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The works must be unpublished and refer to topics of Experimental design, commerce, options, rural-flora and fauna, agronomy, natural and other topics related to Biology and Chemistry.

Presentation of the Content

As a first chapter we present, *Sustainable Management Model in a mining unit in the process of closing in Mexico. Case Study*, by MARTÍNEZ-TORRES, Rosa Elia, RIVERA-ACOSTA, Patricia, HUERTA-GONZALEZ, Juana María and OJEDA-GUTIÉRREZ, Maricela, with adscription in Instituto Tecnológico de San Luis Potosí and Universidad Politécnica de San Luis Potosí, as a second article we present, *LED lighting stimulates root development and height in corn seedlings*, by PÉREZ-JIMÉNEZ Genaro, MARTINEZ-RUIZ, Antonio, QUINTANAR-OLGUIN, Juan, and LÓPEZ MORALES, Fernando, with affiliation in the Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, as the third chapter we present, *Tourism and gastronomic marketing strategies to increase tourist flow at Hotel Tosepan Kali* by RODRIGUEZ-BERNABE, Yessika, BONILLA-PALMA, Daniela Lizeth, MORALES-PAREDES, Yesbek Rocío and CERÓN-CARRILLO, Teresa Gladys, with affiliation at Benemérita Universidad Autónoma de Puebla, as fourth article we present, *Estimation of the phytoplankton biomass in Bahia Manzanillo, Colima (2016-2017),* by ROBLES-JARERO, Elva Guadalupe & PÉREZ-PEÑA, Martín, with ascription in the Universidad de Guadalajara.

Content

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Sustainable Management Model in a mining unit in the process of closing in Mexico. Case Study

Modelo de Gestión Sustentable en una unidad minera en proceso de cierre en México. Caso de Estudio

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Abstract

As part of an Integrated Multiple Case Study (Yin, 2013), a method applied for the implementation of a Sustainable Management Model for the Mining-Metallurgical Industry of Mexico, the individual study of the mining analysis unit is presented, which is in the closing stage and belongs to the Au-Ag-Pb-Cu-Zn Mineralization Trend of the national territory. In addition to collaborating with the validation of the Model in field, this study aims to evaluate whether environmental, practices comply with legislative requirements and align with the international suggestions of the UN (2016) through Sustainable Development Goals selected from the agenda 2030. The contribution of this study lies in the importance that is generated from the closure strategy they have followed and how it impacts on the environment, involving ecological and social aspects primarily; the mining unit in the closing stage has been involved in clashes led by radical groups, arguing excessive devastation of important areas, forcing the corporation to execute plans for total closure.

Open pit mine, Closure plans, Mining environmental liabilities

Resumen

Como parte de un Caso de Estudio Múltiple Integrado (Yin, 2013), método aplicado para la implementación de un Modelo de Gestión Sustentable para la Industria Minero-metalúrgica de México, se presenta el estudio individual de la unidad minera de análisis, que se encuentra en etapa de cierre y pertenece al Trend de mineralización Au-Ag-Pb-Cu-Zn del territorio nacional. Además de colaborar con la validación en campo del Modelo, este estudio tiene por objetivo, evaluar si las prácticas medioambientales cumplen con los requimientos legislativos y se alinean a las sugerencias internacionales de la ONU (2016) a través de Objetivos de Desarrollo Sostenible seleccionados de la Agenda 2030. La contribución de este estudio radica en la trascendencia que se genera a partir de la estrategia de cierre que han seguido y cómo impacta en el ambiente, involucrando aspectos ecológicos y sociales primordialmente; la unidad minera en etapa de cierre se ha visto involucrada en enfrentamientos encabezados por grupos radicales, argumentando devastación desmedida de zonas importantes, obligando al corporativo a ejecutar planes de cierre total.

Modelo de gestión sustentable, Mina a cielo abierto, Planes de cierre, Pasivos ambientales mineros

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Introduction

The implementation of a Sustainable Management Model in the Mining-Metallurgical Industry of Mexico, provides the opportunity to present a transdisciplinary study, since it obeys the observations about the monitoring and evaluation that the Public Administration Agencies carry out to the units of the sector, in which they verify the fulfillment of the regulations and denote official and administrative stability, but contrary to this, the perception of society and non-governmental organizations (NGO´s) in terms of the environment, do not coincide and they set in motion, events that complicate the operability and continuity of various units involving political and economic interests.

There are registered in the industrial sector of mining, as a consequence of the activity of these groups known as radicals or NGO´s, rethinking of strategies, change of corporations, investors, corporate name and, in extreme cases, the closure of units. Such is the case of a mining unit located in the state of San Luis Potosí, dedicated since colonial times, to the extraction of *Dore* and other by-products, with an open pit exploitation system, and which in 2014 presented as official the execution of its Total Closure Plan.

For its part, the validation of the Sustainable Management Model, contemplates in its selection for convenience (Hernández, 2014), various mining-metallurgical units that cover types of mining system, metallurgical process, regions in the national territory and type of ore (metallic, non-metallic), being a unit in the closing stage, a representative unit of analysis.
This Model presents in its conception, elements that promote its inclusion from the Environmental Management, through the strategic planning that is conducted with the purpose of the Sustainable theory in search of opening and adjustment of public policies, as well as the effective execution through Sustainable Development Goals (SDGs) and Legislative Parameters.

The SDGs selected, based on their direct implementation in practices that benefit the environment are: (1) industry, innovation and infrastructure (2) sustainable cities and communities (3) responsible production and consumption and, (4) Life of terrestrial ecosystems.

These objectives were considered in the Sustainable Management Model, in which they become the main axis of the study.

The regulatory analysis takes into account the environmental aspect to mitigate impacts, which is why companies in the mining sector must describe the impact risks in official reports. On this basis, government agencies evaluate their veracity in the document called Environmental Impact Manifest (EIM).

Theoretical bases

Mining Sector

This industrial sector covers land preparation activities, ore extraction through drilling, explosions, clearing, loading and transportation, processing and handling of tailings and gangue (SEMARNAT, 2016).

The value and grade of the ore, size, shape, depth, location of the ore body or deposit, physicochemical properties, environmental conditions of the exploitation area, environmental impact of the operation, geological, hydrogeological, geochemical conditions of the rocks, seismic and particular conditions of the terrain or area (biotic and abiotic aspects), availability or use of land, variable infrastructure (financial, permits, taxes, investment, compensation, operating cost); safe working conditions, mineral value recovery fraction, operation continuity and productivity among many other factors and elements, which are derived and described after in-depth technical studies of a given project, are those that condition or provide the information that must be gathered to decide if the studied unit will have a underground mine or an open pit mine type (SEMARNAT, 2016).

The processes or stages covered by the mining industry, according to the General Coordination of Mining (2014) are: (1) *Exploration*, recognizing the area to verify that mineral deposits exist. (2) *Exploitation*, preparation of the area to extract the ore. (3) *Mineral Beneficiation (metallurgy)*: preparation and treatment work, for the separation of the ore from the sterile material or other minerals. (4) *Closure*: end of mining-metallurgical operation (Martínez, Bednarek, Rivera, Ojeda, 2019).

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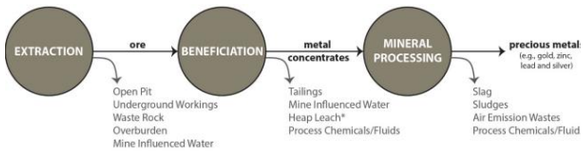

Figure 1. Mining process diagram
Source: EPA, Public Domain (2021)

Open pit mine

Open pit mining consists of the execution of extractive activities of economically valuable material, using techniques such as excavation of pits and shafts on the surface of the earth where there are significant deposits of the material to be extracted (Morán, 2013). This form of extraction expands in the 70's and current decade.

When the rock is removed from the slopes of a hill, the mineral deposit is located on slopes, when the rock is removed from a certain depth from the ground level, the deposit is in pits. For its exploitation, dynamite and crushing machinery are used which occupies reduced spaces, which are located at levels below the upper edges of the exploration; noise is minimized when there are wooded areas around, as a screen effect is generated (Correa, 2000).

Once the excavation has been dynamited, heavy machinery is used to remove waste and recover valuable material, which is transported by trucking to the processing plant or leaching yards. The soil that has been removed is stored in stockpiles or piles for separation; sterile material is also stacked for later use in backfill (restoration).

This method of mineral extraction is more economical and faster, however it produces more waste rock and dust and, devastation of landscape, as well as the consumption of large amounts of large quantities of water (Morán, 2013).

There are four elements to be considered in open pit mining to minimize risks of environmental impacts (Correa, 2000): (1) geographical location, detailing the place of extraction and relationship with neighbors, (2) treatment of the material, measuring noise, vibration (transverse and longitudinal), (3) landscape, changes in it, produce in the physiography, impacts that translate into negative aesthetics (transformation of volumes, earth movement, stripping, loss of vegetation and soil, increased erosion) and, (4) vegetation, allowing selection of species adaptable to the climate, considering meteorological data (precipitation, temperature, humidity, radiation, wind).

Environmental Impacts

Environmental impacts, refer to the adverse effects on ecosystems, climate and society, can be caused by extractive processes, use and deposit of hazardous waste, emission of pollutants into the atmosphere, water, soil and land use change. Classified as direct or indirect according to the side effects they cause, they are also studied on the basis of three dimensions: magnitude, importance and significance (Perevochtchikova, 2013).

De la Maza (2007), describes the character of environmental impacts, which defines the sense of change produced by a project action on the environment, further dividing them into: (1) beneficial or positive impact, (2) harmful or negative impact, (3) neutral impact and (4) foreseeable impact. It also states that they are rated according to their magnitude and expresses it in percentages; it measures them according to human meaning, through levels of importance and certainty.

Environmental impacts can be considered as effects of a project´s actions, in which the time frame to manifest itself is described according to evolution studies, the duration it will have, which may be temporary or permanent and, whether these effects are reversible or irreversible (De la Maza, 2007).

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Environmental impacts of mining processes

Mining activity can generate substantial changes in the relief, modifying the geological structure as a result of exploitation, it can cause destruction of the soil or degrade it, and both, surface and underground water resources can suffer altered; the biological environment can be partially or completely destroyed during mining operations (Arranz, 2015).

SEMARNAT (2016), describes the possible impacts by stages of the process of the sector: the extraction stage can destroy the orography, flora and fauna, in addition to generating dust and particles and during the explosions, combustion gases; underground mines vents emit solid particles containing metals; liquid emissions of residues, there are also traces of compounds from the use of reagents and / or inputs in the extraction and beneficiation process.

There is generation of combustion gases from engines inside and outside the mine, explosive residues. For the benefit of the mineral, flue gases are generated, and the use of water that mitigates dust emissions, will drag particles to the ground, especially in the case of dry operations (SEMARNAT, 2016).

The landscape can undergo modifications, some of them severe, so much so that authors such as Tandy (1979), point out that mining impacts are more aggressive than any other human activity.

Environmental impact risks from mining activities are the combination of the probability of occurrence of an event and the magnitude of its consequence. A risk of lesser magnitude is an event with a low probability of occurrence and negligible consequences, while a risk of greater magnitude has a high probability of occurrence and a catastrophic consequence. The literature that contemplates the impact of the mining industry is usually very broad, inquisitive and directed mainly to liabilities that generate degradation of old mining works.

Mining Environmental Liabilities

The environmental impacts generated by abandoned mining operations or in units where there has not been a regulated and certified mine closure by the corresponding authorities, are known as Mining Environmental Liabilities -MEL-, (Oblaser and Chaparro, 2008); these represent significant or permanent and potential risks.

SEMARNAT (2016), defines MEL as sites contaminated by the release of hazardous materials or waste that were not remediated in a timely manner to prevent the dispersion of contaminants, but involve a remediation obligation.

Mining MEL are usually sites, buildings, surfaces affected by spills, mining waste deposits, sections of disturbed watercourses, workshop areas, machinery or ore yards (Arranz, 2008); these may, depending on their characteristics and those of the context, be arisk of environmental impact.

Abandoned mining

Throughout history, the impact that has produced the old or abandoned mining activity, has been a world reference of damages generated in various places: land without destination or owner, holes that can become traps, aquifers, rivers and contaminated soils, land susceptible to breakage or erosion, destroyed landscapes (Arranz, 2008).

The major difference between active mining and abandoned mining is that the allocation of responsibilities is uneven, and it is an obstacle for the programs, plans, authorities and agencies involved to define the distribution of these among landowners, government agencies, business groups, former beneficiaries and other stakeholders (Arranz, 2008).

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Closing units

Operations in the mining industry can last for decades, accumulating waste (tailings dams) and extracted sterile material (earths or mounds -dumps-) long after the closure of operations. Sometimes these do not represent a danger to the environment, since they do not contain toxic substances, so during closure, in the case of waste, the dam must be drained, the surface flattened and then covered with soil and vegetation and, with respect to the mounds, they must be removed for use as fill, construction or other, avoiding damage to the landscape; on the other hand, if these wastes are considered environmental risks, measures must be taken focused on their stabilization, also reducing the need for monitoring (Adam, 2002, quoted in SEMARNAT, 2016).

When a closing date of a mining unit is stipulated, it should be considered that a re-opening is possible in subsequent years, so it is common that the tailings are deposited in an accessible way, since the unit may recover value due to new mineral deposits, new exploitation techniques or recovery (beneficiation), including the solvency of economic, legal or environmental events (BREF, 2009 quoted in SEMARNAT, 2016).

The aspects that must be followed in a mining unit closure are: (1) physical stability of the buildings, (2) chemical stability of tailings and sterile material and, (3) future land use (SEMARNAT, 2016).

Tailings dams must be prepared for uncontrollable events such as earthquakes, floods and other less drastic but equally destructive events such as air and water erosion; both sterile material and waste, can contain sulfides, causing acid drains, which must be treated even during operation, since if these are discharged and the water level drops, this phenomenon allows the oxygen in the air to react with the sulfides.

The site occupied by the unit, with acid drainage, high metal or sand content, and those not suitable for retaining nutrients or water, hinder closure works such as reforestation.

Mining unit closure plans

At the end of operations, the mining company, government and society, must take measures to protect the safety of people and the environment from harmful effects. Closure planning involves integrating the entire mine area into the closure design, setting times, and considering disposal techniques and methods and economic activities with a social aspect (Sánchez, 2014).

This planning is an environmental management instrument that includes technical and legal actions to be carried out to ensure that the remediation objectives described in it are effective; its strategy includes the rehabilitation of the areas impacted by the mining activity, reaching ecosystem characteristics compatible with healthy environments for the development of life and conservation of the landscape (Chávez, 2015).

