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Comparative Study of Fat and Oil Contaminants in the localities of the Grijalva river basin in the years 2019 and 2020 in Surface Waters of Frontera, Centla, Tabasco

Estudio comparativo de los Contaminantes grasas y aceites de las localidades de la cuenca del rio Grijalva de los años 2019 y 2020 en agua superficial de Frontera, Centla, Tabasco

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Abstract

At a global level, rivers serve as receptors for large amounts of waste generated by human activities such as agriculture, industrial activity and domestic activities, on the other hand, they are an important source of water supply for both agricultural, industrial and domestic. Therefore, in recent years, receptors have been affected by pollutants, in the case of Contamination by fats and oils is a problem caused by activities such as: the existence of outboard motor repair shops, boat landings, discharges of water from houses-rooms, gas stations, public markets, yards, among others. The effects of these pollutants affect the public health of the population living outside the Grijalva basin, with the respiratory and skin conditions when in direct contact with these chemicals, even causing various types of cancer. For all of the above, the development of this research project was motivated, which will allow knowing the levels of contamination of fats and oils in the years 2019 and 2020 in the study area, being Arroyo Polo 1st and 3rd sections of Frontera, Centla, Tabasco, based on the comparison of the maximum permissible limits (LMP) of the NOM-001-SEMARNAT-1996. To evaluate the behavior and projection of the data, the Minitab version 18 software was used, where the analyzed data of the years 2019 and 2020 were taken to be able to indicate if there is a significant increase in later years. A trend towards an increase in contaminating fats and oils was observed. In the first sampling, the average concentrations of fats and oil were 5.23 mg/L. In the second sampling, the concentration of fats and oils was the lowest of 5.02 mg/L and the highest concentration was 6.23 mg/L. of the third and fifth sampling point, it is observed in both cases that there is a tendency towards an increase in contaminants. At the fourth sampling point, It is observed that there is a tendency towards the decrease of this contaminant. In both samples, the concentrations of fats and oils are below what is established by NOM-001-SEMARNAT-1996, since said norm establishes the maximum permissible limit of 25 mg/L per month.

Fats and oils, Physicochemical parameters, Water pollution

Resumen

A nivel global, los ríos sirven como receptores de grandes cantidades de residuos generados por las actividades humanas como la agricultura, la actividad industrial y las actividades domésticas, por otro lado, son una importante fuente de suministro de agua tanto para usos agrícolas, industrial y domésticas. Por lo anterior, en los últimos años, los receptores se han visto afectados por contaminantes, en el caso de la contaminación por grasas y aceites, es un problema originado por las actividades como: la existencia de talleres de reparación de motores fuera de borda, desembarcaderos de lanchas, descargas de aguas provenientes de casas-habitaciones, gasolineras, mercados públicos, cárcamos entre otras. Los efectos de estos contaminantes afectan en la salud pública de la población que se encuentran al margen de la cuenca Grijalva, con las afecciones en las vías respiratorias y de la piel, cuando se efectúa el contacto directo con estos químicos, llegando incluso a ser causantes de diversos tipos de cáncer. Por todo lo anterior, se motivó al desarrollo de este proyecto de investigación que permitirá conocer los niveles de contaminación de grasas y aceites en los años 2019 y 2020 en el área de estudio siendo arroyo polo 1era y 3era sección de Frontera, Centla, Tabasco, basándonos en la comparación de los límites máximos permisibles (LMP) de la NOM-001-SEMARNAT-1996. Para evaluar el comportamiento y proyección de los datos se usó el software Minitab versión 18, en donde se tomaron los datos analizados de los años 2019 y 2020 para poder señalar si existe un incremento significativo en años posteriores. Se observó una tendencia hacia el incremento de los contaminantes grasas y aceites. En el primer muestreo en promedio las concentraciones de grasas y aceite fueron de 5.23 mg/L. En el segundo muestreo la concentración de grasas y aceites fue la más baja de 5.02 mg/L y la concentración más alta fue de 6.23 mg/L. del tercer y quinto punto de muestreo, se observa en ambos casos que existe una tendencia hacia del incremento de los contaminantes. En el cuarto punto de muestreo, se observa que existe una tendencia hacia la disminución de este contaminante. En ambos muestreos las concentraciones de grasas y aceite se encuentran por debajo de lo que establece la NOM-001-SEMARNAT-1996 ya que dicha norma establece el límite máximo permisible es de 25 mg/L mensuales.

