Carpathian Journal of Earth and Environmental Sciences, May 2013, Vol. 8, No. 2, p. 39 - 48

THE PHYSICOCHEMICAL AND BACTERIOLOGICAL QUALITY AND ENVIRONMENTAL RISKS OF RAW SEWAGE REJECTED IN THE COAST OF THE CITY OF EL JADIDA (MOROCCO)

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Abstract: In the city of El Jadida, disposal of untreated wastewater in the ocean has a negative impact on the environment and the health of the populations who live along the urban effluents. The main objective of this study is to monitor the physicochemical and bacteriological quality of raw sewage from the city of El Jadida. Several takings were made at the level of three collectors of the city of El Jadida between year 2011 and 2012. The parameters studied are temperature, pH, electrical conductivity (EC), nitrates (NO_3^-), nitrites (NO_2^-), total phosphorus (TP), orthophosphate (PO_4^{3-}), chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), total kjeldahl nitrogen (TKN), total suspended solids (TSS), volatile suspended solids (VSS), fecal coliform (FC), fecal streptococci (FS), spore sulfite-reducing anaerobes (SSR). Analysis of wastewater in three collectors (C1, C2 and C3) showed that the concentrations of physicochemical and bacteriological parameters are very high and largely exceeding the Moroccan standards and that can cause very serious problems environmental. The pollutant load is between 587.5 and 805.3 mg / L for BOD_5, 691.22 and 1512.1 mg / L for COD and between 524.13 and 1067.2 mg / L for suspended solids. The fecal coliform load average (CF) varies between 2.80 10^5 and 2.24 10^6 (CFU/100 mL). In terms of bacterial load, the collector C1 is slightly more concentrated than collectors C3 and C2. The fecal staphylococci (SF) varies between 1.94 10^5 and 4.04 10^6 (UFC/100 mL). The value of the enumeration of the spore of sulphite-reducing anaerobes in the wastewater is superior at the collector C1 (2.36 10^5 UFC/100 mL).

Keywords: wastewater, pollution, environmental risks, physico-chemical parameters, bacteriological analysis, El Jadida.

1. INTRODUCTION

Raw sewage consist of all waters likely to contaminate the environments in which they are discharged, it contain pollutants and by-products of human use, whether of domestic or industrial origin. In this case, it is often referred to as black water. Sometimes, dirty wastewater drains into watersheds and sea. When this happens, the environment is as much at risk as people. The pathogens in raw sewage can contaminate ecological systems in addition to sickening humans and animals.

One pollutant in the ocean is sewage. Human sewage largely consists of excrement from toilet-flushing; wastewater from bathing, laundry, and dishwashing; and animal and vegetable matter from food preparation that is disposed through an in-sink garbage disposal. Because coasts are densely populated, the amount of sewage reaching seas and oceans is of particular concern because some substances it contains can harm ecosystems and pose a significant public health threat. In addition to the nutrients which can cause over enrichment of receiving water bodies, sewage carries an array of potentially disease-causing microbes known as pathogens.

The major classes of pollutant reaching coastal waters are decomposable organic materials, heavy metals and other toxic matter, dissolved and suspended non-toxic inorganic substances, and pathogenic organisms. While coastal pollution is gradually being controlled in many industrialized countries, it is still rising rapidly as a result of population growth, urbanization and industrial development in developing regions.

In 1990 coastal cities and towns in Southern Africa discharged more than 850 million liters of industrial and human wastes into the sea daily through more than 80 pipelines, largely without any treatment (Cock & Koch, 1991). In 1992, the lack of adequate infrastructure in Maputo caused significant coastal sewage and pollution problems, while in Angola untreated industrial waste pumped into the Bay of Luanda resulted in bacterial contamination (IUCN, 1992). There are no immediate prospects of reducing the coastal pollution problems faced by many African countries. In a context of limited water resources, wastewater in Morocco has not only a new limitation of the available resource but also an affront to human health and environmental quality in general.

But pollution also affects sea unenclosed. The composition of wastewater from household can be extremely variable and depends on three factors, which are the original composition of drinking water, the various uses by individuals who can provide a nearly infinite number of pollutants, and finally the users themselves who will reject the organic matter in wastewater (urine, feces).

