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Various Natural Dyes from Different Sources

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THE only colourful pigments that were available to humanity were (and so) natural dyes until the first synthetic dyes were found in 1856. Indoor and outdoor renewable and biodegradable dyes are sustainable. However, they cannot satisfy the vast demands of the textile sector because of the dominant use of land for food and feed. The over exploitation of natural resources might cause deforestation and imperil native species. Safe synthetic colours may not be used under the Global Organic Textile Standard (GOTS), while natural dyes may not be used for endangered species. There have been a number of global initiatives to overcome inherent colour defects.

Keywords: Natural dyes, dying, mordants

Introduction

Natural dyes are obtained from natural materials. These are widely classed as plant, animal, mineral and microbial thinning, however plants constitute the main source of natural thinning. Different academics researched and accumulated information on the ancient literature, as the interest in natural dyes expanded, and traditional dyeing techniques in different countries. The book on natural dye supplies and procedures used to apply it to domestic textiles was released by Adrosko [1]. In partnership with Marmara University, Istanbul in 1981, DOBAG was the Turkish abbreviation for Natural Dye Research and Development Project which started in Turkey and has a large success in restoring the lost art of natural-coloured tapestries. In a book by Mohanty et al, India's natural dyeing processes were recorded. [2] A book about natural dyeing procedures in India was also published by Chandramouli [3].

Grierson et al. have reviewed the traditional dyes of the Scottish Highlands [4]. The report was described in Buchanan on dye plants that have been applied for natural textile dyeing, such as alkane, annatto, chamomile, coreopsis, madder, sappers, etc. [5] They also detailed later information on different tin-filtering plants, how to cultivate them, how to collect dye components, how to tint wool and the silk and the colour hues obtained [6]. Several natural dyeing sources have now been unveiled via research efforts by people and groups and exchange of knowledge available through numerous conferences, symposia, workshops and papers. In the literature there is currently plenty of information regarding numerous sources of natural dyes. [7, 8] Below is a quick description of the various colouring resources per source [9].

Plant Origin

In the past, a large number of natural dyes have been extracted from plants. Different plant components, including roots, leaves, branches, stumps, core wood, bark, wood shavings, flowers, fruits, hulls, husks... are the natural sources of colouration. The well-known blue, natural colouration, indigo, is derived from the *Indigofera tinctorial* eaves. Some plant-derived colours also have additional applications as culinary components and medicinal products,

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for example, in traditional medical systems [10]. Certain natural dyes, although on a limited scale, were well recognized in the past for their dyeing capabilities. Their commercial availability has expanded with a rising interest in natural dyes. Many papers have documented such significant dyes below. [11-13]

Blue Dyes

Indigo is a natural blue colouring only significant. The most important source of this colour is the plant leaves *Indigofera tinctoria*. From ancient times to now, this highly essential dye, commonly known as the King of Natural Dyes, was utilized for the production of blue colours and is currently the most preferred denim material (see **Figure 1**). In the indigo plant leaves, the colouring ingredient is presented as a light, yellow material termed Indican Natural Dyes (1H-indol-3yl b-D-glucoside). The leaf production of an acre of grown indigo plant is roughly 5,000 kg, and after processing, this may provide roughly 50 kg of pure natural indigo powder. The fresh plant leaves are fermented by the preparation of cakes for colouring reasons [14]. There are other plants which can be utilized to make indigo dye, in addition to Indigofera species [15]. Woad is Europe's native indigo plant. Besides, the traditional indigenous production was done using Dyer's knotweed (Polygonum tinctorium) and Pala Indigo (Wrightia tinctoria). After BASF produced synthetic indigo in 1987, the usage of natural indigo began to decline [16].

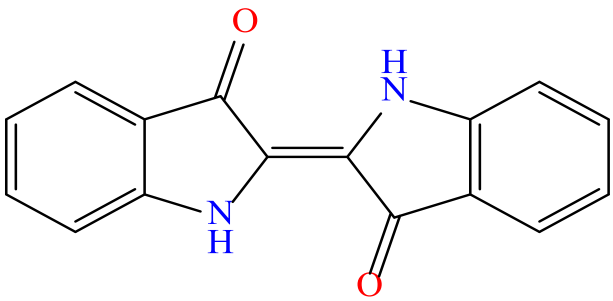

Fig. 1. Chemical structure of Indigo Blue Dyes.

Red Dyes

Many plant sources of natural red dyes are present. The following are a few popular sources.

Madder

Madder is a natural red hue made by plants of different species of Rubia. The colouration is acquired from the plant roots. The Queen of Natural Dyes is also well called Alizarin (see **Figure 2**), it is the principal European Rubia tinctorum colouring component. The root output from the plant is 3-5 tons per acre, with around 150-200 kg of colouring. Like Indigo, with BASF's production of synthetic alizarin, the usage of natural madder powder started decreasing[17]. The Rubia cordifolia is called the Indian manjishth, madder, or manjeet, with a combination of munjiste and purpurin colouring material. Dye is also found in the stems and other sections of the plant in addition to roots[18]. Dye is often extracted with boiled dry root chips or with water stem pieces, although occasionally only soaked for a few hours in cold water. It creates brilliantly coloured insoluble complexes or lakes with metal ions on the bitten cloth, because it's a mordant dye. Alum is commonly used for shading pink and red. An aluminium-iron blend creates lilac colours [19]. Alum in conjunction with other mordants can be used as principal metal salt to create a variety of red colours. Frozen materials provide good speed characteristics[9].

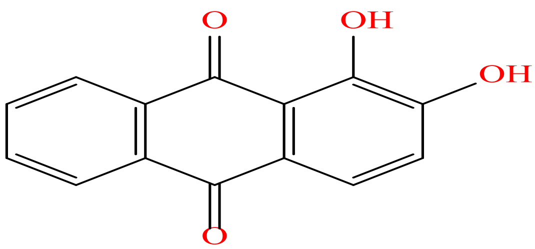

Fig.2. Chemical structure of Alizarin.

Brazil Wood/Sappan Wood

A red dye is derived from the Caesalpine Sapanic woods, a little tree that is known as sappan or "Patang" in India, Malaysia and the Philippines. It is found in woods of Brazil (Caesalpinia echinata), which is named after the word braza, which in its light red hue indicates to be "glowing like fire" (see **Figure 3**). Extraction of alkalis intensifies the hue of red. Textile fabrics can be dyed with or without alum mordant to obtain a red hue. Combined with turmeric, orange colours are generated with catechu and a deep, maroon colour [20, 21].

Morinda

The root and bark of the Indian and Sri Lankan tree Morinda citrifolia is utilized for hues of red (see **Figure 4**). A 3–4-year-old tree can provide the maximum colouring matter. Mature trees have relatively little colouration. After a preliminary wash, the thin colour is recovered from the chipped material for free acid removal. Different hues can be generated with the application of mordants, including purple and chocolate [9, 22].

