REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

This chapter deals with the theoretical and the research aspects of natural dyes, the minor fibres and also the mordants used in the process of natural dyeing. A brief history of the natural dyes selected in this research has been given in the theoretical review and also the chemical nature of the dyes and fibres have been discussed here. The investigator visited and collected the literature from various libraries like ATIRA (Ahmedabad Textile Industry's Research Association) and Smt. Hansa Mehta library, T.K Gajjar library at the Faculty of Technology, Knowledge Management Centre at the National Institute of Design, Ahmedabad and the library at the Department of Clothing and Textiles, Faculty of Home Science, of The M.S.University of Baroda. Another important source of information was the internet.

The review of literature collected was categorized and discussed under the following subsections:

2.1 Theoretical review of the selected natural dyes:

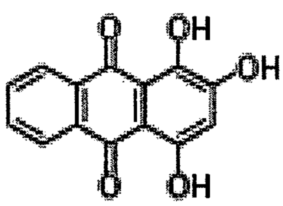
This subchapter discusses the classification and chemistry of natural dyes with respect to colour. The environmental aspects pertaining to the natural dyes are explored in this part. The selection of natural dyes was based on the colour it would yield.

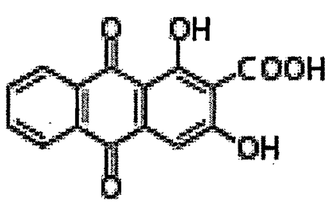
2.1.1 Red colour: Madder [(51)Sekar,N.]

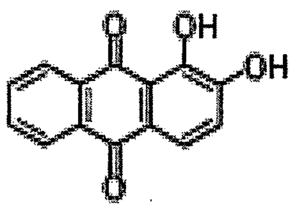
Class: Anthraquinone

Part used: Root

Common name: Manjistha, majith etc.







Purpurin **Munjistin** **Alizarin**

Figure 2.1.a: Madder plant

Figure 2.1.b: Madder roots

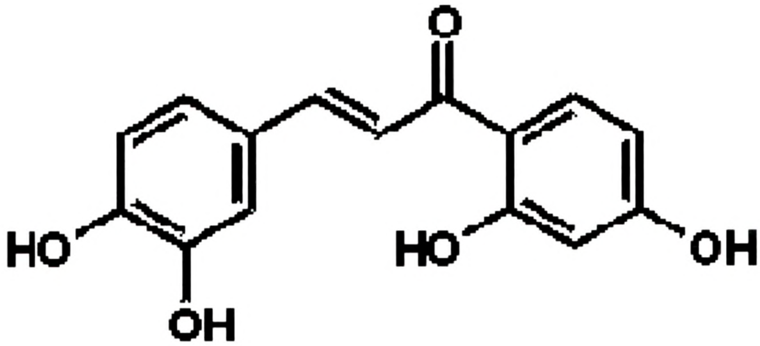
Chemistry:

This is a very common plant found in most parts of the world. The two main types of colour sources are: Indian Madder: Rubia cordifolia and English Madder: Rubia tinctorium. Normally, the dye is extracted from the roots of the plant. The root should be two to three years old. The main colouring constituents of majith are manjistin, alizarin and purpurin. They are present in the majith plant mostly in the form of glucoside/bioside-ruberythric acid. The majith roots also contain a mixture of substances, which are present probably as glucosides in comparatively large quantities (1%). The finely powdered root is extracted in water and the dye precipitated. This precipitates are dried at low temperature after collecting on a filter paper.

2.1.2 Yellow colour: Flame of forest[14]

Botanical name: Butea monosperma
Class: Flavonoid
Part used: Flower
Common names: Flame of the Forest, Dhak, Palas, Flame of forest, Parrot Tree, Dhak or Palas (Hindi); Porasum (Tamil); Khakda (Gujarati).
Origin: India

Flame of forest is a tree of barren appearance with twisted branches, adorned by rich flowering of brilliant orange-red flowers. The tree is a native to India and Malaysia. Butea Frondosa is named after the *Earl of Bute*, a patron of Botany and Frondosa, meaning "leafy". It is a native of India but is not found in the driest parts, being most common in Central India and the Western Ghats. That the flowers contain much nectar is evidenced by the frequent visits of many species of birds; sunbirds, mynahs and babblers are usually to be seen, hurrying from flower to flower, chattering and twittering.



Butein

(78)

Source :(78)http://www.gsfdcltd.co.in/gallery.html

Figure 2.2.a: Flame of forest Flower on tree **Figure 2.2.b: Dried Flame of forest flowers**

From an infusion of the flowers a brilliant colouring matter can be obtained, which may be made into water-paint or into a dye. Cotton, prepared with alum, can be dyed a bright yellow or orange.

Chemistry:

The colouring component of Flame of forest dye is Butin, which is chemically 7,3,4-trihydroxy flavonone ($C_{15}H_{12}O_5$) found as colourless needles of M.P. 224-226°C. It is found as the glycoside butin ($C_{27}H_{32}O_{15}$) in the flowers. Butin is converted into the chalcones butein on boiling with alkali during dyeing. A yield of 2% of Butein is obtained by extracting the flowers with boiling water and hydrolyzing the glycosides.

Extraction:

The flowers are digested for six hours with boiling water and the extract is treated with a little sulphuric acid (5ml for 1000 gm of flowers). These are again heated for one hour. A light, viscous precipitate, devoid of dyeing property separates out and is removed while hot. The filtrate is kept overnight and the clear liquid is decanted from a small quantity of tarry substance and gently evaporated for 3 hours in the water bath. A further quantity of black, viscous product is deposited. When this has been removed, the filtrate deposits crystals after some days. The solution is treated with very little boiling water, which on cooling forms crystals. Butin dissolves in cold alkaline solution and when the solution is boiled in potassium hydroxide, the colour darkens. Acid is added to this solution and bright orange crystalline particles precipitate out immediately. These are collected and washed with boiling water to yield butein. A yield of 2% of butein is obtained by this method of extraction.[(68)]

2.1.3. Brown colour: Cutch [(24)]

Botanical name: Acacia catechu

Class: Flavonoid

Part used: Wood

Common name: acacia catechu, kattha, catechu etc

(72)

Figure 2.3.a: Acacia catechu

Figure 2.3.b: Catechu wood

Chemistry:

The main colouring pigment found in Cutch is catechin. With different mordants it produces yellow to black shades.

Extraction:

The trees are regarded as mature when about a foot in diameter. The bark and the outer sapwood are generally removed and rejected; the heart wood is then cut into chips. There are two methods of extraction; ether and water extraction: the water extraction method was followed for economy and also because most textile wet processing is done with water as a medium.

To the dried and ground cutch, cold water is added. The solution is filtered, the residue is re-dissolved in hot water and charcoal is added. The solution is boiled and is filtered hot. The filtrate is cooled and utilized for dyeing.

2.1.4. Red orange to brown colour: Henna [24]

Botanical name: Lawsonia inermis

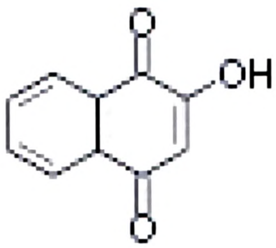
Class: Quinones

Part used: Leaves

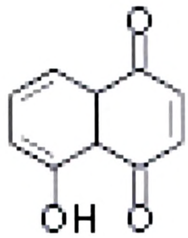
Common name: Henna, Heena etc.

Chemistry:

Lawsone or isojuglone is an orangey red napthaquinone accounting for 1 – 1.5% of the dry leaf weight. It derives from the hydrolysis of primary glycosides, henosides, duing the drying process and from the oxidation of the aglycone thus released. There are also a number of yellow flavonoid colorants in the leaves and tannins and these act as organic mordants as well as contributing to the final colour. It is interesting to compare the compositin of these leaves with those of walnuts.



Lawsone



Juglone

Extraction:

Dried leaf powder was soaked for 30 minutes; it was then extracted at boil for 30 minutes with occasional addition of distilled water. It was then removed form the flame and allowed to cool and settle and the filtrate was taken for dyeing.

