ISSN 2444-4936

Volume 7, Issue 19 – January – June – 2021

Journal of Environmental Sciences and Natural Resources

ECORFAN®

ECORFAN-Spain

Chief Editor
VILLASANTE, Sebastián. PhD

Executive Director
RAMOS-ESCAMILLA, María. PhD

Editorial Director
PERALTA-CASTRO, Enrique. MsC

Web Designer
ESCAMILLA-BOUCHAN, Imelda. PhD

Web Diagrammer
LUNA-SOTO, Vladimir. PhD

Editorial Assistant
TREJO-RAMOS, Iván. BsC

Translator
DÍAZ-OCAMPO, Javier. BsC

Philologist
RAMOS-ARANCIBIA, Alejandra. BsC

Journal of Environmental Sciences and Natural Resources, Volume 7, Issue19, June - 2021, is a journal published biannually by ECORFAN-Spain. Calle Matacerquillas 38, CP: 28411. Moralzarzal-Madrid. WEB: www.ecorfan.org/spain,revista@ecorfan.org. Editor in Chief: RVILLASANTE, Sebastián. PhD. ISSN: 2444-4936. Responsible for the last update of this issue of the ECORFAN Informatics Unit. ESCAMILLA-BOUCHÁN, Imelda, LUNA-SOTO, Vladimir, updated June 30, 2021.

The views expressed by the authors do not necessarily reflect the views of the publisher of the publication.

Reproduction of all or part of the contents and images of the publication without permission of the Centro Español de Ciencia y Tecnología is strictly prohibited.

Journal of Environmental Sciences and Natural Resources

Definition of Journal

Scientific Objectives

Support the international scientific community in its written production Science, Technology and Innovation in the Field of Biotechnology and Agricultural Sciences, in Subdisciplines of agriculture-forest, pathology-sustainable, horticulture, fisheries and aquaculture, agricultural biotechnology.

ECORFAN-Mexico, S.C. is a Scientific and Technological Company in contribution to the Human Resource training focused on the continuity in the critical analysis of International Research and is attached to CONACYT-RENIECYT number 1702902, its commitment is to disseminate research and contributions of the International Scientific Community, academic institutions, agencies and entities of the public and private sectors and contribute to the linking of researchers who carry out scientific activities, technological developments and training of specialized human resources with governments, companies and social organizations.

Encourage the interlocution of the International Scientific Community with other Study Centers in Mexico and abroad and promote a wide incorporation of academics, specialists and researchers to the publication in Science Structures of Autonomous Universities - State Public Universities - Federal IES - Polytechnic Universities - Technological Universities - Federal Technological Institutes - Normal Schools - Decentralized Technological Institutes - Intercultural Universities - S & T Councils - CONACYT Research Centers.

Scope, Coverage and Audience

Journal of Enviromental Sciences and Natural Resources is a Journal edited by ECORFAN-Mexico S.C in its Holding with repository in Mexico, is a scientific publication arbitrated and indexed with semester periods. It supports a wide range of contents that are evaluated by academic peers by the Double-Blind method, around subjects related to the theory and practice of agriculture-forest, pathology-sustainable, horticulture, fisheries and aquaculture, agricultural biotechnology with diverse approaches and perspectives, that contribute to the diffusion of the development of Science Technology and Innovation that allow the arguments related to the decision making and influence in the formulation of international policies in the Field of Biotechnology and Agricultural Sciences. The editorial horizon of ECORFAN-Mexico® extends beyond the academy and integrates other segments of research and analysis outside the scope, as long as they meet the requirements of rigorous argumentative and scientific, as well as addressing issues of general and current interest of the International Scientific Society.

Editorial Board

SANDOVAL – SALAS, Fabiola. PhD
Universidad de Castilla

SAHAZA - CARDONA, Jorge Humberto. PhD
Universidad de Antioquia

ESCOBEDO - BONILLA, Cesar Marcial. PhD
Universidad de Gante

GONZALEZ - TORRIVILLA, Cesar Castor. PhD
Universidad Central de Venezuela

JOVEL, Juan. PhD
University of Alberta

HERNÁNDEZ - MARTINEZ, Rufina. PhD
University of California

ARAUJO - BURGOS, Tania. PhD
Universita Degli Studi di Napoli Federico II

GARCÍA - DE SOTERO, Dora Enith. PhD
Universidad de Sao Paulo

ROMERO - PÉREZ, Diego. PhD
University of California

FLORES - PACHECO, Juan Asdrúbal. PhD
Universidad de Valladolid

Arbitration Committee

SÁNCHEZ - OROZCO, Raymundo. PhD
Tecnológico de Estudios Superiores de Jocotitlán

DEL ÁNGEL - CORONEL, Oscar Andrés. PhD
Instituto Tecnológico de Veracruz

MEDINA - SAAVEDRA, Tarsicio. PhD
Universidad Nacional Autónoma de México

AVENDAÑO - ARRAZATE, Carlos Hugo. PhD
Colegio de Postgraduados

RUIZ - AGUILAR, Graciela M.L. PhD
Instituto Politécnico Nacional

SAHAZA - CARDONA, Jorge Humberto. PhD
Universidad Nacional Autónoma de México

ACOSTA - NAVARRETE, María Susana. PhD
Instituto Tecnológico de Celaya

MORÁN - SILVA, Ángel. PhD
Universidad Veracruzana

CHAVEZ - SANTOSCOY, Rocío Alejandra. PhD
Universidad Autónoma de Baja California

LUCIO - DOMINGUEZ, Rodolfo. PhD
Universidad Michoacana de San Nicolas de Hidalgo

ROSAS - ACEVEDO, José Luis. PhD
Universidad Autónoma de Guerrero

Assignment of Rights

The sending of an Article to Journal of Enviromental Sciences and Natural Resources emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Originality Format for its Article.

The authors sign the Authorization Format for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.

Declaration of Authorship

Indicate the Name of Author and Coauthors at most in the participation of the Article and indicate in extensive the Institutional Affiliation indicating the Department.

Identify the Name of Author and Coauthors at most with the CVU Scholarship Number-PNPC or SNI-CONACYT - Indicating the Researcher Level and their Google Scholar Profile to verify their Citation Level and H index.

Identify the Name of Author and Coauthors at most in the Science and Technology Profiles widely accepted by the International Scientific Community ORC ID - Researcher ID Thomson - arXiv Author ID - PubMed Author ID - Open ID respectively.

Indicate the contact for correspondence to the Author (Mail and Telephone) and indicate the Researcher who contributes as the first Author of the Article.

Plagiarism Detection

All Articles will be tested by plagiarism software PLAGSCAN if a plagiarism level is detected Positive will not be sent to arbitration and will be rescinded of the reception of the Article notifying the Authors responsible, claiming that academic plagiarism is criminalized in the Penal Code.

Arbitration Process

All Articles will be evaluated by academic peers by the Double-Blind method, the Arbitration Approval is a requirement for the Editorial Board to make a final decision that will be final in all cases. MARVID® is a derivative brand of ECORFAN® specialized in providing the expert evaluators all of them with Doctorate degree and distinction of International Researchers in the respective Councils of Science and Technology the counterpart of CONACYT for the chapters of America-Europe-Asia- Africa and Oceania. The identification of the authorship should only appear on a first removable page, in order to ensure that the Arbitration process is anonymous and covers the following stages: Identification of the Journal with its author occupation rate - Identification of Authors and Coauthors - Detection of plagiarism PLAGSCAN - Review of Formats of Authorization and Originality-Allocation to the Editorial Board-Allocation of the pair of Expert Arbitrators-Notification of Arbitration -Declaration of observations to the Author-Verification of Article Modified for Editing-Publication.