Safflower

Safflower is a renowned annual herb from Afghanistan. The oil from its seed, which is rich in polyunsaturated fatty acids, is largely farmed, see the chemical structure in **Figure 5**. The safflower flora has long been utilized for the extraction of dye prized for its beautiful red-cherry colour. It comprises two colouring compounds, one water-soluble yellow (26-36%) which has not been utilized as a dye, and another scarlet-red water-insoluble, 0,3-0,6%. The amorphous yellow colourant should be eliminated from the carthamine entirely before it is used for thinning since the pure pinkish shadow conferred by the red colouring influences its presence in tiny quantities. Safflower was used to direct silk and cotton cherry-red teas [23]. The colours are removed by continually washing them with acidulated water from dried flowering florets to eliminate any water-soluble gelatine colouring substances. The residues that include insoluble red colouring are either partially dried and pressed into cakes, or are extracted using a solution of sodium carbonate and precipitated by diluted acids. The washing quickness and lightness of the colouring are poor. Yellow dye has also been used for dyeing cotton mordanted [9, 24].

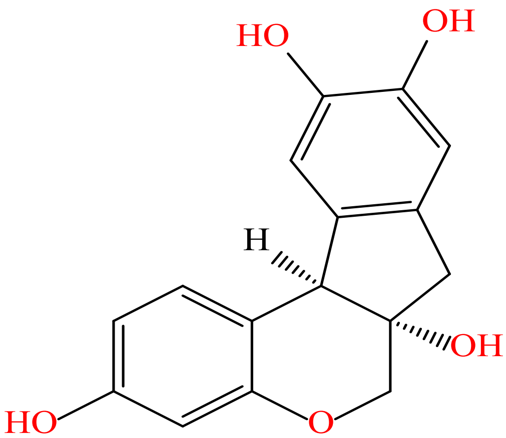

Fig. 3.Chemical structure of brazilin natural dye.

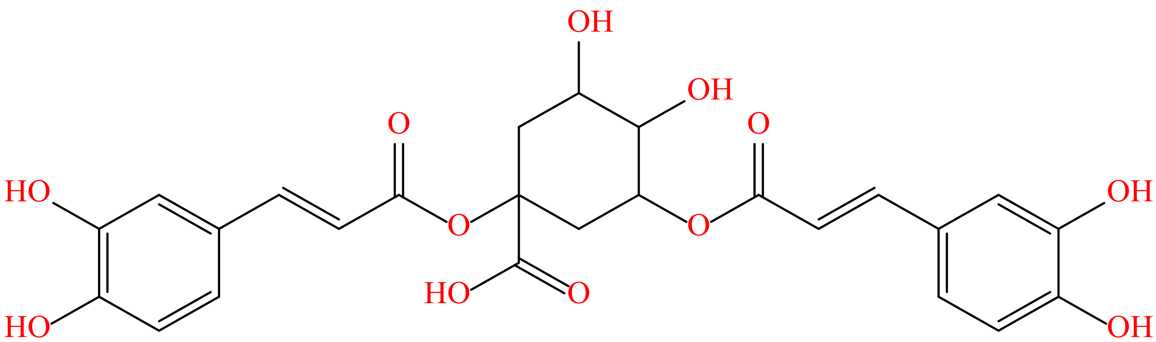

Fig. 4. Chemical structure of compound isolated from Morinda tinctoria leaves.

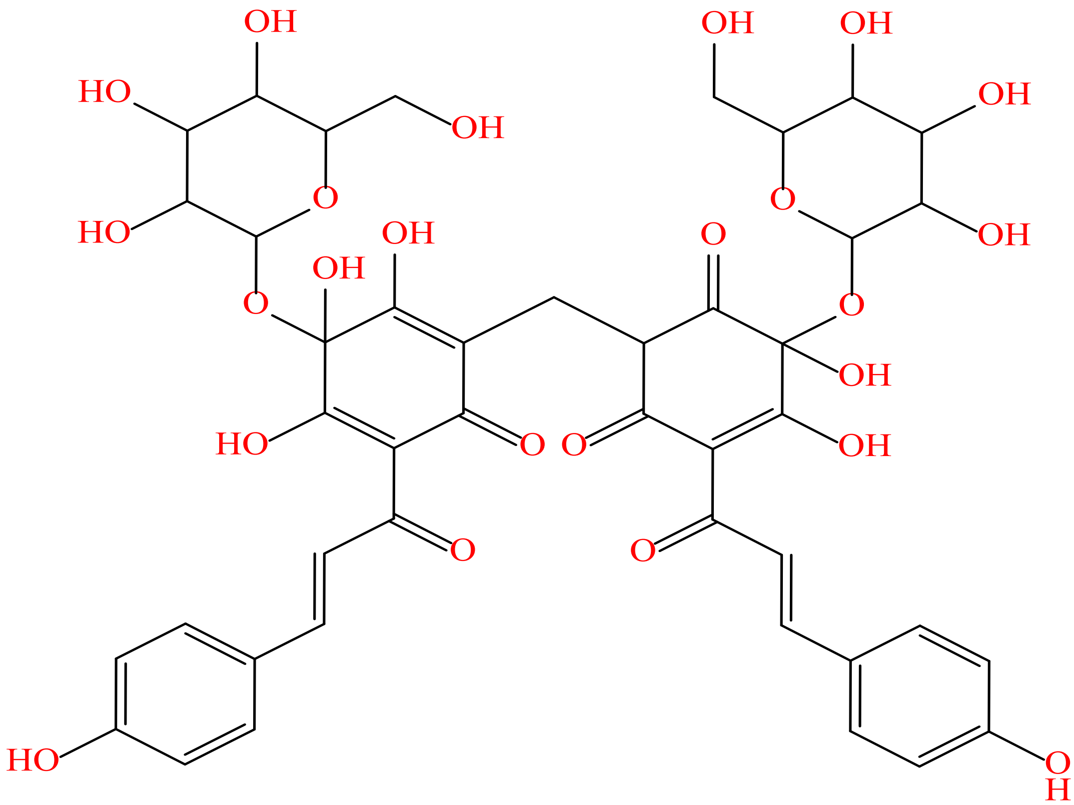

Fig. 5.Chemical structure of Safflower dye.

Yellow Dyes

Multiple plant resources provide yellow dyes. Below are some of the leading sources. Natural colours: sources, chemistry, implementation and issues of sustainability Curriculum Turmeric is a famous natural colour. Fresh or dried turmeric rhizomes are used to extract the teals[9]. Curcumin of the Diaroylmethane class is the chemical colouring present. It is a strong colouring that can be used to thin down silk, wool, and cotton straight. It is easy to wash the shade, but the reaction time to light is slow [25]. Natural mordants such as myrobolan tannin can be employed to enhance rapidity. Turmeric dyeing for quick green production may be overlaid with indigo [26].

Saffron

Saffron, an old yellow colouring belonging to the Iridaceae family, is derived from the dried Crocus sativus plant stigma (see the chemical structure in **Figure 6**). It is cultivated in the Mediterranean, in Iran and in India and is also used for medical and culinary uses[27]. Through boiling in water, the colour is removed from the floral stigmas. It gives the materials a luminous golden colour. It may use to dye wool, silk and cotton straight away. Mordant alum generates a golden orange known as yellow saffron [28].

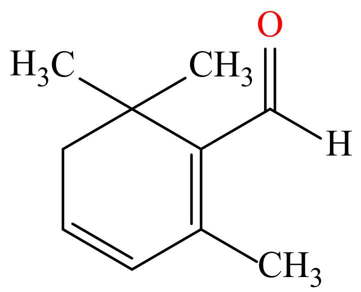

Fig. 6. Chemical structure of Safranal dye.

