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Healthy Hues – Status and Implication in Industries – Brief Review.

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Review Article

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ABSTRACT

Man has always been interested with colours. The mother earth has rewarded us with natural vibrant hues called natural dyes. Natural dyes has their age old usage in textile industry and due to their non toxic and eco friendly nature find their use in food, drugs and cosmetic industries. Though earth is bestowed with plants containing a wide range of attractive and eco friendly pigments only 0.5 % has been exhaustively used and the remaining is left unexploited. Despite centuries of interest in natural pigments, our knowledge of their sources from plants, distribution, availability and properties is limited. But in recent times the environmental awareness about health hazards cause by synthetic dyes has regained importance of natural dyes. Therefore, novel plant pigments must be searched and proper collection, documentation, assessment and characterization has to be done. In this article we briefly review the availability of natural dyes (reference to India), extraction, its application in various industries, advantages, disadvantages, prospects and future thrust.

INTRODUCTION

If "*Colour is Life*", could it be that "*Natural Colour is Natural Life* " ? …..Up to you, …!! Diversities can be found in the flora and fauna of the world due to its cultural and geographical variations. These plants are treasure house of many natural products. One such nature's reward is vibrant natural dyes. Till half of 19th century- natural dyes were used to dye textiles, leather, furs, hairs, feathers, matting, basketry, bone and ivory. In 1856 William Henry Perkin (Germany) accidentally discovered "Mauveine". Advent of synthetic dyes competes and completely replaced natural dyes within a century. But slowly suspection of synthetic dyes reported to be not eco friendly. Ironically Germany in 1996 was the 1st country to ban the use of azo dyes. On the other hand, natural dyes went on being used in some parts for aesthetic value. World which is more conscious towards ecology and environment nowadays , there is greater need today to revive the tradition of natural dye and dyeing techniques as an alternative of hazardous synthetic dyes [2]. In this article we discuss the history, need for natural dyes, types of natural dyes, principles, production technology and its implication in various industries, advantages and limitations, future thrust, prospects and conclusion.

History

From time immemorial, color has been an important criterion for acceptability of products like textiles, cosmetics, food and other items [14]. Primitive men used dye stuff to colour animal skin and their own skin during festival times. He believed that colour gave them magical power and protected tem form evil spirits and got them victory during war [16]. While there no precise date for the earliest human use of colour in Europe, it was practiced during the Bronze Age. The earliest written record of the use of natural dyes was found in China dated 2600 BC [8]. Henna was used even before 2500 BC, while saffron is mentioned in the Bible [7]. India is also fore runners in dyeing and dyes were in use during Indus Valley period (2500 BC), Mohenjo-Daro and Harappa civilization (3500 BC) and this was substantiated from findings of coloured garments of cloth and traces of madder dye ruins [1]. In Egypt, mummies have been found wrapped in colored cloth. The cochineal dye was used by the people of Aztec and Maya culture period of Central and North America. By

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the 4th century AD, dyes such as woad, madder, weld, Brazil wood, indigo and a dark reddish-purple were known. Brazil was named after the woad found there. Colonists and settlers discovered that indigenous dyers used what was abundant including minerals, bodily fluids of animals, plant materials including leaves, bark, roots, lichens, berries, soot, and soil which provided dyes and pigments of purple, black, ochre, red, and yellow. The well known ancient dyes include red dye from roots of *Rubia tinctorum* L., blue indigo dye from leaves of *Indigofera tinctoria*, yellow dyes from stigmas of saffron (*Crocus sativus*) and rhizome of turmeric (C*urcuma longa*). Dyeing might be an accidental happening but the need of dyeing become very common in human life. So the art of dyeing spread widely as civilization advanced. Today dyeing is a complex and specialized science. Natural dyeing is practiced as a unique feature by crafts man and synthetic dyeing only is commercially followed.

Need for natural dye

Natural dyes went on being used and are still used traditionally by artists because of their different and aesthetic colouristic value, symbolic powers and therapeutic functions and green mined consumers priority for organic food with natural colours. Natural dyes are regaining its importance in global society because of growing awareness of the threats on natural environments worldwide. In last few decades, synthetic dyes have been severely criticized and consumers show reluctance towards these products, consequently they prefer to use the natural colorants [6]. Because of health and hygiene, nutrition, pharmaceutical activities, fashion and environmental consciousness, indicate relative dependency on natural products. Besides good market value fetched by the natural colored products and as of now, natural colorants have become the major alternatives to synthetic colorants [4].

