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A study of Natural Dyes and Dye Yielding Plants and its application on Textile in Ancient India

Dr. Nasreen Begum

Abstract
The present research article deals with the information on the natural dyes and dye-yielding plants of Ancient India. Dyes are intensively coloured compounds that are applied to a substrate such as fibre, paper, cosmetics, hair, etc. to give colours and can be extracted from the roots, fruits/berries, bark, leaves, flowers, and stem/wood, fungi, and lichens by various processes of extractions. In addition to their dye-yielding characteristics, many of these plants possess medicinal values and can be used for multiple other purposes. Plant derived-colours have an important role in human life because of their safe and eco-friendly nature. But due to the availability of economically cheaper synthetic dyes, the indigenous knowledge of extraction, processing, and proper utilization has been diminished. Nowadays, the demand for natural dyes has been increased worldwide due to awareness about their beneficial properties.

Keywords: Manjiştha, Kampillaka, Jatuka, Läksä, Krimi, Indragopaka, Gairika and Sindura

Introduction

Natural dyeing is the art of taking organic materials, extracting color from those materials, and applying the color to fiber, yarn, or cloth. The color adheres to the fibers of the material you are dyeing and transforms it into a beautiful piece of art. Natural dyes are somewhat unpredictable, and each one acts in unique ways. Some natural dyes are lightfast; they maintain their color even after prolonged exposure to sunlight. Some natural dyes are fugitive, meaning they will slowly fade over time. The joy of dyeing naturally comes in the experimentation, the unknowns, the crafting of a color. It is an art form that takes patience and diligence, but also a free spirit and sense of creativity and flexibility. Plants are full of life and interest. Not only does a plant grow from a tiny little seed, but then it helps to clean our air, develop fruits, veggies, or other eatables. For the natural dyer, it also opens a world of possibilities for color.

Dyeing and painting activities have accompanied the development of human culture since the early beginnings. The use of dyeing and pigmenting materials was probably born out of the necessity of prehistoric man to adorn and beautify his objects of daily use. The knowledge and use of color began with the dawn of civilization and dyeing is as old as the textile industry itself. The term dye, is derived from old English word daeg or daeh meaning "colour". The earliest dyes were probably discovered by accident and may have been noticed from the stains from available berries, fruits and nuts and blossoms, leaves, stems and roots of shrubs.

India's expertise in natural dyes dates back to ancient times. Colour plays a vital part in Indian textiles. Dyeing of cloth was essential for increasing its beauty. What made the Indian textile fabrics more interesting was the variety of colour employed in dying them. So the art of dyeing was in vogue since remote past and it was an important occupation during the ancient times. The love of brilliant colour combinations like vermilion and yellow, is ingrained in the minds of the Indian people. Although at the beginning these colours were borrowed from nature, the people soon imbued with immense significance, sometimes social, and sometimes spiritual. The chief characteristic of the use of colour in Indian textiles is the principle of 'rhythmic contrasts'.

The principal dye-substance was the plant juice, tinctorial property of which was revealed to the primitive people from the stains of the juices of fruits, crushed flowers, roots, barks, etc., left on their hands while collecting food.

The other dye-producing materials were animals and mineral substances. Some specific substances for producing red, yellow, blue and black are found to have been used throughout the countries of the world. These comprise of madder, and insects like lac, cochineal and kermes for red; turmeric, safflower, saffron, and mineral, like orpiment for producing yellow, indigo for blue, and gall black for black. Throughout the centuries there occurred no changes in the use of the ancient dye-stuffs till the appearance of the synthetic dyes in the middle part of the nineteenth century A. D.

In the present paper a study is being made on the various natural dyes and dye-producing substances in India during ancient periods. Natural dyes are environmental friendly, biodegradable, and nontoxic. Dyes and pigments derived from natural sources suchas plants (leaves, stems, fruits, seeds, flower heads, bark, root, etc) animals (Lac, Cochineal and kermes) and minerals (prussion blue, red ochre and ultramarine blue)for coloring materials have been used for centuries.

Dyes are substantive or adjective. Substantive dyes are absorbed and fixed by chemical bonds within the fibers without further chemical treatment. However, most natural dyes are adjective dyes and need the use of mordants to help their absorption and fixing on fibers. Metal salts act as chemical bonds between the dye molecules and the functional groups of the fibers, and generally change the color produced by the dye.

Review of Literature

India, from antiquity, was famous for the growth and production of excellent dye-stuff's, and has been described as the largest dye-producing country of the world. Recognition of Indian dyes in the world market as early as c. 500 B. C., is evidenced from the instances of indigo (nila), the presumed indigenous dye-drug of India being used in Egypt for the dyeing of muslin. The details about Indian coloring-matters (rangadravya) are found mainly in the lexicon texts appearing between c. sixth century A. D. to seventeenth century A. D.

The coloring matters in Indian terminology are expressed by the terms, like, ranga, raga and rakta originating from the root verb ranj, means 'change from one color to another.' The list of rangadravyas (coloring matter) found mainly in the lexicons are not restricted to enumerate only the dyes but also the auxiliaries (yoga) and mordants (rangabandhana). The use of the term ranga in Indian terminology, therefore, appears to have been used to denote all the elements used for producing the desired color to the substance to be dyed.

The history of Indian 'dyes' appears to have been started from the Vedic period. In the pre-Vedic period, however, a piece of purple colored cotton is available from the antiquities of Mohenjo-Daro (c. 3000 B. C.). Which from recent chemical examinations, suggests its coloration with madder.

The tinctorial properties of vegetable substances recognized in the Vedic period particularly in the Atharva Vedic and the succeeding periods (c. 1000 B.C.-500 B.C.) were kala or asikní (possibly indicating indigo) maharanjana (safflower), manjiştha (madder), lodhra (*Symplecos racemosa*) and haridra (turmeric). Lac is found among the animal dye-stuff.

The dye stuffs introduced in the Post-Vedic period (c. 500 B.C. –3rd century A. D.) include kunkuma (saffron) and nila (indigo) among the plant products, krmi (kermes) and racanã (bright yellow substance prepared from cow's urine) among the animal substances; gairika (red-ochre) among minerals and khanjana (carbon black).

The purple dye on a piece of cotton was in all probability produced from the madder plant and the discovery of dyer's vessel from the Harappa and Mohenjo-daro indicate that the art of dyeing was known and practiced. The chief vegetable dyes used were indigo, clay-root, lac, turmeric and flower.

The Vedic people also knew different methods of dyeing the clothes because the dyeing of textiles was also a subsidiary craft. In this art both male and female dyers were engaged, but the latter excelled the former, so they have been dedicated to delight. The Vedic texts refer to several colours in which cloth was usually dyed. The colours known to the people of Rigvedic period seem to be evidenced from the occurrence in the Rigveda. Though the texts refer to several dye-stuffs and cloths of different colours, but they do not shed any light on the technique of dyeing.

As far later Vedic period dyeing process is concerned, it was done with the juice of "lodhra" flower or with madder or indigo. Several colours are mentioned in later Vedic literature. They include white, red, yellow, green, blue and black.

The compilers of the Grihyasutras were also acquainted with the art of dyeing also, as the Asvalyan Grihyasutra states that a Brahmana should wear reddish yellow (Kasaya), a Kshatriya's garment should be manjistha (dyed with madder), and a Vaisya should put on yellow garment (charindra) at the time of upanayana. So, it appears that vegetable and stone dyes have been widely used from the very early times. The Brhidaranyak Upanishd suggests that clothes used to be dyed with various colours such as yellow, scarlet and red.

In Epics also we get number of references regarding dyeing industry. The Ramayana metnions the ladies of Ravana clothed in garments of variegated hues. "Kusumba" was one of the prominent dyes used. In the Mahabharata we read an uncolored cloth, when dirty, can be cleaned but not a piece of cloth that is dyed with black. A snataka was asked to avoid all dyed dresses and all naturally black cloth. Gautama also forbids him the use of dyed or sumptuous garments. Block printing was also an ancient folk tradition in India. It was certainly known in the days about which the Greek scholar Arrian wrote and probably in the days of the Mahabharata as well. The dye manufacturer "Rangakara" is also referred in the Ramayana and Mahabharata.

