

Eco friendly natural dyes

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■ **ABSTRACT** : The art of dyeing with natural dyes is as old as our civilization. Dyed textile remnants found during archaeological excavations at different places all over the world provide evidence to the practice of dyeing in ancient civilizations. Dyes derived from natural materials such as plant leaves, roots, bark, insect secretions, and minerals were the only dyes available to mankind for the coloring of textiles until the discovery of the first synthetic dye in 1856. Textiles colored with natural dyes are preferred by environmentally conscious consumers and today there is a niche market for such textiles. But the total share of natural dyes in the textile sector is very less due to certain issues involved in the production and application of these dyes. Natural dyes are sustainable as they are renewable and biodegradable but they cannot fulfill the huge demand from the textile sector.

■ **KEY WORDS**: Natural dyes, Mordants, Advantages of natural dyes

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India has a rich biodiversity and it is not only one of the world's twelve mega diversity countries. Nature has given us a number of plants. It has approximately 490,000 plant species of which about 17,500 are angiosperms more than 400 are domesticated crop species and almost an equal number their wild relatives. India is rich in natural wealth and there is no doubt that the plant kingdom is treasure house of diverse natural products. One such product from nature is the dye. There is ample scope to explore and revive application of natural dyes on textiles.

Now a day's natural dyes are commonly used for textile industries, due to their harmless effects and harmful consequences of synthetic dyes. Natural dyes work on cotton silk and wool etc. their colours are stable and ecofriendly because of no irritating effects on human skin (Adeel *et al.*, 2013 and 2014 and Dixit and Jahan,

2005).

Natural dyes are derived from natural resources and based upon their source of origin, these are broadly classified as plant, animal, mineral, and microbial dyes although plants are the major sources of natural dyes. Historically, plants have been used for the extraction of a majority of natural dyes. Various plant parts including roots, leaves, twigs, stems, bark, woods shavings, flowers, fruits, rinds, hulls, husks, and other organic sources such as fungi and lichens serve as natural dye sources (Babel *et al.*, 2016 and Chitra Devi *et al.*, 2013).

Dyeing is an ancient art which predates written records. Its practice could be traced back during the Egyptian civilization. Primitive dyeing techniques included sticking plants to fabric or rubbing crushed pigments onto cloth. The method became more sophisticated with time and techniques using natural dyes from crushed fruits,

barriers and other plant materials which were boiled into the fabric later some light and water fastness tests were developed (Jothi, 2008; Babel and Gupta, 2016; Babel and Rajvanshi, 2015 and Grover and Patni, 2011).

India has a very rich tradition of using natural dyes. The art and craft of producing natural dyed textile has been practiced since ages in many villages by traditional expert crafts- persons in the country. Natural dyes find use in the colouration of textiles, food, drugs and cosmetics. Small quantities of dyes are also used in colouration of paper, leather, shoe polish, wood, cane, candles, etc. In the beginning, there were dyes derived only from natural sources. Some processing was required but essentially the dye itself was obtained from a plant, mineral or animal. After the accidental synthesis of mauveine by William Henry Perkin in 1856 and its subsequent commercialization, heralding the advent of coal tar dyes (now synthetic dyes), the use of natural dyes receded.

Synthetic dyes are widely available at an economical price and produce a wide variety of colours having moderate to excellent colour fastness properties. These dyes however produce skin allergy, toxic wastes and other harmfulness to human body. Presently there is an excessive use of synthetic dyes, estimated at around 10,000,000 tons per annum, the production and application of which release vast amounts of waste and unfixed colorants, causing serious health hazards and disturbing eco-balance of nature. Recently there has been a revival of the growing interest on the application of natural dyes on natural fibres due to worldwide environmental consciousness (Samanta and Agarwal, 2009) researches has shown that synthetic dyes are suspected to release harmful chemicals that are allergic carcinogenic and detrimental to human health. The use of natural dyes for textile dyeing purposes decreased to a large extent after the discovery of synthetic dyes in 1856. As a result, with a distinct lowering in synthetic dyestuff costs, the natural dyes were virtually neglected at the beginning of twenties century (Saravanan and Chandramohan, 2011).