Instructions for Scientific, Technological and Innovation Publication

Knowledge Area

The works must be unpublished and refer to topics of agriculture-forest, pathology-sustainable, horticulture, fisheries and aquaculture, agricultural biotechnology and other topics related to Biotechnology and Agricultural Sciences.

Presentation of content

In the first article we present, *Evaluation of Social and Environmental Management as Stakeholders of USR in the Faculty of Administration Sciences, Universidad Autónoma de Coahuila, Saltillo, Mexico*, by CERVANTES-AVILA, Yazmin Guadalupe, MONTALVO-MORALES, Jesús Alberto, GARCÍA-BERMÚDEZ, Frida and SEGURA-LOZANO, Xóchitl, with adscription in the Universidad Autónoma de Coahuila, as next article we present, *Characterization and analysis of the mango supply chain in San Cristóbal de la Barranca, Jalisco*, by ROMERO-ROMERO, Yair, VÁZQUEZ-ELORZA, Ariel and SÁNCHEZ-GÓMEZ, Julia, with adscription in the Consejo Nacional de Ciencia y Tecnología (CONACYT) and Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ), as next article we present, *Environmental function and control of heno motita (Tillandsia recurvata) in the atmospheric basin of Tula de Allende Hidalgo*, by RESÉNDIZ-VEGA, Marisol & SÁNCHEZ-TRUJILLO, Gabriela, with adscription in the Universidad Tecnológica de Tula-Tepeji and Universidad Autónoma del Estado de Hidalgo, as last article we present, *Proposal to treat leachate from the open-air dump of the Municipality of Zacatecas*, by SOSA-VÁZQUEZ, Olga Lidia, VILLEGAS-MARTÍNEZ, Rodrigo Cervando, CONEJO-FLORES, Ricardo and GARCÍA-GONZÁLEZ, Juan Manuel, with adscription in the Universidad Autónoma de Zacatecas.

Content

Article **Journal of Environmental Sciences and Natural Resources**
June 2021, Vol. 7 No.19 1-11

Evaluation of Social and Environmental Management as Stakeholders of USR in the Faculty of Administration Sciences, Universidad Autónoma de Coahuila, Saltillo, Mexico

Evaluación de la Gestión Social y Medioambiental como partes interesadas de la RSU en la Facultad de Ciencias de la Administración, de la Universidad Autónoma de Coahuila, Saltillo, México

CERVANTES-AVILA, Yazmin Guadalupe†*, MONTALVO-MORALES, Jesús Alberto, GARCÍA-BERMÚDEZ, Frida and SEGURA-LOZANO, Xóchitl

Universidad Autónoma de Coahuila, Mexico.

ID 1st Author: *Yazmin Guadalupe, Cervantes-Avila* / **ORC ID:** 0000-0002-5241-7559

ID 1st Co-author: *Jesús Alberto, Montalvo-Morales* / **ORC ID:** 0000-0001-7341-4106, **CVU CONACYT ID:** 297955

ID 2nd Co-author: *Frida, García-Bermúdez* / **ORC ID:** 0000-0001-7946-1149

ID 3rd Co-author: *Xóchitl, Segura-Lozano*

DOI: 10.35429/JESN.2021.19.7.1.11 Received: January 10, 2021; Accepted June 30, 2021

Abstract

It cannot be possible to form and unite the University that is required these days, without the people who interact within this institution having a sustainable way of thinking, one of the priority ways to achieve this goal is to manage the development of stakeholders of University Social Responsibility (USR). The Faculty of Administration Sciences (FAS) of the Universidad Autónoma de Coahuila has as its priority tasks to develop sustainable thinking through continuous improvement and the incessant search of areas of opportunity in these subjects. The objective of this work was to evaluate the degree of social and environmental management that exists in the FAC focusing on the actions that are carried out in a positive way and in those that must be worked to achieve an advance and development of these stakeholders of the (USR). The empirical research was based on the exploration of a sample that included 211 people who study and work in the FAS. The evaluation instrument incorporated questions that relate the interaction of the FAS with society and the local community and the development of plans, actions and knowledge related to the environmental management required by the University for the training of new types of professionals. For its evaluation, Contingency Tables and Exploratory Factor Analysis were used. The results demonstrate the existence of strategic planning, commitment and integration of social issues in the way the University operates and a linkage in the midst of work and commitment in the improvement of environmental aspects, all of this while there is no training, dissemination and technology innovation that promotes sustainable development in these matters.

University social responsibility, Society, Environment, Exploratory Factor analysis

Resumen

No puede ser posible conformar la Universidad que se requiere en estos días sin que las personas que interactúan en el seno de esta tengan un pensamiento sostenible, una de las vías prioritarias para lograr este objetivo es gestionar el desarrollo de las partes interesadas (Stakeholders) de la Responsabilidad Social Universitaria (RSU). La Facultad de Ciencias de la Administración (FCA) de la Universidad Autónoma de Coahuila tiene como sus tareas prioritarias desarrollar el pensamiento sostenible a través de la mejora continua y la búsqueda incesante de áreas de oportunidad en estos temas. El objetivo de este trabajo fue evaluar el grado de gestión social y medioambiental que existe en la FCA centrándose en las acciones que se realizan de manera positiva y en aquellas que se debe trabajar para lograr un avance y un desarrollo de estas partes interesadas de la (RSU). La investigación empírica tuvo su base en la exploración de una muestra que abarcó 210 personas que estudian y trabajan en la FCA. El instrumento de evaluación incorporó preguntas que relacionan la interacción de la FCA con la sociedad y la comunidad local y el desarrollo de planes, acciones y conocimientos relacionados con la gestión medioambiental que requiere la Universidad para la formación de profesionales de nuevo tipo. Para su evaluación se emplearon Tablas de Contingencia y el Análisis Factorial Exploratorio (AFE). Los resultados demuestran la existencia de una planeación estratégica, compromiso e integración de las cuestiones sociales en la manera de hacer de la Universidad y una vinculación, trabajo y compromiso en la mejora de aspectos medioambientales, mientras que se adolece de una capacitación, divulgación e innovación tecnológica que potencie el desarrollo sostenible en estos temas.

Responsabilidad social universitaria, Sociedad, Medioambiente, Análisis factorial exploratorio

Citation: CERVANTES-AVILA, Yazmin Guadalupe, MONTALVO-MORALES, Jesús Alberto, GARCÍA-BERMÚDEZ, Frida and SEGURA-LOZANO, Xóchitl. Evaluation of Social and Environmental Management as Stakeholders of USR in the Faculty of Administration Sciences, Universidad Autónoma de Coahuila, Saltillo, Mexico. Journal of Environmental Sciences and Natural Resources. 2021. 7-19:1-11.

† Researcher contributing first author.

Introduction

In recent years it can be observed, without going into considerations about possible causes and motivations that explain this phenomenon, that corporate social responsibility has largely permeated in global business. However, the same has not happened at a university level, where reflection on social responsibility has only just began (Ball & Bebbington, 2008). So far, universities, like other public organisms, have shown a lower level of development of the concept of social responsibility in their management and information systems than companies, despite their clear vocation and social orientation.

