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Preliminary evaluation of the bacteriological quality of air in laguna de Cajititlán, Jalisco, Mexico

Evaluación preliminar de la calidad bacteriológica del aire en laguna de Cajititlán, Jalisco, México

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Abstract

The Laguna de Cajititlán, is located in the central portion of the state of Jalisco, approximately 25 km from the city of Guadalajara. This area presents fragmentation of habitat, caused by population growth, the development of new subdivisions around the lagoon, overexploitation of the soil and water and insertion of economic activities that have generated the loss and affectation of natural resources. The purpose of this work was to know the bacteriological quality of the air in the Laguna de Cajititlán, Jalisco and the health risks of the population. The sampling was done in 5 points in summer. 100 liters of air were taken using different culture media for the determination of aerobic mesophiles, Escherichia coli, Salmonella and Staphylococcus aureus by the M Air T Millipore system. The samples were incubated at 37oC for 48 hours, the CFU were quantified and biochemical tests were applied for their identification. The total percentage for Gram positive and Gram negative bacteria shows 62% and 38% respectively. The microbiological diversity found as a function of the frequency observed is as follows: Escherichia coli 30.8%, Staphylococcus aureus 51% and Salmonella 4.8%, all considered pathogenic bacteria.

Wastewater, Bioaerosols, Pathogens, Health, Threats, Risks

Resumen

La Laguna de Cajititlán, se localiza en la porción centro del estado de Jalisco, a 25 km aproximadamente de la ciudad de Guadalajara Esta área presenta fragmentación del hábitat, ocasionada por el crecimiento demográfico, el desarrollo de nuevos fraccionamientos alrededor de la laguna, sobreexplotación del suelo y agua e inserción de actividades económicas que han generado la pérdida y afectación de los recursos naturales. El propósito de este trabajo fue conocer la calidad bacteriológica del aire en la Laguna de Cajititlán, Jalisco y los riesgos a la salud de la población. El muestreo se realizó en 5 puntos en verano. Se tomaron 100 litros de aire utilizando diferentes medios de cultivo para la determinación de mesófilos aerobios, *Escherichia coli*, *Salmonella* y S*taphylococcus aureus* mediante el sistema M Air T Millipore. Las muestras se incubaron a 37ºC durante 48 horas, se cuantificaron las UFC y se aplicaron pruebas bioquímicas para su identificación. El porcentaje total para bacterias Gram positivas y Gram negativas muestra un 62% y un 38% respectivamente. La diversidad microbiológica encontrada en función de la frecuencia observada es como sigue: *Escherichia coli* 30.8%, S*taphylococcus aureus 51% y Salmonella 4.8* %, todas ellas consideradas bacterias patógenas.

Aguas Residuales, Bioaerosoles, Patógenos, Salud, Amenazas, Riesgos

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Introduction

The lagoon of Cajititlán is located in the central portion of the state of Jalisco, approximately 25 km from the city of Guadalajara under the jurisdiction of the municipality of Tlajomulco de Zúñiga. It is located between the coordinates 20 ° 23 '48 "and 20 ° 28' 11" north latitude and the 103 or 14 '290 "and 103 ° 27' 38" west longitude. It has an approximate area of 14.3 km2 with a maximum northwest-southeast length of 7.5 km, it has a northeast-southwest distance of 2 km, with an average depth of 1.69 m.

This body of water is the most important in the area and is supplied by a series of streams that fall both from the Sierra El Madroño and the drains of other hills located in its surroundings. The climate of the zone is classified as temperate subhumid, with rainfall in summer (Cortés, 2000). This area presents fragmentation of the habitat, caused by the demographic growth, the development of new subdivisions around the lagoon, overexploitation of soil and water and insertion of economic activities that have generated the loss and affectation of natural resources. An important factor that makes this body of water more vulnerable to the pollutants poured into it, this is an endorheic basin, so these pollutants accumulate in this.

The streams that flow into the lagoon incorporate large volumes of domestic and industrial wastewater, while the runoff that crosses the cultivation areas or livestock activities contribute agrochemicals dangerously contaminated (Velázquez-López et al., 2012).
Recently there have been episodes of massive deaths of both species of flora and fauna, and the real causes of these phenomena have not been established, which makes its study imperative because of the social and environmental reach of this body of water.