Advantages of natural dyes

Natural dyes have wide viability and huge potential. Natural dyes are non toxic, non polluting, non carcinogenic, non poisonous and environmental friendly. They produce harmonizing colours, gentle, soft, lustrous and subtle creating restful. Many are water-soluble facilitates incorporation into aqueous food systems which make the qualities of natural food colorants attractive. Since the natural dyes are polygenetic nature specialty and rare colour ideas is possible by mix and match system. Along with aesthetic value and quality natural dyes also have potential positive health effects like antioxidant properties. No reports of health hazardous and are anti inflammatory, anti allergic and radiation-protective.

Limitations of natural dyes

Bio colorants have several potential benefits yet their collection extraction procedures are tedious with low colour value. The natural dyes cost higher than synthetic dyes and are instable during processing etc., It is difficult to reproduce shades because this agro product is based with season, place species and maturity period etc. Nearly all-natural dyes with a few exceptions need mordants to fix them. This takes a larger dyeing time and excess cost for mordants and mordanting. Post-harvest processing and handling is cumber some. Scientific back up of the science involved in natural dyeing has not yet been completely explored. Also natural dyes do not perform well with artificial fibers. Problems in food industry is instability during processing because of sensitivity to temperature, oxygen, light and pH Natural dyes are decolourised or degraded during storage. These disadvantages make hinder their popularity.

Natural Dyes

Natural dyes can be defined as those colorants (dyes and pigments) obtained from plants, animals or minerals. They attach to the substrate by physical adsorption, mechanical retention, and formation of covalent chemical bonds or of complexes with salts or metals, or by solution. Natural dyes can be subdivided into dyes and pigments. Dyes lose their crystal structures during application by dissolution or vapourisation and are often used for textile (dyeing) and food colourants (staining). Pigments retain their crystalline or particulate structure throughout their application. Pigments are used in inks, paints and cosmetics.

Principles of dyeing

Plants in nature produce so many colours for so many reasons. Most plants are green (most ubiquitous colour) to capture light energy and converts to chemical energy for preparing food. Also plant produce multi colour flowers, fruits to attract insects, protection from pest and diseases. Along with this plants are able to yield dyes from this colour. Pigmentary molecules in natural dyes present impart colour. Pigmentary molecules are aromatic ring structure coupled with a side chain. This forms a Chromogen-chromophore with auxochrome. Chromogen chromophere is the aromatic structure containing benzene, naphthalene or anthracene rings. Chromogenchromophore structure is not sufficient to impart solubility and causes adherence of the dye only in presence of auxochrome - important for bonding affinity groups [15]. Most of the natural dyes have no substantivity on cellulose or other textile fibers. The majority of natural dyes need a mordanting chemical (preferably metal salt or suitably coordinating complex forming agents) to create an affinity between the fiber and dye or the pigment molecules. After mordanting, the metal salts anchoring to the fibers, attracts the dye/organic

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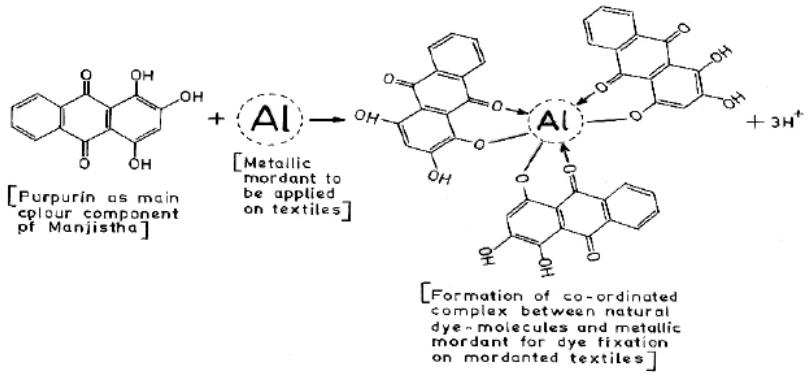
pigment molecules to be anchored to the fibers and creates the bridging link between the dye molecules and the fiber by forming coordinating complexes.