Arranz (2008), states that the closure plans, in addition to rehabilitation, contemplate activities concentrated in diverse programs of: *restoration* (activities to return altered land to its original state), *reformation* (activities that managed to approach the original composition), *rehabilitation* (activities to acquires appearance according to a previous plan, ecologically stable and adapts the landscape) and, *remediation* (refers to the removal, reduction or neutralization of substances, residues, materials, in order to prevent adverse effects on the environment.

The purpose of the closure plans is to conserve, improve, recover and rehabilitate resources, ecosystems or landscapes for other uses: To this end, the intervention of agencies that evaluate the damage and promote direct or indirect programs or activities for proper remediation is necessary; these agencies will also be responsible for monitoring on these plans.

Closure plans consistently describe the appropriate programs: restoration, reformation, rehabilitation, or remediation. Companies will try to resolve the most urgent thing in a context of economic and material means, and then continue with a prior list of established priorities.

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Thus, a closure mining plan, or even an abandoned mine plan, is a general outline of actions to be carried out as a part of its environmental management strategy in a given territory: analysis of scientific-technical documentation, analysis of the suitability of budget items for sampling, characterization by means of field and laboratory equipment, contact with organizations, agencies or investors, design of field sheets and verification of validity of land design, field visits to obtain inventories, delimitation of inventory elements on cartography, analysis of information to interpret analytical data, environmental assessment, editing of results and conclusions (Arranz, 2008).

Methodological bases

Case study *Open pit mine in closing stage*

Description of the problem

Open pit mining can generate substantial changes in the landforms: it modifies geological structures, destroys or gradually degrades the soil, alters surface and subway water resources due to the use of explosives, the formation of pits or banks of 3 meters or more height and/or the use of heavy machinery (Arranz, 2015).

From the point of view of environmental alteration, the type of open pit mining is more impacting, since there are visible devastation to the sites and establishment of important areas of deposit of sterile material (earth pits) and others of material for beneficiation (*patios -open yards*). Some authors have called these impacts: disturbed areas, since they have eliminated vegetation and animal communities (Arranz, 2015).

Mining activity has contributed to the foundation, establishment and economic growth of the regions of the state of San Luis Potosí, so that from being an activity that initially generated economy, it extends and manages to incorporate several dimensions: political, social, cultural and environmental (Sánchez, 2014).

Foreign investment in this industry has not been long in coming in the country and in the state, the unit of analysis, object of study, has been in charge of several transnational mining companies acquiring the rights to exploit, and has done so in excessive ways in the absence of legal limits, extracting the mineral resource in an irrational way, obtaining from it, high economic benefit and leaving desolate landscapes, i.e., high environmental impact (Sánchez, 2014).

Faced to this devastation, between the 1980s and 1990s, numerous social activist movements emerged both to claim peoples´ rights over the territory occupied by the unit and to reverse the degradation of the environment (Sánchez, 2014).

Mining legislation in Mexico, in its execution and description, is widely contained in legal ordinances, presents contradictions and there is a notorious lack of mechanisms to follow up on effective compliance. Throughout history, socio-economic difficulties, political disputes and external pressures have prepared information that has generated that the regulations on mining activity have been constantly exceeded and attacked (Sánchez, 2014).

Contextualization of the analysis unit

The mining unit in the process of closure, is in a town 18 km in a straight-line northwest of the capital of the state of San Luis Potosí. The origin of this mining unit, dates before the foundation of the city, when the Huachichiles Indians notified the friars of the time of the existence of mineral, who in turn informed Captain Caldera, a character that history describes as the one who carries out the registration under his command. There are documents that assure that already in 1595, gold and silver were extracted from this place in considerable quantities, in addition to manganese, mercury, lead and copper (Sánchez, 2014).

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The capital of the state was founded in 1592, when the operation of the mine, which was very coarse, was in need of water for the benefit of the minerals; for its part, the mining town suffers from over-population or abandonment since its foundation, there was no stable number of inhabitants, because of has depended on the success or failure of the mine, which through the years has been a bonanza at the national level as in the time of the crown and has been managed by different companies who have invested in search of new deposits and technologies for mineral extraction in quantities superior to the competitive ones of several times in the world (García, 1992).

It is worth mentioning the importance of this unit in the social sphere of the state, since some historians point out that the name of the town and of the capital of San Luis Potosí, is due to the characters who "discovered or managed" the initial operations, thus, there are versions that the full name was dedicated to a Saint, to foreign landowners and to the similarity with mines of that time with coarse deposits of gold and silver in Bolivia (García, 1992).

Throughout the history of the analysis unit, national companies have been at the forefront of operations and in continuous exploration, however, international companies, especially Canadians, have been protagonists of the boom and detrimental situation, leading to its closure.

Particular problems

It was not until 1997 that the mining unit, operated by a Canadian corporation, formally presented procedures to the authority that at that time governed by means of an Environmental Impact Manifest -EIM-, however it does not contemplate land use, 75% of which is for the conservation of wildlife; the appearance of buildings considered heritage, with the explosions, activists argue deterioration, in addition to the hill itself, which is enigmatic for the area, these, among many other irregularities not contemplated in the legislation are added as problems (Sánchez, 2014).

In 2004, in a series of legal, environmental, cultural and, above all, political conflicts, the unit obtained authorization to change land and to operate by means of the open pit mining and leaching system, which is the process of recovering or separating gold from other minerals and sterile material by means of cyanide, which is considered highly polluting and lethal to life (Sánchez, 2014).

After more than a decade and a half of litigation, irregularities, conflicts, impunity and corruption, variants in charge of all the actors of this unfortunate event in the country´s mining industry, the current company that owns the operations of the unit, of Canadian denomination, announces the closure of the unit, leaving behind important projects for the remediation, rehabilitation and restoration of the area , injuries to aquifers, harmful effects due to the use of cyanide and destruction of the hill, among others for which they are being denounced in spite evidence of proving to be an operationally, socially and environmentally responsible company, even with international awards (Sánchez, 2014).

Justification

The research is *original,* since it considers a case study that, in turn, is part of an integral multiple case study (Yin. 2013), in which four representative units of the Mining-Metallurgical Industry in Mexico, called unis of *analysis for the research,* are examined individually with a standardized methodology and instruments, in their environmental practices to formalize the validation and proposal of a sustainable model that obeys international guidelines and the country's regulations, favoring the minimization or eradication of environmental impacts or risks of impact, which promotes the *relevance* and *relevance* of the research.

Objective

The general objective of the case study of the analysis unit undergoing closure is to determine, through the articulation of sustainability principles with the nation´s legislative parameters, the Environmental Management practices described in the closure *plan* presented to the authorities, for retribution to the population, the remediation, rehabilitation and restoration of the environment.

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Specific objectives

1. Make the connection between the parameters of the law and the sustainable principles that the unit of analysis determines, given its closing situation.

2. Describe the observations of each sustainable principle in the closure stage, as a direct expression of the closure *plan* determined in the environmental management of the unit.

Development

The methodology implemented systematically in the four case studies, in this unit of analysis in the process of closure, has variants with respect to the treatment of the personnel, which is very little and, derived from numerous socio-political problems, they are usually skeptical, so that the visits to the unit were more spaced, more limited, the collection of evidence was complex, that is, they showed it to validate them, but do not allow them to be publicly exposed due to policies established within the corporation that is in charge.

The operational area was visited, i.e., the hill from which the ore was extracted, the leaching yards and facilities in general, as well as reforested fields bodering other municipalities.

The application of the observation guides and checklists were meticulously studied, considering that they have the arguments to respond for the productive process even when it is no longer being exercised, so that the information of this unit does provide data to respond in all the principles and parameters, in addition to generating the most information for the final stage considered by SEMARNAT for the Mining-metallurgical Industry -closing- (Coordinación General de Minería, 2014).

Implementation of the sustainable management model

The Sustainable Principles assessed in the fieldwork are four, extracted from the Agenda 2030, which considers 17 Sustainable Development Goals, proposed by the UN (2016), as a result of a hard work of leaders of the countries involved, these are selected mainly because they directly involve the environment:

(1) *Industry, innovation and infrastructure:* Growth and urbanization generate the need for new investments in sustainable infrastructure that make cities more resilient to climate change and drive economic growth and social stability.

(2) *Sustainable cities and communities:* opportunities, access to services, energy, housing, transportation and other facilities. Cities are characterized by being centers that concentrate commerce, culture, science, productivity, creativity, social and economic development.

(3) *Responsible production and consumption:* Promote efficient use of resources and energy efficiency, sustainable infrastructures and facilitate access to basic services, ecological and decent jobs, improve quality of life. Create more and better things with fewer resources, increasing net profits by reducing resource use, degradation and pollution, achieving better quality of life.

(4) *Life of terrestrial ecosystems:* Promote the sustainable use of terrestrial ecosystems, act against desertification, try to stop and reverse land degradation and slow down the loss of biological diversity. The challenges to sustainable development are deforestation and human desertification, through ecosystem restoration.

The legislative parameters observed are taken from the EIM, where the companies are required to describe in detail how they will carry out the activities for each of the 109 items requested therein. Fifteen of them are extracted, which are: useful lifetime, technical responsible, nature of the project, dimensions, land use, urbanization of the area, site preparation, construction of works, operation and maintenance, abandonment, use of explosives, waste generation and management, infrastructure for waste management and disposal, abiotic aspects, biotic aspects and, landscape (Martínez y Bednarek, 2018).

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Generals of the unit of analysis

It is considered a mine with an open pit mining system of metallic ore, mainly gold and silver, however, manganese, lead and copper were also extracted; the metallurgical process was by means of leaching, i.e., using zinc powder and cyanide for the recovery of precious metals through precipitation.

Located 18 km from the capital of the State of San Luis Potosí, it belongs to a municipal seat with 4021 inhabitants. The mining concessions amount to 407 hectares geologically located in a metallic Trend.

The main inputs of the project were: fuel, electricity, explosives, reagents and water. The water needs of the project were covered from nearby wells, for which the National Water Commission (CONAGUA) had issued authorizations, in the same way, for the exploitation it was necessary for the National Defense Secretariat (SEDENA), to grant permits; they also describe the use of thousands of tons of cyanide (MIA, 2010, quoted in Correas, 2014).

Since 1996, the unit was operated and benefited by a Canadian-invested corporation. It had 500 direct employees. The operational projection was stipulated for the year 2021, however, social and political pressures, lead to the decision to close operations between 2016-2019.

Results

The results of the case study of the unit of analysis, a *mine in the closure stage* is presented, which for the purposes of the complete research, are considered preliminary.

The results of the field work show the articulation of the Sustainable Principles and Legislative Parameters, under the described theoretical basis of Sustainability adhered to Environmental Management (Martínez, Bednarek, Rivera, Ojeda, 2019).

1. Articulation between Sustainable Principles and Legislative Parameters:

Table 1 shows how this case study covers all the productive stages of the mining-metallurgical sector, unlike the three units included in the complete study, which only present aspects of prevention before a closure stage, since they operate normally. However, in the case presented in this document, the stages (exploration, exploitation and profit) are established in a historical way, with the emphasis on obtaining information in the last stage, that of closure, as described by the General Coordination of Mining (2014). Therefore, for the purposes of this document, the final relationship that of the closure stage is presented, which was found with each universal principle and the 16 legislative parameters:

Closing Stage / Legislative parameters	Principles of Sustainability II&I	SCC	RPC	LTE
Lifetime				
Technical manager	x	x	x	x
Nature of the project			x	
Dimensions	x	x	x	x
Land use	x	x	x	x
Urbanization of the area	x	x	x	x
Site preparation			x	x
Construction of works	x	x	x	
Operation and maintenance	X	x	x	x
Abandonment	x	x	x	x
Use of Explosives				
Gener-manag of waste	x	x	x	x
Infraestruct manag of waste	x	x	x	x
Abiotic aspects		x		x
Biotic aspects		x		
Landscape	x	x	x	x

Table 1 Relation of closing stage with principles and parameters
Source: Own elaboration

2. Description of Sustainable Principles based on information generated in fieldwork:

After obtaining, analyzing and interpreting the articulation between Sustainable Principles and Legislative Parameters, through the possible generators of environmental risks for each stage of the productive process, there are descriptions on what has been observed of each Sustainable Principle; the results described here denote the mining-metallurgical process as a whole, however, the description focuses on the closure stage.

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Industry, innovation and infrastructure:

There have been no exploration activities since 2012, which is why drilling is not active either. The unit's current reserves are classified with exploration studies carried out in the past and are not economically exploitable. Control of oil material, equipment leaks, spills from deposits in both workshops and exploration squares, led to the construction of concrete containers and mobile tray-type receivers. For mobile equipment such as front loaders and/or similar, it was envisaged that the engine equipment, hydraulic oil pressure hose joints would be checked and, in case of leakage in remote locations and, on dirt roads, immediate notice is given to special leak containment crews, who lift the contaminated soil to a healthy surface and coordinate movements of the equipment until it is repaired on site and/or dragged to the workshop. All maintenance is performed on concrete slabs with oil collection by gutters to the general containment and control site. A safety and control measure was to build a general storage container with a basin at the bottom that has a normal or regular maximum capacity plus 20% which ensures that any spill can be contained.

There are warehouses that are registered, separated and prepared in order to request shipment for confinement by third parties. According to procedure, the waste is recorded within a delivery-reception manifest, which stipulates the type, weight, quantity, unit of measurement, data´s generator, name, delivery date, seal and data of the company, transport company, operator´s general information. This procedure for each collection.

The formation of plots of land is no longer a current activity, in addition, they show that in relevant time in view of the closure, they took into consideration some internal rules: not to start plots of land without complying with the "change of land use", land clearing (respect for flora and fauna), not to build plots of land with invasion of watersheds that obstruct rainwater flows, among others.

At this stage, no tailings are generated, a final waste product that can be considered a landfill, due to the particle size of the material that is not pulverized and / or ground with in the tailings, since the treatment of mineral benefit is carried out by means of the leaching method and the applied reagent is controlled by piping for its distribution and the land is protected with membranes to prevent leaks inside the container (which in this case are basins and containment of curbas with precise specifications in their construction). This was made possible by means of design programs and calculations of volumes to be treated and stored.

With regard to registered technical studies and investments for project closure, they are elaborated in agreement with the corresponding authorities, likewise, they contract and sign agreements with some companies that officially represent them for diverse activities, as evidenced in the case of the "Official mine and environmental safety Representative " with the company Minera Tierra Adentro.

Operating procedures are very strict in their application, both for employees, suppliers and visitors, and are aligned with governmental other standards, such as ISO.

Sustainable cities and communities:

Historically, the unit of analysis in the closure stage, has been subject to social problems, which have become highly volatile political problems, having started these conflicts with leaders who at the time did not comply with financial and environmental regulations; the accumulation of bad corporate strategies and the process of devastation of an open pit mine so close to the capital of San Luis Potosí, have led the current capitalist company to submit closure documents, scheduled for 7 years from 2014.

