Indian Journal of History of Science, 17(1); 70-81

INDIAN DYES AND DYEING INDUSTRY DURING 18-19TH CENTURY

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In India the earliest evidence of dyeing comes from Indus civilziation (2300-1750 B.C.) from where a piece of cotton at Mohenjo-daro, dyed with madder— a vegetable dye has been found[1]. Since then, there has been a steady growth in dyes and dyeing industry as attested by various literary and archaeological evidences.[2,3] Ajanta and Bagh paintings datable to early christain period were executed with a variety of pigments, viz. yellow, red, blue, white, green and black.[4] These paintings also depict men wearing coloured garments indicating advances made in dyeing industry. The introduction of a few new shades[5] like agilkhani, badshahpasand etc. and dyes like henna[6], during Mughal rule bears testimony to this fact.

In fact, some of the dyes namely Indigo, Madder and Kermes were introduced all over the world by the Indians during very early periods. A red dye obtained either from Madder or Kermes was tactfully used by Alexander the Great, as probably the first important use of camouflage in war to win the battle against Persians.[7] Similarly, Indigo was the dye selected for colouring the uniforms of British navy.[8] The number of Indian dyes which earned international repute grew further till the middle of 19th century which is evident from the list of dyes exhibited[9] at Industrial exhibition of 1851 at London (Table 1).

Extraction of Dyes

The techniques used for extracting the dyes were mostly simple. The mineral dyes *hirmāji* and *ramraj* were obtained by pounding the ochreous clay and mixing it with water.

Animal Dyes

The dyes of animal origin like lac and cochineal were obtained by a different method. In case of lac[10] the encrusted twigs which are host to the larvae of the insect *Coccus lacca*, were cut into pieces. Theses twigs containing nearly 10% colouring matter were further crushed to separate the resinous material. This resinous material was thrown into tubs of water and beaten with a wooden pestle or trodden underfoot. The red coloured solution was then evaporated to dryness and the residue thus obtained was compressed into cakes.

TABLE 1

Dyes Exhibited at the Industrial Exhibition of 1851 *at London*

Dye	Provenance
1. *Annotto*	Dacca
2. *Al*	Bundelkhand & Sagar
3. *Chay* root	Dyndygal, Nellore, Masulipatam
4. *Mañjit*	Assam, Nepal, Bombay, Scindiah's territory and Quetta etc.
5. Myrobalans (*karra* & *behara*)	Bengal
6. Safflower	Dacca
7. Sappan wood	Mergui, Malabar
8. Red Saunders (*lāl Candan*)	Madras
9. Red wood	Madras
10. Log wood	Calcutta botanical garden
11. *Lodh*	Himalayas
12. Barberry wood & root (*kāśmal*)	Himalayas
13. Turmeric	Bengal, Malabar
14. Indigo	Bengal, Madras

Cochineal dye[11] was obtained from the insects *Coccus cacti* host on *Cactus nopalea* cochinellifera plant. The insects were carefully brushed from the cactus plants into bags or small wooden bowls and killed either by immersion in scalding water or by long exposure to the hot sun. In the latter case, the dye was then extracted with the help of water. Roughly 70,000 dried insects were required to produce one pound of cochineal dye.

Vegetable Dyes

Most of the vegetable dyes (being soluble in water) were extracted with water. However, a few dyes like *kusum* (safflower), which are insoluble in water, were extracted with an alkali either *sajji* or wood ashes. From this alkaline solution the dye was obtained by precipitation with an acid chiefly lime juice. Dyes like *dhak* were obtained by steeping the dye containing part in cold water. The water was then evaporated to make the dye commercially ready. Some other dyes like turmeric, harsinghar, madder, catechu, sappan, pomegranate, myrobalan, chay etc. were extracted by boiling the dye yielding part with water (refer to Table 5, Appendix). The infusion thus obtained was strained through a fine cloth and then evaporated to dryness and sold in the market

either as powder or in the form of cakes. For example, the Catechu dye was obtained by boiling the heartwood of the plant *Acacia catechu* with water. The infusion was strained, the residue was used with betal leaves as *kāth* and the filtrate on evaporation yielded the valuable catechu dye of commerce, also known as *cutch.*

However, the method employed for the extraction of the world famous dye—Indigo, was somewhat complicated and is discussed in detail below.