During Buddhist period, dyeing industry was in full-fledged way. The Jataka refers to a variety of colours and to garments. rugs and curtains as dyed scarlet, orange etc. Even an umbrella is noted as red coloured. The word rajaka who performed the work of dyeing after having washed the cloth, may be taken to mean both as washerman and a dyer." The Majjhima Nikaya says that before dyeing the cloth it should be washed properly, so that it may absorb the true colour properly. It says –

"A foul and dirty piece of cloth, if dipped by the fuller in blue, yellow, red or pink dye, would take the dye badly, and not come out in a good colour, and that is because of the cloth's impurity."

The Vinaypitaka informs us that dyed clothes like blue, light yellow were prohibited for the monks. This suggests that clothes of these colours were used by the laity.

In the Buddhist canons we find many references to colored cloth. "Some of the Likkhavis wear dark, dark in color and wearing dark clothes and ornaments, some of them were fair in color and wearing light colors and ornaments, some of them were red in color and wearing red clothes and ornaments, some of them were white, pale in color and wearing white-coloured clothes and ornaments." Now there is no doubt that these were vegetable dyes employed for the purpose of coloring textile goods.

Jatakas also mention various colors such as white (sveta), dárk-blue (nila), brown (pingala), yellow (halidda), golden (suvarna), silvery (rajatamaya) red (rattain dagopo), black (kali), madder like (Manjetha) etc. It can be presumed that these colors were utilised for dyeing clothes. Hence we may infer that the art of dyeing was equally developed as weaving in this period.

Jain literature and Bhasya inform us that the coarse cloth was first washed and bleached before dyeing. Soda (Sajjiyakhara) is mentioned as washing agents.

Clothes dyed in reddish colour (Kasai) were worn in hot weather. The "Parivrajaks" used to wear clothes dyed in red ochre (geruya). Indeed, the cotton tissues and stuffs of India have always been more sought after for the beauty and brilliancy of their natural dyes than for the fineness and softness with which they are interwoven.

Panini also informs about the colors known to the people then. They were raga, red, black, laksha also called jalu, madder (majistha) and orpiment (rochana). It is confirmed that by the time of Panini people were well acquainted with the knowledge of colors. According to Katyayana, powdered potsherds and kardama (black mud from the bottom of pool) also served as dyeing stuffs. Haridra and maharajana are other dyeing agents.

Manu and Milindpanho also refer dyeing and the dyer's street respectively. These instances clearly indicate the prevalence of dyeing and dyer's art in this regard. The dyeing of textiles was practiced in the Maurya period as evidenced by the Arthasastra which mentions white, pure red, rose-red. and black woolen and fur of one uniform colour such as--black, dark red, grey or of wheat color or of straw color." Manjistha or Indian madder is also heard of in the Arthasastra as a red-dye stuff." Kautilya refers to the cultivation of “kusumba in the royal forms for flowers which were, according to the commentator, productive of colouring materials."

Kautilya in his Arthasastra has given proper time limitation for dyeing or coloring the clothes. The dyers were known as 'Rajaka' and they were paid double in amount as compared to washerman." Megasthenese tells that garment were dyed of bright colors. He also refers to the turban and upper garment worn by people of India and informs that generally they dress in white muslin.

Methodology

The Classical Age up to the medieval period acknowledges the tinting capacity of a number of vegetable substances as well as of metals and minerals. The most prized red dye-stuffs of this period were kampillaka, pattanga and jatuka and animal substance, like indragopa (cochineal). In addition to these some black 'dyes' came to be known. These were derived from plant substances, like, abhaya, amalaka, bhrigaraja, nila, pippala from ayas (iron), käsisa (sulphate of iron), tuttha (sulphate of copper) and anjana (sulphate of antimony) among the mineral and metal substances. Apart from these śakala (a kind of black dye prepared from cow-dung) was also used for this purpose.

The medieval period was marked by the discovery of the colour-fixation property of tuvari (alum), and processes employed for the extraction of the colouring principles from the dye-stuff. The late medieval period (eighteenth century A. D.) introduced the applications of iron mordant for the fixation of colours like, blue, green and violet and of aluminium mordant for the fixation of red dye-stuff.

Dye-stuffs which were used in India during ancient period, are to be discussed now in accordance with the sequence of their introduction and uses. The paper concentrates on dye-producing substances. The present study is exploratory in nature. For the present study, a detailed review of existing literature is carried out on natural dyes and dye- producing plants, minerals and insects etc. and dye -producing substances. Research papers published in journals and various articles available in online search engines are also reviewed. On the basis of literature reviews future recommendation is provided.

Results and Discussions

Red Dye-producing substances

In the analysis of Indian dyes, red is found to have been produced by a number of substances, both organic and inorganic matters. Most of these red dye-producing substances were attributed with two tinctorial properties -- red and yellow, the two foremost colours of the Vedic Indians on account of their associations with gods.

The substances with red-yellow tinctorial effects have been included under 'red dyes' as they were more prominent as red tinctures than for their yellow contents. Recognition of these dyes, namely, safflower and saffron, as yellow coloring matter is however noticed in the history of dyes in the other countries of the ancient world.

Purely red-dye producing substances were manjiştha (R*ubia cordifolia*), kampillaka (*Mallotus phillippinensis*), parpata or jatuka (species of *Oldenlandia*) among the plant-products; läksä (lac) krimi (kermes) and indragopaka (cochineal) among animal substances and gairika (red-ochre) and sindura (red-lead) among the mineral substances.

Substances popular as red-dye but also containing yellow colouring matter were kusumbha (*Carthamus tinctorius*), kunkuma (*Crocus sativus*) and patunga or pattanga (Caesalpinia sappan).

Pure Red Dye-Producing Substances*:* Plant Product Dyes

Manjişthä (Indian madder, *Rubia cordifolia*)

Madder (*Rubia cordifolia*) is a perennial and herb-aceous climber plant having very long, cylindrical, and flexuous root with thin red barks. Its stems often have a long, rough, grooved, woody base. Its old roots are richer in color than the young ones. The roots contain dye present in the free or bound glucosides which are anthraquinone derivatives, mainly purpurin and munjistin. The roots also containa small amount of xanthopurpurin, pseudo-purpurin, nordamncanthal, and rubiadin. Madder has been a promising plant for dyeing from the ancient times and worked upon to produce red dyed textiles of varying characteristics with the help of advance techniques and mordants. Since the modern people are more aware about eco-friendliness along with their comfort, demand for the greener textiles was raised and the evolution of bio-mordants gained popularity.

Manjiştha, the most ancient dye-drug, was a cultivated plant of India particularly in the Punjab Himalaya region and a native of either Syria, Palestine and Egypt or Siberia.

The Atharvaveda describes it as a creeping plant and the abode of läksā. It was a "beautiful dye" as the name suggests, and full of dye producing matter. The red tinctorial matter (lohita) is stated to have been diffused throughout the entire system particularly in the stems. The stem was therefore used for extracting colouring matter. The dye properties of both the stem and the root are found to have been utilized in India till the advent of synthetic dye. In different countries of the ancient world, it was called "root" as it was considered the source of dye. The red coloring matter of the dye is

chemically known as Alzirin which is now made synthetically. The colouring principle was obtained from the boiling of the requisite part of the plant. The 'dye' is of course impregnated on the yarn from the boiling of the latter with the powdered root of the plant diluted in water.

The color which the plant produced was bright red and very pleasing. It was a mordant dye for which the use of alum was prevalent. The Samayamätrka states that madder-dye could be lasting if it is first heated and then made cool before dipping the fabrics to be dyed.

The dye was particularly used for the coloration of the textile fabrics. Dyeing of leather and of hair was also performed with this dye-stuff.

