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Journal of Environmental Sciences and Natural Resources

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Presentation of content

In the first article we present, *Urban growth and the impact on the agricultural sector in the community of Nextipac, municipality of Zapopan, Jalisco*, by LANDÍN-ALCÁNTAR, Herlinda, VÁZQUEZ-MIRAMONTES, Nicolás, MARÍN-OROZCO, Emmanuel Rodrigo and SANDOVAL-ORTEGA, María Dolores, with adscription in the Universidad de Guadalajara, as next article we present, *Environmental quality study of the San Rafael Park in Guadalajara, Jalisco, Mexico*, by VILLASEÑOR-ACEVES, Jessica Teresa, OROZCO-MEDINA, Martha Georgina, FIGUEROA-MONTAÑO, Arturo and DAVYDOVA-BELITSKAYA, Valentina, with adscription in the Universidad de Guadalajara, as next article we present, *Biotechnological potential of microalgae from lake Chapala, Mexico*, by LARA-GONZÁLEZ, Martha Alicia, JUÁREZ-CARRILLO, Eduardo, LÓPEZ-URIARTE, Ernesto and ROBLES-JARERO, Elva Guadalupe, with adscription in the Universidad de Guadalajara, as last article we present, *Three way maize (Zea mays L.) hybrids, alternative for producing and using improvement seed*, by SIERRA-MACIAS, Mauro, RÍOS-ISIDRO, Clara, FERNÁNDEZ-CARMONA, Elizabeth and GÓMEZ-MONTIEL, Noel Orlando, with adscription in the Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, INIFAP.

Content

Article **Journal of Environmental Sciences and Natural Resources**
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Urban growth and the impact on the agricultural sector in the community of Nextipac, municipality of Zapopan, Jalisco

El crecimiento urbano y la afectación al sector agropecuario de la Comunidad de Nextipac, Municipio de Zapopan, Jalisco

LANDÍN-ALCÁNTAR, Herlinda†, VÁZQUEZ-MIRAMONTES, Nicolás, MARÍN-OROZCO, Emmanuel Rodrigo and SANDOVAL-ORTEGA, María Dolores

Universidad de Guadalajara, Mexico.

ID 1st Author: *Herlinda, Landín-Alcántar* / **ORC ID:** 0000-0003-4453-6408, **CVU CONACYT ID:** 995045

ID 1st Co-author: *Nicolás, Vázquez-Miramontes* / **ORC ID:** 0000-0001-8782-6398

ID 2nd Co-author: *Emmanuel Rodrigo, Marín-Orozco* / **ORC ID:** 0000-0001-9422-3974, **CVU CONACYT ID:** 272465

ID 3er Co-author: *María Dolores, Sandoval-Ortega* / **ORC ID:** 0000-0002-7620-8030

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Abstract

The Nextipac ejido, located in the municipality of Zapopan, Jalisco, has been a supplier of agricultural food, mainly corn. However, the urban growth of Guadalajara is beginning to affect the agricultural production systems of the ejido and employment in the primary sector, changing the activities to other non-agricultural activities such as land use changes, housing, recreation and industrial activities, reducing employment in the sector.

Changes in land use, employment, agricultural resources, growth of urban areas

Resumen

El ejido de Nextipac, ubicado en el Municipio de Zapopan Jal., ha sido un proveedor de alimentos agropecuarios, principalmente maíz. En este ejido han cambiado las actividades de desarrollo para el mejor aprovechamiento de los recursos naturales con los que cuenta, además por la cercanía a la zona Metropolitana de Guadalajara, sin embargo, el crecimiento urbano de Guadalajara, empieza afectar los sistemas de producción agropecuarios del ejido, el empleo en el sector primario cambiando las actividades por otras no agropecuarias como el cambio del uso del suelo, la vivienda, esparcimiento y de tipo industrial disminuyendo el empleo en el sector.

Cambios en el uso del suelo, empleo, recursos agropecuarios, crecimiento de zonas urbanas

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† Researcher contributing first author.

Introduction

Figure 1

The ejido of Nextipac has agricultural resources and in some cases has been optimized for various types of exploitation of its resources, as is the case of certain livestock species, including pigs, sheep and sheep. However, approximately 10 years ago, changes in land use began, reducing the area dedicated to agricultural activities due to a lack of supervision in companies that were established in different areas such as sports schools, compost production and other types of companies that have not established market marketing strategies for different products as mentioned in case studies on marketing, where marketing strategies and a company philosophy are developed for the success of the company. Lambín (1995), its proximity to the Guadalajara metropolitan area and its infrastructure. A semi-structured survey was conducted to identify the potential of the farmland and livestock activity; changes in land use were identified as well as the application of technologies in the production systems. The ejidatarios described the main causes of land sales for other uses, such as the development of an industrial park, housing, and warehouses, which led to a decrease in the value of their agricultural lands, especially those that have communication routes close to highways and/or avenues with high vehicular flow. The objective of this study is to analyze the ejido's production systems and changes in land use.

Founding and ejido data

Ejido de Nextipac was founded in 1927, with a total of 153 ejidatarios. In 1994 the federal government established the program "Certification of Ejido Rights and Titling of Urban Land "Procede", this gives the Ejidal Assembly the power to delimit and decide the fate of the lands that were endowed" (Rivera 2011).

On October 7, 2001, technical work was carried out in the ejido with the following structure:

- 1,046 has of parceled area.
- 720 hectares of common area.
- 80 hectares of human settlement.
- 64 hectares of infrastructure.
- 2 hectares of rivers and streams.
- 72 has as essential areas.

Figure 2 Water Resources of Ejido Nextipac

A total of 1,984 hectares were legally measured and certified. The ejido was left with a total of 500 legally measured and certified parcels. Hernández (2021).

Today, several ejidatarios rent their land at a cost of $10,000/ha. for corn planting.

It is worth mentioning that some of the community's producers have agricultural machinery that is rented to the ejido's own producers to carry out everything from land preparation to some of the crop's cultural work, for those who do not have machinery.

In order to better describe the community Nextipac shows some characteristics of the population, such as the average population is between 15 and 64 years old and it is worth mentioning that most of the ejidatarios surveyed belong to the elderly, there are about 994 houses, its infrastructure has drainage and services such as water, electricity and telephone lines, INEGI (2020), and based on field observations and surveys of agricultural activity and the distribution of land in the community through the children of how agricultural activity has been developing, given the pressure and population growth of the metropolitan area of Guadalajara. The most relevant points were observed:

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- Of the total 1,984 hectares, producers report that 25% are for corn production, but there are other agricultural activities such as greenhouses, extensive and intensive livestock and backyard livestock on subdivided land, since the ejido has the authority to grant land for these activities, mainly sheep, goats and cattle, without having a specific number of these farms.

Figure 3 Dairy cattle farm, Ejido de Nextipac

- Construction of an industrial park and housing was observed.

Figure 4

- Rental land for sports areas and compost, as well as rental land for corn planting.

Figure 5

Given its topographic conditions and some resources such as trees and water, a recreational area was created that charges a recovery fee for the maintenance and preservation of its natural resources.

The ejido also has an established Bayer company that provides jobs for people from the community. This plant produces up to 620,000 bags of corn seed per year that are supplied to the accident and northern regions of Mexico, in addition to being exported to Central America and the Andean region. Bayer México (2021).

Figure 6

Survey results

The area planted by the 21 producers surveyed stated that the planting area ranged from 200 mt2 to 30 hectares. The responses were very irregular in terms of surface area, and during field observation, several producers reported a subdivision of the ejidatarios' agricultural plots, assuming that the area had already been distributed among the children of the producers' ejidatarios based on the certification of ejido rights and "Procede" Urban Land Titling; this gives the Ejidal Assembly the power to delimit and decide the destination of the lands that were endowed to them. The main agricultural and livestock activities are agriculture and cattle raising, with an average corn yield of 10 tons/ha; corn and stubble are used for milk production, fattening, and small backyard farms. There was little industrial activity by ejidatarios in the community. The average age of those surveyed was 45 years old. The primary income of the ejidatarios comes from agricultural and livestock production, although it is worth mentioning that other income is obtained from the support of family members who work in the urban zone. The average income from farming is three times the minimum wage. Ninety-eight percent of the land is rainfed. Respondents were asked if they received any type of support for agricultural activities, where 80% said no and 20% said yes, mainly in kind.

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Another question asked to the respondents was if they would be willing to sell their land and 95% said No because it is their patrimony as well as their source of employment.

Methodology

For this research, a sample was determined where data collection was carried out in three parts: first, a meeting was convened to conduct an exploratory survey, Ulloa (2009); There, the problem statement was defined, the objective of the research was explained, allowing a first approach with the producers, 9 surveys were obtained, later visits with producers individually allowed to obtain 12 remaining surveys for a total of 21 surveys, which were all taken into account due to the heterogeneity of the responses of the products and children of producers, also a field observation tour was conducted, the formula, knowing the number of producers that exist (153 ejidatarios), is as follows: the number of producers that exist (153 ejidatarios). The formula, knowing the number of producers (153 ejidatarios), is as follows:

$$N = \frac{Z^2\ P\ q\ N}{(E^2)(N) + Z^2\ p\ q} \quad (1)$$

Where:

Z = Value of tables 90%

P = Positive probability

q = Negative probability

N = Total data

E = Error

n = Total sample

$$N = \frac{(1-645)^2\ (.60)\ (.40)\ (153)}{(.15)^2(153) + (1.645)^2\ (60)\ (40)}$$

$$N = \frac{99.36}{7.53}$$

$$N = 13.21$$

Total, samples obtained 21

The projects and programs of the Government of Zapopan for the agricultural sector (2021), which are implemented by the federal and state governments with the region's producers:

Rural Infrastructure	Support for rural productivity
Objective: Rehabilitation of harvesting roads, fords, catchment pans and ditching.	Objective: Subsidy in economic support, to acquire inputs and activities that contribute to the economy of families in the rural sector, to mitigate production costs and thus ensure increased profits to producers who meet the guidelines according to current operating rules.

Table 1

Livestock Testing TB y BR	Physical incentive
Objective: Control and eradicate Tuberculosis and Brucellosis in cattle, goats and sheep in the municipality, through continuous testing in conjunction with COETB.	Objective: To incentivize agricultural producers, to motivate and encourage them to continue productivity in the primary sector. to encourage them to continue productivity in the primary sector.
Backyard Garden	**Piscuculture**
Objective: Integrated backyard management to take advantage of the space to grow vegetables as a source of vitamins and minerals, and raise poultry for meat and egg production as a source of protein, both for self-consumption and to market the surplus.	Objective: Support producers in this industry to obtain the supply of fish at a lower cost.

