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Research Article

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Biological state of the surrounding wells the thermal spring Aïn Allah in Fez – Morocco

ESSAFI Mariam[1,2], BOURAADA Khalid[1], JANATI IDRISSI Abdelatif[1] and EL OUAZZANI Fadoua[1]

1: University Sidi Mohamed Ben Abdellah. Faculty of Sciences. Department of Biology. Laboratory of Biotechnology and of Natural Resources Preservations (L.B.P.R.N.), Fes Morocco.
2: Regional Laboratory of Epidemiology and Hygiene Middle, Public Health Service and Epidemiological Surveillance, Regional Directorate of Health, Region Fes-Meknes, Ministry of Health.

Corresponding author: Khalid BOURAADA.
E-mail: *khbouraada@laposte.net*

Abstract

From the bacteriological point of view, the water of the studied wells has very high levels of indicator germs of fecal contamination (total coliforms bacteria can be revived at 37 ° C and 22 ° C). With a difference from one well to another. This is undoubtedly a health threat and risk of waterborne diseases for the consumers of these waters. The rural location of these wells is characterized by septic tanks and intense agricultural activities, which could explain their high bacterial load. Our study proves, therefore, that the waters studied are vulnerable to anthropogenic pollution. Indeed, the bathers of the spa Aïn Allah are also a main cause of contamination and therefore microbiological dangers related to the wells. As a result, these bacteriology results obtained are not in accordance with the Moroccan standard relating to the quality of water intended for human consumption.

Keywords: bacteriology, Moroccan standard, well water, anthropogenic pollution.

1. Introduction

Water is a mineral, natural, microbiologically sound material. It comes from a tablecloth or an underground deposit exploited from one or more natural or drilled emergences constituting the source. It demonstrates the stability of its essential characteristics, in particular composition (mineral content, trace elements, etc.) and temperature at emergence, which is not affected by the flow of the water taken. It is distinguished from other waters intended for human consumption:

• By its nature (characterized by its content of minerals, trace elements or other constituents),

• By its original purity, both characteristics have been preserved intact due to the underground origin of this water which has been kept safe from any risk of pollution.

These characteristics must have been assessed geologically and hydrogeologically, physically, chemically, microbiologically and, if necessary, pharmacologically, physiologically and clinically. Thermal waters have been used for centuries in the treatment of various pathologies. Alternative medicine, more than 2000 years old, it is experiencing a new boom in a will to return to the sources.

Several studies have shown that the therapeutic effect of thermal waters is associated with certain major elements present in water, such as magnesium and calcium, which play very important roles in lipid metabolism (Zichichi et *al*., 2006). In addition, other research has shown that salt-rich mineral waters have the ability to enhance the conversion of cholesterol to bile acids and their subsequent secretion (Gokgoz et *al*., 2010). Studies conducted in Avène waters in France have revealed the beneficial effect of calcium in the treatment of certain dermatological conditions and the regulation of intracellular calcium in keratinocytes (Athamena, 2006). Otorhinolaryngology pathologies (Ben Moussa et *al*., 2013).

2. Presentation of the Study region

The station Ain Allah is one of the three most famous and most visited spas in the region of Fez. It is frequently used by a large number of visitors and spa visitors for different uses.

The spa Ain Allah located 15 km north-west of the city of Fes is located in the Douyet area (Fig. 1). The water of this source is very hot, a temperature of 42 ° C, extracted from an artesian borehole at 1650 m depth, is intended for feeding the fountain, jet showers and two pools that are open to public bathing. 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.

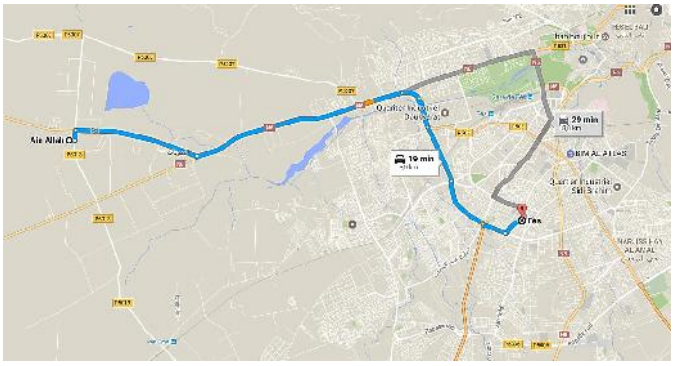

Figure 1: Location of the region of Ainallah extracted from Google Earth

We chose in our study 3 study wells near the Aïn Allah thermal station. The first well station is 274.72 meters from the thermal spring and is located at Lambert coordinates 34 2 20.14 N - 5 8 27.46 W, the second station is 295.15 meters at Lambert coordinates 34 2 28.68 N - 5 16.60 W while the last station is 456.43 meters and Lambert coordinates 34 2 6.71 N - 5 8 7.05 W.

