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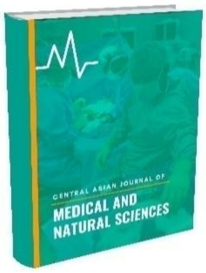

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Impact of Textile Wastewater on Water Quality

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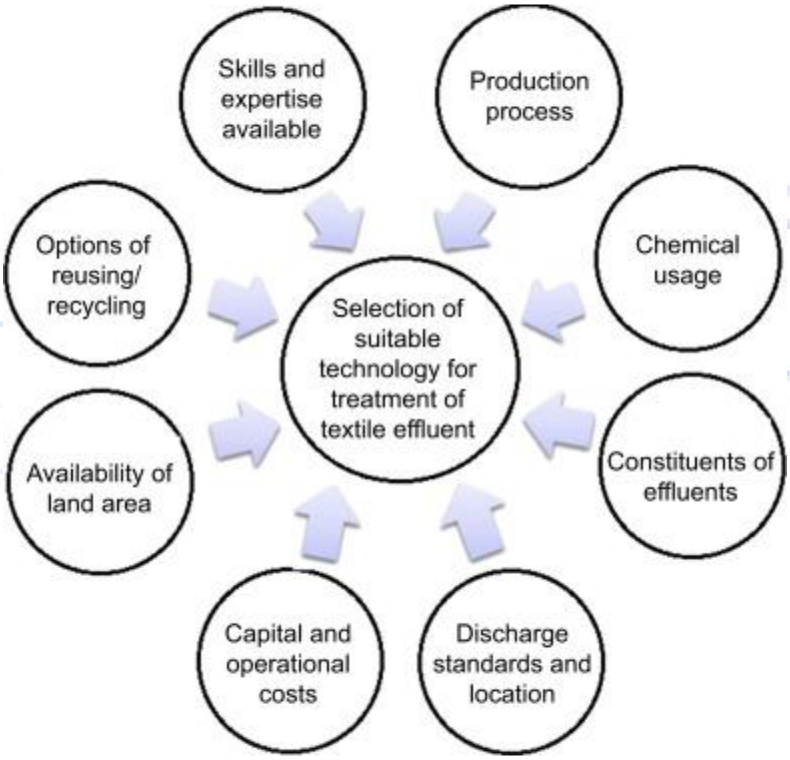
Annotation: Textile wastewater has a high pH value, high concentration of suspended solids, chlorides, nitrates, metals like manganese, sodium, lead, copper, chromium, iron, and high BOD and COD value .The water also has a dark-brown color. The concentration of different contaminant species varies with source of wastewater. Different stages of operation contribute wastewater of various composition. The difference in composition is due to the variation in processes and to the type of fabric produced and machinery in use. The textile sector requires a high demand of water for its various sectors, and the discharge from these sectors causes environmental damage due to the species of contaminants it carries along with it. The most notable environmental impact is water consumption and wastewater discharge (115–175 kg of COD/ton of finished product, a wide range of organic chemicals, color, salinity, and low biodegradability) . The textile dyes significantly compromise the aesthetic quality of water bodies, increase biochemical and chemical oxygen demand (BOD and COD), impair photosynthesis, inhibit plant growth, enter the food chain, provide recalcitrance and bioaccumulation, and may promote toxicity, mutagenicity and carcinogenicity. In spite of this, the bioremediation of textile dyes, that is, the transformation or mineralization of these contaminants by the enzymatic action of plant, bacteria, extremophiles and fungi biomasses is fully possible. Another option is the adsorption.

Keywords: textile, wastewater, BOD, COD, effluents, bioremediation, human, biomass, fungi.

Despite some disadvantages, the bioremediation is essentially positive and can be progressively enhanced by modern biotechnological techniques that are related to the generation of more degrading and more resistant engineered organisms. This is a sustainable solution that provides a fundamental and innovative contribution to conventional physicochemical treatments. The resources of environmental biotechnology can, therefore, be used as tangible technological solutions for the treatment of textile dye effluents and are related to the ethical imperative of ensuring the minimum necessary for a quality life for the humankind.