Figure 2.4.a Henna plant

(74)

Figure 2.4.b: Henna powder

2.1.5. Yellow to Olive green: Marigold flower petals [24]

Botanical name: Tagetes petula

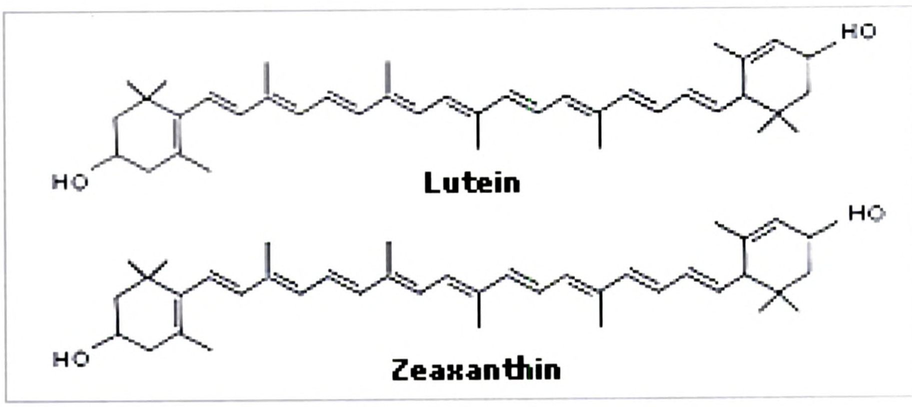
Part used: Flower petals

Common name: Galgota, Genda, etc

Chemistry:

Lutein is abundantly found in marigold flower petals.

1. It is an antioxidant; hence it readily reacts with metal mordants to quench free radicals.
2. It filters highly damaging near-to-blue ultraviolet light spectrum and hence it protects eyes and skin form harmful damage.



(74)

Figure 2.5.a: Marigold flower **Figure 2.5.b: Marigold petals**

Extraction:

The flowers are first allowed to shade dry. The topmost orange florets are cut leaving the black basal segments inside the calyx of the flower. Hence only the orange florets are taken. These are then again allowed to dry completely; the petals are soaked overnight. The solution is boiled for 30 minutes the next day; it is allowed to cool to room temperature and filtered. The filtrates are a pale/muddy yellow liquid; which is used for dyeing.

2.1.6. Grey colour: Ratanjot [24]

Botanical name: Onosma echioides

Part used: plant wood

Common name: Ratanjot, jungle erando

Figure 2.6.a:Ratanjot Stems

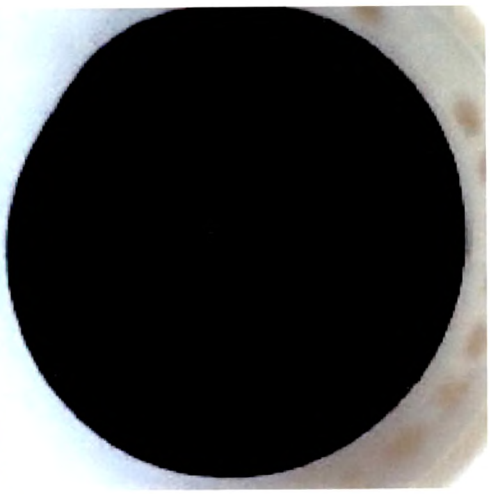


Figure 2.6.b: Ratanjot powder

Source:http://www.gsfdcltd.co.in/gallery.html(78)

Extraction:

The bark and the fleshy portion of the plants' woody stem are taken and the heartwood is rejected. The bark appears purplish black. The crushed bark is soaked for 30 minutes and then extracted for 30 minutes at boil. Solution is filtered and the extract is used for dyeing.

2.1.2:Minor fibres:

By definition minor fibres in textiles mean those fibres that are limited in production and also not available on the economies of scale of a mass market. The fibres have a limited production and application. This research aimed to utilize the exclusivity factor of these minor fibres and also diversify the form of their usage in order to add value and make them applicable for niche market consumption. Cellulose and protein minor fibre categories were selected. Each category had two fibres each; they were: Jute fabric and sisal fibre in the cellulose minor fibre category and Eri silk and Kutch goat wool in the protein fibre category. A detailed description of the fibres used for the study is given below.

2.1.2.1: Jute fibres:

(81)

Figure 2.6.a: Jute Plant **Figure 2.6.b: Extracted Jute Fibre**

Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced from plants in the genus *Corchorus*, family Malvaceae. Jute is one of the cheapest natural fibers, and is second only to cotton in amount produced and variety of uses. Jute fibres are composed primarily of the plant materials, cellulose (major component of plant fibre) and lignin (major components wood fibre). It is thus a ligno-cellulose fibre that is partially a textile fibre and partially wood. It falls into the bast fibre category (fibre collected from bast or skin of the plant) along with kenaf, industrial hemp, flax (linen), ramie, etc. The industrial term for jute fibre is raw jute. The fibres are off-white to brown, and 1–4 meters (3–12 feet) long.[46] When people thought of jute, they invariably conjured up images of hessian sack, shopping bags and coarse door mats. For centuries that had been the extent of the golden fibre's utility. The Indian jute sector comprises organized jute industry as well as a large number of cottage units. The products carried out of these units reflect the traditional excellence of Indian craftsmen. These are not only aesthetically pleasing but also possess immense value. Nowadays both modern jute mills and traditional handlooms spin out high quality yarns and weave light-weight fine textured fabrics of perfect structure in exotic colours and designs to match with the needs of apparel professionals. Though jute can be spun on miniature spinning system, handloom is ideally suited to produce jute fabrics.

Jute, sisal, banana and coir (coconut fibre), the major source of natural fibres, are grown in many parts of India. Some of them have aspect ratios (ratio of length to diameter) > 1000 and can be woven easily. Sisal and banana fibres are cellulose-rich (> 65%) and show tensile strength, modulus and failure strain comparable with other cellulose-rich fibres like jute and flax whereas the lignin-rich (> 40%) coir fibre is relatively weak and possess high failure strain.

During 2004-2005, jute exports were US$ 0.276 billion, recording a growth of 14% as compared to period of 2003-04. During 2005-2006 the Jute exports have amounted to US$ 0.295 billion, recording an increase of 6.64% over the exports during the corresponding period of 2004-2005. During the first quarter of 2006-2007 the Jute exports have amounted to US$ 0.065 billion, recording a decline of 7.79% over the exports during the corresponding period of 2005-2006. [84]

2.1.2.2: Sisal fibre in India:

(82)

Figure 2.8.a: Sisal Plantation in India **Figure 2.8.b: Sisal Harvesting**

The Portuguese introduced agave in India in the 15^{th} century. They are now found throughout the country. The major species of agave available in India are *A.sislana, A.mexicana, A.americana, A.cantala, and A.veracruz.* Among the agaves, the most prevalent is *Agave sislana*, commonly known as sisal. Sisal occupies 6^{th} place among fibre plants, representing 2% of the world's production of plant fibres (Rehm and Espig, 1991).[49]Sisal is a leaf fibre mainly grown in India in arid and semi-arid regions of Andhra Pradesh, Bihar, Orissa, Karnataka, Maharashtra, Chhattisgarh and West Bengal. It can be grown on undulated lands and almost all types of soils except clay and waterlogged soils. It provides working opportunities during off-season in remote tribal areas. The marginal and dry land giving less than Rs. 2500/- profit per hectare annually can safely be brought under sisal cultivation. [74]

Sisal is a perennial hardy plant which unlike the other fibres is not seasonal crop. It can establish and easily grow in all states of India covering sub humid to arid and semiarid regions, which cover major parts of India. It can also survive in almost all soil types and its input costs are least for its survival, regeneration and maintenance on sustainable basis. Sisal tolerates prolonged droughts and high temperatures also. It yields parallel hard fibres.