Other studies conducted by Lamghari, (2005) and Lamghari & Assobhei, (2007) on the parasitological characterization of the wastewater from the city El Jadida in Morocco, their impact on the coast (waters and sediments) and on the infantile population of the discharge area showed that pollution detected in the effluent of wastewater as well as at the coast of El Jadida, is in fact a problem for the environment of the city. It is therefore important to study the parameters of the sewage of the city of El Jadida discharged into the Atlantic coast to supply some possible risks of contaminants in these effluents on human health and the life of marine ecosystems.

Our study aims to evaluate the physicochemical and bacteriological quality of wastewater rejected on the coast from the city of El Jadida between year 2011 and 2012 and to predict their impact on the global state of the environment and the state of the marine ecosystems in particular.

2. MATERIALS AND METHODS

2.1. Studied zone

The city of El Jadida is the second industrial pole of Morocco, is located on the Atlantic coast of Morocco between Casablanca (90 km southwest of Casablanca) and Jorf Lasfar (one of the largest ports in Africa) (Fig. 1),. It covers the area of 2480 hectares, with latitude of 27 m and it has 4 urban districts (Chofqi, 2004). In August there was famous Moussem of Moulay Abdellah Amghar, which attracts over one hundred thousand visitors. It is bounded:

- north by the Atlantic Ocean,
- to the east by the rural commune Haouzia,
- the south by the rural commune Oueld Hcine
- to the west by the rural commune Mly Abdellah and the Atlantic Ocean

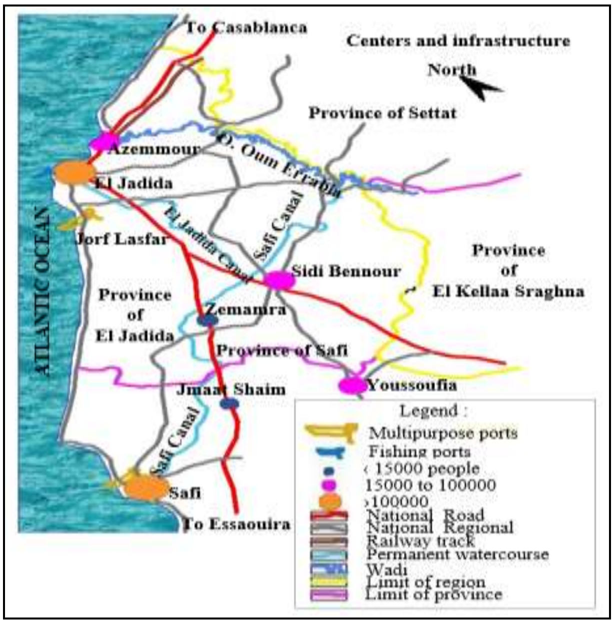

Figure 1. Geographical situation of the site of study

2.1.1 Demographics of the city of El Jadida

The population of El Jadida was 144 440 inhabitants in 2004 to 2,480 hectares, or 58 inhabitants / ha in 1994 against 119,083 inhabitants or 48 inhabitants / ha. The annual growth rate since 1994 is 1.9%. Estimates of future population have been made and the results are reported in Table 1 (Nouha et al., 2002).

Table 1. The Census of Population of El Jadida

Population	1994	2000	2003	2015	2025
Inhabitants	119 083	124 229	133 000	190 000	227 000
Household	24 192	28 762	32 000	45 049	54 700

2.1.2. The morphological units of the coast of the study site

- ***The beach of the town***

This beach stretches 1.5 kilometers long between the harbor breakwater and the start of the rocky outcrops of Deauville beach. NW-SE orientation is inherited Hercynian geological structures.

It is characterized by a narrow range in midair, and become wider or narrower at the ends East and Northwest. In the absence of a bounding, this beach is protected against wind erosion by a wall (1 to 1.5 m high) along the coast. During periods of high winds or storms, sand can be transported beyond the wall (Fig. 2).

The foreshore is 200 m wide at low tide spring tides. We note the presence of rocky outcrops in the lower foreshore next to the harbor breakwater and at the SE end of the beach.