Through verbal and media communication, which exhibited and still exhibits deficiencies and consequences of frequent work stoppages, is how the leaders of this unit know about the organizations that hinder and damage the operation; these are known as non-governmental organizations (NGOs).

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Access to the operating unit was duly channeled and protected by perimeter fences, plant to mine crossings that even provided a road to the town that houses it, in addition to an elevated bridge, designed to support heavy equipment, these and other works to link the town, which were supervised and authorized by municipal and state authorities.

There are no active powder magazines, so the community has not vibration and the part of the hill that houses the mineral has not undergone physical changes for this concept since 2015.

Regarding the budget items generated for closure, they consider quite onerous items applied mainly to the nearby towns of the operational zone and several activities are scheduled in the closure plan. The application of this resource is remarkable and is executed with the consent of the corresponding authorities. They detail that in spite of considering these items as sufficient, on some occasions NGOs have caused them not to be applied, and these facts have been negatively observed due to the expectations of authorities and communities.

Responsible production and consumption:

As for the operation of the unit in the closing stage, this principle is basically completed, so the description will be focused on the activities scheduled in the closure plan regarding the removal of the unit in the physical plane and / or facilities.

The mine was exploited as "open pit", the exploitation stage has ended and the deposits of sterile material have been identified. As for the beneficiation process, they refer to the buildings and equipment, warehouses and laboratories which obeyed a specific design and were authorized at the time by technical specialists, contemplating what was necessary for its operation and respect for the environment.

At present, no material is received from the mine, only reprocessed material accumulated in yards and pools, without recirculation, only reagent irrigation is maintained to collect values for the leaching system, which has a controlled dosage.

For the control and handling of reagents, the dimensions of the warehouses, as well as places for preparation and addition, are determined by the suppliers, the company and are based on the specific standards for the products and their treatment; currently these dimensions are overrun, since the capacity is reduced to the reprocessing of ore.

The tailings dam was designed, built and operated under high design and practicality standards to store hazardous reagents wastes and ore without economic value; it is in its final stage.

Life of terrestrial ecosystems:

There are internal roads that were built to meet operational needs, they are described in programs contemplate characteristics and reported to agencies such as SEMARNAT, following Official Standards. The landfills, their useful life and their impact on the landscape, are described by means of closure activities in the plan, contemplating how the impacted spaces will be left accordance with the area.

The abandonment of the operating area, as well as its impacts, are described in the closure plan, which also details social, economic, environmental, and conservation of beneficiation works. The community members are constantly being trained for possible development activities in preparation for closure.

It has been establish that the use of current facilities, so as not to leave them in abandonment, will be removed except for those that the community believes are relevant for future use, being responsible for them at the time determined by both parties. It is expected that, the NGOs will intervene during the execution of the activities programmed in the closure plan, especially in the aspect of ecosystem care, so it is decided to resort to the experience that has been have with them during the operative time in which they were dormant.The closure plan program, from the outset, established an accumulating economic fund to cover end-of-operation and abandonment costs. These figures are currently reviewed and compared to the value of money over time. For this purpose, they also contemplate activities such as the use of the land they have, either for sale or rent, according to their economic value in mineral deposits.

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Conclusions

This unit of analysis represents the end of a mining unit, so the description focuses on the closing stage and emphasizes what is described in the *closure plan* and what was observed by the researchers. The field work of this case study was decisive in the research, since it is an open pit mine that was forced to close its operations after a social-environmental controversy that was unleashed by NGOs, but which in its foundation contemplates severe landscape damage and operating practices that were not consistent with the company´s official standards.

The unit has canadian capital, which led it to maintain high operating systems, even in the final stage. The case study contains representative information for global research, which once the four selected analysis units are integrated and interpreted together, in addition to meaning that the sustainable model is validated, will provide the opportunity through a guide of best practices, to collaborate with the minimization of impacts and risks of environmental impacts (Martínez, Bednarek, Rivera, Ojeda, 2019).

The general perception of the researchers, in this unit of analysis in the closing stage, becomes peculiar in the attitude of the staff in general; the operatives, it should be clarified that there are very few, with multiple roles and functions and also, with the singular characteristic of belonging to the nearby towns, are calm in the face of the imminent decision of dismissal in the short term, which confirms the effectiveness of the company´s activities in this aspect; on the other hand, the information they have access seems to be limited. For their part, the trusted personnel, who occupy decision-making positions, are not permanently in the unit, but travel with certain frequency, those who are in charge of the operational functions, also multiple, are totally distrustful, susceptible even to provide information and seem not calm before the possibility of dismissal , it should be clarified that some of them may be willing to change in other units that belong to the corporate that represents them.

The evidence, therefore, is reduced to media plans, they were not flexible in showing the official closure plan and documents such as current permits or procedures. This observation is attributable to the multiple social and NGO problems that have arisen throughout history, which have been politized without control: for this reason, they have developed very strict and very conservative internal policies for the exhibition of their operation to society.

As a particular conclusion, it is considered that the budget items to carry out a closure plan must be developed since the unit starts operations, due to the high cost for the company in economic value, for the country in loss of mining production and, the environmental cost, which involves the community , the operating area, the operability itself and the environment, reflected in the ecosystems, being these precisely the sustainable principles measured in this study under the proposed model.

References

Arranz, J. and Alberruche, E., (2008). Minería, medio ambiente y gestión del territorio. España: Ed. RED DESIR.

Arranz, J., (2015). *Rehabilitación o remediación de espacios degradados por minería a cielo abierto.* Investigación, Desarrollo e Innovación en España. España: Instituto Geológico y Minero de España.

Chávez, M., (2015). Los pasivos ambientales mineros: diagnóstico y propuestas. Perú: Red Muqui.

Coordinación General de Minería, (2014). Guía para conocer las etapas del proceso productivo para la pequeña Minería. México: Secretaría de Economía.

Correa, A., (2000). *Situación actual de la explotación de canteras en el Distrito Capital*. Revista de ingeniería e investigación 45. Colombia.

De la Maza, C., (2007). *Evaluación de Impactos Ambientales.* Manejo y Conservación de recursos forestales. Chile: Editorial Universitaria.

García, R., (1992). Evaluación Geoestadística del proyecto Minero Cerro de San Pedro, S.L.P. México: UNAM.

Martínez, R., and Bednarek, M., (2018). *Fundamentos para construcción de Instrumento Ambiental para la Industria Minero-metalúrgica.* Revista de Arquitectura y Diseño. España: ECORFAN.

Martínez, R., Bednarek, M., Rivera, P., and Ojeda, M., (2019). *Principos Sustentables y Parámetros Legislativos en una mina subterránea en México. Caso de Estudio.* Bolivia: ECORFAN

Morán, R., (2013). Preguntas y respuestas sobre Minería. Argentina: Grenpeace.

Perevochtchikova, M., (2013). *La evaluación del impacto ambiental y la importancia de los indicadores ambientales*. Gestión y Política Pública. México: CIDE.

Sánchez, N., (2014). La Industria Minera en México a partir del TLCAN y sus implicaciones sobre el medio ambiente. México: UNAM

SEMARNAT, (2016). *Guía para la elaboración de la Cédula de operación Anual*. Industria Metalúrgica. México: SEMARNAT

Yin, R., (2013). Validez y generalización en futuras evaluaciones de casos de estudio. COSMOS corporation.

Hernández, R., (2014). Metodología de la Investigación, 6ta edición. México: McGrawHill.

Massolo, L., (2015). Introducción a las herramientas de gestión ambiental. Argentina: Editorial de la Universidad de la Plata.

Naredo, J., (1996). Sobre el origen, el uso y el contenido del término sostenible. En la construcción de la ciudad sostenible. España: Ed. Ministerio de Obras Públicas, Transportes y Medio Ambiente.

Martínez, R., (2000). Informe Técnico La Perreña. Edición interna Peñoles.

Martínez R., and Rivera, P., (2017). Articulación de los objetivos de Desarrollo Sostenible y la Legislación Ambiental en la Industria Minera. REMINEO. 2017

Organización de las Naciones Unidas, (2016). Agenda 2030 para el Desarrollo Sostenible. ONU.

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LED lighting stimulates root development and height in corn seedlings

La iluminación LED estimula el desarrollo radicular y altura en plántulas de maíz

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Abstract

The use of LED technology advances rapidly in different fields of agricultural sciences, among others to generate stimulating effects to the physiological development of exposed plants. The objective of the present study was to characterize the physiological response to photoperiod with LED light in corn plants. Four genotypes and four photoperiod treatments were evaluated with LED lighting (white, blue, green, red). The experimental design was randomly complete blocks with three repeats, the treatments were the combination of genotypes and light spectra. The response variables were: height, stem diameter, radicle length, radicle volume and leaf area. The data were analyzed by ANOVA, running a multiple comparison test of means by Tukey. The results showed similarity in the behavior of LED light in some variables, while in the genotypes there was a different interaction before each treatment. For physiological stimulation it was obtained that, blue LED improves root quality (absorbent capillaries and water storage content) in the B1G, RG and B2G genotypes, while the red LED in the WG, B1G and B2G genotypes and in the green LED the B1G, RG and B2G materials, stimulated the vegetative growth of stem in the seedling respectively.

***Zea mays*, Light emitting diode, Root, Seedlings**

Resumen

El uso de tecnología LED avanza rápidamente en diferentes campos de ciencias agrícolas, entre otros para generar efectos estimulatorios al desarrollo fisiológico de plantas expuestas. El objetivo del presente estudio fue caracterizar la respuesta fisiológica al fotoperiodo con luz LED en plantas de maíz. Se evaluaron cuatro genotipos y cuatro tratamientos de fotoperiodo con iluminación LED (blanco, azul, verde, rojo). El diseño experimental fue bloques completos al azar con tres repeticiones, los tratamientos fueron la combinación de genotipos y espectros lumínicos. Las variables respuesta fueron: altura, diámetro del tallo, longitud de radícula, volumen de radícula y área foliar. Los datos se analizaron por ANOVA, corriendo una prueba de comparación múltiple de medias por Tukey. Los resultados mostraron similitud en el comportamiento de luz LED en algunas variables, en cambio en los genotipos se dio una interacción diferente ante cada tratamiento. Para estimulacion fisiologica se obtuvo que, LED azul mejora la calidad radicular (capilares absorbentes y contenido de almacenamiento de agua) en los genotipos GN, GR y GA, mientras que el LED rojo en los genotipos GB,GN y GA y en el LED verde los materiales GN, GR y GA, estimularón el crecimiento vegetativo de tallo en la plántula respectivamente.

***Zea mays*, Diodo emisor de luz, Raíz, Plántulas**

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Introduction

In addition to being an indispensable source of energy for photosynthesis in plants, light is also an important factor for their growth and development (Ding *et al.*, 2010). Since plants are capable of responding to the intensity and color of light (Johkan *et al.*, 2012). Furthermore, the production of plant material can be artificially controlled by the growing environment; regulating the important variables of the environment such as: the intensity of light, temperature and humidity (Ramos and Ramírez, 2016).

Chlorophyll is found in chloroplasts and has the function of absorbing sunlight (mainly they capture red light and blue light) and use its energy to transform water and carbon dioxide into oxygen and organic molecules (sugars and carbohydrates), this process is called photosynthesis (Bures *et al*., 2018). Plants take advantage of light at different wavelengths (Bures *et al*., 2018) and regulating light intensity or wavelength has different effects on plant growth and development (Blanco *et al*., 2015).

Indoor cultivation is appropriate for any type of plant, due to the manipulation of variables such as photoperiod time, temperature, humidity, in addition to regulating LED lighting (Light Emitting Diode - Light Emitting Diode), currently known as lights. of growth, with importance within the emission of artificial light sources, which work in three different ways: 1) providing the light that the plant needs to grow, 2) increasing the photoperiod in order to trigger growth and 3) stimulating flowering (Ramos and Ramírez, 2016).

Corn (*Zea mays* L.) is the staple food consumed by 900 million people, which is why it is considered one of the most important crops in the world (Shiferaw *et al.*, 2011); Such cultivation represents a whole productive and consumption tradition, where various food and socioeconomic functions are fulfilled that have transcended to the present day (SAGARPA-SNICS, 2018). In Mexico, approximately 7.5 million hectares were planted in 2020, surpassing sorghum (*Sorgo bicolor* L.), beans (*Phaseolus vulgaris* L.), and sugar cane (*Saccharum officinarum* L.) (GCMA, 2020).

It is also the raw material for the agricultural industry in Mexico and other countries, such as the United States of America, China, Argentina and Brazil (OECD-FAO, 2014).

The objective of this research was to study the physiological response of four maize genotypes with different grain color: white, black, red and blue, and exposed to different wavelengths of the color LEDs of the white, green, blue and red spectrum. The hypothesis proposed for this research is that LED light will stimulate the viability and physiological variables in seedlings of Creole maize.

Materials and method

Four maize genotypes of white grain color (W), black (B1), blue (B2) and red (R) were evaluated, seminal material provided by the Conservation Program of Creole Maize for the State of Puebla of the National Institute of Forestry, Agricultural and Livestock Research (INIFAP) in the Experimental Field of San Martinito, Puebla; collections of the year 2018 in the towns of the municipality of Ixtacamaxtitlán, Puebla, and sown in the spring-autumn cycle 2019 in San Salvador El Verde, Puebla.

The experiment was carried out in the general laboratory facilities of the INIFAP of the San Martinito Experimental Field, Mexico-Puebla federal highway km 56.5. The corn kernels were sown in 36 x 20 cm plastic trays, with sand as substrate. Using two trays for each color of light, where each tray was divided into eight equal parts, therefore, the experimental unit was five seeds per row. As the tray was divided into eight parts, each tray had two rows for each different seed color¬: white, black, red and blue. The distribution generated four repetitions with five seeds of different color. The initial irrigation was brought to saturation point with 500 mL of water, and later auxiliary irrigations were carried out every third day with 200 mL, during germination and development of the seedling that lasted 20 days after sowing.

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The germination of the seeds was carried out in four treatments of LED light (white, green, blue and red) placing the two trays (already sown with the grains of different colors: white, black, red and blue) on metal shelves; independently lined with black rubber to avoid mixing of lights, where AKSI® LED spotlights with white, green, blue and red light were installed, for each shelf. The wavelength of the lights was determined by a Steren® luxmeter (model HER-408), for white light it was 88.96, blue 83.03, green 53.26 and red 56.36 lux. The established photoperiod was 16 hours of light and eight hours of darkness, programmed by a Steren® timer. The shelf temperature was 20.3 ± 2 °C, with a relative humidity of 45% and an evapotranspiration of water in each light section corresponding to 2.50 mL in white light, 1.86 mL in green light, 2.53 mL in blue light and 2.53 mL in red light, for 24 h.