Theoretical framework

There is a close relationship between development, environment and health. The current development models generate impacts on the environment, as a consequence of the use of available resources (Arbeláez et al., 2010). Contaminants can be incorporated into the environment in the form of gases, dissolved substances, particles or in solid form.

These are incorporated into the aqueous medium through routes such as the atmosphere and the soil (runoff and leaching phenomena). This is generated through point or diffuse sources, the difference between the two is that a pollutant originating in a point source can be collected, measured and treated; In addition, the point source can be identified or georeferenced. A diffuse source consists of various point sources that could be controlled. One of these sources is water that originates in the collection and discharge of urban, industrial wastewater and certain agricultural activities (POFA, 2012).

Several studies on pollution focus only on gases and inert particles, when most of them are biological particles, mainly bacteria, fungi and viruses that cause diseases. These airborne or bioaerosal particles are those that are in suspension in the air alive or dead constituted by products of their metabolism, bacterial endotoxins, mycotoxins, peptidoglycans, as well as pollen, and even small insects and their residues, algae, protozoa and dust mites, which are sometimes pathogenic (Vélez-Pereira and Camargo-Caicedo, 2014).

The atmosphere does not have a native microbiota, but it is a means of dispersing many types of microorganisms from other environments. Certain bacteria and their many metabolites affect atmospheric chemistry through physical processes such as the nucleation of ice and the formation of droplets. clouds, and can also affect the global climate and the hydrological cycle (Hurtado, et al., 2014).

A biological particle to be considered as a bioaerosol must contain a diameter of 3 nm for viruses, from 0.25 to 20 μm for bacteria, from 17 to 58 μm for pollen from plants and from 1 to 30 μm for fungi, the most important are those with a diameter less than 3μm because of their size can penetrate the lower airways such as the pulmonary alveoli where they can cause damage to the bronchial epithelium, induce inflammation or neoplasia, degeneration, or can be transported to the pulmonary blood to spread throughout the body and cause aggressive infections for humans (Ghosh et al., 2015; Quarato et al., 2017). Bio-aerosols can contribute up to 25% to atmospheric aerosols and their exposure to them can cause adverse health effects, including infectious diseases, acute toxic effects, allergies and cancers (Li et al., 2017).

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In Latin America, studies on air quality and social perception are very limited, although in the region there are large cities with serious air pollution problems such as Mexico City, Sao Paulo and Rio de Janeiro, where the population is exposed to levels that exceed the established limits, according to estimates of the World Health Organization. (Catalán-Vázquez, 2006). Anthropogenic activities, such as vehicular traffic, wastewater treatment plants (Rosas, 2003), solid waste management centers, the movement of animals in exposed soils, agricultural practices and the manipulation of compost among others, they release a large amount of bacteria into the atmosphere, causing pollution of the surrounding areas.

In several samples of urban and home dust in Mexico City has been isolated E. coli, bacteria indicator of fecal contamination, and that constitutes 40% of total coliform bacteria isolated in the dust, indicating a potential risk of contamination by this and other pathogenic bacteria, as well as by viruses or parasites. It has been reported that bacteria are present in the atmosphere of extramural environments and that their inhalation represents a risk to health, either in its vegetative form or part of its structural compounds called "biogenic compounds", such as membrane lipopolysaccharides. external of Gram-negative bacteria and teicoic acids of Gram-positive. (Rosas et al., 2004).

In studies on the characterization of bioaerosols both in air of open and closed spaces, the genera of Cladosporium, Rhizopus, Fusarium and C. sphaerospermum have been identified as the most frequent microorganisms. Penicillium, Aspergillus and Cladosporium as the possible causes of respiratory allergies (Mortazavi and Ariya., 2015). Factors such as solar radiation, dehydration and rehydration, thermal effects, meteorological physics, the formation of radicals and ions and air turbulence are potentially harmful and lethal for microbial cells in the air (Karra and Katsivela, 2007).

