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Full Length Research Paper

Survey of physical-chemical and microbiological quality of wastewater of the WWTP effluent in Sebkha (Nouakchott, Mauritania)

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The present investigation was conducted to survey the physicochemical parameters (temperature, pH, electrical conductivity, chlorides, nitrates, ammonia, orthophosphates and chemical oxygen demand) and microbiological (coliform coliforms and fecal streptococci) in the effluent of the WWTP in the scope of vegetable Sebkha. Thus, monthly samples of wastewater were carried out of the WWTP between January and December 2009. The results of physicochemical analysis presented in this work have shown those temperatures between 23.9 ° C and 31.3 ° C. The pH is between 6.91 and 8.17. The pH oscillates between neutrality and basicity. The salinity of the effluent was observed by measuring the electrical conductivity and chlorides giving respective maximum values of 7000 µS/cm and 1633 mgL^{-1} However, the effluent of the WWTP contain potential reserves of nitrogen compounds and phosphate. The microbiological results show that the microbial load of fecal coliforms and fecal streptococci is very important. The levels of fecal coliforms and fecal streptococci varied respectively from 1, 1.104 cfu/100 mL to 2,8.10^4 cfu/100 mL and from 1,2.10^3 cfu/100 mL to 3.10^{4}cfu/100 mL. The presence of high bacteria indicators of fecal contamination is undoubtedly a threat to the market garden, the children of farmers, retailers and consumers.

Keywords : Physico- Chemical, Microbiological, Effluent, Sebkha, Nouakchott, Mauritania.

INTRODUCTION

The use of wastewater in agriculture is a centuries-old practice. Consequence of rapid urbanization and higher volumes rejected the use of wastewater for irrigation on a large scale, was presented as an alternative to circumvent the problem of water (Mario and Boland, 1999). The scope of market-garden Sebkha has been the subject of several studies. The microbiological testing of water and soil, hydrogeological studies in the dry season and rainy season to assess the potential water, studies

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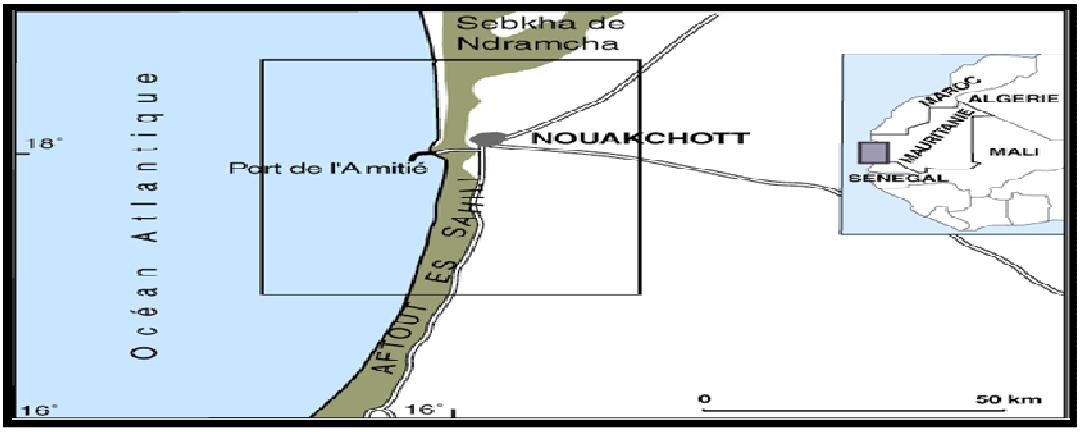

Figure 1. The map of localisation of Nouakchott city.

on agricultural technology and farming practices and irrigation studies were carried out on the market-garden of Sebkha (Schneider et Gagneux, 1997; Azandosessi et al, 1999; Gagneux et al, 1999; Cissé et Tanner; 2000 N'Diaye et al., 2009; N'Diaye et al., 2010). Thus, the present investigation was conducted to survey the physicochemical and microbiological quality of the WWTP effluent for agricultural use in the scope of vegetable Sebkha.