The study variables were from seedlings of 20 days of germination: height (H) (cm), stem diameter (SD) (mm), radicle length (RL) (cm), fresh root mass (FRM) (g), fresh aerial mass (FAM) (g), radicle volume (RV) (mL) and also the leaf area (LA) (cm2) was calculated with the methodology proposed by Sauceda *et al.* (2017).

The experimental design was completely randomized in blocks, the data obtained were analyzed by checking the assumptions of normality and homogeneity of variances: to then perform an analysis of variance (ANOVA) in genotype (Gen), light (Light) and genotype interaction * light (Gen * Light). For variables that showed significance, the comparison of means was performed by Tukey ($P \leq 0.05$) for the source of Gene, Light and interaction, using the statistical program SAS 9.4 (Institute Inc., 2014).

Results and Discussion

Table 1 shows the analysis of variance (ANOVA) of the physiological variables according to genotype (Gen), light (Light) and genotype * light interaction (Gen * Light). ANOVA detected the mean squares with highly significant differences ($p \leq 0.01$) in Gene for the variables seedling height (H), fresh root mass (FRM), fresh aerial mass (FAM) and leaf area (LA); and significant values ($p \leq 0.05$) in stem diameter (SD) and radicle volume (RV).

Likewise, for the Light source, highly significant values were shown in the mean squares in the variable LA and significant in SD and FRM, while all the other variables were not significant for this source. In the ANOVA for the Gen * Light interaction source, significant values were only shown in SD, FAM and LA, while in the variable radicle length (RL) it was not significant for any of the three sources, which means that this variable does not show affection to LED light at any intensity.

	MS ŧ						
FV	H	SD	RL	RV	FRM	FAM	LA
Mean	7.93	2.58	21.42	1.20	1.39	0.81	2.42
Gen	28.62**	0.90*	9.89 ns	1.13 *	2.56 **	0.87**	3.78**
Light	1.80 ns	0.98*	142.78 ns	0.41 ns	0.99 *	0.08 ns	2.49**
Gen* Light	1.90 ns	0.39*	58.78 ns	0.09 ns	0.29 ns	0.13 *	0.51 *
Error	1.49	0.19	71.54	0.38	0.21	0.07	0.24
CV ϕ	15.42	17.16	39.47	43.97	32.94	33.01	20.23
R^2	0.69	0.59	0.35	0.38	0.66	0.63	0.75

**, *: significance to p≤ 0.01 y p≤ 0.05, respectively; CMŧ: mean squares; CV ϕ: coefficient of variation; R^2: Determination coefficient; Gen: genotype; H: Height; SD: Stem diameter; RL: radicle length; RV: radicle volume; FRM: Fresh root mass; FAM: Fresh aerial mass; LA: Leaf arear.

Table 1 Analysis of variance (ANOVA) with seven variables according to their physiological response of corn with four different colors of light

Table 2 shows the physiological response by comparison of means by Tukey ($p \leq 0.05$), where the white grain (WG) has a higher physiological response in SD, RV, FRM, FAM, LA, according to the differences of the means obtained, followed by the black grain (B1G) which showed a development in the variables H (9.69 cm) in SD (2.61 cm), RV (1.27) and LA (2.59 cm^2). The author Blanco *et al.* (2015) refer that a crop can continue its vegetative development as the lengthening of the stem or root when conditions are optimal. The red grain (RG) and blue grain (B2G) showed lower values compared to the white and blue grain in the study variables H, SD, RV, FM, FAM, LA.

	Variables						
Genotype	H	SD	RL	RV	FRM	FAM	LA
WG	7.87 b	2.96 a	21.79 a	1.60 a	2.00 a	1.17 a	3.14 a
B1G	9.69 a	2.61 ab	24.56 a	1.27 ab	1.41 b	0.86 b	2.59 a
RG	8.24 b	2.35 b	17.82 a	0.89 b	0.88 c	0.54 bc	1.94 b
B2G	5.94 c	2.42 b	21.51 a	1.05 b	1.27 bc	0.68 bc	2.01 b
MSD*	1.35	0.49	9.35	0.58	0.50	0.29	0.54

MSD*: minimum significant differene; Values with different letters between columns are statistically different ($p \leq 0.5$). H: Height; SD: Stem diameter; RL: radicle length; RV: radicle volume; FRM: Fresh root mass; FAM: Fresh aerial mass; LA: Leaf arear. Values with different letters between columns are statistically different.

Table 2 Analysis of physiological development according to corn genotype

Table 3 shows the influence of LED light in the comparison of means by Tukey, which showed differences with respect to the means obtained in the variable of SD, FRM, FAM and LA. It was shown that blue light (B2L) excels in variables associated with vegetative growth such as FRM, FAM and LA, which indicates that blue light stimulates or favors vegetative growth.

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According to Kurilčik *et al.* (2008), blue and red light, a synergistic interaction between cryptochromes and phytochromes (blue and red photoreceptors, respectively) occurs, in this way these pigments may be responsible for the perception and activation of the process of rhizogenesis and plant growth, in addition to between 400 and 520 nm range in which the blue LED spectrum is found.

	Variables						
Light	H	SD	RL	RV	FRM	FAM	LA
WL	7.83 a	2.93 a	24.66 a	1.01 a	1.10 b	2.60 a	2.60 a
GL	8.31 a	2.70 ab	22.75 a	1.14 a	1.20 b	2.59 a	2.59 a
BL	7.42 a	2.30 b	21.69 a	1.45 a	1.71 a	2.74 b	2.74 a
RL	8.17 a	2.41 b	16.59 a	1.20 a	1.55 ab	1.74 b	1.74 b
MSD	1.35	0.49	9.35	0.58	0.50	0.54	0.54
MSD*: minimum significant differene; Values with different letters between columns are statistically different ($p \leq 0.5$). H: Height; RL: radicle length; RV: radicle volume; FRM: Fresh root mass; FAM: Fresh aerial mass; LA: Leaf arear; WL: white Light; LV: green Light; BL: Blue Light; LR: Red Light.							

Table 3 Influence of LED light on corn by multiple comparisons of means by Tukey

In Table 4, the comparison of means by Tukey of Gen * Light and light interaction is shown. Results of the means obtained, it was shown that there is an interaction for the variables measured between the Gen * Light. From the above, it was obtained that in height the red LED for the WG, B1G and B2G genotypes and in the blue LED for B1G, RG and B2G respectively. The effect of promoting stem elongation has also been widely documented for the case of the red LED by Kurilčik *et al.* (2008), however, the effect was not known for the case of the green LED, since they showed a percentage increase effect of 10% compared to the white and blue LED.

Gen	H	SD	RL	RV	FRM	FAM	LA
WHITE LED							
WG	9.5 abc	3.93 a	28 a	1.60 a	1.73 abc	1.51 a	3.76 a
B1G	8.16 abcd	2.50 b	25.50 a	0.76 a	0.76 c	0.61 b	2.36 abcd
RG	6 cd	16.66 e	25.50 a	0.76 a	0.76 c	0.61 b	2.65 abcd
B2G	7.66 abcd	2.83 ab	19.66 a	0.93 a	1.17 abc	0.82 ab	1.93 bcde
RED LED							
WG	10.03 ab	2.73 ab	14.66 a	1.53 a	2.29 ab	0.97 ab	2.34 abcde
B1G	8.33 abcd	2.80 ab	20.26 a	1.40 a	1.92 abc	1 ab	2.21 bcde
RG	5.08 cd	1.96 b	10.43 a	0.73 a	0.58 c	0.35 b	0.88 e
B2G	8.50 abcd	2.16 b	19.66 a	1.13 a	1.42 abc	0.47 b	1.54 de
BLUE LED							
WG	10.40 a	2.30 b	17.66 a	1.83 a	2.46 a	1.11 ab	3.40 ab
B1G	7.63 abcd	2.26 b	25.66 a	1.50 a	1.44 abc	0.74 ab	2.76 abcd
RG	5.50 d	2.33 b	16.36 a	1.26 a	1.44 abc	0.74 ab	2.76 abcd
B2G	6.16 cd	2.30 b	27.06 a	1.23a	1.51 abc	0.60 b	2.05 bcde
GREEN LED							
WG	8.83 abcd	2.90 ab	26.83 a	1.43 a	1.52 abc	1.08 ab	3.05 abc
B1G	8.83 abcd	2.90 ab	26.83 a	1.43 a	1.52 abc	1.08 ab	3.05 abc
RG	6.43 bcd	2.63 ab	19 a	0.80 a	0.76 c	0.46 b	1.75 cde
B2G	9.16 abcd	2.40 b	18.33 a	0.90 a	0.99 bc	0.82 ab	2.53 abcd
MSD	1.35	0.49	9.35	0.58	0.50	0.29	0.54
MSD*: minimum significant differene; Values with different letters between columns are statistically different ($p \leq 0.5$). H: Height; RL: radicle length; RV: radicle volume; FRM: Fresh root mass; FAM: Fresh aerial mass; LA: Leaf arear.							

Table 4 Comparison of means between four corn genotypes under LED lights

In determining the effects associated with the interaction between genotypes and LED light, it was obtained that for variables associated with root development, the blue LED showed increases of 15% with respect to the means obtained for the white, red and green LEDs.

The B1G, RG and B2G genotypes showed a physiological response of increase in RV and FRM, however, these values were not related to the increase in the length of the root, so it is inferred that the amount of carbohydrates produced in the aerial part they are used in the root zone, increasing the exploration of the roots and their volume.

In the variables SD, FAM and LA, no specific effects were related for the Gen * Light, however it was observed that in B1G and B2G, they showed an increase of 10% with respect to the means obtained for LA in blue and green LEDs, associated with the H obtained in the same spectra. This may be related to the color of the seed, because dark pigments capture more photons through the environment, promoting vegetative development.

Conclusions

The genotypes put into study showed different physiological response, highlighting that the WG obtained better averages in the variables SD, RV, FRM, FAM and LA. The variables showed a specific response to the LED light, therefore the white light stimulated the SD, FAM, the blue LED increased the amount of FAM and FRM, while for the variable H, LR, RV and LF the LEDs stimulate similar effects.

The Gen * Light interaction made it possible to detect that each genotype shows specific responses to each LED intensity. In physiological stimulation of corn, it was obtained that the blue LED improves the root quality (absorbent capillaries and the content of water storage) in the B1G, RG and B2G genotypes, while the red LED in the WG, B1G and B2G genotypes and in the green LED the B1G, RG and B2G materials, stimulated the vegetative growth of the stem in the seedling respectively.

Referencias

Barbero, A. 2010. Inducción Electromagnética. Teoria/Leccion 1–15. https://previa.uclm.es/profesorado/ajbarbero/Teoria/Leccion_Induccion_Electromagnetica.pdf

Blanco, Y., Afifi, M., y Swanton, C. 2015. Efecto de la calidad de la luz en el cultivo del maíz: una herramienta para el manejo de plantas arvenses. *Cultivos Tropicales* 36(2):62–71.

ISSN-On line: 1390-9959

Bures, S., Gavilán, M. U., y Kotiranta, S. 2018. Iluminación artificial en agricultura. Biblioteca Horticultura. http://publicaciones.poscosecha.com/es/cultivo/395-iluminacion-artificial-en- agricultura.html#

de la Cruz, L. E., Córdova, O. H., Estrada, B. MA., Mendoza, P. JD., Gómez, V. A., y Brito, M. N. P. 2009. Rendimiento de grano de genotipos de maíz sembrados bajo tres densidades de población. Universidad y ciencia, 25(1):93-98.

Ding, Y., He, S., Teixeira da Silva, J. A., Li, G., and Tanaka, M. 2010. Effects of a new light source (cold cathode fluorescent lamps) on the growth of tree peony plantlets in vitro. Scientia Horticulturae, 125(2): 167–169. doi:10.1016/j.scienta.2010.03.019

GCMA (Grupo Consultor de Mercados Agrícolas). 2020. Balance estadístico nacional de granos y oleaginosas. https://gcma.com.mx/gcma-agroimagen-balance-estadistico-nacional-de-granos-y-oleaginosas/

Johkan, M., Shoji, K., Goto, F., Hahida, S., and Yoshihara, T. 2012. Effect of green light wavelength and intensity on photomorphogenesis and photosynthesis in Lactuca sativa. Environmental and Experimental Botany, 75:128–133. doi:10.1016/j.envexpbot.2011.08.010

Kurilčik, A., Miklušytė, C. R., Dapkūnienė, S., Žilinskaitė, S., Kurilčik, G., Tamulaitis, G., Žukauskas, A. 2008. In vitro culture of *Chrysanthemum plantlets* using light-emitting diodes, Central European Journal of Biology, *3*(2):161–1673. doi:10.2478/s11535-008-0006-9

OCDE-FAO (Organización para la Cooperación y el Desarrollo Económicos-Organización de las Naciones Unidas para la Alimentación y la Agricultura, Perspectivas Agrícolas) 2014-2023. 2014. OECD Publishing. http://dx.doi.org/10.1787/agr_outlook-2014-es

Ramos,G. Y., and Ramírez, L. E. 2016. Development of an artificial LED lighting system for indoor farming. Informador Tecnico, 80(2):111–120.

SAS, Institute. 2014. User´s Guide of SAS (Statistical Analysis System). SAS Institute Inc. Cary, North Carolina, USA. 550 p.

SAGARPA-SNICS. 2018. Antecedentes de la Red Maíz. p. 2-4 *In*: Ramírez, G. J., y R. González, S. R. (ed.). Conservación y aprovechamiento sostenible de la diversidad de maíces nativos de México. Servicio Nacional de Inspección y Certificación de Semillas. México. 138 p.

Sauceda, A. C. P., González, H. V. A., Sánchez, S. B. H., Sauceda, R. H., Ramírez, T. H. M., and Quintana, Q. J. G. 2017. Macf-Ij, Automated Method For Measuring Color And. Agrociencia, 51:409–423.

Shiferaw, B., Prasanna, B. M., Hellin, J., and Bänziger, M. 2011. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. Food Security, 3(3), 307–327. doi:10.1007/s12571-011-0140-5

Smith, H. L., Mcausland, L., and Murchie, E. H. 2017. Don't ignore the green light: Exploring diverse roles in plant processes. Journal of Experimental Botany, 68(9), 2099–2110. doi:10.1093/jxb/erx098.

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Tourism and gastronomic marketing strategies to increase tourist flow at Hotel Tosepan Kali

Estrategias de marketing turístico y gastronómico para aumentar el flujo de turistas en el Hotel Tosepan Kali

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Abstract

Tourism and gastronomic marketing has served as a strategy for many destinations or establishments in order to be visited frequently, this promotes a more direct relationship between the consumer and the seller, which influences to achieve the positioning; however, there are some companies that do not have the appropriate elements for this, this is the case of the hotel Tosepan Kali located in the Sierra Norte of the State of Puebla, therefore, the objective of this research is to select tourism and gastronomic marketing strategies and tools to position it, as one of the most visited hotels in the destination. In this sense, the design of this research is quantitative, not experimental and transversal, uses a documentary and field technique with an exploratory and descriptive scope. A measuring instrument was used to find out which tools and strategies are preferred by the population of the states of Puebla and Morelos, with the results obtained, it was observed that the most used strategy is digitization through the use of social networks, and it was obtained that most of the participants trust more in the web pages and phone calls to the hotel to make their reservation.

