DYES IN ANCIENT AND MEDIEVAL INDIA*

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A survey of dye-producing substances in India during ancient and medieval period is being made in this paper. Discussion will be made on the four principal 'dyes,' namely, red, yellow, blue and black. This will, however, be preceded by a brief note on the introduction of particular dye substances in the particular period of Indian history and an account of processes relating to the extraction of colouring principles from the dye substances.

I

The term *dye*, is derived from old English word *daeg* or *daeh* meaning "colour." Dyes and pigments both indicate colouring matter but they differ mainly in their respective properties and techniques of use. The former, which consists mainly of organic matters, soluble in water, is applied by impregnation of an object. The latter composed mostly of inorganic matters, insoluble in water, is applied by painting and staining a material body.[1]

The exact period of the commencement of the art of dyeing in the world could not be ascertained correctly. It is presumed that the appearance of dye-vat occurred in the history along with the brick-kiln.[2] Archaeological evidence however shows that dyeing was an wide-spread industrial enterprise in Egypt, India and Mesopotamia round about third millenium B. C [3]

The principal dye-substance was the plant juice, the 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.[4] 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

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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.[5]

In the present paper a survey is being made on the various dye-producing substances in India during ancient and medieval periods. It must be mentioned at the outset that absence of any or adequate material evidence in some cases put limitations on thorough discussion on some points.

II

India, from antiquity, was famous for the growth and production of excellent dye-stuffs, and has been described as the largest dye-producing country of the world.[6] Recognition of Indian dyes in the world market as early as *c.* 500 B. C., is evidenced from the instances of indigo (*nīla*), the presumed indigenous dye-drug of India being used in Egypt for the dyeing of muslin.[7]

The details about Indian colouring-matters (*raṅgadravya*) are found mainly in the lexicon texts appearing between c. sixth century A. D.—seventeenth century A. D.

The colouring matters in Indian terminology are expressed by the terms, like, *raṅga*, *rāga* and *rakta* originating from the root verb √rañj, means 'change from one colour to another.'[8] The list of *raṅgadravyas* (colouring matter) found mainly in the lexicons are not restricted to enumerate only the 'dyes' but also the auxiliaries (*yoga*) and mordants (*raṅgabandhana*).[9] The use of the term *raṅga* in Indian terminology, therefore, appears to have been used to denote all the elements used for producing the desired colour to the substance to be dyed.

III

The history of Indian 'dyes' appears to have been started from the Vedic period. In the pre-Vedic period, however, a piece of purple coloured cotton is available from the antiquities of Mohenjodaro (*c.* 3000 B. C.), which from recent chemical examinations, suggests its coloration with madder (*Rubia cordifolia.*)[10]

The tinctorial properties of vegetable substances recognised in the Vedic period particularly in the Atharvavedic and the succeeding periods (*c.* 1000 B. C.—500 B. C.) were *kālā* or *asikni* (possibly indicating indigo) *mahārañjana* (safflower), *mañjiṣṭhā* (madder), *lodhra* (*Symplecos racemosa*) and *haridrā* (turmeric). Lac is found among the animal dye-stuff.

The dye-stuffs introduced in the post-Vedic period (*c.* 500 B. C.—*c.* 3rd century A. D.) include *kuṅkuma* (saffron) and *nīla* (indigo) among the plant

products ; *kṛmi* (kermes) and *rocanā* (bright yellow substance prepared from cow's urine) among the animal substances ; *gairika* (red-ochre) among minerals ; and *khañjana* (carbon black).

The Classical Age upto 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* (*Mallotus phillippinensis*), *pattaṅga* (*Caesalpinia sappan*) and *jatūka* (a species of *Oldenlandia*), and animal substance, like, *indragopa* (cochineal). In addition to these some black 'dyes' came to be known. These were derived from plant substances, like, *abhayā* (*Terminalia chebula*), *āmalaka* (*Emblic myrobalan*), *bhṛṅgarāja* (*Eclipta prostrata*), *nīla*, (*Indigofera tinctoria*), *pippala* (*piper longum*) ; from *ayas* (iron), *kāsīsa* (sulphate of iron), *tuttha* (sulphate of copper) and *añjana* (sulphate of antimony) among the mineral and metal substances. Apart form 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 *tuvarī* (alum),[11] 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.[12]

IV

The utilization of dyes was characterized by distinct process of extraction of colouring principles from different dye-producing substances and their preparations, Processes relating to the extraction of coluring principles from organic substances will be discussed later with the description of individual dye substances of vegetable and animal origins.

The vegetable dye-juice on being extracted, was boiled over fire. Then a sample of the dye-liquid was either applied on nails or put into water in order to verify if the boiling had been made perfect.[13]

The following is an account of obtaining colouring matters from inorganic substances.

The colouring principles of the inorganic matter were extracted in two ways. Methods are laid down in the texts belonging to *c.* thirteenth century A. D.—sixteenth century A. D. Though the methods were mainly employed for extracting dye-substances from the minerals and metals, possibly they were also meant for the processing of any dye-producing substance to extract the colouring matter from them.

(i) The general techniques to draw out the pure essence were powdering the desired substance, mixing it in water and allowing the sediment to deposit below. By these processes the essence and the pure things used ro come up on the surface of water. The colour attained perfect purity from the repeated performances of the processes. The essence, thus obtained was dried by being smeared on a new earthen pot, and was used as colouring matter.[14]

(ii) In the second method metals and minerals were rubbed with natron (*svarjikā*) and lime (*cūrṇa*), The pasted mass was boiled in a vessel containing cow urine and water. The red scum, which appeared over the surface after boiling, was separated out. It was then mixed again with the substance and underwent boiling. Thus from the repeated performances of these procedures when white scum came over the surface, the boiled product was filtered by means of a piece of cloth. It was then kept in a glass flask smeared with *kāca* salt (any salt of potash). The flask was placed in the *degayantra*. This apparatus consisted of an earthen vessel with a smaller glass flask containing the substance placed inside it. The flask was placed over sand contained in the bigger vessel. The mouth of this vessel was covered. Fire was kindled below. The material inside the glass flask evaporated on being heated over the sand and was allowed to come out through a glass pipe, attached to the flask. The pipe was passed through an opening in the side of the bigger vessel. It was then collected through this pipe in another glass flask placed alongside. Repeated heating of the extracted essence by being mixed with water was prescribed to obtain the pure colouring matter.[15]

V

Dye-stuffs which were used in India during ancient and medieval periods, are to be discussed now in accordance with the sequence of their introduction and uses. The paper concentrates on fifteen dye-producing substances. Dye substances with no adequate reference to their tinctorial properties in the texts, have not been brought in the main discussion. These will be presented in the Tables for each colour.

A. 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.[16]

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 colouring matter is however noticed in the history of dyes in the other countries of the ancient world.[17]

Purely red-dye producing substances were *mañjiṣṭhā* (*Rubia cordifolia*), *kampillaka* (*Mallotus phillippinensis*), *parpaṭa* or *jatūka* (species of *Oldenlandia*) among the plant-products ; *lākṣā* (lac) *krimi* (kermes) and *indragopaka* (cochineal) among animal substances ; and *gairika* (red-ochre) and *sindūra* (red-lead) among the mineral substances.