A responsible University allows to open the economic, social and environmental thinking of the people and to train students and educators in a responsible way. According to UNESCO (2007), in the World Conference on higher education, one of the points related to University Social Responsibility (article 6 of the declaration) is raised, the responsibility of universities to have long-term orientations that allow solving social needs and aspirations, instilling this responsibility in students. (Gil, 2012)

In the educational field, this concept finds its reference in the social function attributed to Higher Education Instances, compared to their social commitment as a pillar of development and transformation of the economic and social order of the communities that interact in the territory Company-Society-State, which implies also taking care of its ethical dimension, providing skills to its students as responsible citizens (Olarte & Ríos, 2015).

The responsible University reinforces the development of the local community, the interaction with the governing bodies and the environmental concern through a responsible development program in which students, professors, administrators, senior management, graduates and the network of companies, with which the university interacts, intertwine forming a fabric that feels social, economic and environmental concerns as a whole and from each interested party (Stakeholders) the feelings and common actions are reinforced to achieve a general commitment.

Universities apply USR when they take an interest in the way in which the interested parties (Stakeholders) who interact with them behave, evaluating the participation of these parties in a strategic way to achieve competitive advantages and an education with ethical and sustainable principles, the evaluation of Internal interaction between employees, governing bodies and students is the first step to achieve better management stability, social commitment and university development and the foundation for future development in the other stakeholders that make up the USR.

The relationship with the local community, the work for a social improvement and the possible areas of opportunity in the mitigation of environmental impacts as interested parties of the USR that exists in the business schools of the Universidad Autónoma de Coahuila has not been investigated in depth, there is a need to evaluate the degree of development of these practices for a responsible development of the university campus. It's of vital importance to direct the University towards a new structure that takes on current challenges in a more sustainable way through training, planning, investment and the general development of its Stakeholders, all of this focused on the principles of social and environmental improvement that the University can transmit within its framework and beyond the borders of this, disseminating ways of thinking and doing in the thousands of people with whom it interacts daily.

The research is carried out through 5 stages that include the review of the literature, the creation of an evaluation instrument through a Focus Group, made up of several experts, the formulation of the hypotheses and the obtaining of the variables, the resolution of the factors proposed in the objectives through the EFA and the presentation of results and conclusions of the study. The study aims to assess the degree of social and environmental management, as stakeholders (Stakeholders) of the USR and determine a number of factors that concisely explain the areas of opportunity that exist on these issues, focusing on the subjects that are exercised in a positive way and in those in which it is necessary to work for continuous improvement and progress towards a new way of approaching the vision and doing on responsible issues in the large public business school of the Universidad Autónoma de Cohahuila, the Faculty of Administration Sciences (FAS) of Saltillo, Coahuila, Mexico.

ISSN: 2444-4936
ECORFAN® All rights reserved.

Literature review

In the public sector, and particularly in higher education, the current context, characterized by globalization, the privatization of many universities and the greater intensity of competition between such organizations, is causing universities to adopt a business management approach that allows them to improve their competitiveness and thus guarantee their survival in a dynamic and complex environment. (Sanje & Senol, 2012).

According to (Núñez Chicharro et al., 2015) the Universit Social Responsibility (USR) has been defined from the point of view of the impacts that they cause in the development of their activities. In this sense, and starting from the groups of impacts, we can consider a measurement model, identifying the aspects related to MSW with dimensions.

a. Organizational dimension: relative to the performance of the university in the scope of its organization and management. This dimension is also common to the university and the company. Four key factors have been identified in it: 1) Corporate Governance, 2) economic impact, 3) environmental impact and 4) social impact.

b. Educational dimension: relative to the performance of the university in its training and educational function in relation to Social Responsibility.

c. Research and epistemological dimension: related to its research function allied to the areas that make up Social Responsibility.

d. Social dimension: relative to their relationship with social agents, their participation in the local and global community, and their influence on human and social development.

The Technical Commission of the 2015 University Strategy, in its latest report exposes the difficulty of defining this concept in a univocal and precise way. They define USR as the reconceptualization of the entire university institution in light of the values, objectives, forms of management and initiatives that imply a greater commitment to society and with the contribution to a new, more balanced and sustainable development model. (Naval & Ruiz-Corbella, 2012).

The fact that universities have not received adequate attention in research on social responsibility generates a need and an opportunity not only due to the social and environmental impacts that derive from each of the areas of university management, but also because of the exemplary role that they must assume in society and the risk they may have when training professionals exempt from social values and without a true perception of the role that companies should have in the current and future context (De la Cuesta et al. , 2010)

For all these reasons, a university social responsibility model must permeate its activity, pursuing the achievement of various objectives aimed at creating true environments for university life in which all the people who make up this community participate and encourage the participation of social agents from the environment of the institution. In its activity, the university must promote and fuel a more efficient use of resources that respect the environment and be able to create an academic, research and innovative environment that manages to increase its excellence and quality (Madorrán-García, 2012)

The representation of the fundamental principles and values in which the USR is governed according to "The University builds country" are grouped into the following topics described by (Jiménez et al., 2003):

1. Principles and values of the personal plane.

a. Dignity of the person.

b. Freedom.

c. Integrity.

2. Principles and values at the social level

a. Common good and social equity.

b. Sustainable development and environment.

c. Sociability and Solidarity for coexistence.

d. Acceptance and appreciation of diversity and. Citizenship, democracy and participation.

ECORFAN® All rights reserved.

3. Principles and values at the university level:

a. Commitment to the truth.

b. Excellence.

c. Interdependence and transdisciplinarity.

This work addresses the organizational dimension evaluated from the points of view of social and environmental impact, determining the social interaction of the University and the ability to mitigate, through the development of its stakeholders, the environmental impacts that are generated in herself. The identification of the variables that influence the way of doing things and the evaluation of their relationship in the conformation of factors that describe the state of MSW through the use of EFA reinforces the research towards a better understanding of the sustainable dimensions of the Universidad Autónoma de Coahuila.

Relations with the local community and society, the basis for a social development of the University

Within the framework of local development, it is up to the universities to define an adequate communication system with the community in which their role as generator and disseminator of knowledge is set in. In this sense, this system should strengthen the aspect of the linkage with communities, productive agents and local and regional institutions, while creating capacities to disseminate knowledge and local initiatives in global spaces that offer opportunities to contribute to this. local development. (González-Hernández, 2013).

Preparation for the professional field and training for active citizenship are presented today as the two most relevant objectives of education for the coming decades and also as key goals in university education, as in fact they appear in the programmatic documents and strategic of the universities (Kingston, García, Puig, & Santos, 2011).

The sustainable development of the University cannot be seen without the relationships with the community and without that contribution to society that is so much required in our days, not only in what the university can provide support to those in the community who attend it seeking protection and better preparation for their children, a way of escape and entertainment necessary for them to feel welcomed by community work and by what the faculty can give them, but in the sustainable, ethical and moral preparation of the students who attend every day to exchange their social life, with administrators, teachers and staff in general within the campus. This positive influence creates campaigns to support those in need, improve the environment, work and support social causes, of which today's universities cannot be unaware.

Inside and outside the University, strong ties must be forged that promote innovation, there is no better way to serve society than to contribute knowledge capable of being transferred to this in the form of scientific research that can be quickly converted into a common good, in a marketable products or services. This momentum is sustained by the level of preparation, awareness, management and research that exists among the stakeholders that make up the basic core of the campus, its development depends, to a great extent, the sustainable future of the University and its contribution to the society.

USR guarantees the quality of higher education as a whole. For this reason, it cannot ignore: preparing professionals with relevant knowledge to the requirements of the environment, sensitive and motivated by values; orient scientific research towards solving social problems; develop projects with real social impact; promote the transfer of knowledge and technology to society; interact and dialogue with society; train its teachers and employees at the highest level; support student volunteering; make students aware of the co-responsibility of all in solving the world's problems. (Valarezo & López, 2014).

