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Biothermalism: The physicals and chemicals parameters of the thermal station Ain Allah Fez Morocco

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Abstract

The Daily and spatial variations of the physicals and chemicals parameters of the waters of the thermal station Aïn Allah in the region of Fez show that the waters of this studied thermal station are characterized by a significant temperature of the order of 42C ° characterizing its deep origin, a pH is close to the neutrality, the Low nitrate concentrations, low ammonium concentrations, are low in orthophosphate ions. This information on the good protection of these waters against any exogenous pollution. For the values recorded in the samples taken at the pool level, they generally reflect pollution by detergents and disinfectants containing organic phosphate.

Keywords: Biothermalism, physicals and chemicals parameters, thermal station, Pollution.

1. Introduction

In the last few years, hydrotherapy has begun to gain importance, either on the part of tourists or on the part of governments. The success of thermal tourism is largely dependent on other variables which are of exogenous nature, but which guarantee its prosperity and sustainability: the environment and society. And the tourist demands more a product of quality respecting the model of 4 E proposed by Pascal Cuvelier: Equipment, Supervision, Event, Environment.

Spa treatments are often recommended for people suffering from rheumatism, and diseases of the musculoskeletal system, dermatological diseases (eczema, psoriasis ...), cardiovascular diseases, smoking cessation, endocrine disruption, overweight, or respiratory diseases of allergic origin ... The hydrotherapy offers many care according to the affections: baths in bathtubs or in swimming pools, stimulating or emollient showers, aerosols, pharyngées showers, inhalations of thermal vapors, poultices of mud, ... The cure in she herself can join in fitness activities such as massages, relaxations, gymnastics ...

Hydrotherapy, being a set of activities related to the exploitation and use of mineral waters, has been modernized to take advantage of the latest technologies to use mineral waters for therapeutic purposes both for adults and children.

2. Presentation of the Study region

The spa Aïn Allah located 15 km north-west of the city of Fez is located in the Douyet area (Fig. 1). The water from this spring, extracted from an artesian borehole at a depth of 1650 m, is used to feed the fountain, jet showers and two swimming pools that are open for public bathing.

The source of Aïn Allah is extracted by an artesian borehole at 1650 meters depth. The water from this source is without therapeutic indication. It is intended either for irrigation or to supply swimming pools open to popular swimming. But, what characterizes this source is the exfoliation and natural massage activities that take place in its pools and bathing.

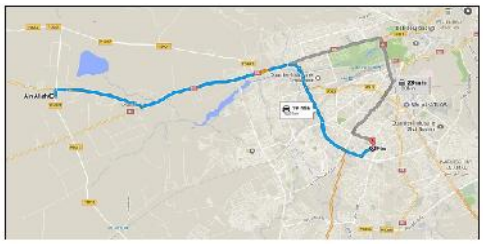

Figure 1 : Location of the region of Aïn Allah extracted from Google Earth

3. Materials and Methods

For the study of the physical and chemical parameters of this thermal water, the samples are collected daily for one week in a study period of 3 months (March, April and May) and from three points, chosen within the traditional pool of women; P1 (Shower water), P2 (Pool water) and P3 (Water discharge). The samples are put in 1-liter flasks, washed beforehand with distilled water and rinsed with the sample at the time of sampling. Their transport to the Regional Laboratory for Epidemiological Diagnosis and Environmental Health (LRDEHM) is done by means of a cooler whose temperature is about 4 ± 2 ° C. For temperature, conductivity, pH and turbidity, these parameters that may vary over time are measured in situ and the others are established in the laboratory according to the methods of Rodier, (2009).

4. Results and Discussion

4-1-Daily and spatial variations of the physical parameters of the station:

4-1-1- The temperature:

The daily evolution remains constant throughout the week at the P1 sampling level. For the other two sampling points, a significant variation is involved, including a decrease in temperature on Thursday and an increase in the first days and days of the week (Fig.2).

The spatial evolution of the temperature at the level of the pool and rejects shows that the values are very close and almost constant during the study period. The difference between these two sampling points does not exceed 0.5 ° C (Fig. 2). For shower water, the temperature values range between 40 ° C and 44 ° C with an average of 42 °.

