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Thermal's water: Daily biological indicators of the therapeutic quality of the new spa of Moulay Yacoub Fes (Morocco)

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ABSTRACT

The study of the microorganism rates in the various microbiological analysis points show that the thermal water of Moulay Yacoub (Morocco) arising from the pool source is a clean water of any contamination which testifies to its good biotypical quality. As a result we can say that the closer we get to the source the closer we get to a healthy zone.
The study of the microorganism rates in the various microbiological analysis points show that the thermal water of Moulay Yacoub (Morocco) arising from the pool source is a clean water of any contamination which testifies to its good biotypical quality. As a result we can say that the closer we get to the source the closer we get to a healthy zone.
On the other hand more away from the hot spring than this water shows a higher contamination especially during the weekend days (Saturday and Sunday) where values are often out of the ordinary something that can be explained by the high rate of visitor attendance during his days. The low microbiological values are found in the middle of the week which is the most favorable period for spa treatments especially on Friday which is a day of reopening after maintenance of the pool which clears the pool of the excessive load of contaminants.

Key words:biological indicators, thermal water, contamination, Moulay Yacoub, Morocco.

INTRODUCTION

The thermalism is a natural medicine par excellence which draws its origins several thousand years ago (Jaltel, 1983). In general the effectiveness of the spa treatment is closely related to a variety of factors such as climate dietetics relaxation and rest (Abane, 2011). The virtues of hydrotherapy have been known since ancient Greek-Roman times. Water sources have always been linked to the miraculous and beneficial properties of the land and the use of natural mineral water hot and cold was an art of healing and living (Melillo, 1995).
The mineral-thermal waters provide a privileged place in the cure of several diseases these waters are characterized by their biological purity the stability of their chemical composition and their therapeutic properties brought to light by generations of clinicians (Salameand*al*., 2013). The improvement of the health of patients who practice a thermal cure is generally manifested in osteo-articular venous gynecological,ORL, cutaneous psoriasis and generalized anxiety disorder (Roques and Queneau, 2009).
Morocco has a rich thermal heritage and varies in the various regions of the country: 117 thermal springs including 29 repertories (analyzed waters and pathologic determined)(Luca and al, 2008). Groundwater which is often geologically protected is also exposed to agricultural industrial and/or urban pollution (El addouliand *al.*,a and b,2009). Khayliand *al.* (2011) have shown the presence in some thermal waters of *Pseudomonas aeruginosa* and other contaminating microorganisms which could constitute a serious health risk affecting the health of patients(Luca and *al.* 2008).

Each thermal water has a specific curative identity,consequently, the cures at home have no interest and requires the displacement of the patient to achieve its treatment in situ to fully benefit from the virtues of this water (Traissac et *al.*, 2006).

I - PRESENTATION OF THE REGION OF STUDY

The spa town of Moulay Yacoub is located 25 km north-west of the city of Fes. It is part of the province of Moulay Yacoub in the region Fes-Meknes. This province extends over a territory of 1700 Km². It is bounded on the north by the province of Taounate, on the east and south-east by the prefecture of Fes, on the south by the provinces of Sefrou and Elhajeb and on the west by the prefecture of Meknes and the province of SidiKacem. This SPA is among the first establishment in Morocco that offers its visitors all the comforts to make the most of modern equipment (Alami, 2006). The other SPAS are operated in an artisanal way and mainly by a local and regional population.