ECORFAN® All rights reserved.

The University based on the mitigation of environmental impacts

The consolidation of the University in USR issues related to the environment is one of the facets of greatest commitment since it closely links ways of seeing and doing, values and characteristics of the people who share the university environment and whose actions and decisions impact the environment. The issues related to the mitigation of environmental impacts go through a required investment in this field, a training in sustainability issues of the faculty that complements the curricula, a teaching staff prepared to promote ethical and environmental development in their students, a program of activities with a responsible base and an innovation and research that encourages the development of critical thinking and acting on sustainable issues.

It is not only about the civil part and the necessary restructuring of the university's infrastructure, going through energy savings, the incorporation of non-conventional sources, the use of low-energy consumption equipment, but also the changes in thinking. Responsible for the university community and the active participation of its members in order, control, decrease or total elimination of the possible impacts that the university can generate, the way of thinking and doing is the foundation for sustainable development. Society is the first place where the responsible aspirations of university students should rest, the criteria learned and shared in it, are modified, improved and strengthened provided that in the place of study and preparation for life there is an environment of continuous improvement to society and the environment.

All that has been said before leads us to evaluate the degree of social and environmental commitment that the FAS possesses and the knowledge that is had within the institution of the issues addressed in this work, the mission and vision of the university must be coupled with in order to be a responsible, sustainable social entity and guide for present and future generations that interact within it.

Research model

The basis for the development of this qualitative research was developed based on key constructions adapted from the literature. For its creation and development, a Focal Group was created, initially, where specialists from the Faculty of Administration Sciences (FAS) of the city of Saltillo, Coahuila, Mexico and from the North Unit participated, which includes the schools of Administration and Businesses, located in the city of Monclova and Piedras Negras in the state of Coahuila, Mexico.

Researchers in the social and behavioral sciences use focus groups to explore phenomena and are accepted as a legitimate qualitative methodology. The main objective of the focus groups is to use the interaction data resulting from the discussion between the participants to increase the depth of the investigation and reveal aspects of the phenomenon that are supposed to be less accessible. The focus group technique is an opinion space to capture the feeling, thinking and living of individuals, provoking self-explanations to obtain qualitative data (Hamui-Sutton & Varela-Ruiz, 2015). (Kitzinger, 1995) defines it as a form of group interview that uses communication between researcher and participants, with the purpose of obtaining information.

For a second stage, once the variables had been excluded, a tool (survey) was created on Google Form which was shared online with Administrators, Teachers and Students who work and study at the FAS, who have the necessary knowledge to express the way in which the relationship of the University with the local community and society is developed and what are the main changes that have been made in it to reduce the impacts on the environment. For the development of the survey, the Likert scale was used, as well as open questions aimed directly at evaluating the objectives of this study, previously validating its reliability using Cronbach's Alpha. In contrasting the hypotheses, the descriptive frequencies were used, which are very useful to visualize the results of these scales in a first approximation.

ECORFAN® All rights reserved.

As there was a large sample, the statistical technique of factoring could be applied. (Hair et al., 2010) indicate that statistics cannot be applied correctly with a sample of less than 50 observations. (Costello & Osborne, 2005) tell us about the need to maintain a sample greater than 50 observations "in order to minimize the probability of error, increase the precision of the population estimators and, therefore, the confidence in the inferences drawn". (Arrindell & Van der Ende, 1985), for their part, concluded that obtaining a stable factorial solution is possible when the sample size is close to 20 times the number of factors.

The empirical inquiry was applied to a random sample of 210 people made up of 184 students from the Bachelor's and Master's degrees in Business Administration, 17 Teachers, and 9 Administrators. The variables obtained were processed by contingency tables, contrasting the null hypothesis, to measure the possible association between the observed and expected frequencies through Pearson's Chi-square (Herrera Madueño, 2016) and an Exploratory Factor Analysis (EFA) was applied. to reduce these variables to factors.

The EFA allows the variables to be grouped into homogeneous groups. All these items can be correlated and grouped together in a single factor (Kahn, 2006) but they are also relatively independent of other items that have been grouped in other factors. For this, the Principal Component Analysis (PCA) is used as a measure for the determination of independent factors. From a conceptual point of view, the PCA assumes that individual scores on a series of measures cause or define the component; according to (Decoster & Hall, 1998): the component is equal to the compound of the observed variables. Therefore, the PCA should be applied when the objective is to reduce the initial dimensionality of the data in a smaller set of components that explain the total variance observed.

To assess whether the application of the EFA is possible, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated, which consists of comparing the observed correlation coefficient with the magnitude of the partial correlation coefficient. This adequacy measure indicates how large the correlation is between the measured variables.

If the correlations are large enough, the matrix is considered suitable for factoring because it will offer stable results, replicable in other different samples, regardless of the sample size, or the number of factors, or the number of items. Otherwise, if KMO is big enough, the results will not be accidental. Kaiser considered a matrix with KMO values below 0.50 inappropriate for the EFA; mediocre if these values ranged between 0.60 and 0.69; and satisfactory only values of 0.80 onwards (Lloret-Segura et al., 2014).

Results

The descriptive analysis of the sample obtained can be seen in Table 1.

Valid	Frequency	Percentage	Valid percentage	Accumulated percentage
Student	184	87.6	87.6	87.6
Teacher	17	8.1	8.1	95.7
Administrative	9	4.3	4.3	100.0
Total	210	100.0	100.0	

Table 1 Percentage analysis of the sample evaluated
Source: Own elaboration

To check the reliability of the scales used and evaluate the level of understanding of the survey presented, Cronbach's Alpha was used, which has a significant impact on the precision of the results obtained by an instrument (Domínguez-Lara & Merino-Soto, 2015), the results of this statistical test can be observed in Table 2.

Cases	N	%
Valid	205	97.6
Excluded	5	2.4
Total	210	100.0
Cronbach´s Alfa	N of elements	
.874	14	

Table 2 Values of Cronbach's Alpha for the scales applied
Source: Own elaboration

The results obtained show, based on the high value of Cronbach's Alpha, that the Likert scales used are highly correlated and have internal consistency. Establishing the internal consistency of a scale is an approach to the validation of the method and consists in the quantification of the correlation that exists between the items that compose it. Cronbach's alpha values between 0.70 and 0.90 indicate good internal consistency. (Oviedo & Campo, 2005).

ECORFAN® All rights reserved.

USR practices that evaluate the relationship of the University with the Local Community / Society and the Environment

For the evaluation of the existing relationship between the University and the Local Community, determining the level of knowledge and immersion that its stakeholders may have in social issues, as well as seeing the interaction and development of environmental practices, the opinions of students, teachers and administrators through contingency tables focused on the variables of the instrument were analyzed.