4-1-2-The pH

The daily variation in pH is very remarkable at the three sites P1, P2 and P3 vary from 7.30 to 7.70 during the week with a significant decrease on Thursday (Fig. 3).

In the same way, the pH values move in the same direction for the three sampling sites. The pH in the majority of cases is neutral to slightly basic. The waters of the sites P1 and P2 have similar values in pH (between 7.2 and 7.3). Whereas for the P3 site, the pH is slightly high, with an average of 7.5 (Fig. 3)

4-1-3- The conductivity

For the daily variation it is found that the values of the conductivity at the site P1 varies insignificantly, the variation remains low with respect to P2 and P3 with values of 806 mS / cm at 820 mS / cm whereas the P2 and P3 increase the days of Saturday and Sunday with values that exceeds 830 mS / cm (Fig. 3) since the number of bathers is very high compared to other days of the week, this phenomenon of attendance concentrated the Week end is due to the reason that most of these curists come to complete their therapies after having initiated the baths of "Moulay Yaacoub".
The spatial monitoring of the electrical conductivity during the study period shows a very small fluctuation between the two studied sites P1 of 806 mS / cm and P2 of 816 ms / cm against against in the site P3 an increase is observed with a average of 837 ms / cm which is close to what was recorded at the resurgence by Houti et al. (2015), this value measured at point P 3 indicates a large mineralization of this site (Fig. 3).

4-1-4- Turbidity

The daily variation of turbidity at points P2 and P3 is remarkable, an increase after the day of Thursday and at the end of the week this increase is due to the discharges thrown by the bathers for the P2 or by the path that crosses this water to the point of sampling P3. The other site P1 remains stable close to (0 NTU) all the week since it is far from any kind of activities concertantes the curists visitors (Fig.4)

The spatial evolution of the turbidity levels at sites P1, P2 and P3 shows that the values vary very significantly. The minimum value is recorded at the level of the shower water (0.7 NTU) and the maximum value is recorded at the point of P3 with a value of (43 NTU) (Fig. 4) (since the shower water is used by swimmers and rejected in site 3).

4-2- Daily and spatial variations of the chemical parameters of the station

4-2-1- Nitrites

Regarding the daily variation of nitrites, we notice a significant presence on Friday and Saturday in points P2 and P3 with maximum values recorded on Sunday (0.18 mg / l in P2 and 0.19 mg / l in P3, on the other hand). The nitrite content in the Waters of the shower remains nil all week (Fig.5).

During the study period, the spatial evolution of the nitrite contents shows that the two sites P2 and P3 have significantly larger values (0.08 mg / l in P2 and 0.3 mg / l in P3) with absence of nitrite at the P1 site (Fig.5). Overall, the nitrite values remain lower at the two sampling points. However, the recorded values remain below the maximum acceptable value set by the Moroccan standard 0.5 mg / L (NM 03.07.001, 2006).

4-2-2- Nitrates

Nitrate levels are stable over the three days of the week with an average of 0.20 mg / l in P1 and P2 0.50 mg / l, except that the maximum value is observed at the P3 level. Nitrate levels increase significantly during the following days (Fig.6).

Overall, the nitrate levels recorded at the three sampling sites do not exceed the threshold allowed by the Moroccan standard (03-7-001) which is 50 mg / l. From there, we can say that they conform to the standards. The maximum is recorded in point P3 with 1.6 mg / l and the minimum of 0.9 mg / l is observed in point P1. Depending on the sampling points, it is also possible to distinguish a small apparent difference between the source P1 and the other points and an increasing order from P1 to P3, once again signaling the external supply to the pool water. Elsewhere, it is noted that the averages of the pool is higher than recorded by Houti et *al*. (2015) (0.001 and 0.06 mg / L). Overall, the nitrate levels recorded at the three sampling sites do not exceed the threshold allowed by the Moroccan standard (03-7-001) which is 50 mg / l. From there, we can say that they conform to the standards. The maximum is recorded in point P3 with 1.6 mg / l and the minimum of 0.9 mg / l is observed in point P1 (Fig.6).

