Commercially Valuable Natural Dyes: Sources and Their Value Addition

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Natural dyestuffs comprise materials of plant, animal, mineral or microbial origin.[1] Natural dyes from vegetable sources can be obtained from different parts of the plants like leaves, fruits, seeds, flowers and bark roots. These types of dyes have been used since prehistoric times for the dyeing of natural fibers such as wool, cotton, silk, as well as for the dyeing of fur and leather. A dye can be defined as a highly coloured substance used to impart colour to an infinite variety of materials like textiles, paper, wood, varnishes, leather, ink, fur, food stuff, cosmetics, medicine, toothpaste, *etc.* Dyes are substances used for colouring, pharmacy, for dyeing leather, staining wood, when dissolved in alcohol, dyeing cloth. Also used in varnishes, leather, ink, wood, medicines, foods *etc.* The art of making natural dyes is one of the oldest known to man and dates back to the dawn of civilization. India's expertise in natural dyes dates back to ancient times. In India, there are more than 450 plants that can yield dyes. Majority of the dyes are in textile industries, food industries, cosmetics, *etc.* Many natural dyes such as myrobalan fruits, turmeric, manjishtha root, arjuna (*Terminalia arjuna*) bark, and safflower florets, among others possess curative properties and have been used in various traditional medicinal systems(Gulrajani, 2001).

The advent of synthetic dyes and their advantages over the natural ones, such as wide range of available colours, improved quality, lower prices, higher colour fastness and reproducibility, had led to a sharp drop in the commonplace of natural dyestuffs at the end of the nineteenth century. However, the widespread environmental awareness of the mid-1960s sparked a revival of the interest in natural dyes.[3] In contrast to the synthetic dyes, natural ones are considered to be non-toxic, non-carcinogenic and environmentally courteous. Further, they exhibit antioxidative, antibacterial, as well as anti-inflammatory properties, since most of them contain phenolic compounds. Moreover, they are regarded as renewably- and sustainably-resourced products, even though the use of some of them, such as Tyrian purple and Indigo, are subjected to limitations because of their scarcity and the labour-intensive procedures imposed by their application and production.

Nowadays being fashionable means to be worried about environmental issues and sustainable development. Dyes which extracted from natural materials such as plant leaves, roots, bark, insect secretions, and minerals for sustainable and eco-friendly textile dyeing are now become lessening the exercise of synthetic dyes in the global industrial markets. Recently the awareness of environment as well as increasing disputes about the risks of synthetic dyes resulted in growing interest in natural resources, environmentally friendly products and new strategies (Pezzolo, 2007; Manley *et al.* 2008). Now, the whole world is looking back, towards the resurgence of natural dyes. Herbal dyes being naturally tended to be softer and their range of tones are very pleasant. At present, the total market of herbal dyes is to the tune of US $ 1 billion and is growing tremendously at the rate of 12 per cent/annum. Per capita consumption of dyes is 400 g to 15 kg in developed and underdeveloped countries, for their utility in paints, inks, textiles, polymers, etc. India is a major exporter of herbal dyes mostly due to the ban on production of some of the synthetic dyes and intermediates in the developed countries, due to the pollution.

Advantages of Natural Dyes

- Natural dyes eco-friendly and obtained from renewable resources
- Easily biodegradable
- No health hazards, sometimes they act as health cure
- No disposal problems; vegetal matter left after extraction of dyes can be easily composted and used as fertilizer.
- Practically no or mild chemical reactions are involved in preparation of dyes
- They produce soft colors soothing to the eye which are in harmony with nature.
- Many of the natural dyes absorb in the ultraviolet region and therefore fabrics dyed with such dyes should offer good protection from ultraviolet light.
- Many of the natural dye materials possess antimicrobial and UV protection properties.
- Users of natural dyed fabrics have also found such fabrics to be mosquito repellent and/or moth repellent
- Cellulosic textiles treated with natural plant extract have been found to exhibit flame-retardant properties.