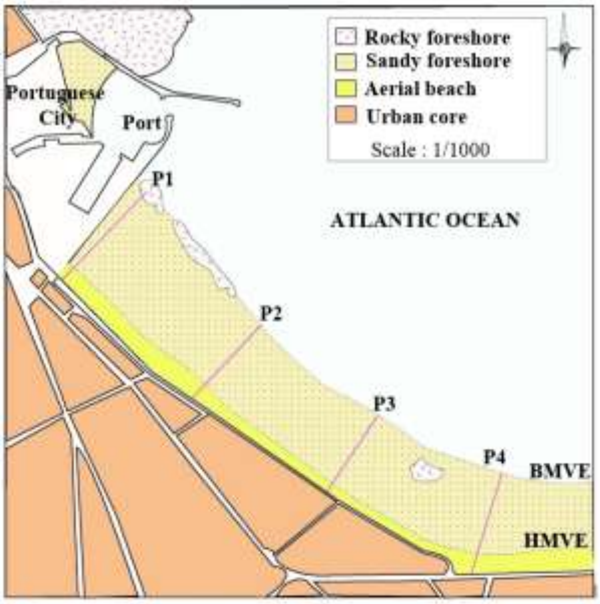

Figure 2. Organisation of the main morphological units in the range of the city

- ***The climatology***

Due to the close proximity of the ocean and the absence of natural obstacles, the city of El Jadida has a moderate coastal climate.

The precipitations are very irregular from one year to the next. Their distribution during the year is not homogeneous. The rainy season covers on average the period going from October till March. Rains fall regularly in autumn and in winter and present an annual average of 386.4 mm. The average annual temperature is 18 ° C with peaks of 35 ° C to 40 ° C in August, and minimum of 5 ° C in January, but significant variations are remarkable from north to south, giving rise to significant increases, as one move away from the coast (Salama et al., 2012).

2.2. Wastewater Sampling

The origin of the poured residuary water in the sea comes from domestic wastewater or mixed with industrial wastewaters (95 and 5%). Samples of wastewater were collected and stored at 4 °C (Fig. 3).

2.3. Analytical Methods

2.3.1. Physico-chemical parameters

The pH and temperature of the wastewater samples were measured on collection site. Electrical conductivity, total suspended solids, volatile suspended solids, nitrates, nitrites, total phosphorus, orthophosphate, BOD_5, and COD were analyzed in laboratory according to the methods prescribed in AFNOR (French national organization for standardization) handbook (AFNOR, 1999). The determination of total Kjeldahl nitrogen (TKN) and total phosphorus were measured by acid digestion - automated colorimetric method (APHA, 1998).

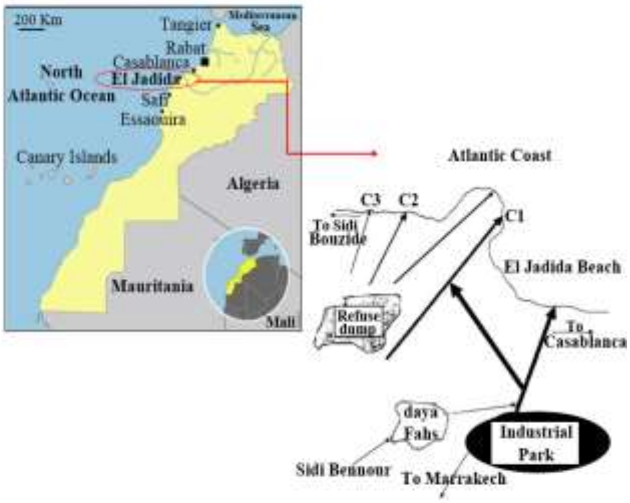

Figure.3. Location of sampling sites in study zone: C1 (Lower town collector), C2 (Collector El Manar), C3 (AB collector).

2.3.2. Bacteriological parameters

The bacteriological analysis of the various samples of waste water consists of an enumeration of the indicator germs of fecal contamination to know fecal coliforms (FC), enterococci (SF) and spore sulfite-reducing anaerobes (SSR):

- ***Enumeration of fecal coliforms***

Fecal coliforms or thermotolerant coliforms are a sub-group of total coliforms able to ferment lactose at a temperature of 44.5°C.

The most important species of this bacterial group is *Escherichia coli* (*E. coli*) and to a lesser extent some species of the genera *Citrobacter, Enterobacter and Klebsiella* (Elmund et al., 1999; Emmanuel et al., 2004).

The spatio-temporal evolution of the abundances of CF was assessed by counting the colonies on the yellow-orange Tergitol agar and triphenyl tetrazolium chloride (TTC - Tergitol 7). The inoculated petri dishes were incubated at 44.5 ° C for 24 hours (AFNOR, 2001).