4-2-3- Ammonium

The average daily value of ammonium is almost zero during all the days of the week with an average of 0.01 mg / L in P1.

This parameter varies slightly by an increase noted in P2 with a maximum value of 0.6 mg / L on Sunday. Concerning the P3, the average value of ammonium increases especially after a stabilization during 4 days before the Friday whose parameter takes its maximum value on Sunday day reaching 3mg / L (Fig.7).

Concerning the spatial variation The minimum value is noted in the P1 is (0,01mg / L) on the other hand a significant increase is noted successively in P2 of a value of (0,6mg / L) and in P3 of a value optimum of 1.2 mg / l.

4-2-4- Sulphates

The variation of the average sulphate content at the pool source P1 is more or less stable during the week with a value of 25 mg / l.

For the other points P2 and P3 their contents are much more variable (due to the contributions of cosmetic products used by the bathers) these variations of average sulphate content remain almost stable during the first three days of the week then decrease in parallel for the 2 sampling points on the day of Thursday which indicates the development and support of swimming pool on this day followed by a notable increase taking place from Friday of a value of 30mg / L for P2 and 40 mg / L for the P3 then this increase continue during the weekend days taking optimal values of 40mg / L for the P2 and 45 mg / L for the P3, this increase is expected because the visitors who come on Friday are often inhabitants of the area of Aïn Allah since it is a weekly holiday among Muslims, the pursuit of this increase in the weekend is because the curists visitors of the "My Yacoub" prefer to swim the Week end at "Aïn Allah" to eliminate the smell of sulfur (Fig.8).

For the location, there is always an increase in order from P1 to P3 which shows the difference between the pure source and the pool water stained by different inputs. However, its values remain close to those found by Benmakhlouf (2001).

4-2-5- Orthophosphate

With regard to the average daily variation of orthophosphate for P1, there is an absence during all the days of the week, while the variation in this element for the other two points remains more or less stable at the beginning of the week until 'on Thursday where there is a slight increase due to development work when using phosphorus-rich detergents; for the rest of the week for the two sites P1 and P2, this increase continues by taking an optimal value on Sunday P2: 0.08 mg / L and P3: 0.1 mg / L. as high attendance of bathers (Fig.9).

During this study, the search for orthophosphates in the different sample points revealed the following results:

The absence of orthophosphates in P1 as long as the average variation in is 0mg / L. This variation takes a minimum value of 0.06 mg / L in P2 but a maximum value of 0.08 mg / L in P3 (Fig.9).

4-2-6- Variation of the total hardness

The total hardness is more or less constant during the week with a variation between 3.1 and 3.3 mmol / L for P1, and from 3.1 to 3.2 mmol / L for P2 and 2.6 at 3.0 mmol / L for P3 (Fig.10). The decrease in the content of the total hardness is recorded especially for P2 and P3 in the days of Saturday and Sunday which is due as seen before at the high spa visits during the weekends.

For the spatial variation of these points, we note that a behavior that differs from the other substances studied, marked by a descending order (from P1 to P3). could be due to the drop in temperature whose effect would cause a decrease in the solubility of dissolved salts, or by the passage of some active ingredients through the skin (National Union of Physicians of Spas, Marine and Climatic in France, 2004 the values recorded at the sampling points is 3.2 mg / l for P1, 2.9 mg / l for P2 and finally for P3 of 2.7 mg / l according to its results it can be seen that the water in play and weakly mineralized (SEQ-Eau., 2003) (Fig.10).

4-2-7- Calcium hardness

For daily averages of calcium hardness, there is not a large variation except that there is a low calcium hardness in P1 at the beginning of the week, we also see that the difference between the points is more apparent in weekends, marking the high influence of bathers (Fig.11).

For the spatial variation of the calcium hardness, it shows a decrease in the calcium hardness at the point P1 of 2.6 mmol / L followed by an increase in P2 of 2.3 mmol / L and a drop in the value of the content of the calcium hardness at the P3 point of 2.5mmol / L, thus certifying the low values of the total hardness and showing a weak mineralization of this water. For P2 and P1 (Fig.11).