MATERIALS AND METHODS

The Study Area

The area of present study is the city of Nouakchott is a coastal city, located about 18 ° 07 North latitude and 16 ° 01 West longitude as shown in Figure 1. Nouakchott is located in the southern part of the Sebkha Ndramcha which locates a sub-ply flush and its level is directly related to that of the Atlantic Ocean. Nouakchott is supplied with drinking water from the well field to Idini, located on the road of hope about 60 km from the city (Mint El Bezeid, 2006).

The sampling site is where all the WWTP raw sewage drained by some of the city of Nouakchott and some industrial units also connected to the WWTP (Society for a bottling company and a specialized fishing in the area Sales cephalopods). The city of Nouakchott benefits only 4 % of system sewage through the sewer. This wastewater is transported to the WWTP. The rest of the population uses pit latrines, pits and cesspools, septic tanks or has no drainage system at all (STUDI, 2000).

Sampling and Analysis

The bimonthly samplings were made at the WWTP during February 2008 to December 2009. The wastewater samples were collected manually in polyethylene bottles capacity 1 liter. The analyses were carried out immediately after sampling, laboratory water chemistry of INRSP (National Institute for Research in Public Health) in Nouakchott.

The parameters studied are: temperature (T), potential of Hydrogen (pH), electrical conductivity (EC), chloride (Cl^-), ammonia (NH_4^+), orthophosphates (PO_4^{3-}), Chemical Oxygen Demand (COD), Fecal Coliform (FC) et Streptococci Coliform (FS). The temperature, pH and electrical conductivity are measured in situ. The pH and temperature were determined by a pH meter Hanna HI 9024 type equipped with a probe measuring the temperature. The electrical conductivity was measured by a Hanna HI 8733 type. The chlorides are measured by volumetric method of Mohr in the presence of silver nitrate. Orthophosphates and ammonium were determined by UV visible spectrophotometer type 722 S Beijing. The ammonia is analyzed by the colorimetric method in the presence of Nessler reagent. For the determination of orthophosphate using molybdic reagent. The COD was determined with a HACH DR 5000 Spectrophotometer from dilutions of the samples analyzed.

For the enumeration of Fecal Coliforms and Fecal Streptococci we used the technique of membrane filtration through a pad filtration. The culture medium used for Fecal Coliform is the Tergitol 7 and the colony count is performed after 24 hours of incubation at 44 ° C. The isolation of Fecal Streptococci is done by the same method but on the culture medium (Slanetz agar) incubated at 37 ° C for 24 to 48 hours. The results are expressed as Colonie Formant Unity per 100 mL (CFU/100 ml).

RESULTS AND DISCUSSION

The Figures 2 to 10 gives the maximum, minimum and

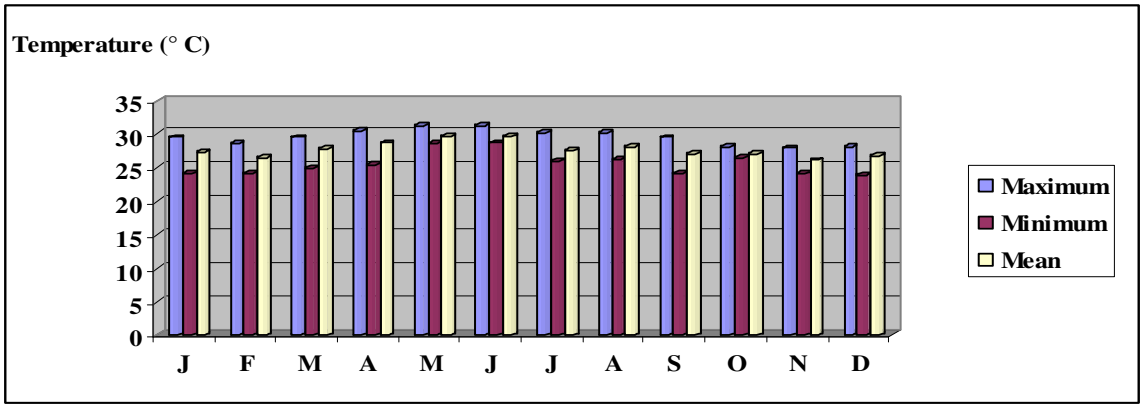

Figure 2. Monthly variations in temperature recorded during January to December 2009.

