Degradation of the Microbiological Quality of Superficial and Ground water around El Haria Landfill.

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Abstract

The controled landfill (technical landfill TL), is a very important pole for the treatment of solid waste. One can cite as a model study El Haria landfill (40 km north of Constantine) in operation from 2010 to 2015. After this year the city wastes were transfered to an open-air dump, just nearby the actual one. However the major problem registered on this dump is the leachate resulting from the degradation of buried wastes which were disposed off the outside of the landfill and which may present a source of potential intense microbiological contamination for the local groundwaters, particularly according to the excellent agricultural character of this region.

The objective of the present work consists in the microbiological characterization of the leachate resulting from the degradation of waste stored in the open-air discharge. In fact this leachate is rejected to the external environment without any treatment, hence the imperative study of its impact on the microbiological quality of waters. The waters of two wells (40-50m deep) used for agriculture irrigation were considered. The obtained results showed that this leachate contained more than $30x10^5$ cfu / ml of enterobacteria and more than $4x10^5$ cfu / ml of total coliforms. The presence of staphylococci, streptococci and even salmonell was recorded. The analysis of the two wells waters confirmed a contamination by total coliforms (10^3cfu / 100 ml) and enterococci (150 cfu / 100ml).

Finally the results showed that these waters (leachates and well waters), presented a poor microbiological quality, compared with Algerian standards.

Keywords: *Coliforms, landfill, enterobacteria, leachate, streptococci, wells.*

I. Introduction

The term landfill is used to describe a final operation for the deposit of domestic, industrial or other wastes. There are two types of landfills: non controlled (open pit) or controled Landfill (technical burial of wastes). This is done in order to minimize the impact of wastes on the environment. In our country, several centers are in operation. The major problem recorded is the leachate resulting from the degradation of buried wastes. Generally this leachate undergoes a treatment by lagooning, then it is rejected outside the landfill; which constitutes an important source of physical, chemical and biological contamination [1, 2].

In this context, several studies have been conducted such as the one reported by HallBoothe et al who have shown that the leachate contains more than 20 pathogenic bacteria such as Staphylococcus, Enterobacteria, Acinetobacteria, Pseudomonas, etc. [3]. The same results have been reported by Trois et al [4]. According to Kattabi et al, the leachate of the Etueffont landfill (France), contains more than 10^6 cfu / ml in 1998, on the same site [5]. Belle [5] registred the presence of 320 cfu/100ml of enterococci in the leachate, (wet and cold region). The Oued Smar dump, Algeria, Bouhezila et al recorded an average of $2.5x10^4$ cfu / 100 ml in total coliforms and 150 cfu / 100 ml in clostridium [6]. Similarly, Mekaikia et al have shown that groundwaters, around landfills were contaminated

by 10-100ufc / 100ml in total coliform, 100 cfu / 100ml streptococci [7].

The first step in this work was the microbiological characterization of leachates leaving the open pit landfill, near the technical landfill. Surface water for agriculture has also been characterized to study the microbial community diversity. In the second step, an enumeration was carried out for the downstream groundwater landfill, suspected to be polluted by the leachate. Finally a biochemical identification on API20E galleries was carried out for strains isolated from these waters.

II. . Materials and methods

A. Presentation of the site

The technical landfill is 4 km north of the commune Ibn Badis (El Haria) town which is about 40 km from the city of Constantine (north-east of Algeria). It was in operation in 2010 until 2015, its official closing date. It accumulated 1000 tons of wastes per year in 2015. Beyond this date the city wastes were transferred to the non-controlled landfill, next to the technical landfill as shown in Figures 1 and 2.

Figure 1. Localisation of the landfill.

The sampling sites (Figure.2) were chosen in such a way as to respect the microbial representativity of water and leachate microbiological quality.

B. Conservation and transport

The closure and the tightness of the vials used, provided total protection against any contamination. The vials were made of 250, 500 and 1000 ml of borosilicate glass, they were washed and sterilized in an autoclave for 15 minutes at 120 °C as reported by Rodier et al. [8].

These flasks were transported in a cooler whose temperature was between 4 and 6°C.

Figure .2 Sampling points.

The bacteriological analysis was done within a maximum of 24 hours after the collection of the samples [8].