Kampillaka or Kampilla (Kamela Powder, Kamala Powder) (*Mallotus phillippinensis*)

Kamala (*Mallotus phillippinensis*) of Euphorbiaceae family, flourishing in the forest of tropical Asia from India to Malaysia, Philippines, China and Australia yields a yellow natural dye, Kamala dye. Kamala tree has long been valued as the source of a dyeing material. The dye is an orange red powder present in the red glandular pubescence covering the ripe capsules and is usually collected in Feb. -March of every year when the fruits have ripened.The material collected from uniripe fruits is greenish in colour and is of little or has no commercial value.The yield of powder is about 1.4-3.7% of the weight of fresh fruit. The colouring components of Kamala (*Mallotus phillippinensis*) comprises of several chalcones. Powdered Kamala (*Mallotus phillippinensis*) dye was formerly employed extensively in the dyeing of silk and wool. Kamala powder exhibits several pharmacological properties such as anti-inflammatory, anti-allergic and antimicrobial activity and also used in the treatment of bronchitis, abdominal disorders and spleen enlargement. Its strong antioxidant and anti-free radical properties suggest that Kamala (*Mallotus phillippinensis*) may be appropriate for use as an additive for food and nutraceuticals.

Kämpilla, the popular dye-drug of the classical period, was a native plant of Kampilla country, i.e., North-Western Province, as the name indicates. It is a small evergreen tree, throughout the tropical India and is distributed to China, the Malaya Islands and Australia. The plant appears to have reached Europe through the Arabs who were acquainted with the plant at an early date.

The plant is described in the ancient literature as red-bodied, containing the red tinctorial matter in form of grainy (karkaša) powders (raktacürṇaka) which covers the plant (gunda). Suśruta refers to this powdery substance of the fruit (phalaraja). The grainy character of the powder finds support in Ibn Sina's description of kanbil, the Arabic form of Sanskrit Kämpilla. According to the modern description of the plant the outer surface of the fruits when ripe, is covered with red powder. The mealy powder covering capsules yields a dye called kamila dye whose action depends on the minute stellate hairs found in the powder rubbed off the capsules and which is also found though in a smaller quantity on the leaves and stalks of the plant.

The dye-substance, which the plant produced, was very pleasing. It was diluted in water to prepare the colouring matter for the dyeing of textile fabrics particularly the silken stuff.

The colouring principle is chemically known as Mallotoxin (modern name: rottlerin) and colouring matter is described as not requiring any mordant. All that is necessary is to mix it with water. Watt states that the colour, which is produced by being diffused in water, is pale yellow, but in combination with alkaline carbonates and caustic alkalies, it forms deep red colour. Without mordant it does not produce good colour to the silk or cotton fabric.

Parpata or Jatuka or Parpat (Species of *Oldenlandia*)

Oldenlandia umbellate, commonly known as Indian madder or chay root, belonging to the family Rubiaceae, is one such unexplored dye yielding plant. It is known that plants belonging to this family contains substantial amounts of anthraquinones, especially in the roots. The root bark of this plant, preferably at two years old, is the source of chay root dye. Apart from its dye yielding character, the leaves and roots are considered to be expectorants and are used in the treatment of asthma, bronchitis and consumption. A decoction of the leaves is used as a wash for poisonous bites.

Although the dyeyielding properties of this plant have been m entioned in a few reportsand its ethnobotanical use has been d ocumented, to date there is no proper protocol for theextractio n of the dye in a scientific way. Further, the chemical characte risation of thisnatural dye has not yet been completed in detail butitisformulated that dye extraction and the coloring compound reveal that the major principle components are present in this plant.

Parpata or jatuka or parpat, as the plant is variously known in Indian literature, came to be recognized as a dye-drug in the medieval period. There is no plausible reference to the particular tincture produced by it. The plant has been identified as red-dyeing *Oldenlandia* which grows throughout the tropical India. It was a slender creeping plant of luxuriant growth in clusters, knotty and dark in appearance, had its growth on light and on sandy ground as well as on cultivable field. It was an excellent abode of the lac insect.

The plant contained good coloring matter and produced the tinctorial effects from the powders and from the watery juice of the stems.

The red-dyeing property of the variety of this plant identified as *Oldenlandia* umbellata, more popularly known as "chay root". The colouring principle is stated to be a mordant dye like madder, kermes and cochineal. The dye matter was obtained from the pulverized dry root-bark dissolved in cold soft water. The cloth, to be dyed, was boiled in this water over gentle heat. The red colouring matter also effected a number of shades, like, brown, purple and orange on being combined with the infusion of myrobalan in milk and water, rice-gruel, cow-dung, etc.

Both the manjistha and the parpata belong to the same botanical family, Rubiacea undergo same treatment for producing tinctorial effects. The dye produced by this plant was solely employed for the coloration of textile matter.

Insect Dyes

The next important red dye-producing agents were the three insects, namely, läksä (lac), krmi (kermes) and Indragapa (cochineal). These three, in addition to *Margarodes polanicus* (producing polish cochinille) also known as "St. John's Blood" or "Polish grains," were the sources of red dye in the other parts of the ancient world. The colours produced by them ranged from bright red to scarlet. In India, however, the color produced by the three insects has been described simply as 'red.' The following are some of these insect dyes in India.

Laksā or Lac (*Coccus lacca*--*Coccidae* Family)

Lakṣa or räksä (from raga, dye) the two names of the insect meaning 'bright dye' was obtained from the resinous excretion

deposited on the twigs of trees from the female lac insects. It was an excellent dye-stuff (rangamātā) in India throughout the centuries starting from the late Vedic period. The word lac in English comes from the Persian word lak and Hindu word lakh both of which mean 'hundred thousand' indicating the vast numbers of minute insects required to produce lac. The red colouring principle of lac is chemically known as laccaic acid which is related to carminic acid in cochineal dye.

The insect was the native of India and of different parts of the South-East Asia. In the Hellenistic age the lakkos, i.e. Greek word for lakṣā was an export article in the part of Adulis from the important port of Barygaza in India. This particular lac is stated to have been originated in Ariaka, e.g. Maharashtra. Laccha the dye substance of Achaia, mentioned by Democritos, probably refers to crude gum lac and shellac which was imported there from the ports of Axum and India during the first century A. D.

The particular dye-producing insect (rangamata) of India has been described by Ktesias during the fourth century B. C. as "the size of beetle, of a red colour, resembling that of minium, having long legs and soft to the touch. They are produced on trees that bear electrum, and they feed on the fruit of those. In Indian literature läksa has been described as an insect "breeding on trees, like, manjiştha, palasa, khadira, parpata or parpati, three species of Mangifera Indica etc., "sucking the fiuid of the tree" and "full of fluid essence" accumulated from the nourishment obtained from the essence of trees. It produced 'resinous substance' (jatu) by being 'attached to the trees" which was produced in female insect after its "impregnation" The resinous substance is stated to be the "disease of tree"

The resinous substance which is the source of dye has been described as both 'dark' and 'red'. This depended on the product of the trees on which the insect was fed on. The colouring material was obtained in two ways; (i) by squeezing the läkṣã and (ii) by bruising. The dye was believed to produce permanent tints to fabric if it was boiled and made cool before being applied to the desired article. Apart from dyeing of fabric the red colouring properties of lakṣa was utilized widely as cosmetic for reddening of certain parts of the body.

During ancient times, scale insects belonging to the *Coccoidea* family were used extensively in the textile industry for dyeing purposes. The strains exploited for this purpose were mainly Porphyrophorapolonica, *P hamelii* (*Armenian cochineal*), Kermes vermilio (kermes), Kerria lacca (Laccifer lacca), and *Dactylopius coccu* (American cochineal or simply cochineal). Among these strains, cochineal and lacca were used as food colorants. It is to be noted that cochineal has been approved by the European Union and the United States for safe consumption. Pigment obtained from lac insects was primarily used in dyeing silk fabrics and Persian carpets, and yielded a color range that varied from red/rose to purple. India was the main exporter of lac dye during the 18th century, but later, after the arrival of synthetic dyes, a significant reduction was observed in the exportation. Subsequent to the ban on azo dyes, naturally synthesized insect dyes have once again gained importance on a commercial level. These naturally occurring pigments can be used extensively in the food, medicine, and cosmetics industries. Lac dye is now officially registered as a natural food preservative in various countries worldwide.