- ***Enumeration of enterococci***

Enterococci bacteria are spherical, in pairs or chains, Gram positive, catalase-negative, facultative anaerobic, which hydrolyze esculin in the presence of bile (CEAEQ, 2006). This test is characteristic of bacteria in group D Lancefield. Under the general description of enterococci (fecal streptococci) and according to WHO, fecal streptococcus are largely of human origin. However, some bacteria of this group were also collected from feces of animals such as *Streptococcus bovis*, *S. equinus*, *S. gallolyticus* and *S. alactolyticus* (Clausen et al., 1977; Farrow et al., 1984; Bitton, 1999), or even meet on plants. They are still considered indicators of fecal pollution, and their main interest lies in the fact that they are resistant to desiccation and persist longer in water (Gleeson & Gray, 1997). They thus provide additional information on pollution. The presence of enterococci was evaluated by counting black colonies with black halo on the agar medium in the bile, esculin and sodium azide, after incubation at 37 ° C for 48 h (AFNOR, 2001).

It is important to mention that the value of the report fecal coliform / fecal streptococci is used as an informative element of the first order. Indeed, when it is greater than 4, the pollution is of human origin. When this ratio is below 0.7, the pollution is of animal origin (Geldreich & Kenner, 1969). However, this ratio is not recommended unless the contamination is really recent.

- ***Enumeration of the spores of sulfite-reducing anaerobes***

The strict anaerobic bacteria Gram positive and sporulated reduce the sulfate in hydrogen sulfide. The spores are resistant to environmental stress in particular solar radiation. Among the sulfite-reducing anaerobes spores, those of Clostridium perfringens, the species most often associated with feces of warm-blooded animals. Spores of sulfite-reducing bacteria are considered indicators of the removal of protozoan cysts (Henze et al., 2008).

The wastewater samples are previously heated to 80°C for 10 min to destroy vegetative cells and keep only the spore forms. Spores of sulfite-reducing anaerobes were enumerated after seeding wastewater or its dilutions in a medium of Meat-liver Glucose Agar. The inoculated medium is covered with paraffin oil to create the anaerobic conditions necessary for germination of these spores. It is then incubated at 37°C for 48 h (AFNOR, 2001).

3. RESULTS

The measure of temperature, pH and dissolved oxygen were achieved in situ. The wastewater was brown in color. It was characterized by considerable pollutant of suspended matter, volatile matters and high concentrations of BOD_5 and COD.

The mean values of the temperature recorded at each collector range between 23°C and 29°C (Table 2). The values of the wastewater temperature recorded are close to 30 °C limit considered a direct discharge into the receiving environment (MEMEE, 2002). These values are below 35°C, considered indicative limit value for water for irrigation (MEMEE, 2002). The values of pH vary from 5.9 to 7.2. The electrical conductivity is probably one of the simplest and most important for the quality control of wastewater. It reflects the overall degree of mineralization, it informs us about the salinity (EL Guamri & Belghyti, 2006). The maximum average value is recorded at the collector C1 (5.52 mS/cm) and the minimum average value is recorded at least the collector C2 (2.9 mS/cm). The conductivity values recorded at each collector exceeding 2 mS/cm (JORA, 2003). Similarly, the mean values are higher than 2.7 mS / cm, considered limit direct discharge into the receiving environment (MEMEE, 2002).

The Ammonium ions derived from the degradation of animal protein (nitrogen cycle), domestic effluents (urea) and urban runoff (Erickson, 2002; Bonte et al., 2008). The maximum ammonium observed at the collector C1 is 282.9 mg/L and the minimum average value of 98.35 mg/L recorded at the collector C2.

Table 2. The average values of physicochemical parameters of raw wastewater in the three collectors

Parameters / **Stations**	**T°C**	**pH**	**EC** (mS/cm)	**TSS** (mg/L)	**VSS** (mg/L)	**NH_4^+** (mg/L)	**NO_3^-** (mg/L)	**TKN** (mg/L)	**PO_4^{3-}** (mg/L)	**TP** (mg/L)	**COD** (mg/L)	**BOD_5** (mg/L)
Collector C1	29	7.2	5.52	1067.2	611	282.9	11	118.6	39	20	1512.1	805.3
Collector C2	26.7	5.9	2.9	524.13	174	98.35	4.84	68.4	18	14.22	691.22	587.5
Collector C3	24	6.2	3.6	855.91	320	103.1	9	73	19.77	17	811.6	637.1