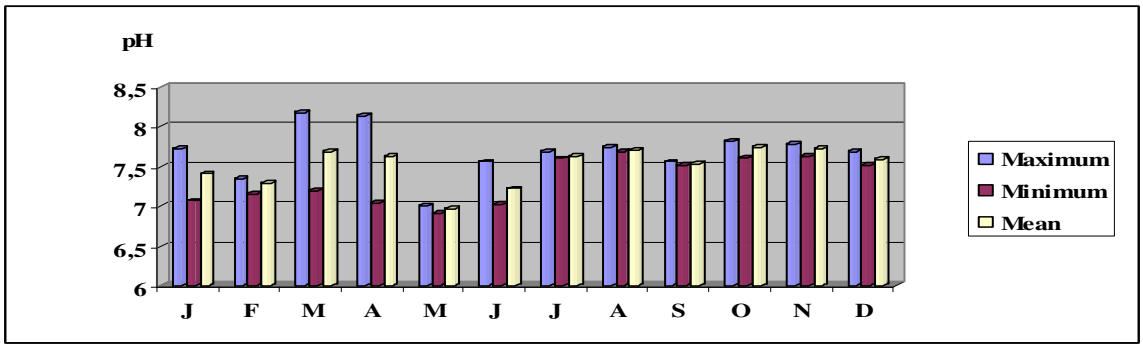

Figure 3. Monthly variations in pH recorded during January to December 2009.

average of temperature, pH, electrical conductivity, chloride, the ammonium, orthophosphate, COD, fecal coliform and faecal streptococci.

Temperature

The water temperature is an ecological factor has important ecological repercussions (LEYNAUD, 1968). It acts on the density, viscosity, gas solubility in water, the dissociation of dissolved salts, as well as the chemical and biochemical reactions, development and growth of organisms living in water and especially microorganisms (WHO, 1987). The average values of temperature recorded oscillate between 23.9 °C and 31.3 °C depicted in Figure 2. The recorded temperatures are below and near 30 ° C (Journal Officiel de la République Algérienne, 2003) and 35 ° C considered limiting value of direct discharge into the receiving environment (Ministére de l'Environnement du Maroc, 2002).

pH

The water pH measures the concentration of H + in the water. It summarizes the stability of the balance between the different forms carbonic acid and is related to the buffer system developed by carbonates and bicarbonates (HIMMI et al., 2003). The mean values of pH of the effluent of the WWTP ranged from 6.91 to 8.17 (Figure 3). The pH values ranged from near neutral to basic values.

Electrical Cconductivity

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 tells us about the salinity. The Electrical Conductivity is the most important parameter in determining the suitability of water for irrigation use and it is a good measurement of salinity hazard to crop. The most important negative effect on the environment caused by agricultural wastewater is the increases in soil salinity, which if not controlled, can decrease productivity in long term (WHO, 2005). The primary effect of high electrical conductivity reduces the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil (Tata-wat and Sing, 2008). The electrical conductivity values of

