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The word ‘natural dye’ refers to all the dyes derived from the natural sources. Its mainly obtained from different plants, animal and minerals resources. It is mostly non-substantive and must be applied on textiles by the help of mordants.Ancient humans used root, wood, bark, grass, berries, leaves, nuts, seeds, flowers as natural dye. Throughout civilization, humans gradually invented hand spinning and handloom weaving for making cloths. People were imparted different colours on cloth in order to develop designs and differentiate clothing from one another. Textile clothing and apparel materials are used to be colored for value addition, look, and desire to the customers.Fig: Natural dyesTypes of Natural Dyes:There are three types of natural dye which must be applied in fabric with appropriate technique. These are as follow:Plant dyes: obtained from leaves, flower, skins of fruit, bark, roots, wood etc.Insect Dyes: obtained from various dried bodies of insects.Animal Dyes: obtained from created from shellfish Carmine, Cochineal and so on.Some Common Natural Dyestuffs are as follow:Part of the PlantsDyestuffs1. RootTurmeric, Onions, Madder, Beet-root, etc.2. BarkPurple bark, Sappan wood, Shillicorai, Khair, Sandalwood, etc.3. LeafHenna, Indigo, Lemon Grass, Eucalyptus, Tea, Cardamon, Coral Jasmine, etc.4. FlowersMarigold, Dahlia, Kusum, Tesu, etc.5. Fruits or SeedsLatkan, Pomegranate rind, Beetle nut, Myrobolan, etc.Natural Dyeing Process:For successful commercial use of natural, the appropriate and standardized dyeing techniques have to be adopted for particular fiber. However, the modern natural dyeing process information is very insufficient. That is why an attempt has been made here to give a scientific overview of the dyeing process.1) Scouring:Scouring is the first procedure for any dyeing process. Raw fabrics and yarns carry impurities and residues such as: dirt, wax, dust, coatings. If the fiber is not properly scoured, the dye will adhere to the coating of residue, instead of the fiber itself. The colors will not fully penetrate, and the fabric will dye unevenly.In scouring process, fibers submerging in water along with a scouring agent. Water temperatures, pH and scouring agents vary depending on fiber. Generally, soda ash or neutral soap uses for plant fibers such as cotton, jute, flax, etc. And orvus paste soap used for protein fibers like: silk and wool, etc. Plant fibers will simmer in the bath for a few hours. But protein fibers are sensitive to higher temperatures, so they need to be handled more carefully.2) Mordanting:Mordant makes a bond between the fiber and the dyestuff. So this step is very important in the dyeing process. Mordanting is most effective if it’s done before the dyeing process. But some manufacturer prefers to combine the mordants and dyestuff in one bath. While it’s possible to dye fibers without a mordant, but it will not achieve a durable, long-lasting color without a mordant. Mordanting is the process of wetting fibers in hot water with a diluted mordant for at least one hour. But it can, let the fibers cool in the solution overnight to ensure maximum color-fastness.3) Dyeing:Powder dyes and extract dyes are concentrated and ready for application in the fabric. But foraged ingredients like fresh plants, insects, flowers, fruits, or roots need some preparation before the dyeing.After the dye materials are ready to go, it’s time to decide to choose a technique that will apply to the fabric. There are different kinds of traditional techniques available. For solid color, the general-submersion method could be applied. Other techniques including ombre (dip-dyeing), bundle dyeing, shibori dyeing, and the like techniques are available to dye the fabric.Advantages of Natural Dyes:Natural dyes shades are lustrous, soft, and soothing to the human eye.Natural dyestuff can provide a wide range of colours by mix and match system. That is not easily possible with synthetic dyestuffs.Natural dyestuffs produce rare color ideas which are automatically harmonizing.Waste in natural dyeing process becomes an ideal fertilizer for use in agricultural fields.Many natural dyes plants thrive on wastelands. Thus, wasteland utilization is an added merit of the natural dye.Application of natural dyes has strong potential to reduce the consumption of fossil fuel-based synthetic dyes.Some of the natural dyes are enhanced with age. But synthetic dyes fade with time.This is a labor-intensive industry. As a result, these processes providing job opportunities for all those engaged in cultivation, extraction, and application of natural dyes on textiles, food, leather, etc.Natural dyes are proved that it’s safe for human skin contact and are mostly non-hazardous to human health.Natural dyes are usually renewable and biodegradable.Limitations Natural Dyes:Natural dyeing processing and colour development doesn’t only depend on colour component but also on materials.It is difficult to reproduce shades by using natural dye.Natural dyeing requires skilled and experience workmanship which is expensive.It is difficult to standardize a recipe for the use of natural dye.Low colour yield of source natural dye thus necessitates the use of more dyestuffs, larger dyeing time and excess cost for mordants and mordanting.Lack of availability of precise technical knowledge on extraction and natural dyeing techniques.Natural dyed textile can be changed colour when exposed to the sun, sweat and air.Natural dyes colour fastness performance ratings are inadequate for modern textile usage.Science involved in natural dyeing is still need to be explored.Environmental Impacts of Natural Dyes:Natural dyes are fascinatedly termed as green chemicals. Its application on textile and apparels has a high demand due to its biodegradability and unique colors. However, during extraction, dyeing, and aftertreatment of natural dyes, textiles face some following important problems. Which pretense an impact on the environment:Pesticides are applied on plants to provide protection against pests. Natural dye extracted from these plants could have traces of pesticides. It may cause problem during eco-testing.All-natural dye could not be extracted by conventional aqueous extraction method. Some natural dyes need acidic or alkaline medium and necessary solvent for efficient extraction.Natural dyes need chemicals other than mordants for their application. It may cause effluent problem.Natural dyeing units are run by small-scale industries. and So, it is economically impossible to set up an effluent treatment plant. As a result, they are disposing the dye effluent to nearby canals or rivers which will further contaminate water sources.Some natural dyes need high amounts of metallic mordants like Cu, Sn, and Fe. Which is eco-friendliness of the process being really questionable.To match the commercial shade 1% the synthetic dye needs. On the contrary, 10 to 25% natural dye is required to match with commercial shade. It may be increased the pollution load in effluent treatment plant.COD and BOD ratio of effluent from natural dye is approximately two. It implied that this effluent is highly biodegradable. Butit’s also indicated the amount of copper, chromium, andiron present in effluent exceeded the acceptable limit.Natural dyeing process consumes more energy and time than conventional dyeing process.Why Natural Dyeing is Important?Today global demand for natural dye in the coloration of textiles products is nearly 0.1 million tonnes, which is equivalent to 1% only of the world’s synthetic dye consumption. Almost every synthetic colorant being synthesized from petrochemical sources. As a result, hazardous chemical dye processes pose threat to its eco-friendliness.Worldwide growing consciousness about organic eco-friendly products has generated renewed interest of consumers towards the use of textiles dyed with eco-friendly natural dyes. Natural dyes are known for its uses in the coloring of food substrate, leather and natural fibers. It was being applicable since pre-historic times. Even after a century, the uses of natural dye never erode completely. Thus, natural dyeing of different textiles has been continued mainly in the decentralized sector for specialty products; besides the use of synthetic dyes in the large-scale sector for general textiles. But natural dye processes are not yet ready for industrial production. We have to make more and more research to make sustainable large production in the textile industry.References:Functional Aspects, Ecotesting, and Environmental Impact of Natural Dyes L. Ammayappan and Seiko JoseNatural Dyes for Textiles: Sources, Chemistry and Applications by Padma Shree VankarColouring Textiles: A History of Natural Dyestuffs in Industrial Europe by Agustí Nieto-GalanDyeing of Textiles with Natural Dyes by Ashis Kumar Samanta and Adwaita Konar, Department of Jute and Fibre Technology, Institute of Jute Technology, University of Calcutta India //fashionangelwarrior.com/natural-dyeing-methods-that-every-designer-should-know-a-fabric-series/ of this Article: Md. 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You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Parenting The Catalog Md. Imran Hossain Introduction: Natural dyes are colourants obtained from plants, invertebrates, insects, fungi or minerals. Most natural dyes are vegetable dyes, the main sources of which are various parts of plants such as roots, stems, seeds, barks, leaves and wood. There are also other biological sources such as fungi, snails, insects, etc. Natural sources were the main source of textile dyes before chemically dyeing. Our ancestors extracted and prepared dyes from these natural sources. Although, all-natural materials can’t produce color but there are some elements except plants that produce some expensive colors like sea snails, Cochineal insects etc. History of the Origin of Natural Dyes Exactly when the use of this natural color began is not yet known. However, the first natural dye use was found around 2600 BC. On the other hand, the colorful cave paintings discovered inside the “El Castillo” cave in Spain show that these cave paintings were painted about 40,000 years ago. The oldest colored flax fiber was found in a Prehistoric Cave in the Republic of ‘Georgia’ around 34,000 BC. Further evidence of textile dyeing is from the ‘Neolithic period’ in Southern Anatolia, where iron oxide dyes obtained from the head, probably with red markings, were found on the top. Data show that dyeing was done by plants, barks and insects in China about 5000 years ago. Also, the earliest evidence of dyeing came from the ‘Sindh’ province of Pakistan, a piece of coats dyed with vegetable dye was recovered from the archaeological site of Mohenjo-Daro. Classification of Natural Dyes Based on Sources Vegetable sources Biological or Animal sources Mineral sources Vegetable Sources of Natural Dye The best source in this case is the plants and the different parts of the plants. Most natural dyes are taken from different parts of plants, for example- Plants, Seeds, Roots, Stems, Barks, Leaves, Flowers etc. Natural Elements Extracted Color Catechu or Cutch tree, Coffee beans Brown Gamboge tree Mustard Yellow Chestnut hulls Peach to Brown Bamboo, Hibiscus Red to Brown Indigofera leaves Blue Kamala seed pods Yellow Pomegranate rind, Tumeric, Lichen Yellow to Orange Gold lichen, Carrots, Onion skins Orange Madder root Red, Pink, Orange Berries, Cherries, Red & Pink Roses, Beets Pink Red sumac berries, Basil leaves, Hibiscus, Logwood Red to Purple Sorrel Roots, Spinach, Peppermint Leaves Green Myrobalan fruit Yellow, Green, Black Blackberries, Iris Root, Walnut hulls Gray to Black Red cabbage Purple Teak leaf Crimson to Maroon Biological Sources of Natural Dye Natural Elements Extracted Color Cochineal insects Red, Purple, Scarlet, Crimson Cow urine Indian Yellow Lac insect Red, Violet Murex snails Purple Octopus/Cuttlefish Sepia brown Uses of Natural Dyes in Textile Fashion Due to the different molecular structures, different mordant treatments are required to prepare cellulose and protein fibers for natural dyes. Cellulose fiber: Cotton, Linen, Flax, Bamboo, Rayon etc. Protein fiber: Wool, Angora, Mohair, Kashmir, Silk, Leather etc. Cellulose fibers have less affinity for natural dyes than protein fibers. The most common method of preparing cellulose fibers is to use Tannin first, then use Aluminum metal salts. The most common method of preparing protein fiber is to use Alum. However, there are hundreds of different mordanting methods for both protein and cellulose fibers in the historical record. Mordant dyeing is required for the weak attraction of natural dyes to textile fibers. Below are