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## Importance of natural dye over synthetic dye: a critical review

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### Abstract

With the increasing awareness of health and environmental hazardous of synthetic dyes, the old culture of textile dyeing with natural sources are coming back. Some people, concerned about the human health and the environment, making efforts on large scale to revive old culture of dyeing with the natural resources such as plant, insects, mineral. These sources are not only biodegradable but also have medicinal properties with them. So natural dye is a topic of international interest due to the increased awareness on various properties of natural dyes. In this article, types of natural dye sources and their potential health, environment and business benefits are reviewed.

**Keywords:** Synthetic dye, medicinal properties, biodegradable, potential health

### Introduction

According to scientists, textile production is one of the most polluting of all industrial sectors, and is considered the second largest source of water pollution in the world after agriculture. According to the World Bank, 17-20% of industrial water pollution comes from synthetic textile dyes, and about 40% of synthetic dyes contain known carcinogens. In addition to harming human health, chemical dyes can accumulate in rivers, releasing toxic, hormone-disrupting chemicals that cause animal mutations and death. On the other hand natural dyes come with many benefits related to human health environment. Natural dyes are biodegradable, easily available, non toxic have lots of medicinal properties and also have large scale of tint and shades of various hues.

### Definition of natural dye

Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources roots, berries, bark, leaves, and wood and other organic sources such as fungi and lichens. (Wikipedia)

### Classification of natural dyes

Natural dyes can be classified in a number of ways. The earliest classification was according to alphabetical order or according to the botanical names. Later, it was classified in various ways, e.g. on the basis of hue, chemical constitution, application class etc.

- In "treatise on permanent colours by Bancroft, natural dyes are classified into two groups: 'Substantive Dyes' such as indigo, turmeric etc. which dye the fibers directly and 'Adjective Dyes' such as logwood, madder etc. which are mordanted with a metallic salt.
- classify the coloring matter as 'Monogenetic Dyes', those produce only one colour irrespective of the mordant present on the fiber or applied along with the dye and 'Polygenetic Dyes', those produce different colour with different mordant applied, e.g., alizarin

On the basis of hues, natural dyes can be classified as follows:

- Red colour dyes: most red dyes are hidden in roots or barks of plants or camouflaged in the bodies of dull grey insects. They are almost invariably based on anthraquinone and its derivatives. These dyes are stable to light and washing.
- Yellow colour dyes: Yellow is the liveliest and perhaps the most abundant of all hues in nature. About 90% of the yellow dyes are flavonoids.

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Generally, they produce pale shade with quicker fading except turmeric, which produce dull deep shade but considered to be susceptible to light as they emit fluorescence. Wash fastness rating of natural yellow dyes ranges from fair to excellent, e.g., tesu, turmeric, kapila.

- iii. Blue colour dyes are indigo and woad, give excellent fastness to light and washing. iv. Black colour dyes: Black shades, generally obtained from tannin rich plant natural dyes and appreciably substantive towards

cellulosic and protein fiber, imparts good overall fastness properties. Examples – logwood, harda, custard apple etc.

### On the basis of origin, natural dyes are broadly classified into three categories

On the basis of origin, natural dyes are broadly classified into three categories: vegetable, mineral and animal origin. About 500 vegetable origin dyes, colouring matter derived from root, leaf, bark, trunk or fruit of plants, are as follows in table.

**Table 1:** Showing some common natural dyestuffs obtained from different vegetable origin.

Parts of the Plant	Dyestuffs
Root	Turmeric, Madder (Manjistha), Onions, Beet-root
Bark/ Branches	Purple bark, Sappan wood, Shillicorai, Khair, Red, Sandalwood
Leaf	Indigo, Henna, Eucalyptus, Tea, Cardamon, Coral Jasmine, Lemon Grass
Flowers (Petals)	Marigold, Dahlia, Tesu, Kusum
Fruits/Seeds	Latkan, Pomegranate rind, Beetle nut, Myrobolan (Harda)

Mineral origin colourants are derived from specific mineral natural source or so-called mineral colours are produced from purified inorganic compounds. Some of the important mineral colourants are chrome-yellow, iron-buff, narkin-yellow, Prussian-blue and manganese brown. Animal origin lac, cochineal and kermes have been the principal natural dyes yielding from the insects.