Annatto

Annatto Bixa is the little tree of the Bixaceae family. The tree is notable for its bright orange colouring, see the chemical structure in **Figure 7**. It is often used for cotton, wool, silk and coloured butter, cheese and similar products. The tannin in the pulp is rich. For the removal of colour under boiling circumstances, the alkaline extraction procedure is performed[29]. On cotton, wool and silk it makes reddish orange hues[30].

Barberry

The roots, bark and stems of plants (Berberis aristata) are used to extract colouring. Berberine, an alkaloid, is the major component of the colour, see the chemical structure in **Figure 8**. It is a basic colouring material and may be used directly to paint silk and wool. The hue of the colour is brilliant, yellow and high washing quickness. After it was mordant, cotton may be coloured[31].

Pomegranate

Pomegranate rinds (Punica granatum) are strong in tannins and used to bite[32]. There is also a yellow teal that may be used to dyes wool, silk and cotton with good speed. It is also used together with turmeric to improve the light speed of the coloured materials[33]. see the chemical structure in **Figure 9**.

Myrobolan

Dried myrobolan fruits (Terminalia chebula) have strong tannins and a natural colour that is used to produce shiny yellow hues for all textiles. see the chemical structure in **Figure 10Figure 9**. Myrobolan is also used for fixing various natural dyes on textile textiles as a natural mordant. Myrobolan is part of the well-known Ayurvedic 'triphala' preparation and tealing ingredients with therapeutic qualities, such as antibacterial, antimicrobial etc[34].

Marigold

A brilliant, yellow flowering plant is the marigold (Tagetus spp.), see the chemical structure in **Figure 11**. It is usually used to make flowery and girls. It may be used in many hues such as yellow, gold yellow, orange and similar. Quercetagetol, a flavanol and two of its glycosides and lutene are the major colouring component. It teals wool and silk with high rapidity characteristics in vivid yellow colours. In conjunction with mordants, cotton may be dyed to produce quick colour. Cotton textiles are subjected to several shades of tannic acid/tannin-containing mordants followed by metallic mordants before thinning[35].

Flame of the Forest

In India, the flame of the tree, known locally as tesu, produces beautiful, orange blooms. The colour derived from the flowers may be utilized to thin out any natural fibres. Glossy yellow to brown and orange hues with a proper mordant can be generated[36].

Kamala

A red and orange powder may be used for colоring wool and silk with vivid orange and golden-yellow colours, thanks to the drying fruit capsula kamala (Mallottus phillipensis, see the chemical structure in **Figure 12**. With moderate quickness, cotton colours are not very excellent[37].

Onion

The external onion skin (allium cepa), which is typically discarded as waste, can be used to create a natural yellow dye. The dye is flavonoid and generates vibrant colours on the wool and soil in its chemical composition, see the chemical structure in **Figure 13**. Cotton can be coloured with an appropriate mordant. The shadow generated is mild in washing and light fastness[38].

Weld

Weld was a significant yellow dye plant in Europe. Weld (Reseda luteola). The colouring material is a flavonoid and gives a nice yellow textile colour with extremely good quickness characteristics on natural fabric[39]. see the chemical structure in **Figure 14**.

Dolu

Himalayan rhubarb radicals and rhizomes (Rheum emodi) provide a yellow colouring which, after mordanting, can be used to colour wool, silk and cotton with an outstanding strength. see the chemical structure in **Figure 15**.

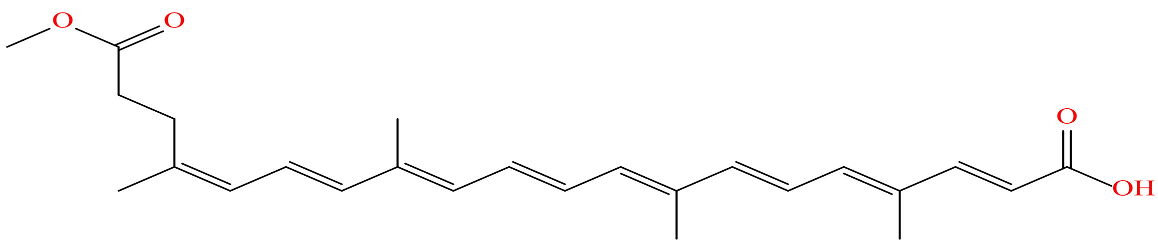

Fig. 7.Chemical structure of Annatto dye.

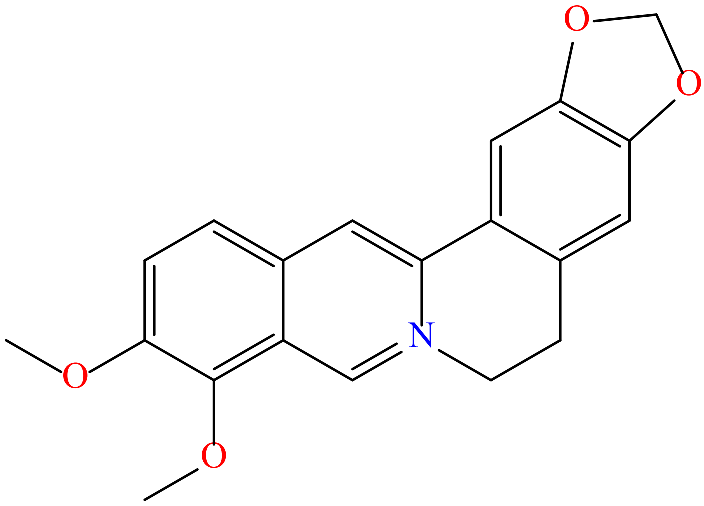

Fig. 8. Chemical structure of Berberis dye.

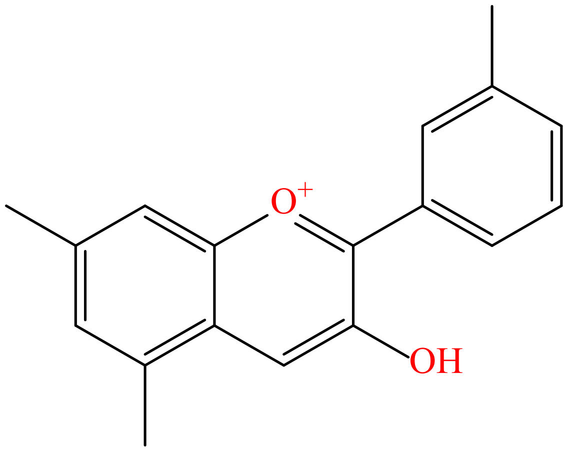

Fig. 9. Chemical structure of Pomegranate dye.

