



Socio-environmental Panorama in the Vicinity of a Sanitary Landfill: The Risk for Aerosols of Leachates and Microbiological Air Transport

Aurora Hernández Cruz ^a, María Elena Cruz Cortés ^a,
Iracema Islas Vega ^a, Jeiry Toribio Jiménez ^b,
Josefina Reynoso Vázquez ^c,
María del Consuelo Cabrera Morales ^d
and Jesús Carlos Ruvalcaba Ledezma ^{d*}

^a Department of Public Health, [ICSa-UAEH] Institute of Health Sciences-Autonomous University of the State of Hidalgo, Mexico.

^b Department of Microbiology in University Autonomus of Guerrero, [UAGro], México.

^c Department of Pharmacy and Masters in Public Health, [ICSa-UAEH], México.

^d Department of Medicine and Masters in Public Health, [ICSa-UAEH], México.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajee/2024/v23i8583>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/119749>

Original Research Article

Received: 08/05/2024

Accepted: 10/07/2024

Published: 13/07/2024

*Corresponding author: E-mail: dcsjpcarlos@gmail.com;

Cite as: Cruz, Aurora Hernández, María Elena Cruz Cortés, Iracema Islas Vega, Jeiry Toribio Jiménez, Josefina Reynoso Vázquez, María del Consuelo Cabrera Morales, and Jesús Carlos Ruvalcaba Ledezma. 2024. "Socio-Environmental Panorama in the Vicinity of a Sanitary Landfill: The Risk for Aerosols of Leachates and Microbiological Air Transport". *Asian Journal of Environment & Ecology* 23 (8):44-51. <https://doi.org/10.9734/ajee/2024/v23i8583>.

ABSTRACT

Aim: To describe the socio-environmental situation in the vicinity of the Tecámac landfill and the health risk associated with leachates and microbiological air transport.

Methodology: An exploratory study was carried out from a visit to the sanitary landfill through direct observation, interviews with sanitary workers and people affected by living in the immediacy of the landfill. Samples of leachate and soil these were analyzed in the laboratory, firstly to achieve the recoverability in Agar Soy Trypticase [AST] and proceeded to their identification by biochemical tests.

Results: Among the chemical products perceived when visiting this socio-environmental context is hydrogen sulfide, which impacts the nervous system at the level of neurobiological vitality. The acute-chronic exposure in the population adjacent to the landfill and its leachates is enough to insist that environmental control of this area be warranted. Among the bacteria detected, 60% were Gram-positive bacilli and 30% were Gram-negative bacilli. Bacteria present in this environment are: *Bacillus cereus*, *Bacillus subtilis*, *Bacillus sp* and *Pseudomonas aeruginosa*, *P. putida*, *Klebsiella pneumoniae*, *Escherichia coli* and *Enterobacter cloacae*. Conversation with people denotes exposure to chemicals-microorganisms and risks to human health.

Conclusion: The presence of microorganisms and virulence profile are aspects to be considered in these bacteria is their virulence profile, and their biotechnological profile when they present an effect as generators of plant growth. For this reason, the study of this type of bacteria is transcendent in the fields of Environmental Sciences and Public Health.

Keywords: Aerosols-microorganisms; health risks; chemical agents; landfill; leachate.

1. INTRODUCTION

Population growth, the irregular development of cities, the pattern of current inadequate consumption among other factors causes problems in human society, particularly in underdeveloped countries. One of the most obvious problems is waste. One of the important types of waste is urban waste, garbage, and there is a lot of water in urban waste that induces leachate production [1,2]. This landfill starts from November 11, 2005, according to Mendoza [3] by the company Waste-Co, dedicated to "waste management and remediation services to areas damaged by non-hazardous waste, aerosols impact systems of the people who live there as in the visitors [4]. Improper disposal and management of waste causes all types of pollution: air, land and water [5,6]. "The accumulation of waste serves as a refuge for various vectors, which find in them the conditions conducive to feeding, growing and reproducing, that is, it favors the existence of vectors and their propagation" [7].

Leachate and its biological processes together with the introduction of rainwater can penetrate layers of permeable soil and in some cases reach the aquifer, contaminating it. Gloria & Omar, [7] Alam, [5]. It is logic to think that by contaminating the water, even if it is subjected to treatment of purification it could represent risks to

human health that coexists day by day with this type of aerosols, supposedly since 2013 this is already covered with soil, that is to say, in the process of termination of its functions as closed [8,9].