### Natural dyes can also be classified on the basis of their chemical constitution (Dedhia, 1998) [6].

- Indigoid dyes:** Indigo and Tyrian purple are the most common examples of this class. Another blue dye, woad also possesses indigo as the main dyeing component.
- Anthraquinone dyes:** Almost all the red natural dyes are based on the anthraquinoid structure having both plant and mineral origin. Madder, lacs, kermes, cochineal do some of the dyes possess this type of structure. These are generally mordant dyes.
- Alphanaphthoquinones:** Typical example of this class is lawsone (henna), cultivated mainly in India and Egypt. Another similar dye is juglone, obtained from the shells of unripe walnuts. These dyes are generally disperse dyes and give shades of orange.
- Flavonoids, which yield yellow dyes, can be classified under flavones, isoflavones, aurones and chalcones. Flavones are colourless organic compounds. Most of the natural yellows are derivatives of hydroxyl and methoxy substituted flavones and isoflavones. Common example is weld (containing luteolin pigment) giving brilliant and fast colours on both wool and silk.
- Di-hydropyrans:** Closely related in chemical structure to the flavones are substituted di-hydropyrans, viz. haematin and its leuco form, haematoxylin. These are important natural dyes for dark shades on silk, wool and cotton. Logwood, Brazil wood and sappan-wood are the common example.
- Anthocyanidins:** The naturally occurring member of this class includes carajurin, a direct orange dye for wool and cotton.
- Carotenoids:** The class name carotene is derived from the orange pigment found in carrots. In these, the colour is due to the presence of long conjugated double bonds.

Another method of classifying natural dye is on the basis of the method of application.

- Mordant dyes are dyestuffs which require a mordant in their application as they have no affinity for the fiber being dyed. A mordant dye should have electron donating

groups capable of forming a complex with the transition metal salt, e.g., madder, fustic, persian, berries, kermes, cochineal etc.

- Vat dyes are water insoluble dyes which are first converted to their water soluble form (reducing with Na-hydrosulphite and then solubilising it with alkali) and then applied to the fibres. The true colour is produced only on oxidation followed by treatment with a hot soap solution, e.g., indigo.
- Direct dyes are those dyes that have tremendous affinity for the cellulosic fibres. They are dyed from a boiling dye bath. Turmeric, harda, pomegranate rind etc. are the few of the direct natural dyes.
- Acid dyes are applied from an acidic medium. The dye molecules have either sulphonic or carboxylic group (s) which can form an electrovalent bond with amino groups of wool and silk. An after treatment with tannic acid known as back tanning improves the fastness of these type of dyes, e.g., saffron.
- Disperse dye has a relatively low molecular mass, low solubility and no strong solubilizing groups. Disperse dyes can be applied on to hydrophobic synthetic fibre from neutral to mildly acidic pH. They can also be applied to silk and wool. These natural dyes can be post-mordanted with chromium, copper and tin salts, e.g., lawsone and many other flavone and anthroquinone dyes.
- Basic or cationic dyes on ionization give coloured cations and form an electrovalent bond with the –COOH group of wool and silk. These dyes are applied from neutral to mildly acidic pH. These dyes have poor light fastness, e.g., berberine.

