

Statistical analyzes of the spatio-temporal evolution of the microbiological quality of water in the region of El Besbes (Algeria)

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ABSTRACT

Access to drinking water is a human right; and it is one of the basic conditions for good health according to UNICEF / WHO. Polluted water could be the cause of serious illnesses such as dysentery, typhoid fever, type A hepatitis ... etc. The spatio-temporal evolution of the mean densities of the microbiological parameters (CT, CTT, SF) in the waters of the El-Besbes region also showed seasonal variability in the majority of the parameters. This variability was noted in the four different ambient environments: cistern water, tap water, well water, spring water. From a qualitative point of view, the spring waters show compliance with certain microbiological parameters to WHO water standards. On the other hand, for the samples of cistern water, tap water, well water, some greatly exceeded the threshold of the WHO drinking water standard during the two study periods (summer, winter).

Key word : Drinkwater, Polluted water, Microbiological parameters, Water standards, Environments

Introduction

Bacteriophages, parasitic viruses of bacteria, have been discovered in human faeces and then in wastewater. Therefore, they were intended as a possible indicator of contamination by bacteria or viruses. They have also been used as tracers in waterborne outbreaks and still are today (Catherine, 1983). Faecal pollution is closely linked to human and agricultural activities; this pollution comes in particular from the rejections of treated and untreated waste waters and excrements of animals, from the rejections of rain waters and other diffuse sources (Kherifi, 2019). The potability of drinking water across the globe has increasingly continued to be in doubt, due to the problem of microbial contamina-

tion, high saline content and external human activity stress, thus making the water quality questionable and no longer guaranteed as safe anymore for human consumption (Azuonwu, 2020). Algeria has been going through for some year a phase of epidemiological transition marked by the persistence of water-transmissible diseases characteristic of developing countries (Algeria NIP) by the poor quality of water linked to anthropogenic or natural pollution, which limits socio-economic development options. (Kherifi, 2017). The most common MTHs in Algeria include (typhoid fever, dysentery and type A hepatitis).

The present study aims to assess the quality of microbial water that can be consumed by citizens through various water samples (cistern, tap, bore-



Fig. 1. Geographic map of the study area

hole, well) from the wilaya of El Tarf (municipality of El Besbes).

Materials and Methods

Material

For justified that the bacteria leads to water-borne diseases, taking it in situ is the best way to confirm this hypothesis. So we took 4 samples of water from the region of El Besbes (El Tarf) in different media which are: tap water, cistern water, spring water and finally well water.

We carried out microbiological analyzes at the bacteriology laboratory EPSP El Taref during the winter period in December (2017) and during the spring period in April (2018) in order to study and enumerate the microbiological parameters (total coliforms, thermo-tolerant coliforms, fecal streptococci) and assess the quality of water in different study environments.

The microbiological analysis was carried out according to AFNOR and WHO methods. In the laboratory, the equipment used is as follows:

- A filtration failure :
The filtration break used to filter the samples (water weakly loaded with microorganisms)
- A vacuum pump :
Vacuum pump is a type of pump
- A membrane with a porosity of 0.45 μm :
The membrane is a physical separation process taking place in the liquid phase. The goal is to purify or concentrate the microbiological parameters in a solvent through a membrane.
- Memmert type 37 ° and 44 ° oven :
The oven was used for reheating, drying product (37° thermo-tolerant coliforms, total coliforms and 44 ° faecal streptococci).

- Petri dishes :

We put the membrane in the petri dish on the agar to see the microbiological results (CTT, CT and SF).

- A bunsen burner to flame the filtration ramp.
- Colony counter
- Colony the bacteria on the petri dishes and find out the number of this bacteria.

Methods

The evaluation of the water quality and the spatio-temporal evolution of bacteriological parameters forced us to use conventional treatment methods and the application of adequate software.

In this study we used a statistical means of data processing which is the Principal Component Analysis (PCA). The variables over time are the microbiological parameters (CT, CTT, SF), the individuals are the sampling points which are carried out at the levels of tap water, wells, sources as well as in the cistern water that feeds the region. from El Besbes (El-Tarf) by two periods of the winter (December) and spring (April) seasons. Its use makes it possible to reduce and interpret the data on a reduced space (Lagarde, 1995; Maliki, 2000). The software used for this study is XL STAT version (2017.1).

