Natural dyes and its Antimicrobial effect

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Abstract

Dyeing is the art of imparting hues and tints to yarns, fabric and other materials by employing colouring matter. Colouring matter can be obtained from both natural and synthetic sources. Synthethic dyes impart vibrant colour and are widely used but it causes carcinogenicity and inhibition of benthic photosynthetic. Recent reviewed of interest in the use of natural dye in textile colouring is due to the stringent environmental standard imposed by many European countries in response to the toxic and allergic reaction associated with synthethic dyes. Germany was the first to take initiative to put ban on numerous specific azo-dyes for their manufacturing and applications. Netherlands, India and some other countries also followed the ban (Patel, 2011) .A varieties of Colour, shades from vibrant jewel tones to dusky heathers and pastels can be obtain from different sources. Various methods are used for colour extraction as well as different extraction procedure depending upon the type of yarns or fabric differes. They are considered as eco-friendly, nontoxic, medicinal properties fitting into similar trends of repurposing, up cycling which is very important for maintaining environmental balance.

Keywords; *dyes, mordant, antimicrobial effect*

Introduction

Nature provides a wealth of plants which will yield their colour for the purpose of dyeing, many natural dyes have been used since antiquity. In the early 21st century, the market for natural dyes in the fashion industry is experiencing a resurge. Western consumers have become more concerned about the health and environmental impact of synthetic dyes in manufacturing and there is a growing demand for products that use natural dyes. Completely capturing the market with natural dyed fabric is an urgent need to maintain a safe environment. Textile materials (natural and synthetic) used to be coloured for value addition, look and desire of the customers. Anciently, this purpose of colouring textile was initiated using colours of natural source, untill synthetic colours/dyes were invented and commercialized. For ready availability of pure synthetic dyes of different types/classes and its cost advantages, most of textile dyers/ manufacturers shifted towards use of synthetic colourant. Natural dyes have lighter tones and are not very colorfast. But these problems can be overcome by using chemicals called as mordants. Mordants are metal salts which produce an affinity between the fabric and the dye (Vankar *et al*., 2009; Samanta and Agarwal, 2009). Metal ions of mordants act as electron acceptors for electron donors to form co-ordination bonds with the dye molecule, making them insoluble in water (Mongkholrattanasit *et al.*, 2011).besides chemical mordants natural mordants like rice stalk , are also gaining importance.natural dyes can produce a wide range of beautiful shades with acceptable level of colourfastness (Ekrami et al 2011). It is easy to design using natural colours as they complement each other well and rarely clash. Synthetic dyes, on the other hand, often look bright and garish and they require more skill in colour matching.In this paper highlight has been given to the importance of natural dyes to the environment and along with procedure and source of dyes.

Source of natural dyestuffs

Dyestuffs are fugitive and non- fugitive colour obtained from different sources. . Almost an organic material will produce a colour when boiled in a dye-bath, but only specific plants will yield a colour that can act as a dye. Natural dyes can be obtained from various sources like leaves and stems, Twigs and prunings ,Flower heads ,Barks ,Roots ,Outer skins, hulls and husks ,Heartwoods and wood shavings , Berries and Leaves seeds ,Lichens etc.