Extraction of Indigo—The leaves of the plant *Indigofera tinctoria* were the chief source of the dye. The dye was prepared in vats which were of two types, namely (*a*) *khari* or alkaline vat, and (*b*) *mithā* or sweet vat. Caustic lime, gur and *sajji* were used in the alkaline vat whereas in the sweet vat slaked lime and sugar (in the form of *sirā*) without the addition of *sajji* were used. Sweet vat method was more popular as its yield was higher than that of alkaline vat.

The plant leaves were steeped in water in a vat to have the soluble glucoside indican ($C_{52}H_{62}N_2O_{34}$) in the infusion which on decomposition gave indigotin ($C_{16}H_{10}N_2O_2$) and indiglucin. The infusion thus obtained was subjected to fermentation to provide the nascent hydrogen for the reduction of indigotin to indigo-white. The chemical reactions taking place in a fermentation vat can be represented as follows:

$$\underset{\text{(Grape sugar)}}{C_6H_{12}O_6} \longrightarrow \underset{\text{(Lactic acid)}}{2C_3H_6O_3} \longrightarrow \underset{\text{(Butyric acid)}}{C_4H_8O_2} + 2CO_2 + 4H$$

$$\underset{\text{(Indigotin)}}{2C_{16}H_{10}N_2O_2} + 4H \longrightarrow \underset{\text{(Indigo-white)}}{2C_{16}H_{12}N_2O_2}$$

When the fermentation process was complete, the greenish-yellow, sweet-smelling liquid was separated and agitated with sticks for two to three hours for oxidation purpose. This converted indigo-white into grains of insoluble Indigo-blue which coagulated and settled at the bottom because of the agitation operation. This sediment was then collected, washed and pressed into cakes for sale. However, at various places, the natives avoided the fermentation step in the production of Indigo. Here the natives used to add a decoction of the bark of *Eugenia jambolana* tree in the vat to the Indigo liquor. The decoction containing some acid probably assisted in the decomposition of indican into indigotin and indiglucin without undergoing fermentation. Similarly, the juices or gums of certain plants, e.g. butea gum were considered to be necessary adjuncts in precipitating the dye.[12]

The proportion of colouring matter in high quality Indigo ranged between 50 and 70 per cent. In good *kurpah*(Cuddapah) Indigo it ranged between 33 to 52 per cent. Oudh Indigo also contained nearly similar percentage of colouring matter. An inferior quality of Indigo known as "Fig Indigo" contained only 6 to 9 per cent colouring matter.[13]

Mordants used during 18-19th Century

It seems that Indians during 18-19th century were very well aware of the importance of mordants in dyeing and the part played by the different mordants or dye-auxiliaries in producing different shades. Mordants were generally used to fix the dye on the fibre on which it could not be fixed easily. A large number of materials were used as mordants, e.g. alum*, iron compounds†, common salt, *sajji* (crude natron), lime, lemon juice, vitriol, etc. Sometimes a few dye stuffs in conjunction with other dyes served as the mordants.

Thus alum was used as a mordant mostly with madder, turmeric, *dhak*, *patañg*, *chay*, *kamela* and *dhau* dyes. Myrobalans were used with *bel*, *kulāñjan*, *dālcini*, *al*, *mañjith*, safflower, *haldi* and *tesu* dyes. As a mordant *lodh* bark was also used with *al*, *patañg*, *dhāk* and *mañjith* dyes. *Imli* was employed as a mordant for dyeing the silk with safflower. Lime, saltpetre and *geru* were also sometimes used as mordants with *al* dye. For *annotto* dye crude pearl ash, vinegar, lemon juice, lime etc. were used as mordants whereas the bark of *annotto* and *dhau* trees were also the mordants used with *al* dye.

The process of mordanting or applying the mordants to the fibre was usually carried out by dipping the cloth in the mordant solution after the cloth had been dyed with the desired dye. Sometimes the mordant was mixed in the vat in which the dye was extracted and the cloth steeped in.