Tourism and gastronomic marketing, Tosepan Kali, tourism

Resumen

El marketing turístico y gastronómico ha servido como estrategia para que muchos destinos o establecimientos sean visitados con frecuencia, este promueve que haya una relación más directa entre el consumidor y el vendedor, misma que influye para lograr su posicionamiento; sin embargo, hay algunas empresas que no cuentan con los elementos adecuadas para ello, este es el caso del hotel Tosepan Kali ubicado en la Sierra Norte del estado de Puebla, por lo que el objetivo de la presente investigación es seleccionar las estrategias y herramientas de marketing turístico y gastronómico para posicionarlo como uno de los hoteles con mayor ocupación en el destino. En este sentido el diseño de esta investigación es cuantitativo, no experimental y transversal, utiliza una técnica documental y de campo con un alcance exploratorio y descriptivo. Por medio de un instrumento de medición para conocer cuáles son las herramientas y estrategias preferidas por la población de los estados de Puebla y Morelos, se determinó que la estrategia más utilizada es la digitalización mediante el uso de redes sociales, así mismo, se obtuvo que la mayoría de los participantes confían más en las páginas web y llamadas al hotel para hacer su reservación.

Marketing turístico y gastronómico, Tosepan Kali, turismos

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Introduction

Nowadays, some companies have tools to make themselves known and position themselves. This paper focuses on tourism and gastronomic marketing strategies to position the Tosepan Kali hotel, located in the northeastern Sierra of Puebla, in the preference of consumers. Santesmases (2007) says: "Marketing is a special way of conceiving the exchange relationship, so that it is satisfactory for all parties involved in it". In the case of tourism and gastronomy, the term tourism marketing was made official in 1971, but began to be used in 1990 in different countries, mainly in Spain (Bigné, 1996 and Krippenddorf, 1971). This discipline has served as a platform for many destinations to be visited frequently, because its strategies and tools can provide greater leverage to publicize the offer of the establishments, in that sense, its implementation in the hotel Tosepan Kali (house of all), which was created in 2004 to offer ecotourism services to visitors to the region of Cuetzalan and is part of a cooperative called Tosepan Titataniske, which in Nahuatl means "together we will overcome", which was born in the Sierra Norte de Puebla in 1977 due to the economic crisis that was being experienced, specifically in the municipality of Cuetzalan. (Unión de Cooperativas Tosepan, 2015), may represent a boost for its positioning in the tourism market.

For Levitt (1990), "when potential customers or the target group of consumers cannot try, test, feel, smell or see the product in advance, what induces is the promise of satisfaction", thus, thanks to marketing it is possible to see and choose some characteristics of the products and services offered by the different establishments, for example the type of room, view, location of the room, gastronomic offer, among others; but not all service providers have the appropriate strategies to have a greater reach and contact for the tourist to reach them. This is the case of Hotel Tosepan Kali, which, unlike other hotels, was created to provide lodging to its members, since due to the way they dressed, the other hotels did not want to provide this service; it has occupancy, however, its seasonality does not work in a conventional way due to the type of market it targets (hotel members, interest groups and undergraduate or graduate programs), so there could be a better use of its services by expanding its type of market, with appropriate strategies to make them known and achieve positioning.

With the above mentioned, the objective of this research is to select the strategies and tools for tourism and gastronomic marketing to position the Tosepan Kali hotel as one of the hotels with the highest occupancy in the Sierra Norte de Puebla.

1 Northern Highlands of the State of Puebla

The state of Puebla is divided into 32 regions: Region I Xicotepec, Region II Huauchinango, Region III Zacatlán, Region IV Huehuetla, Region V Zacapoaxtla, Region VI Teziutlán, Region VII Chignahuapan, Region VIII Libres, Region IX Quimixtlán, Region X Acatzingo, Region XI Ciudad Serdán, Region XII Tecamachalco, Region XIII Tehuacán, Region XIV Sierra Negra, Region XV Izúcar de Matamoros, Region XVI Chiautla, Region XVII Acatlán, Region XVIII Tepexi de Rodríguez, Region XIX Atlixco, Region XX San Martín Texmelucan, Region XXI-XXXI Metropolitan Area of Puebla City and finally Region XXXII Tepeaca.

Region V also known as Sierra Norte, has a total population of 158, 416 people, 52.94% are women and 47.06% are men of which 66.48% are indigenous (Secretaría de Gobernación, 2019).

This region has a diverse vegetation, its climate is varied but most of the year is rainy. There is a great variety of flora, for example; the coffee plant, pepper, orange, passion fruit, oyamel, holm oak, jonote, flowers such as orchids, cempoal Xóchitl (dead flower) and chamaki to mention a few. The fauna is diverse, among the main animals are armadillos, gophers, foxes, squirrels, opossums and acamayas, which is an attraction for tourists who come to the area.

2. Cuetzalan del Progreso

Cuetzalan del Progreso is located in Region V, bordered to the north by Jonotla and Tenampulco; to the east by Ayotoxco de Guerrero and Tlatlauquitepec; to the south by Zacapoaxtla; to the west by Zoquiapan. "The original name was Quetzalan: place of abundance of quetzals or bunch of red feathers with blue tips on two teeth" (Secretaría de Turismo, 2019), is a Pueblo Mágico since 2002, known for its cobblestone streets and the patron saint festival of San Francisco de Asís celebrated on October 4 each year.

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The total population of this municipality as of 2020 was 49,864 people of which 31,681 speak an indigenous language. (INEGI, 2020)

Some of the main festivities of this town are: the huipil fair, the coffee fair, the patron saint festival on October 4 and Yohualichan kampa to xolalmej ilhuitij (or its Spanish translation "En Yohualichan nuestros pueblos están de fiesta", this is the festival that brings together music and dances of the different peoples of the region), some of these are celebrated with traditional dances and music of the region. (Secretary of Tourism, 2019).

This town preserves different traditional dances, among which stand out: that of the Quetzals and that of the Voladores. Both are rituals dedicated to the gods, with music, costumes and multicolored plumes (Secretaría de Turismo, 2014).

3. The Tosepan Kali Cooperative in Cuetzalan

Tosepan Titataniske or its Spanish translation "together we will overcome" was born in 1977 as an Indigenous Cooperative Movement, officialized until February 20, 1980, located in the northern highlands of the state of Puebla, it arises with the purpose of getting for the community basic products such as: corn, beans, rice, pasta among others, at a low cost (Social Production of Habitat, 2015) because at that time, in Cuetzalan there was a sugar crisis. Most of the members are indigenous people from the Nahuatl and Totonaco groups. Tosepan Titataniske groups together several cooperatives: Maseual Xicaualis Cooperative (this one has designed the *café tosepan* brand for Mexican consumers and the *café masehual* brand to offer it to the inhabitants of the region, i.e. in the members' communities of origin), Tosepan Siuamej cooperative (run by women in charge of managing tortilla shops, bakeries, grocery stores, also taking care of the production of jams, cajetas and liquors), Tosepan Tomin cooperative (it was formed in 1998, Tosepan Pajti cooperative (dedicated to disease prevention, with a group called community promoters who train the people responsible for each family to take care of their health through food, hygiene, herbal medicine and sustainable home).

On the other hand, there are cooperatives that are dedicated to the use of natural resources such as Tosepan Tichanchiuaj (which is dedicated to creating sustainable and ecological homes through rainwater harvesting, composting, wastewater treatment and backyard food production, its purpose is to improve housing conditions), Tosepan Ojtat Sentikitinij cooperative (it was integrated in 2009, its purpose is to take advantage of bamboo by creating furniture, construction material or some handicrafts in addition to helping to employ some young people) (Social Production of Habitat, 2015).

In the case of tourism, the cooperative Tosepan Kali (Nahuatl translation "House of all") was created in 2004, mainly to offer lodging services to tourists visiting Cuetzalan, and stands out as one of the three lodging establishments whose owners are Nahua-speakers. Tosepan Kali is a sustainable lodging immersed in nature, made mostly with bamboo, it has 4 different types of lodging in 9 cabins with a maximum capacity for 27 people, 5 cabins for 15 people, a hotel with 15 rooms for 31 people and a hostel for 38 people; it makes use of eco-techniques, such as the use of alternative materials for its construction, rainwater harvesting and a wastewater treatment system. It also has a restaurant, which offers seasonal dishes that change according to the day because it does not have a fixed menu, since it adapts to the products grown in the region. It also has a spa, store and pool, and offers some tours, packages with different agricultural activities and a day of environmental education. (Tosepan Kali, 2017; Cuetzalan Mágico, 2016; Herrera, 2019).

4. The influence of marketing on the tourism and gastronomic product

The authors Kotler and Amstrong (1990) define marketing as "a social and managerial process, by which individuals and groups obtain what they need and want, through the creation and exchange of products and value with others"; Likewise, Buck (1962) says that: "Marketing is the planning and execution of all aspects and activities related to a product in order to influence consumers to buy as much as possible at an optimal price that maximizes the company's profit in the long term".

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According to the American Marketing Association (2007) "Marketing is the activity, set of institutions and processes to create, communicate, deliver and exchange offers that have value for customers, partners and society in general".

With the above it is observed that it is not only focused on a simple exchange of products, but also on the phenomena that compose it, that is to say, it goes beyond just selling, it is rather a process aimed at paying attention to the consumer's needs, the value and characteristics of the product, the demand, so that these aspects can positively influence the consumer and produce a greater scope at the time of purchase.

In recent years, marketing has been evolving thanks to the fact that it has adapted to new trends and social changes, as Kotler and Keller (2009) point out that "it is a social and administrative process, which involves an exchange between groups and individuals of a society to satisfy mutual needs and where the product is its basic variable, as it encompasses both goods and services marketed by a company". In this sense, Alcaide, Bernúes et al. (2013) mention that "concepts such as brand, packaging, image, warranty and after-sales service are part of marketing".

Marketing consists of two stages, the strategic and the operational, within the second are the variables that the company can control, commonly referred to as the *marketing mix*. According to Localle (2015) "the *Marketing Mix* is a marketing concept that gathers all the tools that are available to marketers for the development of efficient actions and thus achieve their objectives of penetration and sales in the target market".

This term first appeared in the work The Concept of *Marketing Mix* (1948) by theorist Neil H. Borden (1895-1980), professor of marketing and advertising at Harvard Business School, who said he was inspired by research by James W. Culliton (1912-2004) who describes the role of the marketing manager as a mixer of ingredients and proposes in this phase a list of twelve elements of the industrial *marketing mix*: product planning, price, brand, distribution channels, sales staff, advertising, promotion, packaging, display, service, physical handling and research; with the common tasks and concerns of the marketing manager (Noblecilla and Granados, 2018, p.41).

Thus, in 1960 Professor Joseph McCarthy made a simplification of these elements to only four, today known as the group of "the 4Ps: Product, Price, Place and Promotion, raised in his work *Basic Marketing: a Managerial Approach*" (Noblecilla, and Granados, 2018, p.41). These P's are described below (Mogollón, 2014; Noblecilla, M. and Granados, M., 2018):

The first is Product, it is defined as the combination of goods and services that the company offers to the target market. It is composed of certain attributes that are: variety, quality, design, features, brand name, packaging and services.

The second is Price, the amount of money that customers have to pay to obtain the product. The attributes that compose it are: list price, discounts, bonuses, payment period and credit plans.

The third P is Place or Distribution, all the company's activities that make the product available to the target consumers and its attributes are: channels, coverage, assortment, locations, inventories, transportation and logistics.

The fourth element is Promotion or Communication, composed of all the activities that convey the product's advantages and persuade target customers to buy it, and its attributes are: advertising, personal selling, sales promotion and public relations.

The four Ps apply to both tangible products and services, which are defined as "Any eminently intangible activity, which does not give rise to transfers of ownership and which can be the object of exchange, whether or not they are associated with a physical product" (Kotler, Cámara, & Grande, 1994).

The service has certain characteristics that differentiate it from a tangible product and that according to Ojeda and Mármol (2012, pp.99) are:

– Intangibility: Services that cannot be seen or smelled, among other characteristics.

– Inseparability: Generally, most services are produced and consumed simultaneously.

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- Expiration: They have a quick expiration date since they cannot be stored as a tangible product, and can cause problems due to fluctuations in demand.

- Heterogeneity: These types of services are provided by individuals, which makes it impossible to get two alike.

Thus, in this research, marketing strategies were developed for the service, for which the term service marketing was used, which "is a discipline that seeks to study the phenomena and facts that occur in the sale of services" (Cobra, 2003); this type of marketing includes the following services: education, tourism, transportation, protection, private retirement, counseling, entertainment, credit, etc.".

Likewise, within the marketing of services there are variables such as educational marketing, tourism marketing, among others.

Tourism marketing is defined as "a set of activities that facilitate exchanges between the various agents acting, directly or indirectly, in the tourism product market" (Kotler, as cited in Vaz, 2002, p.18), whose function is to identify market segments, promote the development of tourism products and provide potential tourists with information on the products offered (Trigueiro, 1999).

Quintana (2003) points out the following elements to be able to carry out this type of marketing:

- Work materials: Elements used to carry out the service.

- Facilities or physical space: Furniture, premises, light, atmosphere, decoration.

- Personnel: in the tourism industry, this is one of the central aspects in the provision of services.

With the above we can say that tourism marketing fundamentally develops relationships between the service provider and the consumer in order to exchange a tourism product, supported by different work materials suitable for the product to be sold.

"The way a service is provided can influence the nature of the relationships that exist between the staff of a service organization and its customers, which will ultimately influence the image of the company" (Garcon, 2009).

In this sense, the satisfaction of needs based on customer perceptions and desires, as is the case in the provision of tourism and gastronomic services, is motivated by eminently intangible aspects (Mogollón, 2014; Noblecilla and Granados, 2018).

Similarly, in the case of tourism and gastronomic services, two other specific characteristics must be added, which are the seasonality of demand and the need for high investment for their commercialization or high fixed costs compared to other products or services. It is, therefore, the very characteristics of the services that determine the use of special marketing strategies, and more specifically, for tourism and gastronomic services (Parra and Beltrán, 2014).

5. Strategies and tools for tourism

According to Parra and Beltrán, (2011) the following strategies can be used to counteract the problems generated by the characteristics of the service:

- Tangibilize the service. Make the essence of the establishment visible through objects and products that the consumer can use (amenities, furniture, among others).