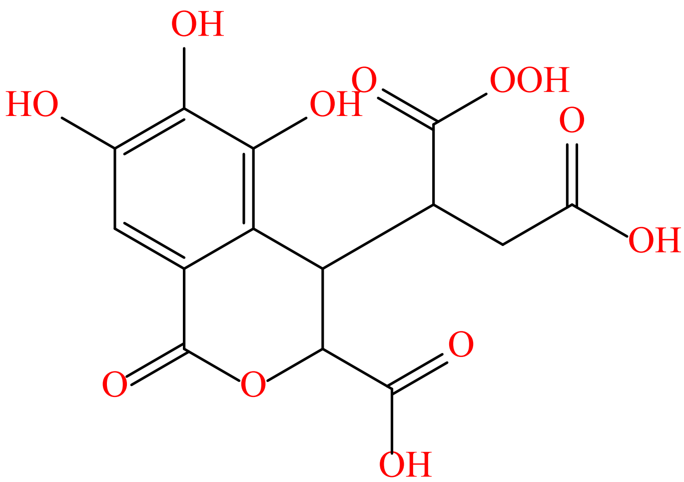

Fig. 10. Chemical structure of myrobolan dye.

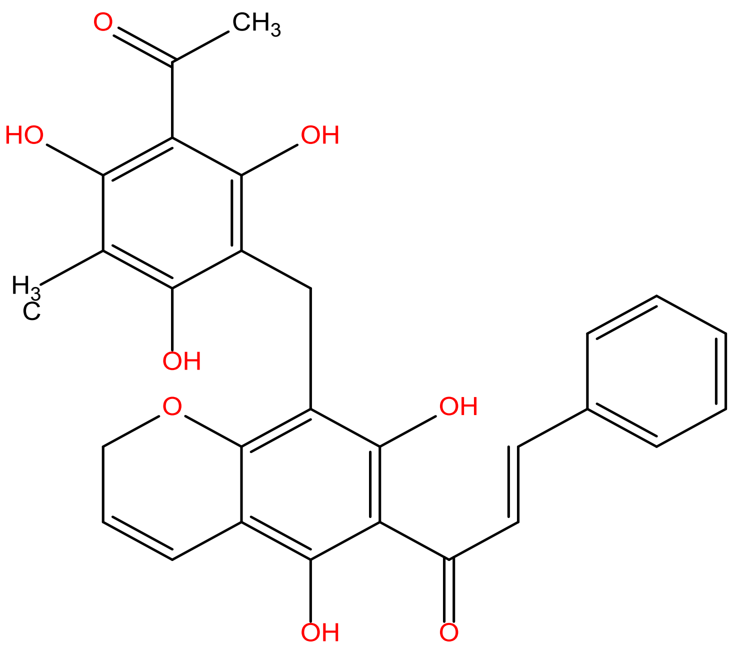

Fig.11. Chemical structure of marigold dye.

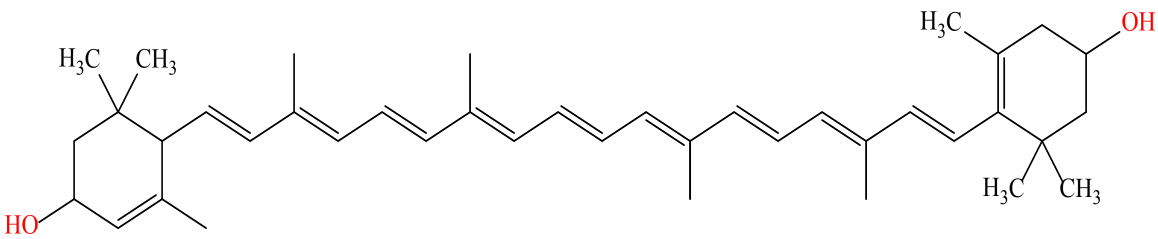

Fig.12. Chemical structure of capsula kamala dye.

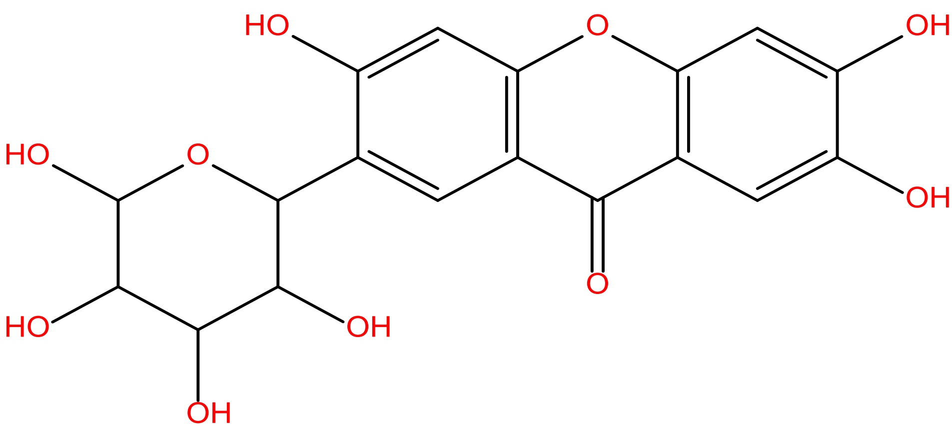

Fig.13. Chemical structure of onion skin (allium cepa) dye.

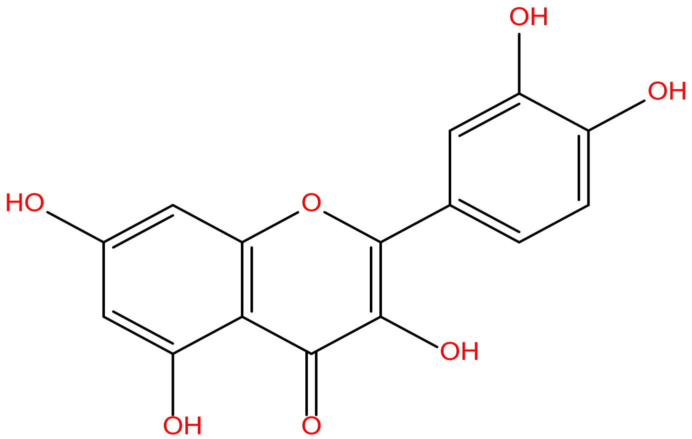

Fig.14. Chemical structure of weld dye

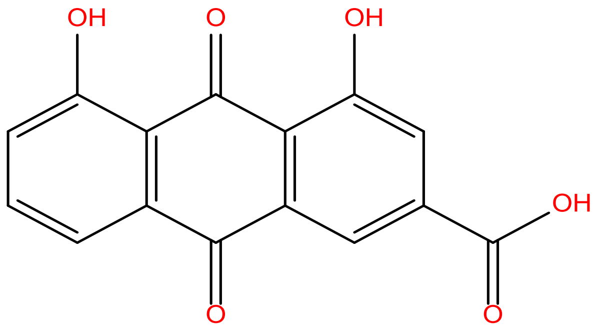

Fig. 15. Chemical structure of Rheum emodi dye.

Brown and Black Dyes

Oak gall is tannin-rich and is used for cuddling. It may also be used to tint brown. Catechesis is made out of Acacia catechu heartwood and is used to directly dye a brown hue of cotton, wool and silk. It is also rich in tannins and may be utilized in iron mordant black colours. It is also possible for iron mordant to acquire black colour from numerous yellow and red dyes. It was produced by mixing the iron mordant with a logwood extracted from the heartwood of the Haematoxylon campechian tree which is cultivated in Mexico and the West Indies[40]. The colours are very fast and have a high quality of rapidity. In addition to the above sources, some researchers have been exploring indigenous plants for their training potential. The leaves, flowers, wood, bark, and other plant materials have been used to dye various textile substrates, with varying results in terms of colour depth and colour resistance on the substrates. The list of plant species that can be utilized as training sources is supplied annually with further additions.

