ISSN: 2456–5474 RNI No.UPBIL/2016/68367 Vol-3* Issue-1*February- 2018
Innovation The Research Concept

Natural Dyes-Need of Future: A Review with Green Chemical Aspects and Antimicrobial Properties

G. Joshi
Research Scholar,
Deptt.of Chemistry,
Pacific Academy of Higher Education and Research Institute,
Udaipur, Rajasthan

G. Vyas
Assistant Professor,
Deptt.of Chemistry,
New Govt. College,
Kansabel, Jashpur, C.G.

N. Bhojak
Associate Professor,
Deptt.of Green Chemistry,
Research Centre,
Gov. Dungar College,
Bikaner, Rajasthan

Abstract

Due to the harmful effects created by synthetic dyes, environmental awareness created by researchers as well as the others, and many other green chemical aspects, Natural dyes from plants have been given much interest in recent years. Dyes derived from natural sources have emerged as an important alternative to synthetic dyes. Water pollution due to effluents from industries particularly textile dyeing industry is a cause of serious concern. India has a rich biodiversity and harbours a wealth of useful germplasm resources and there is no doubt that the plant kingdom is a treasure-house of diverse natural products. One such product from nature is the dye. Dyes are one of the most important uses of the plants. Natural dyes are derived from naturally occurring sources such as plants, insects, animals and minerals. Several synthetic colorants have been banned because they cause allergy-like symptoms or are carcinogens. In present paper review has been done on Natural Dyes, decolorizing effect, Extraction Methods, Analytical Methods etc.

Keywords: Extraction, Natural Dye, Antimicrobial Activity Plants.

Introduction

A Various plant species such as (e.g., indigo and saffron); insects (e.g., cochineal beetles and lac scale insects); and also animal species (e.g., some species of mollusks or shellfish) are main source of origin of natural dyes.Some minerals (e.g., ferrous sulphate, ochre, clay etc.) also responsible for occurring natural dyes. The colours of natural dyes are absorbed 400-800 nm visible rigeon. The constituents of the colouring pigment/ molecules contain various chromophores present in the dye yielding plant to display the plethora of colours. The current preference for naturally derived colorants is due to their healthfulness and excellent performance. A lot of synthetic dyes has been banned due to their hazardous symptoms in human body and also flora and fauna. (1). Due to the no side effects of Natural dyes may also use in cosmetic products. UV protection and anti-aging properties. Various types of plants used in dyes for their dye-yielding characteristics in india. A lot of plants having medicinal value and also dyes such as turmeric which has yellow dye and also antiseptic which revitalizes the skin, while indigo gives a cooling sensation. A lot of Plant has used for extraction of natural dyes like Punica granatum L. And various types of plant extracted dyes used as a antimicrobial and anti fungal properties.

Aim of the Study

Dyes are very important part of our daily life due to their rich diversity of colours. Both Synthetic as well as Natural dyes are using all over the world. In past few years Synthetic dyes are becoming more popular and common than the corresponding Natural Dyes. The harmful effects created by synthetic dyes are very dangerous for our future so researchers and others have been given much interest in Natural dyes from plants. So the aim of present review study is to point out some important areas regarding Natural Dyes, such decolorizing effect, extraction methods, effluents from industries analytical methods etc, from which we can try to solve the problems created by Synthetic Dyes.

Grover et al. have been worked on the dye yielding plant species, Woodfordia fruticosa (Linn.) Kurz is exploited particularly, in perfume, leather and textile industry. It has been also described that the extraction of natural dyes from this species, commonly known as Fire-Flame Bush, and their application on textiles. Three different types of

fabrics as well as yarns have been used in the experiment to observe the strength of dye. Cotton Jute mix sample showed dark yellowish brown colour with Myrobalan, dark blackish brown colour with Ferrous Sulphate, Camel colour with Stannous Chloride and Yellowish brown with Potassium dichromate[1].

Methanolic extract of seven different plants i.e. Aloe vera, Azadirachta indica, Bixa orellana, Curcuma longa, Punica granatum, Quercus infectoria, and Thymus Vulgaris extracts have been utilized by Lekshmi et al. These fabrics have been mordanted with Alum acetate/acetic acid for fastening of the imparted colours. These extracts have also been qualitatively analyzed for the major phytochemical components present in it. All the extracts have been found certain bioactive components like Tannins, Saponins, and terpenoids etc[2].