However, recently there has been revival of the growing interest on the application of natural dyes on natural fibres due to worldwide environmental consciousness. The use of natural dyes has increased substantially during the last couple of years. These dyes are being mainly used by traditional dyers and printers, textile and fashion designers, small and cottage industry

workers, non government organizations, museum functionaries, hobby classes and academic institutes and research associations/laboratories (Gulrajani, 2001).

The use of non allergic, non toxic and ecofriendly natural dyes on textiles has become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes, which are synthesized from chemical precursors. Recently, a number of commercial dyer and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textile to overcome environmental pollution caused by the synthetic dyes. 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 colour fastness behavior and reproducible colour 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 reinvestigate and rebuild the traditional processes of natural dyeing to control each treatment and pre-dyeing process (preparation, mordanting) and dying process variables for producing uncommon shades with balanced colour fastness and eco-performing textiles.

In spite of the better performance of synthetic dyes, recently the use of natural dyes on textile materials is attracting more and more researchers for study on this due to the following reasons:

- Availability of experimental evidence for allergic and toxic effects of some synthetic dyes, and non-toxic and non allergic effects of natural dyes.
- Availability of knowledge base and database on application of natural dyes on different textiles.
- Availability of scientific information on chemical characterizations of different natural colorants, their purification and extraction.
- Specialty colours and effects of natural dyes produced by craftsman and artisans for their exclusive technique and specialty work.
- To 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 framing to produce plants for such natural dyes.
- To protect the ancient and traditional dyeing

technology generating live hood of poor artisan/ dyers, with potential employment generation facility.

- To study the ancient dyeing methods, coloured museum textiles and other textiles recovered by archaeology for conservation and restoration of heritage of old textiles.

- Wide viability of natural dyes and their huge potential.

The restrictions of the natural dyes that were responsible for their decline are availability, colour yield, complexity of dying process, and reproducibility of shade (Glower Brian, 1998).

Besides these, there are the following apparent technical drawbacks of natural dyes are allowed only wool, natural silk, linen and cotton to be dyed, great difficulty in blending dyes, inadequate degree of fixation, inadequate fastness properties, limited number of suitable dyes and non-standardized dyeing process. Water pollution by heavy metals and large amounts of organic substances is also a drawback.

The properties considered to be the advantages of natural dyes are no disposal problems, no health hazards, sometimes they act as health cure, practically no or mild chemical reactions are involved in their preparation, they are obtained from renewable resources they are unsophisticated and harmonized with nature (Gulrajani, 2001).

Textile fibres, especially cellulose, do not have much affinity for the majority of the natural dyes; hence these are subjected to an additional step known as mordanting. Mordants are the substances that have affinity for both textile fibres and dyes, they act as a link between the fibre and dyestuff. Those dyes that do not have affinity for a fibre can be applied by using mordants. In the case of dyes having affinity for the fibre, the use of mordants increases the fastness properties by forming an insoluble complex of the dye and the mordant within the fibres, which also improves the color. Unlike animal fibres, vegetable fibres such as linen and cotton do not readily hold the mordants resulting in duller color compared to the bright colors obtained on wool and silk. Mordanting is very important for cotton as it is more difficult to dye than wool or silk due to the absence of amino and carboxyl groups that provide attachment sites to dye molecules. There three types of mordants, namely metal salts or metallic mordants, oil mordants, and tannins. There are three types of methods for application of

mordants based on the time of their usage. They are pre mordanting, post mordanting and meta mordanting or simultaneous mordanting.