Grasas y aceites, Parámetros fisicoquímicos, contaminación del agua

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Introduction

Rivers are a clear example of surface water, defined as the natural current of water flowing through a riverbed, from an elevated place to a lower one, the great majority of which drain into the sea (Zarate, Luján and Laque, 2022) or into a lake, although some disappear because their waters seep into the ground or evaporate into the atmosphere. Throughout the world, rivers serve as receptors for large quantities of waste generated by agriculture, industrial activities, and domestic uses. They are an important source of water supply for both agricultural and domestic uses; in recent years, they have been affected by pollution.

The amount of water flowing through a river varies in time and space. These variations define the hydrological regime of the river. Temporal variations occur during or after storms as well as runoff that produces an increase in flow. In extreme cases, flooding can occur when the water input is greater than the river's capacity to evacuate it, overflowing and covering the nearby flat areas or floodplain. Derived from the phenomena that can occur other events such as: spills and filtration of diverse materials such as residual oils and greases derived from sources such as mechanic workshops and houses that are dumped anywhere without taking into account the precautions for their handling, represent two of the main pollutants that deteriorate the environment. According to experts, if the aforementioned waste and any other type of waste is not properly treated, it could cause serious problems to our environment. In particular, fats and oils contain a series of hydrocarbons that are not biologically biodegradable and destroy plant humus and soil fertility.

Oil in particular also contains toxic substances such as lead, cadmium and chlorine compounds, which pollute water, sediments and soils. Its action is also reinforced by the action of some additives that are added to it and that favor its penetration into the soil, thus contaminating groundwater. If poured into the water either directly or through the sewage system, used oil has a great capacity for environmental deterioration since it produces an impermeable film that prevents adequate oxygenation and can suffocate the living beings that inhabit it; a single liter of used oil contaminates a million liters of water.

One of the main problems faced by the population is environmental pollution, the result of poor waste disposal that has affected the quality of life of aquatic organisms.

A river is a system comprising both main flow and tributaries, which carry a significant load of dissolved and particulate matter in the unidirectional channel from both natural and anthropogenic sources (Shrestha and Kazama, 2007). The quality of these water bodies at any point reflects several important influences, such as watershed lithology, atmospheric inputs, climatic conditions, and anthropogenic inputs (Bricker and Jones, 1995).

The present study was carried out in the municipality of Frontera, Centla, Tabasco, where the main economic activities are engine maintenance in automotive mechanic workshops, motorcycle workshops, outboard motor workshops, car washing and greasing, establishments that process food using vegetable oils, as well as in homes. The aforementioned activities do not have adequate management in the generation of waste fats and oils and are discharged directly into the pipes or the tributary of the Grijalva River, causing the contamination of surface water by fats and oils. For all these reasons, this work was developed with the purpose of generating an environmental diagnosis, based on fats and oils contaminants, under the normative criteria of NOM-001-SEMARNAT-1996 for public urban use of rivers.

Problem Statement

A recent study has determined that water pollution is increasing by leaps and bounds, which is why more than a billion people do not have access to the minimum amount of clean water that every human being requires to meet their basic needs; likewise, more than 2 billion people lack basic services related to sewage effluents, therefore, every day more water bodies such as rivers, aquifers and seas are polluted. Rivers around the world serve as receptors for large quantities of waste generated by agriculture, industrial activities and domestic uses (Goudie, 2000). In Mexico, more than 70% of water bodies present some degree of contamination, which causes serious problems of availability and access to this vital liquid (CONAGUA, 2011).