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

Pure red dye-producing substances :

Vegetable dyes

Mañjiṣṭhā (Indian madder, *Rubia cordifolia*)

Mañjiṣṭhā, the most ancient dye-drug, was a cultivated plant (*kṣetriṇī*)[18] of India particularly in the Punjab Himalaya region[19] and a native of either Syria, Palestine and Egypt[20] or Siberia.[21]

The *Atharvaveda*[22] describes it as a creeping plant and the abode of *lākṣā*. It was a "beautiful dye" as the name suggests, and full of dye-producing matter (*rāgāḍhya*).[23] The red tinctorial matter (*lohitā*) is stated to have been diffused throughout the entire system (*raktāṅgī*, *samaṅgā*) particularly in the stems (*raktayaṣṭi* or *lohitayaṣṭi*).[24] 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.[25] In different countries of the ancient world it was called "root" as it was considered the source of dye.[26] The red colouring matter of the dye is chemically known as Alzirin which is now made synthetically.[27] The colouring principle was obtained from the boiling of the requisite part of the plant.[28] 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.[29]

The colour which the plant produced was bright red (*vikasāruṇā*)[30] and very pleasing.[31] It was a mordant dye for which the use of alum (*tuvarī*) was prevalent.[32] The *Samayamātṛkā*[33] 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 colouration of the textile fabrics.[34] Dyeing of leather[35] and of hair was also performed with this dye-stuff.

Kampillaka or *Kāmpilla* (Kamela powder, Kamala powder. *Mallotus phillippinensis*)

Kāmpilla, 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.[37] The plant appears to have reached Europe through the Arabs who were acquainted with the plant at an early date.[38]

The plant is described in the ancient literature as red-bodied,[39] containing the red tinctorial matter in form of grainy (*karkaśa*)[40] powders (*raktacūrṇaka*)[41] which covers the plant (*gunda*).[42] Suśruta[43] 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 *Kāmpilla*.[44] 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 quantities on the leaves and stalks of the plant.[45]

The dye-substance, which the plant produced, was very pleasing (*rocanika, candra.*)[46] It was diluted in water to prepare the colouring matter (*karañja*) for the dyeing of textile fabrics particularly the silken stuff (*paṭodaka*).[48]

The colouring principle is chemically known as *Mallotoxin*[49] (modern name : rottlerin) Drury[50] refers to the colouring matter 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.[51]

Parpaṭa or Jatūka or Parpaṭī (species of *Oldenlandia*)

Parpaṭa or *jatūka* or *parpaṭī*, as the plant is variously known in Indian literature, came to be recognized as a dye-drug (*rājavṛkṣa, rañjani*[52]) 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*[53] which grows throughout the tropical[54] India.

It was a slender creeping plant (*kṛśaśākha, sūkṣmavallī*) of luxuriant growth (*bahuputrī*) in clusters, knotty, and dark in appearance ; had its growth on light (*karavallā*), and on sandy ground (*pāṃśu*), as well as on cultivable field (*kṣetraparpaṭa*).[55] It was a cold-loving plant (*śītapriya*), furnished with succulant stems (*toyavallī*), protuberant leaves (*granthiparṇī*), large and curved fruits, red-blossoming and sweet scented.[56] It was an excellent abode of the lac insect.[57]

The plant contained good colouring matter (*suvarcikā*) and produced the tinctorial effects from the powders (*rajaka, rajanāmaka*)[58] and from the watery juice of the stems.

The description given above throws light on two species of *Oldenlandia*, namely, *Oldenlandia herbacea* and *Oldenlandia umbellata*. Some of the distinguishing characters of them are noticed in the description of the *parpaṭa*. The following points might be taken into consideration.

(*a*) Two places cf origin of the plant—one is *kṣetra* (cultivable field) and the other is *pāṃśu* (sandy ground). These two places of occurrence are particular to the *O. herbacea*[59] and *O. umbellata* respectively.[60]

(*b*) Two sources of colouring principles—one is the watery extract of *O. herbacea* giving colour precipitates in combination of some chemical substances[61] and the other is "powdered root bark" of *O.umbellata.*[62]. These two find support in the ancient descriptions of the plant as *toyavallī*, i.e. having sappy stems which might be taken as the source of the "watery juice." and as *rajaka* and *rajanāmaka*, means "performance by powder" which might be indicative of "powdered root-bark."

The red-dyeing property of the variety of this plant identified as *O. umbellata*, more popularly known as "chay root" has been discussed in detail in the French account of Indian painting during eighteenth century A. D. 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, ete.[63]

Both the *mañjiṣṭhā* and the *parpaṭa* belong to the same botanical family, *Rubiacea* and undergo same treatment for producing tinctorial effects.

The dye produced by this plant was solely employed for the colouration of textile matter.[64]

Insect Dyes

The next important red dye-producing agents were the three insects, namely, *lākṣā* (lac), *kṛmi* (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.[65] In India, however, the colour produced by the three insects has been described simply as 'red.'

The exact nature of the Indian insects excepting that of the *lākṣā* could not be ascertained from inadequate references to their entomological characters and tinctorial properties. The following are some of these insect dyes in India.

Lākṣā (lac, Coccus lacca—*Coccidae* family)

Lākṣā or *rākṣā* (from *rāga*, 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.[65] It was an excellent dye-stuff (*raṅgamātā*)[66] in India throughout the centuries starting from the late Vedic period.[67] 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.[68] The red colouring principle of lac is chemically known as laccaic acid which is related to carminic acid in cochineal dye.[69]

The insect was the native of India and of different parts of the South-East Asia[70]. In the Hellenistic age the *lakkos*, i.e. Greek word for *lākṣā* 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.[71]

The particular dye-producing insect (*raṅgamātā*) 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."[72] In Indian literature *lākṣā* has been described as an insect "breeding on trees, like, *mañjiṣṭhā* (*Rubia munjistha*), *palāśa* (*Butea frondosa*), *khadira* (*Acacia arabica*), *parpaṭa* or *parpaṭī* (species of *Oldenlandia*), three species of *Mangifera indica* (*vanāmra*, *kṣudrāmra* and *raktāmra*,)[73] etc., "sucking

the fiuid of the tree" (*palaṅkaṣā*)[74] and "full of fluid essence" (*dravarasa*) accumulated from the nourishment obtained from the essence of trees[75]. It produced 'resinous substance' (*jatu*) by being 'attached to the trees" (*yāva, yāvaka*) which was producad in female insect after its "impregnation" (*krimija*).[76] The resinous substance is stated to be the "disease of tree" (*drumāmaya*).[77]

The resinous substance which is the source of dye has been described as both 'dark' (*kṛṣṇa, nīla*) and 'red' (*rakta*).[78] This depended on the product of the trees on which the insect was fed on[79].

The colouring material was obtained in two ways ; (i) by squeezing the *lākṣā*[80] and (ii) by bruising.[81]

The dye was believed to produce permanent tints to fabric if it was boiled and made cool before being applied to the desired article.[82]

Apart from dyeing of fabric[83] the red colouring properties of *lākṣā* was utilized widely as cosmetic for reddening of certain parts of the body.

Krimi (Kermes, *Kermoccus vermilia* Planch, formerly known as *Coccus ilicis-coccidae* family. Popular as kermes-grain, dyes-in-grain, scarlet grain, etc).

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*.[84] The tinctorial effect of this insect was recognized in the society during the post Vedic period.[85] Kermes from Arabic Qirmis to which the Indian *kṛmi* has been equated[86] was an important red dye of ancient Mesopotamia.[87] At the very beginning kermes was known as a scarlet-berry of the oak plant.[88] 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.[89] Afterwards it came to be known as an oak-feeding mosquito like insect.[90] The dye was believed to be the blood of female insect who poured this substance during the period of hatching.[91] Apart from oak-feeding kermes, mention is also made of a kind of kermes breeding on certain species of grass in Armenian region.[92] 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 real nature of this dye-drug is not presented in any Indian source of information. 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-kṛmi* during the medieval period.[93] *Rudhira kṛmi* 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 Pulicat in Southern India.[94]

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.[95] The colour was also known as vermilion for being produced from vermiculus.[96] The Indian *kṛmirāga* has been explained as carmine.[97] The red dye material of kermes is chemically known as *Acida carminique* or *Rogue de cochenille.*[98]

The colouring principle, as our Indian sources state, was derived by squeezing the insect while submerged in the liquid (blood). Some auxiliaries were mixed with this substance to prepare the 'dye'. This paricular dye-substance is stated to have produced an excellent fast colour.[99] In India its use is mainly noticed for the dyeing of silken and woollen materials.[100]