Introduction

Different treatment methodologies have been employed to treat textile wastewater, such as adsorption, ion exchange, membrane filtration [reverse osmosis (RO), ultrafiltration (UF) and nanofiltration (NF)], ozonation, evaporation (multiple-effect evaporation, mechanical vapour compression and direct contact evaporation) electrochemical oxidation, flocculation, phytoremediation, photochemical and crystallization. Among these different methods, the selection of a suitable methodology for effective treatment depends entirely on several categories. Technologies performed for textile wastewater treatment are mainly divided into three categories: (1) separation and concentration processes, (2) decomposition and degradation processes and (3) exchange processes



Inflow water quality parameters of the prepared synthetic wastewaters, which include fertilizer and textile dye. These parameters compared well with the typical characteristics of textile wastewater . Only the pH and the color values were within the typical range of 6–10 and 50–2500 Pt Co, respectively. The dye inflow concentration was 5 mg/L lower than the typical range, but it compared well with concentrations used in the literature for the treatment of Brilliant Blue R , BR46 , and AB92 . In addition, the treated effluents in preliminary or secondary treatment stages are associated with concentrations lower than the textile factory outflow values.[1,2]

We have discussed the environmental costs of water pollution, but what about its impact on human life. Sadly, about 3,575,000 people die each year from waterborne diseases. Most of these numbers are children. Contaminated water in the textile industry may contain formaldehyde, chlorine and heavy metallic chemicals and when contaminated water is used for drinking and other purposes, people get infected with various diseases.

However, many of the world's leading companies, including Adidas, H&M, and Nike, are now working to reduce the effects of toxic substances on waterways. As a consumer, a powerful way to prevent this is through your shopping habits. Fashionable and cheap textiles may be amusing but they are not eco-friendly. These products are usually made using less expensive toxic chemicals that will contaminate the water in the pond after you wash them at home.Try to buy durable and high-quality products produced by ethical organizations that work to reduce water pollution. Contact them and see if they are treating their wastewater. Before you buy the tags of the textile products you see in the stores, take a quick look to see if the product is made environmentally friendly. We can prevent water pollution from the textile industry if we want. It is important to note, however, that we are currently working to reduce this at both the individual and corporate levels.[3,4]

There are also some ways to prevent water pollution

1. **By using natural resources**

Textiles made from natural sources such as plants or animals can have less impact on the environment. In addition to raw materials, dyeing products that are invented from plants, minerals and insects should be used. If natural is not affordable, look for a dye that will have less impact on the environment.

Some dyes that are safe for the environment are natural, biodegradable, azo-free coolants and fiber reactive dyes. An organization called Keycolor is making eco-friendly dyes in Bangladesh which is good news for us.

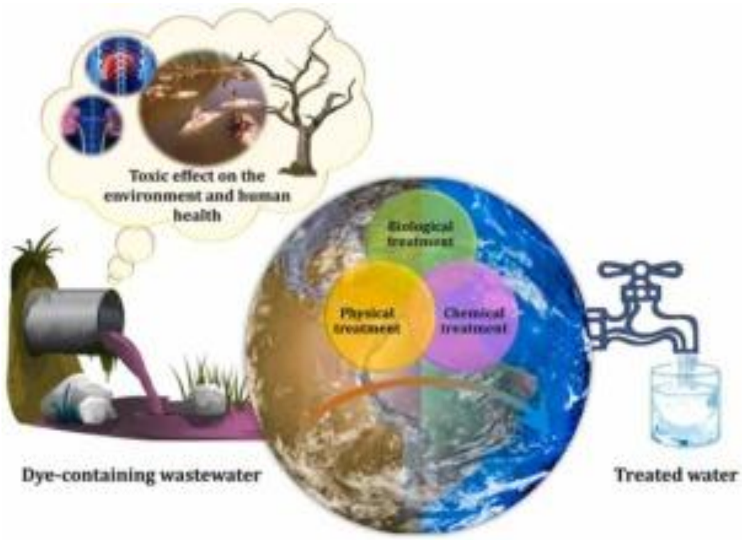
2. **Using sustainable materials for the production of textile products** Sustainable is a material that can be reproduced in a short time and helps prevent environmental pollution. Examples of sustainable sources include fiber such as hemp, bamboo, organic yarn, alpaca wool and soy silk. These use very small amounts of pesticides and dyes.

