Recent Trends in Indian Textile Industry- Exploring Novel Natural Dye Products and Resources

Dr. Sateesh Belemkar [1], M.Ramachandran [2]
[1]Chairperson, School of Pharmacy & Technology Management, SVKM's NMIMS, MPTP, Shirpur.

Abstract

The textiles exports consists of fabrics, ready-made garments, cotton textiles, textiles made from man-made fiber, wool and woollen goods, silk, handicrafts etc. Out of which man-made textiles and silk are showing the highest growth rate. Textiles, namely protein fibers, in continental part of central Europe have been traditionally dyed by natural dyes. Increasing the contribution of small and medium enterprises of textile, chemical & Pharmaceutical in total exports of India is vital to India’s future economic growth. In this century, a global awareness is already in place favoring the use of natural resources for protecting the environment and earth from pollution and ecological imbalances. The present scenario is focused more towards the utilization of the vast diversity of natural resources of color pigments for their use in food materials, pharmaceuticals and textiles, in place of their synthetic counterparts. This trend is aimed at safeguarding human health as well as protecting and prolonging life on earth. Detailed scientific studies with natural dyes have established that in most cases their properties are comparable to those of synthetic dyes. Therefore, if natural dyes have to be commercialized, they need to conform to the same stringent standards of performance that are applied to synthetic dyes. It thus follows that much more research and developmental effort needs to go in this area. The traditional practices may have to be substituted by modern, more scientific practices in order to overcome some of the so-called disadvantages of this dye. In this article, we are illustrating various natural dye materials available for textile industries. Good fastness to processes of textile washing and care implicate to the stability of formed metal complexes.

I. Introduction

Dyeing is an ancient art, which predates written records. It was practiced during the Bronze age in Europe. Primitive dyeing techniques included sticking plants to fabric or rubbing crushed pigments into cloth. The methods became more sophisticated over time and techniques were developed using natural dyes from crushed fruits, berries and other plants, which were boiled into the fabric and gave light and water fastness [resistance]. In many of the world’s developing countries, however, natural dyes can offer not only a rich and varied source of dyestuff, but also the possibility of an income through sustainable harvest and sale of these dye plants. Many dyes are available from tree waste or can be easily grown in market gardens. In areas where synthetic dyes, mordants [fixatives] and other additives are imported and are therefore relatively expensive, natural dyes can offer an attractive alternative. In Ethiopia for example, there is a wealth of marigold flowers available for producing natural dyes, but due to lack of knowledge of the processes involved in harvesting and processing the plants, little use is made of this natural resource. 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 the eco-balance of nature. Currently, ecological considerations are becoming important factors in the selection of consumer goods all over the world. Since the mid-1980s, more interest has been shown in the use of natural dyes and a limited number of commercial dyes, and small businesses have started to look at the possibility of using natural dyes for coloration. At present, large and small-scale industries have begun exploring the use of natural colorants as a possible means of producing an ecologically sound product which would also appeal to the “Green-minded” consumer. In this study, colour pigments
were isolated from the marigold flower and studied in order to understand the processes taking place during its usage in textile coloration.