Indragopa (a kind of red or crimson beetle, identified as cochineal, *Coccus cacti*—belongs to *Coccidae* family)

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.[101] The insect has been identified as cochineal,[102] 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 of Mexico. References are also made to different species of cochineal feeding upon other trees also.[103]

The entomological characters of *indragopa*, as derived from Indian sources, show it as a bright red[104] plant-breeding[105] (*udbhijja*) insect particularly a grass-insect[106] associated with the rainy season or early rain.[107] 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.[108]

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.[109]

The alchemical treatises often refer to the dry and pulverized body of *indragopa* in connection with some chemical operations, particularly colouration of metals.[110] 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.[111]. The tinctorial power of cochineal is attributed to a substance called cochinealin or carminic acid.[112]

The Indian sources recognize this dye as an excellent fast colour.[113]

Mineral Dyes

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

Gairika (red ochre)

Gairika as a red dye-substance became popular in India from the post-Vedic period[114] in connection with textile dyeing. It was used as an ingredient in the recipes for yellow-dyeing.[115]

The colouring matter of *gairika* was used for producing deep red tint.[116]

Sindūra (red lead)

Sindūra as a red-dying material is found to be used in the medieval period.[117] For using it as colouring matter, *sindūra* was treated with *manaḥśilā* (realgar). In this preparation *sindūra* 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.[118]

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

Red-yellow dye-producing substances :

Kusumbha (safflower, *Carmathus tinctorius*)

Kusumbha was the flower-predominating dye-crop[120] in India whose excellence as colouring matter (*mahārañjana*)[121] came to be recognized in the later Vedic[122]period. It was cultivated under royal care for its valuable flowers,[123] and was known as a plant of Gujarat.[124]

The plant is considered to be a cultivated plant of India though its Indian nativity has been assigned by the botanists.[125] 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.[126] The Sanskrit lexicons have imposed some similar attributes to both these flowering plants.

The flowers have been described as bright red (*pāvaka*), furnished with fiery red filaments (*agniśikhā*) and containing two colouring matters red or brownish-red (*aruṇa, babhru*) and yellow (*pīta*).[127]. 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.[128]

The yellow colouring matter is very weak, solublc in water and not much valued as dye. The red is soluble in alkaline water,[129] and is known as carthamic acid.[130]

The plant, as stated above, 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.[131] 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.[132] 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."[133]

The colouring matter was obtained either from the juice of the petals (*dravadalānām*) or from the decoction of the flower (*puṣpakvātha*). It was simply diluted in water before using as[134] 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.[135]

The tinctorial matter of *kusumbha* was considered very fugitive.[136] The dye was exclusively used for colouring textile matters.[137]

Kuṅkuma (*saffron, Crocus sativus*)

Kuṅkuma, another flower-predominating plant (*kusumbha*), was a popular dye-drug (*varṇya*)[138] of the post-Vedic period. In the *Mahābhārata* a particular class of people called Jāguḍa are found to have been engaged for the cultivation[139] of this plant. The plant owed its name *jāguḍa* for being cultivated by this class of people.[140] The cultivation of this plant, under royal care like that of *kusumbha* for its valuable flowers is noticed in the *Arthaśāstra*.[141]

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.[143] Its nativity is ascribed to Greece, Asia Minor and Persia.[144]

Like *kusumbha* the flowers of *kuṅkuma* is also stated to have been furnished with red filaments and possessed two tinctorial properties.[144] The *Ain-i-Akbari*[145] 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 (*raktaparyāya*)[146] 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 (*saṃkoca*).[147] Polychroit is the dye-substance of this particular plant.[148]

The bright red colour produced by this substance was considered durable (*dhīra*) and a little quantity of this substance was believed to impart pleasant tint to the fabric.[149] Murray has also recognized this dye-property of this plant.[150]

Apart from dyeing of textile *kuṅkuma*[151] was used as an excellent cosmetic in the ancient period.

Patańga, Pattańga, Patrāńga (red sanders, ***Caesalpinia sappan***) :

Patańga, an excellent reddye-crop (*surańga, rañjana*) of the Classical period,[152] was an inferior sandalwood tree containing no odoriferous matter (*kucandana*).[153] It was known as *bakkam* in Arabic countries and Brazil wood in medieval commerce.[154]

The tree appears to be indigenous in Malabar, Deccan and the Malay Peninsulas.[155] 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. According to him *Seni* or *Sini* is Chinese, probably indicating an article brought to India by the Chinese traveller most likely from Siam.[156]

The plant is described in the ancient literature as redwood tree (*raktakāṣṭha*) and having leaves resembling that of sesamum (*tilaparṇikā*).[157] Its Malay

name is *Supang*, i.e. redwood from which the Chinese name *Su-fang* was derived,[158]

The red colouring matter (*raktasāra, tāmrasāra, rakta*) is said to have been deposited in the wood.[159] The red matter is also contained in the pods and bark of the tree.[160]

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.[116]

The colouring principle is *Brazilian*. It was considered[162] 'fleeting' (*patańga, pattūra*) in character[163] and required mordanting. This vegetable product was exclusively used for the dyeing of textile matter particularly silken stuff (*paṭṭarañjaka*)[164]

Though the plant was usually known as red dye, its yellow colouring matter, which is deposited in its root,[165] was used in the alchemical preparations related to the colouration of mercury.[166]

B. Yellow Dye-producing Substances

Yellow dye was generally derived from the plant products, of which *haridrā* (*Curcuma longa*) was the principal substance. The other recognised yellow dyes of vegetable origin was *palāśa* (*Butea frondosa*) and the first exudation of *Kusumbha*; and of animal origin was *rocanā*, i.e. *goracanā* (yellow substance prepared from the urine of cow). Discussion will be made here on *haridrā* 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 *haridrā*.

Haridrā (turmeric, *Curcuma longa*)

Haridrā, the Indian saffron (*Croco indiaco*) as observed by Garcia de orta (1560 A. D.)[167], was the popular dye-drug[168] (*rajanī. varavarṇinī, rañjanī*, etc.) since the later Vedic period. It is a cultivated plant of India which is presumed to have came to India with the Aryans.[169] According to Ainslie[170] the plant is most probably a Cochin-Chinese species which superseded all the other species of indigenous *curcuma* in Indla. Forbes[171] refers to *curcuma* dye in Classical times from Southern Arabia, India and Mesopotamia.

Haridrā (which produces yellow colour) has been described in the Indian literature as an auspicious and highly beneficial plant characterized by its rhizome (*śiphā*)[172] containing the colouring matter.

Yellow colouring matter (*pīta, harita,* etc.) of the plant is stated as bright (*piñjā, kāñcanī*, etc.), pleasing (*rocanī*) and producing deep shade to the fabric (*dīrgharāga*).[173] It was also used for the production of bluish yellow (*piṅgalā*) tint. [174] Possibly this was done in combination with other subtances.

The dye-substance in *Curcuma longa* is named as *Curcumin.*[175] The instability of the colouring matter to the fabric has been alluded to in many literary sources[176] which can be substantiated by the 'fleeting' nature of the dye described by the scholars in this field.[177] It was wholly used for the dyeing of textile fabrics.[178]

Recipes for yellow dye as recorded by I-tsing [179].

(*i*) The first preparation was a combination of *Ti-huana* (*Rehmannia gluntinasa*), yellow powder or a thorny *Nich* tree (*Pterocarpus indicus*), and red earth (i.e. red ochre) or red powder.

(*ii*) The second substance was a mixture of dates, red earth, red powder, wild pear or Tu-Tzi (earth purple).

(*iii*) The third was composed of mulberry bark, and blue and green colouring matters.

