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Physico-Chemical and Bacteriological Analysis of Certain Wells and Sources of The Oulmes Water Table, Morocco

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Abstract

Water is a constant concern of all times and places, becoming a question of life and death. It is threatened today by anthropogenic or natural pollution. These waters constitute the main source of drinking water supply for the city of Oulmes. The present study focuses on the hydrogeochemical and bacteriological characterization of certain springs and well water in Oulmes Town, Central Moroccan. The methodology adopted consists of characterizing the physico-chemical and bacteriological properties, by following the spatial variation of the contents of the water pollution indicators of certain wells and sources in the study area, and this, by companions of the samples which were carried out and was subject to analysis at the laboratory level according to evaluation techniques. The results of the physicochemical analyses revealed that the values of the parameters such as pH (6.72), temperature (16.99 °C), and Salinity (0.51 mg/L) conformed to the WHO potability standards. The bacteriological (Total coliforms (0 to more than 250 CFU/100 ml), Fecal coliforms (0 and 34 CFU/100 ml), fecal streptococci (0 and 37 CFU/100 ml) Pseudomonas aeruginosa (0 and 100 CFU/100 ml)) study confirmed that the water from the wells and sources showed pollution of bacterial origin. Using these waters for human consumption without treatment may endanger the populations with the risks of hydric diseases.

Keywords: *Water Quality, Bacteriological, Analysis, Oulmes, Morocco*

INTRODUCTION

Assessment of water availability, water use and water stress in the global scale **(Pastor et al., 2014)** has been a concern of several researchs in the past 20 years. However, the Scarcity of safe drinking water is one of the most known problems in the entire monde **(Kamanula et al., 2014)**, threatens people in various regions and causes environmental degradation, especially in arid and semi-arid region **(Laaraj et al., 2023)**. Water demand in Morocco currently reaches 13.7 Km^3, by 2030 could reach 16.7 km^3 which causes a real challenge in terms of water mobilization (**El Jihad and Taabni, 2017**).

Grunwater is generally located in aquifers underground links with surface water (**Chidya et al., 2011**), in naturals conditions, the flow of a river depends on the flow leaving an aquifer as a water source. Furthermore, the infiltration of water from the wetland can contribute to the recharge of an aquifer (**Vernoux et al., 2010**). therefore, natural morphological and geological factors intervene in the aquifer-surface water relationship. Also, The interaction between the water table and the watercourse plays a very important role both from the point of view of quantitative and qualitative relationships. In this interface zone, different biogeochemical reactions will occur.

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Currentely, sources of water are under threat due to several factors (**Chidya et al., 2011**). The main anthropogenic sources are associated with mining activities, the metallurgical industry, fertilizers and pesticides used in agriculture and domestics effluents (**Najy et al., 2021**).

The microbiological water quality of surface and shallow well water can be influenced by the incoming of fecally derived microorganisms from severals sources including discharge sewage from wastewater treatmnet plants (**Mackowiak et al., 2018; Najy et al., 2020**). Consumption of water that is contaminated with human or animal faeces generates a high risk of having waterborne diseases. Because, thier existence in water are some of the sources of pathogenic bacteria **(Lotfi et al., 2020; Xu et al., 2022a).** According to Morrocan standards relating to water (NM 03.7.001, 2016) and world health organization guidelines, drinking water sources should not contain any Bactery **(WHO, 2011).**

This study, therefore, intended to evaluate the quality of surface water in Oulmes Region and its catchment area. The main objectives were to evaluate the physico-chemical and bacteriological characteristics of Water, to review the effects natural and anthropogenics factors on water quality in studied Regien

MATERIALS AND METHODS

The Study Area Description

The fissured geological formations in the Oulmes plateau can constitute aquifers of major importance, which constitutes an essential tool for the quantitative and qualitative management of the groundwater resources of the Oulmes plateau.

The Oulmes plateau is located in its entirety, in the central Meseta, also called the "Central Moroccan" plateau. It is limited to the north by the South-Rif corridor, to the south by the phosphate plateau, to the east by the Middle Atlas and to the west by the coastal Meseta.

The central Méséta is largely drained by two main rivers: the Beht (left bank tributary of the Sebou) and the Bou-Regreg (Figure 1). The Oulmes plateau is part of the watershed of the Bou-Regreg wadi. This wadi has a watershed with a total area of 9700 km², or nearly 70% of the total area of the central Meseta (**Elbatloussi et al., 2005**).