Mordants

A mordant is a binding agent that adheres well to both the fibers and the dye. Usually chemical mordants are used with restrictions to heavy metals and carcinogenic chemicals. The permissible levels are As (1ppm), Pb (1ppm), Cd (2ppm), Cr (2ppm), Co (4ppm), Cu (50ppm), Ni (4ppm) and Zn (20ppm). No upper limit on Al, Fe and Sn.

Natural dyes from plants

Many natural dye stuffs are obtained from plats like red, yellow, blue, black, brown and combination of these (Table 1). Amazingly plants produce nearly 2000 pigments out of which some 150 pigments have been exploited. Many of the plants used for dye extraction are classified as medicinal and some have shown anti microbial activity. Table 2 & 3 illustrates the traditionally used dye yielding plants which yield pigments and have medicinal values.

Ethical dyeing manifesto

The Earth sustains us all - Treat her with gratitude and respect. Greed should not govern us - We need to give back what we take. The clauses for ethical dyeing 1. To not use synthetic chemicals at any stage of the dyeing process 2. To conserve the sources of natural dyes by not consuming the roots, heartwoods or barks of perennial trees as dye material. 3. To avoid the use of plant materials that is food to man and animals. 4. To minimize the use of (plant organs that propagate a species) flowers, seeds, fruits gathered from the wild. 5. To cultivate the required dye plants.

Preparation of dyes

Gather sufficient dyestuff (plant material) to fill a bucket or pail. Chop or shred if bulky. To facilitate pigment extraction, press the dyestuff down and add sufficient cold water to cover. Use a rock or a heavy plate to keep the mass immersed. Set aside 24 hours. If local water is contaminated with minerals such as iron, a substantial color shift may occur. Iron is a common mordant used by dyers. If local water is not pure, distilled or deionized water can be used to avoid the color shift. Bring the dyestuff and soaking water to a boil (98-100°C.) (Some dyestuffs are heat sensitive and require a lower temperature for extracting the dye from the dyestuff. The heat sensitive dyes are often found in flowers. A temperature of 70-80°C is usually effective for extracting the dye from flowers.) Maintain the temperature over heat for 1-2 hours depending upon the bulk of the dyestuff and the time needed to render it completely limp. (There will be some evidence of color in the "dye liquor" by this time). Once done, set the contents aside. When liquid are cool to the touch, strain the cooked dyestuff Allow the wet dyestuff to drip for several hours. Save all of the liquid as this constitutes the "dye bath" [3]. To the dye bath or dye liquor add the textile. Raise the heat to a slow simmer (90-92°C) (or 70-80°C for the heat sensitive floral dyes). Maintain this temperature for 15 minutes and then reduce to 60°C and process another 45 minutes. Remove and cool the contents to room temperature.. Remove the textile. Drain or squeeze out remaining dye liquor. Shake and then hang to dry in the shade.

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Table 1: Sources of different coloured dyes and mordants [17]

Colour	Botanical name	Parts used	Mordants
Red dye			
Safflower	*Carthamus tinctorius* L.	Flower	–
Caesalpinia	*Caesalpinia sappan* L.	Wood	Alum
Madder	*Rubia tinctorium* L.	Wood	Alum
Log wood	*Haematoxylon campechianum* L.	Wood	–
Khat palak	*Rumex dentatus* L.	Wood	Alum
Indian mulberry	*Morinda tinctoria* L.	Wood	Alum
Kamala	*Mallotus philippinensis* Muell.	Flower	Alum
Lac	*Coccus lacca* Kerr.	Insect	Stannic chloride
Yellow dye			
Golden rod	*Solidago grandis* DC.	Flower	Alum
Teak	*Tectona grandis* L.f.	Leaf	Alum
Marigold	*Tagetes* sp.	Flower	Chrome
Saffron	*Crocus sativus* L.	Flower	Alum
Flame of the forest	*Butea monosperma* (Lam) Taubert.	Flower	Alum
Blue dye			
Indigo	*Indigofera tinctoria* L.	Leaf	Alum
Woad	*Isatis tinctoria* L.	Leaf	–
Sunt berry	*Acacia nilotica* (L.) Del.	Seed pod	–
Pivet	*Ligustrum vulgare* L.	Fruit	Alum and iron
Water lily	*Nymphaea alba* L.	Rhizome	Iron and acid
Black dye			
Alder	*Alnus glutinosa* (L.) Gaertn.	Bark	Ferrous sulphate
Rofblamala	*Loranthus pentapetalus* Roxb.	Leaf	Ferrous sulphate
Custard apple	*Anona reticulata* L.	Fruit	–
Harda	*Terminalia chebula* Retz.	Fruit	Ferrous sulphate
Orange dye			
Annota	*Bixa orellena* L.	Seed	Alum
Dhalia	*Dhalia* sp.	Flower	Alum
Lily	*Convallaria majalis* L.	Leaf	Ferrous sulphate
Nettles	*Urtica dioica* L.	Leaf	Alum

