A critical review of surface water contaminated with dyes from textile industry effluent: Possible approaches

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Abstract
The pollution of surface water is an acute environmental problem because surface water is a primary source of drinking water. The environmental situation of the surface water has degraded, especially regarding eutrophication, primarily caused by pollution from industry, wastewater and agricultural practices. This paper is a review of literature on the different sources of surface water pollution. Ultimately, the discussion is intended to inform of the risk of dye-contaminated wastewater discharged from the textile dyeing industry.

keywords: Surface water pollution, discharged from the textile dyeing industry

I. Introduction
Lack of water, this vital substance, is a serious problem in most countries. This situation results from two fundamental processes: the increasingly excessive scarcity of resources and the deterioration of the quality of existing sources, especially surface water. This deterioration of the quality is a direct consequence of the dumping of the discharges of all kinds (industrial, agricultural, urban ...) at the level of the rivers [1].

The world has undergone remarkable demographic, technological, tourist, agricultural and industrial development over a long period since the industrial revolution accompanied by over-exploitation of raw water, whether superficial or underground. This development has contributed in one way or another to the pollution of the environment, especially water, by human activities and sometimes by natural disasters (volcanoes, earthquakes, tsunamis, and floods). This has depleted natural water resources and even deteriorated their quality over time because of the various liquid, urban, domestic and industrial effluents discharged directly and indirectly into different natural environments (lakes, wadis, rivers, and seas) without prior treatment, [2,3].

In Morocco, the issue of water is one of the main environmental problems, partly because of the health and economic consequences of water pollution and inadequate sanitation and sanitation. On the other
hand, pressures on resources due to increased water requirements. The annual volume of wastewater discharges has increased from 148 to 500 million m³ in the year 2000 and 900 million m³ in the year 2020, [4]. This can be explained by the increase in the urban population, the increase in the supply and the individual consumption of drinking water as well as the significant use of water by the industrial sector.

Morocco is among the countries with the considerable urban expansion with a large production of wastewater volumes posing a threat to the environment. In this country, which is experiencing a water deficit, the reuse of wastewater in the textile industry could cover a significant part of this deficit. Also, the small textile industrial units located along the water currents, in turn, contribute to the pollution of the receiving environment by the direct discharge of wastewater and/or contamination of the water table by septic tanks.

The industrial units are generally generators of effluents whose characteristics are extremely varied and sometimes toxic, among which we recognize as pollutants, in this case, the agro-food industries, the chemical and Para-chemical industries, the mechanical, metallurgical, textile and leather industries. These industries are responsible for a large part of the industrially polluted waters, [5, 6], as they generate a very large volume of wastewater loaded with organic materials such as solvents, additives, phenolic derivatives, fats, oils, dyes, [7–10] and inorganic materials, namely heavy metals such as copper, nickel, chromium, zinc, cobalt, manganese, arsenic and the most carcinogenic, namely mercury, cadmium, and lead, [11–13]. There are also organometallic compounds, [14–17] that have adverse effects on aquatic flora and fauna and, therefore, on the environment and humans in particular, [16, 18].

Therefore, the regulations impose their reduction by requiring their disposal in accordance with industrial wastewater treatment standards before being discharged into aquatic environments [8,21,22].

Our attention was focused on surface water and the different types of associated pollution because they carry especially dyes structure difficult to degrade in receiving environments. Many physicochemical methods manage to treat this type of pollution, but the membrane process (Ultrafiltration) which we are interested in the most promising.

The aim of this research is to present a bibliographical review of the various water resources and sources of pollution, focusing in particular on the pollution of surface water by effluents from the textile industries.

2. Surface waters
The waters come from recycling through the cycle of water from the oceans and seas. These cover more than 70 % of the earth's surface constituting enormous reservoirs of water and representing approximately 97 % of the total volume of water currently existing our planet [23,24].
The quality of surface water is a sensitive problem, linked to anthropic influences (urban, industrial) which lead to an increase in the consumption of water resources [25].

They consist of all circulating, stagnant or stored waters, soft and brackish, which are in contact with the atmosphere. Surface waters are mainly river water, wadis, lakes, ponds, dams, runoff, seas and oceans [26–30].

Surface water is intended for industrial use and domestic consumption. The latter has increased due to the accentuation of demographic development and improvement of living conditions [31–33].

The chemical composition of surface water depends mainly on the nature of the land they cross during their journey through watersheds [34,35].

Most often, these waters are the seat of development of a microbial life because of the waste that flows there and the large surface of contact with the external environment, [36] which deteriorates their quality.

Seawater and ocean waters are characterized by a high salinity of 35 g / l and a pH of 7.6 to 8, [37]. Desalination of seawater and ocean water by distillation and reverse osmosis techniques, [36, 39] remain energy intensive and therefore quite expensive.

