A Review: Importance of Natural Dyes from *Solanum xanthocarpum*

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Abstract*:* Worldwide demand for natural dyes showed great interest which increased awareness on beneficial properties of natural dyes in public. Natural dyes having several applications in textiles, cosmetics, inks, pharmaceutical paper industries etc. The natural dyes existing different shades of colours depends on metabolic functional groups and its testing reagents. The present review, describes the information regarding the basic chemistry of plant pigments in relation to medicinal properties which may prove to be useful for further development of pharmaceutical formulations.

Keywords: Dyes, medicinal value, Natural colors, pigments

Introductions

Natural dyes are derived from natural sources such as plants, animals, minerals and insects without any chemical treatment[1,2] .Nature has gifted more than 500 dye yielding plants species[1] . Colouring agents are derived from roots, leaves, barks, trunk and fruits. The plants Henna, madar, pomegranate, turmeric, eucalyptus etc. are well known for its natural dyes [3] . The first fiber dyes- direct dyes or substantive were already used in prehistoric times after the last ice age, around 1000 B.C. The synthetic dyes have been banned due to carcinogenic and toxic in nature. Research paid attention on synthetic dyes that are suspected to release harmful chemicals that are allergic, carcinogenic and detrimental to human health[4-7]. Natural dyes are the colorants obtained from biological matter by mechanical retention, covalent chemical bond formation or forming complexes with salts or metals or by physical absorption[8] .The natural dyes from the plants have a great importance of medicinal values even in some case nutritional values. From the ancient time people are using the many plants for curing the various types diseases as well as for dying .Today, natural colourants are safer and ecofriendly in nature [9] are emerging globally leaving synthetic colourants behind in the race. It is the vital source from the plants and is related with cultural practices, crafts, rituals, arts and fabrics. The medicinal properties, protective properties, the structures of natural dyes have been recognized only in the recent few years. Natural dyes have demonstrated better biodegradability and are achieved from renewable sources. These are preferred mainly in developed countries, because of their non-allergic, non-carcinogenic, less-toxicity and better biodegradability nature than the synthetic dyes [10] .

Hence, it is important the product from the nature which play vital role in therapeutics. Heena, saffron, kesar, turmeric, the brightest of naturally occurring orange-red / scarlet red to yellow dyes are a powerful antiseptic which revitalizes the skin, while indigo gives a cooling sensation[11].The use of natural products together with their therapeutic properties is as ancient as human civilization; for a long time, mineral, plant and animal products were the main sources of drugs[12] . In India, there are more than 450 plants that can yield dyes. In addition to their dye-yielding characteristics, some of these plants also possess medicinal values that are procured industrial applications and accessed occupation for vicinities where the plant source is existed.

Medicinal properties of natural dyes:

Many of the plants used for dye extraction have recently been revealed antimicrobial activity[13]. *Punica granatum* L. and many some other common natural dyes are reported as potent antimicrobial agents due to the presence of a large amount of tannins. Some other sources of plant dyes rich in naphthoquinones such as lawsone from *Lawsonia inermis* L. (henna), juglone from walnut and lapachol from alkanet are reported to exhibit antibacterial and antifungal activity[14-16]. Singh et al[17]studied the antimicrobial activity of some natural dyes.

Optimized natural dye powders of Acacia catechu (L.f.) Willd, Rubia cordifolia L. and Rumex maritimus, Kerria lacca, were obtained from commercially and they showed antimicrobial activities. Lycopene is a carotenoid pigment responsible for red colour in watermelon, carrot, tomato, and some other fruits; this is used as a colour ingredient in many food formulations in food industries. *Solanum xanthocarpum* and the plant as a whole is used drug in Ayurveda. The drug is used as antiasthmatic, hypoglycaemic, antifungal, anti-inflammatory, antitumor, anti-tussive, antipyretic, antispasmodic, antihistaminic, hypotensive and cytotoxic activity [18,-19].

In recent years it has received considerable attention because of its potential in the prevention of chronic diseases such as prostate cancer[18-19]. The epidemiological studies proved that the consumption of lycopene-rich food such as tomatoes is related with a low risk of cancer[20]. Pomegranate fruit not only used as natural dye it also having traditional medicinal value[21] is now supported by data obtained from modern science showing that the fruit contains anticarcinogenic[22-23,] anti-microbial[24] and anti-viral compounds[25] .A beautiful spectrum of natural colours from yellow to black exists in the above sources. These colours are exhibited by pigments .and due to the absorption of light in the visible region of 400-800 nm. This absorption of light depends on the constituents or structure or of the colouring pigment or molecules contain various chromophores present in the dye yielding plant. Natural dyes are nowadays in demand not only in textile industry but in cosmetics, leather, food and pharmaceuticals and offer an attractive alternative.

