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Microbiological Variations in Leachates from the Fez Controlled Landfill between the Post-COVID19 and Covid19 Periods (Morocco)

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Abstract

The aim of this work is to gain a better understanding of the bacterial load in the leachate from the controlled landfill in Fez by following a temporal evolution during the year 2021 just after the Covid19 pandemic and during the year 2020 marked by the Corvid19 period. The germs studied were total coliforms (TC), faecal coliforms (FC), faecal enterococci (FE), total aerobic mesophilic flora (AMF), staphylococci (Staph) and salmonella. The results show that the landfill has the highest concentration of all germs in the year 2021. This bacterial load intensifies in summer, as the number of residents has increased with the arrival of tourists, resulting in an increase in waste tonnage and a change in the quality of the leachate. In 2020, the citizens of the city of Fez were confined because of the COVID19 pandemic, tourism was limited in space and time which limited the tonnage of waste and influenced the bacterial load. These results revealed the poor microbiological quality of this leachate. The increase in germ concentrations during the summer season has an effect of evaporation of this leachate, which leads to an increase in the bacterial concentration. It is therefore urgent to properly manage this leachate.

Keywords: *Landfill, leachate, bacteriological characterization, seasonal evolution, Fez, Morocco*

1. Introduction

Pollution, water scarcity and climate change are the world's most pressing environmental issues. In recent years, the exponential growth of population and social civilization, changing productivity and consumption habits, changing lifestyles and the continuous development of industry and technology have accompanied by the rapid generation of municipal and industrial solid waste. In Morocco, landfilling is currently the most common way to dispose of solid waste. The percolation of landfill leachate into the environment causing disease and other environmental hazards to both aquatic life and humans is alarming (Disa-Disa & al., 2020) [1]. Landfill leachate is generated as a result of precipitation, surface runoff, and seepage or water contained waste (Kossitse, D. & *al*., 2019) [2]. Indeed, the landfill behaves like a biological reactor in constant evolution in Amenan A. & *al*., 2021) [3] and goes through stages of hydrolysis, acidogenesis and methanogenesis. The microbiological characterization of the leachate is mandatory to assess the environmental risks associated with this leachate, in order to determine the appropriate corrective measures. The present work aims to assess the

bacterial quality of the leachate from the controlled landfill of Fez and to follow the seasonal evolution of the germs studied between 2021 (period post-COVID19) and 2020 (Covid19 period).

2. Materials And Methods

Study site

The controlled landfill of Fez receives on average between 800 and 1,000 tons per day of solid waste previously compacted in a mixed form. Work to bury waste in a basin is carried out daily. Leachate management involves the collection, storage and treatment of leachate. In the case of the Fez landfill, leachate is currently stored in three basins of 2,024 m2, 3,700 m2 and 3,100 m2 without treatment. The discharge of leachate into the storage tanks is carried out in two ways, either by a gravity system by collector, or by pumping through submerged pumps. The Fez controlled landfill is located southeast of Fez, 12 km from the city center (Figure 1), on the Sidi Harazem ring road, in the city of Aïn Bida. The landfill covers 120 hectares and rests on a marl which constitutes a powerful but not permanent obstacle in the face of increasing pollution.