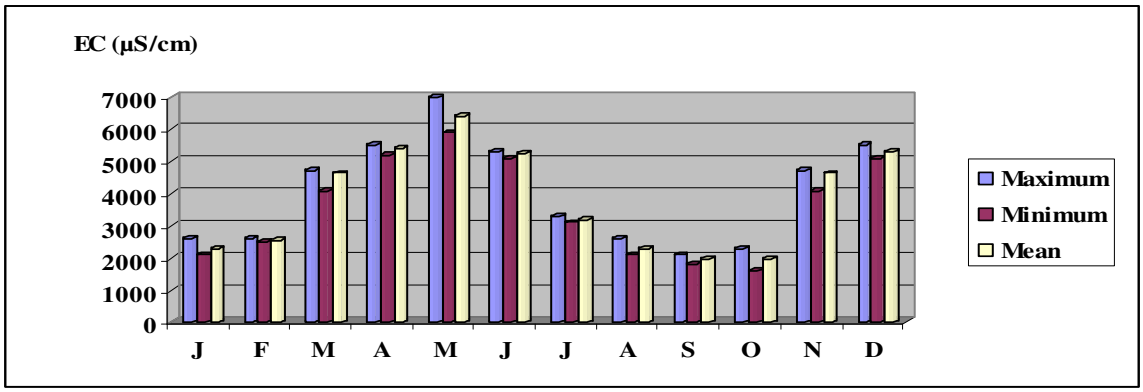

Figure 4. Monthly variations in Electrical Conductivity recorded during January to December 2009.

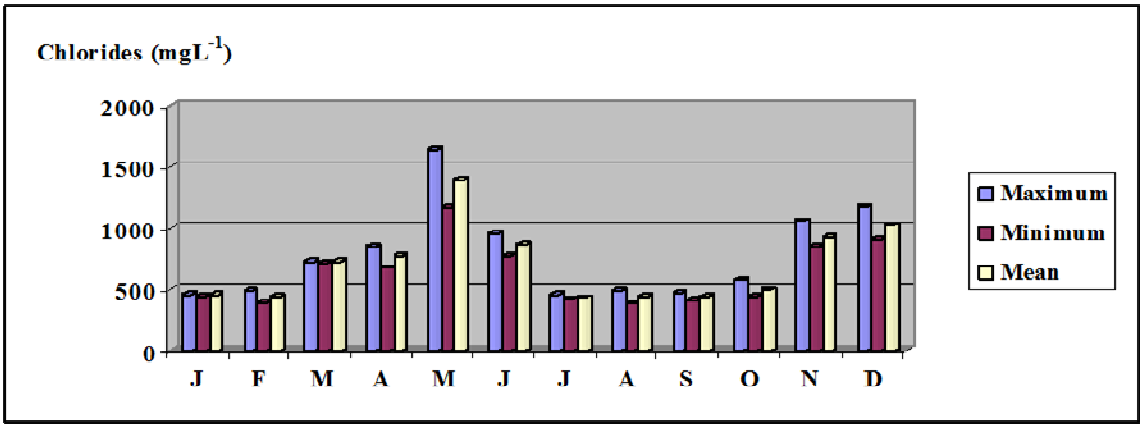

Figure 5. Monthly variations in chlorides recorded during January to December 2009.

experimental samples varied from 1600 to 7000 µScm^{-1} (mean value = 3812.5 µScm^{-1}) (Figure 4). These results could be explained by the release of waste water from industrial units connected to the WWTP. The average values of conductivity recorded at the effluent of the WWTP exceed 2000 µScm^{-1} (Journal Officiel de la République Algérienne, 2003) but slightly closer to 2700 µScm^{-1} (Ministére de l'Environnement du Maroc, 2002).

Chlorides

The chlorides are important inorganic anions contained in varying concentrations in natural waters, usually in the form of sodium salts (NaCl) and potassium (KCl). They are often used as an index of pollution. They have an influence on the aquatic fauna and flora as well as plant growth. The most common toxicity is from chloride (Cl^-) in the irrigation water. The chloride is not adsorbed or held back by soils, therefore it moves readily with the soil-water, is taken up by the crop, moves in the transpiration stream, and accumulates in the leaves. If the chloride concentration in the leaves exceeds the tolerance of the crop, injury symptoms develop such as leaf burn or drying of leaf tissue (Pescod, 1985). The obtained chloride ion concentration of the samples varied from 387.6 mgL^{-1} to 1633 mgL^{-1} (mean value = 950.1) (Figure 5). The drinking water from the city of Nouakchott is characterized by chloride contents ranging from 106.5 mgL^{-1} and 127.8 mgL^{-1}. There is a high chloride content provided by the fishing company using largely sea water for the treatment of cephalopods. The concentrations found in wastewater from the effluent of WWTP are greatly exceed the concentration limit for irrigation water (350 mgL^{-1}) (Ministére de l'Environnement du Maroc, 2002).