### Advantages of Natural Dyes

While common textile dyeing processes are responsible for a large amount of residues in the wastewater from textile finishing companies, dyeing with natural dyes becomes more popular in the last time. In this way, not only water can be saved and water pollution avoided, but a broad spectrum of colors can be reached, opening new possibilities for textile designers. On the other hand, natural dyes are usually less intense and more prone to bleaching due to mechanical impact, washing or UV irradiation. Here we give an overview of different combinations of natural dyes used for dyeing diverse textile materials with and without pretreatment of the textile fabric. The resulting fabrics show a broad range of colors, depending mostly on the textile material and in some cases also on the pretreatment. While washing and UV

treatment show a relatively small influence, Martindale abrasion tests changed some of the colors significantly. (Anastasia Fröse. *et. al*, 2019) <sup>[1]</sup>.

Experimental evidence for allergic and toxic effects of some synthetic dyes is available. Natural dyes are mostly non-toxic, non-allergic. Some of the natural colours have added value for its medicinal effects on skin and are more than skin friendly. Natural dyestuff can produce a wide range of colours by mix and match system. A small variation in the dyeing technique or the use of different mordants with the same dye (polygenetic type natural dye) can shift colours to a wide range or create totally new colours, which are not easily obtainable with synthetic dyestuffs. 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. Many plants thrive on wastelands. Thus, wasteland utilization is an added merit of the natural dyes. In some cases the waste in the process becomes an ideal fertilizer for use in agricultural fields. This is a labour intensive industry, thereby providing job opportunities for all those engaged in cultivation, extraction and application of these dyes on textile. Natural dyes generate sustainable employment and income for the weaker section of population in rural and sub-urban areas both for dyeing as well as for non-food crop farming to produce plants for the natural dyes. Application of natural dyes has potential to earn carbon credit by reducing consumption of fossil fuel (petroleum) based synthetic dyes. The shades produced by natural dyes are usually soft, lustrous and soothing to the human eye. Natural dyes are suitable for protecting and preserving the ancient and traditional dyeing technology and for studying the ancient dyeing methods, colored museum textiles and other textiles recovered by archaeology for conservation and restoration of heritage of old textiles

### Textile Business with natural dyes Brands that Use Natural Dyes

List of few Indian brands that have ventured into producing clothes that use natural fabric and also natural colors:

**Bhu:** Sattva is a Gujarat based organic clothing brand, it uses fabric like hemp, bamboo, organic cotton, soya bean, modal, aloe vera, banana, pineapple, milk protein fiber, flax, and jute. The colors used are sourced from beetroot, pomegranate, henna, catechu, teak tree leaves, turmeric, madder red, kesu, haritaki, sewali flowers, and indigo.

**Forty Red Bangles:** Started by Ramona Saboo, Forty Red Bangles has collaborated with various NGOs, including Aura Herbal Textiles Ltd. that produces herbal textiles and dyes, to produce clothes that are environment friendly.

**Anokhi:** This is a well known brand that is known for block printing the fabrics with vegetable color dyes. Anokhi is distinguished by its prints and sense of designs, range of colours and product quality.

**Tvach:** Tvach's clothes are made of organic cotton, silk, and bamboo and uses natural dyes like turmeric, madder, pomegranate, myrablam, and beetroot.

**Indigreen:** Started by Nidhi Singh and Gaurav G, this brand makes clothes using fabric that is made out of organic cotton, bamboo fabric and hand woven organic khadi. Indigreen uses colors that are natural, non-toxic and environment friendly.

### Is Natural Dyes is the Right choice for Business?

Just like all things, using natural dyes has advantages and disadvantages. Consider its impact on the environment. Natural dyes have lesser environmental impact compared to synthetic dyes. However, you also need to factor in the cost and sustainability.

### Conclusion

So by considering all the facts, it is found that there are so many benefits of natural dye, these resources are not only environment friendly, bio degradable but some of them also have medical values to it and at present, many researchers partly solved the problem of poor color fastness of the natural resources and making continuous efforts in this endeavor. So for a business purpose slowly but surely we can replace synthetic dye with natural dye resources and for initial phase of natural dye business, it is also very important to have the efficient knowledge of dye extraction, mordanting and dyeing. Business of natural dyed fabric is gaining popularity day by day throughout the world. At last it can be said natural dyes are great option to revive back.

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