Almahy et al. have been worked on extraction of Water, methanol and acidified methanol which used as solvent to extract Carotenoids as the natural dyes from plant, as well as dyeing industries. Analytical studies such as UV-VIS spectrophotometry and gravimetric analysis have also been performed on the extract. Several mordants have also been used for fixing the colour on the fabrics. It has been also proved that the dyes obtained from the plant may also be alternative sources to synthetic dyes for the dyeing of natural silk fibre. Therefore Almahy et al. have been suggested that this methodology could be employed for extracting coloring materials from plant materials in a faster and effective manner[3].

Ratna et al. have been worked on the techniques for detection of dyes and also detecting each chemical individually and they advised to study the toxic effect of the effluents on various living organisms. Various techniques of toxicity and carcinogenicity measurements have been reviewed. Remediations using physical, chemical and biological methods have also been critically reviewed[4].

Sharma et al. have been emphasized on the low cost adsorbents obtained from agricultural waste products and found their outstanding removal capabilities. They have also reviewed the suitability of both raw and chemically modified agricultural products in the decolourisation of synthetic dyes[5].

Chengaiah et al. have been obtained Natural dyes from naturally occurring sources such as plants, insects, animals and minerals. Among the all natural dyes, plant-based pigments have wide range of medicinal values. Plenty of the plants have been used for dye extraction and some of these have recently been shown to possess remarkable antimicrobial activity. Chengaish et al. explained in their review paper about the detailed information about basic chemistry of the major pigments and their medicinal importance found in naturally occurring dye yielding plants, which are helpful to further development of pharmaceutical formulations[6].

Saravanan et al. have been worked on dyeing with natural dye from barks of Odina wodier, L. Odina; wodier.L belongs to family Anacardiaceae, commonly known as votiyar tree. In the present study, bleached cotton fabrics have been dyed with chemical and natural mordants. Dyeing was carried out by pre-mordanting, post mordanting and simultaneous mordatning. The various colours have been measured by computer colour matching software. ICPMS studies have been proved that, heavy metals such as antimony, arsenic, cadmium and lead has not presented in the dye extract. Anti-bacterial and anti-fungal activities of the dye have been also studied[7].

Forootanfar et al. have been worked on Decolorization of six synthetic dyes using three sources of fungal laccase with the origin of Aspergillus oryzae, Trametes versicolor, and Paraconiothyrium variabile. Among them, the enzyme from P. variabile was the most efficient which decolorized bromophenol blue (100%), commassie brilliant blue (91%), panseu-S (56%), Rimazol brilliant blue R (RBBR; 47%), Congo red (18.5%), and methylene blue (21.3%) after 3 h incubation in presence of hydroxybenzotriazole (HBT; 5 mM) as the laccase mediator. It has also been observed that decolorization efficiency of all dyes was enhanced by increasing of HBT concentration from 0.1 mM to 5 mM. Laccase from A. oryzae was able to remove 53% of methylene blue and 26% of RBBR after 30 min incubation in absence of HBT, but the enzyme could not efficiently decolorize other dyes even in presence of 5 mM of HBT. In the case of laccase from T. versicolor, only RBBR was decolorized (93%) in absence of HBT after 3 h incubation[8].

Daniel et al. have been described the history of indigo dye and its derivative Tyrian purple. Indigoids are natural dyes that have been produced for centuries, and indigo is currently the most produced dye worldwide. Herein we review the history of these materials, their chemistry and physical properties, and their semiconducting characteristics in the solid state. Due to hydrogen bonding and p-stacking, indigo and Tyrian purple form highly-ordered crystalline thin films. Such films have been used to fabricate high-performance organic field-effect transistors with ambipolar charge transport, as well as complementary-like circuits. With performance on par with the best available organic semiconductors, indigoids demonstrate the potential of sustainable electronics based on biodegradable and biocompatible materials[9].

Ngieng et al. have been isolated twenty endophytic fungi from Melastoma malabathricum (Senduduk).It has been examined for their ability to decolourise azo dyes: Congo red, Orange G, and Methyl red and an anthraquinone dye, Remazol Brilliant Blue R. Initial screening on the glucose minimal media agar plates amended with 200 mg L−1 of each respective dye showed that only isolate MS8 was able to decolourise all of the four dyes. The isolate decolourised completely

both the RBBR and Orange G in the agar medium within 8 days. Further quantitative analysis of the dye decolourisation by isolate MS8 in aqueous minimal medium showed that isolate MS8 was able to decolourise all the tested dyes at varying levels[10].

Forgacs et al. have been worked on the recent methods for the removal of synthetic dyes from waters and wastewater. The various methods of removal such as adsorption on various sorbents, chemical decomposition by oxidation, photo degradation, and microbiological decoloration, employing activated sludge, pure cultures and microbe consortiums has been described. The advantages and disadvantages of the various methods are discussed and their efficiencies have been compared[11].