- Identify the service. Develop a brand and a logo for the establishment.

- Cross-selling. Offer packages that include different services and thus be more economical than paying for them separately.

- Use personal promotional media. Train staff to address the client in an appropriate manner (tone of voice, respect, kindness) as well as to provide information about the place and solve problems.

- Differentiate by quality of service, taking into account its attributes, for example: reliability, speed, responsibility, competence, accessibility, courtesy, communication, credibility and security.

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- Understanding/knowledge of the customer. Empathy with the customer.

- Personalization or uniqueness of service. Staff must adapt to the customer's needs by providing a respectful and immediate response.

- Create a strong corporate image. To complement the brand, it is necessary that the staff has attributes that differentiate it from other organizations, such as uniforms, nameplates.

- Industrialization of the service. Make use of technological tools to facilitate and streamline the service without forgetting that these are to support the staff.

6. Tourism and gastronomic marketing and its relationship with the Internet

A few years ago, for companies the internet was just a means of communication, but over time it became participatory and interactive, which allowed responding to users about their requests in real time, today for many companies it is the main channel for sales, communication and advertising, all due to changes in technology, customs, new jobs, professions and ways of socializing and influencing. (Zuccherino, 2016).

Digital tools are present in more organizations, being part of a great transformation, potentiating each of the strongest attributes, as mentioned in the latest study of digital marketing and social media published by the Mexican Internet Association (AMIPCI, 2014), applied to the 100 largest companies in Mexico, indicating that 79% of them have a presence on Facebook and 80% on Twitter.

On the other hand, in the Study of e-commerce in Mexico, also conducted by AMIPC (2018a) it is concluded that "websites are reference of the first contact of the consumer, however, mobile applications gain ground with 60% of purchases through the use of mobile devices".

These are just some of the trends in the use of digital tools:

- Video Marketing and streaming: Video is one of the formats that is booming and is increasingly important in the tourism and gastronomy sector. It allows to show products or services in a more attractive way and the sensations that transmit to consumers are more appealing, Instagram TV, TikTok are a great way to communicate and attract new users.

- Alliances with virtual and physical travel agencies: So that they can promote the services that a destination or establishment has, and even the packages it may have.

- Travel platforms: As a tourism company, they help past clients to provide reviews about their stay at the hotel, photos, among others, and that these reviews influence the consumer to buy the service. For example: Tripadvisor.

- Advertising campaigns: Creating advertising campaigns can be very useful to incite the purchase decision of a traveler.

- Social Networks: they have become the most influential phenomenon in communication in recent decades (Kaplan and Haenlein, 2010). They enable and facilitate community interaction, helping to foster trust and a common feeling among members (Leimeister et al., 2006), offering people new ways to build and maintain social networks, create relationships, share information, generate and edit content, and participate in social movements, through the Internet (Lorenzo et al., 2011). This type of interaction can include photos, videos, audio, video, links to web pages, among other elements. (Ryan and Jones, 2012).

7. Positioning for the hotel Tosepan Kali with a market expansión

Marketing plays an important role in the positioning of any company regardless of the sector to which it belongs, "*Social media optimization* or positioning in social networks is becoming very important thanks to web 2.0, because it makes it easier for companies to become an active member of these communities, providing very useful information for marketing campaigns" (Morales, 2010, as cited in Carpio et al, 2019).

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There are several marketing tools that exist, but digital marketing, also known as viral marketing, have been the most popular "To have brand positioning on the Internet people must find them when they search, when they browse social media and when they think about them" (Morales, 2010, as cited in Carpio et al, 2019).

There are several hotels that implement the different tourism and gastronomic marketing tools and strategies. "NH Hoteles and Grupo Barceló have carried out growth strategies through market penetration, giving importance in both cases to advertising, promotions and product development, adapting their service to demand, this has helped position the two companies internationally" (Bayón, 2014).

The Tosepan Kali hotel, with the intention of expanding its market could have a presence on the internet and get a greater reach on travel platforms, social interaction and website to be more recognized, achieving greater demand.

Methodology

The research design is quantitative, non-experimental, cross-sectional, uses a documentary and field technique with an exploratory and descriptive scope making use of a measurement instrument (survey) to know the needs and opinions of the target population (people residing in the states of Morelos and Puebla, 18 years old and older and who have a technological device). It began in January and ended in June 2021.

Results

For the present investigation, a questionnaire (see Annex 1) of 15 questions with multiple-choice answers was applied, in which 157 people participated, using a non-probabilistic convenience sampling, considering specific characteristics with a confidence level of 90% and a margin of error of 10%.

Of the people who participated in the survey, the majority were women, 76% of the total respondents were between 18 and 27 years of age, three quarters of the participants were single and the rest were married or divorced.

Given that the majority of respondents are very young and single, the predominant monthly income was less than $5,000, followed by the range of $6,000 to $15,000. Most of the respondents are not familiar with Hotel Tosepan Kali and therefore have not visited their website. Of the 7 social networks exposed in the survey, Facebook is the most used, followed by Instagram, thus, when asked how often they use each social network, Facebook is in first place with 58 votes, in second place, Instagram with 25, in third place, TikTok with 18, followed by YouTube with 17 and finally leaving as the least used Twitter and Pinterest. More than half of the respondents pay most attention to posts and videos on a social network, with a lower percentage following attention to photos and stories.

The media they mainly use to make a reservation are: website and phone call to the hotel with 63.7%, as well as with 26.1% encompassing travel platforms, travel agencies in person and their websites. What they pay less attention to in advertising is: the speed of the page, web page design, slogan and brand, on the contrary, with a greater number of votes are the photos as the main attraction of advertising, followed by the established prices, comments from other people and activities, as for what they would like a tourist and gastronomic package to include, more than half of the respondents prefer it to be all inclusive, with respect to the price they do not take more importance as much as the facilities and customer service.

To find a hotel most of the respondents look for opinions in: travel platforms, social networks and opinions of relatives, as well as, there are some participants who do not take into account the opinions, finally the two payment methods they prefer the most are cash and card (credit or debit), considering that there are also some who prefer to pay with deposit or transfer.

Annexes

Questionnaire 1: Marketing at the Tosepan Kali Hotel

1. Gender:

Male
Female
Intergender

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2. Age:

18-22 years
23- 27 years old
28-32 years old
33- 37 years old
38- 42 years old
43- 47 years old
48- 52 years old
53- 57 years old
Over 58 years old

3. Marital status:

Single
Married
Divorced
Widowed
Other: Click or click here to enter text.

4. How much is your monthly income?

Less than $5,000
$6,000- $15,000
$16,000- $25,000
$26,000- $35,000
$36,000- $45,000
$46,000- $55,000
More than $56,000

5. Have you heard of the Tosepan Kali Hotel?

Yes
No
Maybe you have

6. Have you visited the Tosepan Kali hotel website?

Yes
No
Maybe

7. Which social network do you use the most?

Facebook
Twitter
Instagram
Youtube
Tik tok
Pinterest
Other: Click or click here to write text.

8. According to the frequency with which you use the social networks, order in ascending order, number 1 being the one you use the least and number 6 the one you use the most.

	1	2	3	4	5	6
Facebook	○	○	○	○	○	○
Twitter	○	○	○	○	○	○
Instagram	○	○	○	○	○	○
Youtube	○	○	○	○	○	○
Tik Tok	○	○	○	○	○	○
Pinterest	○	○	○	○	○	○

9. What do you visit most often on a social network?

Videos
Photos
Stories
Posts
Comments
Another

10. When booking your accommodation, by what means do you do it most frequently?

Call to the hotel
Website (hotel)
Web page (travel agencies)
Travel agency (in person)
App of the establishment
Airbnbnb
Travel platforms
Other: Click or tap here to enter text.

11. What appeals to you most in advertising?

Slogan
Brand
Photos
Activities
Website design
Website speed
Comments from other people about the establishment
Prices stated in advertising
Other:Choose one item.

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12. According to needs, what would you like a tour package to include?

Lodging only
Lodging and some food (breakfast, lunch or dinner)
Lodging and recreational activities
All inclusive (lodging, food and recreational activities)

13. When staying in a hotel, what do you consider most important?

Facilities
Customer service
Price
Originality of the hotel
Location
Payment methods
Offers or agreements with other sites
Hotel discounts or packages
Hotel amenities (shampoo, soap, coffee, etc.)
Souvenir store
Gastronomic offer
Pet friendly
Gay friendly
Accessibility for people with disabilities
Other: Choose one item.

14. When looking for a hotel, you review or search for recommendations on:

Travel platform (tripadvisor, booking, trivago, kayak, despegar, bestday, expedia).
Opinions of people in a social network or family members.
Review of a famous person
None
Other: Choose one item.

15. What is your preferred method of payment when booking a hotel?

Card
Cash
Deposit
Transfer

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To the Benemérita Universidad Autónoma de Puebla.

Conclusions

The company IlB conducted a study in the year 2021 regarding the most used social networks globally, the results showed Facebook in first place with 2,701 million users, followed by YouTube and WhatsApp, in the results of the survey conducted for this research it was obtained that indeed Facebook is the most used, however, the next social network is Instagram considering that they had greater participation people from 18 to 27 years old.

Regarding the preference of hotel packages, Vara (2020, as cited in REPORTUR, 2020) mentions that "All Inclusive is a product that the market asks for; we do not command, those who command are the clients, those who have the money in the bag" with this the results obtained in the measurement instrument are confirmed given that the majority prefer all-inclusive tourist and gastronomic packages, the service provider must become familiar with this and take into account the client's needs, Considering that the price does not matter when there is a variety of service, it will be important for the hotel Tosepan Kali to consider an offer of this type, as well as the management of direct reservations in hotels and travel platforms with cash or card payment options.

To conclude, it was observed that the most used strategy nowadays is the digitalization through the use of social networks to obtain a greater reach, in that sense, the hotel should focus its attention to an adequate management of its different social networks. The expansion of the market in the hotel Tosepan Kali can give opportunity to position itself in the conventional market since it has different unique attributes, however, it is necessary to implement a training plan for all staff on the use of technological tools, and thus obtain quality content based on photographs and videos, in the same way, implementing the company-customer interaction having continuity in publications, without forgetting that the strategies that can be implemented are: customization of customer service, maintenance of facilities, creating solid corporate brand and having a presence in travel platforms.

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References

Alcaide, J. C., Bernúez, S., Díaz, A., Espinoza, R., Muñíz, R., & Smith, C. (2013) *Marketing y Pymes: Principales claves de marketing en la pequeña y mediana empresa*. Retrieved March 9, 2014 from: https://goo.gl/K3Tov1

American Marketing Association (Approved, 2007) *Definitions of marketing.* https://www.ama.org/the-definition-of-marketing-what-is-marketing/

Asociación Mexicana de Internet. (2014). *Estudio de marketing digital y social media. (Informe anual)*. Retrieved from: https://www.asociaciondeinternet.mx/es/component/remository/Marketing-Digital-yRedesSociales/MKT-Digital-y-Redes-Sociales-en-Mexico-2014/lang,es-es/?Itemid

Asociación Mexicana de Internet. (2018 a). *Estudio de comercio electrónico en México (Informe anual).* Retrieved from: https://www.asociaciondeinternet.mx/es/component/remository/ComercioElectronico/Estudio-de-Comercio-Electronico-en-Mexico-2018/lang,es-es/?Itemid=

Bayón, R. (2014). *Estrategia de crecimiento en el sector turístico español: El caso de NH Hoteles y el Grupo Barceló.* León, Guanajuato.

Carpio, A., Serezade, M., Cutipa, A.M., Flores, E. (2019). *Estrategias del marketing viral y el posicionamiento de marca en los restaurantes turísticos de la Región de Puno.* Scielo Perú.

Cobra, M. (2003). *Marketing de servicio*. Colombia

Córdoba López, J.F. (2009) *Del marketing transaccional al marketing relacional* construcción [Review article] https://www.redalyc.org/articulo.oa?id=265420457002

Garcon, E. (2009). Palermo.edu. Retrieved from: Palermo.edu: http:// www.palermo.edu/dyc/opendc/opendc2009_2/apuntes/098. pdf

Gutiérrez, H. y Salvatierra, J. (February 12, 2020). *Los turistas cada vez reservan más en las páginas de los hoteles frente a gigantes como Booking.* Retrieved from El País: https://elpais.com/economia/2020/02/11/actualidad/1581439089_213172.html

Herrera, B. (2019, May). *Los Maseual de la región de Cuetzalan y su incursión en el turismo.* Tesis de doctorado. El colegio de Tlaxcala A.C México

INEGI. (November 14, 2020). *Cuetzalan del Progreso*. Retrieved from Cuetzalan del Progreso: https://www.inegi.org.mx/app/indicadores/?ag=21043#divFV1002000001

Kaplan, A. and Haenlein, M. (2010). *Users of the world, unite! The challenges and opportunities of social media.* Business Horizons,pp 59-68.

Kotler, P. Keller, K. (2006) *Dirección de Marketing*. Pearson, Ed. 12. México.

Kotler, P. y Armstrong, G. (2008). *Marketing basics*. Nueva York,EU: Pearson Education.

Kotler, P., Cámara, D., & Grande, I. (1994). *Dirección de Marketing*. Madrid, España: Prentice Hall.

Lacalle, G. (2015). *Operaciones administrativas de compraventa.* México: EDITEX

Leimeister, J., Sidiras, P. and Krcmar, H. (2006). *Ex- ploring success factors of virtual communities: Perspectives of members and operators.* Journal of Organizational Computing and Electronic Commerce,pp 279-300.

Lorenzo, C., Constantinides, E. and Alarcón, M. (2011). *Consumer adoption of social networking sites: Implications for theory and practice.* Journal of Research in Interactive Marketing, 170-188.

Noblecillas, M. y Granados, M. (2018). *El marketing y su aplicación en diferentes áreas del conocimiento.* Machala, Ecuador: Ed. UTMACH

Ojeda G. C., y Mármol, S. P. (2012) *Marketing Turístico*. Asturias, España. Paraninfo

ISSN-On line: 1390-9959

Parra Meroño; M. C.; Beltrán Bueno, M. A. 2011. *Marketing y Dirección Comercial*. Murcia: Universidad Católica San Antonio.

Parra, M.C. y Beltrán, M.A. (2014). *Estrategias de marketing turístico.* Revista Gestión comercial,4-7. file:///I:/seminario/estrategias%20marketing%20turistico.pdf

Producción Social del Habitat. (October 14, 2015). *Unión de Cooperativas Tosepan*. Retrieved from Unión de Cooperativas Tosepan: https://produccionsocialhabitat.wordpress.com/galeria-de-casos/tosepan/

Quintana Navarro, A. B. (2000). *Dirección y administración de marke- ting* . Madrid, España: AQ Professional Learning

REPORTUR. (November 15, 2020). *Cancún sería un cementerio sin "todo incluido", replican a FONATUR.* Retrieved from REPORTUR: https://www.reportur.com/mexico/2020/11/15/cancun-seria-cementerio-sin-incluido-replican-fonatur/

Ryan, D. and Jones, C. (2012). Understanding di- gital marketing: Marketing strategies for engaging the digital generation. London: Kogan Page.