Table 2

Urban Gardens	Forestry
Objective: To train in the urban garden trade, those who do not have any pension or other economic benefit, which will serve as subsistence, occupational therapy and reintegrate into productive life, focused on all people with disabilities, over 65 years of age, women heads of household and those interested in Zapopan and those interested in Zapopan.	Objective: Management for soil and water conservation programs (environmental services) before CONAFOR, manage the acquisition of trees, as well as the management and implementation of concurrent funds (CONAFOR, private initiative and Government of Zapopan).

Table 3

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Technical Advisory Services (Agriculture, Livestock and Forestry)	Virtual Window (Agrifood Credential)
Objective: Program to provide direct support and assistance to producers to improve planting and harvesting processes, as well as to combat different crop diseases.	Objective: Identify the agri-food producers of the municipality of Zapopan, and provides a credential that will help streamline and simplify the procedures to be carried out before the SEDER, as it has a storage chip that will serve for registration and recognition as a producer, avoiding the need to present their documentation with which they have their file. recognition as a producer, avoiding the need to present the documentation in your file.

Table 4

According to the projects and programs for the year 2021 for the agricultural sector, agricultural and livestock support is projected according to the plan of operations of the Municipality of Zapopan, for agricultural, livestock and forestry activities; however, there is a high level of speculation in the purchase and sale of land for housing and industrial parks, as well as the proximity to the urban area; it is possible that this support will not be provided for this current cycle.

Conclusion

There is potential for agricultural activities in the Ejido of Nextipac as long as there is the economic support and technology to generate several projects with an intensive use of the land that generates projects and jobs for the community, otherwise without the appropriate support any project would end in failure.

If a specific agricultural project is to be developed, important technological and financial advice is needed.

It is worth mentioning that population growth has generated other types of problems and demands for services and jobs.

A more orderly growth is required, a planning model that allows for a more harmonious development of what exists and what is to be done, and to regulate land use.

The ejido's General Assembly is authorized to sell land that can change land use for the benefit of the community according to its regulations.

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Environmental quality study of the San Rafael Park in Guadalajara, Jalisco, Mexico

Estudio de calidad ambiental del parque San Rafael en Guadalajara, Jalisco, México

VILLASEÑOR-ACEVES, Jessica Teresa†, OROZCO-MEDINA, Martha Georgina*, FIGUEROA-MONTAÑO, Arturo and DAVYDOVA-BELITSKAYA, Valentina

Universidad de Guadalajara. Centro Universitario de Ciencias Biológicas y Agropecuarias, Mexico.

ID 1st Author: *Jessica Teresa, Villaseñor-Aceves* / **ORC ID:** 0000-0002-1578-6822

ID 1er Co-author: *Martha Georgina, Orozco-Medina* / **ORC ID:** 0000-0002-2619-3408, **Researcher ID Thomson:** T-4562-2018, CVU CONACYT ID: 25755

ID 2nd Co-author: *Arturo, Figueroa-Montaño* / **ORC ID:** 0000-0001-7442-6301, **Researcher ID Thomson:** T-6241-2018, **CVU CONACYT ID:** 76655

ID 3er Co-author: *Valentina, Davydova-Belitskaya* / **ORC ID:** 0000-0001-8224-3150, **Researcher ID Thomson:** X-6164-2019, **CVU CONACYT ID:** 20417

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Abstract

An evaluation of environmental conditions in terms of air and noise pollution was performed in San Rafael Park and completed by a perception survey of how visitors value the park´s environmental state suitable for sport and recreational activities. The park is in the Municipality of Guadalajara, Jalisco, Mexico. CO pollution levels were assessed by data from Tlaquepaque monitoring station from the Atmospheric Monitoring System of Jalisco´s State (AMSJ). CO mean concentration was 1.99 ppm which it is referred as a low health risk (NOM-172-SEMARNAT-2019). Noise levels were evaluated using a CESVA SC 160 noise integrating equipment. At recreational facilities, noise levels were recorded in the range of 49.3-93.2 dB A which were far from specified level of 55 dB A at such facilities (NOM-081-SEMARNAT-1994). Survey results highlighted poor environmental conditions to perform sports and recreational activities (90%) and 77% of responders showed a good intention to continue visiting the park even its environmental state. Reported health effects were: Eye irritation (72%), dry eye (46%), sneezing (33%), allergies (15%) and offending odor (9%). Findings of the study put forward the relationship between the state of the environment and health of a community and the decision users must make to visit parks to get health, social and recreational benefits even the poor environmental conditions within the park´s facilities.

Environmental pollution, Environmental health, Recreational parks, Cities, Guadalajara

Resumen

Se analizaron las condiciones de calidad ambiental y percepción social al interior del Parque San Rafael ubicado en el municipio de Guadalajara, Jalisco. Se estimó la percepción que tienen los usuarios al realizar sus actividades físicas y/o recreativas. El propósito de esta investigación consiste en estimar niveles de monóxido de carbono (CO), y el nivel de ruido al que están expuestos los usuarios y percepción acerca de la calidad ambiental del parque. Para ello se hizo un reconocimiento del área de estudio, se aplicaron un total de 100 encuestas y se integró en una matriz de Leopold, en donde el 90% de los visitantes afirma que la calidad del aire es mala en la zona metropolitana de Guadalajara (ZMG), el 77% muestra interés por acudir al parque a realizar ejercicio o actividades recreativas al haber una mejor calidad de aire, las principales molestias de los visitantes son: irritación de ojos (72%), resequedad (46%), estornudos (33%), alergias (15%), lagrimeo (12%) e inclusive malos olores (9%). Se accedió a la base de datos de la estación de Tlaquepaque del Sistema de monitoreo atmosférico de Jalisco (SIMAJ) mostrando 1.99 ppm como lectura promedio de CO durante el muestreo equivalente a un nivel de riesgo bajo (NOM-172-SEMARNAT-2019). Se seleccionaron y caracterizaron 22 puntos de muestreo para las mediciones de ruido con un sonómetro integrador de precisión CESVA SC 160. La NOM-081-SEMARNAT-1994, establece el límite máximo de 55 dB A en áreas exteriores de recreación. En el monitoreo se registraron niveles de 49.3 hasta los 93.2 dB A. La calidad ambiental es clave en la salud y bienestar de la población.

Contaminación ambiental, Salud ambiental, Parques recreativos, Ciudades, Guadalajara

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* Correspondence of the Author (E-mail: martha.orozco@academicos.udg.mx)
† Researcher contributing first author.

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Introduction

Green areas and open spaces play a set of essential roles in the well-being and quality of life of the inhabitants of urban centers. These places can be conceived, from an environmental point of view, as elements that directly influence the urban environment and, from a social point of view, as generators of direct impacts and benefits in the community (Martínez Soto, J., Montero and López Lena, M., De la Roca Chiapas, J.M., 2016).

According to Spathelf and Nutto, the United Nations World Health Organization recommends a minimum of 12 m2 of green areas per inhabitant in urban areas and a city, in the ideal, should have a coverage of 20% of trees within its territory. (Spathelf, & Nutto, 2004).

The importance of green areas in cities lies in the positive effects they have on the resident population, effects that can be manifested in physical and mental health, in environmental or ecological awareness, in the process of community empowerment, in the feeling of security, among others. Green and recreational areas can be made up of the following components:

Vegetation component: trees (preferably native species), shrubs, garden plants and lawns.

Pedestrian circulation spaces: accesses and paths, among others.

Street furniture: benches, seats, trash cans, tables, lighting components, sculptures or ornamental elements, information panels, bicycle parking and covered seating areas, among others.

Children's play infrastructure: swings, slides, seesaw, hammocks, handrails, rings and sandboxes, among others.

Sports infrastructure: soccer, basketball, five-a-side soccer, and multipurpose sports courts; areas for practicing urban and/or alternative sports such as skate parks, outdoor gyms, among others (Wilson, 2006).

Vegetation in the city, in addition to its ornamental function, has a regulating role: it retains atmospheric water, contributes to evapotranspiration, constitutes a filter against pollution and represents an excellent regulator of air, heat and humidity exchange with the urban environment; it has an important role as a perceptual-landscape element; since ancient times there has been talk of the psychological need of city dwellers to get closer to nature, the therapeutic effects of which are well known: The WHO and many other authors have highlighted the therapeutic effects of nature in reducing stress, fatigue and so many other aspects (Gómez, 2005). (Gómez, 2005).

Guadalajara, the second city in economic importance in Mexico, is distinguished from the rest of the country by the extension of its metropolitan area, as well as by the characteristics of its nearby municipalities, stands out for its cultural, artistic, touristic, food production and state-of-the-art technology leadership; However, in terms of noise pollution control, more elements are required to advance in the diagnosis and control, with this proposal it is possible to document the noise problem, to have a theoretical basis to closely support initiatives that aim to influence the problem and thus provide better welfare conditions to the population (Orozco, 2021).

Perception: It is defined as a learning process that produces knowledge or experience about the environment (Durand, 2008). Health risks are perceived differently by the different groups that make up the social group, depending on their culture, experiences and beliefs; the perception of risks influences people differently according to their condition, gender, experience with health care, and the way they perceive it.

According to their condition, gender, experience in relation to the hazard, and also schooling, socioeconomic level and proximity to the threat (Gran, 2018; Rangel and Hernández, 2018 in Orozco et al 2018; Noriega, 2018). To study the environmental quality of recreational spaces in order to characterize the environmental conditions that influence the wellbeing of users to optimize the quality of life, and to expose aspects that highlight the importance of San Rafael Park, which will allow generating environmental and socio-cultural information about the park.

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Air: CO and health effects

The characterization of recreational spaces may include the analysis of CO in air quality, as well as the perception of environmental and health problems of the exposed population. For the purposes of this study, technical, scientific and regulatory criteria will also be considered, as well as recommendations of guidelines for the characterization of environmental conditions. All this with the purpose of generating information about recreational spaces through a particular study of San Rafael Park in Guadalajara.

Atmospheric pollutants, normally measured in the urban atmosphere, come from mobile sources (vehicles) and fixed combustion sources (industries, residential uses-air conditioning, and waste disposal processes). A distinction is made between primary and secondary pollutants. Primary pollutants are those that come directly from the emission source. Secondary pollutants are produced as a consequence of the chemical and physical transformations and reactions that primary pollutants undergo in the atmosphere, distinguishing, above all, photochemical pollution and acidification of the environment (Ballester, 2005). (Ballester, 2005).

CO is a gas formed in nature through the oxidation of methane (CH4), the anthropogenic source of CO is the incomplete burning of fuels (gasoline, gas, coal, wood and fuel oil). In this sense, in order to have less CO emissions, it is necessary to have more complete combustion processes, which requires an adequate amount of oxygen; when this is insufficient, CO is formed. The ZMG contributes a significant amount of emissions of this pollutant to the atmosphere, due to the number of automobile trips and the age of the vehicle fleet in circulation (NOM-021-SSA1-1993).