C. Blue Dye-producing Substances

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

Vegetable Dyes

Nīla, Nīli, Nīlikā, (indigo, *Indigofera tinctoria*)

Nīla 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*[180] 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 *nīla* which has been identified as *Indigofera tinctoria.* Some hold

that in the remote past *nīla* 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.[181] Ibn-Sina also acknowledges that Indian *nīla*, which is known as *Indicum* in Arabia, was woad.[182] It is further presumed that the *nīla* 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.[183]

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".[184] 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.[185]

The *nīla* in Indian tradition was recognised as a cultivated plant (*grāmya*), growing abundantly (*cāraṭikā*). It was distinguished by its nice fruits (*śrīphalī*), blue leaves at the tips of the twigs (*agrapatraka*), blue hairs (probably indicating hairy stems) and blue flowers.[186] It has been stated as sappy (*mahārasa*, *moca*), full of essence, i.e. dye-producing element (*sāravāhī*). It contained two tinctorial matters, blue (*nīla*) and black (*kālā*, *kālī*).[187] The black property of the plant was recognized by Periplus (c. 78 A. D.) who called it 'Indian black',[188] 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 (*droṇī*).[189] The colouring matter is stated to have been deposited mainly in the leaves (*raṅgapatrī*) and flowers (*raṅgapuṣpī*).[190] The plant required purification (*śodhanī*, *viśodhanī*), i.e. cleansing before its use as dye-produing substance.[191] The colouring principle was extracted in three ways.

(*i*) The first process,[192] particular to the Classical and the medieval periods, consisted of beating of the plant (*tutthā*), (then) squeezing (*tuṇī*) of the beaten plant and stirring (*dolā*) the squeezed substance possibly on being admixed with water. The sediment in the form of pasty mass (*klītaka*, *klītakikā*) 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.[193]

(*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.[194]

The dye substance which is known now as *Glucosid indican*,[195] was considered soluble in water (*melā*).[196] It was an excellent fast colour never fading away (*bhāravāhī*, *sthira*, *sthirarańga*, etc)[197]

Apart from dyeing of all sorts of textile fabric it was also employed for the dyeing of leather.[198] Its black colouring principle was used as hair-dye.[1]

The preparation of indigo from the plant *nīla*, as stated above, bears a striking similarity with the processes adopted in the nineteenth century A. D. for the preparation of this dye substance.[200]

D. Black Dye-producing Substances

A very sketchy information is obtained on the black dye-producing substances having particular adherence to textile matter. *Khañjana*, i.e. *kajjala* (lamp black) and *abhayā* (*Chebulic myrobalan*) 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.[201] These have been however discussed in the section III under Classical period (p. 3).

Khañjana, i.e. *kajjala* (lamp black).

Khañjana (lamp black) as black-dye was popular in the post-Vedic period.[202] 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.[203]

The preparation of lamp black as a colouring matter on being admixed with *nimba* (*Azadirachta indica*) water, gum and pure water, levigated and then dried, has been described in a work of the medieval period.[204]

Abhayā or *Haritakī* (*Chebulic myrobalan*)

Use of *abhayā* as black-colouring matter in textile industry was exclusive of the medieval period.[205] 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.

The dye-substance, as laid down in a 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.[206]

Dyeing of cloth with this substance was also perfomed by boiling textile article in water containing the rind of the fruits.[207]

In modern method the dye substance called chebulinic acid is obtained from the simple infusion of the rind in boiled water.[208]

The discussion on dyes in India will be incomplete if the auxiliary dye substances and mordant are not brought to light. The use of *tuvarī* (alum) for the fixation of the colouring principle to the fabric has been reported above. Among the auxiliary dyes the principal substance was *lodhra* (*Symplocos racemosa*), the use of which for brightening the principal colouring matter particularly lac, has been alluded to in Indian sources.[209]

In the above survey of Indian 'dyes' importance has been given to the 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 (*kuṅkuma*) 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.

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TABLE 1

Red Dyes

(Pure red dye-producing substances)

Name and Period	*English and Botanical names*	*Colour-producing part of the substance*	*Extraction of colouring matter*	*Nature of the dye*	*Uses*
Mañjiṣṭhā (vegetable) (Period of Indus Valley Civilization)	Madder, ***Rubia cordifolia*** Family : ***Kubiacea***	The entire body particularly the stems	Boiling of the requisite part of the plant body	(i) Mordant dye (ii) Long-lasting if the colouring matter is first heated and then cooled down	(i) Dyeing of textile matter (ii) Dyeing of hair
****Madayantikā***[210] (vegetable) (Post-Vedic Period)	Henna, ***Lawsonia alba*** Family : ***Lythraceae***	Leaves	—	--	Colouring of body parts
Kampillaka (vegetable) (Classical Period)	Kamela, ***Mallotus phillippinensis*** Family : ***Euphorbiaceae***	Powdery substance in the different parts of the plant particularly of the fruits	Dissolving of the powder in water	—	Dyeing of textile matter
Parpaṭa (vegetable) (Medieval Period) Two varieties	(i) ***Oldenlandia herbacea*** (ii) Chay root, ***O. umbellata*** Family : ***Rubiaceae***	(i) Sappy twigs (ii) Powder of root bark	—	—	Dyeing of textile matter Dyeing of textile matter
Lākṣā (insect) (Post-Vedic Peried)	Lac, ***Coccus lacca*** Family : ***Coccidae***	Body of the female insect	Squeezing of ***lākṣā*** (i.e. the substance produced by the female insect) after being pressed in mortar	Same as No. (ii) of ***mañjiṣṭhā***	(i) Dyeing of textile matter (ii) Used as cosmetics

*Indicates not included in the main body of the write-up.

TABLE I (*Continued*) *Red dyes* (*Pure red dye-producing substances*)

Name and Period	*English and Botanical names*	*Colour-producing part of the substance*	*Extraction of colouring matter*	*Nature of the dye*	*Uses*
Krimi or ***Krimirāga*** (insect) (Post-Vedic Period)	Kermes, ***Kermococcus vermilio*** Planch.	Body of the insect	Squeezing the body while submerged in liquid substance	—	Dyeing of textile matter
Indragopa (insect) (Classical Period)	Cochineal. ***Coccus cacti*** Family : ***Coccidae***	Body of the insect	Pulverization of the body of insect	—	Dyeing of textile matter.
Gairika (mineral) (Post-Vedic Period)	Red-ochre	—	Powdering, diluting in water, separation of coloured water, and drying by besmearing on earthen pot	—	Dyeing of textile matter
Sindūra (mineral) (Medieval Period)	Red-lead	—	—	—	Dyeing of textile matter

Red dyes
(*Red-yellow dye-producing substances*)

Name and Period	*English aud Botanical names*	*Colour-producing part of the substance*	*Extraction of colouring matter.*	*Nature of dye*	*Uses*
Kusumbha (vegetable) (Vedic Period)	Safflower, ***Carthamus tinctorius*** Family : ***Compositae***	Flowers	(i) Juice of the petals (ii) Decoction of the flowers	Fugitive	Dyeing of textile matter
Kuṅkuma (vegetable) (Post-vedic Period)	Saffron, ***Crocus sativus*** Family : ***Irideae***	Flowers	Pulping the flower and squeezing	Fast	(i) Dyeing of textile matter (ii) Used as cosmetic
Paṭaṅga (vegetable) (Classical Period)	Red sanders, ***Caesalpinia sappan*** Family : ***Leguminosae***	Wood	Pulverized wood dissolved in water along wlth alum	Fugitive	Dyeing of textile matter

TABLE NO. II

Yellow Dyes

Name and Period	*English and Botanical names*	*Colour-producing part of the substance*	*Extraction of colouring matter*	*Nature of dye*	*Uses*
Haridrā (vegetable) (Vedic Period)	Turmeric, *Curcuma longa* Family : *Scitamineae*	Rhizomes	—	Fugitive	Dyeing of textile matter
**Rocanā* [211] (animal product) (Post-vedic period)	Yellow pigment prepared from urine of cow	—	—	—	Dyeing of textile matter
**Palāśa* [212] (vegetable) (Classical Period)	*Butea frondosa* Family : *Leguminosae*	Flowers	—	—	Dyeing of textile matter
**Kusumbha* [213] (vegetable) (Medieval Period)	Safflower, *Carthamus tinctorius* Family : *Compositae*	Flowers (the first exudation)	—	Fugitive	Dyeing of textile matter

* Indicates not reported in the main body of the write-up.