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Table 2. Important dye-yielding plants with pigments

Plant	Colour obtained	Pigment	Dye content	Habitat and distribution
Acacia catechu (L.f.) Willd.	Brown, black	Catechin, catechutanic acid	The chief constituents of the heart-wood vary from 4 to 7% and are distributed throughout the heart-wood from the root to the branches.	Occurs throughout India in dry types of mixed forest on a variety of geological formations and soils.
Adhatoda vasica Nees.	Yellow	Adhatodic acid, carotein, lutolin, quercetin	–	Distributed throughout India, up to an attitude of 1300 m; grows on waste land and in a variety of habitats and soil. It is sometimes cultivated as hedge.
Bixa orellena L.	Orange, red	Bixin, norbixin	The dye content is 5–6% by weight of seed. A carotenoid bixin comprises 70–80% in each seed.	The small tree is found to thrive at elevations of 600–900 m; native to tropical America, it has become naturalized in the hotter parts of India.
Butea monosperma (Lam) Taubert.	Yellow or orange	Butrin	–	Commonly found throughout India, except in the arid region. It grows on black cotton soil, even on saline, alkaline and swampy badly drained soils and in barren lands.
Carthamus tinctorious L.	Yellow, red	Carthamin	The chief constituent carthamin ranges from 3 to 6% of the flower.	Cultivated throughout India. It requires fertile, moisture-retentive and well-drained soil.
Curcuma longa L.	Yellow	Curcumin	Percentage of curcumin varies from 5.4 to 8.7.	Turmeric grown generally as an annual crop. It is cultivable from sea level up to 1200 m. It thrives in well-drained, fertile, sandy and clayey, black red soil.
Indigofera tinctoria L.	Blue	Indigotin, Indican	Indigotin content varies according to season and age of the plant. Best grade contains 70–90% in dried leaves.	Distributed commonly in the tropical region.
Lawsonia inermis L.	Orange	Lawsone	The principle colouring matter, lawsone is present in dried leaves at a concentration of 1.0–1.4%.	It is mainly cultivated in Tamil Nadu, Madhya Pradesh and Rajasthan. It can grows on any type of soil from light loam to clay loam, but grows best on heavy soil.
Mallotus philippensis Muell.	Red	Rottlerin	The yield of powder rottlerin is 1.4–3.7% of the weight of the fresh fruits.	Found throughout India; occasionally ascending to 1500 m in the outer Himalayas. Commonly found in Sal and certain shrub and mixed forests.
Morinda citrifolia L.	Yellow, red	Morindone	Roots are dug out when the plants are 3–4 yrs old, dried and sorted for use by the dyeing trade.	A small tree distributed throughout the tropics.
Oldenlandia umbellata L.	Red	Alizarin, Rubicholric acid	–	Prostrate herb distributed in the tropical and subtropical region.
Pterocarpus santalinus L.	Red	Santalin	Red sanders contains 16% of a colouring matter, santalin (santalic acid).	Grows typically on dry, hilly, often rocky ground and is occasionally found growing on precipitous hillside.
Punica granatum L.	Yellow	Petargonidon 3,5,diglucoside	–	Mostly found cultivated in many parts of India, the tree is also common and gregarious in the gravel and boulder deposits of dry ravines and similar places in the outer Himalayas up to about 1800 m.
Rubia cordifolia L.	Red	Purpurin	Purpurin per cent vary from 2.0 to 4.0.	A hardy climbers common throughout India, ascending to an altitude of 3750 m.
Semecarpus anacardium L.f.	Black	Bhilawanol	Bhilawanol ranging from 28 to 36% of dry weight of seed.	The tree is common in forests often found occurring with Sal, throughout the hotter parts of India.
Toddalia asiatica (L.) Lam.	Yellow	Toddaline	–	In South India, the plant is common in the Nilgris and Palani hills, and also in the scrubby jungles of Orissa.
Wrightia tinctoria R. Br.	Blue	β-amyrine	Leaves are the source of a blue dye called Mysore pala-indigo and β-amyrine ranges from 3.3–5.0% of dried leaves.	Distributed in Rajasthan, Madhya Pradesh and peninsular India, ascending to an altitude of 1200 m in the hills.