II. Indian Textile Industry

In India, the textile industry consists of mostly small-scale, non-integrated spinning, weaving, finishing, and apparel-making enterprises. Due to the policies on tax, labour and other regulations favored small-scale, labour-intensive enterprises. The textile sector is one of the largest employers in the country and within this sector, handloom weaving have a top rank. The textile sector generates more job opportunity from its own industry also opens up scopes for the other ancillary sectors. The textile industry largely depends upon the textile manufacturing and export. To disparity in domestic and international cotton prices, cotton exports couldn't pick up. The Textile segment has grown from a small-scale sector to multidimensional sector. Very few countries including India, which have a presence of complete supply chain, from natural and synthetic fibers right up to finished goods manufacturing. The industry holds vital importance in Indian economy too. After agriculture, only the handloom sector is the largest economic activity providing direct and indirect employment. During the colonial regime the traditional textile industry of India was virtually perished. However, in 1818, when the first textile mill was established at Fort Gloster near Calcutta the modern textile industry took birth in India. One of India’s oldest industries in India is Textile Industry and has a formidable presence in the national economy. The main sectors of the Indian textile industry are man-made textiles, cotton textiles including handlooms, silk textiles, woollen textiles, handicrafts, coir, readymade garments, and jute. The Indian textile industry is huge and growing with presence of a number of national and international brands. India has a varied and integrated fabric and apparel industries, and compared to China, Indian fabric and apparel industries has lower labour costs also the cotton prices in India was cheaper. These and other trends mean that India gained a comprehensive competitive edge over China. In our country textile industry has earned a unique place and this industry among one of the earliest to come into existence in India. In overall exports from India, the textile exports played an important role. The Indian textiles industry export consist wide range of items like readymade garments, cotton textiles, handloom textiles, man-made fiber textiles, wool and woolen goods, silk, jute and handicrafts, including carpets. In the global exports of textiles, India ranked as the third largest exporter. India exports textiles to many countries. USA and the EU account for about two-third of India total textiles exports. The other major export destinations include China, UAE, Sri Lanka, Saudi Arabia, Republic of Korea, Bangladesh, Turkey, Pakistan, Brazil, Hong Kong, Canada and Egypt.

III. Natural Dye Materials

A growing interest in natural dyes application is based on not just the system of national heritage protection and multifunctional properties derived. This interest is found in the fact that a garment dyed by natural dyes holds an alternative economical, touristic as well as humanly, ecological significance. Definition of natural dyes, as given by the Society of dyers and colorists is in accordance to the idea of human ecology theory implying to “unity and harmony with nature”. According to it, natural dyes are dyes and pigments obtained from animal or herbal sources, acquired by using no or minimal chemical treatments. Natural dyes can be classified according to dyeing properties, chemical structure, origin (animal, herbal, mineral), hue or application area (food industry, pharmaceutical industry. In regards to dyeing properties, most natural dyes can be sorted into group of mordant dyes; some can be classified as vat, while a small number of natural dyes belong to groups of direct and
basic dyes. Complexing with metal salts, mordant dyes give different colorations, while polygenetic properties are prescribed to them. Aluminium, copper, ferrite and tin salts are most usually used mordants. These dyes are usually used to dye protein fibers, with: mordant treatment of fibers (prior to Second important group of natural textile dyes are in water insoluble vat dyes, which have to be transformed into soluble form with the addition of reduction agent and alkali. While classifying natural dyes according to color hue, mordant used during the dyeing process should be regarded. Mediation on mordant type leads to obtaining different color hues. Palette of colors was obtained on woolen samples (coloristic parameters and fastness to washing) dyed by watery herbal extracts. Selection of herbs and mordants was guided by traditional process of dyeing with natural dyes, typical to continental Croatia. The definition of dyeing with natural dyes in Croatia refers to flavonoids. Although, water is the most usual solvent used to prepare natural extract it is being substituted with another solvent (ethanol, methanol) in the aim of increasing the overall amount of the extract, isolation of certain extract components or simply to remove unwanted impurities such as waxes and lipids from watery extracts.