Chemistry of dyes:

A dye can generally be described as a coloured substance that has an affinity to the substrate to which it is being applied. The natural organic dyes and pigments cover a wide range of chemical classes. Classification of natural colouring agents on the basis of chemical structure shown in Table No.1.The dye is usually used as an aqueous solution and may require a mordant to improve the fastness of the dye on the fiber. Dyes are used for colouring the fabrics. Dyes are molecules which absorb and reflect light at specific wavelengths to give human eyes the sense of colour[3] Different dye molecules are unique. Each is shaped differently so that it absorbs light in a different way. Often a third molecule is added to a dye. This acts as a bond between the dye molecule and the molecule of the fabric that the dye is being applied on. Along with Chlorophyll, carotinoids, tannins, phenolics, flavonoids and curcumin were determined among the dye yielding plants from the solanaceae family, no report yet observed from *Solanum xanthocarpum*. Natural product was isolated from it having medicinal values are shown various colours with different regents used for identification. Its alkaloids showed creamish color with Mayer reagent, yellow in colour with Hagers reagent, reddish brown color with Wagner's reagent and Dragendroff reagent used for precipitation and its tannic acid gives buff colour. Glycosides/ free sugar of *Solanum xanthocarpum* showed blood red with Legals test and yellow with bromine water test.

Tannin and phenolic compound from *Solanum xanthocarpum* revealed white precipitation with gelatin test, blue green with ferric chloride, yellow –red with alkaline reagents[26].

Moradant dyes also observed from nigrum species showing K, S, P, Ca, Mg, Mn, Zn, Fe, Cu and Co etc. hence these naturally occurring dyes called as 'vegetative dyes' which was prepared simply in pot and applied in textiles. In Manipur, acidic and basic dyes which indigenously formed and used in various handlooms, fibric, and household items. Based on the colours of surviving textile fragments and the evidence

Table No .1 Classification of Natural colouring agents on the basis of chemical structure**.**

Chemical Classification	Colors	Common Names
Flavone dyes	Yellow and Brown	Weld, Quercitron, Fustic, Osage, Cutch Chamomile, Tesu, Dolu, Marigold,
Naphthochinone dyes	Brown and Purple Grey	Henna, Walnut, Alkanet, Pitti
Chromene dyes	Orange-Yellow	Kamala
Iso-quinoline dyes Polyene colorants Pyran colorants	Yellow	Barberry, β-carotene, lycopene gentisin
Indigoid Dyes and Indole colorants	Blue	Indigo
Chinone and Anthrachinone dyes	Red	Lac, Chromene dyes Cochineal, Madder (Majithro) Santalin
Benzophyrone dyes	purple	Black logwood

of actual dyestuffs found in archaeological sites as well as from dyers' house, ten natural dyes yielding plants which have unique uses in the Meitei society of Manipur were analyzed for the biochemical substances responsible for dyeing[12-13]. Since, *Solanum xanthocarpum* leaves has dark glossy greenish in colour having hair and colouring flower prejudiced used treatment of in various diseases and disorder. *Solanum nigrum* plant fruits showed brown color dye was used to dye a cloth worn by the royals in early days known as 'Khamen chatpa'. All brown dyes are reported part of flavonoids and dyeing brown and black hues. Natural dyes are included in the categories of flavonoids, tannins, terpenoids, naphthoquinones, anthraquinones, and alkaloids. Terpenoids or moprenoids form important Flavonoids from purple flowers of *Solanum xanthocarpum* are nothing but Flavonoid dyes that are usually mordant dyes that are precipitated with Shinoda showed pink scarlet, crimson red as per the concentration of reagent used and change in colour observed after 5-10 min was greenish to blue. Also, it changes as per metals used in regents preparation [26] . It contains exogenous antioxidant compounds for animals and humans. It plays important roles in light harvesting, photo-protection and antioxidation flavonoids reduce pain perception. Naphthoquinones and anthraquinones are aromatic compounds that comprise a number of strong, red; Alkaloids contain nitrogen responsible for indigo and Tyrian purple.

Glycosides basic positions in their protein molecules and also minimizes allergic reactions due to textile/fibric category of natural products. The kopentane, isoprene, or C5 unit is the biochemical building stone for these compounds. Crocetin, from saffron, are equally important as a food ingredient. All colours are due to presence of functional group. S. *xanthocarpum* flavonoid shown the function group which are responsible for colour in flower.