Krimi (Kermes. Kermoccus Vermilia Planch, Popular as Kermes-Grain, Dyes-in-Grain, Scarlet Grain, etc.)

Kermes derives from the Sanskrit word Kirmis or kṛmija meaning "worm-made". [This was adopted into Persian and later in Arabic qermez. The modern English word kermes was borrowed from the French term kermès. Kermes is a red dye derived from the dried bodies of the females of a scale insect in the genus Kermes, primarily Kermes vermilio. The Kermes insects are native in the Mediterranean region and are parasites living on the sap of the host plant, the Kermes oak (Quercus coccifera) and the Palestine oak (Quercus calliprinos). These insects were used as a red dye since antiquity by the ancient Egyptians, Mesopotamians, Indians, Greeks, Romans, and Iranians. The kermes dye is a rich red, a crimson. It has good colour fastness in silk and wool. It was much esteemed in the medieval period for dyeing silk and wool, particularly scarlet cloth and it was replaced by other red dyes, starting with cochineal.

The next dye-producing insect was krimi, a term which includes both insect and worm. The dye-juice produced by krimi was known as krimirāga. The tinctorial effect of this insect was recognized in the society during the post Vedic period, Kermes from Arabic Qirmis to which the Indian krmi has been equated was an important red dye of ancient Mesopotamia. At the very beginning kermes was known as a scarlet-berry of the oak plant. It was a worm (vermiculus) to the classical authors which is noticed from different terminological expressions in the languages of the Near East since Accadian. Afterwards it came to be known as an oak-feeding mosquito like insect. The dye was believed to be the blood of female insect who poured this substance during the period of hatching. Apart from oak feeding kermes, mention is also made of a kind of kermes breeding on certain species of grass in Armenian region. The female of this type was also used as red dye. This type of kermes bears some identity with Indian grass feeding indragopa (cochineal).

The so far available information represents it as a weevil produced in stored up blood, particularly human blood, in combination with some auxiliaries (yoga). The weevils are stated to have been covered with a shell formed over the body from a thread like secretion emitted from their mouth while taking breath after birth. The dye-matter was obtained from the body after removing the shell. On account of their growth in blood they were called rudhira-krmi during the medieval period. Rudhira krmi may also mean worm whose blood was used as dye," as is evident in the case of female kermes. In the sixteenth century A. D. Duarte Barbosa, the Portuguese traveller has noted down the culture of kermes-in-grain at Champanea near Baroda and at Pullicat in Southern India.

The colour, which the kermes dye produced, was scarlet, for which in the Middle Ages it was traded as "scarlet-grains" or "venetian scarlet." In combination with alum, it effected crimson tint by which the Egyptians used to dye leather. The colour was also known as vermilion for being produced from vermiculus. The Indian krmiraga has been explained as carmine. The red dye material of kermes is chemically known as Acida carminique or Rogue de cochenille.

The colouring principle, as our Indian sources state, was derived squeezing the insect while submerged in the liquid (blood). Some auxiliaries were mixed with this substance to prepare the 'dye'. This particular dye substance is stated to have produced an excellent fast color. In India its use is mainly noticed for the dyeing of silken and woolen materials.

Indragopa (A Kind of Red or Crimson beetle, Identified as Cochineal, Coccus Cacti--belongs to *Coccidae* Family)

Cochineal is the name of both an expensive crimson

or carmine dye and the cochineal insect (*Dactylopius coccus*), from which the dye is derived. The cochineal insect is a scale insect in the suborder Sternorrhyncha, native to tropical and subtropical South America and Mexico. The cochineal insect, a primarily sessile parasite, lives on cacti from the genus Opuntia, feeding on moisture and nutrients in the cacti. The insect produces carminic acid to deter predation by other insects. Carminic acid can be extracted from the insect's body and eggs to make the dye. Cochineal is primarily used as a food colouring and for cosmetics.

After synthetic pigments and dyes such as alizarin were invented in the late 19th century, natural-dye production gradually diminished. However, current health concerns over artificial food additives have renewed the popularity of cochineal dyes, and the increased demand has made cultivation of the insect profitable again.

A deep crimson dye is extracted from the female cochineal insects. Cochineal is used to produce scarlet, orange and other red tints too. The colouring comes from carminic (kermesic) acid. Cochineal extract's natural carminic-acid content is usually 19–22%. The insects are killed by immersion in hot water (after which they are dried) or by exposure to sunlight, steam, or the heat of an oven. Each method produces a different colour which results in the varied appearance of commercial cochineal. The insects must be dried to about 30 percent of their original body weight before they can be stored without decaying. It takes about 155,000 insects to make one kilogram of cochineal.

There are two principal forms of cochineal dye: cochineal extract is a colouring made from the raw dried and pulverised bodies of insects, and carmine is a more purified colouring made from the cochineal. To prepare carmine, the powdered insect bodies are boiled in ammonia or a sodium carbonate solution, the insoluble matter is removed by filtering, and alum is added to the clear salt solution of carminic acid to precipitate the red aluminium salt. Purity of colour is ensured by the absence of iron. Stannous chloride, citric acid, borax, or gelatin may be added to regulate the formation of the precipitate. For shades of purple, lime is added to the alum.

As of 2005, Peru produced 200 tonnes of cochineal dye per year and the Canary Islands produced 20 tonnes per year. Chile and Mexico have also recently begun to export cochineal. France is believed to be the world's largest importer of cochineal; Japan and Italy also import the insect. Much of these imports are processed and reexported to other developed economies. As of 2005, the market price of cochineal was between 50 and 80 USD per kilogram, while synthetic raw food dyes are available at prices as low as 10–20 USD per kilogram.

The third red dye-producing insect was indragopa, i.e., rain-protected insect. The use of this animal dye goes back to the Classical period. However, the excellence of the redness of the insect is a frequent occurrence in Indian literature from the Vedic period onwards. The insect has been identified as cochineal, which means bright red or scarlet. Cochineal was one of the red dye-producing scale insects of the ancient world, particularly Mexico. West Indies and Russia. The dye was extracted from the female body during the period of hatching. The real cochineal was a cactus-feeding insect. References are also made to different species of cochineal feeding upon other trees also.

The entomological characters of indragopa, as derived from Indian sources, show it as a bright red plant-breeding insect particularly a grass-insect associated with the rainy season or early rain. Apart from the grass-dwelling variety mention is also made of a mountain-dwelling species of the same having their birth in the rainy season.

The blood-red variety, which was probably the commonly found one among the different colours of this insect was used for the dyeing of fabric.

The alchemical treatises often refer to the dry and pulverized body of indragopa in connection with some chemical operations, particularly colouration of metals. Possibly the pulverized preparation of the insect was also employed in dyeing operation. This can be supported by the composition of cochineal dye in the modern world which consists of dried pulverized. bodies of the female insects of cochineal. The tinctorial power of cochineal is attributed to a substance called cochinealin or carminic acid. The Indian sources recognize this dye as an excellent fast colour.

Carminic acid is the main pigment that can be extracted from the cochineal insect. Its main use is with cosmetics, foods and pharmaceutical applications and it can also have textile and plastic applications. Adult female cochineals are killed to produce carmine dye. Chemically, carminic acid is an anthraquinone linked to glucose and present good light stability, with color ranging from orange to red, and also from red to violet.