The sisal plant has a stalk on which the succulent leaves are arranged spirally. Its dimensions are about 1 to 2 meter in height, with a diameter of approximately 20 cm. The lance shaped leaves growing out from the stalk in a dense rosette, are flesh and rigid, with dark green colour. Each is 0.8 to 1.5 m long, 7 to 8 cm wide at the base, and 10 to 15 cm across at the widest portion, terminating in a sharp spine. Cutting usually starts after 2.5 years when the plant has about 100 leaves. The plant matures fully in 4 to 8 years after planting. [54]

The average yield of sisal in our country is very poor, due to absence of proper care and attention. In a life cycle sisal plant produces 210-230 leaves. The dried fibre represents only 4% of the total weight of the leaf. Dry fibre yield of sisal plant varies between 2.5 to 4.0 ton/ha depending upon the plant population and management practices. [76]

In India, sisal is not cultivated and the sector is unorganized, however considering the employment and income generation potential, the District Rural Development Agency (DRDA), Koraput, Orissa implemented an integrated "Sisal plantation, Fiber extraction and Rope making" programme under Jawahar Rojgar Yojana (JRY) in the year 1995 (47). Sisal is currently found on embankments, bunds and roadside, serving the purpose of soil conservation and protection as hedge plantation. Presently sisal fibres are collected and utilized for conventional purposes like ropes, anchors, cordage and handicrafts. They are not optimally utilized and commercially exploited with respect to their abundant availability, superior characteristics/quality and wide applicability. (39)

A high yielding sisal hybrid (Leela) was developed at Sisal Research Station, NIRJAFT (ICAR), Bamra in 1985 which has a yield potential up to 25q/ha. (76)

Global production of sisal fibre in 2007 amounted to 240 thousand tonnes of which Brazil, the largest producing country, produced 113,000 tonnes.(85)

Tanzania produced approximately 37,000 tons, Kenya produced 27,600 tonnes, Venezuela 10,500 tonnes and 9,000 tonnes were produced in Madagascar. China contributed 40,000 tons with smaller amounts coming from South Africa, Mozambique, Haiti, and Cuba. Sisal occupies 6th place among fiber plants, representing 2% of the world's production of plant fibers (plant fibers provide 65% of the world's fibers). (85)

As one of the world's important natural fibres, sisal is covered by activities of the International Year of Natural Fibres 2009. (85)

2.1.2.3: Eri Silk:

(79)

Figure 2.9.a: Eri silk worm   Figure 2.9.b: Eri Silk Moth

Samia cynthia ricini (Lepidoptera:Saturniidae), is the scientific name of the Indian eri silkworm. This variety of silk worm feeds on castor leaves which are commonly called as endi, endudu, erandi etc, and hence the silk derives its name from the feed plant and is called eri silk. This silk worm contributes significantly to the production of commercial silk and is widely distributed in the Brahmaputra river valley in North-Eastern India. [(79)]Populations of *S. cynthia ricini*, that have been commercially exploited and are present in different regions of north-east India had a wide variation in morphological and quantitative characters such as absolute silk content, larval weight, cocoon weight, cocoon shell weight and silk ratio [(60)]. These populations were named as Nongpoh, Kokrajhar Red, Borduar, Titabar, Sille, Dhanubhanga, Mendipathar and Khanapara, after their place of collection. The eri silk for this research purpose was collected form the Nongpoh district of Shillong.

The use of *muga* and *eri* silk is quite closely associated with the culture and tradition of the Assamese society and occupies a unique place in the socio- economic life of the people of Assam. *Eri* culture is mostly predominant among sericulture in Assam and *muga* culture is unique and confined particularly to the Brahmaputra valley and neighbouring States. *Eri* culture is practiced not only for the fabric but also for the protein rich pupae for consumption of people as a delicacy. The *eri* silk has special thermal properties, which supplement the requirements of warm clothing to some extent. The art of weaving is a cultural activity among the women folk of Assam. Sericulture has provided the best ground for removal of under-employment and unemployment. Assam accounts for highest production of non- mulberry silk, *muga* and *eri*. The State alone contributes 99 per cent and 63 per cent of the total *muga* and *eri* raw silk production in the country. Raw silk production figures in the country from the year 2000-2006 are as follows: [73]

Table ૨.૧ India-Raw Silk production (MT) during 2000-01 to 2005-06

Year	Mulberry	Non-mulberry				Total silk
		Tasar	Eri	Muga	total	
2000-01	14432	237	1089	99	1425	15857
2001-02	15842	249	1160	100	1509	17351
2002-03	14617	284	1316	102	1702	16319
2003-04	13970	315	1352	105	1772	15742
2004-05	14620	322	1448	110	1880	16500
2005-06	15445	308	1442	110	1860	17305

૨.૧.૨.૪ : Kutch Goat Wool: [77]

History

The domestication of animals was carried out during Neolithic times along with the cultivation of cereals. First goats and sheep, second cattle and pigs, and finally draft animals such as horses and asses were domesticated.

The goat was the earliest ruminant to be domesticated. The Harappa toys contain representations of a goat. Two seals from Mohan-jo-daro show a wild bezoars' goat with enormous curled horns, and a bearded domestic male goat with side-spreading horns. The Gaddi goat, which greatly resembles the ancestral wild goat, was used as a beast of burden in the mountains and is still used in the Himalayan region of India for carrying salt and food grains. Sheep and goats are important species of livestock for India. They contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of small and marginal farmers and landless labourers.

Sheep and goat may look similar but the goat holds the tail up while the sheep hangs it down. While sheep have fleece, goats have hair. Studies by the Food and Agriculture Organization of the United Nations show that India has vast genetic resources of sheep and goats. There are as many as 40 breeds of sheep and 20 breeds of goats. Most of these breeds are from ancestral stock found in Afghanistan, Baluchistan and the Sind region. Hence, it is not surprising to know that one of the important breeds of Indian sheep and goat are found in Gujarat and specifically in the Kutch. The Patanwadi sheep and the Kutchi goat are the two breeds that yield wool in the Kutch region. (4)

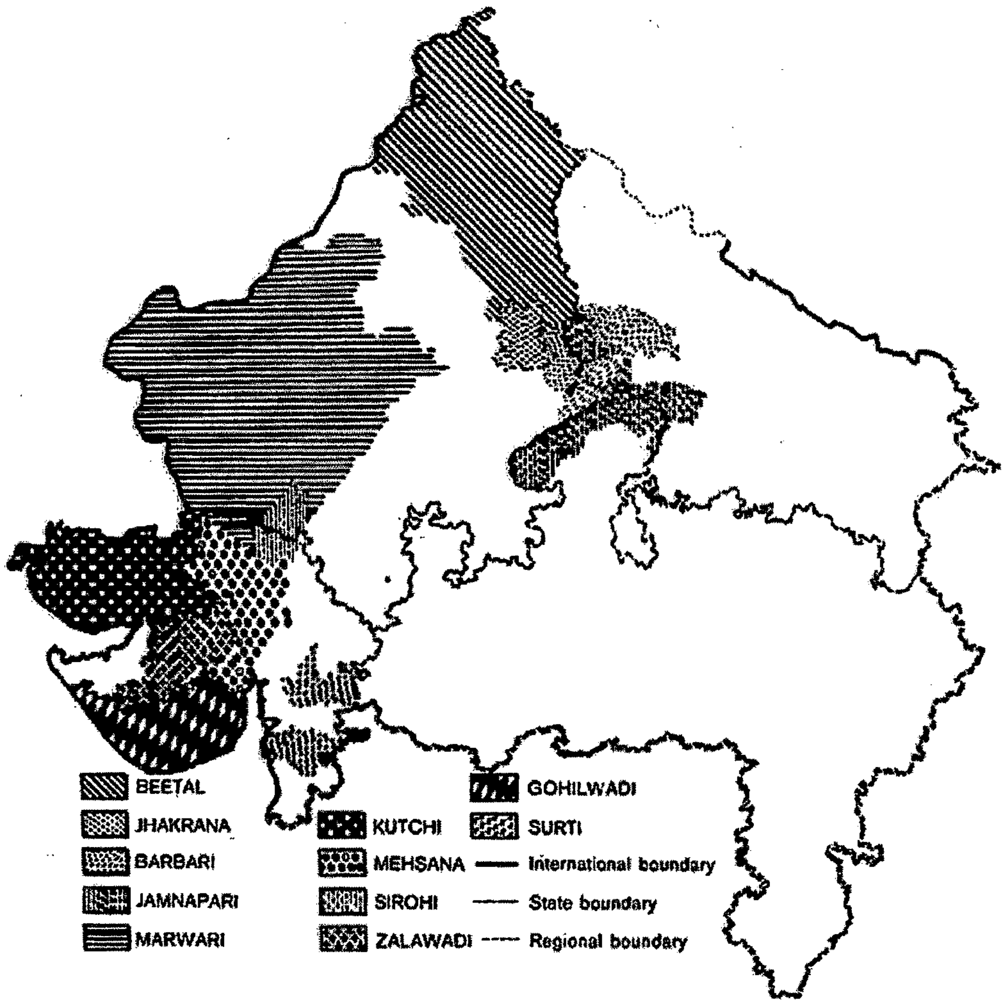


Figure 2.10: A map of Goat breeds in the Northwestern arid and Semi-arid regions

Most of the breeds of sheep and goats in India have evolved naturally through adaptation to agro-ecological conditions; to a limited extent there has been artificial selection for specific needs. These breeds have generally been named after their place of origin or on the basis of prominent characteristics. Most of the breeds of sheep and goats are very well adapted to the harsh climate, long migration, and lack of vegetation and drinking water. A large proportion of sheep and goats (more particularly the latter) are of nondescript or mixed breeds. [4]