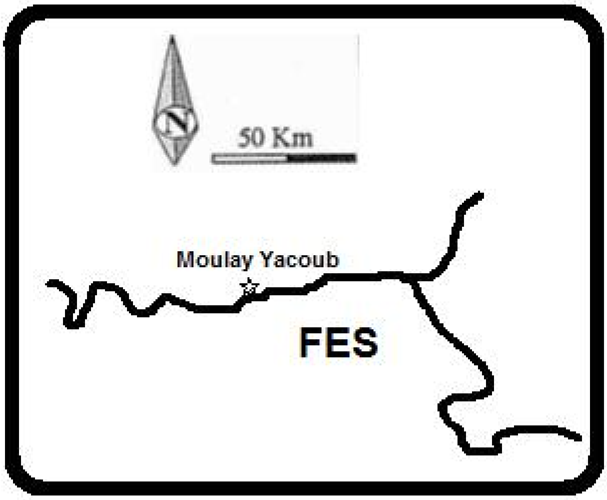

Figure 1: Location of the study station

II- MATERIAL AND METHOD

We conducted the collection of thermal water at different levels of the basin and at the source.
Samples are stored in 500 ml sterile stopper glass vials. We have left an air space in the flask to facilitate the resuspension of the microorganisms by agitation before seeding in the appropriate culture media. The samples were sampled at the source (P1) at the pool level (P2) and at the level of the spa water discharge (evacuation point) (P3). The samples were then stored in a cooler for transport to the Regional Laboratory for Epidemiology and Hygiene in the Middle of Fes (LREHM).
Following a pre-test we decided to prepare a dilution of 10^{-1} for only the water samples from the P2 and P3 sampling points. We applied the filtration technique of filtering through a membrane (0.45 µm porosite for Coliforms,*Enterococci* and *Pseudomonas aeruginosa* and a porosity of 0.22 µm for Anaerobic Sulfito Reducers. The volume of the sample used is 100ml.Then incubate this membrane in a box containing a suitable culture medium.Bacteria eventually present on the filter can develop during the incubation period and give rise to easily identifiable colonies. The Counting of The colony formation unit (CFU) is used to evaluate the microbiological quality of water depending on the (selective) culture medium where the filter is deposited the purpose of which is to show the presence of different microorganisms.
This is an advantageous method because it is fast and inexpensive. For coliforms we used a medium Tergitol 7 TTC, the fecal *Streptococci* were calibrated on a medium Slanetz and Bartley, for research of ASR (AnaerobiesSulfito Reducers) we used the ~~SPS~~medium. However in the case of yeasts and molds the incubation medium is the sabouraud one. For mesophile total aerobic flora it is the yeast extract gelose that was used whereas for *Pseudomonas aeruginosa* it is Cetrimidegelose selective and at the end to know the presence of *Staphylococcus aureus*, Baird-Parker gelose was used.

III- RESULTS AND DISCUSSION

THE AVERAGE TOTAL GERMS:

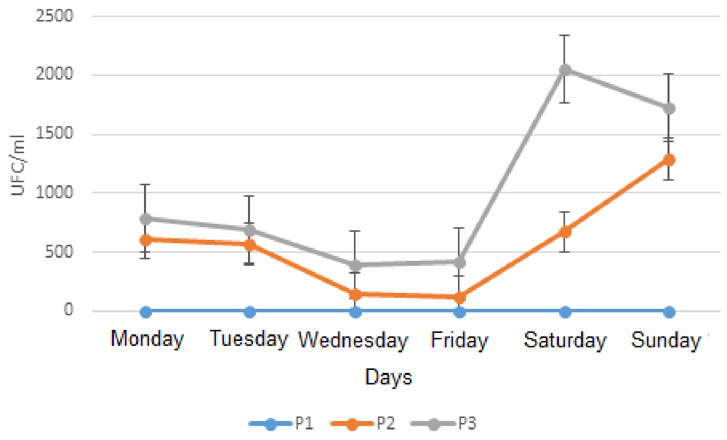

Figure 3: variation of the total germs at 37 °C (CFU/ml).

The daily variation throughout the total seeds germs at 37 °C also shows an almost total absence at source. But for P2 and P3 their values differ and vary by taking almost the same curvature starting to decrease from Monday to low average on Wednesday and Friday to arrive at maximum averages (Saturday and Sunday) reaching on Saturday an average of 2050 CFU/ml. The averages of the three sampling points completely differ by doubling from point to point (from P1 to P3); with almost total absence at the source then about 569 CFU/ml in P2 and finally an average of 1010 CFU/ml for P3 which shows the dominance of the total seeds at 37°C.