some of the important and common natural dyes that are widely used for dyeing textile materials (fiber, yarn, cloth). Jack Fruits The wood of the jackfruit plant is finely chopped and then boiled in water to extract the dye. After the treatment of mordanting, it gives the color of the fabric from Yellow to Brown shade. It was used for dyeing cotton and jute fabrics. The color molecule responsible for this yellow-to-brown color is ‘Morin’. Indigo Tree Indigo dye, which is obtained from Indigofera tinctoria and gives a shade of Blue. Color is found in 0.4% of the total weight of the Indigo tree. Proper reproduction of natural Indigo shades is difficult. Various natural Indigos are used to get Blue shades on cotton. It is a kind of VAT dye and therefore vatting is required for dyeing. It is known as the oldest and most widely used dye. Onion Skins Onion skin is the main source of dyes. It is boiled to remove the color from the onion skins and can later be dyed without mordanting the fabric. The result is a shade of Orange to Brown on the fabric. Pelargonidin is the color molecule responsible for the dye in onion skins. Madder Roots Red dye prepared from herb called Madder. Madder’s color molecule is Alizarin. Cotton, Silk and Wool fibers can be dyed with Madder at a temperature of 100oC. It gives bright Red shades on wool and silk and Reddish to Purple shades on cotton. Tumeric Tumeric seems to be the most common dye found in nature. The Tumeric obtained from the roots of the plant is first dried, then crushed into powder and boiled with water to extract the dye. The result is a bright Yellow shade. It is commonly used for dyeing cotton, Wool and Silk. The color molecule responsible for this yellow color is ‘Curcumin’. Henna Leaves The leaves of the henna tree are dried and ground and then boiled with water to get the dye out of the leaves. Mordanting fabrics range in color from Brown to Mustard yellow. It is a dispersed dye-type color. Therefore, polyester and nylon can be dyed by henna. The color is extracted by boiling the stem of the Logwood tree in small pieces for an hour. Logwood is used to create Black shades on wool. Logwood trees are commonly found in Mexico, Central America and the Caribbean islands. Haematoxylin is the pigment of the Logwood natural dye. Lac Insects Lac dye is made from a special insect (Coccus Lacca). It mainly produces shades of Scarlet to Crimson Red. This pigment produced by insects is called stick lac. Some Luxurious Dyestuffs: Tyrian Purple from Sea Snails: Although these dyes are available and readily available in nature, the preparation of these dyes is very time-consuming and at the same time expensive. Tyrian Purple is also called Royal Purple, it is made from the glands of sea snails. Sea snails are certainly readily available. But the problem is, the amount of dye extracted from about 12,000 snails will be only 1.4 grams. For this reason, this dye is very expensive and the Royal family of that time used this dye to color their dresses. Crimson and Scarlet Dye from Cochineal Insects: This dye is derived from Cochineal insects. It creates beautiful Crimson, Scarlet and Pink colors on cotton, wool and silk. But after mordanting with chromium, iron or copper, grey color is produced from purple. Cochineal is a type of insect from which the natural colorant ‘Carmine’ is produced. Only 1 kg of carmine dye can be prepared from the dry bodies of about 150,500 Cochineal insects. History of Prussian Blue Dye In the 18th century, the German chemist ‘Johann Jacob’ was working in a laboratory with ‘Carmine’ dye obtained from the Cochineal. At one time he came to the conclusion that if he mixed Alum or Iron or Potash with this Red Carmine dye, a kind of faded red color would be obtained. With Alum and Iron, he got a fairly accurate color. But after mixing potash, he noticed that a more valuable ocean blue color was created. After mixing the potash, it underwent a chemical change in the carmine dye to a blue color. The blue color is very rare in the natural environment. The appearance of this blue color there is really amazing and known as ‘Prussian Blue’, discovered by Dizbach. Natural Dye has some special benefits: 1) Not harmful to health. 2) It is possible to easily extract and purify dyes from various natural sources. 3) There is no effluent generation. 4) The durability & sustainability of natural dyeing is very high. 5) Has mild dyeing condition 7) Natural dye is a renewable source. 6) Natural Dye has no Allergic, Carcinogenic or Toxic reactions. 6) Natural dye has high UV ray absorption capacity. Although natural dye has several advantages, it has some technical problems- 1) Natural dyes are suitable for most natural fibers (cotton, linen, wool and silk), but not for man-made fibers. 2) Its color fastness properties are not good. 3) It has less affinity to the fiber and forms a weak bond with the fibers. 4) There is no standard coloring recipe and method. 5) Mordant is used when dyeing with natural dye, which is harmful to the environment. 6) Due to mordanting, many times the dyeing shade changes. 6) Natural dyeing is very expensive & time-consuming. Conclusion We use natural dyes to dye fabrics because we want something non-carcinogenic and that is not harmful to our environment. Toxic and allergic reactions to synthetic dyes are forcing people to think about natural dyes again. Natural dyes are a renewable source of color materials. Natural dyes are being used in food, medicine and handicraft items in addition to textiles. Synthetic dyes have many harmful effects, constantly polluting the environment. So many researchers are currently researching natural dyes to protect them from harmful effects. Many fashion houses and boutique houses are even using natural dyes. There are many types of natural dyes that are beneficial for the human body when using dyed fabrics. So, we need to do more and more research on natural dyes to protect ourselves from environmental pollution. References: Natural dyes are biodegradable, non-toxic, and non-allergenic It has a wide variety of health benefits and it has been mentioned in VEDAs as well. These dyes are easily decomposed in nature after use and they do not pollute the environment while destroying them after end use. In the present situation, sustainability and eco-friendly a big matters. The public demand in recent times has compelled different industries to move toward the frequent use of plant-derived natural colors that do not cause any detrimental effects on the environment and ecosystem. So, the main purpose of our project is to review the sustainability of natural dyes and achieve a process that is eco-friendly as fewer chemicals are used here. What is Natural Dye? Natural dyes are derived from plants, insects, or minerals, rather than from synthetic sources. They have been used for centuries to color fabrics, yarns, and other materials. Examples of natural dyes also include indigo (from the indigo plant), madder (from the madder root), and cochineal (from the cochineal insect). Natural dyes are more environmentally friendly than synthetic dyes, as they do not produce the same level of pollution and toxicity. However, the use of natural dyes is more labor-intensive, and the colors produced are less consistent than fabrics produced with synthetic dyes. Dyeing is a method that imparts beauty to the textile by applying various colors and shades to the fabric. Dyeing can be done at any stage of the manufacturing of a textile- fiber, yarn, fabric, or a finished textile product including garments and apparel. The dyeing process gives a fabric new look.The dyeing of textiles with natural dyes has a long history and also had its presence beforehand. But, because of the invention of synthetic dyes in 1856, the use of natural dyes declined considerably. Again, at the very beginning of the twentieth century, the cost of synthetic dyes production was much decreased and as a result, natural dyes were almost ignored. But, due to creating worldwide environmental awareness, the attention on the application of natural dyes in natural fibers is increased. Stabilizer: Stable the chemical reaction by inhibiting the reaction or slowing down the reaction. Caustic soda: Used to increase the strength, lusture, and dye affinity of the fabric. Hydrogen peroxide: Used as a bleaching agent for cotton fabric. Salt: Used to increase the dye affinity towards the cellulosic substrate & to retain the dye molecules. Soda ash: Used as color fixation, controlling pH, increasing absorbency Wetting agent: Helps in wetting the surface by reducing surface tension and helps water or chemical penetration. Lime/Chalk: Used as a color changer or color modifier to be added to the dye bath or mordant bath. Alum: Used as a mordant which allows a reaction to occur between the dye & fabric. Open dye bath: Used for dyeing the samples. Hydro-extractor: used to extract water from the fabric. PH Indicator: Used to determine the ph of solution Gas stove: Used for heating. Electric Balance: Used to get the weight of the sample & different chemicals. Dry & wet rubbing (Crockmeter): Determines the fastness of a dyestuff to either wet or dry condition. Used to test the color fastness of the fabric against rubbing. GSM cutter: Used to cut samples for gsm checking. For the purpose of making garments with naturally dyed fabric, dye extraction must be required in the preliminary steps. If extraction is done by synthesizing in an effective way and by using good quality mordant then the cost will be very low.The extraction rate of dyeing from natural dye gets increased so that it takes a lower amount of dye particles to produce the required color and shade.One of the major issues of natural dye is cost. After that its price is very high than regular garments price. Even so, there is a tendency to buy these exclusive products in some people because of the world is riding the tide of eco-friendliness. In the industry, the experts use enzyme wash for fading effect. On the other hand with a bleach wash, it is possible to bring the same effect at a low cost. But because of eco-friendly issues, they choose enzyme wash. The motive of a group of people is to create something new and to present something exclusive which is eco-friendly. But there has a personal matter of whether consumers buy or not. And If we follow the buying pattern of consumers and push exceptional eco-friendly products in the market there has always been a high demand for marker followers. So, Natural Dye is very good for the environment. What is Natural Dye/ Dyes? The meticulous environmental standards in textiles and garments imposed by countries cautious about nature and health protection are reviving interest in the application of natural dyes in dyeing of textile materials. The toxic and allergic reactions of synthetic dyes are compelling the people to think about natural dyes. Natural dyes are renewable source of colouring materials. Besides textiles it has application in colouration of foods, medicine and in handicraft items. Though natural dyes are ecofriendly, protective to skin and pleasing colour to eyes, they are having very poor bonding with textile fibre materials, which necessitate mordanting with metallic mordants, some of which are not eco friendly, for fixation of natural dyes on textile fibres. So the supremacy of natural dyes is somewhat subdued. This necessitates newer research on application of natural dyes on different natural fibres for completely eco friendly textiles. The fundamentals of natural dyes chemistry and some of the important research work are therefore discussed in this review article. colour fastness dyeing extraction of natural dyes natural dyes After the advent of mauveine by Henry Perkin in 1856 and subsequent commercialization of synthetic dyes had replaced natural dyes, and since then consumption and application of natural dyes for textiles got reduced substantially. In present scenario environmental consciousness of people about natural products, renewable nature of materials, less environmental damage and sustainability of the natural products has further revived the use of natural dyes in dyeing of textile materials. Natural dyes are having some inherent advantages:No health hazardEasy extraction and purificationNo effluent generationVery high sustainabilityMild dyeing conditionsRenewable sourcesThere are some technical issues and disadvantages related to the application of natural dyes which reduced its applications that are:Mostly applicable to natural fibres (cotton, linen, wool and silk)Poor colour fastness propertiesPoor reproducibility of shadesNo standard colour recipes and methods available.Use of metallic mordants, some of which are not eco friendly.Hill [1] had