IV. Calendula officinalis (Marigold)

*Calendula* or pot marigold, is a genus of about 15–20 species of daisy family *Asteraceae*. They are native to south western Asia. Popular herbal and cosmetic products named ‘calendula’ invariably derive from *C*. A yellow dye has been extracted from the flowers. *Calendula* flowers are sacred flowers in India and have been used to decorate the statues of Hindu deities since early times. The beautiful flowers were once used as a source of dye for fabrics. By using different mordants, a variety of yellows, oranges and browns could be obtained. Marigold is major source of carotenoids and lutein, is grown as a cut flower and a garden flower, in addition to being grown for its medicinal values. Marigold flowers are yellow to orange red in colour, are a rich source of lutein, a carotenoid pigment. Nowadays, lutein is becoming an increasingly popular active ingredient used in the food industry and textile coloration. This pigment has acquired greater significance because of its excellent colour value. Although marigold flower extract has been used in veterinary feeds, the potential use of marigold as a natural textile colorant has not been exploited to its full extent. This is due to the lack of information on its safety, stability, and compatibility in textile coloration. In this study, an experiment was conducted to study the use of an extract isolated from marigold as a natural dye. The dye potential of the extract was evaluated by dyeing, using the flower, in 100 % cotton and silk fabrics under normal dyeing conditions. Studies of the dye ability, wash fastness, light fastness, and colour hue were undertaken. The, ‘a’ and ‘b’ of materials dyed using the extract were studied with the use of computer colour matching software. The surface colour was not affected by washing, and the quality of the flower was maintained even washing at 60°C for 30 minutes. Studies have indicated that the change of some of the colors have been noticed after washing with soap. Most of the metal salts exhibited the highest k/s values, due to their ability to form coordination complexes with the dye molecules. These findings reveal that the extract of Marigold flower can be used for coloration of 100 % cotton, silk, and wool fabrics.
V. Juglans Regia L. (Walnut-Tree)

The Walnut tree is a plant genus of the family Juglandaceae. They are deciduous trees, 10–40 metres (33–131 ft.) tall, with pinnate leaves. The two most commercially important species are J. regia for timber and nuts, and J. nigra for timber. Both species have similar cultivation requirements and are widely grown in temperate zones. Walnuts are light-demanding species that benefit from protection from wind. Walnuts are also very hardy against drought. When grown for nuts, care must be taken to select cultivars that are compatible for pollination purposes; although some cultivars are marketed as "self-fertile", they will generally fruit better with a different pollination partner. Many different cultivars are available for growers, and offer different growth habits, flowering and leafing, kernel flavours and shell thicknesses. A key trait for more northerly latitudes of North America and Europe is phenology, with ‘late flushing’ being particularly important to avoid frost damage in spring. Some cultivars have been developed for novel ‘hedge’ production systems developed in Europe and would not suit more traditional orchard systems. Walnuts are heavily used in India. In Jammu, it is used widely as a Prasad (offering) to Mother Goddess Vaisnav Devi and, generally, as a dry food in the season of festivals such as Diwali. The nuts are rich in oil, and are widely eaten both fresh and in cookery. Walnut oil is expensive and consequently is used sparingly; most often in salad dressings. Walnut oil has been used in oil paint, as an effective binding medium, known for its clear, glossy consistency and non-toxicity. Walnut husks are often used to create a rich yellow-brown to dark brown dye used for dyeing fabric and for other purposes. The dye does not require a mordant and will readily stain the hand if picked without gloves.
**VI. Sambucus Nigra (Elder)**

*Sambucus Nigra (Elder, Adoxaceae)*, this well-loved, bushy tree is a common sight all over Britain (especially southern England), and most parts of central and southern Europe. Its habit usually appears a bit sprawling as several stems emerge from the ground, branching frequently. The bark is light grey, fissured and covered with many lenticles (breathing pores). These branches are bendy and break off quite easily. The twigs contain inner pith, which is very light and cork-like, and can easily be removed. Children have taken advantage of this property for many generations by making pipes and pop-guns from the hollowed out twigs. The pinnate leaves have opposite, ovate leaflets with serrated margins and one larger terminal leaflet. The inflorescences appear in May as big umbel-shaped bunches of tiny 5-petaled whitish flowers, exuding a heavy, sweet, slightly narcotic smell. By the end of the summer they develop into drooping bunches of small purple-black berries, which are a popular food of many birds. The bark, leaves and berries can all be used for dying. The bark gives a black dye, a decoction of the leaves with alum yields a green dye, whilst the berries with alum, dye purple or, if salt is added to the mixture, produce a lilac color.
VII. Quercus ithaburensis (Oak)