Secretaría de Gobernación. (November 27, 2019). *Plan Estatal de Desarrollo, 2019-2024.* Retrieved from Gobierno del Estado de Puebla: https://ojp.puebla.gob.mx/index.php/programas/item/plan-estatal-de-desarrollo-2019-2024

Secretaria de Turismo. (July 15, 2019). *Cuetzalan del Progreso, Puebla*. Obtenido de Cuetzalan del Progreso, Puebla: https://www.gob.mx/sectur/es/articulos/cuetzalan-del-progreso-puebla?idiom=es

Secretaría de Turismo. (April 28, 2014). *Cuetzalan del Progreso, Puebla*. Retrieved from Cuetzalan del Progreso, Puebla: http://www.sectur.gob.mx/gobmx/pueblos-magicos/cuetzalan-delprogresopuebla/#:~:text=Enclavado%20en%20la%20serran%C3%ADa%20poblana,de%20flora%20y%20fauna%20ex%C3%B3tica.

Tosepan Kali. (July 09, 2017). *Bienvenido Tosepan Kali*. Retrieved from Bienvenido Tosepan Kali: https://www.tosepankali.com/v2/

Trigueiro, C. M. (1999). *Marketing e turismo: como planejar e administrar o marketing turístico para uma localidade.* Río de Janeiro: Qualitymark Editora.

Vaz, G. N.(2002) *Marketing turístico: recep tivo e emissivo: um roteiro estratégico para projetos mercadológicos públicos e privados.*São Paulo,Pioneira Thomson Learning

Zuccherino, S. (2016). *Social media marketing: La revolución de los negocios y la comunicación digital*.

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Estimation of the phytoplankton biomass in Bahia Manzanillo, Colima (2016-2017)

Estimación de la biomasa fitoplanctónica en Bahía Manzanillo, Colima (2016-2017)

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Abstract

Phytoplankton biomass (Chl-*a*) was estimated in 7 stations of Manzanillo Bay, Colima on the surface and at the Secchi depth in the rainy and dry season (2016-2017). To evaluate the biomass, a Millipore equipment and fiberglass GF / F filters were used using the spectrophotometric technique (Lorenzen, 1967). The physicochemical parameters were estimated with a YSI 85 equipment and the nutrients using a San Plus II segmented flow autoanalyzer. The average depth of the Secchi disk ranged from 5.9 m at the Puerto station to 12.8m at the center (A1 and A2). The temperature ranged from 26.9 to 28.1 ° C, the salinity between 31.6 and 33 ups and the dissolved oxygen from 3.81 to 4.82 mg L-1. The nutrients presented high values in Puerto, A1 and Carrizales. The central part of the bay registered values greater than one mg of Chl-*a* and a maximum of 2.67 mg .m-3 in the Puerto station. In 2016, Chl-*a* decreased significantly because of a very intense Niño event, also showing high concentrations of phaeopigments, which reveal grazing conditions or degraded chlorophyll. Through an analysis of variance, it was determined that there is a significant difference between the chlorophyll-a values ($p \leq 0.05$).

Phytoplankton, Biomass, Manzanillo

Resumen

Se estimó la biomasa fitoplanctónica (Cl-*a*) en 7 estaciones de la Bahía de Manzanillo, Colima en superficie y a la profundidad Secchi en temporada de lluvia y estiaje (2016-2017). Para evaluar la biomasa se empleó un equipo Millipore y filtros GF/F de fibra de vidrio mediante la técnica espectrofotométrica (Lorenzen, 1967). Los parámetros físico-químicos se estimaron con un equipo YSI 85 y los nutrientes mediante un Autoanalizador de flujo segmentado San Plus II. La profundidad promedio del disco de Secchi fluctuó entre 5.9 m en la estación Puerto hasta 12.8m en el centro (A1 y A2). La temperatura varió de 26.9 a 28.1°C, la salinidad entre 31.6 y 33 ups y el oxígeno disuelto de 3.81 a 4.82 mg L^{-1}. Los nutrientes presentaron valores altos en Puerto, A1 y Carrizales. La parte central de la bahía registró valores mayores a un mg de Cl-*a* y un máximo de 2.67 mg $.m^{-3}$ en la estación Puerto. En 2016 la Cl-*a* bajó significativamente debido al efecto de un evento Niño muy intenso, apreciándose también altas concentraciones de feopigmentos, que revelan condiciones de pastoreo o clorofila degradada. Mediante un análisis de varianza, se determinó que existe diferencia significativa entre los valores de clorofila-*a* ($p \leq 0.05$).

Fitoplancton, Biomasa, Manzanillo

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Introduction

Biomass and phytoplankton productivity support the ocean's trophic webs and are the component of the pelagic ecosystem responsible for the transformation of carbon dioxide into organic carbon (Gaxiola-Castro *et al*., 2010). Therefore, it is essential to know the spatial and temporal variability of chlorophyll-a (Chl-*a*), an index of phytoplankton biomass and primary productivity to understand carbon cycles, changes in the populations of fishery resources, and the coupling of the physic-biogeochemical factors of the ocean.

Research on biomass variability and primary productivity in the Mexican seas is more abundant in the Pacific region of the California Peninsula and the Gulf of California (Lara-Lara *et al*., 1993), however, they are scarce and irregular in the coasts of Nayarit, Jalisco, and Colima (Otero-Dávalos, 1981, Zuria-Jordán, 1995, Blanco-Alonso and Madrid-Hernández, 2004).

The objective of the present study was to estimate the spatial-temporal variability of the phytoplankton biomass in the Bay of Manzanillo, Colima, in rainy and low-water conditions.

Materials and methods

Study area

Bahía Manzanillo, Colima is in the central Mexican Pacific, between 19º 05 ’and 19º 08’ north latitude and 104º 20 ’and 104º 25’ west longitude. This is the port of Manzanillo, one of the most important and with the largest maritime flow in Mexico (Figure 1).

Figure 1 Map of Manzanillo Bay, Colima
Source: *Taken from Google earth*

The beaches are semi-protected with a gentle slope and fine or coarse sand with alternating presence and at the ends of rocky massifs and fixed rocks of different sizes including boulders. The shallow subtidal (> 10 m) has rocky-sandy bottoms, fragments of dead coral and patches of live coral, mainly of the genus *Pocillopora* sp, which are better represented in the Carrizales area.

The region's climate is warm-sub-humid with rains in summer that corresponds to the Awo (e) subtype, according to the Köppen classification modified by García (2004). In the area, maximum temperatures of 39ºC and minimum temperatures of 16ºC are registered; and a humidity percentage higher than 75%. The annual rainfall in the Manzanillo region is **111** mm. The rains occur in the months of July to October in 93% and are mostly subject to cyclonic disturbances that almost always follow a path parallel to the coast (INEGI, 1980).

The prevailing winds come from the west and northwest, reaching an average annual speed of 4.38 m. s^{-1}. The marine currents present a direction towards the outside of the Santiago Bay through Punta Juluapan and then go to the Southeast, towards Punta Campos. There is an anticyclonic turn between Punta Santiago, Cerro del Vigía, near Punta Ojo de Agua and Punta Juluapan and convergence of currents at the center of Manzanillo Bay. The circulation is very homogeneous in the 5, 10, 15 and 20 m depth layers. Average speeds of ocean currents are of the order of 34 cm.s-1 (0.660 knots).

Field work

Four field trips were carried out, two in the dry season months and two in the warm humid season to estimate chlorophyll-*a* and its phaeopigments. Three sampling sites were in the central part (A1, A2 and A3) and the rest around the bay: Puerto, Punta Santiago, Juluapan and Carrizales (Figure 2).

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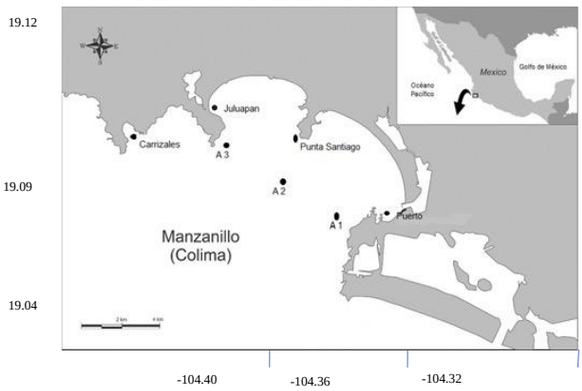

Figure 2 Location of sampling stations for phytoplankton in Manzanillo Bay, Colima

The depth of the sites varied between 8 m at the Puerto station and 70 m at the A1 station. The samples were obtained at the surface and at the Secchi depth using a 5-liter Niskin bottle. The physical-chemical variables (temperature, salinity, nutrients, and dissolved oxygen) were determined with a YSI-85 equipment, the turbidity was determined by means of the Secchi disk, and the direction and speed of the wind with an anemometer.

Chlorophyll-*a* and nutrient samples were kept in a cooler protected from light. One liter of water from each sample was filtered through a Millipore equipment using GF / F glass fiber filters of 25 mm diameter and 0.25 µm pore. Filters were kept frozen until analyzed. The chlorophyll-*a* was extracted with 90% acetone, after remaining 24 hours in the dark and refrigeration. The determinations were made with the spectrophotometric method described by Lorenzen (1967). Nutrients were determined with a San Plus II Segmented Flow Autoanalyzer.

The conditions that prevailed on the sampling days were contrasting, in January there was mild waves and weak winds and in June 2017 more intense waves with gusts of wind of more than 12 m.s-1 due to nearby tropical storms. Table 1 shows the spatial variation of the physical-chemical parameters and in figure 3 its seasonal variation. The depth of the Secchi disk fluctuated from 5.9 m at the Puerto station to 12.8 m in the center of the bay (A1, A2). The greater turbidity of the Puerto station is the result of greater contamination of organic matter in the site and in the most coastal stations due to the contribution of terrigenous materials and urban discharges. In addition, a higher demand for dissolved oxygen can be seen in these stations (Table 1).

The warmest temperatures were recorded in June, decreasing in January and February, with a difference between 3 to 4ºC (Figure 2b). In both months, homogeneous values of temperature and dissolved oxygen were observed in the water column by effective mixing in the bay.

The average salinity values varied according to the wet and dry season (Figure 2c).

Station	Secchi (m)	Temperature (°C)	Salinity (ups)	Oxygen (mgL^{-1})
A1	12.7	27.6	32.7	4.69
A2	12.8	28.1	32.9	4.82
A3	10.7	28.1	32.9	4.70
Carrizales	10.1	28.1	32.7	4.55
Juluapan	6.8	27.8	33.0	4.39
Santiago	9.3	27.4	32.2	4.55
Puerto	5.9	26.9	31.6	3.81

Table 1 Spatial variation of average values of physical-chemical factors in Manzanillo Bay, Colima (2016-2017)

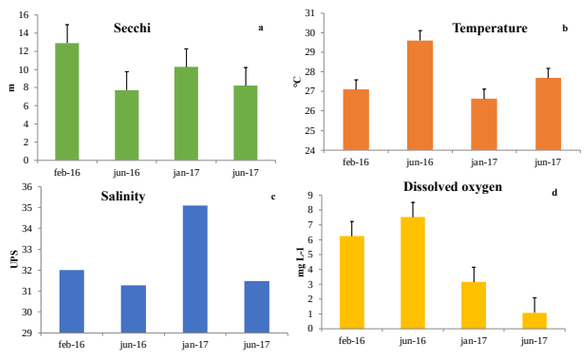

Figure 3 Temporal variation of average values of physical-chemical factors in the Bay of Manzanillo, Colima (2016-2017)

The nutrients presented higher values at the bottom of the stations, being particularly higher at the Puerto, A1 and Carrizales stations. Table 2 shows the average values for each month and the minimum and maximum value in parentheses.

Month	NO_3+NO_2	NH_4 (µM)	PO_4	SiO_2
Feb 16	**7.83** (2.3-18.3)	**1.37** (0.9-1.8)	**0.30** (0.1 -0.7)	**103.29** (38.4-152)
Jun 16	**6.68** (3.9-14.6)	**0.22** (0.19-0.3)	**0.76** (0.3-2.5)	**12.48** (2.9-30.5)
Jan 17	**3.34** (2.6-4.0)	**0.28** (0.20-0.4)	**0.9** (0.78-0.8)	**7.47** (6.5-8.5)
Jun 17	**5.30** (4.6-5.9)	**0.11** (0.08-0.13)	**0.71** (0.6-0.83)	**9.34** (8.6-9.9)

Table 2 Temporal variation of nutrients in Bahía Manzanillo, Colima. Average and minimum and maximum values in parentheses (µM)

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The concentration of nutrients was like those reported by other authors in studies of the Mexican Pacific, where the trend is that they increase with depth, generally at the level of the nutritional content, from there, they can be maintained or decreased, depending on the characteristics. dynamics of local deep circulation (Lara-Lara and Bazán Guzmán, 2005).

The average values of nitrates and nitrites were slightly higher, with respect to those reported for the Mexican Pacific by De la Lanza-Espino (2001), which describes a higher content of nitrites (3.6 µM) and values less than 0.1 ml L^{-1} oxygen in the anoxic layer, and increased nitrates and dissolved oxygen below it.

The phosphate values were lower than those reported for the Mexican Pacific by Vázquez *et al*. (1998). In their study they mention that orthophosphates vary between 0.1 and 1.5 µM at the surface level and increase to 3.0 µM at depths below the thermocline. It is the nutrient that is assimilated in the least amount as shown by the atomic proportion in organic matter (C106N16P1) and when decomposed, the proportion is preserved (Redfield *et al*., 1963).

The values of the silicates in this work presented values like those reported for the Gulf of Tehuantepec (Vázquez *et al*., 1998), where surface variations of 1.0 to 174 µM have been found in autumn-winter and from 0.3 to 207 µM in summer, attributable to river contributions. Diatoms especially assimilate silicates, so their optimal growth is regional.

Photosynthetic pigments

Spatial variation

Values greater than one milligram of chlorophyll-*a* were recorded in the central part of the bay, unlike the rest of the stations, except for the Puerto station, which had a value of 2.67 $mg.m^{-3}$ in February (Figure 4).