Some promising natural dye source with different colour

The literature shows some of the promise of the natural dyes in **Table 1**. [41-43] The cotton dyeing was researched. More than 100 of them were judged promising on the basis of colour created and the colour resistance of dyed cloth in light and washer[9, 44].

Natural dyes production techniques

In contrast to synthetic colours created by chemical precursors, natural pigments are derived largely from different sections of the plant. These colouring products normally comprise a tiny proportion of 0,5–5 percent of colour[9]. These plant resources cannot be used directly for textile thinning. Many plant products, such as flowers and fruits, are seasonal and contain a high quantity of water and are therefore unable to preserve. Thus, these processes are exposed to certain processing activities to make them appropriate for textile training purposes and to make them available over the whole year. Plant materials collected are first dried up: either in the shade or in a dryer of hot air at a low temperature between 40–500 C, thereby reducing the amount of water to around 10–15% or less [12].

TABLE 1. Some promising natural dye source.

No	Common name of the plant	Botanical name	Part used	Colour obtained
1	Siam weeds	Eupatorium odoratum	Whole plant	Yellow
2	Goat weed	Ageratum conyzoides	Whole plant	Yellow
3	Jack fruit tree	Atrocarpus heterophyllus	Bark	Yellow
4	Gulmohar	Delonix regia	Flower Olive	green
5	Teak	Tectona grandis	Leaves	Yellow
6	Babool	Acacia nilotica	Leaves, bark	Yellow/brown
7	Water lilly	Nymphaea alba	Rhizomes	Blue
8	Dahlia	Dahlia variabilis	Flowers	Orange
9	Amla	Emblica officinalis	Bark, fruit	Grey
10	Indian Jujube Ber	Ziziphus mauritiana	Leaf	Pink
11	Drumstick	Moringa pterygosperma	Leaf	Yellow
12	Sausage tree	Kigelia pinnata	Petals, heartwood, bark	Yellow, pink
13	African tulip tree	Spathodeacompanulata	Flower	Yellow/orange
14	Tamarind	Tamarindus indica	Leaves, seeds	Yellow, brown
15	Golden dock	Rumex maritmus	Seeds	Brown
16	Eucalyptus	Eucalyptus camaldulensis	Bark	Yellow and brown

The sun may also be dried by several materials. The dried material is next ground in a pulveriser to reduce the size of the particle and to improve the extraction of colour. In most situations, these powdered and dried ingredients may be kept for at least one year in airtight bags and containers and may be used for training whenever necessary[45]. Nitrogen storage may extend its shelf-life further. Many natural colourants supply these finely powdered components, and many cottage-level dyers do the manual colouring since it is less affordable. However, these powders do not work in different machines, such as a packaging teasing machine, because the textile material acts as a filter, catching the dye particles, resulting in uniform and patchy dyeing. Clean dye powders are thus required for use in dyeing machines[46].

Dye must first be extracted from the dyeing components in order to produce pure colour powders, and the extract obtained thereafter must be concentrated or dried to get liquid concentrate or purified ready to use powder. The participation of different machinery and greater energy usage in various processing, processes are costly owing to their refined shapes. When compared to the use of polished, crude dyeing material for teasing, the effectiveness of colour removal decreases as the dye extraction process continues throughout the dyeing process. The following material describes several procedures of extraction and drying for the creation of natural pure colours. The sun may also be dried by several materials. The dried material is next ground in a pulveriser to reduce the size of the particle and to improve the extraction of colour[9]. In most situations, these powdered and dried ingredients may be kept for at least one year in airtight bags and containers and may be used for training whenever necessary[45].

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Drying Techniques

The colours are extracted in aqueous media, most of which are acquired from natural sources. When it is employed directly for teething, as is the case in several small-scale or cottage teething businesses, it may be utilized after adjustment of shade concentration. But for use in dyeing or in production units for dye extract at a later date, it must be transformed into powder or solid form, either concentrated for long-term storage and ease of transportation. This also guarantees shade consistency for the whole batch of dye powder or concentrate created and naturally converted dyes that may be utilized in industry, such as the powder form or liquid concentrates. Natural extracts of dye are commonly converted into powder or concentrate form using widely used processes such as Spray dry, Drying under a vacuum, and Freeze dry [49].

Spray drying technique

Spray drying is the most utilized approach to turning natural colour extracts into powder, because it is straightforward and cost-effective. The extract is sprayed using an atomizer or a spray pin in the spray chamber as small droplets. These droplets come into touch with the hot air flow to the solvent-removing chamber, and the resultant dry particles are gathered and fall to the bottom of the chamber. This process usually produces natural colours in dry powder form ready-to-use.[50]

Drying under a vacuum

Dye molecules should be sufficiently stable for heating, since dry powder is subjected to dry heat from warm air to follow this drying procedure. Many fine dye particles, too minute to be placed on the bottoms of the chamber, are also moved by heated air and lost, leading to less regeneration[49]. More dye content is also required to obtain bigger particles and lesser losses, since the extract may be preconcentrated or inert substances like lactose etc. may be added. Extracts can also be concentrated under vacuum using a rotary evaporator or tray dryers. To further purify the concentric dye, various solvents can be used[51].

freeze drying technique

An alternative drying method may be employed for the manufacture of natural dye powders, lyophilizing or freeze drying. In this technique, the natural colour extract is congealed, and water is sublimated by lowering the pressure from the frozen extract. Equipment is expensive and operation costs are higher, but heat sensitive dyes may also be turned into dry powders when the procedure is carried out at low freezing temperatures[50]. Any of these procedures can be utilized to produce natural colour powder based on the quality and prices of colour extracting. Highly pure dye extracts are now available in several countries, particularly the United States, although these are very expensive and are utilized for their unique characteristics largely by hobby groups[9, 50].

Application of Natural dyes to textile

Natural dyes are primarily used to improve the environmental friendliness of natural fabrics. It is mainly used for dyeing textiles. Other natural dyes, including indigo, are normally not used directly in printing. The printing is commonly done using mordant material for the production of printed fabrics, and the entire material is dyed, just the region printed with mordants is colourful [52].

Natural dyes may also be used to colour textiles, such as fibre, yarn or cloth, as synthetic dyes. The benefit of fibre training is that any variations in shade can be readily changed by mixing and are thus performed on an industrial scale, but are expensive because of spinning difficulties and dyed fibre[53]. Wool is usually coloured in the form of yarn and traditional dyers prefer yarn dyeing to any material, because the design of wool gives diversity. Dyeing in hank form is chosen by traditional dyers who operate on the cottage level, due to their simplicity and minimal investment and because of their authentication and economic efficiency, it is consistent with their use of crude natural resources[52]. These artisans typically create dyeing by hand in large pots. The vessels are made of iron, stainless steel, copper and aluminium. Dyeing is supposed to generate vivid hues in copper vessels. Aluminium containers are usually stained with a specific colouring and should thus be utilized if just one type of colouring is utilized[53].

For the natural dyeing process, inoxidized steel containers are most suitable. A bigger scale was employed effectively with hank-dyeing machines.