3. **By making reusable products**

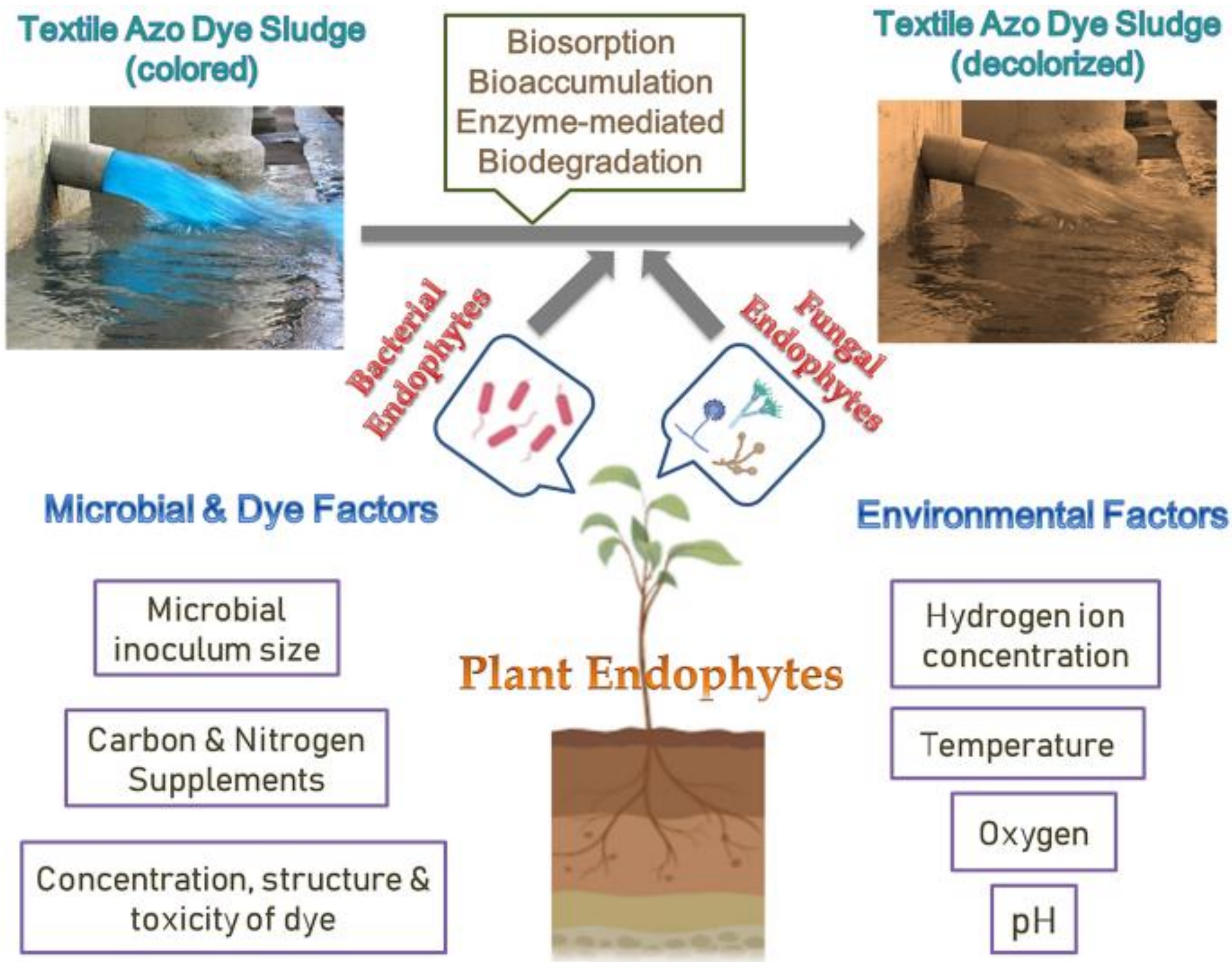
Clothes, linen, towels, etc. can be reused through recycling. Re-dyeing and restructuring can reduce the overall need for fabric and textile production, which ultimately reduces the impact of the industry on the environment.[5,6]

Discussion

The textile production industry is one of the oldest and most technologically complex of all industries. The fundamental strength of this industry flows from its strong production base of a wide range of fibers/yarns from natural fibers like cotton, jute, silk, and wool to synthetic/man-made fibers like polyester, viscose, nylon, and acrylic.