given his views that research work with natural dyes is inadequate, and there is need of significant research work to explore the potentials of natural dyes before its important application to textile substrate.In India initially Alps Industries Ghaziabad (Uttar Pradesh, India) and later Ama Herbals, Lucknow, and Bio Dye Goa done extensive work for industrial research and production of natural dyes and natural dyed textiles. Textile-based handicraft industries in many countries engaged local people to dye textile yarn with natural dyes and weave them to produce specialty fabrics. Printing of textile fabrics with natural dyes in India are specially done in Rajasthan and Madhya Pradesh.Turkish carpets are recognised for their beauty made with natural dyes. The major importers of natural dyes are the USA and the EU. In the EU the major importers of natural dyes are France, Germany, Italy and the UK. Natural dyes have many advantages [2] like non toxicity, eco friendliness, pleasing shade to eye and having special aroma or freshness of shade [3]; however, natural dyes have some disadvantages to showing poor colour reproducibility, poor or inconsistent composition, average washing fastness [4] and lesser availability in different regions, which are of great concern against its revival. Moreover natural dyes are not having any standard established dyeing [5] method. The final shade depends on the type of mordant used in dyeing. Natural dyes are used in the dyeing of cotton [6, 7], linen [8], wool [9, 10], silk [11, 12], nylon and polyester [13, 14] fabrics. The natural dyes can be classified in different ways such as based on origin/source type, type of hue, chemical structure [15, 16] and colour components. The classification of natural dyes based on origin/source is given below:Vegetable originAnimal originMineral originFor vegetable origin of natural dyes, the best source of natural dyes are the different parts of plants and trees. Most natural dyes are extracted from different parts of plants and trees. Natural dyes and pigments are taken from the following parts of plants/trees:SeedRootStemBarksLeavesFlowersNatural dyes are having wide application in the colouration of most of the natural fibres, e.g. cotton, linen, wool and silk fibre, and to some extant for nylon and polyester synthetic fibre. However, the major issues for natural dyed textiles are reproducibility of shade, non availability of well-defined standard procedure for application and poor lasting performance of shade under water and light exposure. To achieve good colour fastness to washing and light are also a challenge to the dyer. Several researchers had proposed different dyeing methods and process parameters, but still these information are inadequate, so this calls for the need of research to develop some standard dye extraction technique and standardisation of whole process of natural dyeing on textiles. Here there are examples of few important natural dyes [17] which are widely used in the dyeing of textile materials, described below.It is a very popular fruit of south India and other parts of India. The wood of the tree is cut into small chips and crushed into dust powder and then subsequently boiled in water to extract the dye. After mordanting treatment of dyed fabrics, yellow to brown shades are obtained. The cotton and jute fabrics are dyed by this dye. It belongs to the family of Moraceae. The dye consists of morin as colouring molecule (Figure 1).Molecular structure of morin (3,5,7,2′,4′pentahydroxy-flavone).The dye is obtained from the root of the plant. The turmeric root is dried, crushed in powder form and boiled with water to extract the dye. It can be used in the dyeing of cotton, wool, and silk. Proper mordanting treatment improves colour fastness to wash. The brilliant yellow shade is obtained after dyeing with turmeric natural dye. Turmeric is a rich source of phenolic compounds known as curcuminoids. The colouring ingredients in turmeric are called curcumin. Curcumin is diarylheptanoid existing in keto-enol form. Turmeric is a member of Curcuma botanical group (Figure 2).Molecular structure of curcumin (diarylheptanoid).The papery skin of onion is the main source of the dye. Onion skin is boiled to extract the colour and subsequently can be dyed with or without mordanting the fabric. The resulting colour is from orange to brown. It contains colouring pigments called pelargonidin (5,5,7,4 tetrahydroxy antocyanidol). The amount of colouring pigment present varies from 2.0 to 2.25% (Figure 3).Molecular structure of pelargonidin (5,5,7,4 tetrahydroxy antocyanidol).It is the leaf of the plant that is traditionally used in making the coloured design on the hands of women. The leaf of the plant is dried, crushed and subsequently boiled with water to extract the dye from leaf. The mordanted fabric gives colour from brown to mustard yellow. This is the dispersed dye type colour; hence, polyester and nylon can be dyed by hina. However, it stains wool and silk giving a lighter brown colour. Hina is commonly known as lawsone. The chief constituent of hina leaves is hennotannic acid; it is a red orange pigment. Chemically hennotannic acid is 2-hydroxy-1,4-naphthoquinone. The colouring molecules have strong substantivity for protein fibre (Figure 4).Molecular structure of lawsone (2-hydroxyl-1,4-naphthoquinone).It is the seed of the plant. The full matured plant has 0.4% colour on weight of the plant. The plants are steeped in the water until the fermentation start. When the hydrolysis of glucoside is completed, the liquor is separated from the plant debris. The extract is aerated which converts indoxyl to indigotin which separates out as a precipitate. The shade of natural indigo is difficult to reproduce exactly. The variety of blue shade on cotton can be obtained by the application of natural Indigo. It is kind of vat dye and hence need reductive vatting with liquid jiggery and citric acid or dithionate.The precursor to indigo is indican which is a colourless water-soluble compound. Indican hydrolyzes in water and releases β-D-glucose and indoxyl. The oxidation of indoxyl resulted in indigotin. The average yield of indican from an indigo plant is 0.2–0.8%. Indigo is also present in molluscs. The molluscs contain mixture of indigo and 6,6′-dibromo indigo (red), which together produce a colour known as Tyrian purple. During dyeing due to air exposure, dibromo indigo is converted into indigo blue, and the mixture produces royal blue colour (Figure 5).Molecular structure of natural indigo.The dye is obtained from the root of the plant. The root is scrubbed, dried in sunlight and finally boiled in the water to extract the dye in solution. The dye has red colour. The cotton, silk and wool fibre can be dyed with madder at a temperature of 100°C for time period of 60 min, and subsequently dye solution is cooled. Bright red shade is produced on wool and silk and red violet colour on cotton. This is a mordantable type of acid dye having phenolic (-OH) groups. The colouring matter in madder is alizarin of the antharaquinone group. The root of the plant contains several polyphenolic compounds, which are 1,3-dihydroxyanthraquinone, 1,4-dihydroxyanthraquinone, 1,2,4-trihydroxyanthraquinone and 1,2-dihydroxyanthraquinone (Figures 6 and 7).Molecular structure of alizarin and purpurin.Molecular structure of 1,4-dihydroxyanthraquinone and 1,8-dihydroxyanthaquinone.India is one of the biggest consumer of tea. The left over waste of tea is collectable in large quantity. The extract of tea waste can be used as a natural dye in combination with different mordants, which can produce yellowish brown to brown shade. This is a mordantable dye. Flavonoids, flavonols and phenolic acids are the main colouring components in waste of the tea. Polyphenols, which are mostly flavonols, are known as catechins with epicatechin and its derivatives.The safflower petals are soaked in distilled water and subsequently boiled with water for more than 2 h, and it is repeated two times. The solution is filtered and the filtrate is vacuum dried. The obtained powder is having strength of 20–30%. In dyeing it produces cherry red to yellowish red shade. Safflower contains natural pigment called carthamine. The biosynthesis of carthamine takes place by chalcone (2,4,6,4-tetrahydroxy chalcone) with two glucose molecules and that resulted in the formation of safflor A and safflor B (Figure 8).Molecular structure of carthamine (safflower).Aqueous extraction is used to extract the dye from sappan wood. Alkali extraction can also be used. It produces bright red colour. It produces an orange colour in combination with turmeric and maroon shade with catechu. The sappan wood tree is found in India, Malaysia and the Philippines. The colouring pigment is similar to logwood. The same dye is also present in Brazil wood.The dye is extracted from the stem of the tree. The stems are broken into small pieces and steepened in cold water for several hours followed by boiling. The extracted dye solution is strained. The logwood natural dye is used to produce black shade on the wool. The logwood trees are found in Mexico, Central America and the Caribbean islands. It is also known as compeachy wood. The colouring matter in logwood natural dye is haematoxylin, which after oxidation forms haematein during isolation (Figures 9 and 10).Molecular structure of haematoxylin and brazilin.Molecular structure of haematein.The dye is extracted from the stigma of flower, which is boiled in water, and the colour is extracted. It imparts a bright yellow colour to the textile material. The wool, silk and cotton can be dyed with saffron. Alum mordant produces orange yellow shade which is also called saffron yellow. This is also used as food colouring. Saffron is a perennial plant which belongs to the Iridaceae family. The aqueous extract of saffron petals contains 12% colourant. The colouring matter of saffron contains phenolic compounds, flavonoids and anthocyanins. Anthocyanidins (pelargonidin) is responsible for the colour in saffron petals. The oxidation of anthocyanidins produces flavonol (Figure 11).Molecular structure of pelargonidin (anthocyanidin) purple and kaempferol (flavonol) yellow.Rind of pomegranate fruit waste is used as a natural dye. Pomegranate fruit is rich in natural tannins. The anar peel produces a yellow colour dye. This natural dye is used in dyeing of wool, silk and cotton fibre. The colouring molecule in pomegranate rind is flavogallol which is called granatonine. It exists in alkaloid form (N-methyl granatonine). The pomegranate rind is rich in tannin content; therefore, it is also used as tanning material (Figure 12).Chemical structure of granatonine.Cochineal is obtained from an insect. It produces beautiful crimson, scarlet and pink colour on cotton, wool and silk. After mordanting with alum, chromium, iron and copper; the colour from purple to grey are produced. Cochineal is a scale insect from which natural colourant carmine is derived. Carminic acid is extracted from female cochineal insects. The body of insect is 19–22% carminic acid (Figure 15).Chemical structure of carminic acid.Some kinds of mineral ores, red clay and ball clay can yield light colours along with mineral salts. But colour composition is not constant and depends on source. Advertisement Two important dyes in this class are indigo blue and Tyrian purple. It occurs as glucoside indicant in the plant. Another blue dye is woad having the same chemical class. The chemical structure which belongs to indigoid class is shown in Figure 16.Indigoid structure.Dyes that belong to this class are having anthraquinone structure and obtained from plant and insect. The red shade is specific to this class. Madder, lac, kermes and cochineal are some of the examples. The general chemical structure of this class is shown in Figure 17.Anthraquinoid structure.The dyes are having alpha naphthoquinone structure such as 2-hydroxy 1-4-naphthoquinone. Hina, lawsone and juglone are examples of this class. The chemical structure of this class is shown in Figure 18.Naphthoquinone structure.The dyes are having yellow shade. The natural dye weld belongs to this category. Most of the dyes are derivatives of hydroxyl and methoxy substituted flavones or isoflavones. The chemical structure of this class of dye is shown in Figure 19.Flavones structure.The natural dyes saffron and annatto belong to this class. The dye structure of this class has long-chain conjugated double bonds. The chemical structure of this class is as shown in Figure 20.Carotenoid structure.The dyes which belong to this category are logwood and sappan wood. Logwood, a natural dye, produces dark black shade on silk, wool and cotton.The natural dye carajurin belongs