The main health effects of CO air pollution range from alterations in lung function, cardiac problems, other symptoms and discomfort to an increase in the number of deaths, hospital admissions and emergency room visits, especially for respiratory and cardiovascular causes. The main potential harmful effect of this pollutant is its affinity to combine with hemoglobin, resulting in a high formation of carboxyhemoglobin and, as a consequence, a decrease in the amount of oxyhemoglobin and, therefore, in the delivery of oxygen to the tissues (NOM-021-SSA1-1993).

Guadalajara became the municipality that generates the greatest impacts to public health due to health indices of environmental pollution in the last decade, concluded a study conducted by the Colectivo Ecologista de Jalisco (CEJ), which released this information (Meléndez, 2012).

Air quality standards, CO

Air quality standards establish the maximum concentrations of pollutants in the environment that should not be exceeded with a certain frequency, in order to guarantee the protection of the population's health, including that of the most susceptible groups such as children, the elderly and people with chronic respiratory diseases, among others. For the development of this work, emphasis was placed on the guidelines for obtaining and communicating the Air Quality and Health Risk Index (NOM-172-SEMARNAT-2019). In addition to the criteria for evaluating ambient air quality with respect to CO (NOM-021-SSA1-1993).

The concentration of CO, as an atmospheric pollutant, must not exceed the permissible value of 11.00 ppm in an eight-hour moving average once a year, as protection to the health of the susceptible population (NOM-172-SEMARNAT-2019).

Air quality	Level of risk associated	Limits ppm
Good	Under	≤8.75
Acceptable	Moderate	≥8.75 <11.00
Mala	High	≥11.00<13.30
Very Bad	Very High	≥13.30<15.50
Extremely Bad	Extremely High	>15.50

Table 1 Reference table, "Air and health index" for CO. NOM-172-SEMARNAT-2019

Noise pollution and health effects

To talk about noise pollution it is necessary to refer to the concept of noise and all its implications, which are so complex and varied depending on the context in which it is produced and the conditions of the receivers (Orozco, 2021). The noise level in cities is an indicator of critical conditions of traffic, concentration of activities and roads, its potential as an indicator in a diagnosis of environmental quality is highly significant. Noise as a pollutant is one of the main environmental stressors affecting the quality of life and health of the exposed population (Orozco, 2008).

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Sound is considered a pollutant when it has negative effects on health or decreases the quality of life. Noise is understood as a sound that is undesirable for the person who hears it and, in general, has one or more of the following characteristics:

- It is long-lasting
- Loud intensity
- Strong intensity
- High frequency
- Caotic

Urban noise (also called environmental noise, residential noise or domestic noise) is defined as the noise emitted by all sources except industrial areas. The main sources of urban noise are automobile, rail and air traffic, construction and public works, and the neighborhood. The main sources of indoor noise are ventilation systems, office machines, household appliances and neighbors (Berglund, 1999).

Noise emission causes various damages on the environment, such as:

- Adversely affect wildlife
- Produce nuisances of greater or lesser intensity to third parties.
- To diminish the quality of the natural environment
- Degrade the quality of life.

The effects of noise exposure on human health are physiological and psychological. The first and most obvious physiological effect of continuous exposure to noise is hearing loss, which in most cases is irreversible.

The sound waves coming from the outside pass through the outer ear and collide with the eardrum, which begins to vibrate, transmitting these vibrations to the chain of ossicles (hammer, anvil and stirrup), which also move and vibrate. The vibration passes to the inner ear, where the snail is located, which has a liquid inside it.

The fluid moves and bathes a set of hair cells that constitute the organ of Corti, which is the real organ of hearing. These cells have a sensitive nerve structure and each group of cells responds to a different tone. They are linked to nerves that go to the upper surface of the brain where sounds are perceived. Excessive noise can cause damage to the hair cells, either due to disappearance of the cilia or degeneration of the transmitter cells.

Some of the main effects caused by noise, unlike deafness, may disappear some time after cessation of exposure:

- Blood pressure
- Change in heart rate
- Change in respiratory rate
- Change in blood pressure
- Change in skin resistance
- Change in visual acuity

Psychological effects of noise:

- Communication problems, with the consequent social problems.
- Alterations in sleep, modification of your sleeping habits
- Decreased work performance and efficiency at work
- Annoyance, or feeling of displeasure. (Lombardero J.L, 2008).

Noise regulations

Urban, environmental, residential or domestic noise is emitted by all sources except industrial ones. Since 1980 the World Health Organization (WHO) has addressed the problem of urban noise and has advanced in different initiatives and one of the most successful was the elaboration of Guidelines for urban noise, which was developed by a group of experts in 1999 in London, United Kingdom.

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The guidelines provided by the WHO have been used in different countries of the world to establish the normative parameters through which the different tours should be adjusted to avoid exposures that endanger the health of people and as far as possible aspire to reduce noise pollution. (Orozco, 2021).

For Mexico there are Official Mexican Standards (NOM's), in relation to this study was based on the following noise pollution standard issued by SEMARNAT, mentioned below:

NOM-081-SEMARNAT-1994.
Establishes the maximum permissible noise emission limits for fixed sources and their measurement method.

ZONE	SCHEDULE	MAXIMUM LIMIT PERMISSIBLE dB A
Residential (outdoor)	6:00 a 22:00 22:00 a 6:00	55 50
Industrial and commercial	6:00 a 22:00 22:00 a 6:00	68 65
Schools (outdoor playgrounds)	During the game	55
Ceremonies, festivals and entertainment events.	4 hours	100

Table 2 Permissible noise limits (dB A). NOM-081-SEMARNAT-1994

Description of the Study Area

San Rafael Park is a recreational space of green areas and sports facilities located in the east of the ZMG, at the following coordinates 103° 17' 54.99" W, 20° 39' 11.37" N. The study area was delimited by the following perimeter streets of San Rafael Park: Manuel M. Ponce, Mariano Azuela, J.R Benítez, San Jacinto Av., and Federico Medrano (Figure 1).

Figure 1 Location of the study area, San Rafael Park. Google earth

Methodology

The specific methods were applied to estimate each of the parameters of interest with a CESVA SC 160 precision integrating sound level meter for noise recording (dB A), for CO (ppm) data from the SIMAJ report (2015) were used. (SEMADET, 2015).

Noise measurement. For the estimation of sound pressure levels, the methodology described by Orozco M., in Curiel, 2008 will be used. Twenty-two sampling points were selected within the San Rafael Park (Figure 2), taking into account as critical points, areas where users carry out their activities within the park, but at the same time that are close to establishments, public, health, religious institutions and avenues perimeter to the Park. A CESVA SC160 precision integrating sound level meter was used at a height of 1.30-1.40 m and at 60 cm separation from the body, in an area clear of trees, with a duration at each point of 5 min (Orozco, et al., 2014).

Figure 2 Location of sampling points inside San Rafael Park. Google Earth

CO ppm parameters. CO information was obtained from SIMAJ (SEMADET, 2015), corresponding to 2015 from the station closest to San Rafael Park. Tlaquepaque station located on the intersection of Boulevard General Marcelino García Barragán and Avenida Niños Héroes, inside the dry stack.

Perception. 100 surveys were applied to visitors and neighbors adjacent to the park, to identify the main causes and annoyances generated by noise, its importance and how it affects the health of the population.

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Using multiple-choice and open-ended questions, the survey was conducted at each sampling site to obtain the perception at different points, from the opinion of neighbors and passers-by (Hernández C., 2018).

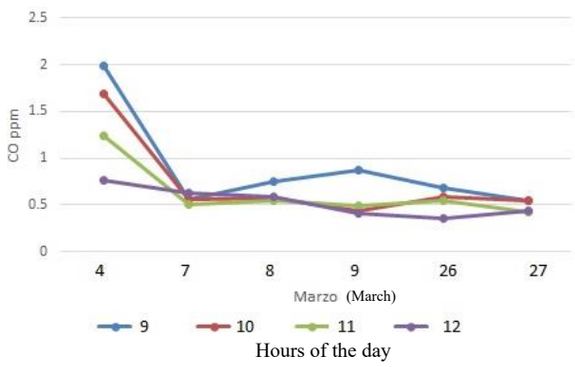
This type of technique is used to collect data based on oral questioning of respondents individually or in groups (Rangel and Hernandez, 2018).

Results

To evaluate the environmental quality, in the points to be studied, the busiest streets were chosen, Av. San Jacinto, C. Federico Medrano, C. Manuel María Ponce, Mariano Azuela, José R. Benítez. Some were adjusted to allow data collection in attention to a greater number of people exposed or to an evidently more limited or critical environmental situation (Hernández C., 2018).

Carbon monoxide

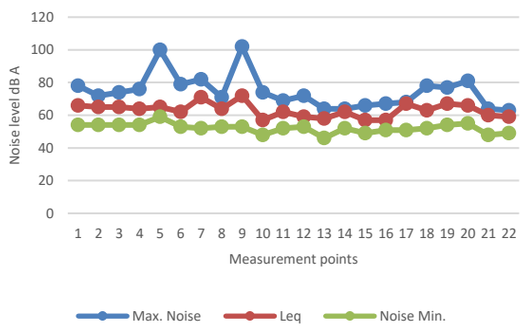
SEMADET records were evaluated. In a schedule from 9:00 am to 12:00 pm yielding values within the permissible limits, being the highest value 1.99 ppm corresponding to a good air quality (Table 1, Graph 1).



Graphic 1 Distribution of CO ppm by hours and days analyzed

Noise

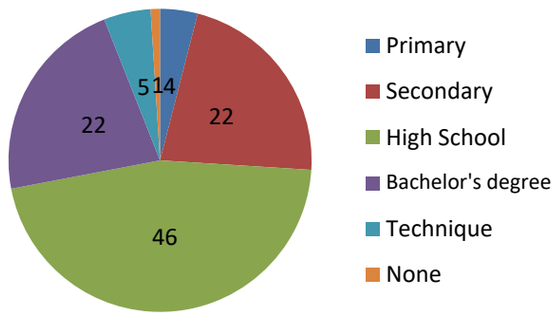
In order to evaluate the noise impact on the park's visitors and neighboring residents, measurement points were strategically selected. The results recorded values above the standard value of 55 dB A according to NOM-081-SEMARNAT-1994 (Table 2, Graph 2).



Graphic 2 Noise levels dB(A) inside San Rafael Park.