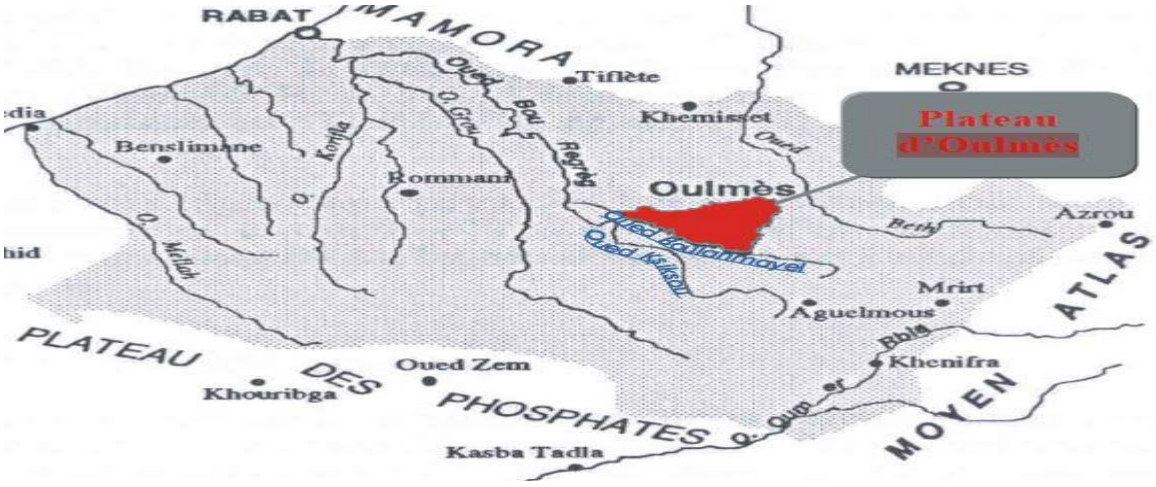

Figure 1: The main rivers of the Central Meseta

A few kilometers south of Jbel Hamou-ou-Guerr, the Bou-Regreg wadi arises following the confluence of the Boulahmayel and Ksiksou wadis, whose watersheds have an area of 973 and 863 km² (Figure 1).

Materials and Methods

We performed a total 14 samples for physicochemical and bacteriological analysis throughout the study period at different water points, including spring and well water. However, water samples were collected randomly using pre-washed and sterilized 1 L plastic containers. The samples were preserved and sent to the

laboratory for analysis of various physicochemical parameters. Hence, those who was not analyzed within four hours of their arrival, was placed in the refrigerator until the time of analysis, Water temperature and pH were measured at the sampling site. In addition, the samples were taken to evaluate pathogenic germs as an indication of pollution, namely: *Total coliforms* (TC), *fecal coliforms* (FC), *fecal streptococci* (FS) and *Pseudomonas aeruginosa* (PA).

The method used for the search for bacteria in the water studied is based on the so-called filter membrane method and according to Moroccan standards. (**Rodier et al., 2009; Safety and Organization, 2006; WHO, 2011)**.

RESULTS

Groundwater chemistry description

Ph

Hydrogen potential (pH) is well known to estimate the availability of cations and nutritive elements in water ecosystems (**Ragot and Villemur, 2022**). Therefore, Figure.1 presents the spatial variations of pH in the study aera, the results obtained in most of the springs and wells studied show that the pH values vary slightly and are closer to neutral. These results show that slightly alkaline waters characterize the Oulmes region. The spatial variation map also shows that high hydrogen potentials are recorded at the following points (W4, W8 and S3), while low concentrations are recorded at the well level (W1).