	(Stakeholders) Means			Sig.
	Students	Teachers	Administratives	χ^2
V7. A high social commitment is reflected in the mission and vision of the University.	3.98	4.70	4.11	0.002*
V11. Faculty, staff, students, and members of the local community are involved in college decisions.	3.51	4.17	3.66	0.000*
V12. The relationship with the Social Councils improves the image and reputation of the University.	4.00	4.58	3.77	0.264
V26. Employees and students are trained through courses on topics related to USR.	2.33	3.88	3.55	0.000*
V28. The University staff (Employees-Students) know the foundations on which a Responsible University is based.	2.26	3.82	3.00	0.000*
V30. Social aspects are integrated into the strategic planning of the University.	3.58	4.35	3.66	0.06***
31. Environmental aspects are integrated into the strategic planning of the University.	3.04	4.23	3.66	0.000*
V34. Campaigns are carried out by employees and students to support social causes.	3.66	4.35	3.66	0.07***
V35. There is knowledge and control of the environmental impacts that are generated in the University.	2.67	3.64	2.66	0.000*
V36. Some technological innovation is carried out to eliminate or mitigate impacts to the environment.	2.54	3.47	2.88	0.000*
V39. Investments are made to save energy.	2.76	3.23	2.44	0.66
40. Alternative energy programs are adopted.	1.40	2.76	1.66	0.000*
V41. Campaigns are carried out to save water.	2.41	2.76	2.66	0.000*
V42. The environmental regulations in force in the country are known.	2.35	3.52	3.00	0.000*
*Chi square: 99%, Sig < 0.01.; ** Chi square: 95%, Sig < 0.05.; *** Chi square: 90%, Sig < 0.1.				

Table 3 Mean values and Pearson's Chi square
Source: Own elaboration

Determination of the factors that express the behavior of USR linked to social ties and the mitigation of environmental impacts

The use of the EFA made it possible to determine four factors from the variables of the measurement instrument that clearly and independently express the conditions in which the University operates in USR issues linked to social management and the mitigation of environmental impacts evaluated by through planning, programming, training, innovation and investment as necessary activities for sustainability. The four factors allow rejecting the null hypothesis H03.

H03: There is not a limited number of variables that identify factors that determine the planning, programming, training, innovation and investment carried out by the FAS based on social and environmental issues.

The results of the KMO sampling adequacy test and Bartlett's sphericity are shown in Table 4.

KMO and Bartlett Test		
Kaiser-Meyer-Olkin measure of sampling adequacy		.883
Bartlett's test of sphericity	Approx. Chi squared	1018.134
	gl	91
	Sig.	.000

Table 4 Test of KMO and Bartlett
Source: Own Elaboration

The reduction of the variables to 4 factors that explain 64.05% of the variance can be seen in Table 5, as indicated (Costello & Osborne, 2005), in empirical research in the Social Sciences the range of saturations is usually moderate or low (.32 <Saturation Range <.50), hence saturations above .50 can generally be considered strong saturations, which validates the result obtained in the total variance explained.

ISSN: 2444-4936
ECORFAN® All rights reserved.

Component	Squared load extraction sums			Squared load rotation sums		
	Total	% of variance	% accumulated	Total	% of variance	% accumulated
1	5.390	38.503	38.503	2.779	19.851	19.851
2	1.371	9.790	48.293	2.511	17.937	37.787
3	1.161	8.293	56.586	1.880	13.426	51.214
4	1.046	7.471	64.057	1.798	12.843	64.057

Table 5 Result of factorial analysis with four components
Source: Own elaboration

Varimax rotation was applied for a better interpretation of the results. Orthogonal rotations (Varimax, Quartimax and Equimax) produce uncorrelated factors, so they could be considered appropriate when independence of the factors is assumed, at least from a conceptual point of view. (Fabrigar et al., 1999; Conway & Huffcutt, 2003; Costello & Osborne, 2005; Beavers et al., 2013). Varimax rotation consists of rotating the four coordinate axes that represent the factors / components. This continues until you get as close as possible to the maximum variables in which (the components) are saturated. According to several authors ((Fabrigar et al., 1999; Conway & Huffcutt, 2003; Costello & Osborne, 2005; Beavers et al., 2013), oblique rotations allow obtaining precise, simple, reproducible and more realistic solutions. Table 6 shows the 4 factors identified with the names (Planning and Integration), (Programming, Training and Logistics), (Innovation and Investment) and the (Knowledge and Social Relationships).

The names chosen are based on the variables that determine each factor. The factors clearly delimit the successes and difficulties that the University has in USR issues and are supported by the initial evaluations prepared by the experts in the Focus Group. The factor (Planning and Integration) encompasses issues related to the development of the Faculty's stakeholders, as well as social and environmental integration in its strategic planning. The factor, (Programming, Training and Logistics) was made up of the programming of issues that encompass environmental development, the logistics applied to that issue and training in that sense, being of vital importance to carry out sustainable activities.

The third factor called (Innovation and Investments) concentrates on whether the need for investment for a sustainable improvement, assessing whether there is an investment aimed at fulfilling these issues in the FAS and at the same time assessing the level of innovative development that is required in a high house of studies to achieve the USR.

The fourth factor speaks of the relationship with the local community and society, its participation in important decisions and the conjugation of all internal and external stakeholders with society, the support provided by the faculty to social causes and stability of these relationships today.

Rotated Component Matrix[a]

	Componente			
	Planning and Integration	Programming, Training and Logistic	Innovation and Investment	Knowledge an Social Relationships
V7. A high social commitment is reflected in the mission and vision of the University.				.603
V11. Faculty, staff, students, and members of the local community are involved in college decisions.				.619
V12. The relationship with the Social Councils improves the image and reputation of the University.				.845
V26. Employees and students are trained through courses on topics related to USR.		.727		
V28. The University staff (Employees-Students) know the foundations on which a Responsible University is based.		.788		
V30. Social aspects are integrated into the strategic planning of the University.	.687			
31. Environmental aspects are integrated into the strategic planning of the University.	.745			
Campaigns are carried out by employees and students to support social causes.	.644			
V35. There is knowledge and control of the environmental impacts that are generated in the University.	.713			
V36. Some technological innovation is carried out to eliminate or mitigate impacts to the environment.			.594	
V39. Investments are made to save energy.			.655	
40. Alternative energy programs are adopted.		.677		
V41. Campaigns are carried out to save water.			.833	
V42. The environmental regulations in force in the country are known.		.584		

Table 6 Main rotated components obtained through EFA

Validation of the factors found as vital points that place Senior Management as the central link of the stakeholders of the USR

Worldwide research relates the variables that make up these 4 factors of our work, focused on social relationships and the reduction of environmental impacts, as vital issues that must be resolved for a sustainable improvement in the university environment, only that we have placed social relations as the guiding center of each process since their connection, support and commitment are considered vital for a takeoff in USR issues.

ECORFAN® All rights reserved.

Institutional congruence refers to the fact that in the socially responsible approach, the university is in charge of contrasting the results of the self-diagnosis with the commitment and compliance with the university philosophy, in addition, improvements in areas, dependencies are planned and then the USR projects are executed, the various levels, but always thinking about the comprehensive participation of all members of the university community and external factors such as civil society and the state (Valarezo & López, 2014).

(Brunner, 2011) tells us that in turbulent times such as the current one, the magnitude, intensity and speed of changes in the environment, within which universities operate, threaten to exceed their capacities for reaction and adaptation, which may cause crises, loss of competitive position and, in some cases, disappearance. The University is responsible if it influences society, channels the influence of a clear transforming orientation of the areas of social, economic and public vulnerability present in our society. (Gil, 2012)

The factors found encompass in general terms the main issues for sustainable development and an improvement in the university's relations with its social and environmental surroundings, which leads us to a higher education of the stakeholders that make up the basic university core. Educating for sustainable development means incorporating the fundamental themes of said development into teaching and learning (climate change, disaster risk reduction, biodiversity, poverty reduction, sustainable consumption, etc.). Likewise, this type of education requires participatory teaching and learning methods that motivate students and give them the autonomy to change their behavior and facilitate the adoption of measures for sustainable development. Consequently, education for sustainable development promotes the acquisition of skills such as critical thinking, the elaboration of hypotheses to anticipate the future and collective decision-making (Cervantes & Aldeanueva, 2016)

Conclusions

The degree of social and environmental management that exists in the FAS was evaluated through the application of an instrument prepared by experts from the Faculty of Administration Sciences (FAS) of the city of Saltillo and the North Unit that includes schools Administration and Business, located in the city of Monclova and Piedras Negras in the state of Coahuila, Mexico.