to this category. The blue and orange shades are obtained from this class.Different natural colourants contain different chromophoric and auxochromic groups. Depending on the presence of a particular group in the dye structure, the chemistry of the dyes can be explained in terms of their chromophoric groups. The different dye structures and chromophoric groups are as explained.The quinoid-based dye structure can be overviewed as three chemical structures (a) benzoquinone, (b) naphthoquinone and (c) anthraquinone. The natural colourant carthamine belongs to benzoquinone group, and juglone and lawsone are having naphthoquinone structure. Alizarine dye possesses anthraquinone structure.In this dye structure the π electron system is small, and the dye contains another unsaturated group in conjugation to π electron system (Figure 21). The red colourant carthamine is present in safflower (Natural Red 26). Safflower (Carthamus tinctorius) is a subtropical plant and cultivated in India, China, North and South America and Europe. In dyeing, the water-soluble yellow dye (safflor yellow) is extracted [18] by cold water, and then red safflorcamin is extracted by diluted sodium carbonate solution. After the neutralisation of extracted solution, it can be used in dyeing of wool, silk and cotton.Structure of carthamine.Lawsone and juglon natural dye belongs to this category. Lawsone is extracted from hina plant; the leaves also contain flavonoid colourants lutcolin. It is cultivated in countries like India, Africa and Australia. Naphthoquinone is present in glycosidic [19, 20] form named as Hennosid A, B and C. The quantitative analysis of lawsone can be performed by high-performance liquid chromatography on reverse-phase C18 column. Chloroform extracted hina leaves were analysed by high-performance thin layer chromatography (Figures 22 and 23).Lawsone (2-hydroxy, 1,4 naphthalene).Juglone (5-hydroxy, 1,4 naphthoquinone).Lawsone form 1:2 complex with Fe(II) and Mn (II) and useful in dyeing of wool and silk fibre. The better dye uptake is obtained at pH 3.0. Agarwal et al. [21] studied the effect of different mordants and different mordanting methods to get the different shades. Hina can be used for dyeing of cotton, polyester, polyamide and cellulose triacetate as the structure of dye molecules are similar to disperse dyes [22, 23, 24].Juglone is representative of natural dye with naphthoquinone structure. The dyestuff is extracted from different part of nut trees. Juglone is present as a glycoside form in trees and plants. Wool dyed with juglone are having good resistance with moths and insects. Mordanting treatment further enhances the fastness properties. Dyeing of textile materials with aqueous walnut extract yields brown shade. Wide range of textile fibre, e.g. wool, silk, nylon and polyester, can be dyed with juglone.It possess biggest group of anthraquinone dyes. Rhubarb (CI Natural Yellow 23) is extracted from the root of the plant. The extracted dye contains emodin, chrysophenol, aloe emodin and pyscion (Figure 24). Rhubarb extract is used in dyeing of wool fibre [25]. It produces yellow to orange shade after mordanting with alum. The mordanting treatment improves light fastness of dyed materials.Different representative structurers of anthraquinone group-based dye molecules.Natural dye alizarin, pseudo purpurin and purpurin (Figure 25) belongs to plant of Rubiaceae family and has an anthraquinone structure [26]. The dye is obtained from the root of plant.Structures of alizarin, pseudo purpurin and purpurin.Madder (C.I Natural Red 8) natural dye produces red colourant; the cultivation of madder is done as a source material for red colour in Europe, Asia and Northern and Southern America. The dyestuff is extracted from the dried roots of the plant. The roots of the plant contain 2–3.0% of di- and tri-hydroxyl anthraquinone glucosides.Carotenoids are red, yellow and orange pigments present in plants and animals [17]. It has a polyisoprenoid structure with a series of centrally located conjugated bonds. The bright colours of many fruits and vegetables are due to carotenoids. Carotenoids are polyisoprenoid structure (Figure 26) which contain conjugated double bonds, which acts as chromophore and responsible for characteristic absorption spectra. Carotenoids are divided into two parts:Hydrocarbon carotenoidOxygen containing called xanthophyllsStructure of β-carotene.Structural changes by hydrogenation, double bond migration, isomerization and chain lengthening and shortening resulted in many carotenoid structure. Carotenoids possess strong UV light resistance, and β carotene (Figure 26) is a typical structure generally found in natural colourants.Pyron dyes contain flavonoids and anthocyanins having structure as shown in Figures 27 and 28. The pyron structure is bound to various sugars by glycosidic bonds [17]. Flavonoids are classified as flavonols, flavones, anthocyanidins, isoflavones, flavon-3,4-diols and coumarins. Yellow flavones and flavonols are used as vegetable dyes. The valuable and very popular flavonoid is yellow quercetin which possess several bio effect.Structure of anthocyanins.Structure of quercetin.Anthocyanins are found in fruits and vegetables; some are grape wine, sweet and sour cherries, red cabbage, hibiscus and different varieties of oranges. There are more than 500 varieties of anthocyanins that produces red, pink, violet and orange colours. There are some important anthocyanins which are cyaniding, delphinidin, pelargonidin, malvidin, peonidin and petunidin. Many plants besides anthocyanins also contain quercetin and chlorophylls, and the resulted colour is a mixture of all these.Violet and purple colours were generally obtained from molluscs and shellfish, and they were source of dyestuff from ancient to the beginning of the Middle Ages. Royale purple and Tyrian purple were the name of the colour obtained originally from molluscs [27]. Lichens and mushrooms are source of natural dyes, and they produce violet and purple colours. Lichens are found in coastal areas and were easier to collect. The dyeing methods with lichens are easy; however, disadvantage associated with lichens is poor light fastness. Therefore, the dyeing of lichens are limited to cheap quality fabrics. Fungi are also used for dyeing of textiles. In America and India, red colour is obtained from fungus Echinodontium tinctorium. In Italy and France, fungi obtained from Polyporales were used to dye the wool.The colourants in lichens and fungi are benzoquinone derivatives, especially terphenylquinone. Some of these species possess compounds such as Sarcodon, Phellodon, Hydnellum and Thelephora [28, 29]. Orchil and litmus are the colourants that are responsible for the colour in lichens. The lichens’ colour are produced through pre-compounds of orchil and litmus by consecutive enzymatic, hydrolysation, decarboxylation and oxidation [30] reactions, respectively. Then some pre-compounds are lecanoric acid, atranorin and gyrophoric acid which take part in the formation of orchil and litmus as shown in Figure 29.Structures of different colourants occurring in fungi and lichens.In the past, the extraction of colourants from lichens were performed by keeping the lichens in water with ammonia for several days. The reaction occurred through enzymatic hydrolysis in which non coloured compounds such as lecanoric acid are converted into orcinol by hydrolysis and decarboxylation. Orcinol after oxidation forms purple orceins or litmus. The colour of both litmus and orchil depend on the pH of the solution [30]. In acidic pH dyestuff forms red cation, and in basic pH, it forms bluish violet anion. The lichens which belong to species Parmelia, Xanthoria parietina, Ochrolechia tartarea and Lasallia pustulata are capable to produce yellowish, brownish and reddish brown colours in dyeing of wool with lichens [31]. The dyeing is done by boiling the wool with lichen solution either premordanted or without mordanted wool in presence of ammonia.The mushrooms which belongs to species Sarcodon, Phellodon and Hydlnellum contain terphenylquinone compounds as a main colourants which produce blue colour in mushrooms. They are benzoquinone derivatives. The Cortinarius species mushrooms are richly coloured in brown, red, olive green and violet. They are anthraquinone derivatives.Tannins are polymeric polyphenols with typical aromatic ring structure with hydroxyl constituents and have relatively high molecular weight. In plants two different groups of tannins are found, (a) hydrolysable tannins and (b) proanthocyanidins (condensed tannin) [32, 33]. Tannins are present in plant cell and are concentrated in epidermal tissues. Tannins are found in wood, leaves, buds, stems, florals and roots [34]. The hydrolysable tannins are concentrated in the roots of several plants. The plants are the source of different variety of tannins. The three major tannins (hydrolysable tannins) are grouped as gallotannins [35] or ellagitannins and which are gallic acid or ellagic acids. The most widespread gallotannins are pentagalloyl glucose. Ellagitannins are esters of hexahydroxydiphenic acids. Gallic acid and hexahydroxydiphenic acid occur together in some hydrolysable tannins [36].Condensed tannins are polymers of 15-carbon polyhydroxyflavan-3-ol monomer units such as (−) epicatechin or (+) catechin. The complex chemical nature of tannins makes the biosynthesis and polymerisation a difficult task; however, there are some established pathways for bio synthesis. The precursor for biosynthesis of hydrolysable tannins is shikimic acid. The direct aromatization of 3-dehydroshikimic acid produces gallic acid, which upon esterification forms polyol.The bio synthesis of condensed tannins occurs through two different ways (a) by phenylpropanoid and (b) by polyketide. The polyketide pathway takes malonyl moieties for aromatic ring formation in flavonoid biosynthesis. The phenylpropanoid pathway takes aromatic amino acid, L-phenylalanine, which is non-oxidatively deaminated to E-cinnamate by phenylalanine ammonia-lyase.The classification of natural dyes are also done according to the hue of the colour. Some important natural dyes giving primary and secondary colours are:Red: Colour index has 32 red natural dyes. The prominent members are maddar, manjistha, Brazil wood, Morinda, cochineal and lac dyes.Blue: There are four natural blue dyes. Some prominent colours are indigo, Kumbh and flowers of Japanese Tsuykusa. Natural indigo blue is known from very ancient time to dye cotton and wool.Yellow: There are 28 yellow natural dyes available which are used in dyeing of wool, silk and cotton. Prominent examples are barberry, tesu flowers, Kamala, turmeric and marigold.Green: Plants that yield green natural colour are very rare; they are made by mixing yellow and blue primary colours. Woad and Indigo produce green colour.Black and brown: There are six black natural dyes. Cutch is used to produce brown shade; for getting black shade lac, carbon and caramel are used.Orange: Natural dyes which produce red and yellow colour are used to produce orange shade. Barbeny and annatto are the examples of orange colour.Vat dyes: Indigo is a water-insoluble dye, and before application it is solubilised in water. The solubilisation of natural indigo is done with the help of sodium hydrosulphite and sodium hydroxide. After solubilisation, it is applied on cellulosic fibre, and after dyeing the development of colour is done by oxidation with hydrogen peroxide. Indigo dye is the representative of indigoid class of vat dyesDirect dyes: The natural dyes which are water soluble and have a long and planar molecular structure and presence of conjugated (single and double bonds) bonds can be applied by direct dyeing method. The dye molecules may contain amino, hydroxyl and sulphonic groups. Turmeric, Harda, pomegranate rind and annatto can be applied by direct dyeing method. Common salt is used to get better exhaustion of dyes. The dyeing temperature is kept at 100°CAcid dyes: The dye molecules possess sulphonic or carboxylic groups in their structure, which produce affinity for wool and silk fibre. The dyeing is done at acidic pH of 4.5–5.5. After dyeing the fastness improvement is done with tannic acid. The dyeing of wool and silk with saffron is done by acid dyeing method. The presence of common salt in dye bath produces levelling effectBasic dyes: The dye molecules produce coloured cation after dissolution in the water at acidic pH. The dye molecules contain $–NH_2$ groups and react with –COOH groups of wool and silk. The dye bath pH is kept 4–5 by adding acetic acid Advertisement The amount of natural dyes present in natural products are very less [11, 37]. They need specific technique to remove dye