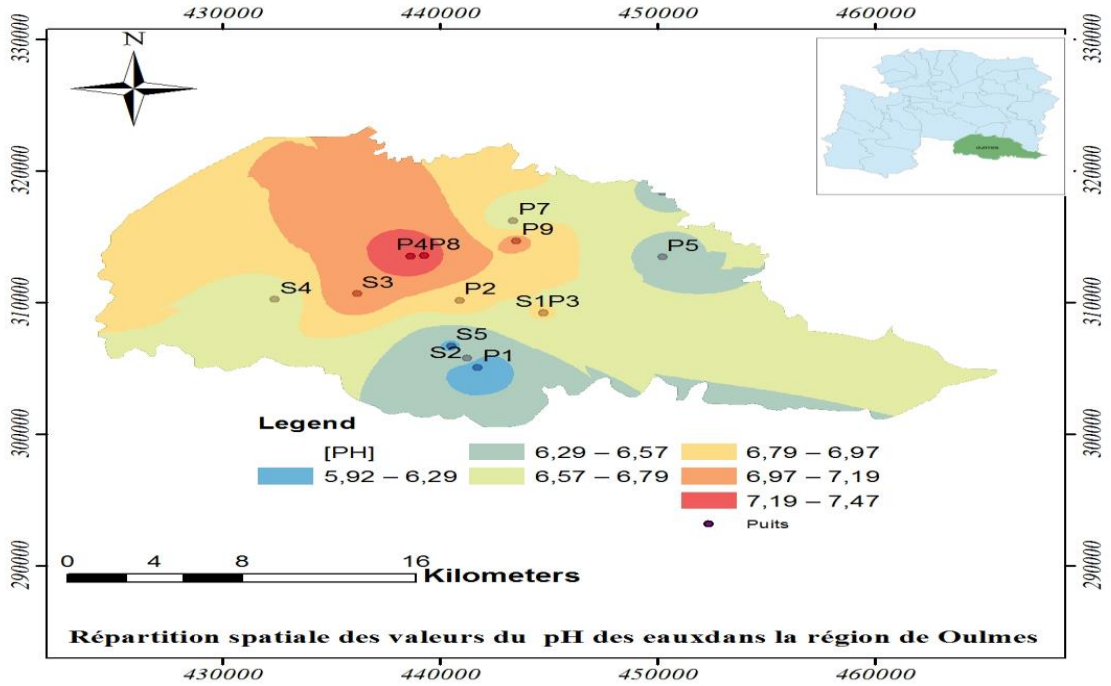

Figure 2. Spatial distribution map of pH in the study area

note that the wells represented in the map by the letter p. W=P

Temperature

According to results found during the study period, the temperature values recorded at the spring water level oscillate between 16°C and 21.23°C, in points S3 and S4. In addition, the temperature values recorded in the wells oscillate between 15 and 18.5°C, the minimum recorded at Well N° 5 and the maximum recorded at Well N° 4

The spatial variation map Figure 3, reveals that the average temperature values do not present large variations from one point to another, with a minimum of 15.78 °C (Well N° 2) and a maximum of 17.78°C (Well N° 4). On the other hand, a very little variation at the source level, with a minimum of 15.91°C (S5) and a maximum of 20.93°C (S4).

Remember that water temperature is influenced by air temperature and varies closely from one season to the next.