Figure 2: Location of the wells on a satellite map taken by Google Earth

3. Materials and Methods

The enumeration and research of the different germs were made in accordance with Moroccan standards. Except for *Pseudomonas aeruginosa* and *Legionella pneumophila*, where the research was done according to the protocols followed by the French standard (EN 162661) and the AFNOR standard (T90-431) respectively for the two bacteria. Samples were taken from the sites studied in sterile 500 ml ground glass stopper vials, leaving an air space in the vial; to facilitate the resuspension of microorganisms, by stirring before seeding in the appropriate culture media. The samples are stored in a cooler of approximately 4 ± 2 ° C for transport to the Regional Laboratory for Epidemiological Diagnosis and Environmental Health (LRDEHM) (Rodier, 2009).

The bacteria that may be present on the filter will thus be able to develop during the incubation period and give rise to easily identifiable colonies. Counting CFUs (Colony Forming Units) makes it possible to evaluate the microbiological quality of water. This is an advantageous method because it is fast and inexpensive.

4. Results and Discussion

4-1- Total coliforms

The figure below illustrates the results relating to spatial variations in the number of total coliforms, in the three wells. Where there is a high total coliform load at 37 ° C with a maximum of 260 CFU/100ml observed for the well No. 1 and 293 CFU/100ml for the well No. 3 against the well No. 2 and characterized by a low load in these seeds with a minimum of 149 CFU/100ml (Fig. 3). It is noted that the differences that exist in charge of these three wells in total coliforms and related to the would probably be due to a contamination mainly related to infiltration water discharged by the pools of the spa which are enriched by the germ of fecal and dermatological origin following the increase of this station by a large number of swimmers during this period of study and also at the temperature favoring growth This shows that the hygienic quality of these waters is very degraded.

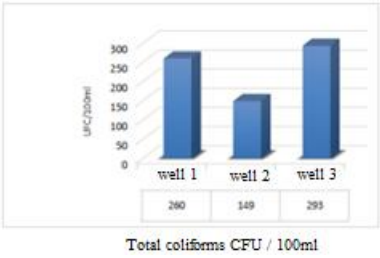

Figure 3: Variation of total coliforms at the three wells

4-2- Total sprouts at (22 ° C) and at (37 ° C)

All the analyzed wells are contaminated by revivable germs with different densities of these germs at the three wells are respectively 28 CFU/ml, 112 CFU/ml and 32 CFU/ml for the total germs at 37 ° C, as well as 32 CFU / ml, 150 CFU / ml and 10 CFU / ml for germs revivable at 22 ° C (Fig. 3). For the 3 wells these results of the analyzes give information on a low contamination by the total seeds in the wells N ° 1 and N ° 3 that it is with 22 C ° or 37 C ° or there is a strong load for the well N ° 2 at 22 ° C and 37 ° C. We also found higher values of the concentrations of the germs in the well N ° 2 indicators of pollution by different sources (the water infiltrated from the rejected waters of the pools of the spa Ainallah cattle breeding, use of the waste of animals as fertilizer for farmland near wells ...)