Package dyeing requires fine purified powders or concentrates; otherwise, the colouring is uneven. Metal containers at cottage level are also used for manufacturing dyes. Machines like jigger and winch were used to thin bigger lots. The colour requirements are selected for the appropriate dyes or colour carrying resources. Information was supplied previously regarding several dye suppliers. Tannin-based barks are generally utilized for the production of brown and grey colours[53].

The flavonoid flower and the leaf are used to achieve colours of yellow. Red colours may be employed with anthraquinone dyes from both plant and animal origins. In general, Indigo is used to make colours of blue. A suitable selection of dye and mordant or the mixture of two suitable dyes, secondary hues such as orange, is available. However, to create a green colour, the material is first dyed with Indigo and then covered with the other colour wherever the blue colour is required to generate a secondary colour[54]. If raw materials of plants (typically at the cottage level) are utilized, then the colouring must be removed before the colouring. Details of several ways of extracting colour were mentioned earlier. Methods of aqueous extraction are used. These can be directly utilized for dyeing, when pure natural dyes are employed[54]. The procedure for dyeing fabrics with natural colours differs from the procedure for applying synthetic dyes because only certain natural dyes may be used directly on the textiles. In most circumstances, the colour is not significant to the fibre it is coloured. This requires a further mordant stage that leads to a two-phase procedure[9].

Mordanting

The bulk of the natural dyes are not very close to textile fibres, in particular cellulosic; hence, they are subject to an extra process known as mordant. Mordants are compounds with textile fibres and teeth affinity, which operate as a connection between fibres and teeth. Those colours that have no fibre affinity can be used with bite. In the case of fibre affinity, the use of mordants improves the quality of rapidity by creating an insoluble combination of dyes and mordants within the fibres, thereby improving colour. Unlike animal fibres, vegetable fibres such as linen and cotton do not easily store mordants, which makes them more dark than the dazzling hues of wool and silk[55]. Cotton requires mordanting because its lack of amino and carboxylate groups, which provide adhesion to colouring molecules, makes it more difficult to colour than wool or silk. The three forms of mordants covered here are metal salts or metallic bite, oil bite and tannins[56].

Metallic Mordants

For dying natural fabrics with natural dye, metal mordant is typically employed. Traditional dyers employed aluminium, chrome, tin, copper and iron metal salts as their bites. Chrome has now been red-listed in accordance with the ecological standards and should thus not be utilized to maintain the ecological character of teared fabrics and waste[57] . Copper is also in a restricted category, but the allowable levels are higher, allowing it to be used in tiny amounts while not exceeding the permitted threshold for treated textiles. Many eco-labels do not limit tin, although its environmental presence in effluent is unwelcome. As aluminium and iron are naturally found in high quantities in the environment, they can be regarded to be ecologically safe[58].

Different colours of the same colour dyestuff can be achieved by the usage of various metallic mordants because of the production of colourful insoluble dyeing complexes with metal salts or mordants obtained with diverse natural colours. The hue of colour complexes with various metals and may also be varied in terms of fastness. Alizarin generates a red lake or an aluminium complex, and a purple lake with iron. Similarly, the natural onion colour, which is yellow, changes into orange with mordant and gray chloride and ferrous sulphate. The following contains information on certain metallic mordants[59].

Aluminium

Potash alum is the most often used aluminium mordant for natural dying, a double sulphate of potassium or aluminium. It can be used alone or with tartar cream or as basic mordant aluminium. The material is just cooked in an aluminium solution when used alone before dying. The quantity of mordant used depends on the colour hue. More mordant is required if deeper tones are teared.10-20% alum may usually be applied on a material weight (owm)[60].

Alum powder (20 percent owm) is combined with cream of tartar in a little warm water and diluted to the appropriate amount with cream of tartar. When used with cream of tartar. Aluminium is used as a cotton mordant in the form of basic sulphate in aluminium (neutral alum). It is produced in the aqueous alum solution by adding sodium hydroxide or carbonate solution until the precipitate forms are redefined by mixing. This material will dip into the aluminium solution and the aluminium solution will be fixed by other chemical substances or aging processes. In order to produce optimal teething outcomes, alumina should be placed on fibre, precipitating it with salts like sodium carbonate or sodium phosphate[60]. The solution of neutral soap is also available. In other methods, tannins/tannic acid or mordants like Turkey Red Oil (TRO) are used before basic aluminium is treated and excellent aluminium attachment is obtained. For bite mordants, other aluminium salts can be employed, such as aluminium sulphate or acetate[61].

Iron

Iron salts, such as ferrous sulphate (also known as green vitriol or cupper), are commonly used in the dyeing and printing processes. The cloth is dyed black or gris with iron salts, and the colour is drab. Ferrous sulphate only leaves very little iron on the textile when applied alone. A large deal of iron is collected from tannin-treated cotton. Tartar cream can be used to attach it to animal fibres using iron. For iron mordanting, traditional dyers apply a fermented iron solution where iron is present as acetate[62].

Copper

Blue vitriol or copper sulphate is typically used for mordanting copper. The lighting resistance of many natural-coloured materials is known to increase, and according to ancient recipes it is essential to get brown catechu and black logwood colour. Because eco-standards limit textile copper content, depending on standard and garment type, to 3–100 ppm, it must be utilized wisely in tiny amounts[63].

Tin

The colour is highlighted by the pitiful tin. As mordants, stannous and stannic chloride are utilized. Cotton is preferred to have stannic chloride. It is usually used on cotton treated with tannin. Tartar cream may be put in the bath for wool as well. While not limited by certain eco-standards, its usage from an environmental contamination perspective is not encouraged. The Global Organic Textiles Standard (GOTS) does not authorize the usage where the level is less than 0.2 ppm. This is allowed[64].

Chromium

Previously employed as a potassium dichromate by many dyers as Chrome, it is now restricted to [0,2ppm, which is why it is preferable to avoid this brittle substance on textiles by most standards[9].

Oil Mordants

They are commonly used to obtain Turkish red colour for thinning madder. The major bite utilized in this is alum. It is attached to the cotton material by creating a complex with the oil mordant and then blends it with madder to achieve the colour of Turkey. Beetle and til (sesame) oil have in the past been employed as mordants but were subsequently substituted with sulfonated beaver oil, Turkey Red Oil (TRO)[9].

Tannins and Tannic Acid

As they have little affinity for metallic mordants, tannic acid and tannins are utilized as the major mordant for cotton and cellulosic fibres. Cotton may absorb all kinds of metal mordants, treated with tannic acid. Tannins may be utilized for the treatment of oak galls, sumacs, or grenade rind in the form of tannic acid and vegetable-tannin–containing compounds such as myrobolan (Harda, Terminalia chebula). Tannins of veggies are cheaper and appear as leaf, fruit and gall excrements in bark and other places. The tannin is ellagitannin-like in myrobolan and is mostly found in the skin of the fruit. It also contains a yellowish-brown colouring substance, which gives the textile material a yellowish colour. It is commonly used as a mordant in cotton dyeing and black hues. Tannins of 15 to 20 percent of gallotannin are found in leaves and twigs from different species of Rhus or sumac. The colour is olive and green. The presence in sumac of some reddish colouring material prevents the use of bright and dazzling colours[9].

Mordanting Methods

The application of mordants based on the timing of their use exists in three different categories. They are the following: (a) pre-mordanting, (b) post-mordanting and (c) meta-mordanting or simultaneous mordanting.