Several studies agree on the need to carry out continuous monitoring of the concentration of bioaerosols in the air in order to assess the potential threats to health to which the population is exposed due to the presence of pathogens present in them, and to establish measures mitigation of this risk, thus improving their quality of life.

In addition to generating data for the establishment of environmental quality indicators that provide the basis for formulating a proposal for an environmental standard that considers the bacteriological quality of air in open and working spaces (Ki et al., 2014, Sánchez-Monedero et al., 2006).

Justification

In the surroundings of the Laguna de Cajititlán, according to INEGI data, in 2010 there were 59,625 people, states the State Water Commission. The Laguna de Cajititlán has a natural storage capacity of 54 million cubic meters. The main pollutants are nutrients mainly nitrogen and phosphorus, which cause the appearance of algae or aquatic weeds and fecal coliforms, caused by the discharges of wastewater, due to poor or no treatment. It is of vital importance to know if this body of water and the activities carried out in its surroundings contribute to the air pathogenic bacteria that put at risk the health of its inhabitants.

Problem Statement

Therefore, the information obtained from the air quality bacteriological studies allow us to assess the potential health threats to which the population is exposed due to the presence of these pathogens, as well as to establish mitigation measures to that risk, thus improving its quality of life, in addition to generating data for the establishment of indicators and the proposal of an environmental standard that considers the bacteriological quality of air in open and working spaces. The purpose of this work was to know the bacteriological quality of the air in the Laguna de Cajititlán, Jalisco and the threats to the health of the population.

Objective

To know the bacteriological quality of the air in the Laguna de Cajititlán, Jalisco.

Methodology to be developed

The Laguna de Cajititlán is located in the central portion of the state of Jalisco, approximately 25 km from the city of Guadalajara under the jurisdiction of the municipality of Tlajomulco de Zúñiga.

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It is located between the coordinates 20 ° 23 '48 "and 20 ° 28' 11" north latitude and the 103 or 14 '290 "and 103 ° 27' 38" west longitude (Figure 1). For the selection of the sampling points, those places where the greatest water contamination is perceived, such as bad odors, presence of noxious fauna, garbage and wastewater discharges, were taken into account.

Figure 1 Location map of the air sampling points in the Laguna de Cajititlán, Jalisco, Mexico. (modified from INEGI, 2012).

For sampling, the mechanical method was used with an M Air T Millipore air analyzer system (Figure 2). Petri dishes with trypticasein soy agar (AST) were placed for the determination of aerobic mesophiles, MacConkey agar for the isolation of Salmonella sp. and Escherichia coli and mannitol salted agar (MAS) for Staphylococcus aureus. Each of the media were independently placed in the head of the air analyzer, 100 liters were selected, and the equipment indications were followed.

Subsequently, the samples were transferred to the laboratory in coolers and incubated at a temperature of 37 ° C for 48 hours. At the end of the incubation the number of colony forming units (CFU) in a Quebec colony counter of each of the exposed plates was quantified and reserved for later isolation and identification of bacteria present (Rosas, 2003).

Figure 2 Air analyzer (Millipore M Air T®)

For the isolation and identification, they were selected by colonial morphology of each of the selective media and transferred to enrichment tubes, incubating them for 24 hours at 35 +/- 2º C. The samples were analyzed and bacteria identification was performed. according to what is described in Official Mexican Standard 113, 114 and 115 (SSA, 1995 and 2011).

Each of the colonies were grouped according to their staining characteristics in: Gram positive or Gram negative. For each group, the conventional tests for Gram-positive cocci were carried out. Fermentation tests for mannitol and hemolysis activity, oxidase, coagulase, catalase were determined. And the group of Gram negative bacilli TSI, LIA, MIO, FAD, citrate, malonate, urea, RM-VP, among others.

The results of the biochemical tests were interpreted by the metabolic changes of each species and compared with the Bergey manual for their identification. Subsequently the bacteriological quality and the frequency of the bacterial diversity at each point were determined.

Results

The results obtained indicate a variation in the concentration of bacteria between 750 and 2150 CFU / m3 in the different points sampled. (Table 1); these bacterial levels of bioaerosols found vary widely by region and site, which indicates a high level of microbial contamination in the air of this area. In a similar work they reported that the area of the Tijuana River, Mexico has a concentration 200 times higher than its reference area (beach) (Hurtado, et al., 2014).