4-2-8- Chlorides

The chloride content generally shows stable values at point P1 throughout the week with a value close to 80mg/l, whereas the other two sampling points vary during the week between 80 to 90 mg/ in P2 and between 90 to 100 mg/l in P3, with a remarkable decrease at point P2 on Thursday, the chloride content in spa Ainallah is lower compared to MoulayYaâcoub station (El morabiti 2000, and Boussagol 1994 and Lakhdar and 2006) (Fig.12).

The spatial variation shows a rising order from the source to the point of evacuation, which can be explained by the sweat rate added in the pool water alongside other products used by the high number of visitors, especially at the end of the week (high attendance) (Fig.12).

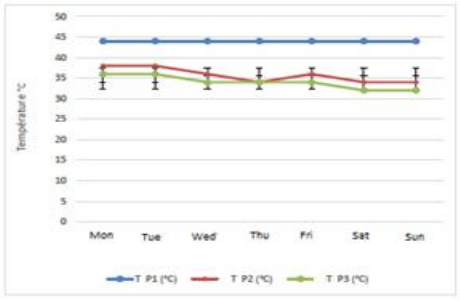

Figure 2: Average of the daily and spatial variations in temperature in ° C

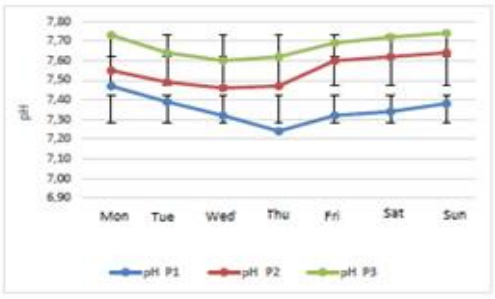

Figure 3 : Average of the daily and spatial variations of the pH

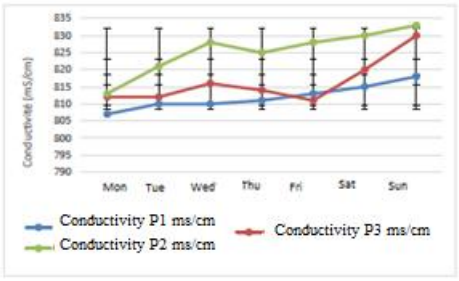

Figure 4 : Average of the daily and spatial change in conductivity in mS / cm

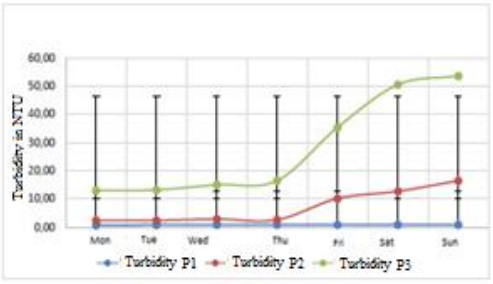

Figure 5 : Average of the daily and spatial variations change in turbidity in NTU