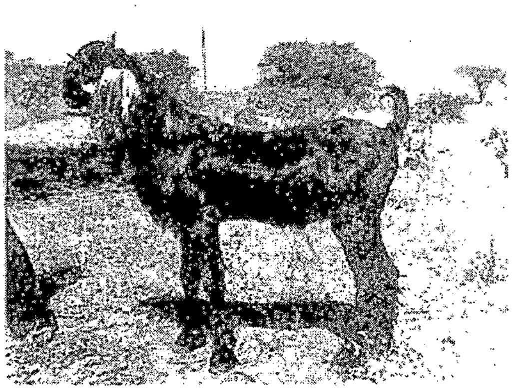


Figure 2.11.a: Adult male Patanwadi Goat

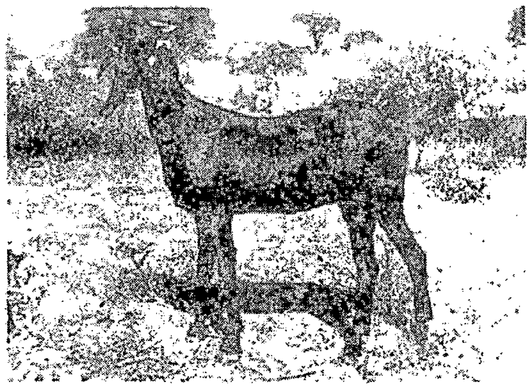
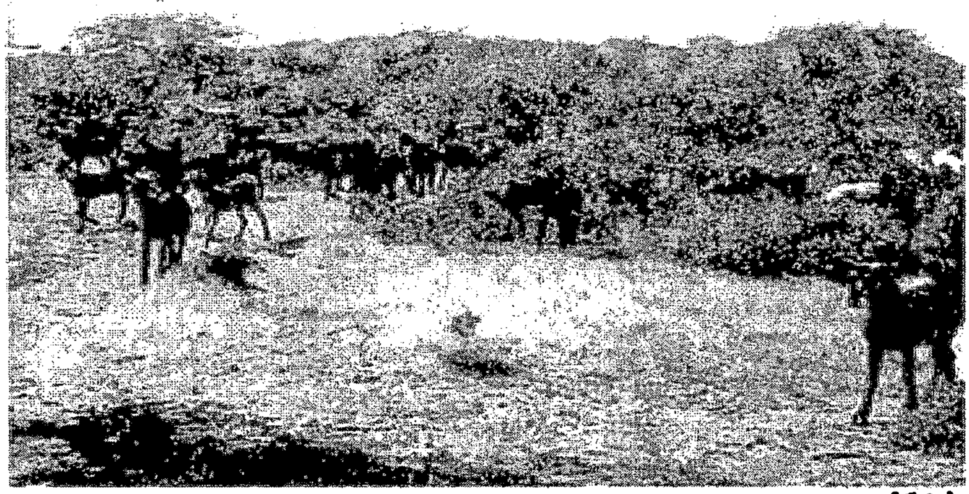


Figure 2.11.b: Adult female Patanwadi Goat



(34)

Figure 2.11.c: The Flock of Patanwadi Goats

Demographic details of the Kutchi Goat:

a) Distribution. Kutch district in Gujarat.

b) Numbers. The total goat population in the Kutch district, according to the 1972 census, was 0.402 m, of which 0.018 m adult males and 0.298 m adult females.

c) Conformation. Large animals; the coat is predominantly black, but a few white, brown and spotted animals are also found. The hair is coarse and long. The nose is slightly Roman. The ears are long, broad and drooping; ear length: 22.0 ± 0.26 cm *(199)*. Both sexes have short, thick horns, pointed upward; horn length: 10.6 ± 0.19 cm *(198)*. The udder is reasonably well developed; teats are conical. [(59)].

d) Flock structure. The average flock contains 83.3 ± 14.5 *(24)* individuals (range: 30 to 300), of which 2.4 adult males, 70.3 adult females and 10.6 young.

e) Hair. Average yield per clip: 229.3 ± 23.9 g *(20)*. The annual hair yield may be taken to be approximately twice this figure, since the animals are shorn twice a year.

2.1.3 : Natural mordants used in the study:

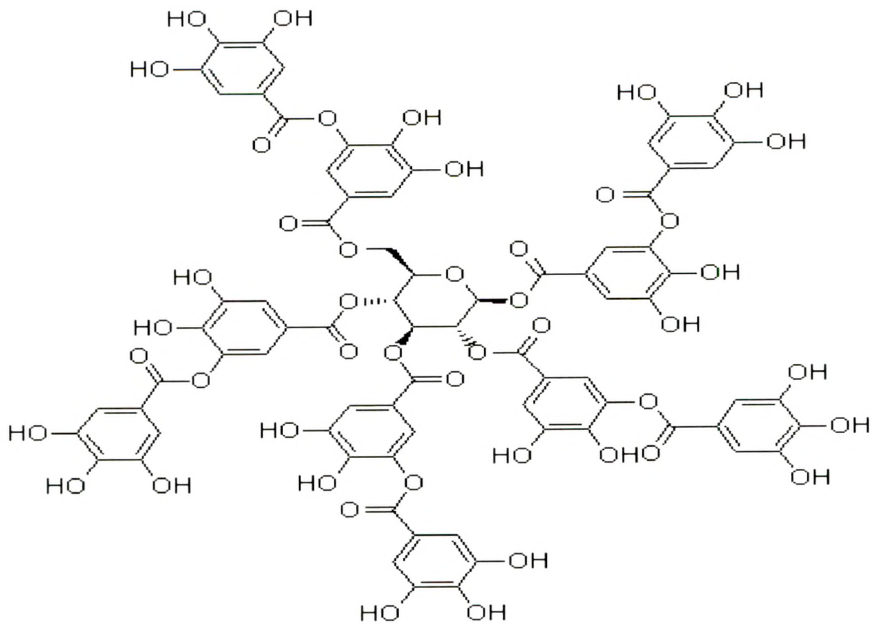
Tannins are high molecular weight plant polyphenols divided into two chemically and biologically distinct groups: condensed tannins or proanthocyanidins (e.g.) from tea, grapes, cranberries etc,) and hydrolysable tannins or ellagitannins (ETs) (e.g. from raspberries, strawberries, pomegranates etc.) and gallotannins (GTs from chebulic and bellurubic myrobolans). Tannins gained original popularity in the commercial 'tanning' industry where animal hides were converted into leather by using plant extracts but have attracted much attention due to their numerous biological activities and implications in potential benefits to human health.

2.1.3.1 : Natural mordant: Myrobolan

Botanical name: Terminalia chebula

Common name: Harda, Harde, Himaj, etc.

Chemistry: Chebulic myrobolan is rich in gallic acid and also has an abundant presence of tannic acid. The gallic acid readily combines with the tannic acid and hence the product that is obtained when an extract of myrobolan is used is a gallo-tannic acid. This tannic acid is readily soluble in water and hence has easy penetration into the fibre structure. Hence, it is used as a pretreatment for providing sites for the metal mordants and further for the dye group to anchor on to it. Moreover, the tannins react with protein fibres to form covalent bonds hence it is very useful for dyeing of protein fibres like wool and silk.



Gallo-tannic acid

(77)

Figure 2.12.a: Myrobolan plant

Figure 2.12.b: Dried Myrobolan fruit

2.1.3.2 : Natural mordant: Pomegranate rind

Botanical name: Punica granatum

Common name: Dadam, anar etc.

Chemistry: Pomegranate (*Punica granatum* L.) fruits are widely consumed fresh and in processed forms as juice, jams and wine. Pomegranate fruit husk/peel is a rich source of hydrolyzable tannins called ellagitannins. In the commercial pomegranate juice industry, these ellagitannins are extracted from the husk in significant quantities into the juice due to their hydrophilic properties. Pomegranate husk, a by-product of the pomegranate juice industry, is therefore an inexpensive and abundant source of ellagitannins.