Mineral Dyes

Various pigments from inorganic metal salts and metal oxides belong to this category of natural dyes. The most important mineral pigments are Cinnabar, Red Ochre, Red lead and Realgar are some of the examples of red pigments originate from minerals. Cinnabar, also known as vermillion, refers to common bright scarlet to brick-red form of mercury sulphide, a common source ore for refining elemental mercury and serves directly as dyeing pigment. Red Ochre (Geru in Hindi) is a natural earth pigment containing anhydrous and hydrated iron oxide. The color of red ochre is not as bright as that of Cinnabar but it is found in several hues, which ranges from yellow to deep orange or brown. Red Ochre is very stable compound and is not affected by light, acids and alkalies. Fine red ochre is obtained by washing its crude variety. Red ochre is used by monks to color their robes. Red lead (Sindur in Hindi) is a bright red or orange crystalline or amorphous pigment has been used in Indian paintings in abundance. Realgar (Manasila in Hindi) is an arsenic sulphide mineral commonly known as Ruby sulphur or ruby of arsenic, found in combination with orpiment which is also a mineral of arsenic. Both are sulphides of arsenic but these are not safe and have not been used much in paintings.

The popular red dye-producing mineral substances for the textile matters were gairika (redochre) and sindura (red-lead) whose uses solely as pigments are noticed in the other parts of the world.

Gairika (Red Ochre)

Red Ochre is clay pigmented by hematite, a reddish mineral that contains oxidized iron, which is iron that's been mixed with oxygen. Because ochre is a mineral, it doesn't wash away or decay, allowing it to persist through the ages. Its vibrant color and ability to adhere to surfaces — including the human body — make it an ideal crayon or paint base.

Ochre occurs naturally in rocks and soil — essentially in any environment where iron minerals have pooled and formed. It can be found in valley edges, eroding out of cliffs [or even] in caves eroding out of the bedrock. In its more eroded form, ochre can be found in certain soils and then sieved out.

Ochre continued to be used as a pigment throughout antiquity and was even used by artists in medieval times and the Renaissance, as well as in modern times.

Ochre is normally found in Lower Palaeolithic sites as a red powder associated with burials. It would be reasonable to consider this red colour is representative of blood and seen as the life spirit of the person. Black ochre has been found in some of these sites but the most common is red.

Since ancient period many colours of pigments were obtained from both inorganic sources such as minerals and organic materials like as dyes from such things as plants or animals. These were used to paint various surfaces such as rock, leather, clothing, tools, and indeed the human body. It's actually very easy to obtain. Anybody who is using caves or operating in and around valleys will quite easily discover ochre.

People who pick up ochre will notice that it stains their hands a nice red or yellow color. Once collected, ochre can easily be grated against a coarse piece of stone or ground by a mortar and pestle and then turned into a powder. Then, this powder can be mixed with a liquid, such as water, saliva or egg whites, and turned into pigmented paint.

Gairika as a red dye-substance became popular in India from the post Vedic period in connection with textile dyeing. It was used as an ingredient in the recipes for yellow-dyeing.

The colouring matter of gairika was used for producing deep red tint.

Sindura (Red Lead)

Considered by Art historians as the earliest manufactured pigment, red lead has been widely employed in paintings since Antiquity. It was identified in a large variety of artworks, including wall paintings, polychrome sculptures, manuscript Illuminations, and canvas paintings. Uses both as a pure color or mixed with other pigments, such as vermilion, orpiment, red ochre, lapis lazuli, or tin sulfide, have been reported. Admixtures with lead white and other red pigments (vermilion, red ochre) were employed on miniatures and paintings to produce the flesh tones.

Sindūra as a red-dying material is found to be used in the medieval period. For using it as colouring matter, sindūra was treated with manahsila (realgar). In this preparation sindura was rubbed up for one half-day in water. Realgar was then ground without being combined with water. Both the substances admixed together with the aid of water, was kept preserved for five days. The entire mass was then ground again and preserved in a vessel.

As a dye-matter sindura was combined with some oleaginous substances for durability of the colour.

Red-Yellow Dye-Producing Substances

Kusumbha (Safflower, *Carthamus tinctorius*)

Safflower; (*Carthamus tinctorius* L.) is a thistle-like herb belonging to the family Asteraceae or Compositae. It is one of humanity's oldest crops cultivated in India mainly for oil from the seeds and a reddish dye from the flowers. Though, safflower flowers have been used in preparations of ayurvedic medicines in India. Safflower was mainly grown for dye. The water-soluble yellow dye, carthamidin, and a water-insoluble red dye, carthamin, which is readily soluble in alkali, can be obtained from safflower florets. Dye manufacture has virtually ceased in Asia, but dye is still prepared on a small-scale for traditional and religious occasions. In order to get a better colouring effect from carthamin, the yellow colour first has to be separated from it. For extracting the dye, fully-grown flower heads are collected every second or third day before they fade. They are then dried in the shade. Florets can be collected, after the crop ripens, so that dye and oilseed can be obtained from the same crop. Colouring 1kg of cotton yarn crimson requires 1 kg of dye, rose pink requires 500g and light pink 250g.

The plant has two uses: as a dye, and as an oil crop (the seeds can be pressed for oil). This puts the plant in good company with other very old domesticated plants such as flax (Linum usitatissimum) for textile and oil, and hemp (Cannabis sativa) for textile, rope, and medicinal (or ritual) use. For dyeing, only the safflower petals are used. They are harvested by pulling them off the large, globular flower every second- or third-day during flowering.

Dyeing with safflower is somewhat complicated. The problem is that safflower contains several different dyes. Most of them are yellow: a mixture of yellow compounds that are nothing like the yellows a natural dyer will normally prefer, coming from plants like weld and tansy. The yellows of those plants are flavonoids, and they are considered the best natural yellow dyes. The yellows in safflower are of a type called C-glycosylchalcones.

But the yellow dyes in safflower are soluble in water, so when the petals are just soaked in water for an hour, lots and lots of yellow will come out. In addition to the yellow dyes, safflower contains a red dye called carthamin. The special thing about carhamin is that it is not soluble in water

Today, safflower cultivation is increasing, but for oil production, not dye. Of course for dyeing – the safflower pink color does not have a very good light fastness, but it is the only plant dye that will bind to plant fibers, and it binds without any mordants or heating.

Safflower is also a beautiful flower. It is good for dyeing, and is said to be very durable when dried.

Kusumbha was the flower-predominating dye-crop in India whose excellence as colouring matter (maharanjana) came to be recognized in the later Vedic period. It was cultivated under royal care for its valuable flowers, and was known as a plant of Gujarat.

The plant is considered to be a cultivated plant of India though its Indian nativity has been assigned by the botanists. It was exported to other countries from India for red dye, and from its resemblance to the dried flower of saffron, it was often mistaken for saffron. The Sanskrit lexicons have imposed some similar attributes to both these flowering plants.

The flowers have been described as bright red (pavaka), furnished with fiery red filaments (agnishikha) and containing two colouring matters red or brownish-red and yellow. In the treatment of the flower to extract its colouring principle, the impure yellow matter is stated as oozing first and then comes the pure red substance.

The yellow colouring matter is very weak, soluble in water and not much valued as dye. The red is soluble in alkaline water, and is known as carthamic acid.

The plant was popular as yellow dye in different parts of the ancient world. In India at the early part (c. 800 B. C.) of the use of this dye-drug, no explicit statement is available regarding the particular colour produced by the plant. However the use of the red-colouring matter of the plant for the purpose of dyeing textile matter is found to have been popular since the post-Vedic period. In this context it is to be noted that the red tinctorial matter of the plant was utilized by the Chinese people to produce different shades of red. The yellow "contents" of this drug came to be fully recognized in

India during early medieval period when its yellow tincture along with the red one came to be used in alchemical preparations particularly in colouration of mercury. The plant is found to have been classified as "red-substance." as well as "yellow substance."

The coloring matter was obtained either from the juice of the petals or from the decoction of the flower. It was simply diluted in water before using as dyeing matter. In modern method the flowers are made into a pulpy mass which after being squeezed in hand, is made into small, flat, round cakes and are dried carefully. The tinctorial matter of kusumbha was considered very fugitive. The dye was exclusively used for coloring textile matters.

Kunkuma (Saffron, *Crocus sativus*)

Kunkuma, another flower-predominating plant was a popular dye-drug of the post-Vedic period. In the Mahabharata a particular class of people called Jäguda are found to have been engaged for the cultivation of this plant. The plant owed its name jaguda for being cultivated by this class of people. The cultivation of this plant, under royal care like that of kusumbha for its valuable flowers is noticed in the Arthasastra.