from their original source. Here there are some methods which are suitable for extraction of natural dyes from their source materials [28]; the different extraction methods are as follows:In this method, the dye containing materials are broken into small pieces or powdered and then soaked in water overnight. It is boiled and filtered to remove non-dye materials. Sometimes trickling filters are also used to remove fine impurities. The disadvantages of this technique are that during boiling, some of the dye decompose. Therefore, those dyes which do not decompose at boiling temperature are suitable by this method. The molecules should be water soluble.Most of the natural dyes are glycosides; they can be extracted under acidic or alkaline conditions. Acidic hydrolysis method is used in extraction of tesu natural dye from tesu flower. Alkaline solution are suitable for those dyes which contain phenolic groups in their structure. Dyes from annatto seeds can be extracted by this method. The extraction of lac dye from lac insect and red dye from safflower is also done by this method.Microwave and ultrasonic waves are helpful in extraction of natural dyes. This technique is having several advantages over aqueous extraction. In this technique less quantity of solvent (water) is required in extraction. The treatment is done at lower temperature and less time as compared to aqueous extraction. Ultrasonic and microwaves are sent in aqueous solution of natural dye, which accelerate the extraction process.In the presence of bio enzymes the fermentation of natural colour bearing substances becomes faster, and the extraction of natural dyes takes place. Indigo extraction is the best example of fermentation method of extraction. Enzymes break glucoside indican into glucose and indoxyl by the indimulsin enzyme. Amatto natural dye extraction is also done by enzyme method. Cellulose, amylose and pectinase are having application in the natural dye extraction from the bark, stem and roots.There is use of organic solvents such as acetone, petroleum, ether, chloroform and ethanol in the extraction of natural dyes. It is a very viable technique as compared to aqueous extraction. The yield of dye is good, and the quantity of water requirement is less. The extraction is done at lower temperature. Advertisement For successful commercial use of natural dyes, there is need of standardized dyeing technique for which characterisation of natural dyes is essential.It is useful in characterising the colour in terms of the wavelength of maximum absorption and dominating hue. The application of UV-characterization is to identify the ability of dye molecules to absorb UV wavelength and fading characteristics of dyes. Some researchers [38] had done UV analysis of natural dyes. Mathur et al. [9] studied UV spectra of neem bark, and it has two absorption maxima at 275 and 374 nm. Beat sugar [39] shows their absorption bands at 220, 270 and 530 nm. Gulrajani et al. [40] studied the absorption bands of ratanjot and observed that at acidic pH, the absorption occurs at 520–525 nm, and in alkaline pH, it occur at 610–615 nm. Red sandal [41] wood shows strong absorption peak at 288 nm and maximum absorption at 504 and 474 nm in methanol solution at pH 10. Gomphrena globosa flower has peak at 533 nm. The dye does not have difference in peak value at pH 4 and 7 in visible region; however it shifted towards 554 nm [42]. Bhuyan et al. studied the dye absorption extracted from Mimusops elengi and Terminalia arjun and concluded that dye absorbed by the fibre varies from 21.94 to 27.46% and from 5.18 to 10.78%, respectively, depending on bath concentration [43, 44, 45]. He also reported absorption of colour extracted from the roots of Morinda angustifolia Roxb using benzene extract. The colour shows absorption at 446, 299, 291, 265.5 and 232 nm.Name of the dyeWavelength of maximum absorptionNeem bark extraction275 and 374 nmBeet sugar220, 280 and 530 nmRatanjot at acidic pH520 and 525 nmAlkaline pH570, 610 and 615 nmRed sandal wood288 nmThe value of the wavelength of the maximum absorption for a particular dye depends on the chemical constitution of the dye molecules which is variable and depends on the growth environment of a particular natural dye. The characterisation of a particular dye is helpful in deciding the hue of the dye.Thin layer chromatography is used to identify different colour components in natural dyes. Koren [46] analysed insect dye, madder and indigoid. Guinot [47] analysed plants containing flavonoids colour compounds. Balakina [48] analysed quantitatively and qualitatively red dyes such as alizarin, purpurin and carminic acid by high-performance liquid chromatography. Mc Goven [49] et al. identified the dyes stripped from wool fibre by HPLC with C18 column. Szostek [50] et al. studied the retention of carminic acid, indigotin, corcetin, gambogic acid, alizarin, flavonoid, anthraquinone and purpurin. He studied examination of faded dyes through emission and absorption spectra by non destructive method. Cristea [51] et al. had reported quantitative analysis of weld by HPLC and informed that after 15 min. Extraction in methanol/water mixture, 0.448% luteolin, 0.357% luteolin 7-glucoside and 0.233% luteolin 3′7 diglucoside were obtained. Son et al. [52] reported analysis of longer dyeing time in indigo dyeing and their effect on structural change in dye molecules through HPLC analysis. The derivative spectroscopy and HPLC were used to analyse annatto dyestuff; the sample preparation involved extraction with acetone in the presence of HCl and removal of water by evaporation with ethanol. The residue was dissolved in chloroform and acetic acid mixture for derivatives spectroscopy or with acetone for HPLC. Advertisement Natural dyes are very suitable for dyeing of protein fibres as compared to cellulosic fibres. Synthetic fibres which contain polar groups such as nylon, acrylic and viscose are also accessible to natural dyes. Natural dyes are thermo unstable and have poor chemical stability, which make the natural dyes unfit for dyeing at high temperature and pressure. The presence of hydrogen bond and Van der Waals force of attraction play important role in the fixation of natural dyes on the fibre. Natural dyes are having poor exhaustion value due to subdued affinity for fibre materials, so to increase the exhaustion of dyes, common salt/Glauber’s salt are added in the dye bath. The isotherm of the natural dyes sorption obeys Nernst isotherm [17, 53, 54].Natural dyes are having poor affinity and substantivity [55, 56] for cellulosic fibres such as cotton and viscose. The absence of reactive groups in fibres and dyes does not allow for bond formation, so they need mordanting treatment to fix the dye on fibre surface. Protein fibres are having bond-forming groups in fibre structure, and the presence of carboxylic groups in natural dyes provides opportunity for bonding and gets bonded with fibre and shows good fastness properties. Natural dyes are having smaller molecular size, and they are not having conjugated linear structure [57]. Therefore, natural dyes are having inferior exhaustion behaviour. Sometimes salt sodium chloride is also used to improve the dye exhaustion % (Figure 30).Sorption isotherm of dyeing of silk fabric (without mordant) with eucalyptus leaves extract at three different temperature 30, 60 and 90°C [17]. Advertisement Different researchers had proposed different methods of dyeing of natural and synthetic fibres with natural dyes. The dyeing of textile substrates depends on dyeing parameters which are fibre structure, temperature, time and pH of the dye bath and dye molecule characteristics. The fastness properties of dyes on textile substrates depend on bonding of dyes with fibre. Since natural dyes are lacking in the presence of active groups to make bonds with textile fibres, the fastness properties are not very good. The cellulosic fibres are difficult to dye with natural dyes as they have poor affinity and substantivity. The lack of bonding of natural dyes with cellulosic fibre requires mordanting treatment. Protein fibres have ionic groups and get bonded with natural dyes possessing ionic groups in dye structure.The dyeing of proteins fibre can be done by exhaust method of dyeing. The dyeing process parameters in wool and silk dying is pH at 4.5–5.5 and dyeing temperature 80–90°C. The exhaustion % of dyes in dyeing is very poor. The longer liquor ratio may be preferred because of poor solubilities of natural dyes in water. Stainless steel-made dyeing machines are suitable in dyeing of wool and silk.Since natural dyes are having poor affinity for cellulosic fibre and due to poor exhaustion, mordanting treatment [29, 58] is done to fix the dyes on cellulosic fibre. The dyeing of cellulosic fibre can be done at temperature of 80–90°C.The exhaustion of dyes can be increased by adding exhausting agents, sodium chloride or Glauber’s salt in dye bath. Most of the dyeing is done at neutral pH. Dyeing of cotton with natural indigo is done at alkaline pH in the presence of sodium hydrosulphite in a container made of stainless steel. The copper container gives deeper shade in dyeing of cellulosic fibre. The mordanting treatment improves the washing fastness of dyed samples. There are three methods of mordanting [44, 45].In the state of Maharashtra, Gujrat and Rajasthan [59], the people follow conventional method of dyeing of cotton fabric with natural dyes which may be explained with the following process sequences. The fabric is pretreated before dyeing to get the absorbency. The grey fabrics are given dunging treatment followed by washing. The bleaching treatment is given to make the fabric white, after that it is steamed and stepped into alkaline solution, and finally rinsing and washing treatment is given. After thorough pretreatment the fabric is soaked into solution of harda/myrobolan and dried. The dried fabric is premordanted with alum and subsequently dipped into natural dye solution at boiling temperature. After dyeing the fabric is given washing and rinsing treatment and dried in the sun light. Water is sprayed on the fabric to brighten the shade. The process is repeated 2 to 4 days. The dyeing method differs from place to place. Here are some examples:The commonly used natural dyes are haldi, babul, madder, pomegranate rind and marigold [59]. In the dyeing of fabric with sappan wood, the fabric is dipped in aqueous extract of sappan wood with or without alum solution and boiled for 2–3 hours. In the dyeing of Indian madder, the madder is extracted either from the stem or root and boiled with water to extract the natural colourants. The pretreated fabric is boiled with dye extract solution. Mordanting treatment may be given either before dyeing or after dyeing with alum solution.The sappan wood chips are boiled with alum and turmeric and after boiling it was cooled. In cooled solution of dye, the fabric materials are kept for 3–4 h. It is a premordanting process. At some places the cold solution of natural dye is taken with sufficient quantity of water, and the fabric is dipped in cold solution for 24 h and finally boiled for 2 h.The application of natural indigo on cotton fabric is done by two methods which are called Khari Mat and Mitha Mat.In Khari Mat’s process to dissolve natural indigo, 40 gallon of water is taken in an earthen vessel, and in that water there are addition of 2.0 lbs. indigo, 2.0 lbs. of lime, 2 lbs. of sajji mati and 1.0 ounce of gur (molasses). After 24 h of fermentation, the indigo dye became water soluble. The indigo dye solution is ready for dyeing. This technique is successful in hot weather.In this technique, the solubilisation of natural indigo is done by taking 60 gallon of water; in that water there are addition of 4 lb. of lime, and after 1 day again 4 lb. of lime is added. After 4–5 days natural indigo dye became fully soluble. During application this mitha vat is added with old mitha vat with continuous string. The fabric is dyed in the dissolved indigo dye solution at temperature of 50–60°C.There is a standard recipe-based dyeing process for dyeing of cotton fibre/yarn/fabric. The important pretreatments before dyeing are desizing (acid desizing or enzyme desizing), scouring (sodium hydroxide and auxiliaries) and bleaching with hydrogen peroxide (H_2O_2). The fully pretreated fabric free from all impurities and absorbent is premordanted (single or double mordanting, in single either harda or aluminium sulphate in double taking both consecutively) with aluminium sulphate. After mordanting the mordanted fabric is passed through aqueous solution of natural dyes. The dyeing parameters will be:Dyeing time = 60–120 min. (depends on depth % of shade)Temperature of dyeing = 