(77)

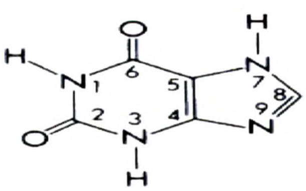
Figure 2.13.a: Pomegranate fruit **Figure 2.13.b: Dried pomegranate rind**

2.1.3.3. Natural mordant: Tea leaves

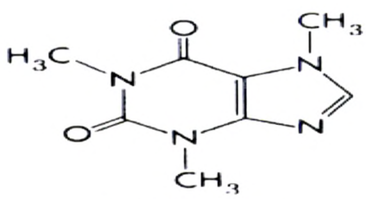
Botanical name: Thea sinensis

Common name: Tea, chai etc.

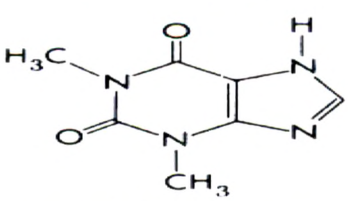
Chemistry:



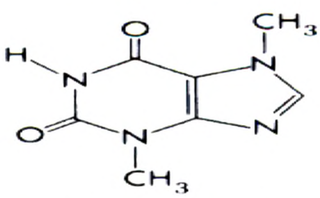
XANTHINE



CAFFEINE



THEOPHYLLINE



THEOBROMINE

Figure 2.14.a: Tea plant

(77)

Figure 2.14.b: Dry tea powder

2.2. RESEARCH REVIEW:

According to a study by the Uttar Pradesh Industrial Cooperative Society, (UPICO), Kanpur, growth in the use of natural dyes in India, was felt in the carpet and woolen clothes sector followed by silk saris.

Domestic demand is stagnant. According to Farooqi, "Clothes dyed with natural colours are costlier by 25-35 percent. Indians cannot afford it but Europeans can. Therefore, natural dyes are not going to take the country by storm, but the export market will surely grow. In the next five years, Europe and U.S. will buy in a major way."

The Paper found that TUFS has been mainly responsible for this new phenomenon as with increased financial assistance to textile industry in the last couple of years, its fruits have now started reaping, added Mr. Dhoot. Therefore, **ASSOCHAM** (The Associated Chambers of Commerce and Industry of India) is optimistic that Indian textile exports and investments will multiply manifold as financial assistance to textile industry is leading to technological infusion in most of the textile units which are revamping themselves to take on the global challenges. Current trends show that India does not lag behind China in International markets as it is observed that our textile units have been performing well in the international markets particularly after August 2006 onwards.

Endowed with inherent advantages of an assured supply of raw materials and human skills, the Indian textile industry is undergoing radical changes with a view to upgrading its technology at par with the world. Investments in the core sector and ongoing modernization process have helped the industry to become competitive in the international market.

Our survey found that an increasing number of units are entering value additions to meet the needs of the global market.ASSOCHAM strongly believes that the government' Vision 2010 for textiles to increase India's share in world's textile trade from the current 4 per cent to 8 per cent and to achieve export value of US $50 billion may come true. We believe that there is much potential in the Indian textile industry. The Associated Chambers of Commerce and Industry of India [83]

"Commercialisation of natural dyes can be successful only with a systematic and scientific approach to extraction, purification and promotion of use of natural dyes," P. Vankar said. In India, consumer demand is restricted by pricing, shade availability and colour fastness. "The need of the hour is certification from the government that our clothes are coloured with vegetable dyes," suggests Prabha Nagarajan from Indigo India, a Chennai-based organisation.

Value addition of khadi silk fabric by natural dyes was studied by **Nagrani, J. (2007).** Premordanted khadi silk fabric was block printed and dyed with madder or turmeric. Metal mordants were used for mordanting. A variety of 48 shades was produced and *krutis* were designed using these shades, to evaluate the market of these products.[40]

Sarkar, D., Mazmudar, K., Datta, S. and Sinha, D. (2005) studied the application of natural dyes from marigold flowers on cotton, silk and wool. The explored the possibility of effective utilization of Marigold flower for producing different shades on cotton, silk and wool substrate, optimization of extraction time and amount of flower required to produce a particular shade as well as colour fastness properties of different textiles dyed with different varieties of Marigold (Tagetes patula) using different mordants. Three vaieties of marigold flowers viz., golden yellow, lime yellow and maroon-yellow varieties were used for the study. Premordanting method was used to prepare all the fabrics for dyeing and 8 different metal mordants were used at 10 percent concentration. Dyeing was carried out for 60 minutes, at 80oC and material liquor ration maintained at 1:30. It was observed that all the three varieties produced substantive dye that was fit for dyeing cotton wool and silk substrate. Different shades produced were measured in terms of L*, a*, b*, values on a double beam spectrophotometer. The dyes had fair to moderate fastness to washing and light on cotton substrate and had satisfactory to good fastness to light on silk and wool fabrics.[53]

Agrawal, M., et.al. (2004), studied the role of pH is very important in dye extraction as it affects the colour. The visual evaluation of printed samples using different extraction pH is presented. It was observed that extraction of dye increased with increasing pH up to 8 and then decreased. Hence, pH 8 was selected as optimum extraction pH. The results indicated that slightly alkaline pH was best for extraction.[3]

Doke,S.S., Sarkar,M.K., (2004), studied Sunhemp referred as San Pat in ancient Indian Culture is a vegetable fibre derived from the bark of the leguminous plant *Crotalaria juncea.* The genus crotalaria is a large one with 200 or more species distributed throughout the world and many of them utilized as green manure or fodder crop. The *C.juncea* is grown for fibre purpose in tropical and subtropical areas of Asia. In India it is cultivated in about 150 districts covering almost all the states of India. It is similar to true hemp fibre of species *Cannabis sativa,* which is nowadays promoted by western countries specially EEC countries and U.S.A. being biodegradable and eco-friendly. The important characteristic of Sunhemp fibre are its high tensile strength and yellow to dark brown depending upon retting conditions and considerable heat and fibre resistance. Cultivation of it is reducing as the fibre has been neglected completely by textile industry to find out its possible applications and at the same time demand for ropes is diminishing because of the availability of nylon ropes. Similar jute fibre is used in different applications and nowadays promoted by the Governemnt and UNDP.[17]

Attempts has been made by the authors to observe whether sun hemp fibre can be spun in jute machinery on 100% and on blends with jute/man made fibres in different proportions. The results indicate a clear picture about the future of the fibre for different end uses. The study was conducted to promote sun hemp fibre in the field of packaging and other end-uses. To meet the objective series of trials were conducted at IJIRA Pilot Plant using following sequence of machinery. The fibre was brought from Maharashtra. As hemp fibre is analogous in character of jute it is hoped that it requires same batching treatment followed by carding etc. for the purpose Jute Batching Oil (JBO) was used in emulsion. Major role of oil is to retain water as it is added during emulsification. Water softens the fibre and increases extensibility and both the factors prevent the excessive fibre breakage at the card making it easier to blend round the pins and rollers. The exact nature of the part played by the oil is not fully understood but it gives cohesion to the fibres.

Singh, J., Yadav S.S. et.al. (2003), studied the effect of mordanting method on dye absorption of *Rein wardtia trigyana* flowers and Neem leaves and it was found that with alum mordant, simultaneous mordanting method for Rein Wardtia flowers and premordanting method for Neem leaves while with chrome mordant premordanting method for Rein wardtia flowers and simultaneous mordanting for Neem leaves and with $CuSO4$, and $FeSO4$ mordant, premordanting method for both dyes gave best results.(61)

Pure woollen yarn was used for dyeing. Scouring of woollen yarn was done for removal of natural and added impurities. Dyeing was carried out at 7 and 8% dye material concentration, 15 and 30 minutes extraction time and 30 and 45 minutes dyeing time at pH 4 for Rein Wardtia flowers and Neem leaves respectively. To optimize mordanting method dyeing was carried out with four mordants namely potassium aluminium sulphate (alum), potassium dichromate (chrome), copper sulphate and ferrous sulphate with three concentrations (1.3 and 5% for chrome, copper sulphate and ferrous sulphate and 3,6 and 9%for alum) of each mordant (per 100 gm. of yarn). *Rein wardtia* flowers with alum mordant simultaneous mordanting method and with other three mordants (Chrome, $CuSO4$, and $FeSO4$) premordanting gave best results. Whereas in case of *Neem* leaves with alum, $CuSO4$, and $FeSO4$ mordants premordanting method and with chrome mordant, simultaneous mordanting method gave best results.