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Table 3. Dye-yielding plants with its medicinal value

Botanical name	Family	English name	Parts used	Colour	Medicinal use
Abies spectabilis (D.Don.) Spach.	Pinaceae	East Himalayan silver fir	Cone	Purple or violet	Used for curing cough.
Acacia catechu (L.f.) Willd.	Mimosaceae	Cutch tree	Bark	Brown/black	Kheersal is used medicinally for sore throat and cough.
Acacia dealbata Link	Mimosaceae	Silver wattle	Bark	Brown/black	Used in bronchial infection.
Acanthophonax trifoliatum (L.) Merr.	Araliaceae		Fruit	Black	Used in paralysis; roots cooked and eaten.
Actaea spicata L.	Ranunculaceae	Banberry grape wort	Seed	Black, red, green	Rhizomes are used for nervous disorders and uterine tenderness.
Adathoda vasica Nees.	Acanthaceae	Adalsa	Leaf	Yellow	Used in bronchial infection
Aegle marmelos (L.) Corr.	Rutaceae	Bael fruit	Fruit rind	Yellow	Unripe or half-ripe fruit is astringent, used as digestive and for curing stomachache diarrhoea.
Ailanthus triphysa (Dennst.) Alston.	Simaroubaceae		Leaf	Black	Bark carminative, tonic and febrifuge; juice used for asthma and bronchitis and also for dysentery.
Aloe barbadensis (L.) Burm.f.	Lilliaceae	Curaco aloe; Indian aloe	Whole plant	Red	Fresh juice of leaves is cathartic and refrigerant used in liver and spleen ailments and for eye infections, useful in X-ray burns and other skin disorders.
Althea rosea Cav.	Malvaceae	Holly hock	Flower	Red	Considered emollient, demulcent and diuretic, used in chest complaints.
Ardisia solanacea Roxb.	Myrstinaceae		Berry	Yellow	Roots used in diarrhoea and rheumatism.
Arnebia benthamii (Wall. ex G. Don)	Boraginaceae	Pan	Underground parts	Purple	Stimulant, tonic, diuretic, and expectorant used in infection of tongue and throat, and also cardiac disorders and fever.
Arnebia guttata Bunge	Boraginaceae		Root	Red	Roots are also used for cough.
Azadirachta indica A. Juzz	Meliaceae	Neem	Bark	Brown	Skin disorders, leaves considered as antiseptic.
Barleria prionitis L.	Acanthaceae		Flower	Yellow	Juice of leaves given with honey in catarrhal infections of children. A paste of the roots applied to boils and glandular swellings.
Bassia latifolia Roxb./ *Madhuca indica* J.F.Gmel	Sapotaceae	Butter tree	Bark	Yellow, brown	Used in rheumatism and skin infections and as a laxative in cases of habitual constipation and piles.
Bauhinia tomentosa L.	Caesalpinaceae		Leaf	Yellow	Decoction of root bark used for inflammation of liver and as vermifuge. Dry leaves, buds and flowers used in dysentery.
Bauhinia variegate L.	Caesalpinaceae	Mahua tree	Bark	Yellow	Roots carminative, decoction prevents obesity, bark tonic and anthelminitic used in scrofula and cutaneous diseases; also used for ulcer and leprosy. Dried flowers eaten in case of diarrhoea, dysentery and piles.
Betula utilis D.Don	Betulaceae	Himalayan silver birch	Tree gum	Brown	Infusion of bark is aromatic and antiseptic; also used as a carminative.
Briedelia stipularis L.	Euphorbiaceae		Fruit	Black	Decoction of the bark used for cough, fever and asthma. Leaves used in case of jaundice.
Butea monosperma (Lam) Taubert.	Papilonaceae	Flame of the forest	Flower	Yellow, orange	Bark astringent, used for piles, tumour and menstrual disorders. Gum is astringent and used in diarrhoea.
Caesalpinia sappan L.	Caesalpinaceae	Bastard teak, Bengal kino	Wood, bark	Red	Decoction provides relief in mild cases of dysentery and diarrhoea.
Carthamus tinctorius L.	Asteraceae	Safflower	Flower	Red, yellow	Oil applied to sores and rheumatic swelling; also used in case of jaundice.
Cassia auriculata L.	Caesalpinaceae	Tanner's cassia	Flower, seed	Yellow	Leaves and fruit anthelminthic. Seeds used in eye infection. Roots employed in skin disorders.