Table 3. The average values of bacteriological parameters of raw wastewater in the three collectors

Parameters / Stations	CF (UFC/100 mL)	SF (UFC/100 mL)	SSP (UFC/100 mL)
Collector C1	$2.24\ 10^{6}$	$4.04\ 10^{6}$	$2.36\ 10^{5}$
Collector C2	$2.80\ 10^{5}$	$1.94\ 10^{5}$	$1.13\ 10^{5}$
Collector C3	$4.60\ 10^{5}$	$3.30\ 10^{5}$	$1.77\ 10^{5}$

The major part of the organic phosphor results from waste of protein metabolism and elimination in the form of phosphates in the urine by man and detergents (Du Chaufour, 1997). The rates of orthophosphates at collectors vary between 18 mg/L and 39 mg/L. The Orthophosphate concentrations recorded at each collector are greater than 10 mg/L considered the limit of discharge into the receiving environment (MEMEE, 2002).

The COD allows to appreciate the concentration of organic matter or mineral dissolved or in suspension in the water, through the quantity of oxygen necessary for their total chemical oxidation (Rodier, 1996). The mean values of COD are vastly superior to 500 mg/L, considered as a limit direct discharge (MEMEE, 2002). COD values recorded at the collector ranged from 691.22 mg/L and 1512.1 mg/L.

The suspended solids are all inorganic and organic particles contained in the wastewater (EL Guamri & Belghyti, 2006). The effluents analyzed are characterized by a high concentration of suspended matter vary between 524.13 and 1067.2 mg/L, higher than 50 mg/L considered the limit discharge into the receiving environment (MEMEE, 2002).

For BOD_5/COD higher than 0.4, the wastewater biodegradability is high, and consequently the biological process is the most suitable for the treatment of these effluents (Metcalf & Eddy 2000). However, at BOD_5/COD ratios lower than 0.30, physical – chemical processes are usually more effective than biological treatments (Alvarez-Vazquez et al., 2004). The values of BOD_5/COD ratio recorded at each collector are presented in the following table 4.

Table 4. The values of BOD5/COD ratio of raw wastewater in the three collectors

Parameters	**BOD_5/COD**		
Stations	***Minimum***	***Maximum***	***Average***
Collector C1	0.52	0.56	0.53
Collector C2	0.83	0.86	0.85
Collector C3	0.76	0.81	0.78

The Table 4 shows that all wastewater has high biodegradability. These values are in the good range of activity of the micro-organism.

The results of the bacteriological analyses of wastewater of three collectors reveal the presence of the indicator germs of fecal contamination as well as certain pathogenic germs (Table 3). The fecal coliform load average (CF) varies between $2.80\ 10^{5}$ and $2.24\ 10^{6}$ (CFU/100 mL). In terms of bacterial load, the collector C1 is slightly more concentrated than collectors C3 and C2. The fecal staphylococci (SF) are $4.04\ 10^{6}$ (UFC/100 mL) in the collector C1 and $3.30\ 10^{5}$, $1.94\ 10^{5}$ (UFC/100 mL) in the collector C3 and C2 respectively.

The value of the enumeration of the spore of sulphite-reducing anaerobes in the wastewater is superior at the collector C1 ($2.36\ 10^{5}$ UFC/100 mL). The result of the enumeration of the germs of fecal contaminations is in good agreement with the bibliographical data relative to the state of bacterial contamination of urban effluents (Baylet & Mandin, 1978; Boutin, 1982; ONEP, 1999), but it far exceeds the standard set by the World Health Organization to 1000 CF/100 ml (WHO, 1989).

4. DISCUSSION

Municipal wastewater effluent consists of sanitary waste, collected in sewers and households in the city El Jadida. The effluent contains a range of contaminants and as a result, has a wide range of potential impacts to environmental and human health (Choukr-Allah & Hamdy, 2005).

A range of typical and emerging contaminants are found in municipal wastewater effluent discharged into the environment. Municipal wastewater effluent is a leading source of biochemical oxygen demand, total suspended solids, nutrients, organic chemicals, and metals contamination. In addition to typical contaminants, newly emerging contaminants such as pharmaceuticals, personal care products, endocrine disrupting compounds and brominated flame retardants are a growing cause for concern.