Kashmira and Vahlika (Balkh) were two places of cultivation of this plant. The Vahlika-originated variety was famous for its yellow tinctorial matter, while the variety growing in Kashmira was popular for its red filaments. Its nativity is ascribed to Greece, Asia Minor and Persia.

Like kusumbha the flowers of kunkuma is also stated to have been furnished with red filaments and possessed two tinctorial properties. The Ain-l-Akbari has given a detailed description of this plant "The plant is about a quarter of a yard long. The flower stands on the top of the stalk, and consists of six petals and six stamens. Three of the six petals have a fresh lilac colour, and stand round about the remaining three petals. The stamens are similarly placed, three of a yellow colour standing round about the other three, which are red. The latter yield saffron."

In India this particular dye-crop was grouped as 'red-colour' producing plant (raktaparyaya) whereas it was known as 'yellow-dye' in the other parts of the ancient world.

The colouring principle which is described as bright and deep red, was obtained by pulping the flower and later squeezing it. Polychroit is the dye-substance of this particular plant.

The bright red colour produced by this substance was considered durable and a little quantity of this substance was believed to impart pleasant tint to the fabric. Murray has also recognized this dye-property of the plant. Apart from dyeing of textile kunkuma was used as an excellent cosmetic in the ancient period.

Mordants are most commonly used on the fiber before dyeing (premordanting) but they can also be used during (simultaneous mordanting) and after dyeing (after-mordanting). Assistant materials such as cream of tartar(potassium hydrogen tartarate),oxalic acid, acetic acid formic acid etc. may be used in addition to dyes and mordants to change the pH in order to brighten colors, and to help the absorption of the mordant metal.

Historically, saffron was particularly important as adye plant. *Crocus sativus* L., commonly known as Saffron, is a perennial meadow grass belonging to Iridaceae family. Saffron is considered to be the most precious and expensive spice in the world Today, the greatest saffron producing countries are Iran, Greece, Spain, Turkey, India, and Morocco. Iran has 50000hectares area (90% of the total world harvest areas) of saffron. Saffron flower is divided into three main parts; namely, stigma, petal and anther. The flower has 3 petals and 3 sepals.

Patanga, Pattanga, Patränga (Red Sanders, Caesalpinia Sappanwood)

Brazilin is a nearly colorless dye precursor obtained from the heartwood of several species of trees including brazilwood from Brazil, sappanwood from Asia and the Pacific islands, and to a minor extent from two other species in Central America, northern South America and the Caribbean islands. Its use as a dyeing agent and medicinal in Asia was recorded in the 2(nd) century BC, but was little known in Europe until the 12(th) century AD. Asian supplies were replaced in the 16(th) century AD after the Portuguese discovered vast quantities of trees in what is now Brazil. Overexploitation decimated the brazilwood population to the extent that it never fully recovered. Extensive environmental efforts currently are underway to re-create a viable, sustainable population. Brazilin is structurally similar to the better known hematoxylin, thus is readily oxidized to a colored dye, brazilein, which behaves like hematein. Attachment of the dye to fabric is by hydrogen bonding or in conjunction with certain metallic mordants by coordinative bonding. For histology, most staining procedures involve aluminum (brazalum) for staining nuclei. In addition to textile dyeing and histological staining, brazilin and brazilein have been and still are used extensively in Asian folk medicine to treat a wide variety of disorders. Recent pharmacological studies for the most part have established a scientific basis for these uses and in many cases have elucidated the biochemical pathways involved. The principal use of brazilwood today is for the manufacture of bows for violins and other stringed musical instruments. The dye and other physical properties of the wood combine to produce bows of unsurpassed tonal quality.

Patanga, Caesalpinia Sappanwood, an excellent red dye-crop of the Classical period, was an inferior sandalwood tree containing no odoriferous matter. It was known as bakkam in Arabic countries and Brazil wood in medieval commerce.

The tree appears to be indigenous in Malabar, Deccan and the Malay Peninsulas. Marco Polo (thirteenth century A. D.) has described it as thorny tree, indigenous in southern India from Goa to Trivandrum. He has recorded three varieties of Brazilwood, namely, Colomni, Ameri and Seni or Sini in India.

The plant is described in the ancient literature as redwood tree and having leaves resembling that of sesamum. Its Malay name is Supang, i.e., redwood from which the Chinese name Su-fang was derived,

The red colouring matter is said to have been deposited in the wood. The red matter is also contained in the pods and bark of the tree.

The red dye substance was extracted, as is evidenced from an eighteenth century A.D. French report on Indian cotton painting, from the pulverized wood of the tree dissolved in water along with alum powder. This liquid substance was then kept in exposure to the sun for two days. Care was taken against sour or salt ingredients which were considered harmful for the dye substance.

The colouring principle is Brazilian. It was considered fleeting in character and required mordanting. This vegetable product was exclusively used for the dyeing of textile matter particularly silken stuff.

Though the plant was usually known as red dye, its yellow colouring matter which is deposited in its root, was used in

the alchemical preparations related to the colouration of mercury.

Yellow Dye-Producing Substances

Yellow dye was generally derived from the plant products, of which haridra (*Curcuma longa*) was the principal substance. The other recognized yellow dyes of vegetable origin was palasa and the first exudation of Kusumbha; and of animal origin was rocana, i.e. goracana (yellow substance prepared from the urine of cow). Discussion will be made here on haridra only as the tinctorial properties of the others are not sufficiently described in the available sources. I-tsing, the Chinese traveller, who came to India during the latter part of the seventh century A. D. has recorded several recipes for yellow dyeing. These will follow the discussion on haridra.

Haridra (Turmeric, *Curcuma longa*)

India is the largest producer, consumer and exporter of turmeric in the world. It dominates the world production scenario contributing 78% followed by China (8%), Myanamr (4%) and Nigeria and Bangladesh together contributing to 6% of the global production. It is an important spice used in cosmetic, colouring agent and also used for colouring textiles and for Medicinal purposes.

Turmeric is highly valued in natural medicine as well as textiles. Its gorgeous color and healing properties have earned it the nickname “Indian solid gold”- indeed it has quite the reputation. In the context of Ayurveda healing, turmeric is believed to help “purify the blood” and help with a number of ailments in the skin, heart, liver and lungs. This makes it the perfect raw material for Ayurveda dyeing, combining both beauty and function.

Turmeric has been used as a fabric dye for hundreds of years. Dyeing with turmeric has been around for centuries and dyeing with natural ingredients is creative. Dyeing clothes with turmeric produces vibrant warm yellow colour on natural fabrics. Turmeric dye is applied on cotton, silk and wool.

Haridra, the Indian saffron (*Croco indiaco*) as observed by Garcia de orta (1560 A.D.), was the popular dye-drug since the later Vedic period. It is a cultivated plant of India which is presumed to have come to India with the Aryans. According to Ainslie the plant is most probably a Cochin-Chinese species which superseded all the other species of indigenous curcuma in Indla. Forbes refers to curcuma dye in Classical times from Southern Arabia, India and Mesopotamia.

Haridrà (which produces yellow colour) has been described in the Indian literature as an auspicious and highly beneficial plant characterized by its rhizome containing the colouring matter.

Yellow colouring matter of the plant is stated as bright, pleasing and producing deep shade to the fabric. It was also used for the production of bluish yellow tint. Possibly this was done in combination with other subtances.

The dye-substance in *Curcuma longa* is named as Curcumin. The instability of the colouring matter to the fabric has been alluded to in many literary sources which can be substantiated by the ‘fleeting' nature of the dye described by the scholars in this field. It was wholly used for the dyeing of textile fabrics.

Blue dye-producing substances

In the history of Indian 'dyes' the sole agency of blue-dyeing is attributed to nila, which is a generic term indicating both the 'colour' and the 'colouring matter'. The term nila might indicate other blue dye-producing substances apart from the plant nila. Because of the paucity of plausible references to other substances producing blue colour, nila is to be taken as the dye obtained from the *Indigofera tinctoria*.