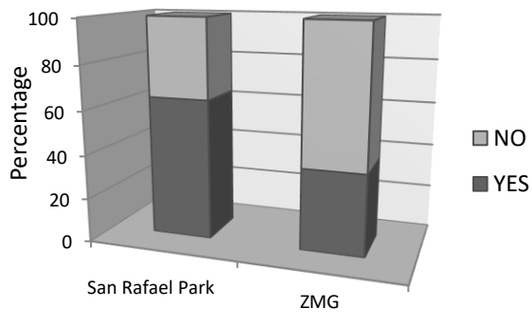
Perception

A total of 100 surveys were administered to visitors and residents around the park, 52% were women and 48% men, 4% had primary education, 22% secondary education, 46% high school, 22% bachelor's degree, 5% technical, and 1% no education (Graph 3).



Graphic 3 Proportion of respondents' level of education in San Rafael park

In terms of air quality, 64% of the visitors reported good air quality as a result of the positive impact of the green areas inside the park, while only 37% mentioned that the air quality in the rest of the ZMG is bad due to the excessive growth of the city and the lack of adequate management of natural resources (Graphic 4).



Graphic 4 Proportion of opinions regarding air quality

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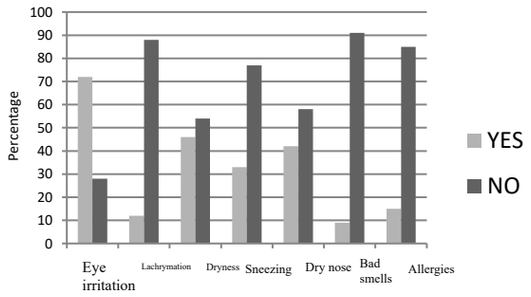
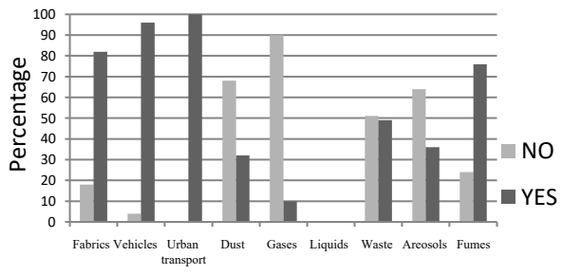
In terms of reported discomfort, 72% had irritated eyes, 46% had dry eyes, 33% had sneezing, 15% had allergies, 12% had watering eyes, and 9% had bad odors coming from outside the park (Graphic 5).



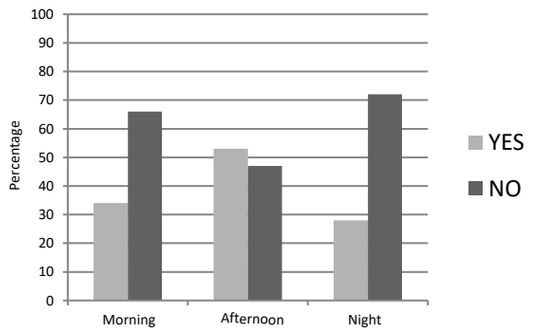
Graphic 5 Proportion of symptoms reported by visitors to San Rafael Park.

They also identified public transportation (100%) and vehicles (96%), industry (82%), smoke emissions from various sources (76%), waste management and handling (49%), aerosols (36%), dust (32%) and gases (10%) as the main causes of poor air quality (Graphic 6).



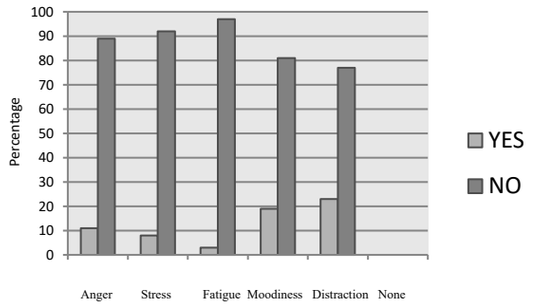
Graphic 6 Agents responsible for poor air quality

Regarding the times that noise affects visitors the most, 40% mentioned that it is annoying at any time, 32% were more annoying at night, 30% during the morning and 22% in the afternoon (Graphic 7).

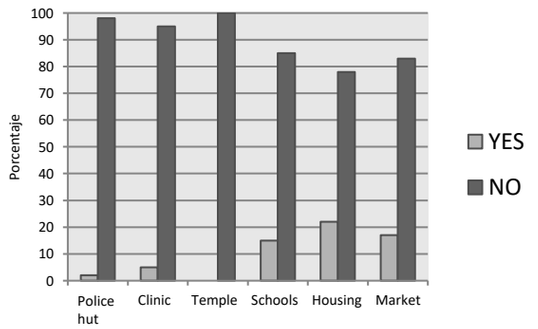


Graphic 7 Proportion in which time of the day noise bothers the most

Regarding the impact of noise on emotions, 23% consider it a distraction, 19% feel bad, 11% feel angry, 8% feel stressful and 3% feel tired (Graphic 8). Noise generated by the settlements around the park 22% comes from homes, 17% from the market, 15% from schools, 5% from the clinic and 2% from the police station, and in general no one is bothered by the noise generated by the church (Graphic 9).



Graphic 8 Emotions most affected by noise to visitors of San Rafael Park.



Graphic 9 Main sources of noise around San Rafael Park

Some park visitors and neighbors report bad odors from sewage and lack of waste collection (35%), while 8% perceive bad odors inside the park (Graph 10), with a higher prevalence during the afternoon.

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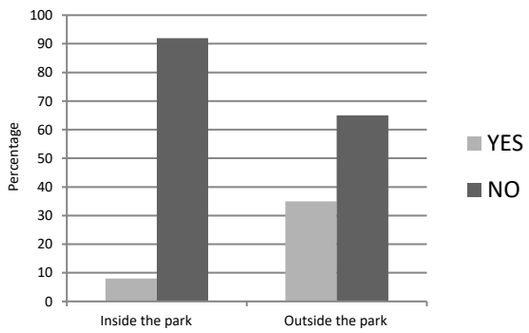

Graphic 10 Proportion of people who perceive bad odors in San Rafael Park

Discussion

Carbon monoxide CO

The AMG, contributes a significant amount of emissions of this pollutant to the atmosphere, derived from the number of automobile trips and the age of the vehicle fleet in circulation (Ruiz, M., 2015).

Poor air quality is currently classified as a cause of cancer by the WHO. That is why it is imperative to implement actions to reduce and reverse these effects, in order to ensure the health of the population (Ruiz, M., 2015).

Recreational Park

It is important the existence of recreational spaces in society, especially in the ZMG that has had an accelerated growth, today there are few spaces that are destined for this use, they are places where people take part of their time to perform some activity going to them, because it generates better feeling to be surrounded by nature, since thanks to these places it influences the physical activity of the population, talking about green areas, open spaces a natural environment motivates people.

Having these green and wooded areas has a contribution for environmental health, decreases air pollution, these wooded areas favor the capture of particles found in the air, in this case carbon monoxide, and of course among other pollutants that affect human health.

It is worth noting that the San Rafael park, despite being located around avenues with heavy vehicular traffic, of course helps us to reduce dangerous particles emitted by the combustion of cars, so it really achieves the objective of the San Rafael park both to improve the quality of life of users who attend by obtaining better air quality and for the environmental impact.

Noise

Noise is an important factor for people who come to the park for recreational activities, since this other factor can influence the health of visitors, deteriorating the quality of life, which is why it is important to choose the place where the recreational activity or coexistence is intended to take place. If the interest is to exercise, it is useless to go to a place where the conditions are not favorable, and this can be reflected in both physiological and psychological aspects, which generate health problems, or discomfort such as headaches, mood swings, among others.

Based on the results obtained during the monitoring inside San Rafael Park, it was found that from point 1 to point 5, corresponding to the perimeter facing San Jacinto Avenue and adjacent to the IMSS UMF 78 clinic, police station and stores, the minimum level was 54.13 dB A and the maximum recorded was 100.2 dB A, with a considerable range of variation that tends to exceed permissible limits (Graph 2).

From point 6 to point 9 corresponding to the boundary of the park with Federico Medrano Avenue, which borders the San Rafael del Parque Parish and businesses, the minimum level recorded was 51.7 dB A and the maximum recorded was 102.15 dB A, the latter is the boundary of the baseball field that borders the "Osos Chatos" Market, a construction materials store (Graph 2).

At points 10, 11 and 12, they are adjacent to one end of the baseball field, SIAPA Coexistence Center, the Baseball All-Star Field, the Guadalajara BMX Track, the latter is located behind the Mixed Secondary School #58 "Victor Cadena Aguayo". In this transect the readings ranged from 48.53 dB A and the maximum of 73.98 dB A, generating an environment with acoustic conditions not so severe in terms of hearing impairment, and it is worth mentioning that the Guadalajara BMX Track was not in use, it is only used in certain seasons (Graph 2).

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From point 13 to 15 from the Guadalajara BMX Track and covering José R. Benítez Street and the intersection of Mariano Azuela, which is a residential area, the levels remained at a satisfactory threshold, registering a minimum of 46.33 dB A and reaching a maximum of 65.98 dB A (Graph 2).

Points 16 to 22 are located in the center of the park in strategic areas between the different courts, the multipurpose gymnasium, the dome for outdoor classes, and the jogging track, and the levels are recorded as a minimum within the permissible limits of 47.81 dB A and with a maximum over the permissible limits of 80.85 dB A outside the Pan American gymnasium, the jogging track, and an area with weightlifting equipment (Graph 2).

In terms of critical points for visitors during recreational activities, the areas with the most noise generated by vehicular traffic are the jogging track adjacent to San Jacinto Avenue and Federico Medrano Street. Inside the park, the noise level tends to decrease a little, and the noise captured is merely from the people themselves or music coming from the terrace where aerobics classes are held.

Carbon monoxide CO

CO, is one of the major pollutants in the atmosphere and that the main sources of emission are motor vehicles with the highest percentage of affectation since every time the vehicle fleet in the ZMG grows irrationally just in 2015 there was a total of 3,268,321 motor vehicles in circulation in Jalisco, which use fuel such as gasoline or diesel and not least the industrial processes that use carbon compounds also causing great affectation to the environment. (IIEG,2020)

Carbon monoxide is a colorless and odorless gas formed by the incomplete combustion of organic material in the presence of oxygen deficiency. It is considered one of the major pollutants in the Earth's atmosphere and one of the major environmental problems in Latin America (Téllez J., Rodríguez Alba, Fajardo A., 2006).

According to SEMADET results, during the sampling days and the time span of 9:00-12:00 hrs, the highest value was 1.99 ppm, corresponding to good air quality (NOM-081-SEMARNAT-1994).

Conclusions

Green Areas (Recreational). The municipality of Guadalajara has an evident deficit of green areas. According to the Population and Housing Census in 2015, the ZMG had a population of 1,460,148 inhabitants (INEGI, 2015), following WHO recommendations, of at least 1.6 m2 of green areas per inhabitant to guarantee their well-being (CONANP, 2018).