Results and interpretations

Research and enumeration of coli forms, thermo-tolerant coli forms by the filtration method

The microbiological quality of the water is assessed by looking for bacteria that are witnesses of faecal contamination. These germs, which in themselves are not very dangerous except for *E. coli*, show that pathogenic microorganisms can enter the network. Their presence in the water therefore reveals a lack of reliability of the equipment (collection failure, malfunction or absence of treatment facilities, insufficient maintenance of the structures). Thus, the detection of faecal coliforms in treated water should raise serious suspicion of faecal contamination (Elmund *et al.*, 1999; WHO, 2000).

The figure shows the count of the three germs which are indices of faecal contamination which are: the total coliforms; -Thermo tolerant coliforms; - faecal streptococci. This count could give important indications to judge the validity of techniques used for the search for other parameters.

- Total coliforms give blue colonies. Total coliforms have been used for a very long time as indicators of the microbial quality of water because they can indirectly be associated with pollution from faecal origin (Archibald, 2000; CEAEQ, 2000; Edberg *et al.*, 2000).
- Thermotolerant coliforms give colonies of yellow, orange or brick red color - are a subgroup of total coliforms capable of fermenting lactose at a temperature of 44.5 °C. (Elmund *et al.*, 1999; Edberg *et al.*, 2000). Although the presence of faecal coliforms usually indicates the presence of contamination of faecal origin, several faecal coliforms are not of faecal origin, rather coming from water enriched in organic matter, such as industrial effluents from the pasta sector. paper and paper or food processing (Barthe *et al.*, 1998; Afnor 2000, WHO 2000).
- Visible red, purple or pink colonies whose coloration is considered colonies of faecal streptococci. The persistence of enterococci in various types of water may be greater than that of other indicator organisms (Clausen *et al.*, 1977; Edbert *et al.*, 1997; WHO, 2000), in particular because of their notorious resistance to disinfecting agents (Haslay and Leclerc, 1993), which makes them

preferred indicators for evaluating the effectiveness of water treatment (WHO 2000).

Spatio-temporal variation of the microbiological parameters of water

Figure 3 represents the spatio-temporal variation of the microbiological parameters of El Besbes waters in different study environments during the winter period in December and during the spring period in April.

The assessment of the bacteriological quality of these waters according to WHO criteria reveals almost all the water samples are of unsatisfactory quality, on the other hand the spring water samples show values of CTT and SF which comply with the WHO standards (0 germs / 100 ml).

The results show that all the values (CT, CTT, SF) in the winter period is significant compared to the spring period. This confirms on the one hand that the climate has an influence on the quality of water, while the increase in temperature and the decrease in the water ratio are negative factors on the behavior of bacteria (Kherifi, 2016). Some authors have pointed out that the increase in temperatures is accompanied by a destruction of bacteria (Chedad and Assobhei, 2007) and on the other hand that it can be