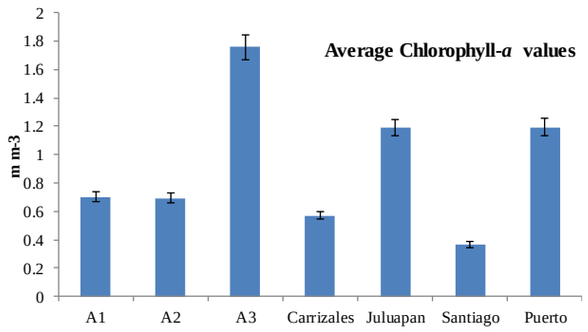

Figure 4 Average values of chlorophyll-a in the sampling stations

In 2017 the values were high in most of the stations, mainly in the center of the bay (A2, A3), with a gradual decrease towards the most coastal stations in a clockwise direction, this due to the geomorphology of the bay and to the anticyclonic turn between Punta Santiago, Cerro del Vigía, near Punta Ojo de Agua and Punta Juluapan with convergence of currents to the center of Manzanillo Bay, with the exception of the Puerto station that is outside this influence and the values tend to increase (Figure 5).

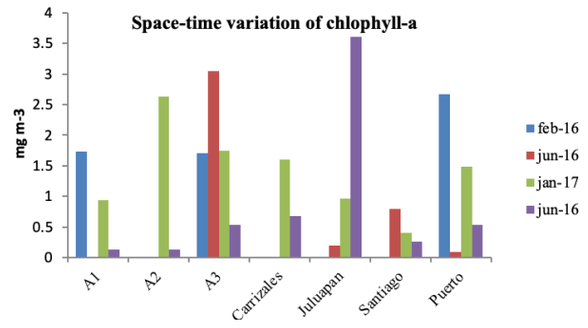

Figure 5 Space-time variation of Chlorophyll-*a*, in Manzanillo Bay, Colima

Temporal variation

A marked seasonal difference in chlorophyll-a values was observed in the study area. The dry months (January, February) presented higher values and decreased in the rainy season (June), mainly associated with consumption by grazing (Figure 6a).

According to an analysis of variance (ANOVA), it was possible to determine that there is a significant difference between the chlorophyll-*a* values ($p \leq 0.05$).

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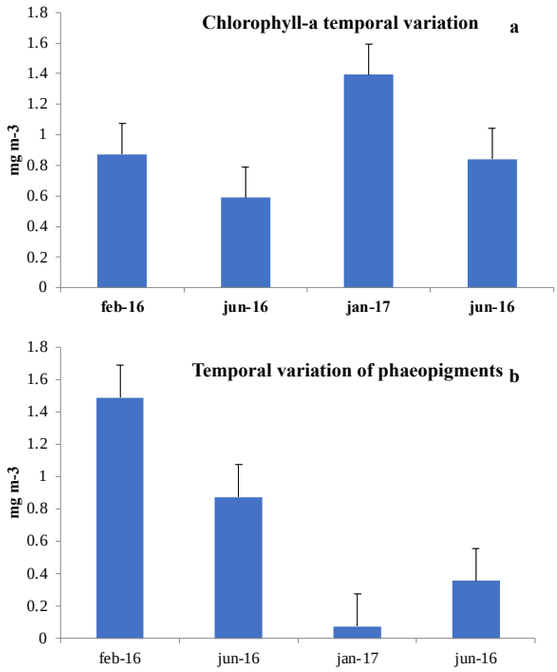

Figure 6 a) Average values of chlorophyll-*a* and b) of phaeopigments in the sampling months

The low values of Chl-*a* in 2016 resulted from a Niño event (2015-2016) that occurred with great magnitude and intensity in the Pacific Ocean. Gómez-Ocampo *et al*. (2017b) reported a decrease in chlorophyll-*a* recorded through satellite images and modeled primary production for the southern part of the California Current, during El Niño from 2015–2016. This phenomenon caused a significant decrease in phytoplankton productivity, economic losses due to collapse in fisheries and droughts in the continental part of several countries (De la Cruz-Orozco *et al*., 2017).

According to these conditions, the high values of phaeopigments registered in 2016 (Figure 6b) reveal conditions of chlorophyll-a degraded by decomposition of phytoplankters (Barreiro and Signoret, 1999). On the other hand, the phaeopigment values registered in 2017 were low or undetectable by the technique in several stations, mainly for the month of January, which suggests a recovery of phytoplankton communities due to the seasonal pattern indicated in several studies.

In winter there is a decomposition-remineralization, with an increase in the nutrients for the next cycle, as observed in the present study (January, February) to be available in the spring bloom, where the nutrient content decreases due to biological assimilation.

In summer it increases by decomposition of dead organic matter and in autumn there is again an assimilation process.

The winds ranged from 0 to 8.7 km. h^{-1} with a predominantly west direction, favoring the mixing of the water column. The depth of the euphotic zone and the mixed layer are of relevant importance for phytoplankton, which receives light energy to carry out its most important physiological functions: photosynthesis and growth.

On the other hand, in regions where the nutrition and thermocline are present near the surface layer, the enrichment of the euphotic zone is favored by the mixture that is generated with a minimum wind effort, increasing the production of these areas (Estrada and Blasco, 1985). In regions such as the tropical eastern Pacific, where the thermocline is very shallow, the euphotic zone can be enriched in nutrients with relatively low winds, increasing phytoplankton productivity (Lara-Lara and Bazán-Guzmán, 2005; López-Sandoval *et al.*, 2009).

A trend of increasing Chl-*a* concentrations with depth was observed in several stations during the sampling months. In the stations located in the central part of the bay, subsurface concentrations were recorded between 10 and 15 m, as has been reported in other studies (Lara-Lara and Bazán-Guzmán, 2005). This increase is associated with the quantity and quality of light, which is optimal for photosynthesis, as well as an increase in the concentration of nutrients at these depth levels.

Table 3 compares the results obtained from phytoplankton biomass (Chl-*a*) with studies carried out in the waters of the Mexican Pacific.

Study area	Chlorophyll*a* (mg m-3)	Authors
Chamela Bay, Jal.	0.0 – 16.0	Blanco-Alonso y Madrid-Hernández, 2004
Gulf of Tehuantepec, Oax.	0.04 -11.1	Robles Jarero y Lara- Lara, 1993
Mexican tropical pacific	0.09 – 3.78	Lara-Lara y Bazán Guzmán, 2005
Cabo Corrientes, Jal.	0.8 – 11.3	López-Sandoval *et al.*, 2009
Manzanillo Bay, Col.	1.1 -20.8	Sosa-Avalos *et al*., 2015
Manzanillo Bay, Col.	0.0 – 2.73	Present study

Table 3 Chlorophyll-*a* values in some places in the Mexican Pacific

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Chlorophyll-a has been related to the estimation of primary production. Raymont (1980) proposes equivalences of chlorophyll-*a* and Carbon in phytoplankton as follows: 1 µg of chlorophyll-*a* = 13.6 to 17. 3 µg C, 1 mm3 of algal volume at 0.01 - 0.125 mg C and 1 µg of chlorophyll-*a* 34.8 µg of dry weight of organic matter. However, this estimate is approximate, since the content of this pigment in phytoplankton varies widely depending on the species, their nutritional and physiological status, the degree of illumination and type of light, among other factors.

Therefore, maximums can be registered below the surface (20 m in coastal areas, 50 to 200 m in oceanic areas), depending on the solar position and experience planktonic increases or sinks within the euphotic zone, depending on the time of day. There is also a temporal variation depending not only on the nictemeral (daily) cycles of the organisms, but also seasonal, as happens more clearly in temperate zones. Therefore, the chlorophyll-*a* content varies widely, depending on the region.

It is important to continue systematic studies of the primary producers of the coast throughout the Mexican tropical Pacific, since the dynamics that together they contribute to the coastal system and the role they play with the flow of carbon is unknown.

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Conclusions

In the present study, the chlorophyll-a values were low, especially in 2016, due to the presence of the El Niño phenomenon (2015-2016) on the eastern coast of the Pacific Ocean, which caused a decrease in phytoplankton productivity and economic damage in several countries, however, the registered values are found in the intervals reported for the Mexican Pacific.

Significant differences ($p \leq 0.05$) were observed in the temporal variation in the Chl-*a* values. In the dry months (January and February) they were higher and decreased in the wet season (June), mainly due to grazing activity. In 2017 the values increased up to an order of magnitude and the phaeopigments were low or undetectable in several sampling stations, particularly in January, being clear evidence that the phytoplankton community was in a process of recovery and growth, which is manifested in flowering. of spring.

According to the geomorphology and local circulation of the study area, a trend was observed in the variation of chlorophyll-*a* and phaeopigments, with increases in the center of the bay (station A2, A3), to gradually decrease towards the most coastal stations and increase again at the Puerto station.

The maximum values of Chl-*a* were recorded at the subsurface level, occurring between 10 and 15 m in the central stations that are deeper, the foregoing agrees with several authors, who mention that adequate light and concentration of nutrients to carry out photosynthesis optimally.

References

Blanco-Alonso, A. y Madrid-Hernández, J. (2004). *Evaluación espacio-temporal de la biomasa del fitoplancton y nutrientes, en la costa central de Jalisco y Manzanillo, Colima*. Tesis de Licenciatura. Universidad de Guadalajara, CUCBA, Guadalajara, Jal, 36 p.

Barreiro-Güemes, M. T. y Signoret-Poillon, M. (1999). *Productividad primaria en sistemas costeros. Métodos de evaluación.* Universidad Autónoma Metropolitana, 81 p. ISBN 970-654-636-7

De la Cruz-Orozco, M. E., Gómez-Ocampo, E., Miranda-Bojórquez, L. E., Cepeda-Morales, J., Durazo, R., Lavaniegos, B. E., Espinosa-Carreón, T. L., Sosa-Ávalos, R., Aguirre-Hernández, E. y Gaxiola-Castro, G. † (2017). Biomasa y producción del fitoplancton frente a la península de Baja California:1997–2016. *Ciencias Marinas* (2017), 43(4): 217–228

De la Lanza-Espino, G. (2001). Características físico-químicas de los mares de México. *Temas Selectos de Geografía de México*. Instituto de Geografía, UNAM. 149 p. ISBN-968-36-9544-2

Estrada, M. y Blasco, D. (1985). Phytoplankton assemblages in coastal upwelling areas. Simposio internacional sobre las áreas de afloramiento más importantes del Oeste Africano (Cabo Blanco y Benguela). *Ins. Inv. Pesq*., Barcelona, 1: 379–402.

Gaxiola-Castro, G., Cepeda-Morales, J., Nájera-Martínez, S., Espinosa-Carreón, T. L., de la Cruz-Orozco, M. E., Sosa-Ávalos, R., Aguirre-Hernández, E. y Cantú Oliveros, J. P. (2010). Biomasa y Producción del Fitoplancton en la Corriente de California frente a Baja California. In. Dinámica del Ecosistema Pelágico frente a Baja California, 1997-2007. *Diez años de Investigaciones Mexicanas de la Corriente de California.* R. Durazo y G. Gaxiola-Castro (Eds.). SEMARNAT-INE-CICESE: 59-85 pp.

Gómez-Ocampo, E., Gaxiola-Castro, G., Durazo, R. y Beier, E. (2017b). Effects of the 2013–2016 warm anomalies on the California Current phytoplankton. *Deep-Sea Res*. (II Top. Stud. Oceanogr.) 0-1.

Lara-Lara, J. R. y C. Bazán-Guzmán (2005). Distribución de clorofila y producción primaria por clases de tamaño en la costa del Pacífico mexicano. *Ciencias Marinas* 31: 11-21.

Lara-Lara, R, Millán-Núñez, R., Lara-Osorio, J. L. y Bazán-Guzmán, C. (1993.) Productividad y biomasa del fitoplancton por clases de tamaño, en la parte oriental del Golfo de California, durante la primavera de 1985. *Ciencias Marinas*, 19(2): 137-154.

López–Sandoval, D. C., Lara–Lara, J. R., Lavín, M. F., Álvarez–Borrego, S., y Gaxiola–Castro, G. (2009). Productividad primaria en el Pacífico oriental tropical adyacente a Cabo Corrientes, México. *Ciencias Marinas*, 35 (2): 169-182

Lorenzen, C. J. (1967). Determination of chlorophyll and phaeopigments: spectrophotometric equations, en *Limnol. Oceanogr*., 12:343-346.

Otero-Dávalos, L. M. (1981). *Ciclo anual de la producción primaria en la bahía de Chamela.* Tesis de Licenciatura en Biología. Facultad de Ciencias, UNAM, México, DF. 98p.

Raymont, J. E.G. (1980). *Plankton and productivity of the oceans*. 2nd ed. V. 2. Pergamon.

Robles–Jarero E.G. y Lara–Lara J. R. (1993). Phytoplankton biomass and primary productivity by size classes in the Gulf of Tehuantepec, México. *J. Plankton Res*. 15: 1341–1359.

Sosa-Ávalos, R., Millán-Núñez, E., Quijano-Scheggia, S. I., Lara-Lara, J. R. y Silva-Iñiguez, L. (2015). Variabilidad del coeficiente de absorción por fitoplancton con influencia de Marea roja en las bahías de Manzanillo y Santiago, México. *Revista de Biología Marina y Oceanología*. Vol 50 (3), 427-438

Vázquez-Gutiérrez, F.G., López, S., Ramírez-Álvarez, A., Turner-Garcés, M., Frausto-Castillo, A., y Alexander-Valdés, H. (1998). La química del agua, en Tapia García, M. (ed), *El Golfo de Tehuantepec: el sistema y sus recursos*, UAM, México, 35-50 p.

Zuria-Jordan, I. L., Álvarez-Borrego, S., Santamarina-del- Ángel, E. y Müller-Karger, F. E. (1995). Estimación de la Biomasa Fitoplanctónica Derivada de Datos de Satélite, frente a Baja California Sur. *Ciencias Marinas*, 21 (3): 265-268

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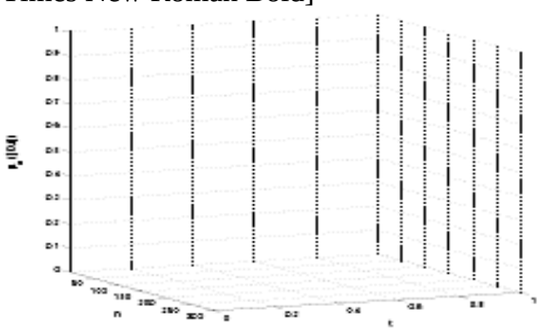

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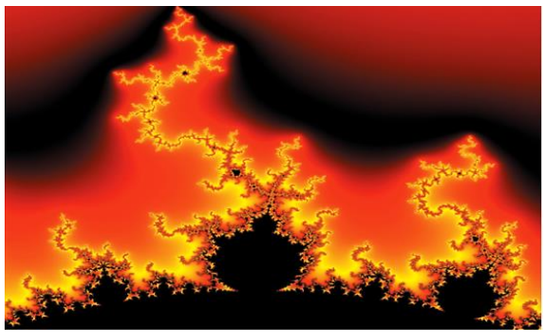

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