Evaluation of the Physicochemical Quality of Water Used for Irrigation in Urban and Periurban Farms of Meknes City Morocco

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ABSTRACT

This study aims to evaluate the physicochemical parameters of irrigation water quality used in urban and periurban farms in Meknes (Morocco). The results showed that in all sampling sites, the mean temperature values ranged from 22°C to 24°C, and mean pH values varied between 7.4 and 7.7, and electrical conductivity ranged from 1392.25 µs/cm to 1823.5 µs/cm; these three parameters are within FAO's guidelines for irrigation. As for the parameters such as biological oxygen demand (BOD5), mean values varied between 86.25 mg/L and 273.25 mg/L. Mean dissolved oxygen (DO) values ranged from 2.95 mg/L to 6.02 mg/L. Orthophosphate concentrations ranged from 13.28 mg/L to 33.17 mg/L. Mean ammonium value varied from 61.3 mg/L to 70mg/L. These parameters do not meet the FAO's irrigation guidelines. Therefore, the water used for irrigation on urban and periurban farms in the city of Meknes is poor quality and requires adequate treatment.

Keywords: Wastewater, irrigation, biological oxygen demand, physicochemical.

INTRODUCTION

Urban agriculture can provide fresh products and income for poor households. However, farmers in these areas usually use wastewater for irrigation to overcome water shortages. This practice can endanger public health and the environment, as this water can contain all types of pollutants from domestic, industrial, and commercial activities (Qadir et al., 2007).

In Meknes, the improvements in living conditions and rapid economic and industrial development have increased wastewater discharges and water contamination. As a result, conventional water resources have been severely affected. To overcome the water demand, farmers use wastewater for irrigation in the small urban and periurban smallholdings. With the growing demand for food, these areas produce various products easily sold on local markets. Reusing wastewater in agriculture is vital for the socioeconomic dynamic of the farms. It is a water supply that allows farmers to grow crops throughout the year. It also contains nutrients that improve crop growth (Keraita et al., 2012).

As this practice can hardly be permanently eliminated, ongoing monitoring of water quality can help guide better intervention practices and decision-making. This work aims to determine and evaluate the physicochemical parameters of this water used for irrigation in the urban and periurban farms of the city of Meknes.

MATERIALS AND METHODS

1. Description of the study sites

Meknes city is part of the Fez-Meknes region located in northwest Morocco, 140 km from the capital Rabat. Meknes is located at 516 m above sea level. The climate is the semi-continental Mediterranean. The average annual temperature ranges from 11°C to 24°C. The average of annual precipitation is 576 mm (Haut Commissariat au Plan, 2017).

The farms are located in the urban and periurban areas of Meknes city, mainly at three streams of water that cross the city: Ouislane, Toulal, and Boufekrane as shown in Figure 1. Horticulture crops are the most produced in these areas. In addition arboriculture, small plots of forage, and livestock farming can also be found. The streams and wastewater are the main sources of irrigation.

2. Sampling and analyses

Sampling was conducted and collected in March 2022 based on their use in agricultural purposes. Three selected water sampling sites were identified:

Site 1: water from the urban sewer that farmers draw directly for irrigation.

Site 2: water from the Toulal stream.

Site 3: water from the Ouislane stream.

The physicochemical parameters are temperature, pH, turbidity, electric conductivity (salinity), ammonium, orthophosphates, dissolved oxygen, chemical oxygen demand, and biological oxygen demand . Twenty seven water samples (nine from each site) were collected in 1.5L bottles plugged and labeled.

Temperature, pH, and salinity were measured in situ using the portable waterproof multipara meter Hanna HI 991301. The device was checked and calibrated according to the manufacturer's instructions. The rest of the parameters were determined in the laboratory according to the standard methods described by (Rodier et al., 2009).The methods used are listed in Table 1.

Figure 1. Map of the location of the study area and sampling sites in Meknes city

Table1.Methods used for water samples analysis

Parameters	Methods	Adapted standards
Turbidity	Nephelometric method	NF EN ISO 7027
Orthophosphate	Method by continuous flow analysis	NF EN ISO 15681-2
Ammonium (NH_4^+)	Manual spectrometric method	ISO 7150-1:1984
Dissolved oxygen	Winkler Method	-
Chemical oxygen demand COD	Open Reflux Method	NF T90-101
Biochemical oxygen demand BOD5	Dilution method	NF EN 1899-1

3. Statistical analyses

The data were processed using Microsoft Excel Office 2010. For each parameter, the mean and the standard deviations were determined and compared with Food and Agriculture Organization standards for irrigation water (Ayers and Westcot, 1985) and World Health Organization (WHO, 2011) guidelines for drinking water quality. The t-test was also performed using STATA software.

RESULTS AND DISCUSSION

The mean values and standards deviation for the different physicochemical parameters of the irrigation water from Meknes urban and periurban smallholdings are shown in Table 2.

The data in table 2 showed that the mean values of water temperatures fluctuated between 22°C and 24°C in the three selected sites. The mean pH values for all samples were within the FAO limits (Table 2), ranging from 7.4 to 7.7. The t-test did not show any significant difference between all samples in the three sites (p>0.05).

Electrical conductivity (salinity of water) values were within the FAO recommended irrigation limits (Table 2). The highest average value of salinity was 1823.5 μs/cm in Site 1, followed by Site 3 with an average of 1687 μs/cm and 1392.25 μs/cm in Site 2. The t-test displayed a statistically significant difference in all samples of the three study sites ($P<0.001$).