Ammonia

The ammonia derived from the degradation of animal protein (nitrogen cycle), domestic effluents (urea) and urban runoff (Udert et al., 2003, Bonte et al., 2008). The maximum value of ammonium in the effluent of the WWTP is 67.14 mgL^{-1} and the mean minimum is 20.3 mgL^{-1} (Figure 6).

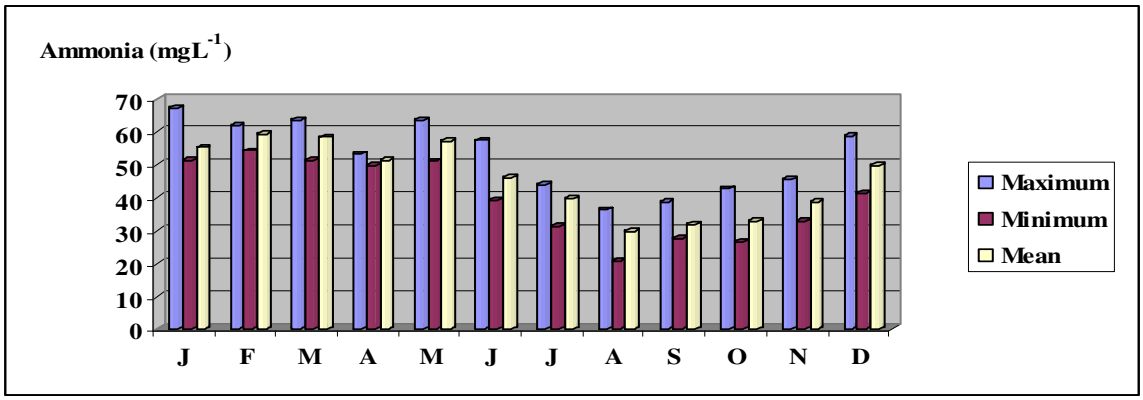

Figure 6. Monthly variations in Ammonia recorded during January to December 2009.

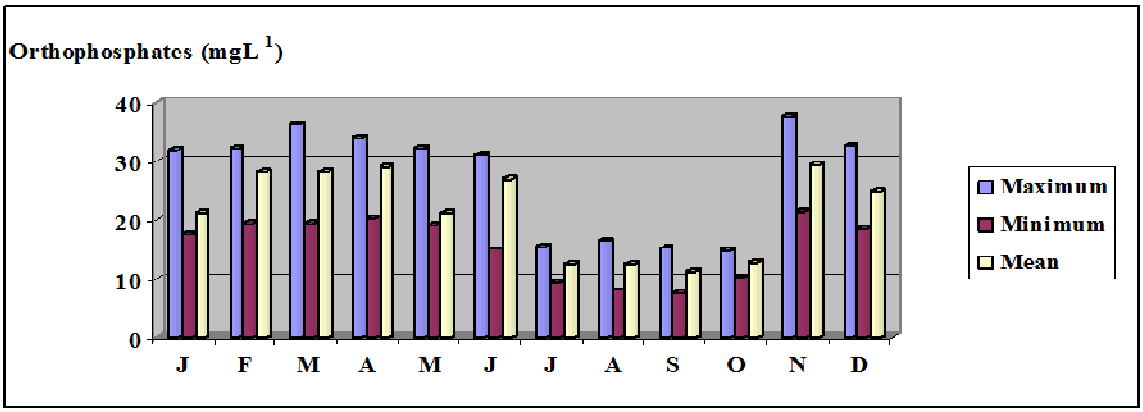

Figure 7. Monthly variations in orthophosphates recorded during January to December 2009.