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Table 3. (*Contd...*)

Botanical name	Family	English name	Parts used	Colour	Medicinal use
Cassia occidentalis L.	Caesalpinaceae	Negro coffee	Seed	Brown	Seeds used in external application for skin disorders.
Cassytha filiformis L.	Lauraceae		Stem	Brown	Used in bilious afflictions, urethritis chronic dysentery, and eye and skin infections.
Cedrela toona Roxb./ *Toona ciliata* Roem		Red cedar	Flower, seed, leaf	Yellow/red	Bark used for chronic dysentery of infants and also in external application of ulcer.
Citrus medica L.	Rutaceae	Citron, lime	Bark	Black	Used for curing dysentery.
Clitoria ternatea L.	Fabaceae		Flower	Blue	Roots are powerful cathartic and diuretic.
Cordia myxa L.	Boraginaceae		Roots, leaf	Yellow, red	Astringent, anthelmenthic, diuretic demulcent and expectorant, used in diseases of chest and urinary tract.
Coscinium fenestratum (Gaertn.) Clolebr.	Menisper-maceae	Tree turmeric	Seed, bark, wood	Red	Root considered bitter tonic and used in dressing wounds and ulcers.
Crocus sativus L.	Iridaceae	Saffron	Flower	Yellow, orange	Used as sedative and emmenagogue.
Cyanometra ramiflora L.	Caesalpinaceae		Wood	Black	Oil from seed used for leprosy, scabies and other cutaneous diseases.
Dioscorea bulbifera L.	Dioscoreaceae	Potato yam, air potato	Tuber	Pale colour	Used for ulcers, piles and dysentery.
Diospyros embryopteris Pers.	Ebenaceae	Gaub persimmon	Fruit	Brown	Seeds used for dysentery and diarrhoea.
Dipterocarpus turbina-tus Gaertn.	Dipterocar-paceae	Common Gurjan tree	Twig, bark	Yellow, brown	Oleoresin, an oil is applied to ulcers.
Elaeodendron glaucum (Rottb.) Pers.	Celasteraceae		Bark	Red	To cure stomach pain.
Eugenia jambolana Lam.	Myrtaceae		Bark, leaf	Red	Decoction of bark and seeds used in diabetes.
Euphorbia tirucalli L.	Euphorbiaceae		Wood	Red	Toothache.
Flemingia congesta Roxb.	Fabaceae		Pod	Red, yellow	Roots used for preparation of external application for ulcer and swelling.
Galium aparine L.	Rubiaceae	Goose grass	Root	Purple	Infusion of herb used as an aperient diuretic, refrigerant and antiscorbatic.
Galium rotundifolium L.	Rubiaceae		Root	Yellow, brown	Used for colic, sore throat and chest complaints.
Galium verum L.	Rubiaceae	Cheese rennet	Root	Yellow, red	Considered purgative and diuretic. Decoction used in epilepsy and hysteria.
Garcinia mangostana L.	Guttiferae	Mangosteen	Fruit	Black	Used in diarrhoea and dysentery.
Gardenia jasminoides J. Ellis	Rubiaceae	Cape jasmine	Fruit	Yellow	Roots used in nervous disorder, fruit stimulant, emetic and diuretic used in jaundice and pulmonary disorder.
Geranium wallichianum D.Don	Geraniaceae	Wallich cranesbill	Fruit, root	Yellow, red, brown	Astringent used in toothache and eye infection.
Haematoxylon cam-pechianum L.	Mimosaceae	Log wood	Heart wood	Red	Decoction used in diarrhoea, dysentery, atonic dyspepsia and leucorehoea.
Heliotropium trigosum L.	Boraginaceae		Leaf	Black	Laxative and diuretic. Juice applied to sore eyes; also used for boils, wounds and ulcers.