Commercially valuable dye sources and their value addition

1. *Bixa orellana*: Lipstick tree, Annatto dye Dye is obtained from seeds and used for colouring silk, sweets, cotton, edible oils, fats, cheese, butter, puddings, chocolate and other products. Lipstick is produced from dye. Because of its use in butter, margarine and cheese, annatto was formerly declared as "buttercolour" or "cheese colour".	 
2. *Mallotus phippinensis*: **Monkey Face tree, Kamela dye** Dye is obtained from the red granules covering the ripe fruit capsules and used for dyeing silk, cotton, colouring paints, varnishes, leather, inks, paper, wool, medicine, colouring soaps, ice creams, cosmetics, body adornments and soft drinks.	 
3. *Caesalpinia sappan* **Sappan wood, Brazilin dye** Red dye used for colouring of cloth, silk and wool fabrics. Dye is also used for making red ink and also for calico printing. Dye is used to add colour to food products like ice creams, baked goods and beverages. Medicinally used as tonic and treating skin	 
4.*Pterocarpus santalinus* **Red Sanders, Santaline dye** This dye, extracted from the heartwood, is known for its vibrant colour and traditionally used for dyeing silk, wool, and cotton fabrics. It's also used in pharmaceuticals and foodstuffs as a colouring agent. It is also used for dyeing leather and staining wood, as colouring agent in pharmacy.	
5.*Artocarpus heterophylus* **Jack, Kathal dye** The dye is used in wood working and textile dyeing. It can be used to enhance wood appearance, create unique colourations and even for dyeing textiles. Yellow dye used for cloth, silk, for dyeing Buddhist monk's robes. The dye can be used to colour fabrics of jute and cotton.	
6. *Indigofera tinctoria* ***Indigo, Indigo dye*** It is known as king of dye stuffs. Dye obtained from leaves is known for their rich blue colour and are used in various applications, including textiles, especially for dyeing denim. It is used on a large scale in the commercial production of blue jeans.	 

7.***Lawsonia inermis*** **Henna (Mehandi), Henna dye** Henna leaves are used for producing brown colour dye; henna bonds well with protein, hence used to dye sin, hair, fingernails, eye brows. also used for dyeing for fabrics, silk, wool and leather.	 
8. ***Rubia cardifolia*** **Indian Madder, Manjista/ Manjit dye** Dye obtained from roots are used for producing reddish hues on textiles like wool, coarse cotton, blankets, carpets and silk. Dye also used for hair colouring, for colouring foods and calico printing.	 
9. ***Butea monosperma*** **Palas, Dhak dye** The vibrant yellow-orange colour obtained from flowers is used for Holi, colouring textiles silk and fabrics. The dye has potential applications in pharmaceuticals, and even as a colouring agent for food products like soft drinks, sausages, jams, and noodles.	 
10. ***Crocus sativus*** **Saffron, Saffron dye** Saffron dye, derived from the dried stigmas of the flower, is used for dyeing food (as natural colorants), textiles and fabrics. It also has historical and cultural significance, including its use in religious ceremonies and as a status symbol.	 
11. ***Terminalia arjuna*** **Arjuna, Reddish brown colour dye** Arjuna bark produces a yellow to reddish-brown colour on fabrics and can be applied to cotton, silk, and nylon.The bark contains tannins and flavonoids that act as natural colorants, and it can be used on various fabrics and materials without requiring a mordant.	 
12. ***Terminalia chebula*** **Chebulic myrobalan, Yellow dye** Yellow dye obtained from fruits is a valuable source of natural dye, particularly for textiles. Dye can be used to produce a range of colorfast shades on silk, wool, and cotton. The fruit is also a good source of tannins, which play a vital role in dyeing various materials like leather, cotton, wool, and silk.	 

13. *Lacciferlacca* **Lac, Lac dye** Lac dye is usually red to burgundy in colour and extracted from resin produced from lac insect. It is used for dyeing wool, silk, and colouring food. It also has applications in traditional crafts like handicraft textiles, varnishes, polishes, and lithographic inks.	 
14. *Dactylopius coccus* **Cochineal insect, Cochineal dye** Dyes are derived from the dried bodies of female insects. Used in textiles, carmine derived, is a popular natural red pigment used in lipsticks, blushes and other cosmetics.Cochineal extract is used in food products like candies, yogurts, and beverages	 

Limitations/drawbacks of Natural Dyes

- Limited number of suitable dyes
- Availability of plant resources and colour yield is less
- Allow only wool, natural silk, linen and cotton to be dyed
- Complexity in dyeing process
- Great difficulty in blending dyes
- Inadequate degree of fixation and fastness properties (Gulrajani, 2001)

Value addition of dyes

Natural dyes find use in the colouration of textiles, foods, drugs, textiles and cosmetics. Small quantities of dyes are also used in colouration of paper, leather, shoe polish, wood, cane, candles, *etc.*

Conclusion

Natural dyes/colorants derived from flora and fauna are believed to be an eco-friendly, safe and viable substitute to synthetic colorants because of their non-toxic, non-carcinogenic and biodegradable nature. Moreover, natural dyes do not cause pollution and waste water problems. As per present trend of meeting peoples demand keeping in view ecological concerns of synthetic colorants, natural dyes are used for textile functional treatments with antimicrobial, UV-protection, de-odorizing, anti-allergic, anti-feedants, fluorescence and some other functional finishing properties. Therefore, constantly increasing demand and new source of natural dyes are to be explored suitably and systematically for sustainable coloration of synthetic, natural textile and food materials.

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