4.1. Environmental risks of physico-chemical parameters

The temperature is very useful for determined if there is a thermal pollution or not.

Generally, the thermal pollution corresponds to the increases or decreases the temperature of the water with respect to the "normal" temperature due to the action of the man and which affect aquatic life.

It is diffuse pollution is not visible and it is not always considered a real pollution. The complexity of estuarine and coastal environmental quality is related to a combination of factors related inters. With increasing temperature, the metabolic reactions are generally accelerated at least as long as the temperature remains within the tolerance range of organisms. If the temperature rises above the critical threshold, the metabolic slow down. Thermal effects are often subtle, and lethality is at best a rough index of the effects of temperature changes. However, it is not necessary to kill fish directly to eliminate populations of a given species. We can do that easily, if not more slowly, acting on the reproductive potential, the ability to avoid predators and susceptibility to pathogens and pollutants. In the salt water (35% of salinity) the solubility of O_2 increases of 11.22 (0°C) in 6.10 mg /L (30°C) but constant reoxygenation water by atmospheric O2 increases:

Increased T°C = Decrease in dissolved O_2 (less soluble)

Biochemical Oxygen Demand refers to the amount of dissolved oxygen in the aquatic environment that is used to break down organic materials in municipal wastewater effluent. The more organic material that is discharged in effluent, the more oxygen is needed to break it down. When aquatic oxygen levels are too low, aquatic organisms are more susceptible to disease, and experience hampered swimming abilities, altered feeding/migration/reproductive behaviours and death.

Total Suspended Solids is organic and inorganic debris suspended in municipal wastewater effluent. High concentrations of total suspended solids impact ecosystems by preventing sunlight from reaching aquatic vegetation and by coating gravel beds where fish spawning occurs. Many chemicals also bind to solids, causing accumulation of toxic compounds in the environment.

The Nutrients primarily refer to phosphorus and nitrogen when considered in the context of wastewater. Nutrients act like a fertilizer and can be beneficial if effluent is properly applied to some crops. Effluent containing high levels of nutrients that is discharged into some surface water may cause an aquatic condition call eutrophication (Campbell & Edwards 2001). Eutrophication ultimately leads to a loss of diversity in aquatic plants and animals and overall ecosystem degradation through algae blooms, excessive plant growth, oxygen depletion, and reduced sunlight penetration.

The presence of nitrogenous or nitrogen-containing wastewaters can adversely impact or pollute the quality of the receiving water. Principle nitrogenous wastewaters that pollute the receiving water are ammonium ions (NH_4^{+}), nitrite ions (NO_2^-), and nitrate ions (NO_3^-). Ions are chemical compounds that possess a negative (-) or positive (+) charge. Significant pollution concerns related to the presence of nitrogenous components include dissolved oxygen (O_2) depletion, toxicity, and eutrophication, (Table 5). The discharge of nitrogenous wastes to the receiving water results in dissolved oxygen depletion. The depletion occurs through the consumption of dissolved oxygen by microbial activity.

First, ammonium ions are oxidized to nitrite ions, and nitrite ions are oxidized to nitrate ions within the receiving water (Fig. 4). The oxidation of each ion occurs as dissolved oxygen is removed from the receiving water by bacteria and added to ammonium ions and nitrite ions. Second, ammonium ions, nitrite ions, and nitrate ions serve as a nitrogen nutrient for the growth of aquatic plants, especially algae. When these plants die, dissolved oxygen is removed from the receiving water by bacteria to decompose the dead plants.

Table 5. Pollution concerns of nitrogenous ion

Nitrogenous Ion	Pollution Concerns
NH_4^+	Overabundant growth of aquatic plants Dissolved oxygen depletion Toxicity as NH_3
NO_2^-	Overabundant growth of aquatic plants Dissolved oxygen depletion Toxicity
NO_3^-	Overabundant growth of aquatic plants Dissolved oxygen depletion Toxicity Methemoglobinemia

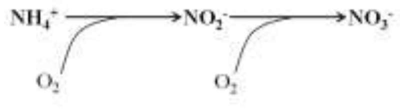

Figure 4. Oxidation of ammonium ions and oxidation of nitrite ions. Under appropriate conditions nitrification occurs when oxygen is removed from water, or a water film, and added to ammonium ions to produce nitrite ions, or added to nitrite ions to produce nitrate ions. Although many organisms such as algae, bacteria, fungi, and protozoa are capable of nitrifying ammonium ions and nitrite ions, a specialized group of nitrifying bacteria is primarily responsible for nitrification in water and soil.