Quercus ithaburensis, Mount Thabor's oak, is a tree in the family Fagaceae. It is found in southwestern Asia from Turkey South through Lebanon, Israel, and neighbouring Jordan. It is a small to medium sized semi-evergreen to tardily deciduous tree growing to a maximum height of around 50 feet (15 m) with a rounded crown and often with a gnarled trunk and branches. The leaves are 1.6-3.5 in (4-9 cm) long and 0.8-2.0 in (2-5 cm) wide, oval in shape, with 7 to 10 pairs of either teeth (most common) or shallow lobes (rare) along a revolute margin. They are dark glossy green above and gray to mentose below. The male flowers are light green 2 in (5 cm) long catkins while the female flowers are small (less than 1/10 in (0.4 mm), produced in 3's on short stalks called peduncles and are wind pollinated. Flowering occurs from March through April in most of its native range. The acorns are generally oval, up to 2 in (5 cm) long and 1.2 in (3 cm) wide with a cap covering roughly 1/3 of the acorn, maturing in 18 months, dropping from the tree in the 2nd fall after pollination. The cap is covered in long stiff loose scales which are rolled backwards or involutes especially along the edges of the cap. A 50 g of oaks peel was dissolved in distilled water, and filtered via Whitman filter paper, and then distillate at 99ºC, where the pH value before distillation was 5. The dyeing process was performed by immersing the cloth with the distillate solution directly.

VIII. Punica Granatum (Pomegranate)

Punica Granatum (Pomegranate, Lythraceae), it is widely cultivated throughout the Middle East, Caucasus region, north Africa, tropical Africa, the Indian subcontinent, Central Asia, and the drier parts of southeast Asia. The yield of dye extracted from pomegranate peel was 19.2% in this process. The amount of dye extracted from rind of pomegranate was 22.5%. Yield of the dye can be improved by using sophisticated techniques. Large number of plants gives yellow color (Cage). The fabrics dyed with pomegranate peel gave different shades of yellow, brown and black. Similarly, red and blue pigments were obtained from crude indigo extract of Indigofera tinctoria. Functional groups such as amino and carboxylic acid on the fiber can occupy the unoccupied sites on interaction with the fiber. Thus, a ternary complex is formed by the metal salt on which one site is with the fiber and the other site is with the dye. The mordanted cotton cloth was immediately used for dyeing because some mordants are light sensitive. The chromatophore of the dye makes it resistant to photochemical attack, but the auxochrome may alter the fastness. Good light fastness was observed in fabrics dyed with the dye extracted from pomegranate peel. This is due to the formation of complex with the metal
which protects the chromatophore from photolytic degradation. Wash fastness of the dye is influenced by the rate of diffusion of the dye and state of the dye inside the fiber. The fiber dyed with pomegranate peel dye showed moderate wash fastness. Good rub fastness was exhibited by the fibers dyed using the dye extracted from the pomegranate peel. Complexing the fiber with mordant has the effect of insolubilizing the dye, making it color fast. The fabrics dyed with pomegranate rind exhibit good fastness properties. Mordants give different shades to the fabric. Similarly, wide range of soft and light colors was obtained on silk using the dye extracted from flower of Spathadia Campanulata. The natural dye extracted from pomegranate peel might be used as a possible substitute for the synthetic dyes having banned aryl-amine moieties. The obtained results have shown the dyeing potential of pomegranate peel as source for cotton dyeing. Good fastness exhibited by the dyed clothes is because of the mordants used. There is need for proper knowledge, documentation and assessment of dye yielding plants as well as the dyeing techniques so as to increase the use of natural dyes. There is a lot of scope to use the pomegranate peel dye for obtaining various color shades using safe mordants under eco-friendly textile dyeing. The process of production of pomegranate peel dye was found to be cost-effective as compared to the cost of dyes in local market.