Therefore, the municipality should have about 23,362,368 m². It is of utmost importance to generate more green spaces, wooded areas, recreational spaces with favorable conditions both to generate a better environmental quality in the ZMG, giving a positive impact to the population, motivation, awareness, environmental health, a better quality of life. And not to continue reducing these spaces to make way for buildings, industries that lead to poor management of natural resources.

Noise. Noise is a very important factor, simply before a physical, recreational or social activity, people go with an objective idealizing that it is a space to be in contact with nature, to obtain better health benefits and apparently within the social perception shows us that the population when exposed to noise levels of up to 102. 15 dB A only presents emotion with 19% bad mood and 23% distraction, could it be that the population is generating a resistance to live in a chaotic city, because it seems normal to them the noise around San Rafael Park, because it should be mentioned that the park is delimited by facilities such as the IMSS clinic UMF 78, Parish San Rafael del Parque, Mercado de los Osos Chatos, Mixed Secondary School 58 "Victor Cadena Aguayo", Primary School Manuel Alatorre, Elementary School Manuel Alatorre, Elementary School Manuel Alatorre, School of the "Victor Cadena Aguayo", Another benefit of these spaces is that we do not perceive noise pollution as such, since the vegetation plays the role of absorbing acoustic energy, dispersing noise and we perceive more the sounds of nature and fresh air.

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Carbon monoxide. Atmospheric monitoring data from the Tlaquepaque station, near San Rafael Park, with a coverage radius of approximately two kilometers, was used. It is clear that topographic and urban characteristics and factors such as wind direction and speed affect the transport and dispersion of pollutants, which causes particular behaviors at points where the station has no influence, which is why the pollutant dispersion models are useful. Regarding the readings taken during the sampling days, it was determined that the air quality for CO was good with a maximum value of 1.99 ppm.

Surveys. Regarding the social perception of air quality, 37% believe that the air quality in the ZMG is good, in contrast to the 64% who identify air quality in the same category inside the park. This demonstrates the environmental services that the population obtains from these ecosystems, such as scenic beauty, tranquility, air purification, microclimate, and shade, among others.

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Biotechnological potential of microalgae from lake Chapala, Mexico

Potencial biotecnológico de microalgas del lago de Chapala, México

LARA-GONZÁLEZ, Martha Alicia†, JUÁREZ-CARRILLO, Eduardo, LÓPEZ-URIARTE, Ernesto and ROBLES-JARERO, Elva Guadalupe*

Laboratory of Marine Ecosystems and Aquaculture, Dept. of Ecology. Centro Universitario de Ciencias Biológicas y Agropecuarias. Biological and Agricultural Sciences. Universidad de Guadalajara, Mexico.

ID 1st Author: *Martha Alicia, Lara-González* / **ORC ID**: 0000-0002-5548-6517, **CVU CONACYT ID:** 330054

ID 1st Co-author: *Eduardo, Juárez-Carrillo* / **ORC ID**: 0000-0002-8158-3943, **CVU CONACYT ID:** 55208

ID 2nd Co-author: *Ernesto, López-Uriarte* / **ORC ID**: 0000-0003-0478-6744, **CVU CONACYT ID:** 62011

ID 3rd Co-author: *Elva Guadalupe, Robles-Jarero* / **ORC ID**: 000-0003-2537-671X, **CVU CONACYT ID:** 59946

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Abstract

During the months of January, May and September 2012, samples of microalgae and cyanobacteria were obtained at 10 stations located in Lake Chapala, to isolate and maintain axenic monoalgal cultures and achieve sufficient biomass to perform an approximate chemical analysis of total lipids and proteins. Various nutrient media were used for the cultures, based on inexpensive formulations and others of reagent grade. To obtain the algal biomass, a Millipore equipment and GF/C filters with a 45 µm pore and 25 mm diameter were used. Lipids were extracted using the Folch technique (1957) and proteins using the Bradford method (1976). Of 10 isolated species, five were cyanobacteria and five chlorophytes; lipid production was higher in this last group, with *Monoraphidium tortile* having the highest percentage of this metabolite (22.9%), while Cyanobacteria *Phormidium* sp. outperformed all cultivated species with 17% protein. Likewise, the modified culture medium of RM6 was efficient in the production of biomass for cyanobacteria and the CHU10 medium for chlorophytes; Both media were prepared with commercial salts to reduce production costs.

Algal biomass, Proteins, Lipids

Resumen

Durante los meses de enero, mayo y septiembre de 2012, se obtuvieron muestras de microalgas y cianobacterias en 10 estaciones ubicadas en el de Lago de Chapala, para aislar y mantener cultivos monoalgales axénicos y lograr suficiente biomasa para efectuar un análisis químico aproximado de lípidos totales y proteínas. Se emplearon diversos medios nutritivos para los cultivos, basados en formulaciones económicas y otras de grado reactivo. Para obtener la biomasa algal se empleó un equipo Millipore y filtros GF/C de 45 µm de poro y 25 mm de diámetro. Los lípidos se extrajeron mediante la técnica de Folch (1957) y las proteínas utilizando el método de Bradford (1976). De 10 especies aisladas, cinco fueron cianobacterias y cinco clorofitas; la producción de lípidos fue mayor en este último grupo teniendo a *Monoraphidium tortile* con el mayor porcentaje de este metabolito (22.9%), mientras que la Cyanobacteria *Phormidium* sp., superó a todas las especies cultivadas con 17% de proteínas. Así mismo, el medio de cultivo modificado de RM6, fue eficiente en la producción de biomasa para cianobacterias y el medio CHU10 para clorofitas; ambos medios fueron preparados con sales comerciales, para abatir costos de producción.

Biomasa algal, Proteínas, Lípidos

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* Correspondence of the Author (E-mail: elva.robles@academicos.udg.mx)
† Researcher contributing first author.

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Introduction

Mass cultures of microalgae and cyanobacteria in the world are a promising source of renewable energy, being highly efficient and fast-growing microorganisms, they produce biomass with proteins rich in essential amino acids and lipids of high value in polyunsaturated fatty acids, besides also containing pigments, carbohydrates, minerals and vitamins (Acién Fernández *et al*. 2018; Galarza, 2019).

Microalgae and cyanobacteria possess an incredible biochemical system, which is why they have been used for several decades, as a commercial basis for value-added products. Currently, other applications are being explored as promising solutions for environmental bioremediation, food, pharmaceutical industry, and biofuel production, among many others (Montero *et al*. 2012; Camacho Aguilar and Flórez-Castillo, 2020; Rojo Gómez, 2022). These organisms are the primary link in the food chain and, by photosynthesizing, provide 50% of the oxygen on the earth. An important characteristic of microalgae is that they are capable of growing in any environment rich in nitrogen and phosphorus, these, plus CO_2, being the main source of nutrients for their growth (Rojo Gómez, 2022).

The world production of algal biomass exceeds four thousand tons per year and tends to increase, on the one hand, because they do not compete with arable land and can be obtained with different sources of nutrients such as wastewater and agricultural fertilizers (Bitog *et al*. 2009), in addition to the various applications they have in the biotechnological area (Jiménez Escobedo and Castillo Calderón, 2021). Microalgae are also used in improving the environmental and economic sustainability of certain processes due to their ability to mitigate CO_2 emissions (Chisti, 2007; Galarza, 2019; Méndez Ancca *et al*., 2022). In short, microalgae and cyanobacteria could satisfy, in a more natural way, many of the human needs of today's globalized society.

Among the various studies carried out in our country to take advantage of phytoplankton from inland waters and study their biotechnological potential is that of Garduño-Solórzano *et al*. (2011) in Lake Catemaco, Veracruz, and in Laguna de Términos, Campeche.

Likewise, fertilizer-based crops have been experimented to reduce production costs, taking advantage of the nutrient absorption capacity of microalgae (Nieves-Soto, 1994; Valenzuela-Espinoza *et al*., 2005; Piña *et al*., 2007; Ortega-Salas and Reyes-Bustamante, 2012). The purpose of the present study was to isolate and culture phytoplanktonic species from Lake Chapala, determine the total lipid and protein content to define their potential exploitation.

Materials and method

Study area

Lake Chapala is the largest lake in Mexico and is considered a polymictic tropical lake, with a certain degree of eutrophication (Lind, *et al*., 1992). It is located in western Mexico at 1524 masl, between 20° 7' - 20° 21' LN and 102° 40' 45"-103° 25' 30" LW (Estrada *et al*., 1983). Its depth varies according to the interannual rainfall cycle, with the greatest depth in September and October (Guzmán and Orbe, 2002). The climate of the region is warm-sub-humid with summer rains, corresponding to the Awo(e) subtype, according to the Köppen classification modified by García (1989). Total annual precipitation is 875.2 mm. The average annual temperature is 19.9° C, the maximum between 27° and 30° C (May to June) and the minimum from December to February between 9° and 12° C. Total annual evaporation is 1912 mm (INEGI, 2010).

Field work

During the months of January, May and September 2012, microalgae and cyanobacteria samples were obtained from ten sites in Lake Chapala (Figure 1). Surface and two-meter depth trawls were conducted in a boat with an outboard motor, for one minute, using a conical net of 30 µm mesh size.

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Figure 1 Location of sampling stations in Lake Chapala, Mexico

Samples were stored in one-liter containers. 250 ml were fixed with lugol for taxonomic determination and the rest was kept in a cooler until analysis at the Laboratory of Marine Ecosystems and Aquaculture (LEMA) of the University of Guadalajara.

Isolation and monoalgal culture

To obtain a monoalgal and axenic culture as far as possible, the method of successive dilutions (Figure 2) and agar-agar plates was used (Richmond, 1986; Andersen, 2005).

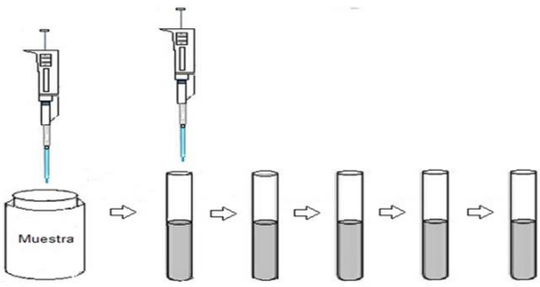

Figure 2 Isolation technique by serial dilutions

Different alternative media (modified RM6, CHU10 and Zarrouk), and formulated with reagent grade salts (F/2 and Bristol) were used. Ambient temperature was maintained between 25 and 28 °C. Illumination of the cultures was constant for 24 h of the day at an intensity of approximately 45 µmol m-2.s-1. Samples were collected from bulk cultures of 18 l capacity carboy, harvested at their exponential phase. They were filtered from 2 to 10 l, using Whatman GF/C filters of 0.45 µm pore size and 25 mm diameter on a Millipore system. The biomass was extracted from the filter, placed in 1.5 ml Eppendorf tubes and frozen at -20 °C for subsequent proximate chemical analysis.