VARIATION OF TOTAL COLIFORMS:

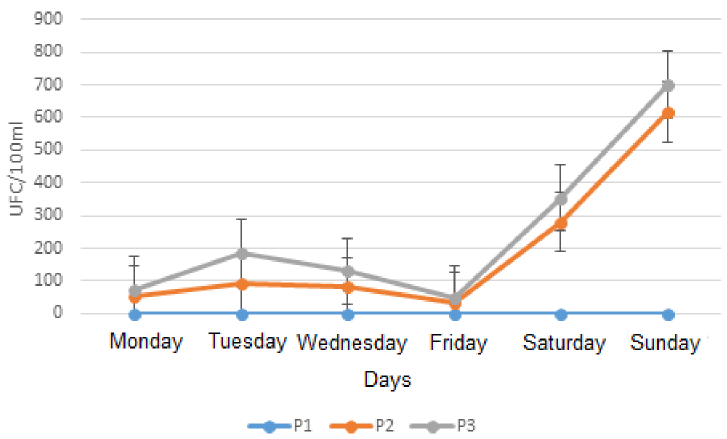

Figure 4: variation of total coliforms (CFU/100ml)

For coliforms at the source there is a persistence of a constant zero throughout the week, which shows the purity of this water. On the other hand for the other points, the center of the swimming pool and the point of evacuation with the periphery they mark a variation in the same direction with a weak increase on Tuesday then decrease until a average which is the weakest of the week recording on Friday then a direct ascent on Saturday and Sunday or it reaches a maximum average of 616 and 700 CFU/100ml respectively for P2 and P3 which exceeds the guideline value of bathing water which is 500 CFU/100ml showing as well the impact of the relationship frequentation intake of contaminant.
The graph indicates that the water arising from source P1 is pure water, untouched by any contamination of total coliform types. But for points P2 and P3 they show respectively increasing average means of 192 and 248 CFU/100ml

which is probably due to the intake of bathers.

VARIATION OF *Escherichia coli*

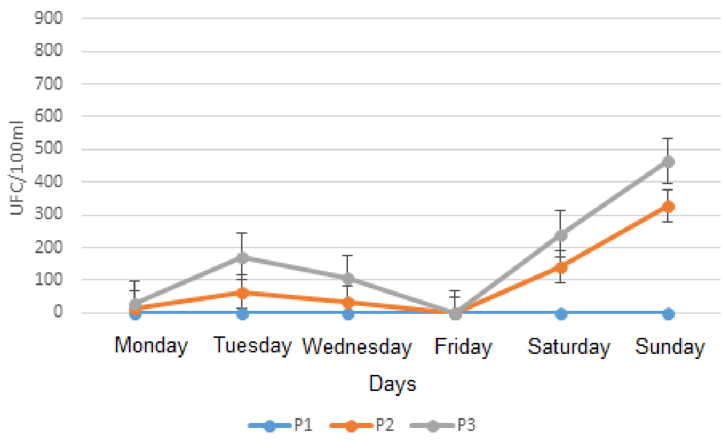

Figure 5: variation of *Escherichia coli*(CFU/100ml)

At source *E. coli* is not detectable throughout the week. On the other hand for the other points the presence is detected and takes values from the beginning of the week increasing slightly on Wednesday and then decreasing to cancel on the Friday and then revive by a pace of right towards more or less average values Saturday and extremes on Sunday respectively for P2 and P3 of 326 and 465 CFU/100ml which exceeds the guideline value of bathing water fixed for *E. coli* (100 CFU/100ml).

We can say that the source is a point purely clean of any faecalcontamination following the absence of *E. coli.* However moving away from this point towards P2 then P3 contamination by this species increases to 96 CFU/100ml in P2 and 169CFU/100ml in P3 thus exceeding for this last point the standard set for bathing water.

variation of intestinal *Enterococci*

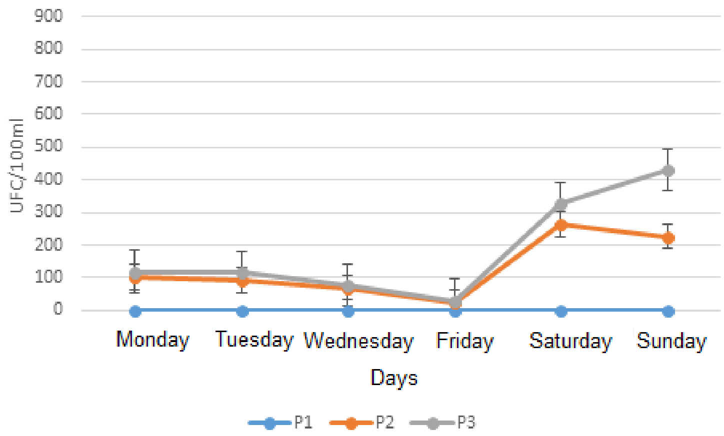

Figure 6: variation of intestinal *Enterococci*(CFU/100ml)

The *Enterococci* at the source point (P1) are the same as the previous microorganisms that are absent. However for the P2 and P3 points there is detection with a variation of the same pace slightly exceeding at the beginning of the week the guide value fixed for these bacteria in the bathing water (guide value = 100 CFU/100ml) then decreasing for minimum values on Friday then increasing and exceeding widely the guide value on Saturday and Sunday.