70–100°CM:L ratio of the bath = 1:20–1:30Amount of dye in bath = 10–50% (on weight of the material)Concentration of common salt = 5–20 g/lpH of the dye bath = 10–11After dyeing, soaping treatment is given to remove any residual/unreacted dyes and auxiliary chemicals from the surface of the fabric. An after treatment with natural dye, fixing agent may be desirable.Wool and silk are protein fibre; both fibres have complex chemical structure and susceptible to alkali treatment. Alkaline pH of aqueous solution damage the fibre. At isoelectric pH of 5.0, the wool is neutral and the silk is slightly positive. The wool and silk can be dyed with natural dyes through premordanting or after mordanting. Mordanting is done with tannin-rich natural source chemical like harda or metal salt aluminium sulphate or ferrous sulphate.In premordanting, the fabric is treated with either harda or metal salt aluminium sulphate (single or double) with 5–20% (on weight of the material) mordant concentration at temperature of 80–90°C for 30–40 min. The M:L ratio is kept 1:5–1:20. After mordanting, drying treatment may be given and subsequently dipped in dye bath containing aqueous natural dye solution. The following dyeing parameters were maintained:The pH of the dye bath = 4–5Temperature of dyeing = 80–90°C.Time of dyeing = 50–60 min.M:L ratio of the bath = 1:20–1:30Amount of dye in bath = 10–50% (on weight of the material)After dyeing, soaping treatment is given to remove any residual/unreacted dyes and auxiliary chemicals from the surface of the fabric. An after treatment with natural dye fixing agent may be desirable.Different synthetic fibres like nylon, polyester and acrylic can be dyed with natural dyes like onion skin extract, babool bark extract and hina. The dyeing can be done either by padding (cold pad batch) method or exhaust method with or without mordanting. Dyeing is carried out at acidic pH. High-temperature high-pressure dyeing gives better results in terms of colour strength than other dyeing methods.Natural dyes are having poor affinity and substantivity for textile materials. The bonding groups are not present in natural dyes, due to that most of the natural dyes are having poor washing fastness. The fixation of natural dyes on textile materials can be done with the help of mordanting agents. Mordanting agents are dyeing auxiliaries and are salts (chlorides and sulphates) of heavy metals. The heavy metals Al, Cr, Cu and Sn are having vacant d orbitals and easily make coordinate bonds with natural dyes and fibre-active sites. The formed complex has bathochromic and hyperchromic shift. There are different types of mordanting agents such as metallic mordants, tannins and tannic acid and oil mordants. The different heavy metal salts work as complexing agent and chelate with natural dye colourants. Some metallic salts are toxic in nature, but even after that, they are having application in fixation of natural dyes. The different mordanting agents are:Most controversial are lead salts and chromates (potassium, sodium, ammonium dichromate).The salt $SnCl_2$ also works as mordant. It is water soluble, having reducing agent properties. It is toxic in nature.Copper sulphate ($CuSO_45H_2O$) and ferrous sulphate ($FeSO_47 H_2O$) molecules are also used as a mordant. They are good chelating agents.Tannins are poly phenolic compounds and able to form complexes with metals and bind with organic substances such as proteins, alkaloids and carbohydrates. The tannins are also called bio mordants. Tannins can be used either alone or in association with metal salts. The phenolic groups of tannins can form effective bonds with fibre and natural dye molecules.Metal salts of aluminium, chromium, iron and copper are used as a mordants. The important mordants are potassium dichromate, ferrous sulphate, copper sulphate, stannous chloride and stannic chloride.Tannins are obtained from the excretions of bark and other parts, e.g. leaves and fruits of the plant. Extractions are either used directly or in concentrated form. Large number of tannin containing substances are employed as a mordant in textile fibre dyeing.Oil mordants are used in dyeing of madder. Oil mordants make a complex with alum used in mordanting treatment. Metal atom combined with carboxylic groups of oil and bound metal then makes bond with the dye molecules, and in this way, superior wash fastness can be achieved.Premordanting: In premordanting process, mordanting is done before dyeing; subsequently the fabric is dyed with natural dye in aqueous media. It is a two-bath process in which the first bath is used for mordanting of fabric and in the second bath, dyeing is done with natural dyes. Dyeing and mordanting are done at the same temperature of 60–70°C. the mordants are complexing agents, and if they are taken in the same bath, they may react to each other, and precipitation of dyes may occur. That deteriorate fastness properties of dyed fabricsMetamordanting: In metamordanting treatment, the mordant chemicals are added with natural dye in the same dye bath; dyeing and mordanting take place simultaneously. The mordanting and dyeing temperature are 80–90°CAfter mordanting: In after mordanting treatment [53, 54], the dyeing of fabric is done first; after that in the same bath mordanting compounds are added. The temperature of chroming is 80–90°C. after chroming, the temperature is dropped to 60°C, and goods are run for 15 minutes after that liquor is drainedThe application of natural dyes on cellulosic materials are done by the pad-dry-washing and pad-dry-steaming-washing method. High-temperature curing is not suggested as dye molecules are susceptible to decompose. Fibre and yarn dyeing can also be done with natural dyes similar to synthetic dye application. Advertisement The quality parameters in dyeing is fastness properties. Several test methods are described to access the colour fastness. The fastness properties give idea about the quality of dyeing. In natural dyes, the fastness properties are strongly related to substrate type and mordant used for dyestuff fixation. Besides the dyestuff itself, there are many factors such as water, chemicals, temperature, humidity, light, pretreatments, after treatments, dyestuff distribution in fibre and fixation of dyestuff affect the fastness properties. In natural dyeing the colour and fastness of natural dyes need special attention for careful selection of materials and process. Natural dyes were in use up to end of the nineteenth century. At that time the dyeing with natural dyes were at peak with excellent fastness properties; however, after commercialization of synthetic dyes in the nineteenth century, the proficiency in natural dyeing started to decrease. The different fastness properties of dyes show the resistance of dyes towards different external environment in which fabric containing dyes are exposed. The fastness properties of dyes depend on the structure of dyes, exposure on the environment and fastness improvers and type of mordant used. There is need to explore some natural after treatment agents to improve the light and washing fastness.The light fastness of natural dyes is poor to medium. The poor light fastness is due to chromophoric change in dye structure after absorption of light. The chromophoric groups are not very strong to dissipate the energy absorbed through resonance. Cook [60] had reported a comprehensive review on light fastness improvement of dyed textile fibres. He studied the use of tannin related after treatments on mordantable dyes to be used in cotton dyeing for improving light and wash fastness, and his findings were useful in improving fastness properties of natural dyed fabrics. Natural dyes have poor light stability as compared to synthetic dyes. Padfield and Landi [61] observed the light fastness of wool dyed with nine natural dyes such as:Yellow dyes (old fustic and Persian berries), light fastness rating 1–2Reds (cochineal with tin mordent, alizarin with alum mordant, lac with tin mordant), rating 3–4Blue (indigo depends on mordants), rating 4–5 and 5–6Black (logwood), rating 4–5Mordants highly influence the light fastness of natural dyes. Turmeric, fustic and marigold dyes faded more than any other yellow dyes; however, the application of tin and alum mordants causes more fading than chrome, iron and copper. This shows the dependency of fastness properties of natural dyes on the type of mordants. Samanta et al. [62] reported the light fastness improvement in natural dyes applied on jute fabric by 1% benzotriazole. The biggest challenge in natural dyeing for colour fastness is related with light fastness. The choice of suitable mordent will improve the light stability except some iron salts which

lead to shift in the resulting colour. Textile auxiliaries also improve fastness properties. To improve the light stability of natural dyes, Lee [63] commended an UV absorber on protein fibre. Oda [18] suggest singlet oxygen quenchers to improve the light fastness rating. Mussak [64] discussed light-induced photo degradation process of natural dyes. Several attempts were made to improve the light fastness of different textile fabrics dyed with natural dyes out of which some are [65, 66, 67]:Effect of various additives on photo fading of carthamin in cellulose acetate film.Critical examination of fading process of natural dyes to reproduce original colour of the fabric after fading.The rate of photo fading effect is effectively suppressed in the presence of nickel hydroxyl-arylsulphonate. The addition of UV absorbers in bath has small effect in reducing photo fading effect.The washing fastness of natural dyes is poor to medium. The bonding of dye with fibre is very poor, and due to that dyes are not very fast with detergent solutions. Duff et al. [29] studied the effect of alkalinity of washing solution in washing of natural dyes dyed fabrics. The alkaline pH of the detergent solution changes the colour value in terms of the hue and value. Logwood and indigo are having good fastness value as compared to others. The mordanting treatment improves the washing fastness of dyes. Samanta et al. [68] reported some improvement in washing fastness by use of fixing agent.The rubbing fastness of most of the natural dyes are moderate to good. Samanta et al. [8, 58] reported that jackfruit wood, manjistha, red sandal wood, babool and marigold having good rubbing fastness on jute and cotton fabric. Advertisement UV-protected fabrics are required to protect the skin and body of the human being from sunburns, tannings, premature skin burns and skin ageing. Researchers had done the work on to produce fabrics which had sun-protecting effect by the application of natural dyes in dyeing. Sarkar [69] evaluated ultraviolet protection factor (UPF) value of cotton fabric dyed with madder, indigo and cochineal with reference to fabric parameters. Grifani [70, 71] studied the effect of natural dyes on cotton, flax, hemp and ramie and got good results. Metallic mordants [72] have potential to improve the UPF value of wool, silk and cotton. Orange peel extract natural dye applied on wool increased the UPF value of dyed wool fabric considerably.Cellulosic materials and woollen are susceptible to moth and fungus attack in humid and warm conditions. Koto et al. [73] studied the effect of natural dyes on wool. The anthraquinone-based natural dyes cochineal, indigo and madder are able to produce insect proof and repellent fabric when used as a dyes in dyeing of wool. Advertisement Natural dyes due to its unique character of natural origin are known as ecofriendly dyestuff; however the bonding of dye molecules with fibre-active sites are very poor, and they need some bridging chemicals to anchor the dye molecules with fibre, and mordanting agents are helpful in bridging the dye molecules with fibre. The synthetic mordanting agents are not very eco friendly, and some are toxic which depress the efficacy of natural dyes and sometime become matter of debate.Natural dye does not have any shade card to match the samples or reproducing the shade. So there is need of collection of spectral data of natural dyes so that any shade can be reproduced.There is need of awareness about natural dyes dyed fabric in people so that it can be popular in big way. and due to that demand and consumption of natural dyed fabric will increase.Natural dyes are costly as compared to synthetic dyes. So some research work should be done to reduce the cost of production.Big production houses, technical institutions and research houses should organised workshops and symposia to spread the advantages of natural dyes.The government should promote the production of natural dyes by giving financial incentives to small manufactures of natural dyes.There must be some very strong research and development work to improve the quality of natural dyes in terms of low cost, use of natural mordent and widespread applications. Advertisement I am very thankful to Prof. A.K. Samanta for inspiring me and giving very excellent suggestions for preparing this review paper. I am very thankful to the editor for his remarkable patience and monitoring. 