With escalating demand for textile products, textile mills and their wastewater have been increasing proportionally, causing a major problem of pollution in the world. Many chemicals used in the textile industry cause environmental and health problems. Among the many chemicals in textile wastewater, dyes are considered important pollutants. Worldwide environmental problems associated with the textile industry are typically those associated with water pollution caused by the discharge of untreated effluent and those because of use of toxic chemicals especially during processing. The effluent is of critical environmental concern since it drastically decreases oxygen concentration due to the presence of hydrosulfides and blocks the passage of light through water body which is detrimental to the water ecosystem. Textile effluent is a cause of significant amount of environmental degradation and human illnesses. About 40 % of globally used colorants contain organically bound chlorine, a known carcinogen.[7,8] Chemicals evaporate into the air we breathe or are absorbed through our skin; they show up as allergic reactions and may cause harm to children even before birth. Due to this chemical pollution, the normal functioning of cells is disturbed and this, in turn, may cause alteration in the physiology and biochemical mechanisms of animals resulting in impairment of important functions like respiration, osmoregulation, reproduction, and even mortality. Heavy metals, present in textile industry effluent, are not biodegradable; hence, they accumulate in primary organs in the body and over time begin to fester, leading to various symptoms of diseases. Thus, untreated or incompletely treated textile effluent can be harmful to both aquatic and terrestrial life by adversely affecting the natural ecosystem and causing long-term health effects.[9,10]



Treating and reusing (recycling) of industrial wastewater and using treated municipal water are proven strategies that can help industries conserve water and reduce their pollution footprint too.

Typically, a textile wastewater treatment system comprises of primary, secondary, and tertiary treatment units to remove the pollutants from the wastewater up to the level prescribed by the state/central regulatory bodies. Although, the organic pollutants are effectively removed by the conventional treatment technologies, the inorganic salts remain in the treated wastewater, which require high-end technologies to remove them and make the water fit for reuse in industry.

Zero Liquid Discharge (ZLD) approach offers an effective albeit costly solution.

Zero Liquid Discharge is an engineering approach in which the wastewater undergoes various stages of treatment essentially comprising of primary, secondary, Reverse Osmosis (RO) and thermal evaporation systems, and finally pure water and other useful resources are recovered for reuse, thus resulting in no wastewater discharge from the industry.

Generally, the need and viability of ZLD is decided by some key factors such as (i) Water cost, (ii) Water scarcity (iii) Regulations and iv) Input characteristic of the wastewater.

A ZLD based textile treatment plant can recover about 95-98% of pure water by volume and 80-90% of salts by weight from the wastewater. This makes it a highly desirable technology in the face of resource scarcity. Currently, the main drawback of ZLD systems is their prohibitive costs—a conventional tertiary treatment facility costs about Rs 4 crores per Million Litres per Day (MLD) capacity, whereas a ZLD system can cost nearly Rs 18 Crores/MLD. This huge difference in costs make it exceedingly difficult for small and medium enterprises to invest in this technology.

Entrepreneurs must also remember that ZLD is not a one-size-fit-all solution. The final choice of equipment and process flow determined by several factors such as volume of wastewater, types of salts in it, colours/dyes present, etc.[11,12]

The Central Government as well as various state governments have several schemes and incentives that can help the industry adopt water conserving and pollution prevention measures. The Integrated Processing Development Scheme (IPDS) helps Micro Small Medium Enterprises (MSME) textile wet processing units construct common treatment facilities, extending crucial financial help to these units who often lack funds to set up individual treatment facilities.