Dyeing Techniques

During 18-19th century, Indians used to produce a wide variety of colours and shades on almost all the types of fibres, e.g. cotton, silk and wool. Towards this object, a large number of dyes, mordants and auxiliaries were used. The techniques used were mostly simple and differed though slightly, from dyer to dyer or according to the nature of fibre to be dyed. However, the basic steps involved in the dyeing were similar and the chief colours produced were blue, red, yellow, green, and black and various shades and hues.

Cotton Dyeing

The dyes used for dyeing cotton were indigo, madder, turmeric, safflower, harsinghar, patang, catechu, dhak, al, pomegranate rind, mybrobalans, etc. For dying

*Large scale manufacture of alum was carried out in Cutch from a pyritous dark-grey or black shale by lixiviating with impure saltpetre which was mainly exported to Gujrat & Bombay for use in dyeing.

†An analysis of iron sulphate, a by-product of the alum industry used in Bihar in dyeing operations, by Stevenson in 1833 showed it to contain—

Iron sulphate	39.0%
Iron Oxide	36.0%
Magnesia	23.0%
loss	2.0%

cotton, the cloth was first impregnated in an aqueous solution of dung. The dung usually containing phosphates, silicates and carbonates of sodium, potassium and aluminium, helped in fixing the mordant on the fibre. The cloth was then washed and bleached in sun. This was followed by soaking the cloth in oil and alkali which made the fibre soft and helped in removing the dirt particles. Castor oil and *sajjikhār* or *papadkhār* were the commonly used oil and alkali, respectively. The cloth was then steeped in the desired dye infusion followed by a dip in the mordant solution. Sometimes the cloth was dipped in different dye solutions successively to produce a definite shade.

However, to dye with indigo, the native dyers used to reduce the dye to indigo-white, temporarily, in a fermentation vat, when it was allowed to permeate the fibres thoroughly. The fabric was then exposed to air to transform the indigo-white to indigo-blue. Generally Indigo-dyeing did not require any mordant.

Silk-dyeing

The dyes used in silk-dyeing were generally turmeric, madder, cochineal, safflower, sappan, lac, red ochre, yellow ochre, catechu, kamela, indigo etc.. The dyeing process consisted of three steps—firstly, the raw silk was bleached by steeping it with an alkali, namely, lime, soda or potash; secondly, the mordant usually alum was applied to the bleached silk; and lastly, the dyeing was affected by steeping the silk in the dye solution. Sometimes a little acidic solution of mango was added to the dye solution.

Wool dyeing

The dyes and the materials generally used for dyeing wool in India during 18-19th century were indigo, lac, madder, babul bark, turmeric, dhak, cochineal; catechu, lodh, ferrous sulphate, myrobalans, tamarind, pomegranate rind, lime, sajjikhar, alum, gall nuts etc.. The dyeing was generally carried out in the yarn and especially so in the case of carpet industry.[14] The first step in dyeing involved the cleaning of yarn with an alkali mostly reh and sajji. The yarn was then mordanted usually with alum, gull nuts, lodh bark, tamarind, etc. and then steeped in the infusion of dye which produced the required colour. A large number of shades were produced in various places. Sometimes an acid (sulphuric) was used in wool dyeing.[15,16]

Chintz Printing

Chintz was the name given to a cloth, stained to give a variegated or spotted design. This industry was indigenous to India. Lucknow chintzes were supposed to be of very superior quality. The process usually involved four steps—(*i*) oiling, (*ii*) production of faint lines on the cloth to help the printers, (*iii*) making fast the marks previously stamped, and (*iv*) production of different colours and shades. However, the method sometimes differed.[17]

Trade in Dyes during 18-19th Century

During this period, the trade of this commodity was quite flourishing. The dyes like indigo, safflower, lac and madder etc. were well-known for their superior quality and were exported to various countries. Bengal lac dye was mainly exported to United Kingdom. Its average export in the years 1879-80 to 1883-84 was 6,010 cwt. valued as Rs. 1,01,803. But during the period 1884-85 to 1888-89, it fell to 684 cwt. valuing Rs. 63,335 only.