Dyeing conditions such as the concentration of the dye, the extraction time, the dyeing time, concentration of the mordants and the method of mordanting for Australian merino wool fiber with madder were studied by **Agarwal, S. and Gupta, K. C. (2003)**. The study indicated that 5 gm per 100ml of water gives maximum optical density of the dy liquor indicating the optimum concentration of the dye while 120 minutes of extraction time and 90 minutes of dyeing were found to be optimum. Different methods of mordanting produced a good range of colours out of these the simultaneous mordanting method gave the best results, by visual evaluation.(2)

Fastness properties of pretreated and mordanted vegetable dyed fabrics to light and washing were studied by **Arora, G. (2003)**. Six vegetable dyes namely Turmeric, Madder, Acacia Catechu, Pomegranate, Flame of forest and Ratanjot were used for dyeing cambric, seri silk and wool. The results indicated that an increase in colour yield by the use of sodium hydroxide and cellulose enzyme. With different dyed pretreatments and mordanting showed that madder had good light and wash fastness in all the three substrates, followed by Ratanjot and Acacia Catechu. (7)

The change in colour parameters (L*,a*,b*,) of three natural fabrics dyed with two natural red dyes, e.g. madder and cochineal were investigated by **Micheal M.N. et.al. (2003)** using a series of different mordanted samples to artificial day-light were calculated. The results indicate that, the characteristic nature of the substrate, chemical structure of the dye and type of mordant used greatly affect on colour parameters and colour for the same dye on the same substrate when varying the mordants. Thus, this type of information and data obtained could be of value in predicting the original colour of the ancient textiles. The results revealed that almost all red dyes have a basic quinine structure (a*,b*). The study also points out that different mordants give different values of colour parameters (L*,a*,b*) and different colour difference (ΔE) for the same dye on the same substrate, where copper and iron decrease the L* value i .e. darken and dull the colour and lower (a* and b*) values making the colour brownish, while stannous chloride and alum increase values, i.e. brighten the colour and increase in a and b values making the colour pink to orange. In considering the change in colour difference (ΔE) after exposing the dyed mordanted samples to artificial day light, the results indicate that wool$<$silk$<$cotton, besides, samples dyed with cochineal having lower (ΔE) than their corresponding dyed with madder.(36)

A study by **Wang Jinhua and Ramaswamy, G., (2003)** states the importance of bast fibers because they are biodegradable and possess other eco friendly characteristics. In this study, chelators, including ethylenediamine tetra acetic acid (EDTA) and citric acid (CA); surfactants, including phosphate ester (Silvatol), alkylarylsulfonates bleaching enhancers, including sodium pyrophosphate, and sodium metasilicate, along with hydrogen peroxide bleaching are evaluated for their efficiency in processing mechanically separated kenaf fibres. Treatment conditions, such as processing temperature, are also used to study fiber chemical composition (syringyl and guaiacyl lignins) as affected by processing. The results indicate that the treatments can substantially remove lignin from bast fibers. The best whiteness and strength results are obtained with fibres processed with 5% sodium pyrophosphate + 5% Silvatol + 1.5% H_2O_2 at pH 10.5 and a temperature of 96 °C for 60 minutes.[71]

Sisal craft is practiced in:

Chamrajnagar:	Karnataka
Balod:	Chhatisgarh
Kolhupani:	Uttranchal
Ramnagar:	West Bengal
Bhopal:	Madhyapradesh, Tamilnadu
Bhalwal, Kathua, Ratnapur, Sarara:	Jammu and Kashmir http://www.rbh.in

In an experiment by **Sharma and Shahnawaz (2003)** shades of green and brown colour were obtained by the combination of Onion Skin (Allium cipa) and Kilmora root (Berberis aristata) dye. Ten grams dried and powdered onion skin was added to 100 ml water and extracted at 100 °C for one hour, cooled and filtered. 0.5 gms kilmora root powder was added to 100 ml water and extracted at 100 °C for one hour, cooled and filtered. [58]

25ml of onion dye solution was mixed with 25ml kilmora dye solution. Pre-soaked wool sample of one gm was added to this dye solution and kept in water bath for extraction at 70 °C for one hour. After 45 minutes of extraction, one gm sodium carbonate was added to the dye solution to increase the exhaustion of the dye. After one hour the sample was withdrawn from the dye bath, washed with cold water and dried in shade.

Simultaneous mordanting and dyeing was carried out at 70 °C for one hour. The material liquor was taken as 1:50 different concentrations of alum (0.1-0.5gms) and 0.2, 0.4, 0.6, 0.8, and 1 gm of ferrous sulphate, copper sulphate, potassium dichromate, tartaric acid and tannic acid were used to dye one gm wool by a combination of 25 ml onion and 25 ml kilmora dye solution.

The natural dye obtained by mixture of onion skin and kilmora root powder produced shades of green and brown colour on wool, along with different mordants. The colours obtained show good to excellent fastness to washing and fair to good fastness to light. The dye can be used to produce mid buff colour of wool along with one gram potassium dichromate. The colour has excellent fastness to washing and good fastness to light. The cost of the dye is very less as kitchen, waste onion skin is used and a very little amount (0.5 gm per 100 ml water) of kilmora dye is added.

Rose, (2002) studied optimum pH for extraction and reported that the best results were at alkaline pH for cotton fabric dyed with banyan leaves. Extracted dye solution was concentrated (100 ml reduced to 5 ml) to prepare printing paste. Guar paste was added to prevent the rapid diffusion of dyestuff through boundaries of design. The samples were printed with natural pH of guar paste (6.6) but best results were with 6 pH. Hence, slightly acidic pH of guar gum paste was best for printing and selected for further study. Hence it was concluded that natural dye extracted from mango bark used for dyeing can be employed for printing on cotton fabric. Colours obtained using different mordants were soft, pleasant, lustrous and natural with very good colour fastness to washing and excellent sunlight fastness. This printing paste can be effectively used for mass printing.

Another research conducted by **Tawfik, S. (2002)** indicated that the k/s depends on the nature of printed fabrics, the concentration of dye, type of fixation and to some extent the time elapsed before commencing printing. It was also revealed that the k/s increased as the concentration of the dye increased in the printing paste. The research also indicated that thermo fixation of the dyes in printed fabrics acquires higher k/s values than their corresponding samples of steam fixed fabrics. Another important observation was that pH plays an important role on k/s of the dyed fabric. In case of turmeric dye the highest k/s was obtained at pH 6.3, but an increase in pH to 11.9 was accompanied by a significant decrease in the value of k/s.[66]

Agarwal, et.al. (2001) designed a coordinated product range for a bed room using natural dyes on silk. A range of bed linen was designed from nylon, cotton, wool and silk using natural dye and block printing technique. Rhubab, Gall nut, Harda, Madder and Cutch were selected for the study. The selected colourway or combination was visually appealing with soft and subtle look, which was appreciated.

In a study by **Suri, M., Sethi,B., Bedi, D. and Anand, S. (2000)** silk fabric was dyed with Eco Rust Red, Eco Orange, Eco Mud Yellow, Eco Pale Yellow and Lac dyes were the dyes used for the study. All the samples were dyed with 10 percent concentration of all dyes. The study revealed that with the increase in concentration of the dyes the colour value increases if the concentration of the mordant is optimum. Also the chemical mordants can be substituted by the natural mordants to some extent to make the entire process more eco friendly. [65]

Oils: In a study conducted by **Singh,O.P. (2000)** it was enumerated that an oil mordant's function is to form a complex with alum used as the main mordant which is soluble in water and does not have affinity for cotton an easily washed out from the treated fabric. The oils contain fatty acids, such as palmitic, stearic, oleic, ricinolic, etc and their glycerides. The COOH group of the fatty acid react with metal salts and converts into COOM where M denotes the metal. Sulphonated oils have better metal binding capacity than the natural oils. Oils are generally used in dyeing of madder for Turkey red colour. [62]

Application of mordant:

The applicability of mordants on different fibres is discussed as following:

On cotton: Cotton has very low affinity for most of the natural dyes. Metallic mordants are also held loosely by cotton fibres and are soluble in water. Hence, these mordants have to be precipitated on the cotton fabric by converting them into insoluble form, or by first treating the cotton fabric with oil or tannic acid and subsequently impregnating the treated fabric with the solution of a mordant, whereby the metallic mordant is held onto cotton substrate via oil or tannic acid. Tannic acid is the best 'tannin' for mordanting of cotton since it does not contain any impurities and is the purest of all. Tannic acid is extensively used in dyeing of light and bright shades. A higher quantity of tannic acid is used for dark shades than that used for light shades.