The government sometimes needs to enact regulations to nudge the industries in the direction of environmental sustainability. Considering the detrimental impacts of textile wastewater to the environment, the Tamil Nadu Pollution Control Board (TNPCB) had mandated textile processing units in Tirupur to adopt Zero Liquid Discharge (ZLD) System based effluent treatment plants to treat and reuse the wastewater in the dyeing process. This regulation was triggered by the deteriorating water situation in Tamil Nadu, which is receiving scanty rainfall since many years.

Some state governments and municipalities have created a system in which municipal sewage water is treated up to industrial grade and supplied to clusters in the vicinity of the municipalities. The city of Surat in Gujarat is one such example.

While the industry and government are the major players in water conservation and preventing pollution at a large scale, all stakeholders need to play their part in the fight against a looming water crisis around the globe. Consumers can exert a lot of influence on decision making in the private sector. If consumers demand sustainable products, i.e., products manufactured with less water, energy, less pollution, etc. and with no social injustice, brands and manufacturers will be forced to adopt good practices in their supply chains.[13,14]

Water stewardship is a holistic approach that underscores the importance of collaboration among all stakeholders. Water is a critical resource that can’t be managed effectively in isolation by individual stakeholders. The private sector (industry), government bodies, consumers, and even farmers need to come together and better allocate resources and responsibilities among themselves. This approach will ensure that the future generations aren’t deprived of this precious resource

Results

The synthetic dyes and pigments applied to textile finishing processes are numerous and diverse in terms of chromophore groups (Azo groups, anthraquinone groups, indigoids, xanthenes, phthalocyanines, nitroseds, triphenylmethanes and polymethines) and application techniques (Water-soluble dyes (Acidic, basic, metalliferous, reactive and direct dyes) and water-insoluble dyes (Vat dyes, sulfur dyes and dispersible)). The majority of these dyes are azo (60–70 %) characterized by high chemical stability with respect to chemicals and products due to the combination of azo groups with aromatic rings. The presence of these dyes and its residues in the effluents discharged into aquatic environments, as well as their relative biodegradability, have a negative impact on the environment and more particularly on aquatic ecosystems because of their toxic and carcinogenic effects as they occur. Accumulate throughout the food chain of aquatic fauna, on the one hand and dysfunctional physiological processes of aquatic flora (Plants, diatoms and algae) by disrupting their photosynthesis mechanisms by the lack of circulation of the oxygen and absorption of light in aquatic environments, on the other hand. Besides, these textile dyes must eliminate according to processes, which will be the interest of a future review, of biological, chemical, physical and physicochemical treatment before their evacuation in aquatic environments.

As the wastewater is harmful to the environment and people, there are strict requirements for the emission of the wastewater. The standards of the wastewater discharge (Table 1) There have far too many parameters due to the variation in the raw materials used, different types of dyes, technology and equipment. These standards are established by the national environmental protection department of Central Pollution Control Board (CPCB) depending upon the local surroundings and environmental safety necessities which are unfixed.[15,16]

Table 1: Textile industry standards for water

S. No.	Parameters	Standards
1	pH	6.9
2	BOD	30 ppm
3	COD	250 ppm
4	TDS	2000 ppm
5	Sulphide	2 ppm
6	Chloride	500 ppm
7	Calcium	75 ppm
8	Magnesium	50 ppm

The textile dyeing wastewater has a large amount of complex components with high concentrations of organic, high-color and changing greatly characteristics The textile wastewater generated from cotton dyeing industry is extremely polluted due to presence of reactive dyes which are not readily amenable to biological treatment. Color water causes scarcity in the light which is essential for the development of the aquatic organisms. As result, it leads to an imbalance in the environment. To reduce the treatment cost of the river water which is used the purpose of drinking; it should not have any color and toxic compounds. Therefore, before discharge of textile wastewater into river, many treatment processes including chemical, biochemical, physical, hybrid treatment processes have been developed to treat it in an economic and efficient way. These technologies are verified to be highly effectual for the treatment of textile wastewater [8].

