

Are Sustainability of the Application of Natural Dye on the Textile Materials

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Abstract

This paper reports the studies available on the textile materials such as cotton, wool, and silk, etc. dyeing of natural dyes; extraction of colorants from different natural plant sources; effects of different mordants and mordanting methods; effect of dyeing time, temperature, and dye concentration; PH of the dye bath conventional and nonconventional methods of plant natural dyeing; Use of analytical instruments; Thermodynamic parameters and kinetics of dyeing; and dyeing of compatibility for application of binary, and a ternary mixture of plant natural dyes. Attempts for improvement in overall color fastness properties have been discussed.

Keywords: Natural dyes; Textile materials; Mineral dyes; Natural protein fibres; Eco-friendly

Introduction

Since ancient times natural dyes have been used for the dyeing of textile materials. Natural dyes can be categorized into three parts, these are: animal dyes, vegetable dyes, and mineral dyes, dyestuffs usually obtained from plants are used.

Natural dyes are known for their use in coloring of food substrate, leather as well as natural protein fibres like cotton, wool, and silk as major areas of application since pre-historic times. Since the advent of widely available and cheaper synthetic dyes in 1856 having moderate to excellent color fastness properties, the use of natural dyes having poor to moderate wash and light fastness has declined to a great extent [1]. However, there has been a revival of the growing interest in the application of natural dyes on natural fibres due to worldwide environmental consciousness [2,3].

We know natural dyes have non-allergic, non-toxic, and eco-friendly properties. For this reason, natural dyes on textiles materials have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes. For all that, worldwide the use of natural dyes for the coloration of textile materials has mainly been confined to artisans, small-scale, cottage-level dyes, and printers as well as to small-scale exporters and producers dealing with highly valued eco-friendly textile production and sales [1,4].

Nowadays, manufacturing more different commercial dyes, their ease of use, widely available at an economical price, and produce a wide variety of colors and the increasing human population worldwide have increased the possibilities of using synthetic dyes. Mankind is using synthetic dyes and these dyes are putting them at risk for their lives, such as producing skin allergies, toxic wastes, and other harmfulness to the human body [5]. Surprisingly, everyone knows and agrees on that. In spite of all this, mankind is not protecting the earth, so we have more problems with the environment. For this reason, general the use of natural dyes and renewable resources has recently attracted increasing attention, predominantly due to environmental concerns and the depletion of petroleum resources. Based on the previously studied literature on natural dyeing, this article aimed to determine whether natural dyeing will be sustainable in the textile industry today.

Studies of Application of Natural Dyes on the Textile Materials

Chemical analysis of natural dyes

Many researchers have done chemical, chemical structure, and chemical-based classification of the plant dyes having anthraquinone, alpha naphthoquinones, flavones indigoids, carotenoids, etc. which give a basic understanding of chemical nature of such colorants [1,6-8].

Analytical devices use

High-Liquid Pressure chromatography (HLPC), Ultra High liquid Pressure Chromatography (UHLPC), and Thin Layer Chromatography (TLC), spectrophotometer (CIE L a* b*) was used by many researchers to identify different color components in plant dyes to be applied to textile materials.

It shows the maximum wavelength of the color, indicating the main hue using UV- visible spectroscopy. For natural dyes, the spectra especially indicate different peaks for mixed colorants available in their extract in both UV and visible regions [9,10]. investigated the UV-visible spectroscopic studies of different natural dyes. McGovern et al. [11] studied the separation and identification of natural dyes from wool fibers using reverse-phase HPLC with a C-18 column. Koren [12] analyzed the Chromatographic and colorimetric characterizations of brominated indigoid dyeings. Similar studies reported by Deveoğlu et al. [13], Samanta et al. [14], Vankar [15] and Deepti et al. [16].

Extraction of natural dyes

Priyanka et al. [17] extracted colorants from the *Thespesia populnea* flowers using ethanol under with soxhlet apparatus at 70 °C the extraction of for 1h the extract was isolated, filtered, and used for staining. Koyuncu [18]. Studied the aqueous extraction of *Mahonia aquifolium* nutt having PH4, 5-5 for dyeing wool yarns. Gajenda [19] extracted from *Eucalyptus* bark by soaking it in boiling water for 60 minutes. As a result, many researchers have done the extraction process with conventional extraction methods; Ultrasound-assisted extraction; Micro-wave assisted extraction; Pressurized liquid extraction, and Super/Subcritical fluid extraction. Duval et al. [20].