Vegetable Dyes

Nila, Nili, Nilikā, (Indigo, *Indigofera tinctoria*)

Indigo, or indigotin, is a dyestuff extracted from the indigo and woad plants. Indigo was known all through the old world for its capacity to shade textures a dark blue. Indigo is an ancient dye and there is evidence for the use of indigo from the third millennium BC, and possibly much earlier for woad.

Several sources claimed that ancient linen fabrics that are dyed blue are likely to have been dyed with indigo because indigo was thought to be superior to woad for dyeing linen. Another example was found on ancient tablets from Mesopotamia in 600 BC that explained a recipe for dyeing wool blue by repeatedly immersing and airing. The earliest example of indigo from Indigofera probably comes from the Harappan Civilization (3300 -1300 BC). Archaeologists also recovered remains of cloth dyed blue which dated back to 1750 BC from Mohenjo-Daro, now present-day Sindh, Pakistan.

There are at least 50 different types of Indigofera in India. In the Northwest region, indigo has been processed into small cakes by producers for many centuries. It was exported through trade routes and reached Europe. Between 300 BC to 400 AD Greeks and Romans had small amounts of blue pigment in hard blocks, which they thought was of mineral origin. They considered it a luxury product and used it for paints, medicines and cosmetics.

The Greeks called this blue pigment ‘indikon’, which translates into ‘a product from India’, this word then became Indigo in English. Another ancient term for the dye is ‘nili’ in Sanskrit which means dark blue from which the Arabic term for blue ‘al-nil’ was acquired. This word in Spanish was called anil and later made its way to Central and South America where it is simply referred to as indigo. The English word aniline is also derived from anil, and it is used to describe a class of synthetic dyes.

In the late 13th century Marco Polo returned from his voyages through Asia and described how indigo was not a mineral, but in fact was extracted from plants. Small quantities of indigo were available in Europe then, but they were very expensive due to the long journey required and the taxes imposed by traders along the route. Locally grown woad was the main blue dye used in Europe at the time. By the late 15th century Vasco da Gama discovered a sea route to China, allowing indigo to be imported directly. Large scale cultivation of indigo started in India and in the 1600s large quantities of indigo were exported to Europe. The cost of indigo dropped considerably and by the end of the 17th century it had virtually replaced woad in Europe.

The most widely recognized procedure of extracting Indigo colour is the point at which it is derived from the bushes of the *Indigofera tinctoria* and Suffruticosa plants that have been particularly developed to make colours. The colour can be separated from either the leaves or the roots, however for reasons for sustainability, the colour from the leaves is utilised more often than not.The leaves are then soaked in water so as to mature. This stage is one which basically removes the colour material from the plant, in spite of the fact that at this stage it is a lighter shade. After this point the leaves are removed and the existing solution is is then beaten and exposed in the air to form the Indican into Indigo Dye. Excess water is poured off and the blue slime is dried. This sludge is then pressed into balls and left to dry. This is the

conventional indigo colour powder.

After dying, the yarn may be sun dried to deepen the colour. The process of Indigo dyeing is completely different while done using the traditional process, it's 100% natural and often organic. Instead of using heat and a mordant, it is done using a living fermentation process that naturally sets the dye into the textile. The texture colouring process takes no less than seven days, from colouring till drying. At first the texture is dunked in a vat of dye and kept under the water for a couple of minutes. When brought out into the air, the shading is a splendid green and gradually it changes to a wonderful profound and rich blue of Indigo.

The procedure is repeated around six to ten times, depending upon the shade required. It is then hung out to dry in the sun. By the end of the 19th century, natural indigo production was no longer able to meet the demands of the clothing industry and a search for a simpler and easier way to procure indigo started. In 1865, Adolf von Baeyer, a German chemist began working on the synthesis of indigo and in 1897 synthetic indigo was launched. The world's current production of natural indigo could not cope with the demand for this dye. However, environmental concerns and an increased demand for natural and sustainable dyes may lead to a resurgence of natural indigo production. Although the chemical formula for natural as well as synthetic indigo is the same, synthetic indigo is almost pure indigotin.

Synthetic indigo on the other hand, produces an even blue that never varies or fades with time. Natural indigo is a sustainable dye. After the pigment has been extracted the plant residue can be and id composted and used as a fertiliser whereas the water is reused to irrigate crops. The production of Indigo produces a variety of by-products that must be handled carefully.

Some of these materials are considered to be hazardous and must be disposed of in consideration with local and federal chemical waste disposal guidelines. Such chemicals can enter the environment in at least three different ways. The first, during the actual manufacture of the molecule. The second is when the dye is applied to the yarn, and the third is when the dye is removed from the yarn and enters the wash water during the initial stone washing or wet processing of the fabric.

Compared to traditional methods of stone washing fabric dyed with indigo, their new process uses few, if any, pumice stones which help give the fabric its faded look. Therefore, pumice stone handling and storage costs are reduced, along with time required to separate pumice from garments after stone washing. It also uses much less bleach. Therefore, this new process not only reduces garment damage, but also reduces waste produced by the stones and bleach. By using natural Indigo, we make a conscious effort to help and provide sustainable employment to rural population in third world countries. Not just that but we can also contribute towards helping the environment and reducing the use of petrochemicals.

Nila was one of the most prized dye-crops in India from the remote peroid. As kālā or asikni its use goes back to the period of the Atharva Veda for imparting natural colour to the skin afflicted by some cutaneous skin diseases.

There is difference of opinion among the scholars about the botanical source of nila which has been identified as *Indigofera tinctoria*. Some hold that in the remote past nila was the blue dye-producing plant, Dyer's woad, Isatis tinctoria, the source of indigo prepared in Upper Asia. The Indian people in the past were acquainted with this dye-drug and used it as blue dye. Ibn-Sina also acknowledges that Indian nila, which is known as Indicum in Arabia, was woad. It is further presumed that the nila in India in the past epoch indicates neither woad nor species of Indigofera but a large number of indigenous blue dye-producing plants which are still used in place of modern commercial article for blue dyeing.

In the Classical Age (beginning from the Hellenistic period-c. 500 B. C.) of the ancient world the blue pigment from India, known as Indicon (according to Dioscorides) and as Indicum (according to Pliny and Vitruvius), was used both in painting and in dyeing. Pliny describes it as "slime adhering to foam on the reeds. When first separated it is black, but, on treatment with water it gives a wondrous blend of purple and blue". The scum, according to Forbes, might be taken as the indigo scum taken from the bamboos stirring the liquid in the beating-vat and dried.

The nila in Indian tradition was recognized as a cultivated plant (gramya). growing abundantly (căratikä). It was distinguished by its nice fruits, blue leaves at the tips of the twigs, blue hairs (probably indicating hairy stems) and blue flowers. It has been stated as sappy, full of essence, i.e. dye-producing element. It contained two tinctorial matters, blue (nila) and black (kala, kali), The black property of the plant was recognized by Periplus (c. 78 A. D.) who called it 'Indian black', exported to other country from Barbarican on Indus. According to some the dye was used as black colour before its blue dyeing property was discovered.

It was a vat dye, The colouring matter is stated to have been deposited mainly in the leaves and flowers. The plant required purification i.e. cleansing before its use as dye-producing substance. The colouring principle was extracted in three ways.

I) The first process, particular to the Classical and the medieval periods, consisted of beating of the plant, squeezing of the beaten plant and stirring the squeezed substance possibly on being admixed with water. The sediment in the form of pasty mass was deposited below in the vessel. This pasty substance was used as the dye-matter.

II) In the other process as observed by Marco Polo (thirteenth century A.D.) the colouring matter was derived from the decomposed plants. The plant, leaving its roots, was preserved a whole day in big vessels containing water.