TABLE NO. III

Blue Dyes

Name and Period	*English and Botanical names*	*Colour-producing part of the substance*	*Extraction of colouring matter*	*Nature of dye*	*Uses*
Nīla (vegetable) (Vedic Period)	Indigo, *Indigofera tinctoria* Family : Leguminosae	Entire plant particularly leaves and flowers	Pasty mass of the decomposed plant	Fast	(i) Dyeing of textile matter (ii) Dyeing of hair

TABLE NO. IV

Black Dyes

Khañjana or *Kajjala* (Post-Vedic Period)	Carbon-black	—	—	—	Dyeing of textile matter
Śakala [214] (animal product) (Classical Period)	Black pigment prepared from cow-dung	—	—	—	Dyeing of textile matter
Abhayā (vegetable) (Classical Period)	*Chebulic myrobalan* Family : *Cambretaceae*	Rind of the fruits	—	—	(i) Dyeing of textile matter (ii) Dyeing of hair

REFFERENCES

1 Forbes. R. J. 'Dyes and Dyeing' *Studies in Ancient Technology*, **4**, 1956, Leiden, p. 98; Clark, C. D. and Cockett, S. R. 'Dyes and Dyeing' *Encyclopaedia Britanica*, **7**, 1965, U. S. A. p, 814,

2 Mumford, L. *Technics and Civilization*, 1953, p. 11.

3 Crockett, S. R. *Dyeing and Printing*, 1964, London p. 1.

4 Forbes, *Ibid*,

5 See No. 1. *Encyclopaedia Britanica*.

6 Ray, P. C. *Desi Rang*, 1912. Calcutta. p. 13.

7 Wilkinson, J. G. *Manners and Customs of Ancient Egyptians*, 3, 1837, London, pp. 123-124; Kennedy, J. 'Early Commerce of Babylon with India' *Journal Royal Asiatic Society of Great Britain and Ireland*, 1838, p. 251.

8 Pāṇini's *Aṣṭādhyāyī* (c. 4th cent.ury B. C.) iv, 2-1

9 *Mahāvyutpatti* (c. 8th-9th century A. D.) Ed. by Myneaf and Myronof. St. Petersburg. Imperial Academy of Sciences, *Bibliotheca Buddhica*. No. 13. 1911, 234.

10 Marshall, John. *Mohenjodaro and Indus Valley Civilization*. **1**, 1931, London p. 33.

11 *Rasaprokāśasudhākara* (c. 13th century A.D.) Ed. by Jadavji Tricumji Acharya, *Āyurvediya Granthamālā*, **1**, 1910-1911, vi, 11.

12 Schwartz, P. R. 'French Documents on Indian Cotton Painting'. (The Beaulien Ms, c, 1734), *Journal of Indian Textile History*, No 2. 1956, pp. 16-20.

13 *Mahāvagga* (c. 3rd-2nd century B. C.) Ed. by Herman Oldenberg, 1878, London, VIII, 10. 3.

14 *Śilparatna* of S'rīkumāra (c. 16th century A. D.), Ed. by T. Ganapati Sastri, Trivandrum Sanskrit Series, No. 75. 1922, **46**, 41-44.

15 *Rasasāra* of Govindācharya (c. 13th century A. D.). Ed. by Jadavji Tricumji Acharya. *Āyurvediya Granthmālā*, Vol. **2**, 1911-12, ix 2-14.

16 Hopkins, E. W. 'On the words for colour in the Rgveda. *Journal American Oriental Society*, **11**, 1882, p. cxxii.

17 Forbes, R. J. *Ibid* pp. 121-122.

18 *Dhanvantari Nighaṇṭu* (Doubtful age—possibly between 8th-9th century (A. D.). Ed. by Vaidyanarayana Purandare. Anandasrama Sanskrit Series. Poona, *Varga*, **1**, Vs. 18.

19 Murray, J. *The Plants and Drugs of Sind*. 1881, London, p. 196; Watt, G. *Dictionery of Economic Product*, Vol. vi (1). p. 571.

20 Forbes, R. J, *Ibid*. p. 10.

21 See No. 19.

22 *Artharvaveda*, iv. 12.1; v. 5. 3; 5.9 (See Roy, M' Family relations of some plants in the *Atharvaveda*', *Indian Journal of History of Science*, 5 (1). 1970, p. 170.

23 *Rājanighaṇṭu* (c. 13th century A. D.) of Narahari, Ed. by Vaidyanarayana Purandare. Anandasrama Sanskrit Series, No. 33, 1896, Poona, *Varga* 6. 17.

24 *Amarakośa* (c. 6th century A. D.). Ed. by H. D. Sharma and N. G- Sardesai with the commentary of Kṣīrasvamiā, 1941, Poona. *Vanauṣadhivarga*, Vs. 91 ; *Nighaṇṭuśeṣa* of Hemchandra (c. 12th century A. D.) Ed. by Muniraj Sri Punya Vijayi with the commentary of Vallabhagani, 1968. Ahmedabad, Vs. 312.

25 Watt. G. *Ibid*, vol. VI. (1) pp. 573 ff.

26 Forbes. J. *Ibid* p. 106.

27 *Ibid* ; *Encyclopaedia Britanica*, **14** (1965 Edition), p. 547.

28 *Samayamāṭṛkā* of Kṣemendra (c. 10th century A. D.) Ed. by E. V. V. Raghavacharya and D. G. Padhye (*Kṣemendra Laghu Kāvysamgraha*), 1961, Hyderabad. v. 21.

29 Ray, P, C. *Ibid*. p. 11.

30 As In No. 24.

31 *Sāhityadarpaṇa* of Viśvanātha Kavirāja (14th century A. D.) Ed. by Krishnamohana Shastri. Kasi Sanskrit Series, No. 145, 1967, Benaras. Chap. III. Vs. 197.

32 *Rasaratnasamuccaya* (c. 13th century A. D.) of Vāgbhaṭa. Ed. by Vinayaka Apte. Anandasrama Sanskrit Series, 1890, Poona, iii. 19.

33 As in No. 28.

34 *Altareya Āraṇyaka*, iii. 2.4 ; *Sāṅkhāyana Āraṇyaka*, vii. 10 ; Pāṇini's *Aṣṭādhyāyī*, viii 3.27 ; *Dhanvantari Nighaṇṭu*. *Ibid* ; *Bhāvaprakāśa* of Bhāva Miśra (c. 16th century A. D.) Ed. by Pandit Sri Brahma Sankara Misra, Kasi Sanskrit Series, No. 130. *Pūrvakhaṇḍa*. Vs. 159 (Page 250).

35 *Mahāvagga*, v. 2. 1.

36 *Kādambari* of Bāṇabhaṭṭa (7th century A. D.). Ed. by Pandit Krishnamohana Shastri, Kasi Sanskrit Series, No, 151, 1961, Benaras, p, 238.

37 Dymock. *et. al. Ibid*, Vol, III. p. 296 ;
Watt, G. *Ibid*. Vol. V. p, 115.

38 Dymock, *et. al. Ibid*, p. 297.

39 *Amarakośa, Vanauṣadhivarga*. Vs. 147 ; *Maṅkhakośa* (c. 12th century A. D.). Ed. by T. Zachaiae, 1897. Vs. 9. ; *Nighaṇṭuśeṣa*, Vss. 155-156.