High humidity and extreme conditions cause the growth of a wide variety of biological agents; microorganisms such as fungi, bacteria, amoeba cysts and viruses causing damage to human health through inhalation, ingestion or contact with the skin, it should be noted that microorganisms generate and transfer virulence factors to survive, this in turn puts human health at risk, hence the presence of multi-resistant bacteria to antimicrobials [10]. Heavy metals among other chemicals makes the treatment and restoration of the health of the human population more difficult, which is why they can be used as indicators of environmental impact and of human health [10].

The objective of this article is To describe the socio-environmental situation in the vicinity of the Tecámac landfill and the health risk associated with leachates and microbiological air transport.

2. MATERIALS AND METHODS

Isolation and identification of native bacteria:

An exploratory study was carried out from the visit to a landfill, to make direct observations, talk with dustmen and people affected by living in the

immediacy of said scenario. Samples of leachate and immediate soil were also taken from the leachates, these were analyzed in the laboratory. For the isolation of bacteria, 1 g or 1 mL of each sample was taken, and dilutions from 10^{-1} to 10^{-3} were prepared, 100 μ L of the last dilution was inoculated on LB agar in triplicate, and they were incubated at 30 °C for 24 - 48 h, the colonies were selected based on their macro and microscopic characteristics [11,12]. All experiments were done in triplicate and expressed in CFU mL⁻¹ or g of sample. Then the strains were reseeded, and their identification was carried out by Gram stain and biochemical tests, include oxidase, catalase, TSI, Indole, mobility, H₂S production, citrate, urea hydrolysis, gelatin liquefaction, phenylalanine, lysine and ornithine decarboxylation, carbohydrate fermentation and were interpreted according to Koneman [13].

3. RESULTS AND CRITICAL ANALYSIS

A field visit was made in the immediate vicinity of the Tecámac dump, one of the municipalities in the metropolitan area of the northeast of the State of Mexico. Said landfill according to a publication of the magazine *ContraLínea* of November 11, 2015, written by Elva Mendoza, reports that this has been operating since 2005, being a company of the Waste-Co group, dedicated to “waste management and services remediation to areas damaged by non-hazardous waste.” Mendoza, [3].

This is a huge hill of garbage that until July of this year received about 800 tons of garbage daily from neighboring municipalities and the federal district according to a report by Javier Salinas Cesáreo, published in the newspaper *La Jornada*

on September 10, 2013. By the date of the visit, the place was “closed” IMAGE observing the hill covered by land, according to surveillance personnel of the same “was already in the process of treatment” so it was covered with dirt and “With some respirators” for the exit of gases.

Although there has already been steps towards closure of the garbage dump, the garbage continues there, generating bad odors as described and in a comparative way in the article *Perception of the Impact of the Final Landfill of Garbage on Health and the Physical Environment and Social in Cali*, by Janeth Mosquera-Becerra et.al, 2009, these odors have the capacity to cause discomfort, the residents of the landfill area state that bad odors are not permanent, but that their presence is associated with the conditions of the climate and the direction of the winds, being the night hours and the warm days that follow the rains when the smells are more intense, in addition they indicate that the odors coming from the dump cause respiratory diseases to both residents and visitors.

In addition to the above, the presence of residential houses a few meters from the garbage dump is surprising, the Fortaleza housing complex has a total of 400 houses, just few meters away from the dump. According to the report of the newspaper *La Jornada* dated Wednesday, September 4, 2013, the real estate company Casa Quma SA of SV sold the houses without even notifying its buyers that the housing complex was located near the dump, in addition, there are some more houses in the denominated apple YF where 262 families live because of a relocation coming from the municipality of Tulpetlac during the year 2011.



Fig. 1. A mountain of trash with dirt and leachate on top



Fig. 2. The immediate socio-environmental context to the landfill

Houses that are used as urban waste collection tanks for recycling are also observed in the immediate vicinity, as detailed in the article "Work on garbage collection in Mexico: new realities, new inequalities", generally dustmen live in homes built in the dumps - elaborated with poorly durable materials such as plastic, cardboard and wood - that expose them to the inclement weather. They lack public services such as a monitored attention to their health since they are people exposed to diseases of multiple causation. Usually, they have a low educational level, which prevents them from measuring the risk that their health weighs, arguing "the body creates defenses, one gets used to breathing through the mouth," also, "the accumulation of waste serves as a refuge for various vectors, which find in them the conditions conducive to feeding, growing and reproducing. It favors the existence of vectors and their propagation" [7] being also a risk factor for the generation of pathologies.