Bianchini et al. have been worked on naturalize synthetic azadyes through their linkage with lactose to induce their water solubility. Glyco-azadyes (GADs) have been obtained through a diether linker to bond the azadye and the sugar. Tinctorial tests have been carried out with fabrics containing wool, polyester, cotton, nylon, and acetate. GADs have been found to be multipurpose and capable of dyeing many fabrics efficiently under mild conditions[12].

Rangabhashiyam et al. have been explained the physical, chemical and biological methods for the textile dye effluent treatment, particularly focused on the importance of laccase, an effective enzyme for dye degradation through the various fungal source, the different classifications of the textile dye and the textile dye degradation[13].

Adinew et al. have been explained that the Textile industry consumes large volume of water and produce large amount of wastewater during all phases of textile production and finishing. The release of colored effluents represents a serious green pollution. Color removal, especially from textile effluents, has gargantuan challenge over the last decades, and up to now there is no single and cost-effectively attractive treatment that can effectively decolourise as well as treat the dyes effluents. The objective of this review article is to discuss a variety of textile wastewater treatment techniques (physical, chemical and biological techniques) from the environmental point of view[14].

Rungruangkitkrai et al. have been reported the studies available on the ultra violet (UV) protection property of natural dyes; antibacterial and deodorizing properties of natural dyes; application of natural dyes for textile printing; effect of different mordants and mordanting method; ultrasonic method of natural dyeing. Dyeing with natural dyes using padding techniques; thermodynamics and kinetics of dyeing with natural dyes have also been discussed[15].

Wanyama et al. have been determined the toxicological capability of Albizia coriaria, Morinda lucida and Vitellaria paradoxa selected Ugandan dye-yielding plants in normal textile use. Crude aqueous dye have been extracted from the three potential dye plants were tested using the Acute Dermal Toxicity test administered on healthy albino wistar rat models in accordance with the OECD test guidelines for analysis of chemicals no. 402(1987). None of the tested crude dye extracts caused dermal irritation effects at sites of application even up to the high dose levels of 5000mg/kg bogy weight. Based on these investigations, a risk to exposure and use of textiles dyed with crude extracts of Morinda lucida (root), Vitellaria paradoxa (bark) and Albizia coriaria (bark) must not be anticipated. Thus, topical application of ethanol extracts can be successively formulated for the toxicological evaluation of natural dye activity in the textile industry[16].

Aberoumand et al. reviewed that Natural colorants are usually extracted and concentrated using either water or lower alcohols for water-soluble pigments and organic solvents for lipophilic pigments[17].

Zuraida et al. study used biological method to explore the usability of the microorganisms i.e. bacteria, Lactobacillus delbruckii for the removal of two commercial synthetic dyes i.e. Reactive orange 16 (RO 16) and Reactive black 5(RB 5) from aqueous solutions. The effects of different parameters such as pH, temperature and initial dye concentration were studied and the effectiveness of this method to remove the dye solution was determined by measuring the percentage of colour removal. The results showed that the bacteria are able to decolorize these two reactive dyes and the optimum pH, temperature and initial dye concentration were found to be 10 ppm, 6 and 37°C, respectively. Therefore, Lactobacillus delbruckii is a tremendous potential strain for decolourization of reactive textile dye effluent, and it can be used as a practical alternative in the treatment of textile wastewater to achieve effluents that congregate the Malaysian emissions standards [18].

Dayaram et al. have been worked on decolorisation of 4 Reactive dyes which commonly found in the effluents such as Reactive blue, Reactive orange, Ramazol black and Congo red. It has been examined by treatment with enzyme from Polyporus rubidus. Treatment of effluent has been done in a laboratory scale bioreactor constructed with laccase immobilized Na-alginate beads. Greater than 80% of dyes were degraded within 5 days under stationary incubation conditions. In this study the Polyporus rubidus has been reported for the first time to have laccase activity offering a promising possibility to develop an easy and cost effective method for degradation of dangerous dyes[19].

Rymbai et al. have been prepared Biocolorants from renewable sources and majority is of plant origin. The main food biocolorants are carotenoids, flavanoids, anthocyanidins, chlorophyll, betalain and crocin, which are extracted from several horticultural plants. In addition to food coloring, biocolorants also act as antimicrobials,

antioxygens and thereby prevent several diseases and disorders in human beings. Although, it is presumed that with the use of modern techniques of biotechnology, these problems in extraction procedures will be reduced, yet to meet the growing demand, more detailed studies on the production and stability of biocolorants are necessary while ensuring biosafety and proper legislation [20-21].