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The high levels of contaminants, fats and oils, are a problem associated with the health of people exposed to the respiratory tract and skin, when in direct contact with these chemicals. Considering the study area in the Grijalva river basin, this research project was developed to allow a study prior to the diagnosis of the contamination levels of fats and oils for two years 2019 and 2020. It is worth mentioning that the area where the project was developed is where the main fishing and agricultural activities exist. By doing this type of study, we can solve the following problems:

- Prevent infectious diseases, whether cutaneous or internal.
- Prevent contamination by raising awareness among the inhabitants of the area.
- To make important decisions for the well-being of the inhabitants.
- Identify through the results issued by the coastal laboratory of Ciudad del Carmen, Campeche, the amount of contamination of fats and oils in the Grijalva river.

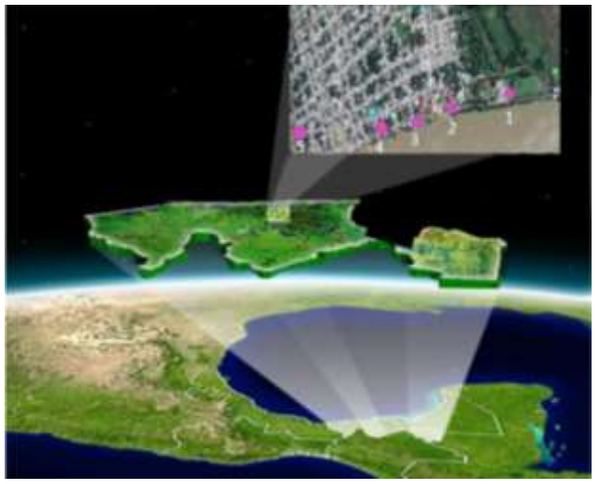
Objectives

- Identify the levels or concentrations of fats and oils that exist in the five sampling points and evaluate if there is an increase between each sampling year 2019 and 2020.
- To evaluate the behavior of the levels of fats and oils contaminants in subsequent years.

Methodology

a) Description of the sampling site

The municipality of Centla is located in the Mexican Republic in the state of Tabasco. The municipal seat is the city and port of Frontera. It covers an area of 3,093 square kilometers, which corresponds to 10.8% of the state's total; this places the municipality in fourth place in territorial extension. It is bordered to the north by the Gulf of Mexico, to the south by the municipalities of Macuspana and Centro, to the east by the state of Campeche and the municipality of Jonuta, and to the west by the municipalities of Centro, Nacajuca, Jalpa de Méndez and Paraíso.



Symbology
Sampling points:

1. House-home (arrollo polo 2da.seccion).
2. Fifth Naval Zone Battalion (arrollo polo 1st Section, Benito Juárez García Street).
3. Farmer's Market (Madero Street between Abasolo and Reforma).
4. Morelos Market (Francisco Madero, Colonia Centro).
5. Gasolinera Cosugo (Esteban Samberino #413, Colonia Centro).

Figure 1 Micro-location of sampling points

b) Criteria for determining sampling sites

The following criteria were used to determine the sampling points, thus defining the five sampling points for the two years of work.

1. Existence of outboard motor repair shops.
2. Boat landing sites
3. Discharges of water from residential homes
4. Gas stations (supply of fuel to boats).

c) Design and implementation of the sampling plan

Once the sampling points were defined, water samples were taken as established in NMX-AA-005-SCFI-2013, "From the surface of the water body, collect a volume of approximately 1 L of sample in a wide-mouth glass bottle with a plastic lid or Teflon back cover". The samples were simply taken and labeled as established in the aforementioned standard.

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First sample	Second samle
October 1, 2019	October 1, 2020

Table 1 Sampling Dates

d) Water sample processing

The following is a diagram of the processing of the samples in the laboratory.