On wool: Unlike cotton, wool is highly receptive towards natural dyes and mordants. On account of its amphoteric nature it can absorb acids and bases with equal effectiveness. When it is treated with a metallic salt it hydrolyses the latter into an acidic and basic component. The basic component is then absorbed at the sites – COOH and the acidic component is removed in the course of washing. For mordanting of wool, potassium dichromate is mostly used as it is comparatively easy to apply and cheap and gives full bright shades with fairly good fastness. Sometimes, additives are used to improve the fullness, brightness and rubbing fastness of shades. For example, tartaric acid can be used with potassium dichromate or aluminum sulphate. Sometimes, mordants are used in conjunction. For example, copper sulphate is used with aluminum sulphate and ferrous sulphate in dyeing of logwood blue and logwood black.

On Silk: Silk is also amphoteric like wool and can absorb both acids and bases. However, silk does not have thiol groups (-SH) of wool (present in cystine amino acids), which act as a reducing agent and reduce hexavalent chromium of potassium dichromate to trivalent form. The trivalent chromium forms a complex with the fibre and the dye. Hence, potassium dichromate cannot be effectively used as a mordant for silk as it lowers the luster and pliability of silk. Stannic chloride is the most important for mordanting of silk, which is also weighted by it, resulting in lowering of strength. Iron salts are also often used both for mordanting and weighting of silk, which give excellent black colours on tannic acid-treated silk.

Since natural dyes have low fastness to light and washing, one may surmise that they have a dismal future. But similar is the case with some synthetic dyes like rhodamine and phthalocyanine dyes, which have very bright magenta and turquoise shades respectively, but very poor washing fastness. Yet they are much used. Similarly, natural dyes can find much use in spite of poor fastness, especially if innovative methods of using hem are developed. For example, faded blue jeans dyed with indigo are a craze in casual wear due to poor rubbing fastness. Moreover, natural dyes' main drawback of poor light and washing fastness may be over come in future by research on optimization of their dyeing conditions and mordanting processes, new mordants and dyeing auxiliaries. Above all, with the ever-growing eco-consciousness the natural dyes, being very eco-friendly, can be harnessed to play a bigger role.

In the paper **Dedhia and Khanna,P., (1999)** deal with the dyeing of pineapple leaf fibres (PALF) with tow natural dyes using mordants and their various combinations. In the wake of ecological consciousness, eco-friendly products are today's major demand and hence a quest to find an alternative to synthetic dyes, and attempt was made to find out the effect of various mordants and their combinations and pretreatments with tannin compounds on the strength, percentage reflectance, light and wash fastness of PALF dyed with two natural dyes, namely – Ratanjot and Eucalyptus leaves. PALF is a multicellular lignocellulosic fibre, obtained from the leaves of the pineapple plant, Ananas comosus. Ratanjot (Onosma echoides) is a biennial plant which belongs to the family; Borginaceace. In general properties and colour reactions, the pigment resembles "Alakanet" from, Alkanna tinctoria. The bark and roots are used to obtain grey, purple and red colours. With different mordants the bark extract gives various shades of grey colour. Eucalyptus dye when applied with mordants produce bright and dark colours. Both leaves and barks can be used. The colouring principles of this dye are mainly tannins and other polyphenols. [15]

The raw PALF were put to scouring bath prepared with 3% NaOH using M:L ratio as 1:25 at boil for 3 hours, followed by bleaching with 2% H_2O_2 with M:L being 1:40 at room temperature for 1 hour. Tannin treatment was given with myrobolan and pomegranate rind respectively, followed by simultaneous mordanting and dyeing. The PALF dyed with Ratanjot gave a variety of shades like violet, purple, grey, black, greyish green and green; with different mordants and their combinations. All the dyed samples showed excellent wash fastness and no loss in depth. No staining on the adjacent white cotton fabric was observed. Regarding myrobolan and pomegranate rind treatment, no significant difference was observed and both exhibited similar results. PALF can be successfully and easily dyed with Ratanjot and Eucalyptus leaves to give a variety of shades with different mordants and their combinations.

When the pre-treatment with myrobolan and pomegranate rind compared regarding the strength, reflectance and fastness properties, it was inferred that in some cases myrobolan treatment was better whereas in some pomegranate rind. Sometimes both had similar effects too. It was also found that the type of mordant/mordant combination does have an effect on the reflectance, strength as well as fastness properties of PALF dyed with respective dyes.

Chromium residues from chrome dyeing of synthetic dyes on wool have been studied by **Rao, T.R. (1999)**. This was because of regulations limiting the discharge of chrome in dye house effluent in some countries; accordingly efforts were made to find out techniques for applying chrome in the dye bat h to meet with the prevalent regulations. The studies made are with respect to finer variety of wool. Residual levels of chrome in chrome dyeing depend upon several parameters which, when optimized, enable considerable reduction in chrome residues in complete dye bath exhaustion prior to chroming and proper actual chroming, the chance of contamination of the effluent from its sources is almost reduced and maximum fastness properties achieved.[(50)]

But in natural dyeing of wool, chrome is not the only metal to be regulated during mordanting, but copper, tin, aluminum and iron are also in line in that order. Besides this, mordants and application of chrome on to wool in natural dyeing is not fixed at a particular stage, since shades can be obtained by direct dyeing and development of the shade through mordanting or vice versa. Even multi combination of metal salts may also become necessary in some cases. Hence it becomes difficult to determine the method of mordanting with metal salts as per the requirement. Use of natural mordants and employing standing baths for inorganic mordants meant for reuse in mordanting after necessary replenishments are not exclusive solutions.

Keeping this in view an attempt was made to understand the level of absorption and receptiveness of the wool fibre to the above mentioned mordants. It has been observed from the study of mordants for their absorption on to wool substrate, residual part in the left over liquor and loosely adhered component going into the washing, with aluminum as having the least affinity towards wool and that even in case of other metal salts the receptivity varies according to the state and nature of the wool fibre.

The AAS method for determination of the said metals was by using flame of Air-acytelene falme as adopted. Wavelengths of determination were: Fe – 248.3 nm, Cu – 324.7nm, Al – 396.2 nm, Cr – 357.9 nm, Sn – 286.3 nm. [Rao, T.R., (1999)]

A paper by **Shah, A.K. and Bhattacharya, S. D. (1999)** investigated dying of wool fabric with two natural vegetable dyes: 1. Tea leaves and 2. Poi's fruit[(57)].

Tea leaves (Thea sinensis), has its characteristic colour due to the presence of a yellow volatile oil. Tea leaves also contain an enzymatic mixture. The different chemicals contained in tea are as below:

Caffeine ($C_8H_{10}O_2H_4$) occurs as white powder without any odour but possesses a bitter taste. It is a weak base and feebly soluble in water, chloroform and solvent ether. But its solubility in water is sharply increased in the presence of benzoates, bromides, citric acid and salicylates.

Indian Spinach: the hindi name of which is poi, is botanically identified as Basella rubra; the fruit of which is used as a colourant in this study.

Dyeing was carried out without mordanting. To maintain pH little amount of H_2SO_4 was added to the dye bath. H_2SO_4 plays an important role in dyeing. During experiment it was observed that from 10 to 45 minutes, colour was changed. In the first 10 minutes colour was pink on wool, after 10 minutes it changed to orange. And after 25 minutes it turned to lemon yellow.

For dyeing of wool fabric with both vegetable dyes e.g. tea and poi's fruit, dyeing pre-mordant is good in both the cases and without mordanting is also good in case of tea dyeing. When mordant is used, this changes the colour but does not change the λ max value. In case of dyeing with tea as well as poi's fruit when pre-mordanted with $FeSO_4$ it exhibits very good colour yield with very good all round fastness properties. Among the two vegetable dyes studied, tea produces very attractive and soothing colours.

Extraction of dye from natural source: The raw dye sources were ground to fine powder in a stainless steel grinder. 200 gm of dye source was boiled in 1 litre water for 1 hour. The solution was cooled to roon temperature and sieved through a nylon fabric to get a clear dye solution. The dye solution was then concentrated by evaporation by heating at low flame.