Flavonoids and carotenoids are naturally occurring pigments present in the plants and other types of photosynthetic organisms. It plays important roles in photo-protection, light harvesting, and antioxidation [27-28] .They are exogenous antioxidant compounds for humans and animals through daily consumption of a diet of, vegetables, fruits and grains[29–33] . Flavonoids reduce pain perception was due to its free radical scavenging activity as these free radicals are involved during pain stimulation[33] .Proteins showed white precipitation with millones test while as amino acids exhibited violet colour with ninhydrin which is same in Molisch test indicating glycoprotein but Fehling solution has been showed the brick red colour, But Salkowski procured yellow colour terpenoids. All whole as plant *Solanum xanthocarpum* extract changes its characteristic as per its preparation in various solvent such as aqueous, ethanol, methanol, petroleum ether, ethyl acetate, chloroform etc.

CONCLUSION:

Natural dyes are more constructive, ecofriendly, renewable, cost efficient and observed harmless with soothing effect. They have various medicinal properties. Due to nontoxic, non-carcinogenic, and non-allergic nature it is popular among natives for dyeing textile, paper, cosmetics, and food. Hence to fill demand-supply gap of colour bearing plant production necessarily improved. Ultimately, natural dyes may be beneficial to medicinal, and environmental /synthetic chemistry and enhance the severance to society for it large scale production and reducing pollution problems by synthetic dyes. Hence, recent years have seen renewed interest in dyes that are derived from natural sources.

REFERENCES:

[1]Mahanta D and Tiwari S C, Natural dyes yielding plants and indigenous knowledge on dye preparation in Arunachal Pradesh, North East India, Curr Sci, 2005, 88, 1474-1480.

[2.] Sara Kadolph, Natural Dyes: A Traditional Craft Experiencing New Attention, The Delta Kappa Gamma Bulletin, 2008, page no:14.

[3.] Hernandez-Ceruelos,A.,E.Madrigal -Bujaidar and C.deLa cruz, Inhibitory effect of chamomile essential oil on the sister chromatid exchanges induced by daunorubicin and methyl methane sulfonate in mouse bone marrow,Toxic.Let.,2002,135:103.

[4].Chitra Devi T., Ravikumar R., Kavita N. and Sudarshana Deepa V., Impact of agitation for the color removal from dye effluent using isolated fungal species, J. Environ. Res. Develop., 7(4A), 1559-1564, (2013).

[5]Naik D. J., Deasi H. H. and Desai T. N., Characterization and treatment of infected wastewater generated from dyes and dye intermediates manufacturing industries of Sachin industrial area, Gujarat, India, J. J. Environ. Res. Develop. Journal of Environmental Research And Development Vol. 8 No. 3A, January-March 2014 687 Environ. Res. Develop., 7(4A), 1602-1605, (2013).

[6.] Goyal Varsha, Sudesh and Singh Seema, Physico-chemical analysis of tentile effluents of dye and printing clusters of Bagru region, Jaipur, India, J. Environ. Res. Develop., 8(1), 11-15, (2013).

[7]. Balamurugan B. and Kannad asan T., Photocatalytic oxidation of anaerobically degraded reactive red dye bath effluent, J. Environ. Res. Develop., 7(2A), 827-837, (2012).

[8]Harivaindaran KV, Rebecca OPS, Chandran S. tudy of optimal temperature, pH and stability of Dragon fruit (Hylocereus polyrhizus) peel as potential natural colorant. Pak J Biol Sci 2008; 11(18): 2259-2263.

[9] Asma Inayat, Shahid Rehman Khan, Amran Waheed and Farah Deeba, Proc. Pakistan Acad. Sci., 2010 47(3), 131-135.

[10] A Purrohit, S. Mallick. A.Nayak, N.B.Das, B.Nanda and S.Sahoo, Current science, 2007, Vol. 92, No.12.

[11].R. Siva, Status of natural dyes and dyeyielding plants in India, Current science, vol. 92, April 2007, no. 7, 10.

[12]. Kim HK, Park SK, Zhou JL, Taglialatela G, Chung K, et al. (2004) Reactive oxygen species (ROS) play an important role in a rat model of neuropathic pain. Pain 111: 116-124.

[13] Joylani D. Saikhom , Jekendra S. Salam, Kumar S. Potshangbam , Manabendra D. Choudhury, Haripriya D.Maibam iochemical Studies in Several Dye Yielding Plants Not Sci Biol, 2013, 5(3):303-308

[14] Gerson, H., Fungi toxicity of 1,4-napthoquinones to Candida albicans and Trichophyton mentagrophytes. Can. J. Microbiol., 1975, 21, 197–205.