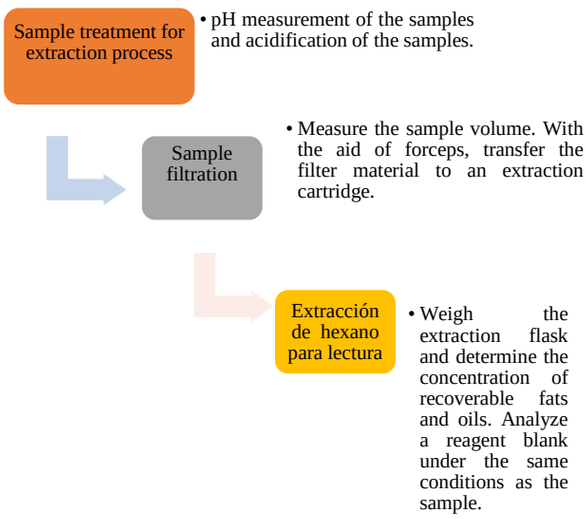


Figure 3 Sample procedure under the criteria of the NMX-AA-005-SCFI-2013

e) Data analysis and interpretation

To evaluate the behavior and projection of the data, the minitab software version 18 was used, the existence of data analyzed during the years 2019 and 2020 were taken to be able to indicate if there is a significant increase in subsequent years.

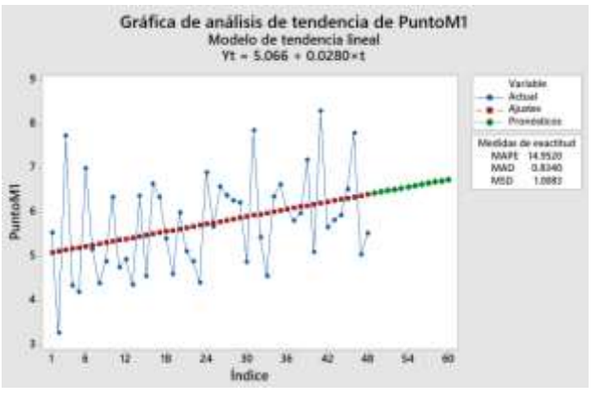
Results

The following are the results of the sampling carried out in October 2019 and October 2020 (Table 1), where the behavior of the concentrations of fats and oils can be observed, analyzed under the NMX-AA-005-SCFI-2013 standard, and compared with the maximum permissible limits (MPL) of NOM-001-SEMARNAT-1996.

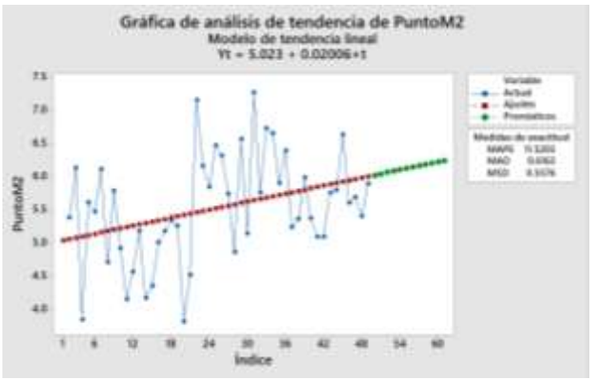
Site	Sample 2020	Sample 2019	Difference	LMP NOM-001-SEMARNAT-1996
1	≤6.23	≤5.25	0.98	25
2	≤6.12	≤5.37	0.75	25
3	≤5.51	≤5.16	0.35	25
4	≤5.02	≤5.21	-0.19	25
5	≤5.94	≤5.19	0.75	25

Table 2 Measurements of fats and oils concentrations of the sampling periods October 2020 vs. October 2019 of the samples supported by the methodology

In Table 2, it is observed that in the first sampling the monthly average of fats and oils is 5.24 mg/L of 2019, in the second sampling the monthly average of fats and oils is 5.76 mg/L of 2020. In both samplings, the concentrations of fats and oils are below what is established by NOM-001- SEMARNAT-1996, since this standard establishes a maximum permissible limit of 25 mg/L per month.