40 *Amarakośa, Ibid* ; *Valjayeanti* of Jādavaprakāśa (c. 11th century A. D.) Ed. by G. Oppertr Madras Sanskrit and Vernacular Text Publication Committee, 1893, *Bhūmikāṇḍa*, Vs. 9.

41 *Nighaṇṭuśeṣa* Vss. 155-156 ; *Dhanvantari Nighaṇṭu, Varga* 3, 138.

42 *Vaijayanti* (see No. 40).

43 *Suśruta-Saṃhitā* (c. 4th century A. D.), Ed. by N. N. Sengupta and B. C Sengupta. 1937, Calcutta, *Sū*. 39, 3,

44 As in No. 38.

45 Dymock, *et. al. Ibid*. p. 299.

46 As in No. 39.

47 *Amarakośa, Vanauṣadhivarga*, Vs. 147 (see commentary of Kṣīrasvāmi).

48 *Nighaṇṭuśeṣa* (see No. 38).

49 Dymock, *et. al. Ibid*. p. 300 ; also see under 'Safflower', in *Encyclopaedia Britanica* **19** (1965 Edition), p. 810.

50 Drury. H, *Ibid.* p. 379.

51 Watt, G. *Ibid.* Vol. V. pp. 72-73.

52 *Rāja Nighaṇṭu, Varga* 3, 128 ; *Bhāvaprakāśa*, Vs. 127 (p. 297),

Kalpadrukośa of Keśava (c. 17th century A D.). Ed. by Ramavatar Sarma, 192, Vol. I. Gaekwad Oriental Series No. 42. 1928, Baroda. *Saṅkirṇavarga*, Vs. 439. 440,

63 William, Monier. Sanskrit-English Dictionary (Indian Edition) 1970, Delhi. pp. 332 (*kṣetraparpaṭi*). 409 (*jatīka*). 439 (*taruvallī*), etc.

54 Watt, G. *Ibid.* Vol. V. pp. 480-81.

55 *Dhanantari Nighaṇṭu, Varga* 1, 45. *Rāja Nighaṇṭu, Varga* 3, 128 ; 5. 65, 66 ; *Kalpadrukośa, Ibid.* Vs. 440.

56 *Rājanighaṇṭu, Varga*, 3, 129 ; 5, 65 ; *Kalpadrukośa. Ibid* Vs, 438.

57 *Amarakośa, Vanauṣadhivarga*, Vs. 154 ; *Nighaṇṭuśeṣa* Vss. 284-285.

58 *Nighaṇṭuśeṣa*, Vs. 259.

59 Dymock, *et, al. Ibid.* Vol. II. p. 198.

60 Drury, H. *Ibid.* p, 247.

61 Dymock, *et. al. Ibid* p. 199.

62 Watt, G. *Ibid.* Vol. V. p. 48.
Drury, H. *Ibid.* p. 247.

63, 64 Schwartz, P. R. 'The Roxburgh account of Indian cotton painting, *Journal of Indian Textile History*. No. 4, 1959, pp. 49-50.

65 Forbes, R, J. *Ibid.* pp. 100-106.

66 *Dhanvantari Nighaṇṭu. Varga* 3, 82.

67 Pāṇini's *Aṣṭādhyāyī*. IV. 2.2. ; *Saṃyutta Nikāya*, (c. 3rd-2nd century B. C.), Ed. by M. Leon Feer 1890. London. Pt. 3. xxii. 100. 11 ; *Rtusaṃhāra* of Kālidāsa (c. 4th century A. D.). Ed. by Narayana Rama Acharya, N. S. Press, Bombay. vi. 13.

68, 69, 70 Heiberger, P. Lac, *Encyclopaedia Britanica* (1965. Edition), 13, p. 568.

71 Forbes, R. J. *Ibid.* p. 105.

72 Yule, H. and Burnell. A. C. *Hobson-Jobson*, p. 499 ; Forbes, R. J. *Ibid.* 115.

73 *Atharvaveda*, v. 5.7 ; *Rāja Nighaṇṭu, Varga* 5. Vss. 141-142 ; *Amarakośa* and *Nighaṇṭuśeṣa* (see No. 56) ; *Nighaṇṭuśeṣa*, Vss. 123-124 ; *Kalpadrukośa, Saṃkirṇavarga*, Vss. 49-50.

74 *Amarakośa, Bhūmikāṇḍa*, Vs. 125 ; *Abhidhānacintāmaṇi* (c. 12th century A. D.), Ed. by Kalivara Sarman and Ramadasa Sen, Saṃvat 1934, Calcutta, *Martyakāṇḍa*. Vss. 349-350 ; *Vaijayanti, Pātālakāṇḍa*, Vs. 153.

75, 76 *Rāja Nighaṇṭu, Ibid.* Vs. 142.

77 As in No. 74.

78 *Vajiayanti, Ibid.* Vs. 153 ; *Dhanvantari Nighaṇṭu, Varga* 4. 88 ; *Rāja Nighaṇṭu, Varga*, 5, Vs. 142.

79 Yule, H. and Burnell, A. C.—*Hobson-Jobson*, p. 499.

80 *Nāyadhammakahāo* (period of redaction 454 A. D.), Ed. by N. V. Vaidya, 1970. Poona Vol. I. p. 10.

[81] As in No. 79.

[82] *Samayamātṛka* v. 20.

[83] As in No. 67.

[84] Abhayadeva Suri's (c. 11th century A. D.) commentary on *Sthānāṅga Sūtra* iv. 2. 293.

[85] *Ramāyāṇa* (c 200 B. C. –200 A. D.) Ed. by N. C. Vedantatirtha, Calcutta Sanskrit Series No. 2, 1956, Calcutta, IV. 22.18 ; *Anuyogadvāra Sūtra* (period of redactions 454 A. D.), ed. with commentary of Hemachandra. Published by Agamodayasamiti, N. S. Press, 1924, Bombay, *Sutra*, 37 ;
Sthānāṅga Sūtra (period of redaction 454 A. D.), Ed. with the commentary of Abhayadeva Suri. Published by Agamodayasamiti, N. S. Press, 1918, Bombay, iv. 2. 293 ;
Bṛhat Kathākośa, Ed. by A. N. Upadhyaya, 1943, Bombay, p. 83.

[86] Chandra, Moti—*Jaina Miniature Painting from Western India*, Ahmedabad, pp. 80-81
Sheth Haragovind—*Paia Sadda Mahannavo* (Prakrit Hindi Dictionary with Sanskrit Equivalent and References), 1928, Calcutta, p. 308.

[87] Levey, M.—*Chemistry and Chemical Technology in Ancient Mesopotamia*, 1959, Amsterdam, p. 106.

[88] Theophrastus's—*Enquiry into Plants* III. xvi. (*Vide* Forbes, R. J.—*Ibid.* p. 142) ; Schoff, W. H.—(Ed. & Transl.) *Periplus of the Erythrean Sea*. 1912. London, p. 73.

[89] Accadian *tultu Samtu* and Hebrew *tôla'athśani* (deep-red worm) is to be compared with Sanskrit *Kṛmi*, Old Persian *Kermes*, Persian *Kirm*, worm. Hence the Arabic *Dud il Qirmis* for *Kermes*, and the Pahlavi *Kalmir* and *Karmil*, from which comes English Carmine or Crimson.
(see Forbes. R. J.—*Ibid.* p. 143. ; Partington. J. R. *Origin and Development of Applied Chemistry*, London, 1935, p. 523).

[90, 91] Forbes, R. J.—*Ibid.* p. 104.

[92] Kurdiz, H. "Kirmiz", *Journal of American Oriental Society*, **61**, 1944, pp. 105-106.