Variation of *Pseudomonas aeruginosa*

Point P1 is pure of any contamination. But for the points P2 and P3 the average value increases respectively by 129 and 183 CFU 1/100ml thus exceeding the set standard (Council Directive 76-160 of 8 December 1975).

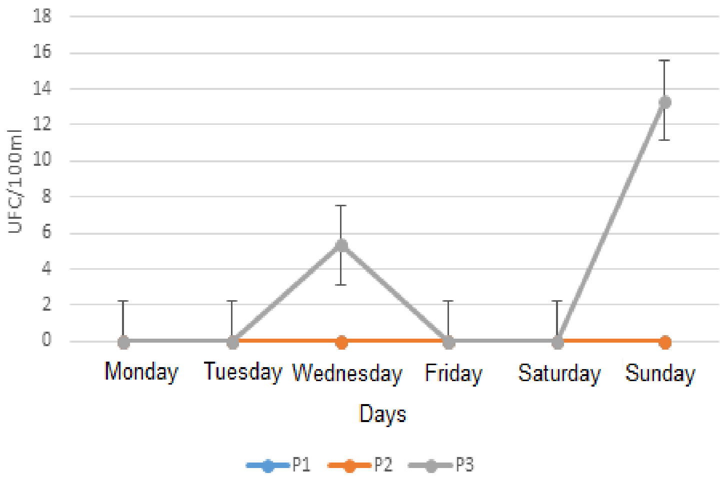

Figure 7: variation of *Pseudomonas aeruginosa*(CFU/ 100ml)

For *Pseudomonas aeruginosa* the source P1 and the point P2 are intact of contamination however the point P3 represents a point where this opportunistic species has been detected only for two days removed on Wednesday and Sunday. Noting that this detection has only been reported during the last month which shows a new contamination which has not occurred in previous months the origin of which could be due to any origin (bathers or other) result that does not agree with Houtiand*al*. (2013). The spatial variation shows that *Pseudomonas aeruginosa* was only detected at point P3 which shows the health risk for swimmers at this point of evacuation. Average variation of *Staphylococcus aureus* and yeast and molds:

For its three types of microorganisms no detection was reported indicating that there was no old contamination taking into account the absence of ASR and the moderate bactericidal power on S. strains. aureus; which could be related to the manganese and iodide ions (Abane2011)and also the antiseptic action of this sulfuric water which is at the origin of the interaction between the radicals of sulfur and oxygen which leads to the formation of by-products such as penta thionic acid (H2S5O6) which may be at the origin of the antibacterial and antifungal activity of this thermal water (Houtiand*al*. 2015).

CONCLUSION

From a bacteriological point of view we found that the water at the P1 source of the swimming pool is generally of good quality and almost intact total aerobic mesophilic flora (TAMF) and quite sterile vis-à -vis the indicators of fecal contamination (TC,FC and *Enterococcus*) and other types which meets the Moroccan standard NM 03.07.001-2006, thus testifying to its purity. However for pool water (center P2 and point of evacuation P3) a high density of indicators of faecal contamination is recorded and it is more critical for P3 (collector point) exceeding the set threshold values of the Moroccan norm and Council Directive 76-160 of 8 December 1975 concerning the quality of bathing water. The main source of contamination is bathers especially during the busy period (Saturday and Sunday). In theory a bather brings a micro-organism rate of about 106 CFU especially during the first 15 minutes of immersion through the skin mucous membranes nasopharyngeal secretions fecal matter etc ... thus representing a great risk for the people in contact with this water which necessitates an earlier use something which the authorities must pay with great attention in order to avoid serious health risks. The situation becomes even more critical in the event of poor sanitary control in the spa establishments with the presence of patients whose immune system is weakened which constitutes a significant health risk.

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