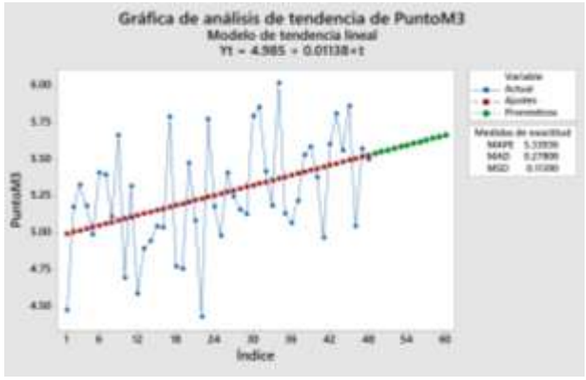
Graph 1 Trend of the first sampling point and behavior simulation



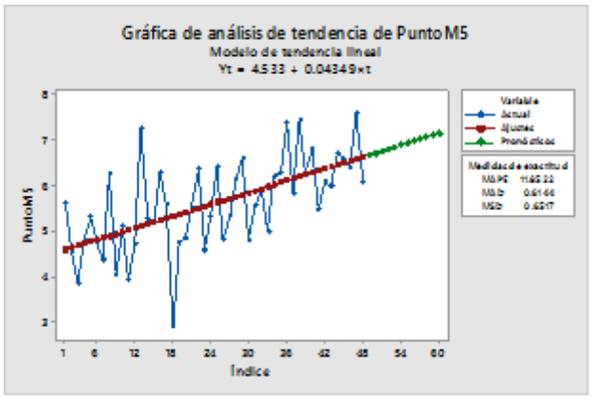
Graph 2 Trend of the second sampling point and behavior simulation

In the following graphs 1 and 2, a projection was made with data from the years 2019 and 2020 obtaining a projection for the years 2018 and 2021, of the first and second sampling points, it is observed that there is a trend towards the increase of fats and oil pollutants, it is worth mentioning that the first sampling point is located at a boat dock in Colonia Arroyo Polo 2nd section, The location of the second sampling point is located at the dock of the fifth naval zone facilities where loading and unloading activities are identified, as well as maintenance of the Secretary of the Navy vessels, and could indicate a significant increase in pollutants for the data obtained.

In both samplings 2019 and 2020, in sampling points 1 and 2, an increase of the pollutant grease and oil is observed according to the trends in graphs 1 and 2, considering that these values are due to the sampling season since they were sampled in October (rainy season) and as mentioned by Caho-Rogriguez and López-Barrera (2917), who register in their work the lowest concentrations of fats and oils in the rainy season, due to the higher rainfall, showing that an increase in the water level allows diluting their concentration more easily and facilitates the microbial activity for their degradation.



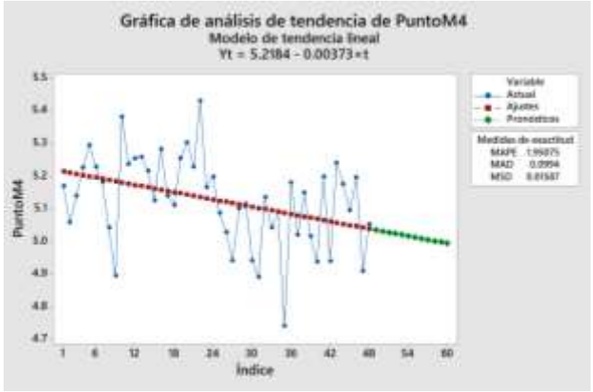
Graph 3 Trend graph of the third sampling point and behavioral simulation



Graph 4 Trend graph of the fifth sampling point and performance simulation

In graphs 3 and 4, a projection was made with data from the years 2019 and 2020, obtaining data in the projection of 2018 and 2021, from the third and fifth sampling points, where it is observed in both cases there is a trend of increase in pollutants, it is important to mention that this third sampling point is located in the facilities of a market called farmer in the municipal capital of Frontera, Centla, Tabasco, The fifth sampling point is located at the dock of the Cosugo gas station, where the main activity is the loading of fuel to the boats and the risk is that the outboard motors may have oil leaks into the body of water, this factor can be an influence in the generation of increased concentrations of fats and oils in the area.