Proximate chemical analysis (AQA)

Protein Determination

Proteins were obtained using the method of Bradford (1976). Fifty mg of biomass was weighed in 2 ml Eppendorf tubes; adding 500µl of 0.1N NaOH as buffer. It was then homogenized in an Ultraturrax (ultrahomogenizer) for 3 minutes at 10,000 rpm. The standard protocol suggested by BIO-RAD brand was used to determine protein concentrations in the range of 20-150 µg protein, 2 stock samples were made, to make 5 replicates of each with 5 µL of sample in microplates and 250 µL of Coomassie Brilliant Blue G-250 dye was added to each, the samples were read in a THERMO Multiskan Ascent Elisometer for reading with a 595 nanometer filter, the elisometer program shows results by correlating the amount of known protein and its absorbance value, it is calculated by the absorbance value of the samples to know the amount of protein present in this.

Lipid Determination

Lipids were extracted using the Folch (1957) technique. We weighed 150 µg of algal biomass, in 13 x 100 tubes with bakelite stopper in an analytical balance (Sartorius capacity of 250g and precision of 0.0001g), adding 5 ml of Chloroform-Methanol (C:M) 2:1 solution with BHT (Butyl hydroxytoluene) at 0. 01 % (C:M BHT), then they were homogenized with an Ultraturrax at 20,000 rpm for 4 min, rinsing the blade of the ultrahomogenizer with 5 ml of C:M, to this homogenate was added 2 ml of KCl at 0. 88 % and was centrifuged at 2000 rpm in a centrifuge (Hermle Z233 Mk-2 brand) for 6 min. 2 phases were obtained, the upper one is removed and the lower one is extracted with a long-stemmed pipette, filtered with blotting paper soaked with chloroform and potassium chloride (KCl) powder (to sequester excess water in the extract) to 13 x 100 mm glass tubes previously labeled and weighed. They were allowed to stand for 24 h in the freezer at a temperature of -4 °C. The extract was immersed in a water bath (34 °C) and evaporated to dryness with nitrogen. The tubes with lipids were transferred to a desiccator with silica gel for 1.5 h to eliminate moisture and were subsequently weighed and quantified with respect to the sample obtained. Three replicates were made per species.

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Moisture

Moisture was determined according to the method proposed by AOAC (1980). The wet weight was obtained by gravimetry using an analytical balance (Sartorius). The weights of the empty glass slides were recorded, then 1 g of the wet sample was placed on the slide and the weights were noted, finally the samples were kept at 100°C for 24 h, after which time they were removed from the oven and placed for one hour in a silica gel desiccator, the moisture content was calculated as the weight lost from the sample during drying with the following formula:

Where:

Pi = Initial weight.

Pf = Final weight.

Ash

The ash content indirectly indicates the amount of minerals present in the sample. The method to obtain the percentage of dry ash was carried out according to the methods proposed by the AOAC (1980), the porcelain crucibles were weighed and recorded separately in an analytical balance that remained 24 h in a silica gel desiccator and later the crucible was weighed together with the sample. Approximately 0.1 g of sample was carbonized in the crucible and subjected to 550° C for a period of 8 h, in a muffle furnace model SX2 -2.5 - 12N, removed from the furnace and cooled in a silica gel desiccator for a couple of hours, then weighed on the analytical balance to record, the weight and the percentage of ash obtained using the following formula:

Where:
%CbH= Percent Ash on Dry Basis.

Mc = Weight of ash sample.

Mh = Weight of wet sample.

Data Analysis

Results

Ten species with biotechnological potential were isolated, five cyanobacteria and five chlorophytes. In general, cyanobacteria recorded a higher biomass production according to absorbance values than chlorophytes. In *Chlorella vulgaris*, the culture media with the highest efficiency in algal biomass production according to absorbance values were CHU10 and Zarrouk, showing no significant differences between them, according to the ANOVA test p >0.05 (Table 1). The culture media with the lowest efficiency in biomass production were F/2 and Bristol.

Days	F/2	Bristol	CHU 10	Zarrouk	RM6 modified	P
1	0.199 ±0.09^{b}	0.189±0.02^{b}	0.486±0.07^{a}	0.156±0.06^{b}	0.156±0.04^{b}	<0.001
3	0.295±0.08^{b}	0.236±0.05^{b}	0.628±0.03^{a}	0.42±0.05^{c}	0.419±0.06^{c}	<0.014
4	0.317±0.03^{b}	0.262±0.03^{b}	0.661±0.04^{a}	0.438±0.08^{c}	0.431±0.02^{c}	<0.001
6	0.347±0.05^{b}	0.317±0.02^{b}	0.705±0.07^{a}	0.539±0.09^{c}	0.486±0.01^{c}	<0.001
9	0.351±0.07^{b}	0.261±0.05^{b}	0.700±03.09^{a}	0.629±0.07^{c}	0.502±0.04^{c}	<0.001
10	0.404±0.05^{b}	0.293±0.09^{b}	0.873±0.08^{a}	0.795±0.05^{a}	0.661±0.03^{b}	<0.001
12	0.457±0.08^{b}	0.296±0.04^{b}	0.806±0.07^{a}	0.864±0.07^{a}	0.669±0.07^{b}	<0.001
15	0.499±0.02^{b}	0.291±0.06^{b}	0.848±0.05^{a}	0.905±0.04^{a}	0.703±0.08^{b}	<0.001
16	0.518±0.06^{b}	0.268±0.03^{b}	0.902±0.09^{a}	0.68±0.06^{a}	0.68±0.09^{b}	<0.001
17	0.583±0.03^{b}	0.258±0.08^{b}	0.995±0.03^{a}	1.071±0.04^{a}	0.774±0.02^{b}	<0.001
	0.3970	0.2671	0.7604	0.6497	0.5481	

Table 1 Absorbance of *Chlorella vulgaris* biomass tested on five culture media, F/2, Bristol, CHU 10, Zarrouk and modified RM6. Subscripts with the same letter are not different

The most appropriate media for biomass production, macronutrient content, salts and low cost were CHU10 and modified RM6, since these were prepared by replacing the technical and reactive grade salts with fertilizers, observing very good results in terms of biomass production, probably due to the availability of nutrients and better adaptation of microalgae and cyanobacteria to the salts of the new medium, where it is observed as in the case of green algae such as *Chlorella vulgaris* (Table 1), the comparison between the growth of the different culture media Zarrouk and CHU10 are very similar for biomass development and have no statistical differences in the final phase of exponential growth.

Table 2 shows the results of proximal analysis of lipids and proteins in the 10 isolated species. In the Chlorophyta Division, the highest amount of lipids can be seen for the species *Monoraphidium tortile* with a percentage of 22.9% followed by *Chlorella vulgaris* (20.5%), *Desmodesmus quadricaudatus* and *S. obliquus* with a similar amount of lipids (17.7%), the lowest amount being *Desmodesmus acutudesmus* with 14.8%.

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Regarding proteins, the species with the highest amount was *Desmodesmus quadricaudatus*, with 14.5%, and those with the lowest amount were *Chlorella vulgaris* with 10.5% and *Monoraphidium tortile* with 2.78%. The highest moisture content was found in *Monoraphidium tortile* and the lowest in *Desmodesmus quadricaudatus*. The ash content was highest for *Chlorella vulgaris* and lowest for *Monoraphidium tortile.*

Group	Parameters			
Cyanobacterias	Lipids	Proteins	Humidity	Ashes
Aphanomenon flos-aquae	7.6 ± 1.11	5.4±0.16	86.6±1.54	3.2±0.2
Pseudanabaena cf *papillaterminata*	10.5±1.0	6.0±0.03	84.9±1.38	3.4±0.28
Planktolyngbya cf *limnetica*	4.4±0.81	8.7±4.3	87.1±3.26	4.6±0.19
Leptolyngbya sp.	10.0 ±1.93	13.4±0.09	77.1±1.94	1.7±0.05
Phormidium sp.	10.4±7.6	16.9±0.39	71.9±0.97	4.02±0.33
Chlorophyta				
Desmodesmus acutudesmus	14.8±3.66	13.8±0.3	72.9±0.09	2.9±0.09
Desmodesmus quadricaudatus	17.7±2.29	14.5±0.04	67.7±0.98	4.4±0.04
Scenedesmus obliquus	17.1±1.70	13.0±0.11	70.2±1.35	2.9±0.65
Chlorella vulgaris	20.5±0.63	10.5±0.69	69.3±0.17	4.5±0.89
Monoraphidium tortile	22.9±0.72	2.7±0.28	75.2±0.11	2.2±0.28

Table 2 Approximate chemical analysis of microalgae and cyanobacteria isolated from Lake Chapala in percent dry weight

According to the percentages of proteins and lipids obtained in the present study, a decrease in the values could be observed with respect to other authors. In the case of *Leptolyngbya sp*. and *Phormidium sp*. species, they registered the highest percentage of proteins (13.4%) with respect to the other cyanobacteria studied, being a low value compared to that reported by Taton *et al*. (2012) of 35.4% in microalgae cultivated in conventional media. Even so, our results are considered acceptable and are associated with the stress caused by lack of photoperiod in the cultures, since they were maintained under continuous light conditions 24 hours a day. The same case is handled for *Phormidium sp*., which obtained a total of 16.9%, compared with other studies that have reported percentages of 29.9 to 40.7% (Jonte *et al*., 2003). Regarding the species *Pseudanabaena cf papillaterminata*, there is little biochemical characterization data regarding its lipid and protein content, so as in the case of lipids we will take its synonym, of the genus *Phormidium*, mentioned above, where the amount of proteins reported is very high compared to that obtained of 6.02% for this study.

Table 3 shows the potential use of some species isolated in this study.

Species	Biotechnological potential	Bibliographic reference
Chlorella vulgaris	Obtaining proteins, lutein, and immunonutrition, obtaining long chain lipids, bioremediation.	Bich *et al.*, 1999; Cleber *et al.*, 2006 ; Morris *et al.*, 2009; Chader *et al.*, 2011
Scenedesmus sp.	Live feed in aquaculture, wastewater bioremediation and lipid production.	Abalde *et al.*, 1995; Chisti, 2007; Badwy *et al.*, 2008
Monoraphidium tortile	Biodiesel production Aquaculture feedstock	Bogen *et al.*, 2013
Aphanomenon flos-aquae	Nitrogen fixer	Mayz-Figueroa, 2004
Pseudonabaena sp.	Potential source of pigments phycocyanin, chlorophyll-a and carotenoids, exopolysaccharides, phycobiliproteins protect against liver damage and oxidative stress caused by Hg2+, Fertilizer, Biohydrogen	Moreno, 2000, Gallardo *et al.*, 2010
Leptolyngbya sp.	Beauty *et al.*, 2003	Belleza *et al.*, 2003
Planktolyngya sp.	Biofuel production	Chinnasamy, 2010
Phormidium sp.	Antibiotics, chlorophyll-a, phycocyanin and protein production	Torres-Ariño, 2004; Jonte, *et al.*, 2013

Table 3 Biotechnological applications of the isolated microalgae and cyanobacteria

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Conclusions

The culture media with the highest biomass production for cultured cyanobacteria and chlorophytes and the lowest formulation cost were modified RM6 and CHU10.