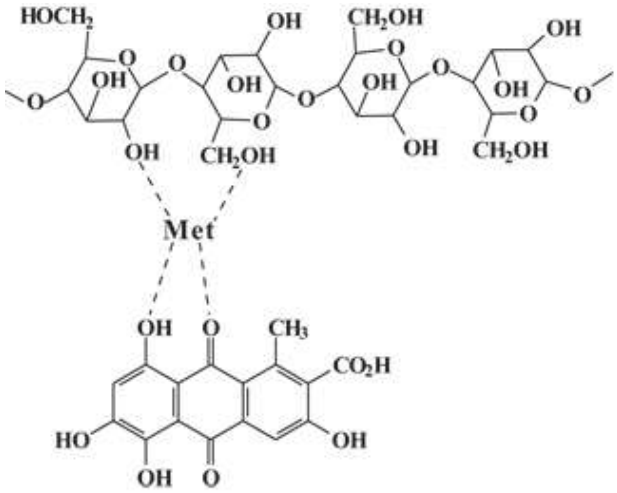
Some common dyestuffs

Common Name	Latin Name	Parts Used	General Colour Guide	Suggested Mordant
Alder	Alnus spp	Bark	Yellow/ brown/ black	Alum, iron. Copper sulphate
Alkanet	Anchusa tinctoria	Root	Grey	Alum, cream of tartar
Apple	Malus spp	Bark	Yellow	Alum
Blackberry	Rubus spp	Berries, young	Pink,	Alum, tin
Blackwillow	Salix negra	Bark	Red, brown	Iron
Bloodroot	Sanguinaria canadensis	Roots	Red	Alum, tin
Buckthorn	Rhammus cathartica	Twigs, berries, bark	Yellow, brown	Alum, cream of tartar, tin, iron
Cherry (wild)	Prunus spp	Bark	Pink, yellow, brown	Alum
Dahlia	Dahlia spp	Petals	Yellow bronze	Alum
Dog's mercury	Mercurialis perennis	Whole plant	Yellow	Alum
Dyer's broom	Genista tinctoria	Flowering tops	Yellow	Alum
Datura	Datura Stramonium	leaves	green	Alum,Copper sulphate
Elder	Sambucus negra	Leaves, berreis, bark	Yellow, grey	Iron, alum
Eucalyptus	Eucalyptus	Leaves	Deep gold, grey	
Henna	Lawsonia inermis	Leaves	Gold	
Hypogymnia lichen	Hypogymnia psychodes	Whole lichen	Gold, brown	
Indigo	Indigofera	Leaves	Blue	Not required
Ivy	Hedera helix	Berries	Yellow, green	Alum, tin
Madder	Rubia tinctora	Whole plant	Orange, red	Alum, tin
Maple	Acer spp	Bark	Tan	Copper sulphate
Marigold	Calendual spp	Whole plant, flower heads	Yellow	Alum
Nettles	Urtica dioica	Leaves	Beige, yellowy greens	Alum, copper
Onion	Allium cepa	Skins	Yellow, orange	Alum
Oak	Quercus spp	Inner bark	Gold, brown	Alum
Ochrolech-ina lichen	Ochrolech-ina parella	Whole lichen	Orange, red (when fermanted in urine then boiled)	Alum
Privet	Ligustrum vulgare	Leaves, berries	Yellow, green, red, purple	Alum, tin

Safflower	Carthamus tinctoria	Petals	Yellow, red	Alum
Sloe-Blackthorn	Prunus spinosa	Sloe berries, bark	Red, pink, brown	Alum
Tea	amelia sinensis	Leaves	Beige	
Turmeric	Circuma longa	Root	Yellow	
Wild mangosteen	Diospyros peregrina	Fruit	Grey, pink	

Types of textiles suitable for dying

Natural dyes can be used on most types of material or fibre but the level of success in terms of fastness and clarity of colour varies. Users of natural dyes, however, tend to also use natural fibres, to give a total natural effect. Synthetic fibers can also be dyed with natural dyes, if proper mordant and proper procedure is used. Natural fibres come mainly from thee different origins, animal origin,vegetable origin and mineral origin. Fibres from an animal origin include wool, silk, mohair and alpaca, as well as some others which are less well known. All animal fibres are based on proteins. Natural dyes have a strong affinity to fibres of animal origin, especially wool, silk and mohair and the results with these fibres are usually good. Fibres of plant origin include cotton, flax or linen, ramie, jute, hemp and many others. Plant fibres have cellulose as their basic ingredient. Today, the application of natural dyes to textiles involves cotton as the principal substrate. This process involves four key steps: plant extraction; mordanting; rinsing; and dyeing. The second step is especially important because nature did not develop its colors for textile use and have no inherent substantivity for textile fibers and must be bonded through the use of an intermediary



Dye bonded to cotton cellulose using a mordant (Met; a metal ion such as Al3+, Fe2+)

Natural dyeing of certain plant based textiles can be less successful than their animal equivalent. Different mordanting techniques are called for with each category. When a blend of fibre of both animal and plant origin is being dyed, then a recipe should be chosen which will accentuate the fibre which is required to be dominant. Mineral fibers are not mostly choose for dyeing.