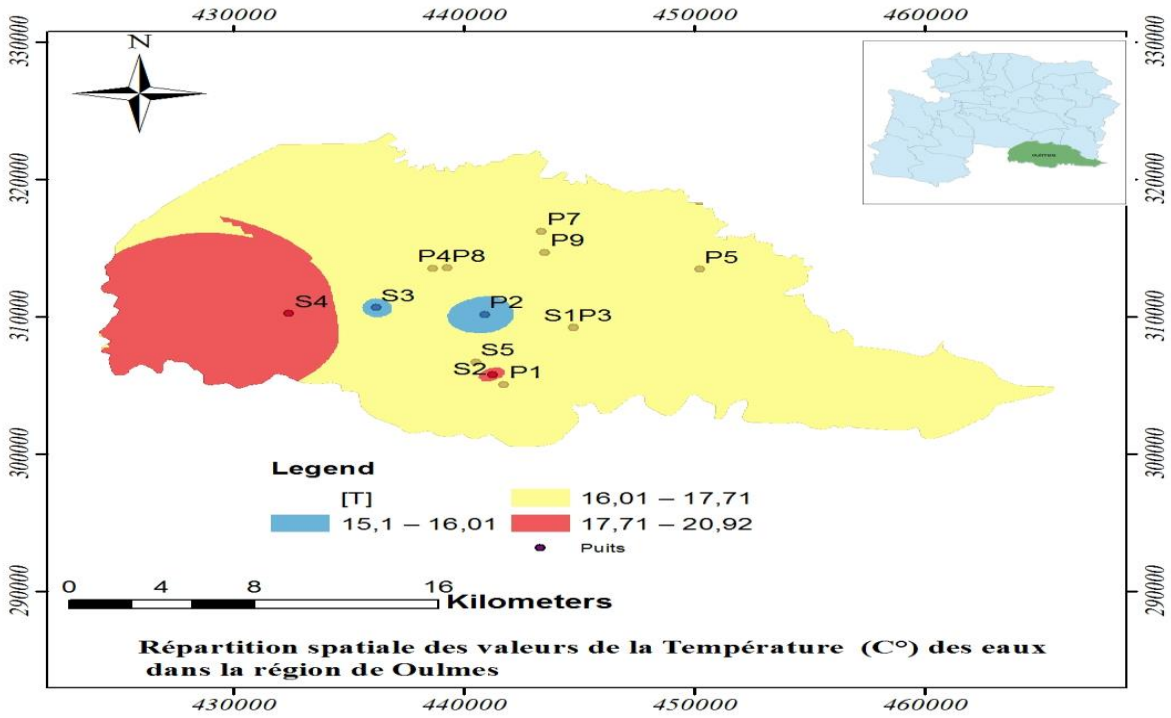

Figure 3. Map of spatial distribution of temperature in the study area

Salinity

Salinity translates into the evaluation of the total concentration of salt dissolved in water. However, during the study period, the salinity values recorded at the spring water level oscillate between 0.3 and 1 mg/l, while the salinity values recorded at the well water level oscillate between 0 and 1mg/l. The map of the spatial variation of salinity Figure 4 shows that the average contents found in the waters of the Oulmes region do not show notable fluctuations, passing from one point to another, with a minimum of 0 mg/l at wells (W3 and W6) and a maximum of 7.95 mg/l at source N° 4.