Before the pre-mordanting, the mordants are applied to the material, as the name suggests. The most widely used cotton and cellulosic are not affected in their nonmorbid form by various natural dyes. Some natural dyes like cochineal even require this sort of mordant technique to provide acceptable hues for animal fibres. Different prominent styles of traditional natural colour printing[65].

This approach has the advantage of being able to utilize standing baths for mordanting, which means that the bath may be repeatedly utilized once the mordants have been filled. This makes the process more economic while reducing the emission charge, making it ideal for large-scale uses. The cloth is treated with mordant in a separate bath after teasing in the post-mordant process. During the last process, the final colour is generated. Very commonly, iron salts are used in this way to generate hues of gray and black.

Dyeing and bite-making operations are performed in the same bath itself using the meta-mordanting or simultaneous bite technique. Mordant is typically applied to the teeth at the start of training for cotton and cellulosic, allowing both dyeing and bite processes to occur in the same bath at the same time. Mordant can be added to the dyes bath for animal fibres such as wool at the end when a lot of dye has already been spread on the cloth. In this process, the dying time is decreased since the number of stages is decreased. The colour rates for some dyes are lowered due to the loss of some dye and to a complicated forming of mordant to dyer in the dye bath, which can also cause uneven dyeing. This procedure gives deeper tints for certain dyes. This procedure is most helpful for small amounts, as the mordant cannot be reused[9].

Dyeing

The dye to be ingested is commonly indicated as a percentage of shade for prosthetic teeth. It indicates the amount of colouration (in grams) for 100 g of textiles to be taken for training. For both rough dye and cleaned extracts, the nomenclature stays the same. Because of the low colourant content of the raw materials, 10-30% shade is common, while the number of threaded extracts can be reduced to 2-5%. In proportion to the colour dyed, the amount of mordants is also chosen. For greater shades, a larger number of mordants are required. As with synthetic dyes, the amount of water used in the dyes bath is critical. It is expressed as a ratio of material to liquor in the recipe in technical terminology (MLR). The MLR indicates that per gram of the textile needs water in ml[9].

Due to the difference in natural dyes in their chemical ingredients, they also differ in dyeing techniques. The optimal thinning temperature, duration and pH may vary, but the essential stages are the same.

Many natural colours are teared at nearly boiling cotton temperatures. Wool and silk are tinted at a lower temperature, but likewise, at lower temperatures, some teats may tease cotton. Almost all colours need neutral pH. However, some acidic pH is required and some alkaline pH may be necessary[66]. In the case of dyeing, 1–2% of the acetic acid is applied to animal fibres, wool, pashmina, and silk. The material to be tinted, whether pre-mordant or not, is placed in the dyeing bath at room temperature and the temperature is gradually raised to ensure consistency. The cloth is normally coloured for at least an hour to allow the colour to seep into the fabric. It is quite important to move textile materials in the dye bath. When the teeth are performed in the teeth machinery, the material movement is ensured. However, when the dye is done by the hand, the fabric must be continually agitated in the dye bath[67].

After the training is finished, the teared materials are removed and refreshed a bit and then cleaned with water. Some conventional dyers chill the textile in the colouring water and remove the washing substance. The cleaned teeth will next be seasoned to remove loosely retained colouring with a warm soap or no-ionic detergent solution and again be rinsed in the shade in water and air. On an industrial scale, surplus water during washing is removed using hydro-extractors[66]. If post-mordanting must be done, after washing, the cleaned material is picked up for post-mordanting without soaping or soaping.

If cotton material is teared with colour thinners without a biting affinity like madder, then the pre-mordant colourant material may be post-mordant further in order to get varied hues and enhanced speed qualities. Treatment with modest quantities of mordant copper increases light quickness for many teas, while it also leads to modest changes in the nuance[67]. This treatment with copper has also been used previously for certain synthetic colours to increase light resistance. A tannin and alum post-dyeing treatment may contribute to improved washing speed[66].

Process Indigo Dyeing

Because it is a vat dye, indigo dying differs from traditional methods of natural dying with mordants or direct dying. As a result, indigo dyeing is never combined with any other natural dyeing procedure. The method of indigo colouring involves reducing the indigo to its alkaline leuco form. In the past, a fermentation method was utilized to diminish indigo and the alkaline soil supplied for its breaking up by calcareous, plant or alkaline earth. For a period of years, indigo-reducing bacteria continually maintained. Before teasing as required, Indigo and other ingredients were added to these vats[9].

Today, only a few dyers keep the original small-scale fermenting tubes. In most cases, reduction agents, such as hydrosulphite, thiourea and so on, employed for the purpose of reducing synthetic indigo and caustic soda are also utilized as alkali. The materials that must be torn after reduction are immersed in the bath, and the dying process is carried out for the specified time, usually a few minutes [9].

Natural dying advantages

In comparison to the synthetic dyes that are created from non-renewable oil resources, natural dyes are regarded to be eco-friendly. These are organic and may be composted easily and utilized as fertilizer for the remaining vegetable material remaining after dye extraction. It creates mellow hues that soothe the eye and harmonize with nature. Natural dyes can provide functional advantages for wearers and consumers of such fabrics in addition to these environmental benefits. Many natural dyes in the UV-region absorb and should thus provide strong ultraviolet light protection for teeth stained with such dyes[11]. Different investigators have observed improvement in the UV protection qualities of natural cellulosic fibres following treatment with natural dyes[68-70]. Griffony et al. [71]noted that tannin treatment increased UV protection of textiles during mordanting itself. [72]It was also noted that extracts of pomegranate rind high in tannins have shown substantial UV absorption and cotton textiles treated with such extracts have demonstrated outstanding UV protection that is resilient to washing. Since cotton and other cellulosic materials are often treated with tannins during mordant thinning with natural dyes, they may also be protected against the UV. Many natural colourants have antibacterial characteristics.

Textiles made from these materials are thus expected to have antibacterial properties, which have been documented in several studies[73, 74].Ibrahim et al. [75]observed improved UV protection and antibacterial activity in the treatment of polyamide 6 materials after treatment with natural dyes. Fabrics with certain natural dyes were found to be odour-free in the wearers, probably because of the natural dye material's antibacterial or bacteriostatic qualities. Users of natural-coloured dyed textiles discovered that mosquito and/or moth repellent materials may also be natural repellents to the vegetable material from which these thymes were formed. More recently, flame retardant qualities have also been observed in cellulose fabrics treated with natural plant extract[11][5].

Many of the natural dyes, including myrobolon fruit, turmeric, manjishth root, bark and safflower flora, are healing-like and have been utilized in a variety of traditional medicines. Textiles coloured with these ingredients can also be cured by absorbing medicinal components in the skin. Textiles made in Kerala, India with herbal teeth according to the ancient Ayurvedic system of medicine and called "Ayurvastra" have been very popular and exported in many nations as well as textiles for health and wellbeing and also as medical and therapeutic textiles[11]. Several firms currently commercialize natural textiles as well as textiles for health and welfare[74].