Benefits of natural dyes

Shade:The shades produced by natural dyes/colourants are usually soft, lustrous and soothing to the human eye.Natural dyestuff can produce a wide range of colours by mix and match system. Asmall variation in the dyeing technique or the use of different mordants with the samedye (polygenetic type natural dye) can shift the colours to a wide range or create totally

new colours, which are not easily possible with synthetic dyestuffs Natural dyestuffs produce rare colour ideas and are automatically harmonizing.

Biodegradability: Unlike non-renewable basic raw materials for synthetic dyes, the natural dyes are usually renewable, being agro-renewable/vegetable based and at the same time

biodegradable. In some cases like harda, indigo *etc.*, the waste in the process becomes an ideal fertilizer for use in agricultural fields. Therefore, no disposal problem of this natural waste.www.intechopen.com

Historical and ethnographic: The use of natural dyes means a return to dyestuffs traditionally

used in different geographical and cultural areas, revitalising traditional dyeing techniques in danger of disappearing.

Sustainability: The eventual depletion of fossil fuels such as coal and oil, which are used in the production of synthetic dyes, means that a return to the use of dye plants is a matter of foresight. The cultivation of these plants is also an opportunity for farmers in areas where other crops are difficult to grow. Again looking towards the future, the dye industry must start to exploit material from forestry and agricultural waste, which at present is thrown away or burnt. Application of natural dyes has potential to earn carbon credit by reducing

consumption of fossil fuel (petroleum) based synthetic dyes.

Job avenues

These practices provide new job opportunities for traditional artisans and producers. Many plants thrive on wastelands. Thus, wasteland utilization is an added merit of the natural dyes. Dyes like madder grow as host in tea gardens. So there is no additional cost or effort required to grow it.Natural dyes can produce special aesthetic qualities, which, combined with the

ethical significance of a product that is environmentally friendly, gives added value to

textile production as craftwork and as an industry.

ANTIMICROBIAL PROPERTIES OF NATURAL DYES

Cotton, wool, silk, and linen fibers are the most widely used natural fibers in textile industry today; they are used to make soft, breathable, and functional textiles for a wide range of applications.Despite their endless uses, they have some drawbacks, mainly the susceptibility to microbial attacks.(kohl.J 2011) They provide several favorable conditions such as moisture, temperature, oxygen, and nutrients required for rapid growth and multiplication of pathogenic microorganisms resulting in high offensive odors, color degradation, cross-infections in hospitals, and transmission of diseases, allergic responses, and deterioration of textile materials.(gupta.D, 2007) . To overcome these problems, scientists have applied some innovative antimicrobial finishes on textile surfaces. Substantial investigations have revealed the application of wide range of synthetic chemicals and auxiliaries as antimicrobial agents, etc. Toxicity is the ability of a substance to cause damage to living tissue, impairment of nervous

