Chapter 3
Toxicology of Dyes

Aarti Singh
Indian Pharmacopoeia Commission, India

Anupama Mittal
Indian Pharmacopoeia Commission, India

Nirmala Kumari Jangid
Banasthali Vidyapith, India

ABSTRACT

Colours play a prominent and dominant role in human life. The dominating feature of any product has been found with its colours elevating the market of colouration in different sectors. Studies have shown that around 10,000 dyes are being circulated in market. Chemistry has been found to lead this industry of colours. Vast production of fabric colours include azo dyes, whereas anthroquinone is also one of the prevailing complexes for cotton and fabric dyeing. The toxic level of the dyes and pigments are not confined till manufacturing but also have after usage effect of the products. It has been found that the chemicals have a carcinogenic effect on human health. During the manufacturing procedure, around 50% of dye stuff gets along with the effluents of the industry leading to release of colourful water. Modification in choice of chemicals is being considered to lessen the toxic effects of existing complexes. This chapter is mainly focused on the toxicology of dyes.

INTRODUCTION

The two major types of colorants or dyestuffs produced today are dyes and pigments. Dyes are coloured organic (i.e., they contain carbon) compounds that are used to impart color to various substrates, including paper, leather, fur, hair, drugs, cosmetics,
Toxicology of Dyes

waxes, greases, plastics and textile materials (Sivashankar et al. 2014). Pigments which are finely ground solids dispersed in a liquid, such as paint or ink, or blended with other material pigments may be inorganic compounds (i.e., they do not contain carbon) or organic compounds they generally give brighter colours.

Dyes possess colour because they:

1. Absorb light in the visible spectrum (400–700 nm),
2. They possess at least one chromophore (colour-bearing group that can undergo π-π* and n-π* transitions)
3. They have a conjugated system, i.e. a structure with alternating double and single bonds
4. They exhibit resonance of electrons, which is a stabilizing force in organic compounds

When any one of these features is lacking from the molecular structure the color is lost. In addition to chromophores, most dyes also contain groups known as auxochromes (color helpers that cannot undergo π-π* transitions, but can undergo transition of n electrons), examples of which are carboxylic acid, sulfonic acid, amino, and hydroxyl groups (Anna 2014). Auxochrome are not responsible for colour, their presence can shift the colour of a colorant and they are most often used to influence dye solubility.

In Indian chemical industry dyes and dye intermediates industry is an important sector that has grown at a very fast pace (Gonawala & Mehta 2014). India is now the second largest producer of dyes and intermediaries in Asia. Today dyes are being used by almost every industry producing household goods, food, textile paints, paper, pulp, printing etc. The release of toxic and hazardous dyes from these industries has created a global concern due to their huge toxicity toward mankind. Many dyes and pigments are toxic and have carcinogenic and mutagenic effects that affect aquatic biota and also humans (Mathur et al., 2014). Color blocks light penetration which delay the photosynthetic activity and also has a tendency to chelate metal ions which result in micro-toxicity to fish and other organisms. The dyes undergoing oxidation and reduction in water which produces toxic and hazardous intermediates/substances which further increase need for their removal from wastewater. The remnants of dyes in water pose serious problem during water purification process (Pirkarami & Olya 2017). The dyes are being designed with combination of complexes which when leach out in water do not get break down and mark their existence for a very long period of time which disturb the water ecosystem. Presence of dyes in water is serious concern as a high concentration of water being affected by these dyes. In addition, food has also become a huge market for dye industries. Food market use dyes in high concentration to make food more attractive and colourful. The chemicals
GIS Approach for Collaborative Monitoring and Prediction of Environmental Noise in Urban Areas
www.igi-global.com/chapter/gis-approach-for-collaborative-monitoring-and-prediction-of-environmental-noise-in-urban-areas/213006?camid=4v1a

Understanding Glacial Retreat in the Indian Himalaya: Historical Trends and Field Studies from a Large Glacier
www.igi-global.com/chapter/understanding-glacial-retreat-in-the-indian-himalaya/171249?camid=4v1a