Four factors were determined through the application of the Exploratory Factor Analysis that evaluate Planning and Integration, Programming, Training and Logistics, Innovation and Investment and Knowledge and Social Relationships, key points within the investigation that allow determining the degree of management that the FAS has in terms of work and social integration and in the assessment and mitigation of the environmental impacts generated by the faculty.

The degree of understanding and veracity of the answers provided by 210 people who work and study at the faculty was made through Cronbach's Alpha statistics and the use of Contingency Tables with the evaluation of Pearson's Chi square, finding a high percentage of agreement in the response of the groups participating in the study.

It is concluded that there is a development in the FAS of its social practices and an active participation in activities of this nature through the incorporation of stakeholders in social projects, the programming and development of social campaigns that benefit the local community and other communities further away from the university (V7, V11, V13) and to a lesser degree lacks training that complements these activities in a better way (V26 and V28).

It was determined that there are measures and actions in environmental management that improve this performance, such as activity planning and some actions for improvement (V31), however, innovation, investment and the application of effective programs that favor development are insufficient. sustainable in this area (V36, V39, V40 and V41), while at the same time there is a lack of knowledge of the impacts and of the regulations that the country governs in environmental matters (V35 and V42).

ECORFAN® All rights reserved.

Conflicts of interest

The authors declare that there is no conflict of interest in the present investigation.

References

Arrindell, W. A., & van der Ende, J. (1985). An Empirical Test of the Utility of the Observations-To-Variables Ratio in Factor and Components Analysis. Applied Psychological Measurement, 9(2), 165–178. https://doi.org/10.1177/014662168500900205

Ball, A., & Bebbington, J. (2008). Editorial: Accounting and Reporting for Sustainable Development in Public Service Organizations. Public Money & Management. https://doi.org/10.1111/j.1467-9302.2008.00662.x

Beavers, A. S., Lounsbury, J. W., Richards, J. K., Huck, S. W., Skolits, G. J., & Esquivel, S. L. (2013). Practical considerations for using exploratory factor analysis in educational research. Practical Assessment, Research & Evaluation. https://doi.org/ISSN 1531-7714

Brunner, J. J. (2011). Gobernanza universitaria: Tipología, dinámicas y tendencias. Revista de Educacion. https://doi.org/10.1088/1751-8113/44/8/085201

Cervantes Rosas, M. de los Á., & Aldeanueva Fernández, I. (2016). Las instituciones de educación superior y el desarrollo Sustentable: Estudio exploratorio desde la perspectiva del alumno. Ra Ximhai, 12(6), 259–267. https://www.redalyc.org/articulo.oa?id=46148194017

Conway, J. M., & Huffcutt, A. I. (2003). A Review and Evaluation of Exploratory Factor Analysis Practices in Organizational Research. In Organizational Research Methods. https://doi.org/10.1177/1094428103251541

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment, Research & Evaluation. https://doi.org/10.1.1.110.9154

De la Cuesta Gonzalez Marta, De la Cruz Ayuso Cristina, R. F. J. M. (2010). Responsabilidad Social Universitaria.

Decoster, J., & Hall, G. P. (1998). Overview of Factor Analysis. In Practice. https://doi.org/10.2307/2685875

Domínguez-Lara, S. A., & Merino-Soto, C. (2015). ¿Por qué es importante reportar los intervalos de confianza del coeficiente alfa de Cronbach? RLCSNJ; Vol. 13 Núm. 2: Julio - diciembre de 2015, 13(2), 1326–1328. http://revistaumanizales.cinde.org.co/rlcsnj/index.php/Revista-Latinoamericana/article/view/2030

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. Psychological Methods, 4(3), 272–299. https://doi.org/10.1037/1082-989X.4.3.272

Gil Osorio, I. M. (2012). El rol de las universidades públicas frente a la responsabilidad social universitaria. Panorama Económico, 20, 235–250.

González-Hernández, A. (2013). La universidad como factor de desarrollo local sustentable. Ra Ximhai, 9(1), 65–78.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2010). Multivariate Data Analysis (7th Edition). In Uppersaddle River, New Jersey: Pearson Education International. https://doi.org/10.1016/j.ijpharm.2011.02.019

Hamui-Sutton, A., & Varela-Ruiz, M. (2015). La técnica de grupos focales. Investigación En Educación Médica, 2(1), 55–60. https://doi.org/10.1016/s2007-5057(13)72683-8
Hernández, M. (2007). La responsabilidad social dentro del sector público. Ekonomiaz, 65, 84–107. http://dialnet.unirioja.es/descarga/articulo/2533613.pdf

Jiménez, M. (2003). Proyecto Universidad. Construye País. www.construyepais.cl

Kahn, J. H. (2006). Factor Analysis in Counseling Psychology Research, Training, and Practice: Principles, Advances, and Applications. The Counseling Psychologist. https://doi.org/10.1177/0011000006286347

Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. BMJ, 311(7000), 299. https://doi.org/10.1136/bmj.311.7000.299

ECORFAN® All rights reserved.

Lloret-Segura, S., Ferreres-Traver, A., Hernández-Baeza, A., & Tomás-Marco, I. (2014). El análisis factorial exploratorio de los ítems: Una guía práctica, revisada y actualizada. Anales de Psicologia. https://doi.org/10.6018/analesps.30.3.199361

Lozano, J. M. (2007). Promoción pública de la responsabilidad social empresarial. Ekonomiaz: Revista Vasca de Economía, ISSN 0213-3865, No. 65, 2007 (Ejemplar Dedicado a: Responsabilidad Social de La Empresa. Más Allá de La Sabiduría Convencional / Coord. Por José Miguel Rodríguez Fernández), Págs. 108-127, 65, 108–127.

Madorrán-García, C. (2012). ¿ Es la universidad pública española socialmente responsable ? Universia, 8–III, 90–103. ttp://ries.universia.net/index.php/ries/article/view/90/pdf_31

Naval, C., & Ruiz-Corbella, M. (2012). Aproximación a la responsabilidad social universitaria: la respuesta de la universidad a la sociedad. Bordón, 64(3), 103–115.

Núñez Chicharro, M., Alonso Carrillo, I., & Pontones Rosa, C. (2015). Responsabilidad Social Universitaria: Estudio empírico sobre la fiabilidad de un conjunto de indicadores de Gobierno Corporativo. Innovar, 25(58), 91–103. https://doi.org/10.15446/innovar.v25n58.52428

Olarte, D., & Ríos, L. (2015). Enfoques y estrategias de responsabilidad social implementadas en Instituciones de Educación Superior. Una revisión sistemática de la literatura científica de los últimos 10 años. Revista de La Educación Superior, XLIV (3) N, 19–40.

Oviedo, H. C., & Campo, A. (2005). Aproximación al uso de coeficiente alfa de Cronbach. Revista Colombiana de Psiquiatría, 34(4), 572–580.

Queen's University (Kingston, O.). F. of E., García, R. (Rafaela), Puig, J. (Jose), & Santos, M. A. (Miguel A. (2011). Encounters on education. Encounters on Education / Encuentros sobre Educación / Rencontres sur l´Éducation. http://dadun.unav.edu/handle/10171/36656

Sanje, G., & Senol, I. (2012). Corporate Social Responsibility in Higher Education Institutions: Istanbul Bilgi University Case. American International Journal of Contemporary Research, 2(3), 95–103.