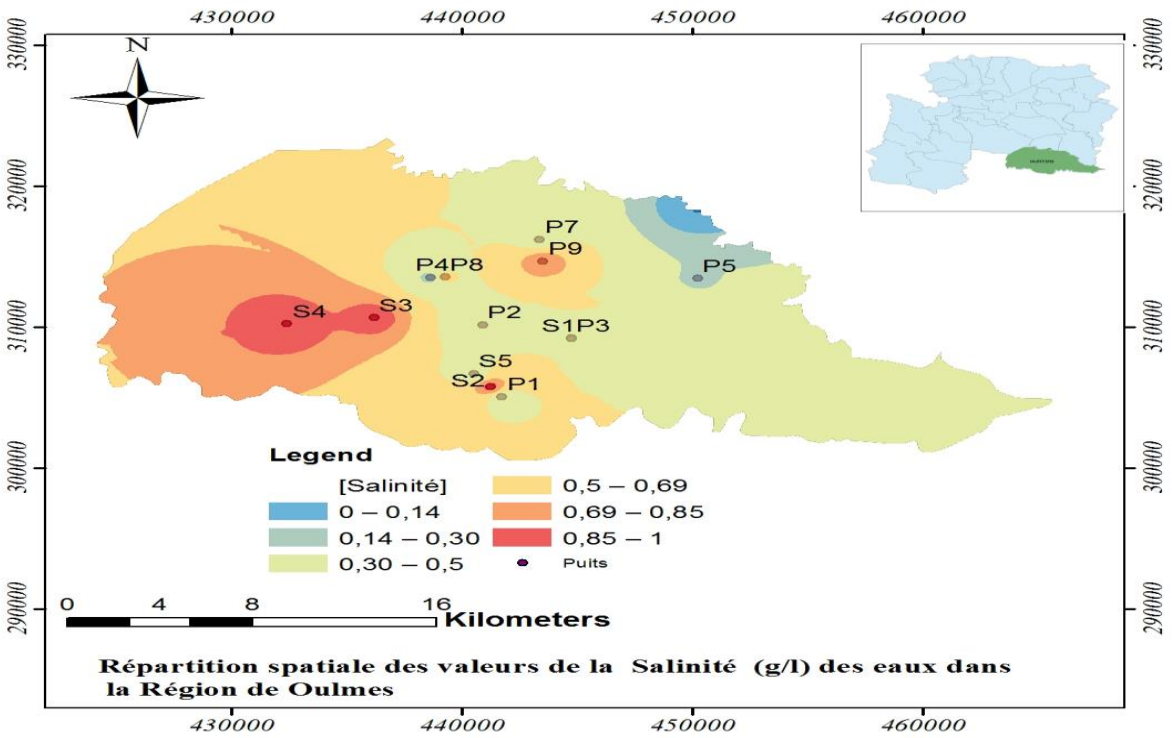

Figure 4. Map of spatial distribution of Salinity in the study area

Distribution of Fecal Contamination

Total coliforms

Total coliforms are indicators of fecal contamination. Their presence in water means that it is contaminated by pollution of fecal origin and that it may therefore contain pathogenic microorganisms.

The evaluation of the enumeration of total coliforms in the water from wells and springs concerned was made based on the quantity of the latter.The cncentration of Total colforms was detremined culturally using Tergitol-7- agar at 37C°, all simples for water tested for total colforms were positive with a very remarkable variation from one site to another. Indeed, the maximum value of 250 CFU /100ml was recorded at Site (S_3) and the minimum value which is less than 25 CFU /100ml at Site (S5) as illustrated in Figure 5. In addition, those who performed at the well water levels revealed successive values (75; 5 CTU100 ml), in the wells (W6 and W8) as shown in Figure 6. Furthermore, wells W1, W2; W4; W7 and W9 contain no contamination. Therefore, these results reveal a high concentration at the level of spring water S_3 and at the level of well W8.

Based on current standards **(NM 03.7.001, 2016; WHO, 2011)**, most of the well water analyzed during the study meets Moroccan and World Health Organization standards. In contrast, the concentration was above the range of quantification in spiring waters.

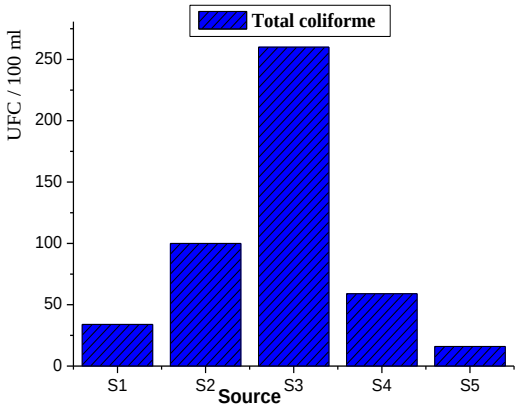

Figure 5. Total coliforms in analyzed source waters

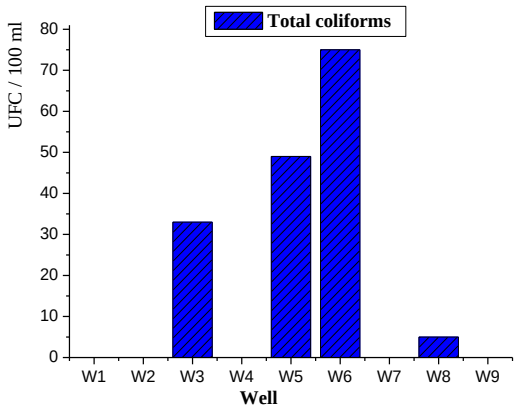

Figure 6. Total coliforms in analyzed well waters

Fecal coliforms

Fecal coliforms are a subgroup of coliform bacteria, which ferment lactose at a temperature of 44.5 ± 0.2 °C within 24 hours, the main representative of which is the Escherichia bacteria, of exclusively fecal origin.

The concentratons of FC at 14 simples (spring and well Water) are summarized in Figure 7 and 8. During study period, the maximum FC concentration was 34 CFU/100 ml, which occurred at point W4 (p), the minimum value was 0 CFU/100 ml and occurred at points W1, W2, W4, W7 et W9 as shwed in Figure. 8. While, spiring water FC concentractions ranged from 10 CFU/100 ml (S2) to 26 CFU/ 100 ml (S4).