IX. Tamarindus indica (Tamarind)

Tamarind is a tree in the family Fagaceae, a tropical fruit found in Africa and Asia is highly valued for its pulp. Tamarind seed coat tannin was extracted and its tannin class was determined. The extracted tannin was employed as a natural mordant alone and in combination with metal mordant namely copper sulphate for cotton, wool and silk fabrics and dyed using natural dyes namely turmeric and pomegranate rind. The seed consists of 30% hard but brown seed coat and 70% kernel. The kernels are separated from the seed coat either by roasting or by soaking the seeds in water. The boiled or roasted kernels are eaten and sometimes dried and grounded into flour for making pan-cakes or mixed with rice. The seed coat containing 40% water soluble matter is nothing but a mixture of tannins. It is used for wound healing and as an anti-dysenteric drug. It is also used as a raw material for the preparation of plywood adhesives. Tannin is an astringent vegetable product found in a wide variety of plant parts such as bark, wood, fruit, fruit pods, leaves, roots and plant galls. Tannins are defined as naturally occurring water soluble polyphenolic compounds of high molecular weight (about 500–3000) containing phenolic hydroxyl groups to enable them to form effective crosslinks between proteins and other macromolecules. They are primarily used in the preservation of leather, glues, stains and
mordants. Meanwhile, natural fibres such as cotton have very low affinity for most of the natural dyes. The tannins play an important role in cotton dyeing to retain colouring matter permanently. The ultimate aim, the purpose of preparing the vegetable fibres with tannin is not so much to fix the colouring matter, as to fix certain metallic salts such as copper, iron, etc., in the form of insoluble tannates. The metal tannates present on the material forms insoluble lakes with the natural dyes during the dyeing process and results in improved fastness properties.

X. Conclusion

Recently, due to increasing awareness of environmental issues and also pollution produced by synthetic dyes, wide spread interest has emerged in the dyeing of textile fibres using natural colorants on account of their better biodegradability and higher compatibility. However, most research on natural dyes had been focused on the fundamental aspects of the natural dyes, e.g. the property of dyeing, light fastness and washing fastness. Little attention has been given to the other functions of the natural dyed materials such as antibacterial properties. Almost all the natural textile material made of cotton, wool, silk, etc., are susceptible to microbial attack as these fabrics offer larger surface area and absorb moisture, thus providing a suitable atmosphere for microbial growth and reproduction. It is also observed that micro-organisms cause degradation of the polymer chains of textile material bringing down the strength and the durability of such products. Hence textiles finished with antibacterial finishes are preferred by the modern consumer. Regardless of rich tradition, beauty of the hues, positive effect on health, natural dyes are still competing for their place under the sun. According to literature references, many technologists and scientists deal with the issues and perspectives of applying natural dyes on industrial level. They point out numerous disadvantages brought about by modern industry: unavailability of resources, limited number of dyes, dye exhaustion, complex processes, coloration repeatability, selection of fibers, dye mixture issues, lack of standardization, unacceptable dye fixation degree, water pollution by heavy metals and organic compounds. Other important thing, which should never be neglected, is that natural dyes do not present a substitution for synthetic dyes. Natural dyes have a reserved place on the market; their development is based on tradition, creativity, fashion, tourism. Possible issues and disadvantages, which may arise from utilization of metal salts, low fastnesses, waste biomass etc. may easily be solved by aimed scientific research. Opposed to disadvantages, numerous advantages are tied to natural dye, such as that they are obtained from renewable resources, health risk free and there is no need for toxic chemicals, which are hard to dispose off.

References

[16] Cotton textiles and the great divergence: lancashire, India and shifting competitive advantage, 1600-1850 Stephen Broadberry and Bishnupriya Gupta p.15
[18] Indian Standards Institution (BIS), Handbook of Textile Testing, (1982), Manak Bhawan, New Delhi,539, 550, 553, 569