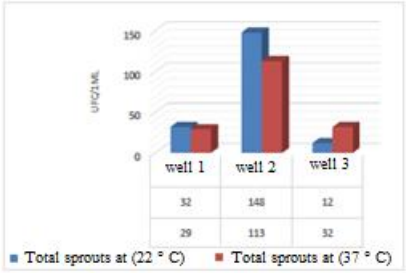

Figure 4: Total sprouts at (22 ° C) and at (37 ° C) in the three wells

4-3- Total coliforms and intestinal enterococci:

E. coli makes it possible to highlight a pollution of fecal origin, the well N ° 2 which we analyzed presents 37 CFU/100 ml of *E. Coli*, with an absence for the other two wells analyzed. This type of bacteria comes exclusively from the intestines of warm-blooded animals, including humans, and its presence is the most accurate indicator of fecal contamination. The presence of E. coli bacteria in the water indicates fecalcontamination, it identifies the specified sources of fecal matter. There are several possible sources: grazing, septic tanks, latrines and other sources such as wild animals. According to our surveys of the sites of the wells studied, we noticed the existence of some septic tanks among which the closest of these wells is the septic tank of the spa of Aïnallah. The presence of fecal coliforms may be an indication of the presence of enteropathogenic microorganisms [Zmirou et *al*., (1987)], such as Salmonella and Norwalk virus [Goodman and*al*., (1982); Craun, (1986)].

The search for intestinal enterococci in the studied wells has shown that the concentration of intestinal enterococci in these wells varies between a minimum concentration of 10 CFU/100 ml recorded in the well No. 1, and a maximum concentration of 36 CFU/100 ml recorded. In well 2 and 31 CFU/100 ml for well 3 (Fig.5). The high contamination of the wells by the intestinal enterococci in wells2 and 3 can be explained by fecal pollution of animal or human origin (septic false, cattle breeding, use of animal waste as a fertilizer for the land near the wells ...). These results show that these wells do not conform to the Moroccan norm 03.7.001 of the year 2006.

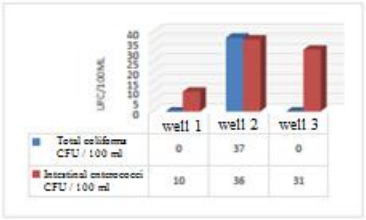

Figure 5: Variation of Fecal Coliforms and Intestinal Enterococci

Table 1: Maximum allowable bacteria values for drinking water (described by NM ISO 17025 and adopted by the LRDEHM)

Germs enumerated or sought (NM 03.07.001, 2006) [15]	References of the method of analysis	Maximum Eligible Values (NM 03.07.001, 2006)
Total aerobic mesophilic flora (FMAT) 22 ° C and 37 ° C	ISO 6222, NM 03.7.005,2007	20 ml to 37 ° C 100/l at 22 ° C
Total and fecal coliforms 20 ml to 37 ° C 100/l at 22 ° C	ISO 9308-1,NM 03.7.003,2007	0 /100 ml
Fecalenterococci	ISO 7899-2,NM 03.7.004,2007	0 /100 ml
Sulphito-reducinganaerobicbacteria	ISO 6461-2,NM 03.7.004,2007	0 /100 ml

From a bacteriological point of view, the waters studied have very high levels of germs indicating fecal contamination (total coliforms, bacteria that can be revived at 37 ° C and 22 ° C). With a difference from one well to another. This is undoubtedly a health threat and risk of waterborne diseases for the consumers of these waters. For well water, their geographical location in a rural area, where there are septic tanks and intense agricultural activities, could explain their high bacterial load that the waters of the source. Our study proves, therefore, that the waters studied are vulnerable to anthropogenic pollution. Indeed, swimmers are the main sources of contamination and therefore microbiological hazards related to pools, rejecting a high number of microorganisms through the skin, mucous membranes, rhinopharyngeal secretions. This shows that the bacteriology results obtained are not in accordance with the Moroccan standard for the quality of water intended for human consumption (Table 1).

Conclusion

The thermal establishments provide care using mineral water as therapeutic agent by the present work, we have tried to present the results of spatio-temporal study of the characteristics of the bacteriological quality of these waters and the search for a single bacterium pathogen responsible for nosocomial infections in thermal establishments (*Pseudomonas aeruginosa*).

E. coli makes it possible to highlight a pollution of fecal origin, the well N ° 2 which we analyzed presents 37 CFU/100 ml of *E. Coli*, with an absence for the other two wells analyzed. This type of bacteria comes exclusively from the intestines of warm-blooded animals, including humans, and its presence is the most accurate indicator of fecal contamination.
That the waters studied are vulnerable to anthropogenic pollution. Indeed, swimmers are the main sources of contamination and therefore microbiological hazards related to pools, rejecting a high number of microorganisms through the skin, mucous membranes, rhinopharyngeal secretions.

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