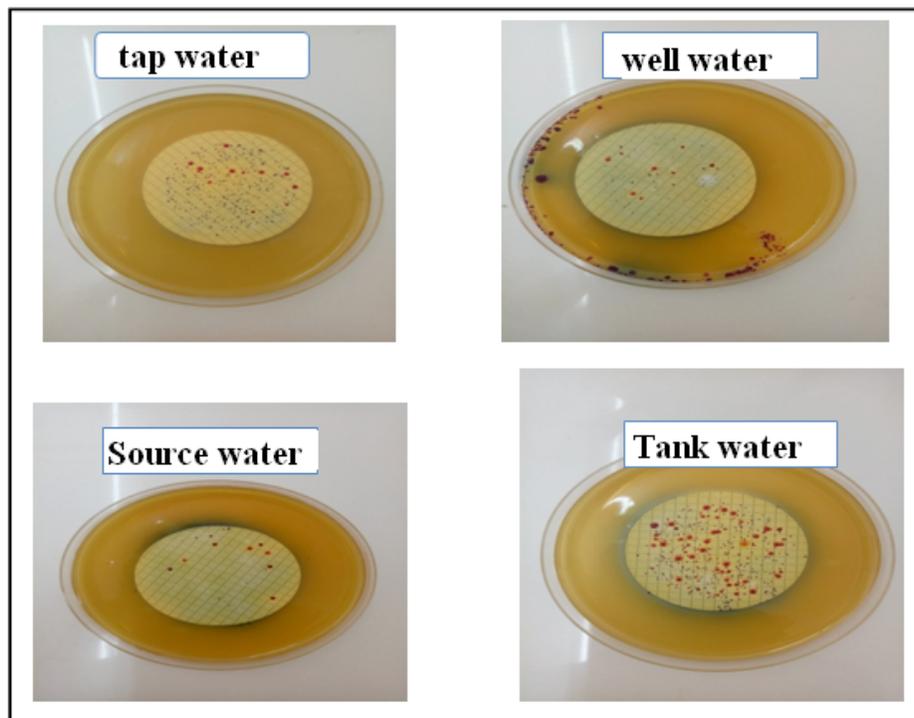


Fig. 2. Photo represents the results of colonies of total coliforms and thermotolerant coliforms and streptococcus on culture medium Chromocult Es

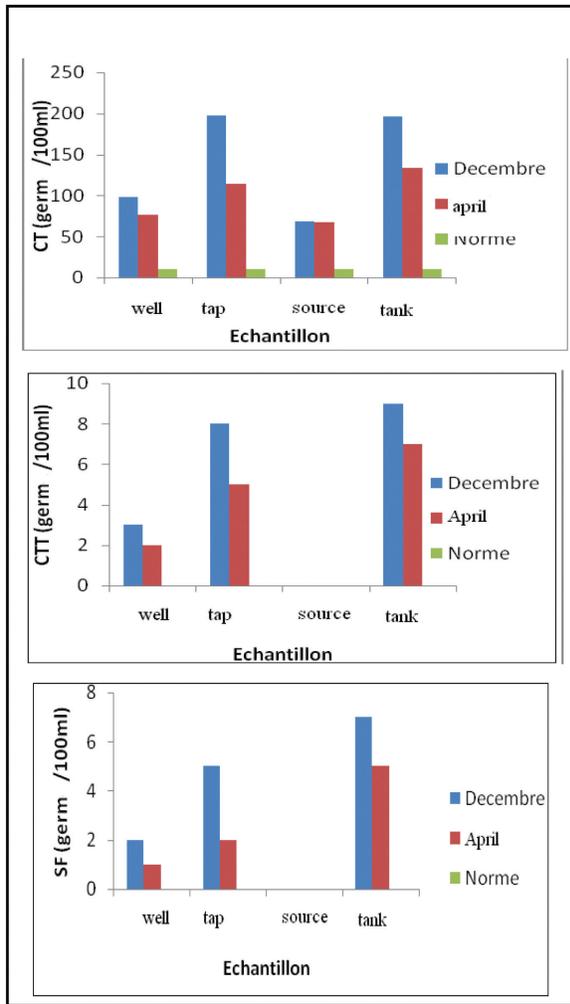


Fig. 3. Spatio-temporal variation of the microbiological parameters of water (2016/2017)

dependent on the influx of urban wastewater in faecal matter which feeds the water due to runoff and infiltration during the winter period. As the count of bacteria is very varied from one medium to another, during the two study periods, we notice that the values of the two types of bacteria (CTT, SF) are important in the water samples “of faucet, tank and well “versus” the source “, which scores very low values. On the other hand, the CT values always remain high in the four samples.

Statistical analysis of data by the PCA

Principal Component Analysis (PCA) is a data analysis tool that helps explain the structure of correlations or covariances using linear combinations of the original data. The objective of the PCA is to present, in graphical form, the maximum amount of

information contained in a data table, based on the principle of double projection on the factor axes.

Distribution and spatial variability of the data from the sampling points studied

The graphic presentation of Figures 4, 5 shows that the microbiological pollution parameters (CT, CTT, SF) are very high in source and tap water compared to well and spring water samples during the two periods. study (winter and summer), which is explained by the poor management of water resources in Algeria (Idder, 1998) led to water pollution (lack of water quality control, lack of tank control , the distribution of water from the source is done by the drain valve, lack of protection for water dams, poor protection or maintenance of catchment works...