Tannin → mordanting → dyeing

This is the sequence of colouring textile matter in the traditional process. This process gave higher colour yield compared to the modified method experimented by the researchers, [12]

The colours used for natural dyeing were mostly collected from flowers, seeds, roots, leaves and barks of the plants/trees. The most important natural colourants used were Indigo for blue, saffron for yellow and Majith for red. Pomegranate, Harda have been identified as non-toxic and eco-friendly and found place in among direct colours. Catechu obtained from the wood of various species was an old Indian dye for cotton producing fine rich brown colours. Indian Madder, dried roots of a plant rubia tinctorium was one of the best natural dyes to produce red colour as it consists of alizarine colouring matter. The unripe myrobolan and the flower were used for yellow and khaki colours on cotton. A black colour was also obtained with its combination with iron chips.[35]. The study was an attempt to develop different colours by applying the extract of some of the frequently available natural colourants with the help of selected morfants and by mixing among themselves. [38]

Silk has very good affinity for dyes. No matter whether the dye is a natural or a synthetic one, the first step before dyeing is to de-gum the silk. It absorbs dyes at a low temperature. The article by **Gogoi,N., Kalitr,B. (1999)** was the outcome of an experiment undertaken to study the effect of natural dyes with mordant on mulberry silk fabrics with the following objectives.[22]

To study the effect of mordant on selected physical properties of test fabrics and the colourfastness of dyed fabrics.

Henna leaves (Lawsonia alba) were selected as a natural dye for the study. According to Dantyagi; Henna can be suitably employed for dyeing fabrics. Dyeing solution is obtained by soaking crushed 'Henna' leaves in water, filtering it through a piece of cloth. Mordanting was carried out by the following methods:

The fabrics were immersed in water containing Aluminium Potassium Sulphate at different percentages (1% - 3%) and was boiled for 30-45 minutes at 60 °C and steeped in cold water and washed.

The required amount of henna leaves were crushed and soaked in water, filtering it through a piece of cloth. The solution was then mixed with a small quantity of acetic acid and the mixture so obtained was heated. A brownish yellow colour is obtained from this process. The mordanted fabric was put in the heated bath and continued heating for about 10 minutes with constant stirring. Salt (5gm/lit) and caustic soda (2gm/lit) was added to the dye bath and again boiled for 20 minutes. Then the dye bath was allowed to cool and the fabric was washed in soft water. The samples were subjected to visual inspection to evaluate the properties such as colourfastness to washing, crocking and sunlight.

Results revealed that fabric thickness was increased by 3.4% after dyeing the fabric without mordanting. And it was interesting to observe that the weight of the test fabric has increased 3.44% after dyeing. All the samples treated with mordant (1%-3%) show increasing trend in fabric weight/unit area. The increasing trend in weight is due to the absorption of dye and mordant by the fabric during dyeing and also consolidation taking place in the fibres of the fabric. This increase may be due to the consolidation of yarn during dyeing and also due to the higher crimp percentage. From this study it can be concluded that silk fabrics dyed with mordant at different percentages show better results with respect to physical as well as colourfastness properties. Fabrics mordanted in 3% concentration performed best than other two concentrations.

Madder:

The colouring matter present is in the root and the plant is of commercial importance because of the valuable dye present in its root. Madder is used for colouring of ivory and lacquering. It is used in the dyeing of cotton, wool and silk and used as an important Red colour in block printing. During the process of dyeing, it was observed that initially the dye yields a pink colour and takes a very long time to get the darker shade. Mordanted wool readily absorbs the colour and care needs to be taken that uneven dyeing does not happen.[64]

Acacia Catechu:

Catechu is the solidified extract of wood, while *kattha* is a crystalline substance found embedded in the wood and much valued as medicine by Hindus. It is used for cotton, silk dyeing and in calico printing. There are said to be the three form of catechu.

1. Dark catechu or catechu-chiefly used for industrial purpose.
2. Indian pale catechu or *kattha* is a crystalline substance eaten with *paan* or used medically.
3. *Keersal* or *Khersal*

Bhattacharya, N., et.al. (1998), dyed bleached jute fibres with natural dyes on different colour and shades. The dyes used were Acacia Catechu, Ornosmas Echiodes, Indigoferra Tinctoria, Artocarpus Integrifolia, Adenanthera pavonina, Rubia Cordifolia, Terminalia Chebula, etc. The dyeing procedure was standardized without using any mordant except in the case of Rubia Cardifolia, where aluminium sulphate was used and in the case of artocarphus integrefolia where the copper sulphate and potassium dichromater were used in small amounts (< 0.1%). Studies were also carried out to investigate the efficacy of dyeing from used dye baths. All the samples showed good dye uptake. The fastness properties viz., light, water and perspiration (both acidic and alkaline) were fount to be good. Marginal tonal variations were observed where mordants were used.[9]

Gogoi, A. (1998) had studied the dyeing of Eri silk fabric with turmeric. The key objective of the study was to develop a colour palette with various mordanting techniques. It was observed from the study that pre mordanting of eri silk fabric with metal mordants improved the fastness properties of dye on Eri Silk fabric.[21]

Chattopadhyay D.P., et.al. (1997) studied the effect of mordant and mordanting techniques on the dyeing of jute and cotton fabric with natural dyes has been studies. Different concentration of mordant and salt are used and has been applied through different techniques in premordanting, simultaneous mordanting and post mordanting. With jute, simultaneous mordanting was found better at low concentration of mordants as compared to other two techniques. In case of cotton, the depth of shades found was too light and among the three techniques of mordanting, pre and post gace comparatively better results. With both jute and cotton, the colour depth found was higher with FeSO4 than to alum.[11]

Value addition methods were studied by **Teli, M.D. and Khakhar, A., (1996)** by dyeing with natural dyes, denim effect, batik printing, tie and dye, block printing, screen printing, stencil printing etc. were carried out and these fabrics were finally evaluated by 100 respondents for their aesthetic appeal. The test result revealed that with 10 percent concentration of hydrogen peroxide for 60 minutes at pH 10 gave the optimum results and there was an improvement in crease recovery angle and softness of the fabric. Assessment of aesthetic properties revealed that a vast majority of individuals accepted the various techniques and appreciated the embellished fabric.[67]

Achwal,W.B. (1995) states mechanism of mordant dyeing of wool is a three component system wool fibre/metal salt/dye. The acidic as well as the amide groups in wool are centres for coordinate bond formation. Chromium and aluminium mordants were mainly used as mordants and to a lesser extent iron, copper and tin salts. This was due to their stronger complex forming capacity resulting in better fastness properties. The complex formation of the dye with the metal may result in changes in tone and light fastness. Although chrome mordants give higher fastness dyeing, their use is now avoided due to toxicological and ecological considerations.[1]

Mordant dyes can be natural or synthetic dyes having neighbouring groups containing lone pairs of free electrons, e.g., hydroxyl, carboxyl, azo and amine in the ortho position. Alum is the most commonly used aluminum salt and it forms different types of hydrate complexes in water. The absorption of aluminum or its hydrate complexes by wool involves nucleophilic substitution of water around the cation by ligand groups in wool fiber during pre-mordanting. The dyeing in a fresh dye bath also involves coordinative attachment of dye molecules on metal cation replacing water molecules.

Comparison of K/S values also shows that, for 5 natural dyes studied by increasing the alum quantity in premordanting, depth of dyeing increases up to 10% alum and further increase has no significant effect. Hence, the optimum concentration can be considered as 10%..

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Natural dyes are currently undergoing a renaissance in the textile industry **Sewekow,U., (1995)**. Underlying reasons may be found in a general criticism of dyes and finishing agents which allegedly pose a threat to the consumer. Using production figures for a series of important natural raw materialist was shown in this report that there was not enough arable land to grow the plants which are a source of natural dyes, not to mention the subsidies which would be needed. The emotional discussions over the past few years have not been objective. Naturally dyed textiles samples show that those cases having satisfactory fastness which can be produced using non-toxic mordants, the costs of the dyes and dyeing procedure are high. Hence cost of dyeing with natural dyes therefore was clearly higher. Dyeing with natural dyes will therefore remain limited to niche products even in the future.[(56)]

In view of tougher environmental requirements avers **Nicolai,M., et.al. (1994)** the reduction of metals in waste water is becoming increasingly important. When dyeing wool with natural dyes aluminium salts are often used as mordants. Here a large part of the aluminum gets into the effluent depending on the amount used. A description is presented of which influential factors lead to the reduction of aluminium content in waste water when mordanting. The depth of shade and colour fastness properties of dyeing with natural dyes depends on the amount of aluminium mordant, which is investigated. Mordanting with aluminium sulphate is more favourable than alum. [(43)]