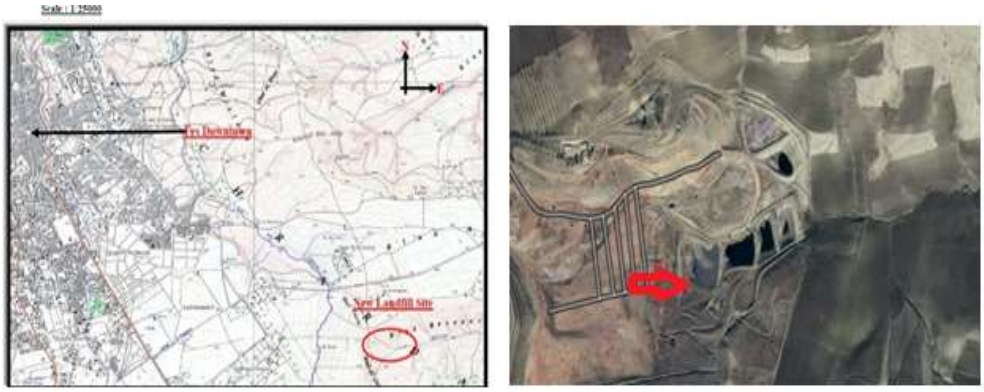

Figure 1: Location of the rubbish dump of Fez

Sampling

Leachate is taken from the pipes and analyzed once a month from February 2020 to December 2021. The samples included leachate taken from the storage tanks (Figure 1). Sampling, transport and storage of leachate samples refer to the protocol and procedures defined by Rodier and his collaborators (Rodier J., 1996) [4]. The study of bacteriological parameters focused on the quantification of parameters of faecal origin and classically based in wastewater: faecal coliforms (FC), total coliforms (CT) and faecal enterococci (EF); The total aerobic mesophilic flora (FMAT) and the pathogenic germs, *Salmonella* and *Staphylococcus aureus* (Staph) are determined. CF, CT, EF and staphylococci are counted using the membrane filtration method. The search for Salmonella is carried out using the simple method of pre-enrichment on nutrient broth, followed by enrichment on selenite broth. The isolation is then carried out on Hektoine agar (Rodier J., 1996) [4]. Typical or suspect colonies are identified by biochemical tests.

3. Results and Discussion

Total coliforms

Total coliforms form a bacterial group used as an indicator of the microbial quality of water because it contains bacteria of faecal origin. The analysis of total coliforms showed that this leachate has a very high load, on average 5×10^6 UFC/100 ml (2021) and 4×10^5 UFC/100 ml (2020). It fluctuates between 5×10^4 (February) and 7×10^6 CFU/100 ml (August) in 2021 and from 1.6×10^4 (February) to $4x10^6$ (July) in 2020. Temporal monitoring of total coliforms presents in leachate for two years showed a seasonal evolution marked by a decrease in loads in winter and an increase in summer (Figure 2). The results obtained reflect the great variability of the bacterial load existing between the two years studied. Indeed, the leachate in 2021 is more loaded with germs than the leachate of 2020. This difference is due to bacterial multiplication and is linked to the BOD concentration (Ezzoubi Y. & *al*., 2021; Belay Z. & *al*., 2020) ([5]; [6]). Indeed, the BOD concentration reflects the availability of nutrients necessary for bacterial growth. Consequently, in this study, the concentration of germs is more marked in the leachate

in 2021 after the Covid19 pandemic (high BOD) than the leachate of the year 2020 in the midst of the Covid19 pandemic (low BOD).

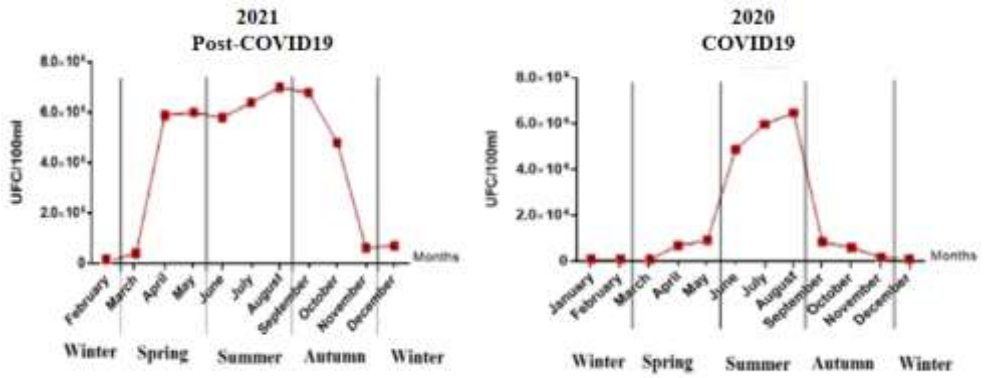

Figure 2: Temporal evolution of total coliforms of Fez landfill leachates (Post-COVID19 and COVID19 period)

The highest concentrations have been recorded in summer, where the optimum temperatures for the development and growth of germs are recorded. As a result, the limiting role that temperature plays in bacterial growth (Mherzi N., & *al*., 2021) [7].

Faecal coliforms

Leachates have the highest CT load, giving an average of 4.5×10^5 CFU/100 ml (2021) and 3.4×10^5 CFU/100 ml in 2020. The minimum load is recorded in February with 6×10^3 UFC/100 ml in 2021 and 5.8×10^3 UFC/100 ml in 2020 (Figure 3), the maximum is recorded in August (6.9×10^5 UFC/100 ml (2021) and 7.2×10^5 UFC/100 ml (2020). The bacteria studied were chosen for their usual presence in polluted water. The results obtained show that the discharges from Fez therefore contain too many total coliforms and still high concentrations for other faecal bacteria (Figure 3). Also, that the variation of faecal coliforms follows that of total coliforms. With the concentrations increasing during the summer season (Mherzi N., & *al*., 2021) [7], this indicates that the majority of total coliforms are faecal coliforms.