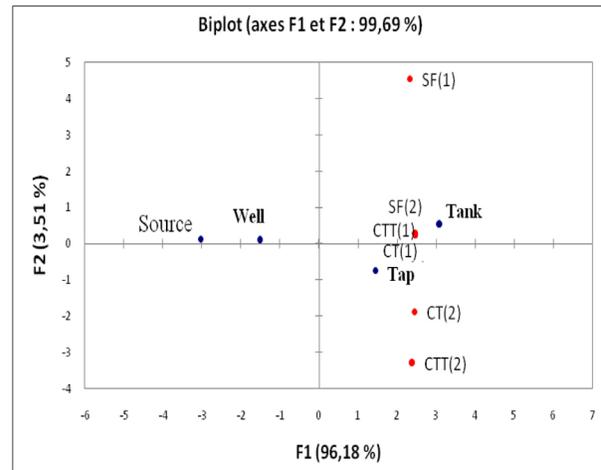


Fig. 4. Projection of variables and individuals on the factorial plane (1x2).

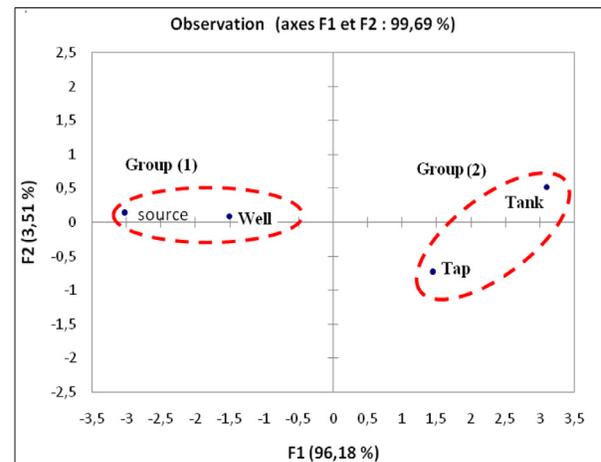


Fig. 5. Projection of individuals on the factorial plane (1x2).

.etc.). Water quality control is useful, allowing the orientation of the use of water resources for different economic sectors (Saker, 2011).

The sampling stations are grouped into two partitions according to the sources of water pollution (type of pollution), the first corresponds to water that contributes to the pollution of the water by a direct voice (tank, Tap) and the second includes pollution by an indirect voice (Well, Source).

Hierarchical classification

We considered the microbiological pollution parameters (CT, CTT, SF) during the two study periods for the four sampling points by the Dendrogram for the hierarchical classification.

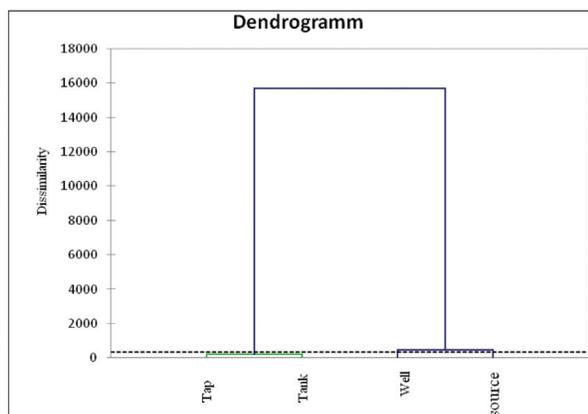


Fig. 6. The dendrogram of sampling points studied from the El Besbes region (2017)

The graphic representation of figure (06) shows the classification tree of the water abstraction points that supply the region of El Besbes where it is noted that the two abstraction points (Tap and tank) are similar and oppose the two other sampling points studied (Well and Source), which confirms the results of the PCA.

Conclusion

From our experimental results, we can conclude that during the two study periods, the values of the two types of bacteria (CTT, SF) are important in the water samples "from tap, cistern and well" by compared to "the source", which scores very low values. On the other hand, the CT values always remain high in the four samples.

The presence of these germs known as indicators of faecal contamination is synonymous with certain

health risks because their survival in drinking water gives rise to serious suspicion that of pathogenic germs. In view of these results, it is therefore urgent that measures be taken, placing priority on the hygiene and health of sellers, on production and sales conditions, on rigorous and regular health checks, but also and above all. on consumer awareness and education. In perspective, more in-depth studies including the search for pathogens as well as physico-chemical analyzes, by trying to better define the various links of this sector in their entirety would be relevant and would serve as a complement to our study.

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