Indigo was the most important item of trade and Britain was its most important importer. In 1782, India supplied only a small fraction of indigo (495,100 lbs.) imported by Britain. But after that British imports of Indian indigo rose steadily. Thus, in 1795, Bengal alone furnished 29,555, 862 lbs. of indigo out of Britain's total import (of 4,368,027 lbs.). This export of indigo to foreign countries continued to increase and during the ten years 1878-79 to 1887-88 the average export of indigo was 15,097,622 lbs. (equivalent to Rs. 3,79,76,724). Table 2 shows the amount of Indigo exported to various countries in the year 1887-88.

TABLE 2

Export of Indigo from India in 1887-88

Countries to which exported		Cwt.	Value (Rs.)
United Kingdom	..	56,986	1,54,34,982
United States	..	21,350	71,33,493
France	..	17,406	49,76,119
Egypt	..	13,154	29,49,421
Austria	..	11,780	35,70,817
Germany	..	6,392	20,24,291
Persia	..	5,229	7,98,723
Turkey (Asia)	..	2,841	7,58,833
Russia	..	1,668	5,13,964
Italy	..	1,533	4,57,013
Arabia	..	404	52,234
Turkey (Europe)	..	222	50,770
Belgium	..	208	69,610
Malta	..	205	45,831
Greece	..	145	38,857
China-Hongkong	..	73	21,861
Aden	..	18	2,487
Australia	..	13	3,500
Other countries	..	12	2,063
Straits Settlements	..	5	1,625
Total	..	1,39,644	3,89,06,494

After the year 1887, the chain was reversed. The synthetic dyes were being imported into India and the export of Indian dyes received a great set back. Thus in 1887, the value of Indigo exported was Rs. 3,89,06,000 but it continued to decrease and fell to Rs. 1,42,39,000 in the year 1900, whereas the import of synthetic dye stuffs in India which was equivalent to Rs. 38,14,000 in the year 1887 rose to Rs. 45,07,000 in the year 1900.

Apart from the foreign trade, the part played by the dyes in internal trade was also a significant one. The chief dyes of internal trade were indigo, madder, safflower, turmeric, al, lac, catechu, sappan, pomegranate, harsinghar, etc.. The import and export of various dyes between Northern India, Kashmir, Laddakh, Tibet, Kabul, Tirah, Nepal, Sindh, Rajputana, Bundelkhand, Central provinces, Bombay presidency, Bihar, Bengal, etc. were quite significant. In Northern India, Lucknow was one of the important centres of trade in dyes. During the year 1877-78, Northern India exported 80,092 mds. of Indigo, 7769 mds. of safflower, 40,159 mds. of lac, 4,969 mds. of madder, 4,889 mds. of turmeric and 16,715 mds. of other dyes whereas the imports amounted to 81,333 mds. of madder, 17,643 mds. of turmeric, 5,794 mds. of safflower, 6,113 mds. of al and 85,850 mds. of other dyes. An idea about the trade in dyes like indigo, myrobalans, cutch, turmeric etc. done by the various divisions of North-Western provinces and Oudh during the ten years 1885-86 to 1894-95 can be had from the Tables 3 & 4.

British Impact Over Indian Dyes and Dyeing Industry

The Indian dyes and dyeing industry had a glorious record till the middle of 19th century as is evident from the trade in various dyes. Ever since the Britishers arrived as a trading company Indian dyes became an item of regular export to European countries. There was a great demand of Indian dyes in Europe as the dyes were of very superior quality and besides that these fetched good returns to the trading companies. Till the end of 18th century the Britishers received their major supply of indigo from West Indies but after sometime the West Indians found the remuneration low and switched over to the production of coffee and sugar. Thus the British dyers turned to India for their indigo supply. In the initial years the East India Co. extended every possible support to improve the indigo plantation and dye extraction. As a result of this in 1787 the quality of Indian indigo surpassed the quality of French and Spanish indigo. For about 22 years (1780-1802) the East India Co. directly supported the industry.