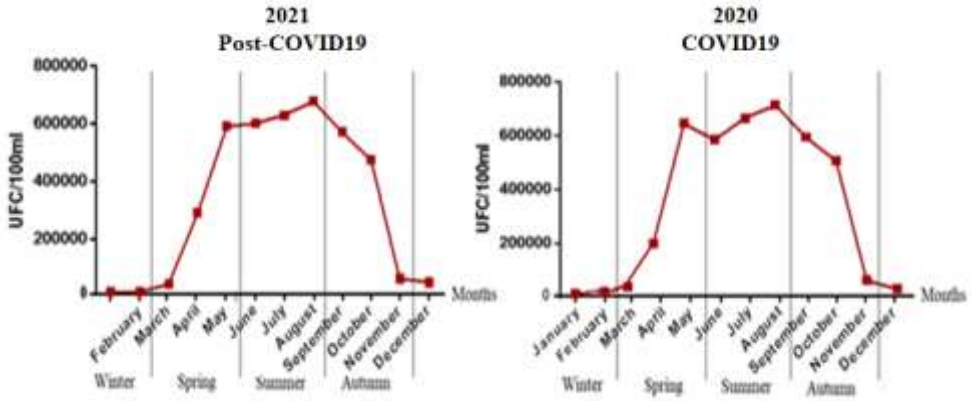

Figure 3: Temporal evolution of fecal coliforms of Fez landfill leachates (Post-COVID19 and COVID19 period)

Faecal enterococci

In the environment, the survival of faecal enterococci is favored by low temperatures and a pH between 6 and 7. Their lifespan is longer than that of coliforms and even equivalent to that of viruses. All this makes them a very good indicator of fecal contamination and also of viruses. The temporal monitoring of the EFs present in the samples analyzed reveals a very high polluting load (Figure 4). It turns out that the leachate in 2021 also has the highest load for faecal streptococci and fluctuates between 9×10^4

CFU/100ml (January 2021) and 9.2×10^4 CFU/100ml (January 2020) at 3×10^7 CFU/100 ml (August 2021) and 1.1×10^7 (July 2020). The dumping of biodegradable materials is at the origin of a biological evolution under the action of aerobic bacteria and then of anaerobic bacteria. Monitoring of these bacteria identified a significant load of total coliforms in the types of leachates from the landfill. Monitoring has shown that these concentrations are very high from April for both years.

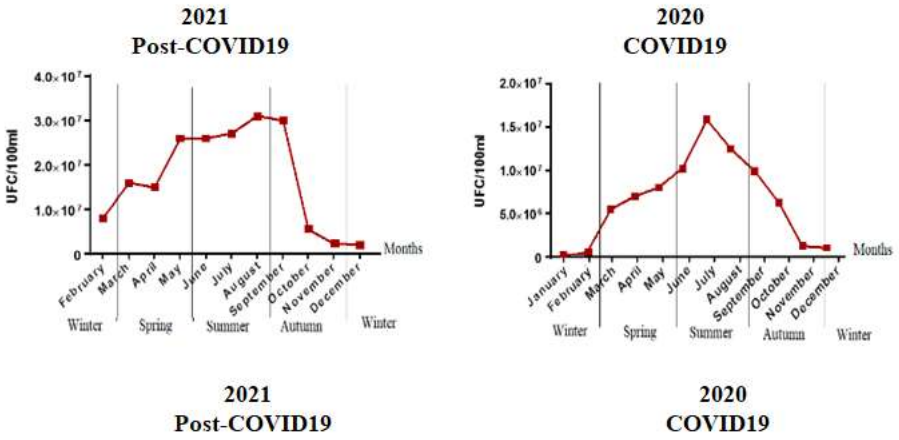

Figure 4: Temporal evolution of fecal enterococci of Fez landfill leachates (Post-COVID19 and COVID19 period)

Total aerobic mesophilic flora (TAMF)

The total aerobic mesophilic flora is used as an overall indicator of pollution. It provides information on pollution-induced microflora. The counting of the FMAT reveals that the two effluents are highly charged. The FMAT are on average 8×10^6 UFC / ml in 2021 and 6.2×10^7 UFC / ml in 2020, it oscillates between 2.7×10^5 UFC / ml and 5×10^3 UFC / ml in the same month (February) of the years 2021 and 2020 respectively at 2.1×10^7 UFC/ml (June 2021) and 2×10^8 UFC/ml (June 2020). The concentrations increase during the summer season (Figure 5).