Sampling Site	Coordinates	Aerobic mesophiles UFC/ m^3
Cajititlan	20º 25' 58"N 103º 18' 490"	2135
Fractioning the Reservation	20º 25' 50"N 103º 20' 400"	920
Cuexcomatitlan	20º 25' 48"N 103º 21' 370"	795
San Juan Evangelista	20º 24' 25"N 103º 19' 200"	1605
Los Cedros	20º 40' 96"N 103º 28' 361"	2120

Table 1 Cantidad de mesófilos aerobios en el aire en la Laguna de Cajititlán, Jalisco, México

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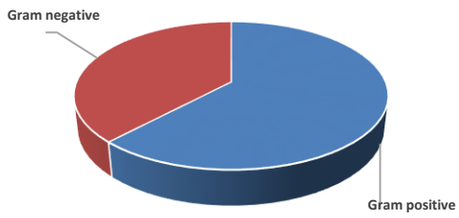
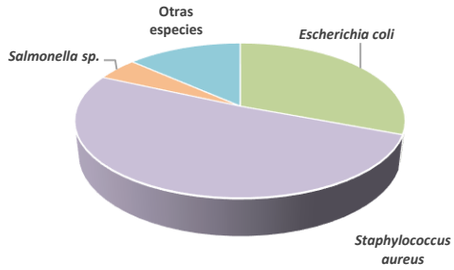
It is important to highlight that these results represent the concentrations of bacteria at the moment in which they are sampled, which is why meteorological factors such as relative humidity, temperature, speed and wind direction determine the concentration, the viability of the same and their transport. (Vélez-Pereira and Camargo-Caicedo, 2008, Li et al., 2017). In this study, a higher percentage of Gram positive bacteria (62%) was determined in the total of the sampled sites (Graph 1). The relative abundance of Gram-positive bacterial cells (cocci) could be explained by their structural composition of the cell wall, which is more resistant to hostile environments such as desiccation and solar radiation. This allows these bacteria to remain viable for longer in the air and to be pathogenic, causing infectious diseases in humans when they are inhaled or ingested in food and water (Hurtado, et al., 2014).



Graphic 1 Total percentage of Gram positive and Gram negative bacteria isolated in the air in the Laguna de Cajititlán, Jalisco, Mexico

The bacterial frequency of the five sampling points was determined, in all the points the following bacterial groups were identified: Escherichia coli with 30.8%, Staphylococcus aureus with 51%, in Salmonella 4.8%, and other bacteria 13.4% (Graphic 2), their concentrations depend on the sites sampled. Several pathogenic bacteria such as E. coli is an opportunistic pathogen and is found in high concentrations in fecal matter and wastewater, so it is an indicator of pathogenicity; Staphylococcus aureus can cause diseases of the skin, upper respiratory tract and oral cavity (Hurtado, et al., 2014).



Graphic 2 Bacteriological diversity isolated in the air in the Laguna de Cajititlán, Jalisco, Mexico

The atmosphere is considered as a means of transporting organic, inorganic and microbiological contaminants that disperse and affect the environment globally (POFA, 2012). This is a problem whose importance is evident in most of the world, which affects human health, plants and animals (Yassi, 2002).

It also registers a higher bacterial frequency in places densely populated by settlements, discharges of wastewater that are close to lakes or highly polluted rivers, such as the Laguna de Cajititlán, a body of water that with the various anthropogenic activities that are carried out in their environment they contribute to the air the presence of pathogenic bacteria that put the health of the population at risk. These findings coincide with those studied in similar works in open spaces (Catalán-Vázquez, 2006).

Conclusions

The presence of Escherichia coli, Staphylococcus aureus and Salmonella, in all the sites studied represents a threat to the health of the population of Cajititlan, Jalisco; the predominance of E. coli indicates contamination of fecal origin.

It is likely that the high incidence of gastrointestinal and respiratory diseases presented by the population located in the study area are caused by the bacteria found. It is important to carry out more studies on the emission sources of bioaerosols, the exposure of the population, and the risks for health.

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