Tedious application processing

Compared with synthetic dyes, natural dyes need a longer dying period, as an extra bite step is necessary quite often. The use of raw materials provides genuineness, but at the same time it includes other procedures of colour extraction, which take time and distinct configuration. Natural dyes are not suitable for use in many commercial textile dyeing machines because they intensify the process work. The disposal of solid leftover biomass is also challenging in an industrial set-up. Although machine-appropriate, purified extracts are expensive and not cost-effective. There are no forest logistics that would have reduced expenditure on producing agriculture by-products, such as grenade rind, skins of organon or leaves and fruits of trees useful for the purpose of dyeing.

Although the mordants left significant amounts in the dyebath after dyeing, the exhaustion of most natural dyes on textile materials is poor. This raises the dyeing costs, while the biodegradability of these teeth does not have any negative environmental effects as observed in synthetic colours.

Traditional dyers reused the dyer, but the acquired hue differed from the previous batch, which is not permitted under the current criteria. These factors raise natural fabrics' costs[9].

Limited Shade Range

Natural dyes have a restricted variety of shades. While there are several sources for red or yellow dyes, there is only one main source of blue dye out of three main hues – Red, Yellow and Blue-indigo. Due to the variation in natural dyes in their application procedure, the choice can only be limited by a few dyes in mixes and variances in speed attributes. Even common secondary colours like green must be made by overthrowing because blue dye indigo is a vat colour with a completely different application procedure to increase the time and cost of the colouring[76].

Nonreproducible Shades

Another significant disadvantage of natural dyes is the difficulty in reproducing shades due to inherent variations in the proportion of chemical components in the natural material and thus in the crude extract of that material, which vary depending on maturity, variance, agroclimatic variations such as soil type, region, and so on. Therefore, in every thinning procedure it is not feasible to get the same hue with a specific natural dye [77]. The production of uniform colouring powders is costly and difficult since most of the natural colours. Some natural colours are sensitive to pH and tend to change colour as a result of pH changes. The mineral makeup of water may also produce shade changes since natural dyes are often colourful compounds containing metal ions. Thus, due to variations in mineral content and water pH, which make reproducing hues difficult, even the same standardized plover may offer different colours in two distinct areas[11].

Fastness Properties

Lighting and washing colour resistance are significant factors for the assessment of textile performance and for determining its end-use, while rubbing colour resistance and swelling are also significant in particular if used as outerwear. If a material is to be used to construct tapestries, its fastness should be good light, although a slightly reduced washing speed might be suitable. There is a source of concern about the colour resistance qualities of natural dyes. Only a few natural colours, which adhere to current textile criteria, have fastness capabilities. Restrictions on the use of metal salts for bite, such as chromium, copper, tin, etc. have not only decreased the colour range of natural dyes, but made it hard to manufacture hues with appropriate speed characteristics. Improper techniques utilized by certain natural dye practitioners may lead to poor speed quality. Enhanced mordanting and thinning methods and optimizing them may assist to resolve this problem. The exploration of new sources of dyes can enhance the number of colouring dyes[11].

Safety Issues

Exploring new dye sources can surely assist in improving the hue of natural dyes at good speed. However, substantial investigation would be necessary before its use is spread since everything from natural origins would be uncertain to humans and the environment. Nature is also renowned for producing dangerous compounds; rigorous assessments are thus essential for new sources[11]. Metallic mordants must also be used to prevent unwanted health effects while handling. Precautions should also be required to avoid pollution concerns in their use, and the level of limited mordants in teased textiles should be assured within eco-regulatory limitations[9].

Characterization and Certification Issues

Despite extensive research on the dyeing of textile textiles with dyes derived from various natural resources, there is little information available on the identification and characterisation of natural dyes. Natural dyes are only present in minute quantities in dye-bearing materials, together with huge quantities of other compounds, such as plants' metabolites. Depending on the age, plant section and agroclimate circumstances, the colour composition may vary and its composition is crucial to understand in order to develop repetitive shades. If powdered dye substances or extracts are used, the pricing should be based on dyes composition and genuine. Therefore, it is necessary to measure the concentration of the dye and to define the dying material in the case of natural dyes[9].

Future Prospects and Conclusion

Brief information about the use of natural dyes, their sources, application processes and their benefits and inconveniences. Although research and awareness might readily address many limitations, including inadequate rapidity characteristics and the usage of bans on metal salts, other drawbacks such as shadow reproducibility and increased availability require more study and industry investment. Presently, only traditional craftsmen, hobbyists and small entrepreneurs' colour around 1% of textiles using natural dyes, largely in the cottage sector. However, it is made on a modest commercial level, with the sale of natural tearing materials and their purified extracts. Some of the problems responsible for their failure to embrace mainstream textile processing include the stiff application procedure and the non-reproducibility of shadows and limited availability. However, at the present level of availability of the dye resource, the use of the textile industry is unwanted since, despite their huge ecological benefit in terms of less pollution of the effluent, this would cause an environmental disaster via a loss of biodiversity and depletion. Traditional craftsmen can exploit this advantage to protect their environment from the adverse impacts of synthetic dyes pollution as they do not have access to expensive effluent treatment systems needed for synthetic dyes.

A clean manufacturing strategy with natural dying is a superior solution. In order to earn a livelihood, these people should profit from the advantages of research on enhanced application procedures for better quickness and compliance with environmental conditions. The availability of natural dye must be improved through the sustainable use of by-products and trash from agricultural and agro-processing businesses, as well as the careful gathering of forest products. Furthermore, essential dyeing plants can be grown in wastelands and marginal soils, providing farmers with new revenue streams.

Setting up adequate processes on natural dyes for characterisation and certification would certainly enhance customer trust in natural dyes and help producers and users as well. If natural dye availability can be improved by the measures described above and the costs of cleaned dyes can be reduced with the correct certification, the small colouring units are able to adopt these colourants because they lack the resources to install and operate costly effluent treatment plants necessary to bring the synthetic dye effluent within the limits set by the regulatory authors. If, in future, biotechnological procedures such as tissue culture or genetic engineering, resulting in the mass production of microbes with low costs, can at any time increase the availability of natural dyes to very high levels, then the use of these dyes can only become sustainable for mainstream textile processing. Natural dyes can be viable only for small-scale applications at the present level, and they can complement synthesizers as an environmentally-friendly choice and a livelihood for diverse stakeholders in the natural dye value chain.

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أصباغ طبيعية مختلفة من مصادر مختلفة

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كانت الأصباغ الملونة الوحيدة التي كانت متاحة للبشرية هي (وهكذا) الأصباغ الطبيعية حتى تم العثور على أول أصباغ اصطناعية في عام ١٨٥٦. الأصباغ المتجددة والقابلة للتحلل في الداخل والخارج هي أصباغ مستدامة. ومع ذلك ، لا يمكنهم تلبية المطالب الهائلة لقطاع النسيج بسبب الاستخدام المهيمن للأرض في الغذاء والأعلاف. قد يتسبب الاستغلال المفرط للموارد الطبيعية في إزالة الغابات وتعريض الأنواع المحلية للخطر. لا يجوز استخدام الألوان الاصطناعية الآمنة وفقًا لمعايير المنسوجات العضوية العالمية (GOTS) ، بينما لا يجوز استخدام الأصباغ الطبيعية للأنواع المهددة بالانقراض. كان هناك عدد من المبادرات العالمية للتغلب على عيوب الألوان المتأصلة.

كلمات مفتاحية: أصباغ طبيعية ، صباغة ، مواد