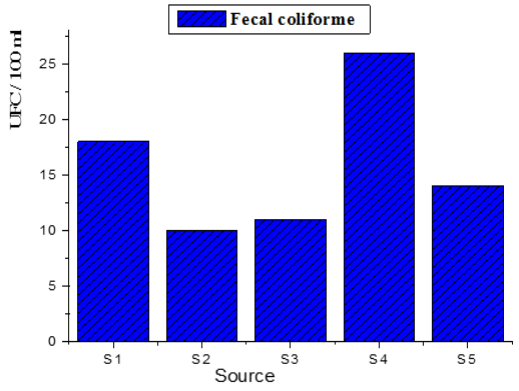

Figure 7. Fecal coliforms in analyzed source waters.

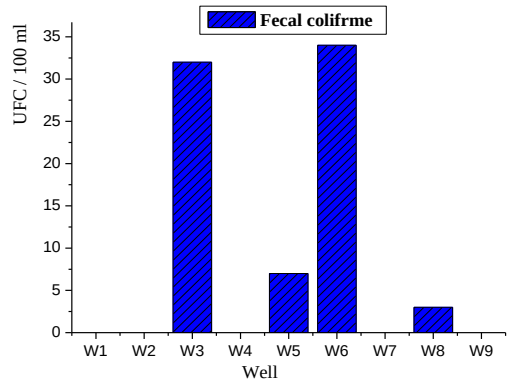

Figure 8. Fecal coliforms in well water analyzed

Fecal streptococci

The results of the analysis of different water points studied in the study area showed that fecal streptococci are present in most sources (80%) and 55.56% of wells, but much less abundant. than fecal coliforms. Also, the results found showed that the concentrations of fecal streptococci varied between 0 CFU/100 ml and 22 CFU/100 ml for the waters of the sources whose maximum value (22 CFU/100 ml) within the 3rd source (S3) and minimum at within the 5th source (S5) Figure 9. While, in the waters of the wells the concentrations are between 0 CFU/100ml and 37 CFU/100ml as the SF whose value (37 CFU/100ml) is maximum for those of P5 and minimum for the SF of W1, W2 , W4, W7 and W9 Figure 10. Furthermore, the results show that most of the points are contaminated by fecal streptococcus and that there is a difference between well water and spring water. High concentrations are observed at source water level S3 and at well level W6.

Most of the values recorded at the sources exceed the standard with the exception of source No. 5 which recorded a zero value (not exceeding the standard). On the other hand, well water, of which 44.45% of recorded values exceeded the standard (WHO).

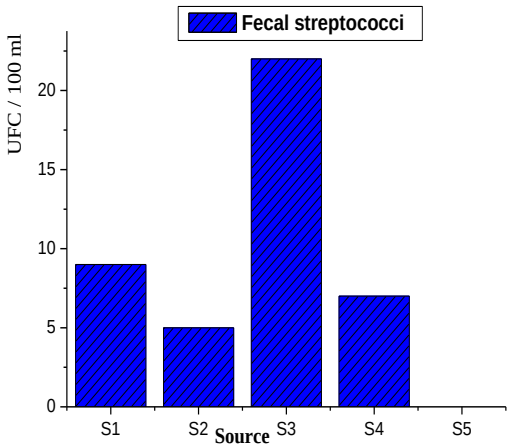

Figure 9. Fecal Streptococci in analyzed source waters.

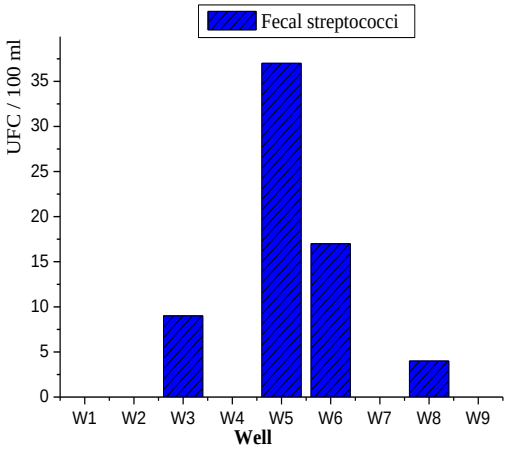

Figure 10. Fecal Streptococci in well water analyzed

Pseudomonas aeruginosa (PA)

The results of the analysis of water points studied showed the absence of contamination by pseudomonas aeruginosa (PA) at most of the wells and sources with the exception of the source (No. 3), which revealed a concentration of 100 CFU/100ml Figure 11. This can be explained by the nature of the water which is characterized by low turbidity, with substantially constant chemical compositions. The affectation of the only source N°.3 by *pseudomonas aeruginosa* could be explained by pollution, whether of animal or human origin (**Belghiti et al., 2013**). Indeed, the presence of this genre of bacteria in water intended for human consumption could cause the transmission of infectious diseases which are responsible for diarrhea, wound infections and genitourinary and ocular infections in immunodeficient subjects **(Pécastaings, 2010)**. Referring to the standards in force (**WHO, 2011**), the waters of the region studied during the study period meet the standards and present no risk to human health.