[93] Hemacandra's commentary on *Anuyogadvāra Sūtra* 37 ; Abhayadeva Suri's (c. 11th century A. D.) commentary on *Sthānāṅga Sūtra* iv. 2. 293 ;

[94] Dames, M. L. (Translated)—*The Book of Duarta Barbosa*, Hakluyt Society Series 2. Nos. 44 (Vol. I), 49 (Vol. II). 1918, 1921, London, p. 124 ; p. 139.

[95] Forbes, R. J.—*Ibid.* p. 103.

[96] Forbes, R. J.—*Ibid.* p. 104.

[97] Chandra, Moti—*Ibid.* p. 80.

[98] Kurdiz, H. *Ibid.* p. 106.

[99] See commentary of Abhayadeva Suri on *Sthānaṅga Sūtra*, iv. 2. 293.

[100] See No. 85 for *Rāmāyṇa* and other references.

[101] *Śatapatha Brāhmaṇa*, Ed. by A. Weber, Chowkhamba Sanskrit Series, 1964, Varanasi, XV. 3.8.3 ;
Bṛhadāraṇyakopaniṣad, Ed. by E. Roer with the commentaries of Śaṅkara and Ānandagiri, Asiatic Society, Calcutta. Bibliotheca Indica, No. 2. ii. 3.6. (see Śaṅkara's commentary).
"*Vessantara Jātaka*", *Jātaka*, Ed. by V. Fausball, 1895. London. Vol. VI. p. 50.

[102] (i) Bohtlingk, Otto. and Roth, Rudolph—*Sanskrit Worterbuch*, Vol. I. St. Petersburg, 1855 p. 803.

(ii) William, W. Monier—*Sanskrit-English Dictionary* (Indian Edition), 1970, Motilal Banarsidass, p. 166.

(iii) Gupta, Madhusudan--*Vaidyaka Śabdasindhu*, 1894, Calcutta, p. 121.

(iv) *Rasārṇava*, Ed. by P. C. Rây and H. C. Kaviratna, Asiatic Society, 1909, Calcutta, see Glossary, p. 4.

[103] Watt, G. *Ibid.*, Vol. II, p. 400 ; Forbes, R. J. *Ibid.* p. 102 ; Cuvier, Baron, *Animal Kingdom*, Vol. XV, 1832, London, pp. 281 ff.

[104] *Kirātārjunīyam* of Bhāravi (c. 6th century A. D.) Ed. with the commentary of Mallinātha, N. S. Press, 1954. Bombay, x. 3. 27.

Abhidhānacintāmaṇi, Bhūmikāṇḍa. Vs. 275 ;

Vinayapiṭakam (c. 3rd-2nd century B. C.) Ed. by H. Oldenberg, Vol. III. 1881, London. iii. 4.2.

[105, 109] *Suśruta Saṃhitā, Sū* 14, 18 (see Dallaṇa's commentary).

[106] *Rāmāyaṇa*, see No. 85 ; *Kirātārjunīyam*, see No. 101.

[107] *Suśruta Saṃhitā, Sū*. 14, 18.

[108] *Therā* and *Therigāthā*, Ed. by H. Oldenberg and R. Pischel. Pali Text Society, 1883, London, i. 13.

Therāgāthā, Translated by Rhys Davids. Pali Text Society. 1951, London.

[109] See No. 105.

[110] *Rasahṛdaya* of Govindabhikṣu (c. 11th century A. D.) Ed. by Jadavji Tricumji Acharya, *Āyurvediya Granthamālā*, Vol. I. 1910. Bombay. xv. 7.

Rasaratnasamuccaya, v. 19.

[111, 112] Broderick, Rev. J. F.—"Cochineal" *Encyclopaedia Britanica* (1965 Edition), Vol. V, p. 996 ; Watt, G. *Ibid.*, Vol.II, p. 407.

[113] See No. 105 ; *Kādambarī*, p. 107.

[114] *Bhagavatī Sūtra* (period of redaction 454 A. D.), Ed. by Srijut Roy Dhanapati Simha with the commentary of Abhayadeva Suri, 1182, Benares. ii. 1.90 ; *Mahāvyutpatti*, 234.

[115] Takakusu, J. (Translated).—*I-tsing's Record of the Buddhist Religion as Practised in India and the Malaya Archipelago*, 1896, Oxford, p. 77.

[116] *Abhilaṣitārthacintāmaṇi, Viṃśati* 3. 153.

[117] *Ibid. Viṃśati*, 6, 29.

[118] *Śilparatna*, 46, 120-122.

[119] *Samayamāṭṛkā*, v. 19.

[120] *Trikāṇḍaśeṣa* of Puruṣottamadeva (c. 12th century A. D.). Ed. by Sri Sīlaskandha Mahanayaka 1916, Bombay. ii. 9. 34.

[121] *Amarakośa, Vaiśyavarga*, Vs. 106 ; *Abhidhānacintāmaṇi, Bhūmikāṇḍa*, Vs. 225.

[122] As in No. 103.

[123] *Arthaśāstra* (c. 3rd century A. D.) Ed. by R. P. Kangle, 1960, Bombay. ii. 17.10.

124 *Dhanvantari Nighaṇṭu, Varga* 6, 118 ; *Abhidhānacintāmaṇi, Bhūmikāṇḍa*, Vs, 225 ; Ray, P. C. *Ibid.* p. 16.

125 Watt, G.—*Ibid*, Vol. II, p. 184.

126 Yule, H. and Burnell, A.C.—*Ibid.* p. 779.

127 *Amarakośa, Vaiśyavarga* Vs. 106 ; *Abhidhānacintāmaṇi* (see No. 130), *Harṣa-carita* of Bāṇabhaṭṭa (7th century A. D.). Ed. by P. V. Kane, 1965. Delhi. v. 29 ; *Dhanvantari Nighaṇṭu* (see No. 130).

128 *Suśruta Saṃhitā. Sū*, 8, 20.

129 Dymock, *et. al.* Vol. II. p. 310 ; Watt, G.—*Ibid.* Vol. II pp. 188-89 ; Ray, P. C. *Ibid.* p. 16.

130 Watt, G. *Ibid.* p. 190.

131, 132 *Ṛtusaṃhāra*, vi. 4. (*vasantavarṇanam*) ; *Deśīnāmamālā* of Hemacandra (c. 12th century A. D.) ed. by S. Pischel, 1880, Bombay. ii. 65 ; ii. 111 ; vii. 3 ; *Bhāvaparakāśa. Ibid.* Vs. 190, p. 250 ; *Dhanvantari Nighaṇṭu* (see No. 124).

133 Murray, J. *Ibid.* p. 185.

134 *Rasārṇava*, v. 39 ; *Rasaratnasamuccaya*, x. 92.

133a *Vācaspatyam* (a Sanskrit Dictionary) compiled by Taranatha Tarakavacaspati 1962, Benares. Vol. III. p. 2161.

134 *Caraka-Saṃhitā*, (c. Before 1st century A. D.), Ed. by G. Pandeya with the commentary of Cakrapāṇi. K. S. S. 194. 1970. Benares. *Siddhi sthāna*, 8, 65.

135 Watt, G.—*Ibid.* Vol. II, p. 189.

136 *Samayamātṛkā*, v. 19 ; *Sāhityadarpaṇa*, iii. 197.

137 As in No. 131.

138 *Vaijayantī, Bhūmikāṇḍa*, Vs. 116 ; *Nighaṇṭuśeṣa* Vss. 234-235.

139 *Mahābhārata*. Ed. by V. S. Sukthankar. Bhandarkar Oriental Researeh Institure, 1942. Poona, iii. 48. 21.

140 *Trikāṇḍaśeṣa, Manuṣyavarga* ,ii. 6. 36.

141 As in No. 123.

142 *Nighaṇṭuśeṣa* Vss. 234-235 ; Blochman, H, -(Transl.) *Ain-i-Akbari*, Vol. I. 1873, Asiatic Socicty Publication, Calcutta, p. 84 ; Voi. II Jarrett, H., and Sarkar, J, N. (Transal.) Asiatic Society, Calcutta, 1949. p. 358.