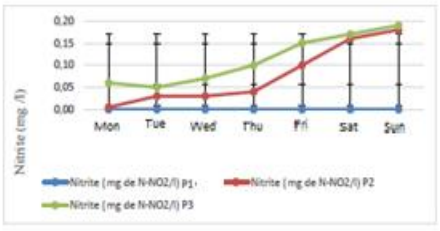

Figure 6 : Average of the daily and spatial variations of nitrites in mg / L

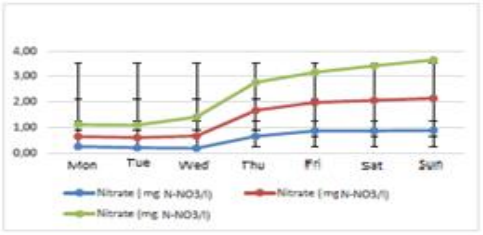

Figure 7 : Average of the daily and spatial variations of nitrates in mg / L

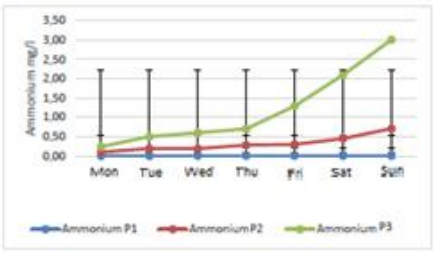

Figure 8 : Mean daily and spatial variations of ammonium in mg / L

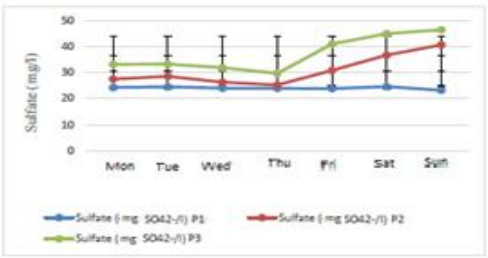

Figure 9 : Mean daily and spatial sulphate variation in mg / L

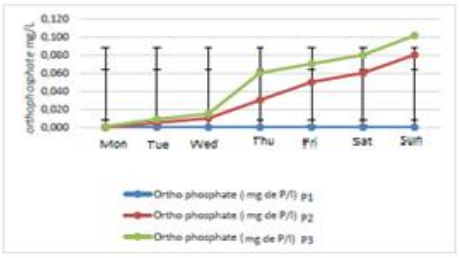

Figure 10 : Average of the daily and spatial variations of orthophosphate

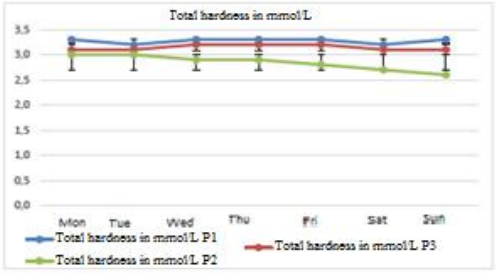

Figure 11 : Average of the daily and spatial variations in total hardness in mmol / L

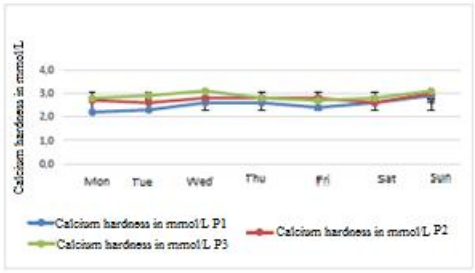

Figure 12 : Average of the daily and spatial change in calcium hardness in mmol / L

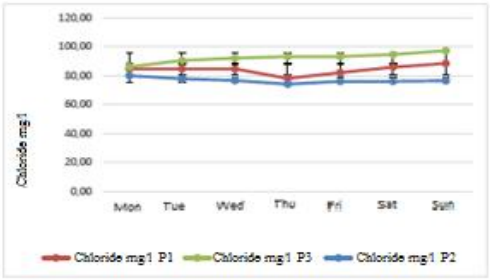

Figure 13 : Average of the daily and spatial variations of chloride in mg / l

Conclusion

The results of the daily and spatialvariationsof the physicochemical characteristics of the waters of the spa Ain Allah in the region of Fez show that from the temperature of the waters of Aïn Allah and we can classify these waters as meso-waters.

The results of the physicochemical analyzes carried out during this study made it possible to show that the waters of this studied thermal station are characterized by a significant temperature 42C °, this indicates that these waters are deep origin. Indeed, the waters of Aïn Allah are characterized by a temperature. The pH is close to neutrality with a more or less alkaline character.

On the other hand, the waters of the studied stations are characterized by a weak mineralization translated by a low conductivity. This is in close relation with the nature of the crossed lands, the quantity of the ions in solutions and the temperature.

The thermal waters of Aïn Allah contain low concentrations of nitrates, therefore they comply with the Moroccan standard 03.7.001 which recommends values lower than 50 mg/ l in nitrate ions. However, this poverty in these elements could probably be due to an impoverishment of the lands crossed in these ions.

The ammonium ions are always the witness of an organic pollution, in the waters of the station studied, one records low concentrations in ammonium does not exceed 1.2 mg / l. Likewise, these hot springs Aïn Allah are poor in orthophosphate ions. This information on the good protection of these waters against any exogenous pollution. For the values recorded in the samples taken at the pool level, they generally reflect pollution by detergents and disinfectants containing organic phosphate.

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