1. Oxidation Methods

These are the most usually used methods of degradation of dyes by chemical means due to its easiness of application. These oxidation technologies can be categorized as advanced oxidation processes and chemical oxidation. These processes have the ability to degrade the toxic initial and their byproduct chemicals, dyes, pesticides, etc. either partly or completely under ambient conditions. Advanced oxidation processes (AOP) are the processes in which hydroxyl radicals are produced in adequate amounts. These hydroxyl radicals are powerful oxidizing agents. These oxidizing agents have an oxidation potential of 2.33 V and shows faster rates of oxidation reactions as compared conventional oxidants such as hydrogen peroxide or potassium permanganate. Hydroxyl radicals react with most dyes with high rate reaction constants [9].Chemical oxidation methods use oxidizing agents like O3 and H2O2. Ozone and H2O2 forms strong non-selective hydroxyl radicals at high pH values. These radicles due to this high oxidation potential can effectively break down the conjugated double bonds of dye chromophores as well as other functional groups such as the complex aromatic rings of dyes. Subsequent formation of smaller non-chromophoric molecules decreases the color of the effluents [10]. These methods are useful for double bonded dye molecules. These oxidizing agents have a low rate of degradation as equated to the AOP processes due to less production of hydroxyl radicals [9].

One major benefit of the ozonation is that ozone can be used in its gaseous state and consequently does not raise the volume of the wastewater and does not result into sludge generation. However, the major disadvantage of using ozone is that it may form toxic byproducts even from biodegradable dyes in wastewater [11].

Degradation of the dye is also possible by the combined treatment of UV light and the H2O2 due to the production of high concentrations of hydroxyl radicals. This combined method of UV light and the H2O2 is advantageous for dye- containing textile effluent due to no sludge production and reduction in foul odors. Here, UV light is used to activate the decomposition of H2O2 into hydroxyl radicals. These hydroxyl radicals cause the chemical oxidation of dye or organic material, mineralizing the same to CO2 and H2O. The parameters such as UV radiation intensity, pH, structure of dye molecule and the dye bath composition need to be optimized to get a more rate of dye removal [12], [13].

Biological Methods[17]

The biological process removes only the dissolved matter in textile wastewater. The removal efficiency is influenced by the ratio of organic load/dye and the microorganism load, its temperature, and oxygen concentration in the system. On the basis of oxygen requirement, biological methods can be classified into aerobic, anaerobic and anoxic or facultative or a combination of these.The biological methods for the complete degradation of textile wastewater have benefits such as: (a) eco-friendly, (b) cost competitive, (c) less sludge production, (d) giving non- hazardous metabolites or full mineralization (e) less consumption of water (higher concentration or less dilution requirement) compared to physical/oxidation methods [14].

The efficiency of biological methods for degradation depends on the adaptability of the selected microbes and the activity of enzymes. A wide range of microorganisms such as bacteria, fungi and algae are able to degrade a wide variety of dyes present in the textile wastewater.

Fungal Cultures for Degradation of Dyes

A fungal culture has an ability to acclimate its metabolism to changing environmental conditions. This ability is a vital for their existence. Here, intra and extracellular enzymes help in metabolic activity. These enzymes have ability to degrade various dyes present in the textile wastewater. These enzymes are lignin peroxidase (LiP), manganese peroxidase (MnP) and laccase [15], [16]. Mostly, white rot fungal cultures have been used for the removal of azo dyes .