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Table 3. (*Contd...*)

Botanical name	Family	English name	Parts used	Colour	Medicinal use
Indigofera aspalathoides Vahl.	Fabaceae	Wiry indigo	Leaf	Blue-black	Leaves, flowers and tender shoots demulcent, used in cancer and leprosy.
Indigofera hirsuta L.	Fabaceae		Leaf	Indigo	Decoction of leaves in stomachic and used in diarrhoea and jaws.
Indigofera tinctoria L.	Fabaceae	Indian indigo, common indigo	Leaf	Blue, blue-black	Extract used in epilepsy and other nervous disorders; in the form of ointment used for sores, old ulcers and piles. Root used in urinary complaints and hepatitis.
Jatropha curcas L.	Euphorbiaceae	Physic nut, purging nut	Bark, leaf	Blue	Used in sciatica, dropsy and paralysis, and externally for skin disorders and rheumatism.
Kirganelia reticulate (Poir) Baill.	Euphorbiaceae		Bark, root	Red	Leaves diuretic, used for diarrhoea in case of infants.
Lawsonia inermis L.	Lythraceae	Henna	Leaf	Orange, red	Used as prophylactic against skin disorders.
Lycopus europaeus L.		Gipsy wort	Fruit	Green	Useful for treatment of hyperthyrosis; inhibits the action of thyrotropic harmine and thyroxin output of thyroid.
Mallotus philippiensis Muell.	Euphorbiaceae	Kamala tree	Fruit	Red	Glandular hairs from fruits yield a Kamala powder, employed as an antioxidant for ghee, as an antihelminthic and for cutaneous infections.
Malphigia glabra L.	Malpigiaceae	Barbedos cherry	Flower	Yellow	Fruits used in diarrhoea, dysentery and liver disorders.
Melastoma malabathricum L.		Indian rhododendron	Fruit	Black, purple	Bark and leaves used for skin disorders.
Michelia champaka L.	Magnoliaceae	Champak	Flower	Yellow	Flowers uses as tonic for stomachache and carminative, used in dyspepsia, nausea and fever, also useful as a diuretic in renal diseases.
Mimusops elengi L.	Sapotaceae	Bullet wood	Bark	Brown	Bark and fruits used in diarrhoea and dysentery.
Morinda citrifolia L.	Rubiaceae		Root	Red, yellow	Fruits used for spongy gums, throat infection, dysentery, leucorrhoea and sapraemia.
Morinda umbellata L.	Rubiaceae		Root	Red	Decoction of roots and leaves useful in diarrhoea and dysentery.
Naregamia alata Wight & Arn.	Meliaceae		Leaf	Red	Useful in chronic bronchitis.
Nyctanthes arbortristis L.	Oleaceae	Coral jasmine	Flower	Yellow	Used in rheumatism and fever.
Oldenlandia umbellata L.	Rubiaceae	Chay-root	Root	Red	Used for asthma and bronchitis.
Oxalis corniculata L.	Oxalidaceae	Indian sorrel	Leaf	Blue	Fruit juice of plants given in dyspepsia, piles, anaemia and tympanitis.
Papaver rhoeas L.	Papaveraceae	Corn poppy	Petal	Red	Fresh petals used in preparation of galinicals, syrup or tincture used for colouring medicines.
Peltophorum pterocarpum (DC.) K.Heyne	Caesalpiniaceae	Copper pod	Wood, leaf	Brown, black	Used for eye infection, muscular pains and sores.
Perilla ocimoidea L.	Labiatae	Kumboo millet	Fruit	Black	Herb sedative, anti-spasmodic and diaphoretic, used in cephalic and uterine disorders.
Pistacia intergerrima L.	Anacardiaceae	East Indian mastechae	Flower, leaf	Yellow	Useful for asthma and other respiratory tract disorders and also for dysentery.
Toddalia asiatica (L.) Lam.	Rutaceae	Wild orange	Root	Yellow	Has diaphoretic, stomachache relieving and antipyretic properties. Root is also used for treatment of cough.

Siva [16]

Extraction Technology

Extraction technology is done in many ways like aqueous extraction system - Material-to-liquor ratio (MLR), Solvent Extraction system, Super critical fluid extraction system, Microwave assited Extraction technology, Continuous steam distillation method. While purification includes filtration or reverse osmosis or preparatory HPLC and drying of the product may be by spray or under using vacuum or freeze drying technique.