As mentioned in the previous paragraph, the concentrations of fats and oils are largely due to the generating sources of domestic wastewater discharges, mechanical workshops and activities such as cleaning boat engines, the presence of fats and oils allow measuring the degree of contamination of the surface waters under study, since it is an indicator of the solubility of other substances that may be in the environment Caho-Rodríguez and López-Barrera (2017).



Graph 5 Trend graph of the fourth sampling point and behavior simulation

In graph 5, a projection was made with data from the years 2019 and 2020 obtaining data in the projection of 2018 and 2021, of the fourth sampling point, it is observed that there is a trend towards the decrease of pollutants, it is worth mentioning that point four is located in the main market Morelos (Mercado Grande) of the municipality of Frontera, the activity of the sampling area has a great activity in the preparation of food using edible oil in the fondas, It is also important to mention that this market has an oil waste collection program for the aforementioned businesses, as well as other waste, considering that this collection activity has an influence on the reduction of contaminants.

Conclusion

It is important to mention that the five sampling points selected did not exceed the MPLs corresponding to the NOM-001-SEMARNAT-1996 standard, since the reference value is 25 mg/L. With the support of the Minitab program, a simulation was performed for the years 2018 and 2021, using data from the years 2019 and 2020, where it is observed that four sampling points tend to increase the concentration levels of fats and oils influencing future industrial and domestic activities that are not considered in the study period 2019 and 2020, for the fourth point it is observed that there is a downward trend, This is due to the fact that there is currently a collection program for used oils by an external company that provides the final treatment to avoid contamination in the receiving water bodies, which allows us to observe in general that there is an adequate environmental education among the market's tenants to avoid pouring used oil into the water body.

Previous studies in Tabasco's rivers, in which trends in the parameter fats and oils were made, date from 1978-1984 (Rodríguez, Ramos, Romero and Hernández, 1997) in which they applied the Aquatic Quality Index (ICA), where they mention that the parameter fats and oils is one of the main environmental variables that affect the detriment of water quality in Tabasco. On the other hand, Ramos-Herrera, Broca-Martínez, Laines-Canepa & Carrera-Velueta, (2012), conducted trend studies of physicochemical parameters in the rivers of Tabasco, using data from 1978 to 2011, finding that in general the parameter fats and oils has a tendency to decrease.

Recommendations

– In order to obtain other results, it is recommended to carry out sampling in other study periods in different zones that include other communities in the Grijalva river basin, in order to determine if the MPLs for fats and oils are exceeded.

– Identify other sampling points to be able to have with greater precision, diverse activities carried out by the population in general, as well as businesses that generate fats and oils, in such a way that the results obtained would be known if there could be environmental impacts in the future.

– Establish by various means an adequate risk communication to the population in case of high limits in the parameters of fats and oils in the study basin.

– That there is a laboratory of some agency or educational institution that has all the equipment, reagents and tools, as well as the human resources are trained in the mentioned instances and can perform the sampling and analysis in a timely and efficient manner.

– The environmental protection coordination of the Centla town hall should have an updated list of outboard motor maintenance establishments, as well as any business that generates grease and oil as part of its activities, in order to locate sources of contamination in receiving water bodies.

Continue with the edible oil collection program in the Morelos Public Market in the municipality of Centla by an external company to keep the results of the presence of fats, oils, and grease at a low level.

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