143 Dymock, *et. al. Ibid.* Vol. IV. p. 453.

144 *Nighaṇṭuśeṣa* (see No. 148) ; *Vaijayntī, Ibid.* 116-117 ; *Abhidhānacintāmaṇi, Martya-kāṇḍa*, Vs. 309.

145 As in No. 142 (*Ain-i-Akbari*).

146 *Nighaṇṭuśeṣa* Vs. 235.

147 *Amarakośa, Nṛvarga*, Vs 124 ; *Abhidhānacintāmaṇi, Martyakāṇḍa*, Vs. 309.

148 *Amarakośa, Ibid.* ; *Nighaṇṭuśeṣa* Vs. 234 (*dhīra*).

149 *Samayamātṛkā*, v. 20.

150 *Murray*. J., *Ibid.* p. 20.

151 *Harivaṃśa*.. Published by Asiatic Society, Calcutta, 1839. Vs. 7072; *Harṣa-carita*. IV. 16. *Bhagavatī Sūtram* ii. 33. 385 ; *Trikāṇḍaśeṣa*, ii. 6.36.

152 *Amarakośa*, Vs. 132 ; *Vaijayantī*, *Bhūmikāṇḍa*, Vs. 115.

153 *Amarakośa*, *Ibid*. ; *Nighaṇṭuśeṣa*, Vs 25-26 ; *Abhidhānacintāmaṇi*, *Martyakāṇḍa*, Vs. 306 ; *Paryāyamuktāvali*. Ed. by T. Chaudhuri, 1947, *Hīnagandhavarga*, Vs. 3.

154 Yule, H. and Burnell, A. C. *Ibid*. p 794.

155 Yule, H. (Transl.). *The Book of Ser Marco Polo*, Vol. II, (Second Edition), 1875, London. pp. 368, 369.

156 Yule, H. *Ibid*. p. 380.

157 As in No. 153.

158 Rockhill, W. W. (Transl.) *Chou-Ju-Kua*, 1912. p. 217. (see. Foot-Note).

159 As in No. 153.

160 Watt, G. *Ibid*. Vol. II. p. 10.

161 Schwartz, P. R. French document on the Indian cotton painting *Journal Indian Textile History*, No. 3, 1957, p. 30.

162 Watt, G. *Ibid*. Vol. II. p. 11.

163 As in No. 153.

164 *Nighaṇṭuśeṣa*. Vs. 25.

165 Watt, G. *Ibid*. Vol. II. p. 10.

166 *Rasārṇava*, v. 39.

167 Yule, H., Burnell, A. C. *Ibid*. p. 780 ; Watt, G, *Ibid*. Vol. II. p. 664.

168 *Amarakośa*, *Vaiśyavarga*, Vs. 41 ; *Nighaṇṭuśeṣa* Vs. 213 ; *Dhanvantari Nighaṇṭu*, *Varga* 1, Vs. 54.

169 Dymock, *et. al*. *Ibid*. Vol. III. p. 412.

170 Watt, G. *Ibid*. Vol. II. p. 660.

171 Forbes, R. J. *Ibid*. p. 122.

172, 173, 194 *Rāja Nighaṇṭu*, *Varga* 6, Vs 80.

175 Watt, G. *Ibid*. Vol. II. p. 667.

176 *Samayamāṭṛkā* v. 22 ; *Vaijayantī*, *Sāmānyakāṇḍa*, Vs. 26.

177 Watt, G. *Ibid*, Vol. II. pp. 664-665.

178 *Vāśiṣṭha Dharma Sūtra* (300 B. C.—100 B. C.), xi. 65-66 ; *Āpastamba Dharma Sūtra* (600 B. C.—300 B. C.) i. 1. 2. 41 ; 1. 3. 1—2; *Aṅguttara Nikāya* (before 1st century A. D.) Ed. by E. Hardy, Pali Tex Society, 1899, London, Pt. 3. cxciii. 3.

179 Takakusu, J. *Ibid*.

180 *Atharvaveda*. i. 23. 1 ; i. 24 1-4.

181 Watt, G. *Ibid*. Vol. IV, 1890. p. 390.

182 Dymock, *et. al*. Vol. I p. 407.

183 As in No. 181.

184 Pliny's *Natural History*, Tr. by H. Rackham, Cambridge. Vol. IX. Book. XXXV. 46.

185 Forbes, R. J. *Ibid*. p. 111.

186, 187 *Amarakośa*, *Vanauṣadhivarga* Vs 95; *Nighaṇṭuśeṣa*. Vs. 251; *Rāja Nighaṇṭu*, *Varga* 4, 349-350; *Dhanvantari Nighaṇṭu*, *Varga* 1, Vss. 232-233.

188 Watt, G. *Ibid.* Vol. IV. p. 391.

189 191 *Amarakośa*, *Nighaṇṭuśeṣa* (see No. 192)

190 *Rāja Nighaṇṭu*, *Ibid.* Vs. 351.

191, 192 As in No. 189.

193 Yule. H *Ibid* Vol. II. p. 363.

194 Schwartz, P. R. *Ibid.* p. 28.

195 Forbes, R. J. *Ibid.* p. 111.

196 As in No. 189.

197 *Samayamāṭṛkā* and *Vaijayantī* (as in No. 176); *Abhidhānacintāmaṇi*, *Martyakāṇḍa*, Vs. 130.

198 *Saṃyutta Nikāya*. *Ibid*, pt. 3. xxii. 100. 11, Law books (period ranged fro 200 B. C. —800 A. D.). *Manu Saṃhitā*. Ed. by G S. Nena and C. S. Behera, 1935, Benares. x. 89; *Ūṇaviṃśa Saṃhitā*, Calcutta (*Āpastamqa Saṃhitā*, ch. 6; *Vāśiṣtha Saṃhitā* xi. p. 3; *Aṅgirah Saṃhitā* Vss. 12-32). *Abhilaṣitārthacintāmaṇi*, *Viṃśati* 6. 29; *Mahāvagga* v. 2. 3.

199 *Navanītakam* or Bower Manuscript (c. 4th century A. D.). Ed. by B. S. M. Kaviraja, 1925, Lahore, ii. 10. 5.

200 Reid, W. N. *Culture and Manufacture of Indigo*, 1887, Calcutta. pp. 56 ff; Ray, P. C. *Desi Rang* pp. 59 ff.

201 *Navanītakam*, *Ibid* ii. 10.5-10; 25.

202 *Sthānāṅga Sūtra*. iv. 2. 239; *Bhagavatī Sūtra* vi. 1. 229.

203 Forbes, R. J. *Ibid*. p. 125.

204 *Śilparatnam*. 46. 47-51.

205 *Abhilaṣitārthacintāmaṇi*, *Viṃśati*, 6. 30.

206 Schwartz, P. R. *Ibid*. p. 25.

207 *Ibid*. p. 28.

208 Watt, G. *Ibid*. Vol. VI. (4). pp. 26, 35.

209 *Amarakośa*. *Vanauṣadhivarga*, Vs. 33.

210 *Suśruta Saṃhitā*, *Ci*. 2. 91; 25. 43 (see Ḍallaṇa's commentary).

211 Pāṇini's *Aṣṭādhyāyī*, iv. 2. 2.

212 *Nāyadhammakahāo*, Vol. I. p. 10; *Arthaśāstra* ii. 17. 10.

213 *Dvyāśrayakāvyam* of Hema Chandra (c. 12th century A. D.), Ed. hy A. Vishnu Kathvate with the commentary of *Dvyāśrayakāvyavṛtti* of Abhayatilaka Gani., Bombay, Sanskrit and Prakrit Series. No. 76.. 1921, Bombay. ix. 30.

214 *Kāśikā* (7th cent. A. D.) on Pāṇini iv. 2. 2.