In 1856, the first synthetic coaltar dye was prepared in Europe as a result of Industrial revolution there and in 1867 a Bombay firm 'Cama Ramji' imported the Magenta dye. After sometime a few German chemists and salesmen came to India with a view to introduce their synthetic dye 'Alizarin' in the Indian market but could not succeed initially. But the better salesmanship of the Germans prevailed and they ultimately succeeded in introducing their dyestuff in Indian market. Due to their pro-

TABLE 3

Import of dyes (in maunds) in different divisions of North-Western Provinces and Oudh during 1885-86 to 1894-95

Dye	Meerut Division		Agra Division		Allahabad Division		Banaras Division		Rohilkhand Division		Oudh		Total	
	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95
Indigo	2,568	2,565	1,381	776	2,586	1,517	320	245	237	203	180	273	7,272	5,579
Myrobalans	7,909	11,209	2,323	2,796	18,102	27,793	317	393	2,275	2,542	1,863	1,484	32,789	46,217
Cutch	880	1,045	744	1,068	11,667	17,749	1,011	1,309	985	1,962	2,317	2,874	17,604	26,007
Turmeric	15,674	19,488	12,461	14,967	42,846	48,160	8,839	9,300	5,720	11,710	6,507	12,341	92,047	1,15,966
Other Dyes (Safflower, tessu, etc.)	51,116	26,336	10,213	9,024	24,800	38,276	8,028	4,369	11,170	6,294	4,357	4,060	1,09,684	88,359

TABLE 4

Export of dyes (in maunds) in different divisions of North-Western Provinces and Oudh during 1885-86 to 1894-95

Dye	Meerut Division		Agra Division		Allahabad Division		Banaras Division		Rohilkhand Division		Oudh		Total	
	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95	1885-90	1890-95
Indigo	15,832	14,401	12,366	14,398	10,155	10,231	6,997	6,235	1,556	1,730	1,188	1,699	48,094	48,694
Myrobalans	3,229	5,172	672	658	5,600	8,747	15,737	23,202	125	76	177	354	25,540	38,209
Cutch	962	276	1,759	3,444	11,726	15,644	1,595	6,281	2,545	1,963	9,560	12,384	28,147	39,992
Turmeric	8,128	7,277	1,622	1,798	23,306	24,767	30,945	34,652	11,415	9,771	18,315	12,680	93,731	90,945
Other Dyes (Safflower, Tessu, etc.)	27,596	14,511	4,347	7,894	22,874	14,871	4,816	2,293	2,394	3,531	655	12,563	62,082	55,663

motional activities the use of the synthetic dyes became popular amongst the native dyers. It got further momentum because of the superiority of synthetic dyes over the indigenous ones. The advantages were low cost, uniformity of shades obtained, saving in time and the labour involved. After establishing 'Alizarin' in the Indian market, other synthetic dyes were slowly introduced and this introduction of the synthetic dyestuffs forced the indigenous dye industry to gradually fold-up. This is evident from the fact that during the years 1896-97 to 1901-02 the export of Indian indigo declined from £ 4,125,000 to £ 3,850,000 whereas the import of artificial indigo rose from £ 2,50,000 in 1897 to £ 1,250,000 in 1903.[18]

Reasons of Dwindling of Indian Dye Industry

The reasons responsible for the extinction of the native dyes and dyeing industries during 19th century can be summed up as follows:

1. After the victory of Plassey in 1757, the East India Company started plundering enormous wealth from India through the export of various Indian items including dyes to foreign countries. The wealth thus accumulated by the Company helped them in financing the industrial revolution taking place there which was ultimately responsible for the downfall of Indian industries particularly dye industry.

2. When the British Government took over the East India Company they treated India as a colony and started filling the Indian market with their own products which were cheaper, without caring of its adverse effect on indigenous industries.

3. The British Government dealt with the indigenous industries with a heavy hand. Thus, when Indian dyes were in great demand in England and other European countries, they taxed them heavily so that the export was affected very much.

4. The introduction of synthetic dyes into Indian market gave the indigenous dyes and dyeing industry a death blow.

5. The Europeans were better salesmen. Initially they introduced the dye to the native dyers at reduced prices and even free of cost at some places and thus created an attraction for the synthetic dyes so that the indigenous dyes started loosing the ground.

6. The methods of producing indigenous dyes were very cumbersome. They involved a lot of labour and time. Also, the yield was small.

7. Unscrupulous adulteration of their products which fetched them good price was also responsible for the downfall of the indigenous industry.