1. Hill DJ. Is there a future for natural dyes? Review of Progress in Coloration and Related Topics. 1997;27:182. Dedhia EM. Natural dyes. Colourage. 1998;45(3):453. Chavan RB. Chemical Processing of Handloom Yarns and Fabric. Delhi: Department of Textile Technology, IIT; 1999. p. 64. Ghosh P, Samanta AK, Das D. Effect of selective pretreatments and different resin post-treatments on jute-viscose upholstery fabric. Indian Journal of Fibre and Textile Research. 1994;19:2985. Gulrajani ML, Deepti G. Natural Dyes and their Application to Textiles. Delhi: Department of Textile Technology, IIT; 1999. p. 236. Senthil P, Umasankar P, Sujatha B. Ultrasonic dyeing of cotton fabric using with neem leaves. Indian Textile Journal. 2002;112(6):147. Saxena S, Iyer V, Shaikh AI, Shenai VA. Dyeing of cotton with lac dye. Colourage. 1997;44:238. Samanta AK, Preeti A, Siddhartha D. Dyeing of jute and cotton fabrics using Jackfruit wood extract: Part I—Effects of mordanting and dyeing process variables on colour yield and colour fastness properties. Indian Journal of Fibre and Textile Research. 2007;32:4669. Mathur P, Metha A, Kanwar R, Bhandari CS. Use of neem bark as wool colourant—Optimum conditions of wool dyeing. Indian Journal of Fibre and Textile Research. 2003;28:9510. Gulrajani ML, Gupta DB, Agarwal V, Jain V, Jain M. Some studies on natural yellow dyes. Indian Textile Journal. 1992;102(4):5011. Mahale G, Sakshi, Sunanda RK. Silk dyed with Acalypha (Acalypha wilkesiana) and its fastness. Indian Journal of Fibre and Textile Research. 2003;28:8612. Katti MR, Kaur R, Shrihari N. Dyeing of silk with mixture of natural dyes. Colourage. 1996;43(12):3713. Lokhande HT, Vishnu A, Dorngade, Nayak SR. Application of natural dyes on polyester. American Dyestuff Reporter. 1998;4014. Rathi DR, Padhye RN. Studies on application of natural dyes on polyester. Colourage. 1994;41(12):2515. Paul R, Jayesh M, Naik SR. Natural dyes: Classification, extraction and fastness properties. Textile Dyer & Printer. 1996;29(22):1616. Teli MD, Paul R, Pardesi PD. Natural dyes, classification, chemistry and extraction methods. Colourage. 2000;60:4317. Krizova H. Natural dyes. In: Kryštůfek M, Vik W, editors. Chapter 18: Textile Dyeing—Theory and Applications. 1st ed. TUL: Vysokoškolskýpodnik Liberec s.r.o., Studentská 2. Liberec. pp. 317-33418. Oda H. Improvement of light fastness of natural dyes. Part 2: Effect of functional phenyl esters on the photo fading of carthamin in polymeric substrate. Coloration Technology. 2001;117(5):25719. Badan BM, Burkinshans SM. Dyeing of wool and nylon 6.6 with henna and lawsone. Dyes and Pigments. 1993;221:1520. Kawamura T, Hisata Y, Okuda K, Noro Y, Takeda, Tanka T. Quality evaluation of plant dye henna with glycosides. Natural Medicine. 2000;54(2):8621. Agarwal A, Grag A, Gupta KC. Development of suitable dyeing process for dyeing of wool with natural dye henna (Lawsonia inerma). Colourage. 1992;39(10):4322. Gupta DB, Gulrajani ML. Kinetic and thermodynamic studies on 2-hydroxy-1,4-naphthoquinone (lawsone). JSDC. 1994;110:11223. Singh K, Karr V, Mehra S, Mahajan A. Solvent-assisted dyeing of polyester with henna. Colourage. 2006;53(10):6024. Bechtold T, Turcann E, Ganglberger, Geisslers. Natural dyes in modern textile dyehouse. Journal of Cleaner Production. 2003;11:49925. Rita M, Bechtold T. Natural colourants in dyeing. In: Thomas B, Mussak R, editors. Handbook of Natural Colourants. United Kingdom: John Wiley and Sons Ltd.; 2009. p. 31626. Bechtold T. Natural colourants. In: Thomas B, Mussak R, editors. Handbook of Natural Colourants. United Kingdom: John Wiley and Sons Ltd.; 2009. p. 15427. Cardon D. Natural Dyes, Tradition, Technology and Science. London: Archetype Publications; 200728. Casselman KD. Lichen Dyes and Dyeing: The New Source Book. Mineola, New York: Dover Publications; 200129. Grierson S, Duff DG, Sinclair RS. Natural dyes of the Scottish high lands. Textile History. 1985;16:2330. Gill M, Steglich W. In: Herz W, Grisebach H, Kirby GW, Ch T, editors. Progress in the Chemistry of Organic Natural Products. Vol. 51. 1987. p. 12531. Raisanen R. Dyes from lichens and mushrooms. In: Bechtold T, Mussak R, editors. Handbook of Natural Colourants. United Kingdom: John Wiley and Sons Ltd.; 2009. p. 200332. Porter CJ. Tannins. In: Harborne JB, editor. Methods in Plant Biochemistry. Vol. 1, 389. London: Academic Press; 198933. Seigler DS. Plant Secondary Metabolism. Bostan: Kluwer Academic Publications;34. Waterman PG, Mole S. Analysis of Phenolic Plant Metabolites. Oxford: Blackwell Scientific Publications; 199435. Ayres MP, Class JP Jr, Macclean SF, Redman AM, Reichart PB. Diversity of structure and antiherbivore activity in condensed tannins. Ecology. 1989;78:169636. Julkunen R, Tiitto, Haggman H. Tannins and tanning agents. In: Bechtold T, Mussak R, editors. Handbook of Natural Colourants. United Kingdom: John Wiley and Sons Ltd.; 2009. p. 200337. Agarwal A, Paul S, Gupta KK. Effects of mordants on natural dyes. Indian Textile Journal. 1993;1:11038. Erica J, Jiedemann, Yang Y. Fiber-safe extraction of red mordant dyes from hair fibers. Journal of the American Institute for Conservation. 1995;34(3):19539. Mathur JP, Bhandari CS. Use of beet sugar as wool colourant. Indian Journal of Fibre and Textile Research. 2001;26:31340. Gulrajani ML, Gupta D, Maulik SR. Bio polishing of tasar silk. Indian Journal of Fibre and Textile Research. 1994;24:29441. Gulrajani ML, Bhaumiks S, Oppermann W, Handman G. Dyeing of red sandal wood on wool and nylon. Indian Journal of Fibre and Textile Research. 2003;28:22142. Sankar R, Vankar PS. Dyeing wool with Gomphrena globosa flower. Colourage. 2005;52(4):3543. Bhuyan R, Sai Kai CN, Das KK. Extraction and identification of colour components from the barks of Mimusops elengi and Terminalia arjuna and evaluation of their dyeing characteristics on wool. Indian Journal of Fibre and Textile Research. 2004;29(12):47044. Samanta AK, Priti A. Application of natural dyes on textiles. Indian Journal of Fibre and Textile Research. 2009;34:38445. Kharbade BV, Agarwal OP. Identification of natural red dyes in old Indian textiles. Journal of Chromatography. 1985;347:44746. Zvic K. HPLC analysis of the natural scale insect, madder and indigoid dyes. JSDC. 1994;110(9):27347. Guinot P, Roge A, Aradennec A, Garcia M, Dupont D, Lecoeur E, et al. Dyeing plants screening: An approach to combine past heritage and present development. Coloration Technology. 2006;122:9348. Balankina GG, Vasiliev VG, Karpova EV. HPLC and molecular spectroscopic investigations of the red dye obtained from an ancient Pazyryk textile. Dyes and Pigments. 2006;71:5449. Mc Goven PE, Lazar J, Michel RH. The analysis of indigoid dyes by mass spectrometry. JSDC. 1990;106(1):2250. Szostek S, Grwrys JO, Surowiec I, Trojanowicz M. Investigation of natural dyes occurring in historical coptic textiles by high performance liquid chromatography with UV–Vis and mass spectrometric detection. Journal of Chromatography. 2003;A1012:17951. Cristea D, Bareau I, Vailarem G. Identification and quantitative HPLC analysis of the main flavonoids present in weld (Reseda luteola L.). Dyes and Pigments. 2003;57:26752. Son A-Y, Heng PJ, Kim KT. Dyes and Pigments. 2007;61(3):6353. Patel KJ, Patel BH, Naik JA, Bhavana AM. Eco-friendly dyeing with Tulsi leave extract. Man Made Textiles. 2002;45(11)54. Bhattacharya SD, Shah AK. Metal ion effect on dyeing of wool fabric with catechu. SDC. 2000;116(1):1055. Maulik SR, Bhowmik KI. Studies on application of some vegetable dyes on cellulosic and lignocellulosic fibre. Man-Made Textiles in India. 2006;49(4):14256. Siddiqui I, Gous MD, Khaleq MD. Indian Silk. 2006;145(4):1757. Samanta AK, Priti A. Application of natural dyes on textiles. International Dyer. 2008;193(3):3758. Samanta AK, Priti A, Siddthartha D. Studies on color interaction parameters and color fastness properties for dyeing of cotton fabrics with binary mixtures of jackfruit wood and other natural dyes. Journal of Natural Fibers. 2009;6:17159. Mohanty BC, Chandramouli KV, Nail HD. Studies in Contemporary Textiles Crafts of Indian Natural Dyeing Process of India. Calico Museum of Textiles, Ahmedabad: H.N. Patel Publication’; 1987, I and II60. Cook CC. Aftertreatments for improving the fastness of dyes on textile fibres. Review of Progress in Coloration and Related Topics. 1982;12:7861. Pad Field P, Landi S. Natural dyes of the Scottish highlands. Studies in Conservation. 1966;11:16162. Samanta AK, Konar A, Chakarborty S, Datta S. Dyeing of jute fabric with tesu extract: Part 1—Effects of different mordants and dyeing process variables. Indian Journal of Fibre and Textile Research. 2011;36(3):6363. Lee JJ, Lee HH, Eom SI, Kim JP. UV absorber aftertreatment to improve light fastness of natural dyes on protein fibres. Coloration Technology. 2001;117:13464. Mussak R, Bechtold T. Renewable resources for textile dyeing–technology, quality, and environmental aspects. In: Proceedings of the IFATCC International Congress. Barcelona; 200865. Samanta AK, Konar A, Chakarborty S, Datta S. Effect of different mordants, extraction conditions and dyeing process variables on colour interaction parameters and colour fastness properties in dyeing of jute fabric with Manjistha, a natural dye. Journal of the Institute of Engineering. 2010;91:766. Micheal MN, NAEl Z. Colourage. 2005; Annual 8367. Hofenk JH, Graff D. Conservation restoration of church textiles and painted flags. In: 4th Int Restorer Seminar. Vol. 2. Hungary; 1983. p. 21968. Samanta AK, Priti A, Siddhartha D. Application of single and mixtures of red sandalwood and other natural dyes for dyeing of jute fabric: studies on colour parameters/colour fastness and compatibility. Journal of the Textile Institute. 2009;100(7):56569. Sarkar AK. An evaluation of UV protection imparted by cotton fabrics dyed with natural colourants. BMC Dermatology. 2004;4(1):1570. Grifani D, Bacci L, Zipoli G, Carreral G, Baronti S, Sabatini F. Laboratory and outdoor assessment of UV protection offered by Flex and Hemp fabrics dyed with natural dyes. Photochemistry and Photobiology. 2002;85:31371. Grifani D, Bacci L, Zipoli G, Sabatini F, Albanete I. The role of natural dyes in the UV. Protection of fabrics made of vegetable fibres. Dyes and Pigments. 2011;91(3):27972. Gulrajani ML, Gupta D. Emerging techniques for functional finishing of textiles. Indian Journal of Fibre and Textile Research. 2011;36:38873. Koto H, Hata T, Tsukada M. Potentialities of natural dyestuff as antifeedants against varied carpet beetle, Anthrenus verbasci. Japan Agricultural Research Quarterly. 2004;38(4):241