However, the most shocking aspect of this environmental context is that despite the fact that the landfill is closed to its skirts and due to the effect of gravity, leachates are seen "biological processes together with the introduction of rainwater produce a leachate that can penetrate layers of permeable land and in some cases reach the aquifer, contaminating it" [7]. As described by research professor Ruvalcaba Ledezma et. al, [10] in his article Bacteriological Indicators the Environment and in Human Health "the air transports many microorganisms such as saprophytes and aerosolization products, flagella fragments, genetic material, metabolites, volatile organic compounds endotoxins and mycotoxins" later states "a high humidity or extreme

conditions cause the growth of many microorganisms such as fungi, bacteria, viruses and cysts of amoebas causing damage to human health through inhalation, ingestion or skin contact.

3.1 Microorganisms Detected

Serial dilutions of the samples obtained 1: 1000 were made, seeded in LB, incubated for 24 to 30 hours, colonies counted and 120,000 CFU / ml were obtained in soil samples and 240,000 CFU / ml of samples were collected. leached, among the microbial diversity it was detected that 60% correspond to Gram positive bacilli and 30% to Gram negative bacilli. Among the microorganisms were identified: *Bacillus cereus* (6), *B. subtilis* (3), *Bacillus sp* (6), in addition to *Pseudomonas aeruginosa* (4), *P. putida* (1), *Klebsiella pneumoniae* (7), *Escherichia coli* (5) and *Enterobacter cloacae* (2) [Tables 1 and 2].

One of the aspects to consider in these bacteria is their virulence profile and their possible associations in the disease health process in the neighbors of this environment, although these bacteria supposedly do not interact with the human, such is the case of the genus *Bacillus* and its profile Biotechnological by presenting effect as generators of plant growth, due to its important source of biofertilizers, since the flora of the place shows exuberant growth and for this reason the study of this type of bacteria is transcendent in public health.

The presence of bacteria such as *Pseudomonas sp*, could represent a high risk for diseases of the respiratory tract, eyes and skin, we believe it is transcendental to study in depth the virulence factors of these bacteria, since people bordering

on aerosols derived from the leachates live with them and demerit their quality of life, their health condition and finally, social impact at the level of families and the same health sector. Since diseases generated by contact or exposure to this type of microorganisms generates a greater expense in medical treatments, this coupled with the shortage existing in hospitals in terms of medicines, translates into a complication and demerit of the quality of health care.

3.2 As for the Qualitative Analysis

The present interview with a person who lives as a neighbor of the landfill and leachate denotes exposure to health risks of people bordering on this type of socio-environmental environment.

So in his speech denotes exposure to chemicals.

Interviewed: *Well, in fact, all of us, we are very delicate skin, precisely for the same reason. At night and in the morning, it stinks of gas.*

Interviewer: *What do they commonly get sick of here?*

Interviewed: *From the airways and skin*

Interviewer: *Do the garbage odor get here?*

Interviewed: *Come back at 6:00 in the morning or at 8:00 or 9:00 at night and it stinks, Awful.*

This person's speech indicates that aerosols are noticeable, this denotes exposure to chemicals and airborne microorganisms.

Interviewed: *Yes, in fact, in the mornings when it is hot, when the sun is at about 7:00 in the morning on that hill (indicates) we can observe how the steam is coming out. It's what I was talking about, the dump has no vents or emergency exits.*

The interviewee's speech emphasizes that temperature facilitates the generation of aerosols, visible to the naked eye and harmful for their respiratory system.



Fig. 3. The leachate is distributed around the landfill in the lower part



Fig. 4. Note the constant runoff of leachates, these could impact on groundwater

Table 1. Diversity of microorganisms detected in diluted soil samples and leachate

Type of sample	UFC/ml
Soil samples	120, 000 UFC/ml
Leachate Samples	240,000 UFC/ml

Note: Microbial diversity was 60% for Gram positive bacilli and 30% for Gram negative bacilli.

Source: Laboratory of microbiology of the Biological Sciences Unit of the UAGro, 2017.