C. Used media and techniques

The media used are PCA (Plat Count Agar) for enumeration of total aerobic mesophilic flora (AMF), BCP medium (bromocresol pourpe) or TCC (lactose medium ou tergitol7) for enumeration of total coliforms, and VRBG (violet red bile glucose agar) for enterobacteria, the prepared samples dilutions were inoculated on these media and incubated for 24-48h at 37 °C (Delleras) [9]. The research techniques used were dilution technique and surface seeding for leachates and membrane filtration technique using sterile cellulosic membranes of 0.22µm for wells waters analyses.

III. Results and discussion

A. Counting results

The results obtained for the analysis of polluted water are presented by the following tables and figures:

Table.1 Microbiological analyses of leachates leaving the open-air landfill (points L1 and L2).

	Total flora	enterobacteria (cfu /ml)		Total coliforms (cfu / ml)	
	L1	L1	L2	L1	L2
2016	10^6	$20x10^4$	$20x10^5$	$2x10^3$	$3x10^5$
2017	$40x10^{10}$	$30x10^5$	$60x10^5$	$4x10^5$	$7x10^6$

L1 : lessivat 1. L2 : lessivat2.

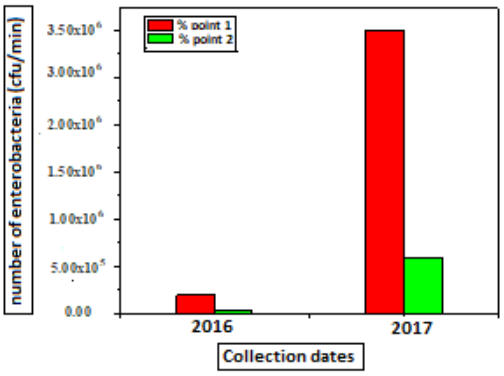

Figure.3 evolution of germs in the leacheat1 (cfu: colony forming unit)

1- Total aerobic mesophilic flora (AMF) is used as an indicator of global pollution. They are able to grow at optimum growth temperatures between 25 and 40 °C. The AMF provides information on the autochthonous microflora brought by the pollution [10] The results of the microbiological analyzes show that the average content of the total aerobic mesophilic flora fluctuated enormously, of the order of 10^{10}cfu / ml for leachates leaving the landfill as shown in Table 1.

2- Enterobacteria family gathers all the germs to study, it contains pathogenic and not germs. It was found that the presence of enterobacteria in the leachate (L1 and L2) was $20x10^4$ in 2016 and $30x10^5$cfu / ml in 2017, which was a maximum value. It would evolve as a function of time, the risk increased , for point L2, which resulted from run off of leachates in an agricultural zone where there was always a great change in enterobacterial family.

3- total coliforms are gram (-) rods, aerobic and optionally anaerobic; non-sporulating agents capable to ferment lactose. The results relating the variation of the average coliform content, showed that this organisms had an average values recorded in the leachate of $2x10^3$ in 2016 and $4x10^5$cfu / ml in 2017, so the risk evolved. The same observation was recorded for the point L2 with values comparable to that of the Kenitra landfill 3.10^4ucf / 100ml in April 2013 [10]. These results are presented in Figure 4.

B. Identification results

A volume of 100 ml of the surface waters (well 1, well2) were filtered on cellulose membrane of 0.45 mm of diameter, the conditions of sterilization were respected. These membrane were seeded on VRBG , haktoen and EMB (Eosine Methylene Blue) medium. After 24 hours of culture, they were transplanted to the same medium for the purpose of purifying the strains, then transplanted on a non-colored medium (TCC). After 24 h of culture, they were subject to API20E gallery and incubated 24 h at 37 °C, the necessary reagents were added, and the oxidase test was carried out. The results were read referring to the API20E catalogue (see Figures 4- 7).

Table.2 Results for the waters of two wells

Germs cfu / ml	Enterobacteria		Total coliforms		Enterococcus D		Total flora	
	P1	P2	P1	P2	P1	P2	P1	P2
2016	250	---	100	---	30	---	≥300	---
2017	120	80	50	60	20	abs	≥300	200

----- not made, P1: well1, P2: well2.

An example of agar seeding is presented by the following figures:

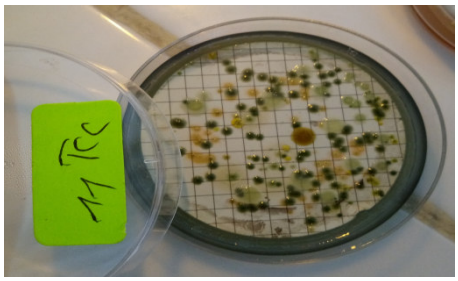

Figure.4 seeding results on 100 ml TCC of W2 water.