All three nitrogenous ions can be toxicity to aquatic life, especially fish. Ammonium ions and nitrite ions are extremely toxic, and nitrite ions are the most toxic of the three nitrogenous ions.

Although ammonium ions are the preferred nitrogen nutrient for most organisms, ammonium ions are converted to ammonia with increasing pH (Fig. 5). It is the ammonia at an elevated pH that is toxic to aquatic life.

At the cellular level, phosphorus (P) is required to synthesize nucleotides, phospholipids, sugar phosphates, and other phosphorylated intermediate compounds (Wetzel, 2001). Phosphate is also an important component of a number of low molecular weight enzymes and vitamins essential to metabolism. Compounds containing P influence nearly all phases of cellular metabolism and are particularly important in the energy transformation of phosphorylation reactions during photosynthesis in plants (Wetzel, 2001).

In the 1970's, strong relationships between P loading rates and lake trophic status were identified (Vollenweider, 1976). Studies also showed that P has a primary role in promoting algal growth in a series of whole lake enrichment studies in the Experimental Lakes Area of Ontario (Schindler, 1974; Schindler, 1975). Studies such as these firmly established P as the central focus of biogeochemical and ecological studies in Coastal water (Elser et al., 1990). This early work even prompted detergent companies to remove phosphorus from their products to reduce eutrophication problems (Wetzel, 2001).

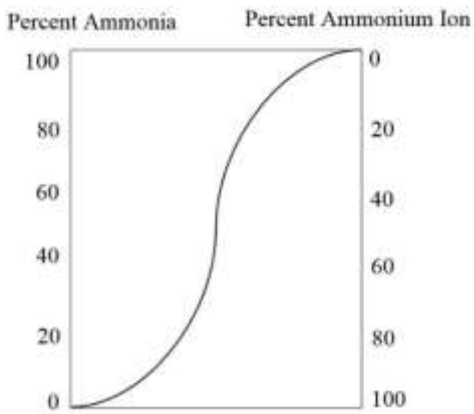

Figure 5. pH and the conversion of ammonia and ammonium ions. The relative quantities of ammonia and ammonium ions in water are determined by the pH of the water. As the pH of the water decreases, ammonium ions are favored. As the pH of the water increases, ammonia is favored. At a pH value of 9.4 or higher, ammonia is strongly favored.

Phosphorus found in aquatic systems in both the dissolved and particulate forms (Wetzel, 2001). Particulate phosphorus includes P present in organisms, and mineral phases of rock and soil (Wetzel, 2001). Dissolved P consists of orthophosphate; polyphosphates, often originating from synthetic detergents; organic colloids or phosphorus combined with adsorptive colloids; and low molecular weight phosphate esters (Wetzel, 2001).

In contrast to the numerous forms of nitrogen in aquatic systems, the most significant form of phosphorus is orthophosphate (PO_4^{3-}). Orthophosphate, the most biologically available form of P, is typically found only in very low concentrations in unpolluted waters.

Increased P inputs can have many negative effects on aquatic ecosystems including: increased biomass of phytoplankton; shifts in phytoplankton to bloom-forming species such as cyanobacteria, that may be toxic or inedible; increased biomass of benthic and epiphytic algae; changes in macrophyte species composition and biomass; decreases in water transparency; oxygen depletion; and, decreases in perceived esthetic value of the water body (Carpenter et al., 1998).

Increased growth of algae and aquatic weeds interferes with use of the water for fisheries, recreation, industry, agriculture, and drinking.

The Bacteria in wastewater can be found in the form of isolated cell or collection of cells forming a floc or biofilm (Low & Chase, 1999). We find there mainly of bacteria such as the case in our study (faecal coliforms, faecal streptococci and Clostridium perfringens) and other, but also protozoa, rotifers, fungi and algae.

The population in presence will be directly related to the characteristics of the wastewater and the prevailing environmental conditions (Qasim, 1999). These microorganisms convert organic matter to new biomass as well that byproduct well as less complex such as CO_2 and of water. Some bacteria also have the capacity of nitrifying ammonia nitrogen in NO_2 and NO_3 while others transform the oxidized form of nitrogen into nitrogen gas (N_2). Other specific bacteria will allow a superior elimination of present phosphor in waste water.