Orthophosphates

The majority of organic phosphorus from the waste of protein metabolism and elimination in the form of phosphates in the urine by humans Phosphorus is not inherently toxic to wildlife and terrestrial and aquatic flora. For cons, the "eutrophication" most direct consequence of an excess of phosphorus in the middle, a very worrying effects on many levels (Du Chaufour, 1997). The maximum value in orthophosphate in the effluent of the WWTP is 37.6 mgL^{-1} and the mean minimum of 7.6 mgL^{-1} (Figure 7). The levels of orthophosphate recorded at the WWTP are much lower than 10 mgL^{-1} considered as an acceptable limit of a direct discharge to the receiving environment (Ministére de l'Environnement du Maroc, 2002).

Chemical Oxygen Demand

The COD is a vital test for assessing the quality of effluents and wastewaters prior to discharge. The COD test predicts the oxygen requirement of the effluent and is used for monitoring and control of discharges and for assessing treatment plant performance. Thus, COD is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. The COD is the amount of oxygen consumed by the chemically oxidizable matter in the water. It is representative of most organic compounds but also oxidizable mineral salts (sulphides, chlorides …). The COD allows us to appreciate the concentration of organic or inorganic, dissolved or suspended in water, through the amount of oxygen necessary for their total chemical oxidation (Rodier, 1996). The values of COD recorded at the WWTP effluent range from 561.8 mgL^{-1} and to 210 mgL^{-1} (Figure 8). The values of COD recorded in effluent from the city of Nouakchott are slightly greater than 500 mgL^{-1}, considered as direct discharge limit value (Ministére de l'Environnement du Maroc, 2002).

Fecal Coliforms and Fecal Streptococci

Bacterial parameters which serve as indicators of fecal pollution are also very important when human is the

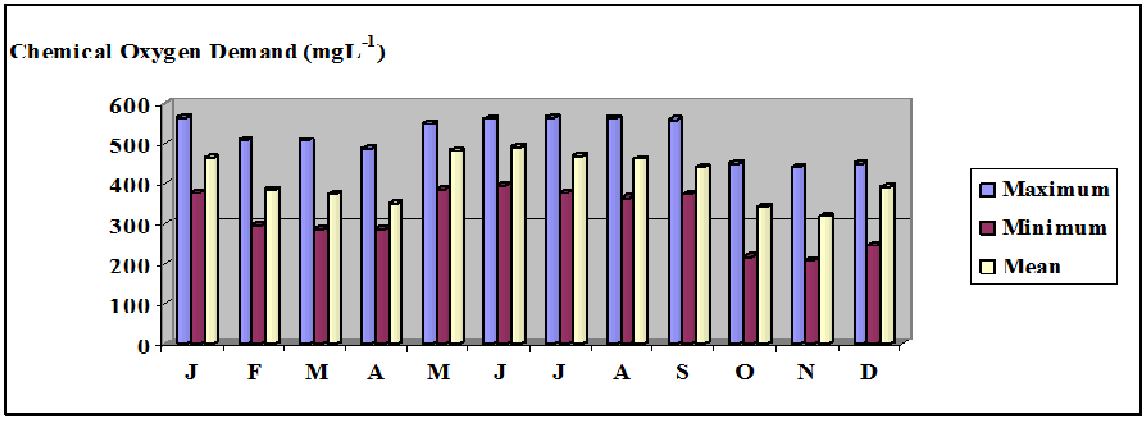

Figure 8. Monthly variations in COD recorded during January to December 2009.