Turbidity is the content of suspended particles in water. The result in table 2 showed that the mean values of turbidity were 215 NTU for Site 1, 171 NTU for Site 2, and 115 NTU for Site 3. The t-test showed a statistically significant difference in all the samples of the three sites ($P<0.005$). In the present day, there is no guideline for eligible limits for turbidity for irrigation water. Taking into consideration the WHO guidelines for drinking water (Table 2), all samples (streams and wastewater) showed high turbidity levels.

Chemical oxygen demand (COD) is the amount of oxygen chemically consumed to oxidize all organic matter in water using a strong chemical oxidizing agent. It makes it possible to characterize the overall pollution of water by organic matter (Khan and Ali, 2018). Average Chemical oxygen demand (COD) values were ranged from 141 mg/L to 459.05mg/L in all samples. Site 1 had the highest value. In all three sites, the t-test showed a highly significant difference ($P<0.001$).

Table 2. Mean values of the physicochemical parameters of irrigation water at the three study sites of urban and periurban farms in Meknes compared to the permissible limits

Parameters	Site 1	Site 2	Site 3	Limits Recommended
Temperature T °C	22.8± 1.27	23.775 ± 0.55	22.01 ± 0.84	-
pH	7.675 ± 0.37	7.4475 ± 0.48	7.535 ± 0.33	6.0-8.4 FAO (Ayers and Westcot, 1985)
Conductivity μs/cm	1823.5 ± 38.44	1392.25 ± 46.03	1678.5 ± 49.99	700- 3000 FAO (Ayers and Westcot, 1985)
Turbidity (NTU)	229.75 ± 8.26	171.5± 8.50	115.5 ± 6.45	≤5 WHO (WHO, 2011)
Orthophosphate (mg/L)	131.285 ± 2.07	180.365 ± 2.89	330.175 ± 6.49	2 FAO (Ayers and Westcot, 1985)
Ammonium (NH_4^+) mg/L	61.5 ± 6.45	62.75 ± 3.09	70 ± 5.47	0- 5 FAO (Ayers and Westcot, 1985)
Dissolved oxygen (mg/L)	3.2 ± 0.88	3.93 ± 1.964	5.26 ± 0.94	>4.0 FAO (Ayers and Westcot, 1985)
COD (mg/L)	459.05 ± 41.63	141.75 ± 47.87	228.75 ± 22.58	-
BOD5 (mg/L)	273.25 ± 28.70	86.25 ± 31.88	128.25 ± 23.02	≤8.0 FAO (Ayers and Westcot, 1985)

(-) not found

Biochemical oxygen demand (BOD5) is the amount of oxygen required to degrade biodegradable organic matter in water by developing microorganisms in 5 days at 20°C. It gives an approximation of a load of biodegradable organic matter (Wilhelm, 2009). BOD5 values obtained in Site 1 were the highest; its mean was 273.25 mg/l, followed by Site 3 and Site 2 with the respective mean values of 128.25 mg/l and 86.25 mg/l. The t-test showed a statistically significant difference ($P<0.001$) between all samples of the three sites. BOD5 values were also all above the irrigation standards. The ratio of COD to BOD5 helps determine the level of biodegradability of the water. The COD/BOD5<2.5 ratio indicates that all the samples can be easily treatable by biological treatment (Rodier et al., 2009).

Mean dissolved oxygen (DO) values ranged from 3.2 mg/L to 5.26 mg/L. Dissolved oxygen levels were low, at sites 1 and 2, with a mean of 3.2 and 3.93, respectively. They do not meet the FAO recommended limits for irrigation (Table 2). The t-test did not show any significant difference between all sampling sites ($p>0.05$), except for samples of site 1 compared with samples of site 3 ($p<0.001$). Dissolved oxygen (DO) is essential for plant growth. Low (DO) concentrations can negatively impact plants' ability to absorb nutrients and resist stress and diseases (Holtman et al., 2004).

The levels of orthophosphate varied between 13.28 mg/L and 33.17 mg/L. The highest values of phosphates were observed in Site 3. The t-test showed a statistically significant difference ($P<0.001$) between all samples of the three sites. For ammonium (NH_4^+), the highest values were observed at Site 3 with an average of 70mg/l, followed by Site 2 with an average of 62 mg/l, and Site 1 with an average of 61.3. The t-test showed a significant difference of samples of site 3 compared with samples of site 1 and site 2 ($P<0.01$). However, there was no significant difference between samples of sites 1 and 2 ($P>0.05$). Both orthophosphates and ammonium values exceed the FAO acceptable limits (table1). This is explained by the fact that these waters receive domestic and industrial discharges without prior treatment.

CONCLUSION

In this study, the physicochemical quality parameters of the water used for irrigation on urban and periurban farms in Meknes (Morocco) were evaluated. The pH, conductivity, and temperature parameters conform to irrigation guidelines. The other parameters turbidity orthophosphates, ammonium, biochemical oxygen demand, and dissolved oxygen exceeded the irrigations guidelines. The high levels of these parameters would be due to anthropogenic action and discharges. This water used for irrigation is not of good quality. However, it is biodegradable as the COD/BOD5 ratio was less than 2. The search for common contaminants, such as pathogens, inorganic chemicals, and organic pollutants, needs further investigation. It is essential to monitor and assess the water quality and its impact on soil and crop quality.

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