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Potential use in industries

The natural dyes can be used for coloration of the product in food industry, pharmaceuticals industry, textile industry, leather industry, cosmetics industry.

A. **Textile industry** – Dyes can be used for colouration of textile material like yarn, silk wool fabric and applied on the apparels. Common dyes used are annatto, indigo, harda kamala. Natural dyes are substantive and require a mordant to fix to the fabric. The Colours of Nature (TcoN) is one of only few remaining natural dyeing units in the world, entirely focused on an environmental friendly, vegetable dyeing process and research. The unit is specialized in the natural indigo fermentation Process. The products should be organic and grown without the use of pesticides and fertilizers. Production methods are environment-friendly and do not pollute the environment and practice water conservation. Water used is stored after each step of the dyeing process and recycled for agricultural use. Alum, a non-polluting mordant is only used to fix the colours. Materials which have beneficial effects like Tannin (mordant) – Powerful antiseptic, Turmeric – revitalises the skin; Indigo – Cooling sensation and relaxing are used in the dyeing process.)

B. **Food and confectionery industry** – Most common dye used for coloration of the edible items are annatto seeds, The water soluble extract are used for coloration of butter while oil soluble extract are used for colouration of ghee & ice cream, etc. Producers of confectionery, soft drinks, alcoholic beverages, salad dressings and dairy products are the most significant users of natural colorants. Currently 43 colorants are authorized as food additives by the Council of the European Union. Juices or extracts from some fruit and vegetables are used for coloring purposes. The Food preservatives have antagonistic activity against micro organisms. Norton [12] reported that corn carotenoids inhibit the synthesis of aflatoxin by *Aspergillus flavus* (90%) and by most of the *A. parasiticus* (30%) strains. Quality control markers are anthocyanin profiles used to determine the quality of fruit jams like adulteration of black berry jams with straw berries by pellargonidin test. As nutritional supplements bio colurants possess "vegetable principles" (biological active source). These are sources for obtaining drug substances (biologically active) and many other natural compounds used in various industries such as food, pharmaceuticals, cosmetics, with important commercial value [5]. Carotenoids are also used as vitamin supplements [9], since β-carotene is the precursor of vitamin A.

C. **Pharmaceutical and Therapeutic industry** – Natural colourants also play an important role in human health because they contain some biologically active compounds, which possess a number of pharmacological properties like strong antioxidant, antimutagenic, anti-inflammatory and antiartheritic effect [10,11]. Carotenoids also act as biological antioxidants, protecting cells and tissues from the damaging effects of free radicals and singlet oxygen and also as a good source of anti-tumor agent [18]. Grape seed extract is the primary commercial source of a group of powerful antioxidants known as oligomeric proanthocyanidins (OPCs), also generically called pycnogenol, a class of flavonoids [4]. Also bio colourants are used to colour pills and tonics [13].

D. **Cosmetic industry** – Dyes derived from plants like Bi*xa orellana and Lithospermum erythrorhizon* serves as sources for colouring lipstick and eye shadow liners

E. **Leather industry** – Vegetable tannin are used for tanning the leather, Walnut bark, eucalyptus bark, turmeric rhizomes and tea leaves commonly used, confined to cottage and small-scale leather units while large units use Chrome Tanning.

Future thrust

Optimization of the selection, cultivation and extraction process of the major "historical" dye plants, improving the quality and yield of natural dye substances is likely by understanding the physiological and agronomic factors affecting the quality and yield factors plant. To improve the quality and yield by selection, conventional breeding, and by genetic manipulation and transformation is needed. We have to develop efficient systems of dye plant production (eg, nutrition, pest, weed and disease control, husbandry, suitable rotations and soil type. Researching "new" sources of natural dyes from local sources is necessary. Waste products from dye plant exploitation should be diverted for other uses, like food or timber.

PROSPECTS AND CONCLUSIONS

In essence, the message to consumers that "Natural is Better" is gaining popularity day-by-day. Although, natural colors are on the rise but they are unlikely to be a total replacement for synthetic dyes because the area of land required for production of natural colourants, yielding plants increasing due to inadequate strategies and horticultural practices on this crops. Thus, natural dyes is likely to occupy a small niche market, unless technology of horticultural practices and pigments extraction is redefined and standardisation on modern scientific lines.

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