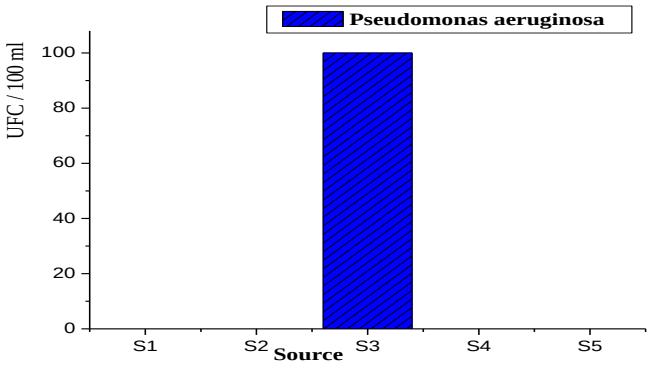

Figure 11. Pseudomonas aeruginosa (PA) in the waters of the sources analyzed.

DISCUSSION

Results of our study show that, the values of the pH of ground waters of Oulmes do not show variations notables, with a minimum of 5.53 with the well P5 (Winter) and a maximum of 7.86 with the wells P6 and P7

(Winter). These results show that the area stydies is characterized by water slightly alkaline **(Akkaoui et al., 2019; Najy et al., 2023, 2021)**.

The temperature of water is an ecological factor very important in the study of the environmental phenomena **(Akkaoui et al., 2019)**.The temperature values recorded in the study area oscillate between 15°C and 21.23°C,

The increase in temperature promotes self-purification and increases the sedimentation rate, which can be of interest in wastewater treatment plants. It can promote the mortality of certain species and the development of others **(Najy et al., 2018, 2020)**

The salinity values obtained in most (71.43%) of the water points studied are in agreement with standards while 28.57% are slightly above the concentration thresholds recommended by the standards of the World Health Organization. **(WHO, 2011)** which indicates a guideline value of 0.1 to 0.5 g/L.

From a bacteriological point of view, analyzes reveal contamination of the majority of samples taken from the sources. On the other hand, most well water is not contaminated. The very high values of coliforms and spectrococci recorded at different points in the study area could be explained by several factors; poor protection of water points, by the accumulation of organic waste surrounding water points, by the intensification of agriculture. according to **(Purnell et al., 2020; Xu et al., 2022b)** domestic wastewater and livestock sewerage are deemed main sources for these pollution indicator in surface water. Other studies have emphasize that agriculture lands, such as dairy farming and cropland irritated with wastewater could influence the surrounding surface or groundwater to varying degrees (**Singh, 2021**).

Quantifying fecal contamination (**Borrego and Romero, 1982**) makes it possible to monitor the evolution of the fecal coliform/fecal streptococcal ratio in the area studied. The ratios found (50% less than 0.7) indicate an animal origin of this pollution, 7.14% between 1 and 2 indicates a mixed, predominantly animal origin, 28.57% between 1 and 2 indicates an uncertain origin. , 7.14% between 2 and 4 (2 <CF/SF<4); the origin of contamination is mixed, predominantly human. In contaminated sites, it has been noted that there is a predominance of contamination of animal origin compared to human contamination.

CONCLUSIONS

The data collected during this study made it possible to draw up a portrait of the physico-chemical and microbiological quality of the water from certain wells and sources of the Plateau d'Oulmes and will make it possible to provide the authorities with basic data capable of be exploited as part of improving quality for domestic use.

From a bacteriological point of view, the wells and sources studied present very high concentrations of fecal contamination germs in almost all the wells and sources with the exception of Pseudomonas aeruginosa which was only found in the S3 source. These heavily polluted waters, whether human, animal or mixed, undoubtedly constitute a threat to residents. Consequently, the water analyzed must not be intended for human consumption without prior treatment.

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