

Review on Natural Dye and Methods of Dye Extraction from Natural Sources

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Abstract: The commonly available dyes which are synthetically produced are toxic and harmful for humankind. These dyes when used on textiles, results in skin diseases and disorders like allergy, skin rashes, and even cancer in some cases. Hence the demand for alternative dyes which does not cause any side effects rose. This led to extraction of dyes from natural sources like plants, insects and even from certain minerals. Dyes extracted from plant source (bark, flowers, leaves and fruits) are more preferable than other natural sources in textile industry. Most of the natural dyes which are extracted from plants had shown notable fastness property and also exhibits some special properties such as anti-microbial, less toxicity and less allergenic character when compared to synthetic dyes. Natural dyes also provide comparatively more UV protection than synthetic dyes. This review is aimed to focus on different types of raw materials and extraction processes from which natural dyes are produced and different properties of naturally dyed fabric.

Keywords: Natural dye, Pigment, Colorant, Mordant, Extraction process, Eco-friendly

1. Introduction

The textile industry effluent is one of the major sources of pollutant on Earth. Because it contains harmful chemicals like benzene (C₆H₆), toluene (C₇H₈), naphthalene (C₁₀H₈), xylenes or dimethylbenzenes (C₈H₁₀) and so on (Yaseen DA, Scholz M. *et al.*). Water is the most essential resource of life. The dyeing process of a single T-shirt needs around 250 gallons of water. The effluent from dyeing textile industries contains thousands of physical and chemical pollutants which are being dumped into rivers and canals nearby. This led to production of eco-friendly dyes using eco-friendly chemicals. Using natural dyes will cause less environmental impact when compared to synthetic dyes. Green and eco-friendly textile is the new generation motto. All fashion brands are now stepping forward to use eco-friendly dyes which will help to make the world a better

place. From 21st century, the planet travels towards safer, less hazardous, recyclable technology. Thus, the need for environment friendly, biodegradable, non-toxic, less polluting natural dye is increasing day by day in various sectors. The UV safe character of most natural dyes makes it better than synthetic dyes. Foods, drugs, cosmetics and textiles are the most market place for natural dyes. The main drawback of using natural dyes is poor fastness property. Research works are being carried out to eliminate this problem.

Natural Dye Yielding Plants:

There are plenty of plants and trees from which dyes have been extracted and some among all the plant sources and the colour obtained are tabulated below:

Plant Source	Part of the plant used	Colour Obtained
<i>Acacia leucophloea</i>	Leaves	Red
<i>Adhatodavasicanees</i>	Leaves	Yellow
<i>Allium cepa</i>	Fruits and leaves	Yellow
<i>Aloe barbadensis miller</i>	Whole plant	Red
<i>Azadirachata indica</i>	Bark	Brown
<i>Capsicum annum</i>	Fruits	Red
<i>Chukrasiatabularis</i>	Leaves	Red, Yellow
<i>Convallaria majalis</i>	Leaves	Green
<i>Crocus sativus</i>	Flower	Yellow, Orange
<i>Curcuma longa</i>	Rhizome	Yellow
<i>Impatiens balsamina</i>	Flower	Red
<i>Indigofera cassioides Rottl. ex DC.</i>	Leaves	Blue
<i>Indigofera tinctoria</i>	Leaves	Blue
<i>Isatis tinctoria Linn</i>	Leaves	Black, Blue
<i>Juglans regia</i>	Bark	Brown, Black
<i>Lawsoniainermis L.</i>	Leaves	Brown
<i>Mangifera indica</i>	Leaves	Yellow
<i>Ocimumtenuiflorum</i>	Leaves	Reddish Brown
<i>Opuntia ficus-indica</i>	Fruits	Orange, Red
<i>Phyllanthus emblica</i>	Bark	Yellow, Green, Black
<i>Punica granatum</i>	Bark	Pale yellow
<i>Solanum xanthocarpum</i>	Fruits	Red
<i>Syzygiumcumini (Linn.) Skeel</i>	Leaves	Red

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<i>Tectona grandis</i>	Leaves	Pink
<i>Urtica dioica</i>	Leaves	Green
<i>Woodfordia fruticosa</i>	Leaves	Pink, Red
<i>Wrightia tinctoria</i>	Leaves	Blue
<i>Zingiber officinale</i>	Rhizome	Brown
<i>Ziziphus mauritiana Lam.</i>	Leaves	Pink, Red

Methods of extraction:

For any method of extraction, the basic and first step is to wash and dry the raw sample from which the dye is extracted. The drying process include both sun drying and also drying in hot air oven because the sample should be completely dry in order to grind the sample into powder.

The next step of extraction includes mixing the powdered sample in the solvent used to extract the colorant dye. The foremost solvent which is used to extract the colorant is water different solvents used to extract are distilled water,

In some study paper mixture of 2 or more solvents together, namely acidified methanol which is Methanol mixed with any acid, acidified ethanol which is Ethanol mixed with any acid, Homogeneous mixture of Hydrochloric acid and water are also been used as solvents to extract the colorant product from the raw sample.

There were many extraction methodologies being followed in order to extract the dye from the source sample. Among all of those Soxhlet method is most common where the sample is soaked in the solvent for certain number of hours and then the extract is recovered with the help of Soxhlet at the optimum temperature (temperature which is less than the boiling point of the solvent used).

The other most commonly used method to extract the colorant from the sample is by incubating the sampled powder which may be coarse or fine in the solvent in the temperature which is less than the boiling temperature of the solvent used.

Purification Process:

The dye extracted by either of aqueous extraction or solvent extraction, is then purified in order to attain its pure form without any other impurities or unwanted things. The purification process is most commonly done by column chromatography method.

Dyeing Process:

Once the purification process is done, dyeing process takes place. Dyeing is mostly carried out by exhaust method with the dye extracts under optimized temperature and pH for the fabric to be dyed. Some even optimize the temperature by leading the dyeing process done under several temperatures and pH. By doing this they compare and understand which temperature and which pH is more preferable for attaining the proper results. In some cases, mordants are used in the process of dyeing. Mordants are nothing but the colour enhancers. The main and most commonly used mordants are Ferrous sulphate (FeSO_4) and Copper sulphate (CuSO_4).

Property tests done after dyeing process:

There are many property tests which ensure the quality of the dye and the dyed fabric. Those tests include

aqueous solution of NaOH, Ethanol ($\text{C}_2\text{H}_5\text{OH}$), Chloroform (CHCl_3), n-Hexane (C_6H_{14}), Acetic acid, 45% glacial acetic acid ($\text{C}_3\text{H}_5\text{OH}$), Dichloromethane / 2% solution of Chloral hydrate in chloroform, Tin (II) chloride (SnCl_2), etc.,

Even though water is also employed as a solvent in order to extract the colorant substance from the sample, the extraction process which is carried out with water is said to be aqueous extraction and the extraction process which is carried out with solvents are said to be solvent extraction.

- 1) Colour strength test
- 2) Rubbing fastness test
- 3) Wash fastness test
- 4) Light fastness test
- 5) Perspiration fastness test
- 6) Antimicrobial testing
- 7) Antioxidant testing

2. Conclusion

Since plant-based dyes are organic in nature, they prevent mankind from getting many sorts of skin rashes, allergies and disorders which are caused by using synthetically derived textile dye in the same place. At the same time, the damages done to the nature and water bodies, aquatic and land-living animals by the effluents released can be cut off into less than half by using naturally derived or naturally extracted dyes from the most natural resources which are plants and trees. Even though the fastness properties of naturally derived dyes are comparatively less than that of synthetic dyes, the future works in this field will provide a better solution for this drawback.

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