8. Britishers made no attempt to install chemical industries in India, least the synthetic dyes.

It may be concluded that upto middle of 19th century, India was in the fore-front in the field of dye manufacture. Though the methods of extraction were primitive and mostly manual, yet India earned a lot of money from this trade. Britishers helped the dye industry especially indigo plantation and extraction with the sole object of its export and taking the earnings to their native country. The moment the trade became less remunerative they did not hesitate to switch over to import synthetic dyes to India in place of exporting Indian dyes abroad—their sole interest in India being that of mercenaries and exploitation to the benefit of their native country.

ACKNOWLEDGEMENT

Thanks are due to Dr. Kalyan Krishna, Department of History of Art, B.H.U., for supplicating us some of the literature scanned by us.

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APPENDIX

INVENTORY OF 18-19TH CENTURY INDIAN DYES

18-19th Century was the period when a large number of materials of vegetable, animal or mineral origin were in use in India for producing a wide variety of colours

and shades for cotton, silk and wool. Important dyes and auxiliaries of vegetable origin were—

Acacia catechu (*ḳhair*), *Acacia concinna* (*ritṭā*), *Acacia leucophloea* (*safed kikar*), *Adhatoda vasica* (*arusa*), *Aegle marmelos* (*bel*), *Alpinia galanga* (*kulañjan*), *Anogeissus latifolia* (*dhau*), *Areca catechu* (*supāri*), *Artocarpus integra* (*kānthal*), *Berberis lycium* (*kashmal*), *Bixa orellana* (*laṭkān*), *Bombax malabaricum* (*semal*), *Butea frondosa* (*dhak*), *Caesalpinia sappan* (*patañg*), *Carthamus tinctorius* (*kusum*), *Cassia auriculata* (*tarwār*), *Casurina equisetifolia* (*jañgli saru*), *Cassia fistula* (*amaltas*), *Cedrela toona* (*tun*), *Ceriops roxburghiana* (*goran*), *Cinnamomum tamala* (*dālcini*), *Crocus sativus* (*keśar*), *Curcuma amada* (*ām-haldi*), *Curcuma longa* (*haldi*), *Curcuma zedoria* (*kacorā*), *Datisca cannabina* (*akalbir*), *Diospyros embryopteris* (*makar-ṭendi*), *Emblica officinalis* (*avala*), *Eugenia jambolana* (*jāmun*), *Garrcinia morella* (*tamāl*), *Glycyrrhiza glabra* (*mulhatti*), *Hedychium spicatum* (*kāeri*), *Indigofera tinctoria* (*nīl*), *Lawsonia alba* (*mehendi*), *Mallotus philippinensis* (*kamela*), *Mangifera indica* (*ām*), *Memecylon edule* (*añjan*), *Morinda citrifolia* (*al*), *Myrica nagi* (*kaiphal*), *Nyctanthes arbor-tristis* (*harśiñghar*), *Ochrocarpus longifolius* (*suriñgi*), *Oldenlandia umbellata* (*cherivelu*), *Pterocarpus marsupium* (*bija*), *Pistacia integerrima* (*kākar-siñgi*), *Punica granatum* (*ānār*), *Quercus infectoria* (*majuphal*), *Ricinus communis* (*araṇḍi*), *Rubia cordifolia* (*manjit*), *Shorea robusta* (*śāl*), *Symplocos sumuntia* (*lodh*), *Tageteserecta* (*genda*), *Tamarindus indica* (*imli*), *Tamarix gallica* (*jhāu*), *Tectona grandis* (*segun*), *Terminalia belerica* (*baherā*), *Terminalia Chebula* (*harra*), *Ventilago madraspatana* (*surabi*), *Woodfordia floribunda* (*dhau*), etc. .

Important dyes of animal origin were only two namely, *Coccus cacti* (cochineal) and *Coccus lacca* (lac). The most common mineral dyes were Red ochre (*hirmāji*) and Yellow ochre (rāmrāj). However, a few minerals like alum, lime, salt, iron sulphate, and crude natron in the form of *sajjikhār* and *papadkhār* were used as auxiliaries in dyeing.

In Table 5, salient features of some of the important dyes in vogue in India during 18-19th century have been listed.