Table 2. Microorganisms identified in leachate samples

Microorganism	Frequency	Percentage
<i>Bacillus cereus</i>	6	17.6
<i>Bacillus subtilis</i>	3	8.8
<i>Bacillus sp</i>	6	17.6
<i>Pseudomonas aeruginosa</i>	4	11.7
<i>P. putida</i>	1	2.8
<i>Klebsiella pneumoniae</i>	7	20.5
<i>Escherichia coli</i>	5	14.7
<i>Enterobacter cloacae</i>	2	5.8
Total	34	100

Source: Laboratory of microbiology of the Biological Sciences Unit of the UAGro, 2020.

4. DISCUSSION

Municipal garbage dumps or landfills are a constant in any urban area of the world; There are several studies that confirm the aforementioned about the risk that this implies in the health of the inhabitants who live in the surroundings of these sites and the null appropriate treatment of waste. Such is the case of leachates, it should be noted that in the journey through this context among the researchers there were effects on their health; among them vertigo, headache and respiratory tract conditions, such as flu with involvement in the upper airways with cough for 3 to 4 weeks. In addition it was observed that the dustmen have pale to yellowish coloration on their facial skin, irritated eyes, among other effects on the skin, although they point out that working here for years now produces defenses to their body, it is also worth noting that their lifestyle is not entirely satisfactory, since they live between garbage and PET containers, where they are probably exposed to dioxins among other chemicals.

Bernache Pérez in [14] indicates that in the study carried out in 41 municipalities in the central western area of Mexico it was found that only 2% of the municipalities have a leachate treatment plant, 46% do not have a pit to capture the leachate and 61% do not have adequate infrastructure for final disposal (geomembrane); in addition to finding that only 3 municipalities had by that date a controlled destruction of methane gas, 54% of the municipalities had

ventilation wells for which the biogas escaped into the atmosphere and 39% of the municipalities did not do anything about the biogas management [14]. This indicates that the mishandling of leachate and other garbage waste such as methane gas is not an exclusive case of some landfills polluting the environment of the soil and the air of those who live around.

In another study conducted by León-Gómez et al. [15] it was found that, although in general terms the landfill of the city of Linares, Nuevo León complies with the guidelines set by the regulations, it presented important deficiencies that could seriously affect water quality as the null leachate management there generated or breaks in the geomembrane of the same fill. The chemical analysis of surface and groundwater adjacent to the landfill revealed high concentrations of NO₃⁻, high concentrations of Pb, Mn and Fe. The leachate also shows an excess of NO₃⁻ so there was a large mobilization of metals [15].

Therefore it is important to know those socio-environmental factors that determine the lifestyles of the population that lives in the vicinity of this dump, as well as if there is any treatment for the leachates that come from it to prevent diseases in the population that put their population at risk health, beyond the exposure in which they already are.

One of the aspects in which the work will continue is to study the antimicrobial resistance

and its virulence factors of the strains detected, since in the people who attended this context common symptoms were manifested in terms of respiratory infection with duration for at least 3 weeks, including headache, rhinitis and congestive cough with phlegm difficult to eject, as well as vertigo and pruritus of the eye with redness or irritation. Symptoms coinciding with those manifested as common among people living in this context.

The results obtained in the present work agree with respect to the type of bacteria detected in this Environmental environment and those reported by Thamlikitkul V, et al., [16] in various environmental environments, including the washing of garbage trucks and leachate from a garbage dump.

5. CONCLUSIONS

Preventing the final disposal of leachates from the landfill is a matter of vital importance in their operation despite the fact that it has been allegedly closed, once the contamination has been established, decontamination measures take longer to make effect.

The presence of leachates represents a risk to the health of the human population adjacent to the landfill due to the airborne transport of microorganisms that, due to survival in adverse environments, generate virulence factors and resistance to antibiotics.

The outline of this panorama is intended to propose an in-depth investigation into the specific damages that can be generated by the presence of leachates so close to the human population that, as previously stated, allow the dissemination of pathogenic organisms for health.

The presence of microorganisms and virulence profile are aspects to be considered in these bacteria is their virulence profile, and their biotechnological profile when they present an effect as generators of plant growth. For this reason, the study of this type of bacteria is transcendent in the fields of Environmental Sciences and Public Health.