Valarezo González, K., & Túñez López, J. M. (2014). Responsabilidad Social Universitaria. Apuntes para un modelo de USR. Revista de Comunicación.

ECORFAN® All rights reserved.

Article **Journal of Environmental Sciences and Natural Resources**
June 2021, Vol. 7 No.19 12-18

Characterization and analysis of the mango supply chain in San Cristóbal de la Barranca, Jalisco

Caracterización y análisis de la cadena de suministro del mango de San Cristóbal de la Barranca, Jalisco

ROMERO-ROMERO, Yair†*, VÁZQUEZ-ELORZA, Ariel and SÁNCHEZ-GÓMEZ, Julia*

Consejo Nacional de Ciencia y Tecnología (CONACYT)- Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ).

ID 1st Author: *Yair, Romero-Romero* / **ORC ID:** 0000-0002-7779-4211, **Researcher ID Thomson:** F-1649-2019, **CVU CONACYT ID:** 239572

ID 1st Co-author: *Ariel, Vázquez-Elorza* / **ORC ID:** 0000-0002-6710-8935, **CVU CONACYT ID:** 169076

ID 2nd Co-author: *Julia, Sanchez-Gómez* / **ORC ID:** 0000-0001-5648-8920, **CVU CONACYT ID:** 375361

DOI: 10.35429/JESN.2021.19.7.12.18 Received: January 15, 2021; Accepted June 30, 2021

Abstract

The little development and disruption of in agri-food supply chains are important factors that prevent the growth of small Mexican producers, being the link with the lowest income of the entire chain and in which there are the greatest injustices. The objective of this research work is to map and identify the links the supply chain of the mango barranqueño; and benchmarked with the Tommy Atkins chain. The methodology used consisted of three steps: 1) Data analysis of the Barranco mango, 2) Mapping the supply chain of the mango barranqueño and Tommy Atkins and, as well as their relationships, and 3) Compare of supply chains to analyze the links that could be developed and improve in the supply chain of the mango barranqueño. The contribution of this work is the first approach for the analysis and improvement of the supply chain management of small producers of the barranqueño mango, in order to strengthen short sustainable supply chains.

Supply chain management, Small producers, Sustainable chains

Resumen

El escaso desarrollo y la disrupción de las cadenas de suministro agroalimentarias son factores importantes que impiden el crecimiento de los pequeños productores mexicanos, siendo estos el eslabón con menor ingreso de toda la cadena y en el que se presentan mayores injusticias. El objetivo de este trabajo de investigación es mapear e identificar los eslabones de la cadena de suministro del mango barranqueño; y realizar un benchmarking con la cadena del mango Tommy Atkins. La metodología utilizada constó de tres etapas: 1) Análisis de datos del mango barranqueño, 2) Mapeo de la cadena de suministro del mango barranqueño y Tommy Atkins y, así como sus relaciones, y 3) Comparar las cadenas de suministro para analizar los vínculos que se podrían desarrollar y mejorar en la cadena de suministro del mango barranqueño. La contribución de este trabajo es un primer acercamiento para el análisis y mejora de la gestión de la cadena de suministro de los pequeños productores del mango barranqueño, con el fin de fortalecer cadenas sostenibles cortas.

Gestión de la cadena de suministro, Pequeños productores, Cadenas sostenibles

Citation: ROMERO-ROMERO, Yair, VÁZQUEZ-ELORZA, Ariel and SÁNCHEZ-GÓMEZ, Julia. Characterization and analysis of the mango supply chain in San Cristóbal de la Barranca, Jalisco. Journal of Environmental Sciences and Natural Resources. 2021. 7-19:12-18.

* Correspondence of the Author (E-mail: yromero@ciatej.mx)
† Researcher contributing first author.

©ECORFAN-Spain

Introduction

For decades the Mexican countryside has been greatly impacted in the social, environmental and economic spheres. In the social sphere, the migration of the rural population to the cities has caused a change in the social structure, namely, in 1900 the rural population was 9.8 million inhabitants and represented 72.1% of the Mexican population. This percentage decreased to 23% in 2015, which is why 77% of the population is currently concentrated in cities (INEGI, 2020; SERMARNAT, 2016). Of the 27.5 million people who currently live-in rural areas, only 5.5 million work in the fields, and of these, 56% are farmers with an average age of 42.7 years (Hablemos de Campo, 2018). In addition, it is worth mentioning that the 36 million Mexican migrants who reside in the United States work mainly in the agricultural and construction sectors (Sulbarán, 2019). This migration to cities and other countries has caused a shortage of labor for rural activities (Ríos, 2017). Another factor that affects the field is the environmental one, mainly due to climate change, which is defined as "the variation in climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and adds to the natural variability of the observed climate. during comparable periods" (CEDRSSA, 2019).

Agricultural products, mainly those that are in the open air, are vulnerable to climate change due to its negative effect on the vegetative cycle, due to the increase or decrease in temperature and humidity (droughts, floods and frosts). This causes volatility in food prices and affects the economic factor.

Small-scale farmers face high input costs and high transport costs (Leonardo *et al*., 2004), coupled with this, low modernization and climate change lead to a decrease in production and consequently, profitability for the producer. . In addition, most markets have a reduced opening for the products of small farmers (Jaller, 2010), pushing them to sell their production to collectors. These establish the price of production, so that most of the time, the peasant only recovers what he has invested without a return so that his productive unit is sustainable over time. This has caused some producers to abandon their harvest in the field, or to dedicate themselves only to planting and harvesting products for their own consumption.

There are rural producers who have sought alternatives to invest in their fields, through financing, but since they do not exist or deny them credit in institutions governed by the National Banking and Securities Commission (CNBV) and Banco de México (BM), they have fallen into markets informal financial institutions in which they pay very high interest rates (Norton, 2010).

The products of the field that are being harmed by the negative externalities of these three factors (social, environmental, and economic) are many and affect small producers to a greater extent. This is the case of the Barranca mango, considered as Creole mango, produced in the bowels of the Barranca de San Cristóbal that surrounds the Santiago River (Government of the State of Jalisco, 2020), on the north side of the Metropolitan Area of Guadalajara, and that is harvested during the season of April and June.

According to the local inhabitants of San Cristóbal de la Barranca, the mangoes have a sweeter taste and the ones with the greatest flavor are the Barranco mangoes called "swollen", being those that ripen on the tree. Once they reach maturity these mangoes fall under their own weight (also locally called pulled mangoes), due to the blow of the fall most of them are bruised, which reduces their quality and restricts the bargaining power of the small ones. producers in the market, as a result they are used mainly for self-consumption.

The main market for cut mangoes is developed on the side or near the highway that leads from Guadalajara to Zacatecas, the marketing and logistics channels are limited, a low quantity of mangoes reach other local markets and on wheels. Generally, the mangoes are transported by the producer in small quantities, which increases the cost of transportation, in addition, most of the markets they reach stipulate the purchase prices of the product (Calderón, Roark, Urrutia, Paravié, & Rohvein, 2017) which results in lower income for the producer. Under this scenario, it is no longer enough to only improve the operations and internal cultural activities of agricultural producers, but rather, it is necessary to go beyond their borders and initiate relations of exchange of information, materials, and resources in the most appropriate way. integrated (Calderón *et al*., 2017).

ECORFAN® All rights reserved.