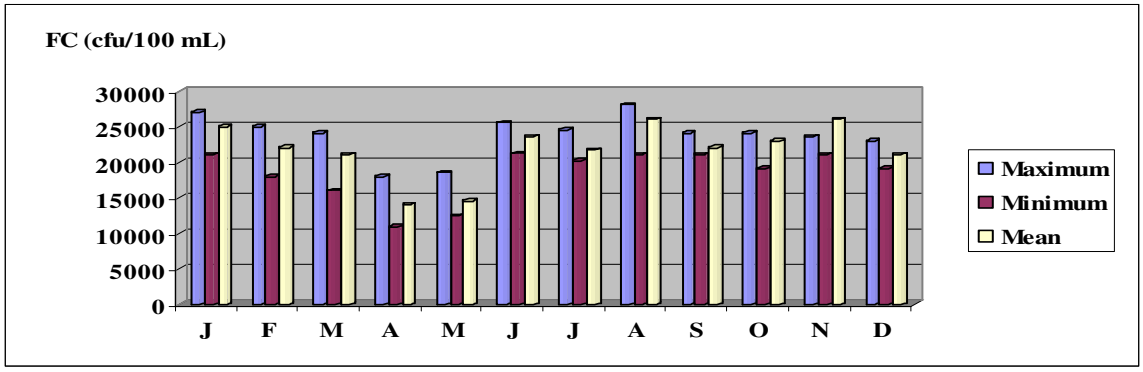

Figure 9. Monthly variations in Fecal Coliform recorded during January to December 2009.

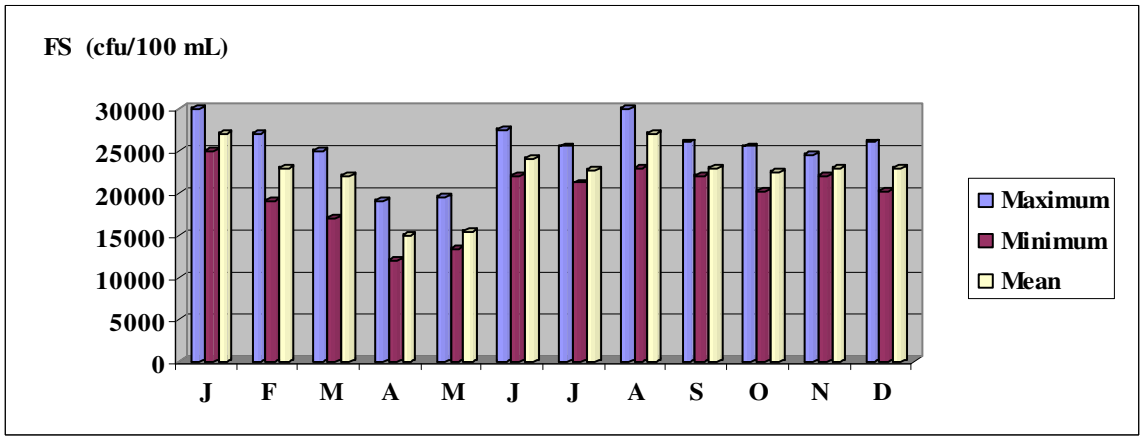

Figure 10. Monthly variations in Streptococci Coliform recorded during January to December 2009.

prime concern. The specific identification of pathogenic bacteria is extremely difficult; the coliform group of organisms is used as an indicator of the presence in wastewater organisms. Coliform bacteria are found in intestinal tract of human beings. Coliform group of bacteria include genera Escherichia and Aerobacter. In the effluent of the WWTP, the microbial load of fecal coliforms and fecal streptococci is very important. The levels of fecal coliforms and fecal streptococci ranged respectively 1, 1.10^4 cfu/100 mL to $2,8.10^4$ cfu/100 mL (Figure 9) and from $1,2.10^4$ cfu/100 mL to 310^4 cfu/100 mL (Figure 10). These values are lower and sometimes comparable to those found in municipal effluents in Dakar (Niang, 1996). Also, the bacterial load than that

recommended by WHO for the irrigation water and is of the order of 10^3 CFU / 100 ml (WHO, 1994).

CONCLUSION

The survey of the physicochemical quality of the WWTP effluent showed the existence of pollution resulting in high salinity can have a negative impact on soils and crops the perimeter of vegetable Sebkha. Bacteriological pollution levels recorded at the WWTP effluent are higher than the thresholds recommended by WHO. The presence of high bacteria indicators of fecal contamination is undoubtedly a threat to the market garden, the children of farmers, retailers and consumers. The introduction of legislation for wastewater management in Mauritania stations and treatment of polluted water in the city of Nouakchott, which is growing day by day and the generalization of the sewerage in the city of Nouakchott our community to avoid any form of environmental pollution.

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