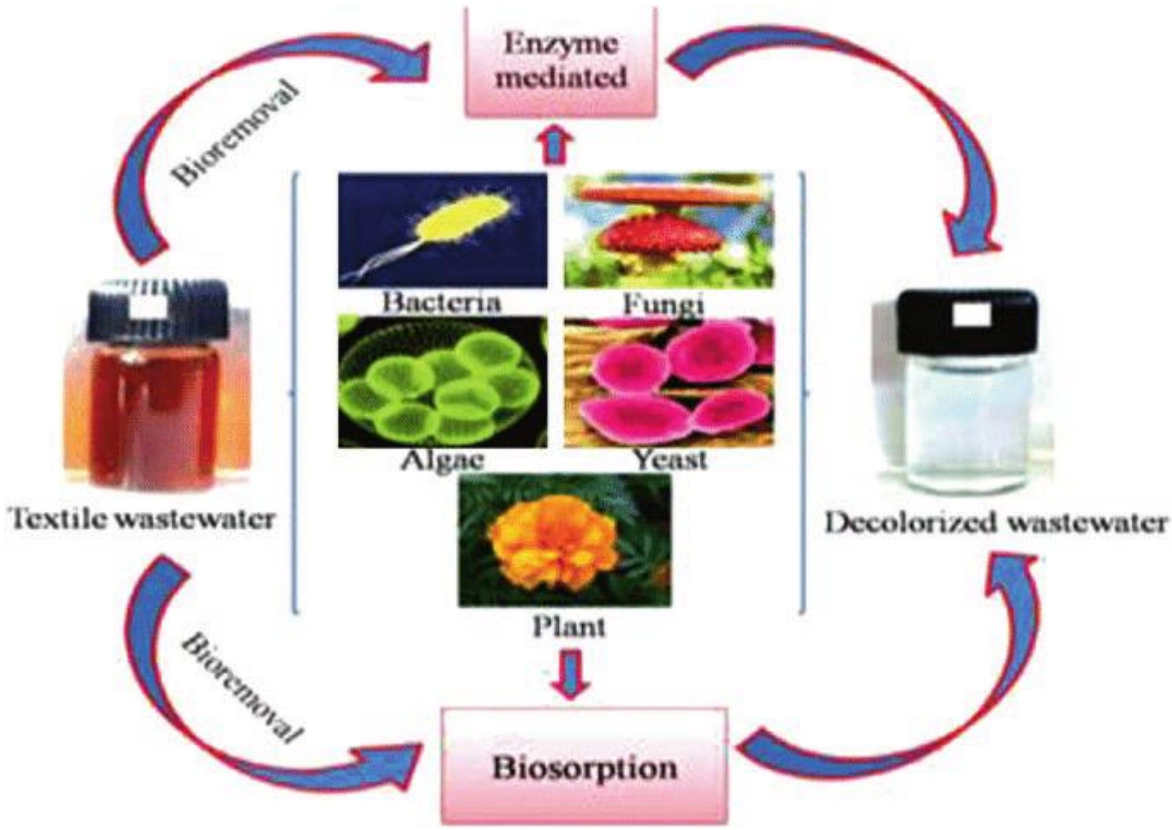
Algae for Degradation Dyes

Algae are omnipresent and are getting an increasing consideration in the area of degradation of textile wastewater. Several species of algae which have been successfully used [18,19]

2. Physical Methods

Coagulation – flocculation based physical methods are useful for the decolorisation of wastewater containing disperse dyes. They also have low decolorisation efficiency for the wastewater having reactive and vat dyes. These techniques also limit their use due to the low decolorisation efficiency and large generation of resultant sludge [17], [18].

Adsorption approaches have attracted significant attention due to their greater decolorisation efficiency for wastewater containing a variety of dyes. High affinity, capability for the compounds and adsorbent regeneration ability are the main characteristics which need to be considered during the selection of an adsorbent for color removal [19]. Activated carbon is an effective adsorbent for a wide range of dyes. But, its high price and difficulty in its regeneration limits the application for decolorisation [20].



Conclusions

The presence of dye in water stream leads to unexceptional effects on living life. As dyes are consumed globally from small-scale to large-scale industries inculcating tanneries, food, cosmetic, textile, medicinal sectors with the production of 1,000,000 tons all over the world. Majorly, the textile sector plays a pertinent role in dye emissions into the ecosystem. Only dying industries discharge about 7.5 metric tons annually.[21,22]

The complex structures of dye comprising of aromatic rings bonded with different functional groups having π-electron could absorb light within 380–700 nm spectra. They impart coloration due to the presence of chromogens and chromophores. Out of several natural and synthetic dyes, azo group proliferation has been highly carcinogenic due to amine and benzidine emissions. Besides this, the fact of being non-biodegradable makes the dye molecules last longer in the environment producing hazards. [23] Henceforth, eradication of dye molecules from wastewater is thus needed before discharging the stream into the environment with long- and short-term effects. The severe implications have been reported for the aquatic life due to direct contact. Whereas to human life, there were observations from skin irritations to cancer-like disease. Several approaches were reported for the treatment of dye-containing streams but the exploration for the best available technique is still ongoing.[24,25]

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