extracted from flower petals are found to be poor to medium. So an extensive work has been carried out to improve the light fastness properties of different natural dyed textiles. The study includes tannin- related after treatment for improving the wash fastness and light fastness of mordant able dyes on cotton. Some of these treatments might be applicable to specific natural dyes [9].

A large proportion of natural dyes are course, mordant dyes. There is strong influence nature, type, concentration of mordents on wash and light fastness grades. The influences of different mordents were found to play important role in fading of 18 yellow natural dyes. Wool dyed with different natural dyes specimens was exposed to a xenon arc lamp for assessing its light fastness. The corresponding color change after exposure to xenon arc lamp was also assessed in each case. Turmeric, fustic and Marie gold dyes faded significantly more than any of the other yellow dyes. However the use of tin and alum mordents causes significantly more fading than that with the use of chrome, iron, or copper mordant. Thus the types of mordant are found to be more important than the dye itself in determining the light fastness of natural colored textile [10].

4.3. WASH FASTNESS

The light fastness and wash fastness under standard condition (50°c) and also at 20°c with a washing formulation used in conservation work for restoration old textiles. Some dyes undergo marked changes in color on washing due to the presence of even small amounts of alkali in washing mixtures, high lighting the necessity to know the pH of alkaline solutions used for the cleaning of textiles dyed with natural dyes. As a general rule natural dyes show moderate wash fastness on wool [11].

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4.4. RUB (SHINE) FASTNESS

In general, shine fastness of most of the natural dyes is found to be moderate go good and does not require any after treatment. The dye color strength related parameters and compatibility for dying cotton fabrics with binary mixture of jack fruit wood and other nature of dyes. However it must be remembered that the color fastness of natural dyes not only depends on chemical nature and type of natural colorants, But also on chemical nature and types of mordant's being used. So a dye must know. The use of proper combinations of fiber mordant is to achieve best color fastness. The use of natural after treatment agents is to improve both wash and light fastness of natural dyes [11].

5. CONCLUSIONS

It has been found that the required scientific studies and systematic reports on dying of textile with natural dyes are still insufficient. There are a lot of natural products still UN watched though natural coloration is known from ancient time as artisanal practice for handicrafts, paintings, and hand 100m textiles. The chemistry of interaction of such colorants with textile materials is relatively recent interest for producing eco-friendly textiles. Thus there are need of many more active researches to build a knowledge base and database with production of appropriate shade cards for different textile.

6. RECOMMENDATION

Based on this study, natural dyes are important organic molecules with a great advantage in textiles for many activities. Therefore it is recommended that further and detailed works have to be conducted on these chemical species.

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8. REFERENCE

1. K. Agarwal, Application of natural dyes on textiles, *Indian Journal of Fibre & Textile Research*, **34**, 2009, 384-399,
2. Pierce, Are natural colorants good for your health*? Journal of the Society of Dyers and Color*, **109**, 1993, No. 5-7,

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A knowledge Repository
Science

3. P. S. Vankar, *Handbook on natural dyes for industrial applications*, National Institute of Industrial Research, 2007
   A. Manhita & T. Ferreira, Extracting natural dyes from wool, Anal Bioanal Chem, 2011, 1-14
4. O. Korankye, Extraction and Application of plant dyes to serve as colorants for food and textiles, phd thesis, 2010.
5. Irobechni, Analytical methods for the characterization of organic dyes in art work and in historical textile, Appl spectrosc rev, **44**, 2009, 365-410.
6. Rosenberg, Characterization of historic al organic dyestuffs by liquid chromatography – mass spectrometry, Analytical bioanol chemi. Journal, **391**, 2008, 33-57.
7. Z.C. Koren, Historico –chemical analysis of plant dyes tuffs used in textiles from ancient Israel, American chemical society Washington, 1995, 269-310.
8. Z. Lauresen , Development of mild extraction methods for the analysis of natural dyes in textile of historical interests, Anal Bioanal Chem, **77**, 2005, 2022-2015.
9. J. Lee, Characterization of Natural Dyes and Traditional Korean Silk Fabric by Surface Analytical Techniques, www.mdpi.com/journal/materials, **6**, 2013, 1-19.
10. R. Kanchana, Dyeing Of Textiles with Natural Dyes, International Journal of Chem. Tech Research, **5**, 2013, 2102-2109.
11. P. Mishra and V. Patni, Extraction and Application of Dye Extracted from Eriophyid Leaf Galls of *Quercus Leucotrichophora*, African J. Biochem Research, **5**, 2011, 90-94.