Mordanting methods and mordants

Mordanting is the treatment of textile materials (Natural fibers, and natural fabrics) with salts or other complex-forming agents which bind the natural mordantly dyes onto the textile fibres. There are three types of mordanting. These are pre-mordanting, simultaneous mordanting, post- mordanting. Different types of mordants or their combination can be applied to the textile fibers and fabrics to obtain varying colors to increase the dye uptake and to improve the color fastness behavior of any natural dye Samata [1]. As a mordant agent, Copper II sulfate pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), potassium aluminum sulfate dodecahydrate [$\text{KAl}_2(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$], iron II sulfate heptahydrate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), potassium dichromate,

($\text{K}_2\text{Cr}_2\text{O}_7$) tin II chloride (SnCl_2), sodium sulphate (Na_2SO_4), and natural mordants. More extensive work has been reported in this area of study in literature.

Methods of natural dyeing

There are generally two methods which are nonconventional and conventional. Conventional dyeing is applied in an acidic/alkaline or in a neutral bath, depending on the chemical nature of natural methods. The operations processes of this method take more time compared to nonconventional methods. Day-to-day technology increased, and the use of new technological tools, new dyeing methods, and optimization conditions was found, and dyeing processes were carried out. Customers to demand for eco-friendly dyes and eco-friendly textile materials has led to the demand for natural dyes and the development of new dyeing methods.

Non-conventional dyeing methods have less energy, less time dyeing and efficient dyeing processes, and more reproducible shade-developing processes, such as such as ultrasound-energized dyeing, and high temperature, high pressure dyeing, Infrared dyeing, and microwave tools etc.

Fastness properties of natural dyed textiles materials

Colorfastness is the resistance of the colored textile material to the conditions to which it is exposed or the degree of contamination of its colorants to adjacent white materials in touch. The color fastness is usually rated either by loss of depth of color in original samples or it is also expressed by staining scale, i.e the accompanying white materials get tinted or stained by the color of the original fabric. What is important in all color fastnesses is the conditions under which the material will be exposed. such as perspiration, and fastness considered specifically for apparels only.

The most important fastness values for natural dyes are washing fastness, light fastness, rub fastness. Light fastness of many vegetable dyes, particularly found to be poor to medium. So, researchers have studied to improve the light fastness properties of textile materials different vegetable dyed. Almost all natural dyes have poor light fastness properties as compared to synthetic dyes, and this is very important for textile materials dyed with natural dyes, and textile materials are often different from their original colors in museums.

Studies of thermodynamic and dyeing kinetics

It is possible to see many studies on thermal and kinetic studies in the literature, especially in the journal of the textile institute, Indian journal of fiber & textile research, Journal natural fibers, pigment and dyes, coloration technology etc.

Samata [21] Investigated the physico-chemical studies on dyeing of jute and cotton fabrics using jackfruit wood extract: part II dyeing kinetic and thermodynamic studies. Arora et al. [22]. Studies kinetic and thermodynamic of dye extracted from *Arnebia nobilis* rech.,f. on wool. Samanta et al. [23] reported that dyeing of jute with tesu extract: Part II Thermodynamic parameters and kinetics of dyeing. As can be seen in the examples given in the studies, studies

have been carried out on the use of different dyeing methods and new natural dyes in different perspectives with analytical devices using dyeing methods with developing technology.

Conclusion

It has been found that the required scientific studies and systematic reports on the dyeing of textile materials with natural dyes are sufficient for me. However, science will maintain its structure that is not static and continues to pursue innovation. Natural coloring will continue today as an artisanal practice for handicrafts, paintings, and woven fabrics since ancient times, albeit on a small scale. Problems such as lack of standardization in the dyeing method, inability to improve fastness problems, and dullness of colors will not be solved.

The rapid increase in the world population, environmental pollution, and urbanization have affected the presence of natural plants in their natural state. Therefore, the environmental and climatic conditions required for the growth of the natural plant are not suitable.

Synthetic dyes and their manufacturing some of containing toxic, carcinogenic, and not eco-friendly. Although Mankind used synthetic dyes on textile materials and these materials are put at risk their lives, surprisingly, everyone knows and agrees with that. Samata [1] investigated, the coloration of this huge quantity of textiles needs around 700.000 tonnes of dyes which causes a release of a vast amount of unused and unfixed synthetic color into the environment. This amount has increased even more today. The use of synthetic dyes in the textile industry cannot be stopped because consumers always believe that colored textiles are pleasing to the eye, suitable for indispensable aesthetic purposes, and decoration.

As a result, such a huge amount of required textiles materials cannot be dyed with natural dyes. Due to climate change in the world, deterioration of the ecosystem, and changes in the growing conditions of natural plants, so they plant does not grow, and the dyeing process takes a long time, natural dyes are not seen as sustainable in the dyeing of textile materials today. In addition, they may contain heavy metals in some natural dyes and show some toxic properties, for this reason, we cannot say that all natural dyes are environmentally friendly. Although natural dyes have many advantages, for example, non-allergic, non-toxic, environmentally friendly, and renewable, obtaining different colors from the same plant with mordant is best for health, but unfortunately, it is not sustainable in dyeing textile materials.

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