III) In the third process, laid down in the eighteenth century A. D. French report on Indian Cotton Painting, the leaves were dried, reduced to powder, poured in big vessel full of water and whipped strongly in the sun by means of a bamboo split in four. The water was then allowed to run through a small hole in the bottom of the vessel, where the indigo was deposited. It was then taken and divided into pieces.

The dye substance which is known now as *Glucosid indican*, was considered soluble in water. It was an excellent fast colour never fading away.

Apart from dyeing of all sorts of textile fabric it was also employed for the dyeing of leather. Its black colouring principle was used as hair-dye.

Black dye-producing substances

Charcoal Black, Lamp Black, Ivory Black, Bone Black, Graphite, Black Chalk and Terre-noire (Black Earth) are among the list of black pigments. Well ground charcoal has

often been used as black pigment. In India, charcoal prepared from twigs and woods of tamarind tree after burning in a closed pot, is powdered to make black pigment. Some other substances which after charring were used for preparing black pigment are the shells of almonds and coconuts. The charcoal so produced is soft and gives homogeneous and fine black pigment. By far, the most important black used in India is 'Kajal' prepared by burning oil in a lamp and depositing the soot on an earthen bowl. Ivory black is prepared by charring ivory cuttings in a closed earthen pot and then grinding, washing and drying black residue. The black so prepared is very intense. It is not favoured now for ecological and animal rights considerations. Bone black is prepared by charring animal bones in closed earthen pots. It is not as intense as ivory black but used as a substitute. Powdered graphite, a mineral found in different parts of India, has been used as writing material. It gives a dull grey pigment. However, it has mostly been used for drawing rather than for painting. Black chalk is the name given to black clay used for paintings and terracotta. Terre-noire is the same as black clay. It is a mixture of carbonate of calcium, iron and manganese with clay.

A very sketchy information is obtained on the black dye-producing substances having particular adherence to textile matter. Khanjana, i.e. kajjala (lamp black) and abhaya were the two popular black dye-substances for the purpose of textile dyeing. Apart from these two substances a number of vegetable, metal and mineral substances are found to have been used in the recipes for hair-dyeing.

Khanjana, i.e. Kajjala (Lamp Black)

Khanjana (lamp black) as black-dye was popular in the post-Vedic period. As a pigment its use goes back to the Harappa period. It was one of the article for black dyeing in the other countries of the ancient world.

The preparation of lamp black as a colouring matter on being admixed with nimba water, gum and pure water, levigated and then dried, has been described in Shilparatnam, a work of the medieval period.

Abhaya or Haritaki

Haritaki is described in Charaka samhita, Sushruta samhita and both Ashtanga Samgraha and Ashtanga Hradaya, other samhita granthas and in chikitsagrantha like Chakradatta, Sharangadhara samhita, Yogaratnakara etc. and also in nighantus. In Charaka samhita, Haritakiwas mentioned with synonyms i.e. abhaya, amrita, pathya, vijaya, shiva and haritaki

In Sushruta samhita Haritaki was mentioned with synonyms i.e. abhaya, amrita, pathya, vijaya and haritaki.

Use of abhayā as black-colouring matter in textile industry was exclusive of the medieval period. As an ingredient in hair-dyeing preparation its use is traced to the Classical period. Its tinctorial property was not much popular like the other substances in the history of Indian dyes. The lexicons are completely silent about the dyeing property of this vegetable substance.

Conclusion

The dye-substance, as laid down in eighteenth century A. D. French report on Indian cotton painting, was extracted from the rind of the fruit. The rind was powdered, sieved and combined with buffalo milk. As a rough substance its treatment with oily substances, like that of the vermilion, was considered essential for fixing the colour to the textile material.

Dyeing of cloth with this substance was also performed by boiling textile article in water containing the rind of the fruits.

In modern method the dye substance called chebulinic acid is obtained from the simple infusion of the rind in boiled water.

The discussion on dyes in India will be incomplete if the auxiliary dye substances and mordant are not brought to light The use of tuvrari (alum) for the fixation of the coloring principle to the fabric has been reported above. Among the auxiliary dyes the principal substance was lodhra, the use of which for brightening the principal colouring matter particularly lac, has been alluded to in Indian sources.

Based on method of application, natural dyes have been classified into following classes:

Mordant Dyes

Mordant dye/colorants are those which can be bound to a material for which it otherwise has little or no affinity by the addition of a mordant, a chemical that increases the interaction between dye and fibre. This classical definition of mordant dyes has been extended to cover all those dyes which are capable of forming complex with the metal mordant. Most of these dyes yield different shades or colors with different mordants with different hue and tone.

Vat Dyes

Vat dyeing is a process that takes place in bucket or vat. They are insoluble in their colored form, however can undergo reduction into soluble colorless (leuco) form which has an affinity for fibre or textile to be dyed. Re-oxidation of the vat dyes converts them again into 'insoluble form' with retention of original color. Only three natural dyes belong to vat dyes: indigo, woad and tyrian purple.

Direct Dyes

Direct dyes are water-soluble organic molecules which can be applied as such to cellulosic fibres such as cotton, since they have affinity and taken up directly. Direct dyes are easily applied and yield bright colors. However, due to the nature of chemical interaction, their wash fastness is poor, although this can be improved by special after-treatment. Some prominent examples of direct natural dyes are turmeric, annatto, harda, pomegranate and safflower.

Acid Dyes

Acid dyes are also another type of direct dyes for polyamide fibres like wool, silk and nylon. These dyes are applied in acidic medium and they have either sulphonic acid or carboxylic acid groups in the dye molecules. At least one natural dye, saffron has been classified as acid dye. This dye has two carboxylic acid groups.

Basic Dyes

Basic dyes are also known as cationic dyes. These dyes on ionization give colored cations which form an electrovalent bond with the carboxyl group of wool and silk fibres. These dyes are applied from neutral to mild acidic condition. Berberine has been classified as basic dye. Structurally, this dye carries a non localized positive charge which resonates in the structure of the dye, resulting in poor light fastness.

Disperse Dyes

Disperse dyes are water insoluble dyes which dye polyester and acetate fibres. The principle of disperse dyeing is recent one as compared to the age of natural dyeing. However, in

view of their structural resemblance and solubility characteristics it is felt that some of the natural dyes such as lawsone, juglone, lapachol and shikonin can be classified as disperse dyes.

In the above study of Indian 'dyes' importance has been given to substances with adequate references to their tinctorial properties. In addition to these substances a great number of substances possessing tinctorial capacities but with no specific colouring attributes, are frequently mentioned in Indian literature. Hence in comparison to dye-substances used in different countries of the ancient and medieval world, the Indian dyes are very few in number particularly in cases of blue and black dyes.

The Indians, of course, were more expert in discovering the quality of tinctorial matter of a substance. The best examples are the safflower (kusumbha) and saffron (kunkuma) which were known as yellow dyes in the other parts of the world. The Indians acknowledged their red colouring attribute but not the yellow because the latter lacked significant durability.

Evidence of well-developed dye works exists in many parts of the world. Ancient Egyptians, Phoenicians, and Peruvians were known for their excellent dyeing. Italian dyers were among the best from Roman times through the sixteenth century. Dyers from India were supreme in dyeing cotton. Dyers in China specialized in dyeing silk. Natural dyes were major trade items throughout history until the development of synthetic dyes. By the early years of the twentieth century, natural dyes had been replaced in most applications. However, most of these dyes remain important for artists, craftspeople, and niche producers.

In the present context of eco-preservation, natural dyes have acquired tremendous commercial potential as some of the synthetic dyes are associated with the release of enormous amount of hazardous chemicals into the environment. The revival of interest in the use of natural dyes in textile coloration has been gaining incessant popularity all over the world, probably due to environmental concerns, eco-safety, and pollution control. Natural dyes are supposed to be friendlier and exhibit better biodegradability to the environment than their synthetic counterparts. Reproducibility, inadequate availability, cost efficiency, inadequate degree of fixation, and poor color fastness properties are common discernable drawbacks of natural dyes. In addition, dyes and pigments of natural origin also possess bio-logical and biomedical activities, so they may serve as a green alternative towards synthetic dyes.

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