TABLE 5

Salient features of some important 18-19*th Century Dyes*

Name Hindi (English)	Botanical Name	Remarks
1. *Nīl* (Indigo)	Indigofera tinctoria	Colouring matter—indigotin in leaves; used in dyeing cotton, silk and wool; the fast colour because of the insolubility of indigo blue in water, acid or alkali.
2. *Kusum* (Safflower)	Carthamus tinctorius	Colouring matter carthamine ($C_{16}H_{16}O_7$) and a yellow material ($C_{24}H_{30}O_{15}$) in flowers; dye extracted with alkali; used for dyeing cotton and silk.
3. *Naspal* (Pomegranate)	Punicagranatum	Flowers yield a fleeting red dye; rind of the fruit used as an auxiliary to other dyes.

TABLE 5—*Contd.*

Name Hindi (English)	Botanical Name	Remarks
4. *Harśiṅghar*	Nyctanthus arbor-tristis	Flowers yield a fleeting orange dye; colouring matter crocetin ($C_{34}H_{46}O_9$) dye extracted by boiling with water; alum or lime-juice used as mordants with it; used for dyeing cotton and silk.
5. *Al* (Morinda)	Morinda citrifolia	Colouring matter—alizarin contained in the roots; used for permanent red colour; myrobalans and alum used as mordants.
6. *Haldi* (Turmeric)	Curcuma longa	Colouring matter—curcumin ($C_{21}H_{20}O_6$) present in rhizomes; used in dyeing cotton, wool and silk yellow; used with or without mordants.
7. *Patańg* (Sappan)	Caesalpinia sappan	Colouring matter—brazilin ($C_{16}H_{14}O_5$) present in the wood; yields a red dye; for cotton, alum is the mordant used, whereas for wool a mixture of alum and cream of tartar is the mordant.
8. *Mañjith* (Madder)	Rubia cordifolia	Colouring matter—a mixture of purpurin ($C_{14}H_8O_5$) and munjistin ($C_6H_6O_3$) present in the roots; yields a red dye; used in dyeing cotton and silk.
9. *Lākh* (Lac)	Coccus Lacca	Colouring matter laccaic acid present in resinous material excreted by the insects; red dye soluble in water; used in dyeing silk.
10. *Dhak* (*Palāś*)	Butea frondosa	Colouring matter—butin ($C_{19}H_{12}O_5$) is contained in the flowers; gives fleeting yellow dye, used in dyeing cotton and wool.
11. *Laṭkan* (*Annotto*)	Bixa orellana	Pulp covering the seeds contains the colouring matter Bixin ($C_{25}H_{30}O_4$); yields bright orange dye; used for silk.
12. *Mehendi* (*Henna*)	Lawsonia alba	Colouring matter henna ($C_{10}H_6O_3$) present in the leaves; yields red dye; less used for dyeing fabrics.
13. (*Chay*)	Oldenlandia umbellata	Root is the colouring matter containing part; yields a red dye; used with mordant alum.
14. *Khair* (Catechu)	Acacia catechu	Heartwood yields a water insoluble dye; colouring matter present is catechin ($C_{15}H_{14}O_6.4H_2O$); used for colouring cotton and silk in maroon colour.
15. *Kirmaz* (Cochineal)	Coccus cacti	Colouring matter is carminic acid ($C_{22}H_{20}O_{13}$); obtained from dried female insects; yields permanent red colour to silk and wool; not used for dyeing cotton.
16. *Imli* (Tamarind)	Tamarindus indica	Infusion of the leaves yields a yellow dye; leaves, flowers and fruits are also used as mordants in dyeing.
17. *Harra* (Myrobalan)	Terminalia chebula	Rind of the fruit yields a grey dye; mostly used as a mordant with other dyes.
18. *Behara* (Myrobalan)	Terminalia belerica	Rind of fruit yields a brownish-yellow dye; used as a mordant.
19. *Lodh*	Symplocos racemosa	Bark yields a yellow dye; chiefly used as a mordant with Lac, Madder and Al dyes.
20. *Kamelā* (Indian *kamilā*)	Mallotus philippinensis	Fruit yields a yellow dye; used for dyeing silk.