Pollution of aquatic environments is defined as any modification of the physical, chemical or biological properties by the release of liquid, gaseous or solid substances into the water so as to create a nuisance or to render it harmful or prejudicial to public health, safety and well-being, or its uses for domestic, commercial, industrial, agricultural, recreational and other purposes, or wildlife and aquatic [40, 51].

2.1. Types of surface water pollution
Pollution of surface water is an acute environmental problem because surface water is a primary source of drinking water for a large part of the population, [51]. Surface water pollution is any change in the composition of water that is troublesome or harmful to human use. This change may be caused by the overall release of toxic compounds that humans release into the ecosphere, [52–54]. The types of surface water pollution can be classified into three main categories: physical, chemical and biological, [55–57].

2.1.1. Physical pollution
The physical pollution of rivers by suspended solids should be considered as one of the global dangers of freshwater fauna, [58]. Siltation is caused not only by erosion, but also by extraction processes or rinsing of tank outlets, [59,60]. The increase in solid loads causes changes in the stream ecosystem, [45,46,61,62].
2.1.2. Chemical pollution

This type of pollution results from the discharge of wastewater, which contains large quantities of nitrogenous species, from households and agricultural sources (pesticides and insecticides), various household products (detergents), industrial waste (dyes, pigments, pharmaceuticals, paints, solvents, etc., [62,64].

2.1.3. Biological pollution

Biological pollution is defined as the negative impacts of micro-organism species such as pathogens, fungi, bacteria, parasites, viruses, planktonic blooms, etc, [65, 67]. The presence of these microorganisms in aquatic environments may pose a risk to the quality of surface water.

3. Depending on the origin of the pollutant

Depending on the origin of the pollutant, there are five categories of water polluted by industrial, urban, domestic, agricultural and accidental causes [47,69–71].

3.1. Industrial pollution

The accelerated development of modern industrial techniques has led to a massive and intensive loading of various wastes and effluents from different industrial units, which are mainly installed on the coastline both for waste disposal and for saving transport, [72–77]. These industrial units use a very large quantity of water which, while remaining necessary for their proper functioning, is only consumed in a very small part and the rest is rejected.

The main industrial activities responsible for the degradation of surface water include food industries, oil mills, sugar factories, refineries, paints, galvanizing, chemicals, petrochemicals, paper mills, tanneries, leather and textiles, [78]. Given the extreme diversity of these industries, it is clear that discharged wastes and effluents discharged without proper treatment will result in undesirable changes in the receiving environment and, therefore, adverse effects on living aquatic organisms, [70].

Given the extreme diversity of these industries, it is clear that discharged wastes and effluents discharged without proper treatment will result in undesirable changes in the receiving environment and, therefore, adverse effects on living aquatic organisms, [79–81].

One of the main problems causing pollution of the watercourse environment is that of industrial effluents with high concentrations of heavy metals, with disagreements on the maximum values allowed by the legislation in force, [82,83]. The main source of chromium (VI) pollution from surface water comes from effluents from the tanning, plastics, pigments and paint industries, [84,85].

3.1.1. A special case of study is the textile industry pollution

The textile manufacturing industry consumes nearly 200 l of water to produce 1 kg of tissue, [86] and uses a variety of dyes and chemicals. The textile market has used more than half of the world's colorant and organic pigment, and demand is expected to increase by more than $ 30 billion in 2019, [87,88]. Reactive and disperse dyes continue to account for almost half of the global demand for dyes,
due to their popularity in the large textile market. During the dyeing process, not all dyes are attached to the fabrics. There is always a part of loose dye that is washed away with the water that is the main pollutant in the textile effluents. The reactive dye is a water-soluble, loose dye applied to cotton fabrics and spills 50-90% into the textile effluent, [89]. Other pollutants include alkalis, organic and inorganic salts, acids and heavy metals. It is estimated that approximately 3 106 l of wastewater is produced after the treatment of approximately 20 000 kg of textiles per day, [88,90].

Textile wastewater has a high color, a high BOD / COD and a salt load (total dissolved solids, TDS). Textile wastewater produced by the cotton dye industry is extremely polluted due to the presence of reactive dyes that are not easily treated by biological treatment, [91]. Colored water causes a rarefaction of light essential for the development of aquatic organisms. As a result, this leads to an imbalance in the environment. To reduce the cost of water treatment of the river that is used for its fresh water; it should not have color and toxic compounds. Thus, before the dumping of textile wastewater into the river, many treatment processes, including physical, chemical, biochemical and hybrid processing processes have been developed to treat it economically and efficiently.