[15]. Schuerch, A. R. and Wehrli, W., b-Lapachone, an inhibitor of oncornavirus reverse transcriptase and eukaryotic DNA polymerase inhibitory effect, thiol dependence and specificity. Eur. J. Biochem., 1978, 84, 197–205.

[16] Wagner, H., Kreher, B., Lotter, H., Hamburger, M. O. and Cordell, G. A., Structure determination of new isomeric naphthol[2,3,- b]furan-4,9-diones from Tabebuia avellanedae by the selective INEPT technique. Helv. Chim. Acta, 1989, 72, 659–667.

[17] Singh, R., Jain, A., Panwan, S., Gupta, D. and Khare, S. K., Antimicrobial activity of natural dyes. Dyes Pigm., 2005, 66, 99–102.

[18] Clinton, S. K., Lycopene: Chemistry, biology, and implications for human health and disease. Nutr. Rev., 1998, 56, 35–51.

[19] Rao, A. V. and Agarwal, S., Role of lycopene as antioxidant carotenoid in the prevention of chronic diseases. Nutr. Res., 1999, 19, 305–323.

[20]Giovannucci, E., Tomatoes, tomato-based products, lycopene and cancer: Review of the epidemiologic literature. J. Natl. Cancer Inst., 1999, 91, 317–331.

[21.] Al-Maiman, S. A., & Ahnad, D., Changes in physical and chemical properties during pomegranate (Punica granatum L.) fruit maturation. Food Chemistry, 76, 2002,437– 441.

[22.]Adhami, V. M., & Mukhtar, H,. Polyphenols from green tea and pomegranate for prevention of prostate cancer. Free Radical Research, 40, 2006, 1095–1104.

[23]Bell, C., & Hawthorne, S. Ellagic acid, pomegranate and prostate cancer – A mini review. Journal of Pharmacy and Pharmacology, 60, 2008, 139–144.

[24.] Reddy, M. K., Gupta, S. K., Jacob, M. R., Khan, S. I., & Ferreira, D.,Antioxidant, antimalarial and antimicrobial activities of tannin-rich fractions, ellagitannins and phenolic acids from Punica granatum L. Planta Medica, 73,2007,461–467.

[25] .Hussein, S. A. M., Barakat, H. H., Merfort, I. and Nawwar, M. A. M., Tannins from the leaves of Punica granatum. Photochemistry, 1997, 45, 819–823.

[26]Nilapu Nilima,Naikwadi Gajanan Devidas, Muvvala Sudhakar, Jadhav Kiran V. preliminary phytochemical investigation on the leaves of *Solanum xanthocarpum* International J.of Research in Ayurveda and Pharmacy. 2011, 2(3) 845-850.

[27]. Demmig-Adams, B.; Adams, W.W., III. Antioxidants in photosynthesis and human nutrition. Science 2002, 298, 2149–2153.

[28]. Pietta, P.G. Flavonoids as Antioxidants. J. Nat. Prod. 2000, 63, 1035–1042.

[29] Beutner, S.; Bloedorn, B.; Frixel, S.; Blanco, I.H.; Hoffmann, T.; Martin, H.-D.; Mayer, B.; Noack, P.; Ruck, C.; Schmidt, M.; et al. Quantitative assessment of antioxidant properties of natural colorants and phytochemicals: Carotenoids, flavonoids, phenols and indigoids. The role of β-carotene in antioxidant functions. J. Sci. Food Agric. 2001, 81, 559–568.

[30.] Ruck, C.; Schmidt, M.; Frixel, S.; Ernst, H.; Walsh, R.; Martin, H.-D. Assessment of Carotenoid Function during Antioxidant Activity. Special Publication in Biologically-Active Phytochemicals in Food Analysis, Metabolism, Bioavailability and Function; Royal Society of Chemistry: Cambridge, UK, 2001.

[31] Buer, C.S.; Imin, N.; Djordjevic, M.A. Flavonoids: New roles for old molecules. J. Integr. Plant Biol. 2010, 52, 98–111.

[32]. Paiva, S.A.; Russell, R.M. β-Carotene and other carotenoids as antioxidants. J. Am. Coll. Nutr. 1999, 18, 426–433.

[33] Roshy Joseph C1, Ilanchezhian R , Patgiri BJ THERAPEUTIC POTENTIALS OF KANTAKARI (Solanum xanthocarpum Schrad. & Wendl.) Ayurpharm Int J Ayur Alli Sci., Vol.1, No.2 (2012) Pages 46 – 53.