As natural dye-bearing materials contain only a small percentage of coloring matter or dye along with a number of other plant and animal constituents such as water-insoluble fibres, carbohydrates, protein, chlorophyll, and tannins, among others, extraction is an essential step not only for preparing purified natural dyes but is also required to be carried out by users of crude dye-bearing materials. As natural coloring materials are not a single chemical entity and the plant matrix also contains a variety of no dye plant constituents, extraction of natural dyes is a complex process. The nature and solubility characteristics of the coloring materials need to be ascertained before employing an extraction process. The different methods for extraction of coloring materials are aqueous extraction, alkali or acid extraction, microwave and ultrasonic assisted extraction, fermentation, enzymatic extraction, solvent extraction and super critical fluid extraction. Coloring matter extract obtained from natural sources is mostly in aqueous media. If it is to be immediately used for dyeing as in many small-scale or cottage-dyeing establishments, it can be used as such after adjustment of concentration according to the shade requirements. However, if it is to be used at a later date for dyeing or in dye extract producing units, it has to be converted into either powder form or concentrated solid rich form for long-term storage and ease of transport. This also ensures uniformity of shade for the entire batch of dye powder or concentrate produced and natural dyes thus converted into powder form or liquid concentrates can be used like synthetic dyes by the industries. The techniques generally used for converting natural dye extracts into powder form or concentrates are spray drying, drying under vacuum and freeze drying.

As for synthetic dyes, the amount of dye to be taken is normally given as % shade. It denotes the amount of dye (in grams) to be taken for dyeing 100 g of textile material. The terminology remains the same for both crude dye material and purified extracts. As the dye content of raw materials is low, it is common to use 10–30 % shade whereas the amount can be reduced to 2–5 % for the purified dye extracts (Balamurugan and Kannadasan, 2012). The amount of mordants is also selected in relation to the shade dyed. A larger quantity of mordants is needed for higher shades.

As is the case with synthetic dyes, the amount of water to be taken in the dye bath is an important parameter. In technical terms, it is given in the recipe as the material-to-liquor ratio (MLR). The MLR denotes the amount of water in ml required per gram of the fabric to be dyed. As natural dyes differ in their chemical constituents, their dyeing procedures also differ but their basic dyeing process is similar. There may be different optimum temperature, time, and pH of dyeing but the basic steps remain the same. Many natural dyes are dyed at near boiling temperature on cotton. Wool and silk are dyed at a lower temperature although some dyes may dye cotton also at lower temperature. Most dyes require neutral pH but some dyes require acidic pH and some may need alkaline pH. For dyeing animal fibres wool and silk, generally 1–2 % of acetic acid is added during dyeing (Ghoulia *et al.*, 2012 and Haji, 2010). The material to be dyed is pre mordanted or otherwise is introduced into the dyeing bath at room temperature and the temperature is then increased slowly to ensure uniformity of dyeing. The material is usually dyed for at least an hour to allow the dye to penetrate well inside the textile material. The movement of textile material in the dye bath is very essential. If the dyeing is carried out in dyeing machines, movement of the material is taken care of but in hand dyeing, the fabric needs to be continuously stirred in the dye bath, otherwise uneven dyeing may result. If delicate fabrics are to be dyed, the dye bath should not be stirred continuously as that will damage the fabric structure. In such cases, it is advisable to have a material-to liquor ratio of at least 1:100 so that the fabric is completely immersed in the dye liquor during dyeing and dyeing is uniform. If simultaneous mordanting is to be carried out, the required quantity of mordant is also added to the dye bath. After the dyeing is over, the dyed materials are removed and allowed to cool down a little and then washed with water. Some traditional dyers leave the material in the dye bath itself to cool and then remove the material for washing. The washed dyed material is then soaped with a hot soap or nonionic detergent solution to remove loosely held dye and is again rinsed with water and air dried in shade. At industrial scale, hydro extractors are used to remove excess water during washing. If post mordanting is to be carried out, the washed material is taken up for post mordanting without soaping and soaping is carried out on the post mordanted material after washing.

Conclusion:

On the basis of above, review of literature natural dyes are found ecofriendly, more useful and cost effective, harmless with soothing effects. We should use natural dye cloths to make these practices popular in society. So, that plant production may be increased in future which will be beneficial for environment. Although natural dye cloths are costlier than synthetic ones, but they can be made cost effective in coming days by more production of dye yielding crops on large scale with cheaper techniques of dyeing. Thus natural dyes are beneficial to save environment by large scale production of plants, to human society for safer and harmless life and to reduce pollution problems by synthetic dyes.

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