The toxicity of liquid textile discharges can come either from the metal part of the dye molecule, as is the case of chromium in acid dyes or copper in direct dyes, or other materials used in the process of dyeing, like traces of mercury present in various chemical reagents, [8,92]. Heavy metal contents of less than 100 mg / l have been reported for non-metallic dyes. In the case of metallized dyes and metal salt dyes, reported metal levels were considerably higher, [93].

3.1.2. Textile dyes

The dye of the textile dye used has a unique chemical structure for each color, [91]. The chromophore is a group of atoms or electrons present in the dye molecules responsible for its color. A compound containing a chromophore is called a chromogen. Azo and anthraquinone are the most important groups. Another group of atoms or electrons connected to the chromophore called auxochrome, which enhances the color of the chromogen, [94]. The most common chromophores are the carbon-carbon double bond (C = C), the carbon-nitrogen double bond (C = N), the carbonyl (C = O), the azo (N = N), the nitro (NO₂), methylene (CH =) and quinoid rings, [95]. These chromophores also cause contamination that renders an unacceptable color to textile wastewater.

The available auxochromes are the carboxyl (-COOH), amine (-NH₃), sulfonate (-SO₃H) and hydroxyl (-OH) groups. The auxochromes are present in all classes of reactive dyes, acidic, direct, basic, mordant, vat, sulfur and dispersed, [96].

The important reactions involved in the printing process are similar to those in the dyeing process. In the case of dyeing, the dye is applied as a solution, while in printing the dye is applied in a thick dough form to prevent its spread. The printing effluent also contains waste components similar to the dye effluent, [97].
3.2. Urban pollution
Pollution in urban areas is a growing health problem in Morocco, where the use of fossil fuels has increased rapidly as a result of industrialization and socio-economic development.

Urban pollution is generally composed of coarse and fine particles from mineral dust, combustion processes, sulfur dioxide (SO\textsubscript{2}), nitrogen oxides, ammonia, volatile organic compounds, \cite{98,99}, household waste, \cite{100}\textsubscript{ex}, expired medicines, \cite{101,102}\textsubscript{and}, waste oils, \cite{103}

3.3. Domestic pollution
Domestic pollution from the burning of wood, charcoal, liquefied petroleum gas or animal dung in poorly ventilated homes, \cite{104,105}. Domestic waste contains a large amount of fatty and oily substances, which are used oils, detergents, dyes, paints, pesticides, solvents and personal care products, \cite{106–108}\textsubscript{greywater and greywater (rooms baths and kitchens)}. The increase in pollution loads generated by domestic pollution flows has negative impacts on the quality of water resources, as well as negative effects on fauna and flora.

Domestic water consumption varies from a few liters per day in countries without public offering and little domestic comfort to several hundred liters in developed countries, \cite{109–111}. These waters are never distributed until after adequate treatment. They must therefore be treated according to the regulatory requirements for the quality of drinking water at any point in the network so that they can be consumed by humans without any danger.

3.4. Agricultural pollution
This is due to agricultural activities including pesticides, fertilizers, insecticides and other agricultural chemicals that are responsible for releasing many organic and inorganic pollutants into surface water by runoff, \cite{45,71,112,113}. These compounds-rich, phosphatic and nitrogenous products cause eutrophication in dams, \cite{114,115}.

Pesticides pose a particular pollution problem because they are specifically designed to have lasting effects on living organisms and persist in soil, water and sediment for long periods of time, \cite{116–118}.

Pesticide pollution of surface water poses a considerable risk to the aquatic environment. However, the average amount of pesticides reaching water resources varies considerably between regions and strongly depends on application rates, chemical characteristics of pesticides and natural conditions during application, \cite{119}.

Despite the implementation of new regulations and the gradual introduction of new agricultural practices, the use of the most mobile pesticides are still in progress, these products are still frequently found in surface water at higher concentrations for drinking water, \cite{112–114}.

3.5. Accidental pollution
Accidental pollution of natural environments by harmful aromatic compounds has often occurred by a mixture of various compounds (e.g. various polycyclic aromatic hydrocarbons (PAHs) in petroleum
and intermediate products, final products, and by-products from chemical plants), which range from biodegradative to highly persistent compounds, [46,123–125].

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Conclusion
The quantity and quality of water resources are diminishing due to the overexploitation of water and the presence of dyes and pigments and other chemicals in textile finishing industries. Treatment of dye-contaminated wastewater discharged from the textile and other dye-stuff industries is necessary to prevent contamination of soil and surface and ground water. This requires increased efforts by state institutions, industrial units and interested researchers around the world to put an end to this danger that threatens the living conditions of aquatic living beings as well as humans. For this reason, research on new techniques has been carried out, namely; physicochemical and biological methods, and mixed processes, namely; Ultrafiltration, Nanofiltration, adsorption, coagulation-flocculation, adsorption / ultrafiltration, coagulation / ultrafiltration, and coagulation-flocculation / ultrafiltration, etc.

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