Mirjalili et al. have been investigated antibacterial activity of some natural dyes- Curcuma longa rhizome (turmeric), walnut, and henna.The viscose rayon fabrics have been dyed with different mordant at a variety of conditions. The dyed fabric and treated fabric with Ag nanoparticles have been evaluated for antibacterial activity against pathogenic strain of Gram-negative (Escherichia coli) bacteria. The results indicated that treated fabrics with these natural dyes had excellent antibacterial activity as well as Ag nanoparticles before and after wash [22].

Khare et al. have been done an exploratory study to test if some natural dyes have inherent antimicrobial activity with a view to develop protective clothing from these. Four natural dyes have been tested against common pathogens *E.ichia* coli, Bacillus subtilis, Klebsiella pneumoniae, Proteus vulgaris and Pseudomonas aeruginosa. The result showed that Quercus infectoria dye was most effective and showed maximum zone of inhibition thereby indicating best antimicrobial activity against all the microbes tested. Minimum inhibitory concentration has been found to be varying from 5 to 40 µg [23].

Conclusion

As per the present review study regarding Natural and Synthetic Dyes we can see the various harmful effects of Synthetic Dyes. So it is very necessary to minimize the use of Synthetic dyes, but for this we need thorough research on natural dyes for its alternative. In addition to this more decolorizing agents are also required to solve the problems of effluents from industries.

References

1. *N.Grover and V. Patni, Ind. J. of Nat. Prod. and Res., 2011, 2, 403-408.*
2. *D. Lekshmi R. B and D Ravi, IJTFT, 2013, 3, 53-60.*
3. *H.A. Almahy and M.A. Ali, Res. J. of Chem. Sc., 2013, 3, 63-66.*
4. *Ratna, Padhi. B.S, Int. J.of Env. Sc, 2012, 3, 940-955.*
5. *N.Sharma,D.P.Tiwari, and S.K.Singh, Int. J. of Sc. & Engg. Research, 2012, 3, 1-10.*
6. *B. Chengaiah, K. M. Rao, K. M. Kumar, M. Alag. and C.M. Chetty, Int.J of Pharm.Tech Res., 2010, 2, 144-154.*
7. *P.Saravanan, G.Chandramohan, S.Saivaraj and D. Deepa, J. Nat. Prod. Plant Resour., 2013, 3, 80-85.*
8. *H. Forootanfar, A. Moezzi, M. Aghaie-Khozani, Y. Mahmoudjanlou, A. Ameri, F. Niknejad and M. Ali Faramarzi, Iranian. J of Env. Health Sci.& Engg. 2012, 9(27), 1-10.*
9. *E. Daniel,G G Leonat, M. Irimia-Vladu, S.Bauer, and N. S. Sariciftci, Israel Journal of Chemistry. 2012, 1-12.*
10. *N.S.Ngieng,A.Zulkharnain,H.A.Roslan and A.Husaini, Biotechnology, Article ID 260730, 2013, 1-7.*
11. *E. Forgacs,T. Cserha´ ti ,G. Oros, Elsevier. 2004, 953-971.*
12. *R. Bianchini, G. Catelani, E. Frino, J. Isaad and M. Rollaa, Bioresources 2007, 2(4) 630-635.*
13. *S Rangabhashiyam, N. Anu and N.Selvaraju, Res. J. of Chem. and Env., 2013, 88-95.*
14. *B. Adinew, Bulg, J. of Sc. Ed., 2012, 21(3) 434-456.*
15. *N. Rungruangkitkrai, R. Mongkholrattanasit, RMUTP Int. Conference: Textiles & Fashion 2012 July 3-4, Section- 2012, 3, 1-17, Bangkok Thailand.*
16. *P.Wanyama,B.Kiremire, International Journal of Natural Products Research, 2012), 1(2), 16-20.*
17. *A. Aberoumand., World Journal of Dairy & Food Sciences, 2011, 6(1), 71-78.*
18. *S. Zuraida, C.R. Nurhaslina, K. Halim, IRJES, 2013, 2(5), 1-7.*
19. *P. Dayaram and D. Dasgupta, J of Env. Bio. 2008, 3(2), 831-836.*
20. *H.Rymbai,R.R.Sharma, M. Srivastav, Int. J. of PharmTech Research, 2011, 3, 2228-2244.*
21. *A.K. Indrayan, N.Bhojak, Nikhil Kumar, A. Shatru and A.Gaur, Ind Journal of Chemistry, 2011, 50B, 1136.*
22. *Mirjalili, M. & Abbasipour, M., J Nanostruct Chem, 2013, 3, 37.*
23. *Khare S.K., Gupta D., Panwar S., Singh R., Jain A., Dyes and Pigments, 2005, 66(2), 99-102.*