The content of primary metabolites such as total lipids and proteins in cyanobacteria and chlorophytes are within the range reported by other authors.

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The species *Monoraphidium tortile* (Chlorophyta) is suggested for the production of total lipids and for proteins the species *Phormidium sp*. (cyanobacteria).

Desmodesmus quadricaudatus culture is suggested as a balanced microalgae for lipid and protein production.

The environmental conditions of cultivation during the experiments are the minimum necessary to obtain biomass, total lipids and proteins susceptible to be used in the biotechnological area.

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Three way maize (*Zea mays* L.) hybrids, alternative for producing and using improvement seed

Híbridos trilineales de maíz (*Zea mays* L.), alternativa en la producción y uso de semilla mejorada

SIERRA-MACIAS, Mauro†*, RÍOS-ISIDRO, Clara, FERNÁNDEZ-CARMONA, Elizabeth and GÓMEZ-MONTIEL, Noel Orlando

Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, INIFAP, Mexico.

ID 1st Author: *Mauro, Sierra-Macías* / **ORC ID:** 0000-0001-6476-2192, **CVU CONACYT ID:** 5116

ID 1st Co-author: *Clara, Ríos-Isidro* / **ORC ID:** 0000-0003-2148-3745

ID 2nd Co-author: *Elizabeth, Fernandez-Carmona* / **ORC ID:** 0000-0002-5683-4202

ID 3rd Co-author: *Noel Orlando, Gómez-Montiel* / **CVU CONACYT ID:** 5945

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Abstract

With the objective of knowing the yield and agronomic characteristics of maize hybrids for the tropical region in México, during the spring summer season in 2021, there were evaluated 27 three way hybrids, on which, there are participating inbred lines of the maize breeding program of Cotaxtla, Ver., and Iguala, Gro., experimental stations of INIFAP and inbred lines from CIMMYT; Besides, there were included the commercial checks H-562, H-565 and H-520. These genotypes were arranged under complete blocks at random, with 30 treatments and three replications in plots of two rows 5m long, and 62,500 plants ha^{-1}. The agronomic traits were: Grain yield, days to tassel and silking, plant and ear height, plant and ear aspect and sanity, lodging, bad husk cover and ear rot. The best 13 maize hybrids at 0.05 of probability were above 7.0 t ha^{-1}, in grain yield and from 5 to 12% more than the commercial check H-520; Among those: (LT155x T48)xCLWN247, (LT156xCML549)xT49, (CML311x T48)xCLWN247, CML549xT49) xCLWN247, (CML549 xLT154)xT48, LT156xLT154) xCLWN247 and (CLWN247xLT154) xT49. The inbred lines LT156, LT154, CLWN247, CML549 and T49 participated in the best hybrids; It suggest that these lines present good General Combining Ability.

***Heterósis, Trópic, genotypes, Zea mays* L.**

Resumen

Con el objetivo de conocer el rendimiento y características agronómicas de híbridos de maíz para la región tropical de México, durante el ciclo primavera verano 2021 se evaluaron 27 híbridos trilineales en los que participan líneas endogámicas de los programas de maíz de los Campos de Cotaxtla, Ver., e Iguala, Gro., del INIFAP y líneas provenientes del CIMMYT; Así también, los testigos H-562, H-565 y H-520. La distribución de tratamientos fue bajo un diseño bloques completos al azar con 30 tratamientos y tres repeticiones en parcelas de 2 surcos de 5 m de largo, en una densidad de 62,500 pl ha^{-1}. Las variables fueron días a floración, altura de planta y de mazorca, calificación de aspecto y sanidad de planta y de mazorca, % de plantas acamadas, % de mazorcas con mala cobertura; % de mazorcas podridas y rendimiento de grano. Un grupo de 13 híbridos, con rendimientos superiores a las 7.0 t ha^{-1}, con 5 a 12% más en relación con el testigo H-520; Entre ellos: (LT155xT48) xCLWN247, (LT156xCML549) xT49, (CML311xT48)xCLWN247, (CML549xT49)xCLWN247, (CML549xLT154)xT48, LT156xLT154)xCLWN247 y (CLWN247xLT154)xT49. Las líneas LT156, LT154, CLWN247, CML549 y T49 participan en híbridos sobresalientes, lo que sugiere que son líneas con buena aptitud combinatoria general.

Heterósis, Trópico, Genotipos, *Zea mays* L.

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* Correspondence of the Author (E-mail: sierra.mauro@inifap.gob.mx)
† Researcher contributing first author.

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Introduction

During 2020, there were sown in México, 7.47 million of de hectares with maize with an average in yield of 3.83 t ha^{-1}, and a total production of 28. 61 million tons, which of them 12.6 million tons are utilized in different ways through the direct consume for human consumption (SIAP, 2020). Improved seeds are the most important input in corn production, they represent the genetic yield potential and quality production (Sierra *et al.,* 2016).

In the humid tropic in México, at the same year there were sown 2.66 million of de hectares with maize, which of them, one million are included in agronomic provinces of good and very good productivity, and 100 thousand hectares under irrigation conditions, where is recommended the improved seed of synthetic maize varieties and hybrids (SIAP, 2020; Sierra *et al*., 2019). In this great area, particulary are recommended hybrid seed, which express their genetic potential because of the heterotic effect by crossing parental lines genetically different (Ramírez *et al.,* 2019; Velasco *et al.,* 2019; Ledesma *et al.,* 2015; Reyes, 1985).

In the maize breeding program of Cotaxtla experimental station, INIFAP, there have been generated maize hybrids and varieties, which expressed good yield and favourable agronomic characteristics through the tropical region in the southeast of México, but above all, they have been adopted by maize farmers (Sierra *et al.,* 2019).

Three way maize hybrids present the advantage of the heterosis (López *et al.,* 2021; Ramírez *et al.,* 2019; Reyes 1985); In the maize commercial production, besides, they represent agronomic and economic advantages in certificated seed production because they use as a female parent a single cross with high yield and complete vigor and as a male parent an inbred line with very good *per se* behaviour, general combining ability and enough pollen production, such as the hybrids H-520, H-567 and H-568, whose specific nomenclature is (LT154xLT155) LT156, LT164xLT165)LT166 y (T47xT48)T49, for each hybrid, respectively (Tadeo *et al.,* 2021; Tadeo *et al*., 2018; Sánchez *et al.,* 2016; Velez *et al.,* 2018; Sierra *et al.,* 2019; Sierra *et al.,* Sierra *et al.,* 2018; Sierra *et al.,* 2016; Sierra *et al.,* 2014; Sierra *et al.,* 2011; Ramírez *et al.,* 2019; Gómez *et al.,* 2017; Virgen *et al.,* 2016; Espinosa *et al.,* 2012; Cervantes *et al.,* 2016).

Genotypes, fertilizers and bioestimulating treatments are important to increase the grain yield in maize; Particulary, Martínez *et al.,* 2022, found for high valleys in México, that the best hybrids were, H-66, H-50 and H-76; In addition the bioestimulating treatments increased the grain yield from 7.9 to 11.4%. The objective of this research was to know the yield and agronomic characteristics of three way tropical maize hybrids.

Materials and Methods

Localization. The evaluation of the maize hybrids was carried out in Cotaxtla Experimental Station in Veracruz, which belongs to INIFAP, México, and is located at the Km 34 through the public road from Veracruz-Córdoba in the municipality of Medellín de Bravo, Ver., in the 18º 56' North Latitude and 96º 11' West longitude and altitude of 15 masl. The clime condition is Aw1(w), according with the clime classification described by Köppen modified by García (2004) and correspond to subhumid warm conditions with average annual temperature of 25 ºC and annual precipitation of 1400 mm, distributed from june to November with a dry season from December to May. The soil is Vertisol, from alluvial origin, deep, with medium texture troughout the profile, slope less than 1% and good drainage and slightly acid pH (6.6) (INEGI, 2020).

Germplasm used. The germplasm used in the present research, belongs to the Tuxpeño race and there were evaluated 27 experimental maize hybrids, on which, participate inbred lines of the maize breeding program of Cotaxtla, Ver., and Iguala, Gro., experimental stations of the National Institute of Agricultural, Forestry and Livestock Research (INIFAP) in México and inbred lines from The International Maize and Wheat Improvement Center (CIMMYT Int); Besides, there were included the commercial checks H-562, H-565 and H-520.

Description of the experiment. During the spring summer season in 2021, under rainy conditions, there was carried out an experiment, for evaluating experimental maize hybrids, which of them, were distributed in complete blocks at random, with 30 treatments and three replications in plots of two rows 5 m long and 80 cm wide in a density of 62,500 plants ha^{-1} (Reyes, 1990). The fertilization was made according to the recommendations of INIFAP,

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Thus, in this experiment was utilized the formula 161-46-00, applying all the Phosphorus and a third part of Nitrogen at sowing moment, the rest of Nitrogen in bunchy stage using Urea as Nitrogen source; The weeds were controlled by Atrazine applied before emerging and there were controlled pests during developing crop.

Variables and data recording. During the development of the crop and at harvest time, there were recorded in the experiment the following agronomic variables: Grain yield, days to tassel and silking, Plant and ear height, measured since the base of soil even the highest leaf and the node where is inserted the principal ear, respectively; days to tassel considering 50% of the anthers in anthesis stage, days to silking when stigmas are in receptive stage, total number of plants and ears, qualification of plant and ear aspect and sanity, using a scale from 1 to 5, where, 1 correspond to the best phenotypic expression and 5 for the worst; lodging, ears with bad husk cover, dry matter and ear rot.

Statistical methods. The experimental design used was complete blocks at random with 30 treatments and three replications in plots of two rows 5m long and 80 cm wide. Individual analysis of variance was made for each variable recorded and were analyzed statistically and for the separation of means, the significant minimum difference test was applied at 0.05 and 0.01 of probability (Reyes, 1990). There was made an adjust for grain yield by number of plants using the IOWA formula (Reyes, 1990). This formula is described as follow:

Corrected weight = (Weight at harvest time x H-0.3M)/H-M

Where:

Weight at harvest time= Weight without correction.

H= Número of plants that the plot must have without fail.

M= Número of lost plants.

0.3= Coefficient for correcting and compensating the lost plants.