On the other hand, a cell requires three elements to assure growth: a carbon source, a power source and inorganic elements. The carbon allows among others to develop the cellular material of new cells. The carbon source can result from either the organic matter contained in wastewater (heterotrophic organisms) or carbon dioxide (autotrophic organisms). The required energy is used for the synthesis of new cell material and to assure the functions of maintaining the existing biomass. This energy is obtained from light (phototrophic organisms) or oxidation reactions of the organic matter in water (chémotrophes organisms). As for the inorganic elements, some are necessary for the synthesis and for the growth of the cellular organisms.

4.2. Environmental risks of bacteriological parameters

Classical indicator bacteria have proved to be useful in studies describing the environmental distribution of wastewater discharges (Davies et al., 1995; Elliott & Colwell, 1985; Grimes et al., 1984; Howington et al., 1992; McFeters et al., 1993; Paul et al., 1995; Sorensen et al., 1989; Takizawa et al., 1993).

Pathogen contamination of aquatic ecosystems is known to occur from a range of sources including municipal waste water effluents, agricultural wastes, and wildlife (Environment Canada, 2001).

The World Health Organization (WHO) has stated that infectious diseases are the world's single largest source of human mortality (WHO, 1996). Many of these infectious diseases are waterborne and have tremendous adverse impacts in developing countries.

Fecal Coliforms are bacteria found in the digestive tract of warm-blooded animals. The level of coliforms an streptococci in the environment is an indicator of other contaminants. Shellfish can become contaminated through filtering fecal coliforms from the water during feeding, which can make humans sick if the shellfish are eaten.

Most of the clostridia are saprophytes, but a few are pathogenic for humans, primarily Clostridium perfringens, C. difficile, C. tetani and C. tetani. Those that are pathogens have primarily a saprophytic existence in nature and, in a sense, are opportunistic pathogens. Clostridium tetani and Clostridium botulinum produce the most potent biological toxins known to affect humans. As pathogens of tetanus and food-borne botulism, they owe their virulence almost entirely to their toxigenicity. Other clostridia, however, are highly invasive under certain circumstances. Human infection may be due to the consumption of fish contaminated with bacteria clostridia.

The bacteria studied are excellent indicators to confirm the quality and the level of biological contamination of wastewater discharged in the aquatic environment. The results of the bacteriological analysis showed high levels of fecal coliforms, faecal streptococci and Clostridium perfringens in wastewater collected at the collector C1, while the collector C2 has the lowest values. The difference between the values recorded in each collector can be explained by the origin or the source of wastewater transported by each collector, the conditions and the elements necessary for the survival of these bacteria in the wastewater studied.

Indeed, the wastewaters of the collector C1 are of mixed origin (mixture of domestic and industrial wastewater (Fig. 3), also the physicochemical analysis of the effluent showed that the collector has a high biodegradability (Table 4) and a high percentage of organic matters, which plays a major role in bacterial growth.

As regards the collectors C2 and C3, the wastewater is of domestic origin but with average biodegradability in effluent of the collector C3 and low in the collector C2.

5. CONCLUSIONS

This work is part of a reflection on bacteriological and physicochemical characterrization, of liquid effluents discharged into coastal waters from the city of El Jadida. It responds to the need to assess the pollution caused by excessive pollutants discharged into the receiving environment.

From the data collected from this research, the physicochemical and biological parameters monitored in point C1, C2 and C3 showed high levels of all the parameters compared to Moroccan standards. This must be as a result of the nature of wastewater. Collector C3 showed the highest concentration of the physicochemical and bacteriological parameter, while Collector C2 shows the lowest values.

The discharge of wastewater rich in nitrates, phosphorus, organic matter and biological contaminant can cause serious changes in the chemical, physical and biological of different types of marine ecosystems and the organisms that live in them marine in the Atlantic Ocean.

ACKNOWLEDGEMENTS

The authors express their thanks to all members and Ph. D. Students the Lab of Marine Biotechnology and Environment (BIOMARE) in Faculty of Science for their support and for providing the equipment. We would also like to give our thanks to all the colleagues from Lab of Water and Environment who provided a lively atmosphere all throughout the research.

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Received at: 22. 10. 2013
Revised at: 11. 02. 2013
Accepted for publication at: 24. 02. 2013
Published at: 26. 02. 2013