system or severe illness when ingested, inhaled or being absorbed by skin. The toxicity(Zippel, 2004; Joshi & Purwar, 2004) data provide evidence about the adverse effect of natural dyes to human body. The LD50 is the best-known figure for toxicity rating of any substance. It describes the 'lethal dose for 50% of the test animals' which is the amount of substance in kg/kg of body weight which kills half of the animals. Most of the natural dyes are found to be non-carcinogenic in nature. Moreover, natural dyes have positive effect on antifungal and anti bacterial growth. The crude methanolic extracts of stem and roots stem, leaves, fruit, seeds of artocarpus hetrophyllus (Khan et al, 2003) and their subsequent partitioning with petrol, dichloromethane, ethyl acetate and butanol fractions exhibit a broad spectrum of antibacterial activity.However, most of the synthetic agents either produce toxic chemicals or generate dangerous effluents thus pose considerable energy and environmental challenges. Therefore, the textile processing industry has imposed strict bans on certain synthetic dyes and auxiliaries which are posing serious challenges to sustainability issues. tion are classified as medicinal, and some of these have recently been shown to possess remarkable antimicrobial activity. *Punica granatum* and many other common natural dyes

are reported as potent antimicrobial agents owing to the presence of a large amount of tannins. Lee et al.reported that cotton, silk, and wool fabrics dyed with the extract of pomegranate and other natural colorants showed antimicrobial activity against S. aureus and K. pneumonia. The phenolics and flavonoid compounds present in pomegranate have been found to be responsible for its antimicrobial activity. Koh and Hong noticed that the gallnut extract dyed cotton and wool displayed good antioxidant and antimicrobial properties, and that the pretreatment using plasma

improved their finishing effects. Several other sources of plant dyes rich in naphthoquinones such as lawsone from henna, juglone from walnut and lapachol from alkannet are reported to exhibit antibacterial and antifungal activity. Owing to the existence of large number of structurally diverse active compounds such as tannins, flavonoids, curcuminoids, alkaloids, and quinines in their

extracts, the use of natural colorants offers promise in developing antimicrobial textiles for aesthetic, hygienic, and medical applications in the near future. observed that the catechins from green tea extract induced leakage of 5,6-carboxyfluorescein from phosphatidylcholine liposome from bacteria and suggested that the death of cells resulted from the disruption of bacterial membrane. They found that Gram-positive bacteria were more susceptible to catechins as compared to Gram-negative bacteria. Yusuf and co-workers investigated antibacterial and antifungal potential of leaves extract of henna before and after application on wool yarns. They observed that leaves extract of henna in solution is highly active against common human pathogens such as Escherichia coli, Staphylococcus aureus, and Candida albicans and retains its activity after application on wool yarns up to several washing cycles. Hoshino and co-workers(1999) found that in the presence of a non lethal concentration of copper(II) metal ion, catechins are more effective against Gram-negative E. coli than Gram-positive S. aureus. They believe that the interaction of (-)-epigallocatechin,(-)-epicatechin, and copper(II) results in the generation of hydrogen peroxide which accounts for its bactericidal activity. Datura a local plant is very helpful in reducing human body pain, it also produce very pleasant green colour, (fig.1).However, dyes commonly used in textile are seldom screened for use as antimicrobial agents for textile finishing. Also, overexploitation of natural resources to obtain dyes may result in deforestation and threaten endangered species. For these reasons, the Global Organic Textiles Standard (GOTS) prohibits the use of natural dyes from endangered species.

Conclusion

Textile dyeing industry at present uses excessive amount of synthetic dyes to meet the required coloration of global consumption of textiles due to cheaper prices, wider ranges of bright shades, and considerably improved fastness properties in comparison to natural dyes (El-Nagar et al. 2005; Iqbal et al. 2008. The application of such dyes causes serious health hazards and influences negatively the eco-balance of nature (Bruna and Maria 2013; Goodarzian and Ekrami 2010; Jothi 2008). As a result, natural dyes are among the promising options for developing a greener textile as well as for construction of medicinal clothings. The use of standard natural dyes both in the form of paste and powder manufactured by the leading companies in our country should be promoted through training and education to enable artisans to produce more qualitative and standard textiles in the vegetable dyed form. Public awareness may be generated through advertisement, holding of workshops, seminars etc with regard to benefits of using vegetable dyed cloth in comparison to synthetic dyed cloth.

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Fig-1 Eri shawl woven from datura (*Datura stramonium*) dyed yarns