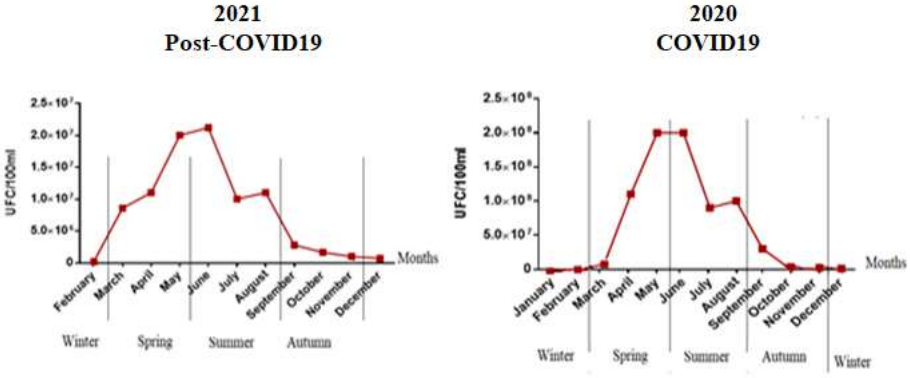

Figure 5: Temporal evolution of Total aerobic mesophilic flora (FMAT) of Fez landfill leachates (Post-COVID19 and COVID19 period)

Staphylococcus aureus

This bacterium can survive for a long time in the environment. Its ubiquity and its growing resistance to antibiotics are the cause of frequent and serious infections. The search and count of staphylococci revealed that the 2021 leachate is very heavy, namely 4×10^9 CFU/100 ml in 2021 and 3.8×10^9 CFU/100 ml in 2020. For the 2021 leachate, the number of staphylococci varies from 4×10^7 UFC/100 ml (February 2021) to 3.8×10^7 UFC/100 ml (February 2020) to 9×10^9 UFC/100 ml (August 2021) and 10^{10} UFC/100 ml (July 2020). The maximum bacterial load is identified in summer (Figure 6). Concentrations increase during the summer season. Staphylococci survive less than coliforms.

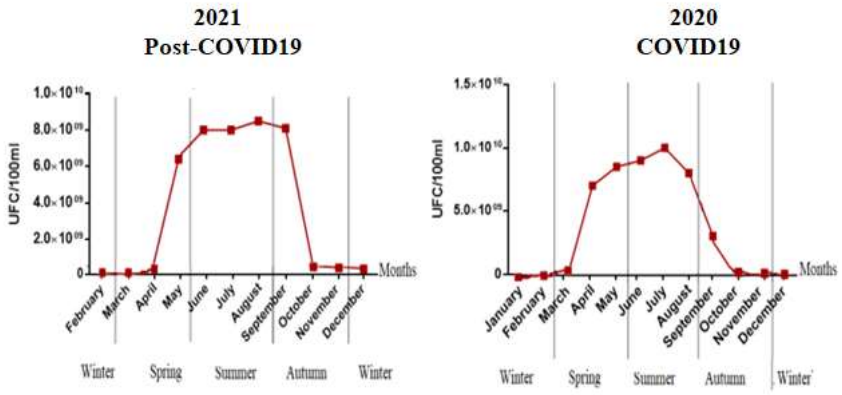

Figure 6: Temporal evolution of staphylococci of Fez landfill leachates (Post-COVID19 and COVID19 period)

Salmonella

Salmonella is generally considered pathogenic, although their virulence and pathogenesis vary widely (Rodier J. & *al*., 2009) [8]. These germs are widespread in the environment and can survive for several weeks in dry conditions and several months in water. The search for Salmonella in the effluent studied showed the presence of these pathogenic germs throughout the study period. These germs contribute to bad odors. Concentrations increasing during the summer season. The presence of Salmonella in the leachate from the landfill indicates a high occupation of the environment by vertebrates, in particular by birds which are the main vectors of Salmonella. Indeed, we noted an abundance of storks on the landfill in addition to other birds (kites, corvids).

4. Conclusion

The present study highlights that the leachate from the Fez landfill has a high concentration of total and faecal coliforms, faecal streptococci, total aerobic mesophilic flora and staphylococci. The results of the monthly analyzes of the leachate from two collectors reveal the presence of germs indicating faecal contamination as well as certain pathogenic germs. A clear distinction between the two years, that of 2021 just after the Covid19 pandemic and the other in 2020 during the Coronavirus period characterized by a leachate with a low bacterial biomass content probably linked to the low quality of household waste, a large number of citizens in confinement and unemployed. Monthly monitoring of variations in recorded concentrations makes it possible to deduce the limiting effect of the seasons. A seasonal variation in germ concentrations has been observed. Concentrations increase during the summer season. Precipitation plays a direct role in diluting bacteria in the leachate, high temperatures can have an effect of leachate evaporation, leading to an increased concentration of germs.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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