Submitted: 15 May 2019 Reviewed: 30 September 2019 Published: 22 December 2019 Natural dyes are natural sources of dyestuff. This dye is collected from food, plants, vegetables, minerals, animals, and many other natural resources. It is also called organic dyes. Its application, use, properties, and benefits are different from other synthetic dyes. In textiles, natural dye is used for dyeing fiber, yarn, fabric, and garments. Its toxicity level is lower than other synthetic dyes so that is 100% safe for human skin. The use of natural dyes in textile dyeing dates back to ancient times and is considered one of the oldest forms of artistic expression. While natural dyes have been employed for centuries, the advent of synthetic dyes in the 19th century largely replaced them, particularly after the discovery of mauve colorants. Natural dyes are derived from renewable sources like plants, animals, and minerals, making them environmentally friendly. They have a wide range of applications, including coloring textiles, food, protein fibers like wool and silk, cotton, and leather, as well as use in food and cosmetics. Natural dyes encompass a variety of components obtained from diverse natural substances, including plants, insects, and minerals, offering a spectrum of colors. In contrast, synthetic dyes, extensively utilized in industries, pose environmental challenges such as waste disposal, non-biodegradability, water pollution, and carcinogenicity. Natural dyes, despite facing commercial challenges, present a more sustainable alternative due to their biodegradability, eco-friendliness, and capacity to produce vivid and appealing hues. They also imbue materials with additional functional properties, contributing to their suitability for various applications. Type of Natural DyeSourceColors ProducedIndigoIndigo plantShades of blueMadderMadder plant rootsRed, pink, orangeWeldWeld plantBright yellowCochinealCochineal insectRed, purpleTyrian PurpleMediterranean sea snailPurple Natural dyes are low-energy dyes as a result we can get the below benefits. Less time and energy consumption compared to the conventional dyeing method Helps to shorten lead time Embracing sustainable production and lower-impact clothing Having a lower impact on ETP and wastage It is a sustainable dyeing process that contributes to reducing the environmental load, improving production efficiency, and improving the working environment Process simplification from conventional to one bath Scouring- Dyeing- RC will shorten the process for polyester dyeing Less water, time, and energy consumption Helps to shorten lead time Embracing sustainable production and lower-impact clothing One-Bath Simplicity: Streamline your dyeing process with a simplified, one-bath approach encompassing Scouring, Dyeing, and RC steps. This innovation is a game-changer for polyester dyeing. Resource Efficiency: Witness a significant reduction in water, time, and energy consumption. Our sustainable approach ensures that every drop counts. Swift Turnaround: Shortened lead times mean faster delivery, helping you meet market demands promptly. Lower Environmental Impact: Embrace sustainable production practices and be a part of the movement towards eco-conscious and low-impact clothing. Here is the difference between Natural and Synthetic dyes which are used in the textile industry. AspectNatural DyesSynthetic DyesSourceDerived from plants, animals, mineralsChemically synthesized from petrochemicalsEnvironmental ImpactBiodegradable, minimal environmental impactEarthy, subtle tones with a limited color rangeSustainabilityRenewable and sustainable resourcesReliant on non-renewable fossil fuelsHealth and SafetyGenerally safer for humans and the environmentMay contain hazardous chemicalsColor RangeEarthy, subtle tones with limited color rangeWide range of bright and vivid colorsColor FastnessGenerally lower color fastness compared to synthetic dyesHigh color fastness, less likely to fadeApplicationUsed traditionally for cultural and artisanal productsDominant in commercial textile and industryChemical UsageMinimal chemical processing requiredRequires chemical additives and auxiliariesAllergenic ReactionsLess likely to cause allergic reactionsSome synthetic dyes may cause allergiesEco-FriendlinessEco-friendly, derived from natural resourcesMay contribute to pollution and wasteCostCan be more expensive due to extraction and processing effortsGenerally more cost-effective due to mass production Here’s a list of natural dyes along with the color they produce, their chemical structure, and their source: Indigo: Color: Blue Chemical Formula: $C_{16}H_{10}N_2O_2$ Source: Indigofera tinctoria plant Madder (Alizarin): Color: Red Chemical Formula: $C_{14}H_8O_4$ Source: Rubia tinctorum plant Cochineal (Carminic Acid): Color: Red Chemical Formula: $C_{22}H_{22}O_{13}$ Source: Dactylopius coccus insect Turmeric (Curcumin): Color: Yellow Chemical Formula: $C_{21}H_{20}O_6$ Source: Curcuma longa plant Henna (Lawsone): Color: Reddish-Brown Chemical Formula: $C_{16}H_{10}O_6$ Source: Lawsonia inermis plant Logwood (Haematoxylin): Color: Purple Chemical Formula: $C_{16}H_{14}O_6$ Source: Haematoxylum campechianum tree Brazilwood (Brazilin): Color: Red Chemical Formula: $C_{16}H_{14}O_7$ Source: Caesalpinia echinata tree These natural dyes produce a range of colors, from blues and reds to yellows, purples, and reddish-browns. Their chemical structures contribute to their unique coloring properties, and they are derived from various parts of plants or insects. Keep in mind that the exact shade of color can vary based on factors such as concentration, mordants used, and the type of fabric being dyed. Primary ColorSecondary ColorTertiary ColorIndigoIndigo + Indigo = BlueBlue + Blue = Dark BlueMadderMadder + Madder = RedRed + Red = Dark RedCochinealCochineal + Cochineal = Deep RedDeep Red + Deep Red = Dark Deep RedTurmericTurmeric + Turmeric = YellowYellow + Yellow = Dark YellowHennaHenna + Henna = BrownBrown + Brown = Dark BrownLogwoodLogwood + Logwood = Dark PurpleDark Purple + Dark Purple = Very Dark PurpleBrazilwoodBrazilwood + Brazilwood = Deep RedDeep Red + Deep Red = Very Deep Red Natural dyes, with their unique properties, have gained significance in the textile industry for their eco-friendly and sustainable characteristics: Eco-Friendly: Natural dyes are derived from renewable resources, reducing the environmental impact associated with chemical synthesis. Biodegradable: They break down naturally, minimizing pollution and harm to ecosystems. Non-Toxic: Unlike synthetic dyes, natural dyes do not contain harmful chemicals, making them safer for both the environment and human health. Low Water Consumption: Natural dyeing processes typically require less water compared to conventional dyeing methods, contributing to water conservation efforts. Varied Color Palette: Natural dyes offer a wide range of colors, often with unique and subtle variations, adding depth and character to textiles. Cultural Significance: Many natural dye sources have cultural and traditional importance, connecting products to their geographic and historical origins. Potential for Organic Certification: Textiles dyed with natural dyes have the potential to meet organic certification standards, appealing to eco-conscious consumers. Minimal Carbon Footprint: The production and use of natural dyes often involve fewer carbon emissions compared to synthetic alternatives. Promotes Biodiversity: Cultivation of natural dye plants can contribute to biodiversity and support local ecosystems. Artisanal Opportunities: Natural dyeing can be a source of livelihood for local artisans and communities, preserving traditional crafts and skills. Less Hazardous Waste: The waste generated from natural dyeing processes is generally less hazardous and easier to manage compared to synthetic dyes. UV Stability: Some natural dyes demonstrate good UV stability, providing longer-lasting color retention in textiles. Aesthetic Appeal: Natural dyes often lend textiles a unique, organic appearance, which can be highly desirable for certain fashion and home textile applications. Reduced Allergenic Potential: Natural dyes are less likely to cause allergic reactions or skin sensitivities in comparison to some synthetic dyes. Regeneration Potential: Many natural dye sources can be grown and harvested sustainably, providing a renewable resource for the textile industry. These properties collectively position natural dyes as a compelling choice for the textile industry, aligning with the increasing consumer demand for sustainable and eco-conscious products. Natural dyes have played a pivotal role in the textile industry for thousands of years. Ancient civilizations like the Egyptians, Greeks, and Romans employed plants, insects, and minerals to create vibrant hues. The Silk Road facilitated the exchange of dyeing techniques, introducing prized dyes like indigo, cochineal, and wool to different regions. During the Islamic Golden Age, scholars made significant strides in documenting dyeing methods. In medieval Europe, wool and madder were crucial for textile production. The Age of Exploration brought new dye sources like cochineal from the Americas. However, the advent of synthetic dyes during the Industrial Revolution led to a decline in natural dye usage. In recent decades, a resurgence of interest in sustainability and eco-friendliness has sparked a revival of natural dyeing, with artisans and designers worldwide embracing its unique and environmentally conscious approach to coloring textiles. Color Fastness and Variability: Ensuring that colors remain vibrant and do not fade over time, especially with exposure to factors like light and washing, is a critical concern in textile production. Natural dyes, while eco-friendly, may exhibit lower color fastness compared to synthetic dyes. Additionally, the variability in color outcomes due to natural sources can pose a challenge for consistent production. Impact: Maintaining color durability is crucial for meeting consumer expectations and industry standards, necessitating careful selection of dyeing methods and consideration of dye sources. Cost and Availability: The extraction and preparation of natural dyes can be labor-intensive, potentially leading to higher production costs. Additionally, the seasonal and geographical availability of certain natural dye sources can impact their accessibility. This can result in higher material costs and limited availability compared to readily accessible synthetic dyes. Impact: Affordability and consistent availability of natural dyes are important factors for textile manufacturers, particularly for large-scale operations looking to balance cost-effectiveness with sustainable practices. Processing and Application Techniques: Achieving desired and consistent colors with natural dyes requires specialized knowledge and skills. Factors such as pH levels, mordanting techniques, and dye extraction methods play a crucial role in determining the final color outcome. Inadequate or incorrect processing techniques can lead to uneven coloration or undesired color shifts. Impact: Proper training and expertise in working with natural dyes are essential to ensure high-quality results. This may increase production complexity and potentially add to the overall cost of production. In the future, there are several potential developments and plans for natural dye usage in the textile industry: Research and Innovation: Continued research into discovering new sources of natural dyes and refining extraction processes is likely. This could lead to a broader palette of colors and improved dyeing techniques. Scaling Production: Scaling up the production of natural dyes will be essential to meet the growing demand from conscious consumers and businesses. This might involve optimizing cultivation and extraction methods for dye-yielding plants. Certification and Standards: Establishing certifications and standards for natural dyes can help ensure quality, authenticity, and sustainability. This can also build trust with consumers. Collaborations and Partnerships: Collaborations between textile manufacturers, dye producers, and agricultural communities can help create a sustainable supply chain for natural dyes. Education and Awareness: Raising awareness among consumers and businesses about the benefits of natural dyes and their environmental impact will be crucial. Educational programs can also help train artisans and manufacturers in the use of natural dyes. Integration of Technology: Implementing technology for better dye extraction, application, and waste management can enhance the efficiency and effectiveness of natural dye processes. Waste Management and Recycling: Developing methods to recycle and reuse natural dye materials and byproducts can further reduce the environmental impact of dyeing processes. Regulatory Support: Governments and regulatory bodies may implement policies and incentives to encourage the adoption of natural dyes and discourage the use of harmful synthetic alternatives. Market Demand and Consumer Preferences: Continued consumer demand for sustainable and eco-friendly products will be a driving force for the adoption of natural dyes. This may lead to more brands incorporating natural dyes into their product lines. Circular Economy Practices: Implementing circular economy principles in the textile industry, including dyeing processes, can contribute to a more sustainable and less wasteful approach. Biotechnology and Genetic Engineering: Advances in biotechnology may lead to genetically modified plants that produce more vibrant and diverse natural dyes. However, ethical and environmental considerations will be important in this field. Lastly, we can say, we are going to sustainability or Green textiles so natural dye is the best option for dyeing the textile industry. It is 100% safer than other dyestuff, so for kids, we can use natural dyed products. Though it has some limitations it is healthy for us. Natural dye in textiles offers a sustainable alternative to synthetic dyes, sourced from plants, insects, and minerals. It minimizes environmental impact and supports ethical practices. With the increasing demand for sustainable fashion, natural dye is poised to play a pivotal role in shaping a more eco-conscious textile industry. For more info, you may read: You may read some related articles: Best Natural Dye For Cotton Dyeing Fabric With Natural Lavender Dyes FOR MORE INFO ABOUT GARMENT DYEING CLICK HERE TO VISIT