DECLARATIONS

Data availability. The information was obtained through an interview with people who live immediately to the landfill, structured and in

depth. In addition to the analysis of leachate samples in the microbiology and biotechnology laboratory of the Autonomous University of Guerrero, Mexico. This study allows thesis of the Master in Public Health in UAEH, Mexico.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ACKNOWLEDGEMENTS

The authors are deeply grateful to PROMEP for the support for the publication of this article, since it represents a stimulus to generate knowledge and its transference with a scientific character.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Panahpour E, Gholami A, Hossein Davami A. Influence of Garbage Leachate on Soil Reaction, Salinity and Soil Organic Matter in East of Isfahan. *International Scholarly and Scientific Research & Innovation*. 2011;5(9):530-535.
2. Stamps BW, Lyles CN, Suflita JM, Masoner JR, Cozzarelli IM, Kolpin DW, Stevenson BS. Municipal Solid Waste Landfills Harbor Distinct Microbiomes. *Front. Microbiol*. 2016;7:534. DOI: 10.3389/fmicb.2016.00534
3. Mendoza Alva, Garbage dump in Tecamac, time bomb. *Contraline Magazine*; 2015.
4. Mosquera J, Gomez O, Mendez F. Perception of the Impact of Final Landfill on Health and on the Physical and Social Environment in Cali. *Journal of Public Health*. 2009;11 (4):549–558. Available:<https://doi.org/10.1590/S0124-00642009000400006>
5. Alam P, Ahmad K. Impact of solid waste on health and the environment; 2013. IJSDGE No.: 2315-4721, V-2, I-1, 165-168.
6. Aluko OO, Sridhar MKC. Characterization of leachates from a municipal solid waste landfill site in Ibadan, Nigeria. *Journal of*

- Environmental Health Research. 2003;2 (1):32-37.
7. Gloria P, Omar Z. Waste and health: Tartagal - Salta. Rev. Fr. Cienc. Technol. 2011;35–43.
Available:http://www.sky.org.ar/sky.php?script=sci_arttext&pid=S1851-75872011000200005&length=pt
 8. Salinas Javier, Abandoned, 400 houses next to garbage dump in Tecamac, newspaper La Jornada. Section States; 2013.
 9. Brennan RB, Healy MG, Morrison L, Hynes S, Norton D, Clifford E. Management of landfill leachate: The legacy of the European Union Directives. Waste Management. 2016;55:355–363.
DOI:10.1016/j.wasman.2015.10.010.
 10. Ruvalcaba Ledezma JC, et.al, Bacteriological Indicators on the Environment and in Human Health, Current World Environment. 2014;9(1):96–104.
 11. Yu XY, Li C. Zhang H, Liu J, Liu W, Zheng X, Kang X, Leng K, Zhao Y, Gu X, Zhang Q, Xiang Q, Chen. Culturable heavy metal-resistant and plant growth promoting bacteria in V-Ti magnetite mine tailing soil from Panzhihua, China. Plos One. 2014; 9:e106618.
DOI:<https://doi.org/10.1371/journal.pone.0106618>.
 12. Santana-Flores, Amairani, Sánchez-Ayala, Alejandro, Romero-Ramírez, Yanet, Toledo-Hernández, Erubiel, Ortega-Acosta, Santo Ángel, & Toribio-Jiménez, Jeiry. Aislamiento e identificación de bacterias tolerantes y bioacumuladoras de metales pesados, obtenidas de los jales mineros El Fraile, México. Terra Latinoamericana. 2020;38(1):67-75. Epub 20 de junio de 2020.
Available:<https://doi.org/10.28940/terra.v38i1.430>
 13. Koneman E, Allen S, Dowell VR, Sommers H. Diagnóstico Microbiológico. Editorial Médica Panamericana SA, Buenos Aires, Argentina. 2006;145-150.
 14. Bernache Perez G. Risk of contamination by final waste disposal. A study of the central western region of Mexico. Rev. Fr. Int. Contam. Environ. 2012;28(1).
 15. Leon-Gomez H, Cruz-Vega CR, Davila-Porcell RA, Velazco-Tapia F, Chpa-Warrior JR . Impact of leachate generated in the municipal landfill of Linares (Nuevo León) on surface and groundwater quality. Rev. Fr. Mex. Cienc. Geol. 2015;32(3)
 16. Thamlikitkul V, Tiengrim S, Thamthaweechok N, Buranapakdee P and Chiemchaisri W. Int. J. Environment. Res. Public Health. 2019;16:3753.
DOI:10.3390/ijerph16193753

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/119749>