Results and Discussion

From the analysis of variance for grain yield and agronomic characteristics (Table 1), There was found statisticall significance differences for treatments, with a Coefficient of Variation of 15.78%, value relatively low, and suggest that the results gotten and the management of the experiments are reliables (Reyes, 1990). Besides, The highest variance was recorded for the source of variation treatments, factor valued in 2.049*, which means that these hybrids were different and important in the yield and the behavior (Reyes, 1990).

For the agronomic characteristics of the maize hybrids, there was found statisticall significance differences at 0.05 of probability of error, in the variables: Plant and ear height, plant and ear asopect and ear sanity. Besides, The Coefficient of Variation were from 2 to 15%, values relatively low, and suggest that the results gotten and the management of the experiments are reliables (Reyes, 1990).

Source of Variation	Degree Free	Grain Yield	Days to tassel	Days to silk	Plant height	Ear height	Plant aspect 1/	Ear aspect 1/	Plant sanity 1/	Ear sanity 1/
Hybrids	29	2.05*	2.178	2.192	449.79 *	326.8*	0.166*	0.3085*	0.0536	0.305*
Blocks	2	1.18	17.678 *	18.43 *	19.21	142.81	0.21	0.71	0.019	0.1
Error	58	1.06	1.39	1.387	113.94	65.13	0.0588	0.113	0.03609	0.1287
Total	89									
CV (%)	15.78		2.09	2.05	6.08	10.6	11.42	15.26	9.65	15.71

1/ = Qualification scale from 1 to 5 where, 1 correspond to plants and ears with the best phenotypic expression and 5 for the worst; *= Statistical Signifficance for the Sources of Variation at 0.05 of probability of error; B= Spring Summer season; CV= Coefficient of Variation.

Table 1 Mean square and significance for yield and agronomic characteristics of maize hybrids. Cotaxtla Experimental Station. CIRGOC. INIFAP. 2021B

Grain yield

According with the statisticall test SMD at 0.05 of probability of error (Table 2), there were found 13 three way maize hybrids with yield above 7.0 t ha-1, signifficant different and higher from 5 to 12% than the commercial check H-520; Among those, the hybrids: (LT155xT48)x CLWN247, (LT156xCML549)x T49, (CML311 xT48)xCLWN247, CML549xT49)xCLWN247, CML549xLT154)xT48, (LT156xLT154)x CLWN247, (CLWN247xLT154)xT49; (T48x T49)xCLWN247; (T47xLT156)x LT154. These hybrids, expressed the maximum genetic potential, due by the heterotic effect of crossing inbred lines genetically different (Ramírez et al., 2019; Velasco et al., 2019; Velez et al., 2018; Sanchez et al., 2016; Ledesma et al., 2015; Reyes, 1985). Besides the agronomic potential in hybrids fertilizers the agronomic management may be increase the grain yield in maize, (Martínez et al., 2022)

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Particulary, in these hybrids, participate as parental lines those inbred lines of the maize breeding program of Cotaxtla, Ver., and Iguala, Gro., experimental stations of INIFAP and inbred lines from CIMMYT; The inbred lines LT156, LT154, CLWN247, CML549 and T49 participated in the best hybrids; It suggest that these lines present good General Combining Ability. The three way maize hybrids present the advantage of the heterosis in the maize commercial production, (López et al., 2021; Ramírez et al., 2019; Reyes 1985); Besides, they represent agronomic and economic advantages in certificated seed production because they use as a female parent a single cross with high yield and complete vigor and as a male parent an inbred line with very good per se behaviour, general combining ability and enough pollen production (Tadeo et al., 2021; Tadeo et al., 2018; Velez et al., 2018; Sanchez et al., 2016; Ramírez et al., 2019; Sierra et al., 2019; Sierra et al., 2018; Sierra et al., 2016; Sierra et al., 2014; Sierra et al., 2011; Gómez et al., 2017; Virgen et al., 2016; Espinosa et al., 2012; Cervantes et al., 2016).

Agronomic characterístics

In reference to agronomic characteristics, the experimental hybrids (Table2), expressed intermediate biological cycle with 56 to 58 days to tassel, short plant and ear height with average values from 175 and 76 cm for plant and ear height, respectively; Besides, they present good qualifications for plant and ear aspect and sanity. It suggest good adaptability to clime, soil and management by maize farmers, principally in good and very good areas and under irrigated conditions in the southeast of México, Thus, there were observed Coeficient of variation relatively low, which suggest that the management of the experiment and the results gotten area reliables (Reyes, 1990). These results indicate the importance of collaboration and the use of the best germplasm of different maize breeding programs.

Entry	Genealogy	Grain Yield t ha-1	Relative %	Days to tassel	Days to silk	Plant height	Ear height	Plant aspect 1/	Ear aspect 1/	Plant sanity 1/	Ear sanity 1/
19	(LT155xT48)xCLWN247	7.46*	112	56	57	180	87	2.17	2.17	2	2.33
6	(LT156xCML549)xT49	7.42*	111	56	57	180	64	2.5	2.33	2	2.5
20	(CML311xT48)xCLWN247	7.39*	111	56	57	180	84	2.17	2.17	2	2.33
14	(CML549xT49)xCLWN247	7.34*	110	58	59	189	84	2	1.5	1.5	1.83
25	(CML549xLT154)xT48	7.32*	110	57	58	175	67	1.83	2.33	2	2.33
17	(LT156xLT154)xCLWN247	7.30*	109	55	56	178	74	1.83	2.33	2	2.33
1	(CLWN247xLT154)xT49	7.29*	109	56	57	178	73	2	2	2	2.17
18	(T48xT49)xCLWN247	7.22*	108	58	59	179	84	2.17	2.17	1.83	2.5
11	(T47xLT156)xLT154	7.18*	108	57	58	195	84	2	1.83	1.83	2
22	(T47xLT156)xCLWN247	7.18*	108	57	58	182	85	2	2.17	1.83	2
21	(T47xCML549)xCLWN247	7.12*	107	57	58	205	98	1.83	1.83	2	1.83
10	(T48xCLWN247)xLT154	7.03*	105	56	57	183	85	1.83	1.83	1.83	1.83
3	(CML550xCLWN247)xT49	7.01*	105	55	56	165	73	2	2	2	2.17
5	(CML549xLT154)xT49	6.75*	101	57	58	166	65	2.33	2.5	2	2.67
8	(CLWN247xT48)xT49	6.71	101	55	56	178	77	2.33	2.33	2	2.5
30	H-520	6.67	100	54	55	190	81	1.67	1.83	1.83	2
2	(LT156xLT154)xT49	6.64	100	56	57	194	96	2	1.83	1.83	2
29	H-562	6.54	98	56	57	159	71	2.33	2.5	2.17	2.33
28	H-565	6.39	96	57	58	171	76	2	2.5	2	2.33
13	(CLW247xCML549)xLT154	6.29	94	57	58	158	66	2.17	2.17	2	2.17
15	(CML549xLT154)xCLWN247	6.27	94	57	58	182	83	2	1.67	1.67	1.67
26	(CML549xT49)xT48	6.20	93	57	58	164	65	2.17	2.5	2.17	2.83
24	(CML550xCLWN247)xT48	6.13	92	55	56	168	72	2.33	2.33	2	2.33
23	(CML311xCLWN247)xT48	6.00	90	56	57	165	74	2.17	2.17	2	2.5
4	(CML311xCLWN247)xT49	5.94	89	56	57	166	70	2.33	2.5	2	2.33
27	(T47xLT154)xT48	5.69	85	56	57	161	66	2.17	2.83	2	2.83
12	(CML549xT49)xLT154	5.17	77	57	58	158	57	2.17	2.17	1.83	2.33
16	(T47xLT154)xCLWN247	5.13	77	56	57	187	91	2	2.5	2	2
9	(T47xT49)xLT154	5.06	76	57	58	169	66	2.33	2.33	2	2.5
7	(B49xB47)xT49	4.30	64	57	58	160	63	2.83	2.83	2	3
	Average	6.54		56.38	57.37	175.49	76.08	2.12	2.21	1.94	2.28
	MSE	1.065		1.39	1.39	1133.94	65.13	0.059	0.113	0.037	0.129
	CV (%)	15.78		2.09	2.05	6.08	10.61	11.43	15.27	9.85	15.71
	SMD 0.05	0.53									
	SMD 0.01	0.71									

*/ Significance of the treatments at 05 of probability; B= Spring Summer season; 1/ = Qualification scale from 1 to 5, where, 1 correspond to plants and ears with the best phenotypic expression and 5 for the worst; MSE= Mean square of error; CV= Coefficient of Variation; SMD= Significant Minimum Difference

Table 2 Grain yield and agronomic characteristics of three way maize hybrids. Cotaxtla 2021B

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Conclusions

The best 13 three way maize hybrids, registered grain yield 5 to 12% over the commercial check H-520. According with the yield and agronomic characeristics the best hybrids were: (LT155xT48)xCLWN247, (LT156xCML549)xT49, (CML311xT48)xCLWN247, CML549xT49)xCLWN247, CML549xLT154)xT48, LT156xLT154)xCLWN247, (CLWN247xLT154)xT49. In the best hybrids participate as parentals inbred lines, from Campo Cotaxtla, Ver., and Iguala, Gro., INIFAP, and lines from CIMMYT. The inbred lines LT156, LT154, CLWN247, CML549 and T49 participate in several of the best hybrids and suggest that these lines are characterized with Good General Combining Ability

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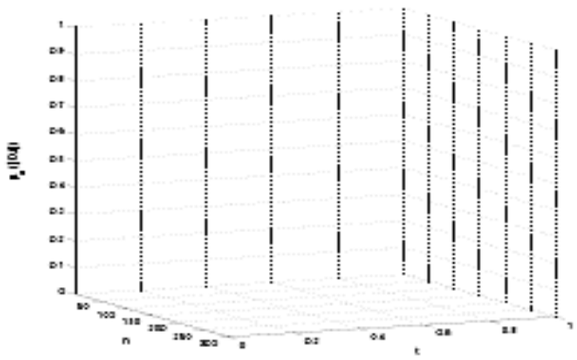

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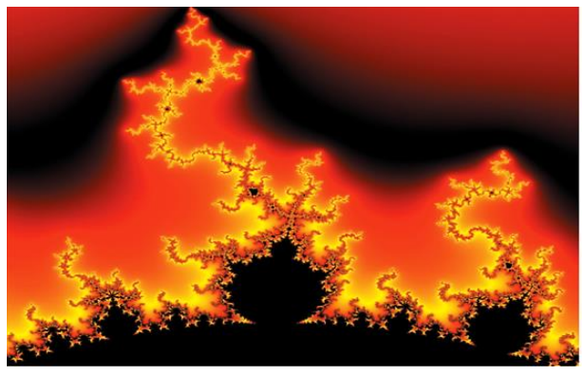

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