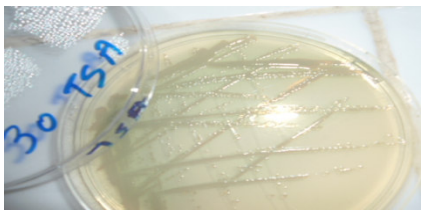

Fig.5: Purification of an isolated TSA colony from fig4.

Figure.6 Results of incubation of API gallery seeded by a strain (Enterobactercloacae).

Table 3. Germs recorded in two wells.

Strain	Number	Source
Non farmenterspp	3	Well 1
Acinetrobacterbaummania	3	Well 2
Pseudomonas aerogenas	5	Well 1
Pontoea spp3	5	Well 1
Flavimonashyzihabita	3	Well 1
Acinetobacter pneumania	3	Well 2
Chryseomonaslutela	4	Well 1
Serratiaphymuthca	2	Well 2
Seerratiamarcescens	3	Well 2
Serratiaodorifera	4	Well 2
Enterobacter gergovine	9	Well 1
Enterobacter cloacae	7	Well 1
Cotrobacterfendii	3	Well 1
E. coli1	8	Well 1and 2
Salmonella arizonae	2	Well1and 2

Aerobic microorganisms were identified to confirm contamination of groundwater (2 wells) by leachate from the non-controlled landfill. More than 50 isolated strains were chosen to identify on API20 E galery. These strains were isolated from points 1 and 2 (the wells available in the region), knowing that the presence of these different bacteria did not eliminate the presence of other germs, because of sampling dates (always in May / April).

The obtained results are shown in Table 3. They are presented according to their number and their sources, more than 50 different strains were recovered by membrane filtration technique of 100 ml of water, from samples 1 and 2 on VRBG medium, TCC, EMB and SS (salmonella-shigella).

Serratia bacteria (S. phymutica, S. marcescens, S. odorifera) (9 species), these bacteria were total coliforms, they were opportunist pathogens and they were detected in points1 and 2. Pseudomonas aerogenas (5species), Entirobactercloacae) (9 species) and 8 species of citrobacter (C. broaki) were also recorded and they were pathogenic fecal coliforms [12]. These germs were found naturally in wastewater and soil but originally in human fecal matter [13] which confirmed the hypothesis of a contamination by landfill leaching.

E.coli1was present in the two wells and was considered to be the best indicator of recent faecal contamination (100 days) of the aquatic environment by human fecal matter to warm-blooded animals [13]:

Salmonella arizonae was also detected in point 1 and 2 and was classified as a pathogenic bacteria [9], although Drinking water was not often involved as a source of Salmonella infection [13]: The genus Acinetobacter was present in well 2 and was an ubiquitous and opportunist pathogene. Acinetobacter pneumania was the most common species in terms of pathogenicity [13].

Chryseomonaslutela (4 species) or also called Pseudomonas luteola can cause serious infections [14]. Pontoea spp3, Flavimonashyzihabita were also detected in wells 1 and 2.

For the distribution of germs in wells, It is noted that the greatest quantity of species was isolated from point 1 which was logical since the well (50 m depth and 400 m downstream of the landfill) was well exposed to the leachate of this landfill, although Well 2 was deeper (120 m deep). These two wells were poorly or not treated and the water of these two points was destined for agriculture, hence the danger since the World Health Organization (WHO) requires a total absence of these bacteria [9]

.IV- Conclusion

The non-controlled landfill ElHaria (open air) receives more than 1000 tons/day on average, from 2015, of all kinds of wastes of household, industrial, hospital and trade type.

The bacteriological analysis of the generated leacheat, showed that the agricultural environment of the landfill had a very high level of pollution, which was characterized by the presence of different enterobacteria, especially total and faecal coliforms, streptococci, salmonella, etc.

These germs were also recorded in the surface waters for agriculture (L2) and groundwater with high depths (50m), so the waters of the region were not fit for human consumption, according to the standards advocated by the WHO, without ignoring that this study was carried out in March / April of each year, a period characterized by a moderately high temperature (25-30°C) accompanied by a drought in this region, explaining the high rates of germs that had been recorded.

For a good exploitation of this non-controlled landfill, leachates require a treatment before being thrown away towards the environment, particularly in Winter periods with a high rainfall.

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