One way to achieve this is through the design and management of the supply chain, in which all operations carried out on the product are referenced and monitored, from raw materials to the end customer (Ballou, 2004). The reason is that today companies no longer compete for their internal efficiency, but for the efficiency of the supply chain to which they belong (Calderón *et al*., 2017).

The objective of this research is to map and identify the links in the Barranco mango supply chain; and benchmarking with the Tommy Atkins handle chain. The article is divided into the following sections: 1) Materials and methods where the methodology followed to achieve the desired results is described. 2) Background, in this section the main terms used throughout the article are defined. 3) Development and results, the mapping of the two supply chains of the Barranco mango and the Tommy Atkins mango are described. Subsequently, the conclusions are made known.

Materials and methods

The research was quantitative exploratory in nature (Hernández Sampieri & Mendoza Torres, 2018), which was useful to obtain information on the characteristics and processes of the Barranco mango supply chain. The methodology considers three stages (Figure 1).

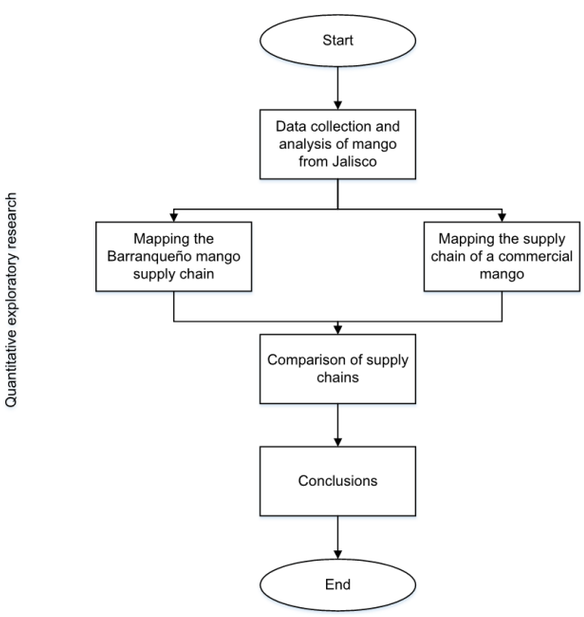


Figure 1 Methodology: Quantitative exploratory research
Source: Own elaboration

Stage 1, data collection and analysis of the Barranco mango. There is a large volume of information about the agricultural sector on electronic pages of the Internet and, instruments, methodologies and / or techniques are required that are capable of processing them in volume, speed and quality (Gutiérrez-Pulido & Vara-Salazar, 2013). In this first stage, to analyze information on mango from San Cristóbal de la Barranca and commercial mango (Tommy Atkins), descriptive statistics were used, which is a set of numerical and graphic techniques to obtain, collect, process, summarize and present data (Rustom, 2012). In this case, data referring to mango production, characteristics of each of the links in the supply chain, quality indices, among others.

Stage 2, supply chain mapping. Supply Chain Management (GCS) aims to ensure the provision of safe and healthy products that are fully traceable from "farm to fork" (Moxham, 2004), however, Chains of Food Supply (CSA) operate in a complex environment where there are conflicts of interest, paradoxes, power struggles, uncertainties, risk elements, injustices, in addition to the fact that the Mexican countryside is one of those with the largest number of intermediaries, increasing the cost of products up to 630% (Chávez, 2014). Likewise, this environment is dynamic (climate, inflation), and requires taking into consideration variables of great importance such as time and critical care (integrity is important in food products due to their perishability and handling) (Gustafsson *et al*., 2006).

Consequently, in this second stage of exploratory research, supply chain mapping was applied, a tool that allows a panoramic view of the entire process chain, how actions are developed and links with other links (Ballou, 2004; Chopra & Meindl, 2008) and is useful to identify activities or processes that add value and those that should be omitted.

Stage 3, comparison of the chains. Finally, a comparison was made of the supply chains for Barranco mango and Tommy Atkins mango, both produced in Jalisco. The second, a chain with greater development, served to observe the challenges and opportunities of the Barranco mango chain.

ECORFAN® All rights reserved.

Background

The supply chain represents a series of activities that are important for any agricultural production unit. Generally, small producers do not have the capacities and infrastructure to achieve high levels of competitiveness. According to Ballou (2004), the supply chain "is made up of processes that range from the purchase of raw materials to the delivery of the final product, including suppliers, production, warehouses, distribution, supply and customers". The articulation of the chain and implementing an order of intervention of the participating actors and processes can increase the profits of the entire chain in the short to medium term (Anaya-Dyck, Hernández-Oñate, Tafolla-Arellano, Báez-Sañudo, Gutiérrez-Martínez, & Tiznado-Hernández, 2021).

The Barranco mango is a product considered as a Creole fruit, in contrast, the Tommy Atkins mango is a commercial variety and presents an organized logistics chain with national and international marketing scope. In other words, the supply, production, and distribution processes of Barranco mango are far from reaching high standards of competitiveness. In this sense, Anand & Kodali (2008, p. 258) point out that there are companies that strive to be faster, better and cheaper than others that are in the competition, so Benchmarking is a good tool to have a thermometer that helps analyze and compare the innovations and improvements implemented in the productive sectors. In this way, it is relevant that the organizations and economic units of the Barranco mango begin with the knowledge of other varieties of the fruit that are succeeding not only in the production but also in the sale and transformation of the same.

Development, Results and Discussion

The supply chain is a poorly developed issue for small producers in the agricultural sector, as is the case of the Barranco mango producers, where it was identified that, in the best of cases, they are part of a chain with informal links between its links. . This mainly generates loss of the product, high transport costs and lack of markets. As is the situation of the majority of the small mango producers in San Cristóbal de la Barranca.

Barranqueño mango

The Barranco mango supply chain is mainly made up of four links: supply, production, retailers, and customers. This structure turns out to be relatively less complex than the chain of a mango variety that has an industrial or export process in Jalisco. Among the actors that make up the links in the Barranco mango chain are (Figure 2):

Suppliers: the labor force is made up of around 10 people for cutting in an orchard, 3 haulers, 2 packers, suppliers of boxes and sacks for harvesting and packing the fruit. On the other hand, there are those who offer the transport service to transport mangoes to urban areas (metropolitan) and those who move damaged mangoes, which are not used for sale but for animal feed.

Production units: according to the agricultural census prepared by INEGI, in the municipality of San Cristóbal de la Barranca there are 29 territorial units of mango production, of which 15 are seasonal and 14 have irrigation conditions. The total area amounts to 3,502.63 ha.

Retail: there is a small number of actors dedicated to retail sales, generally they come from other locations, given that they have the capacity to mobilize and transport high volumes of the fruit. Most orchards have plantations that can be more than 100 years old; In other words, there is a low rotation and production of new plants, although some governmental efforts and producers can be found that have planted new plants in their fruit orchards. In this way, in the medium term the integration of other actors to the chain for soil analysis, innovation, transfer of technical knowledge and value addition will be required, to increase the income of the families that produce the fruit.

Market: the point of sale of the Barranco mango is located mainly in the shops on wheels and municipal markets. The low volumes marketed by the economic productive units (small scale) represent a real challenge to cover the large volumes demanded by the large self-service stores.

ECORFAN® All rights reserved.

It is important to point out that some Barranco mango producing families are beginning activities to add value through the production of boxes, sweets and other products that include the raw material. In the field work, at least three units were identified, mainly where women producers collaborate (personal communication).

Tommy Atkins handle

As more actors are added to a supply chain, a complexity begins to develop in the relationships between the actors. In this case, the Tommy Atkins mango chain includes more specialized actors, such as technicians, input suppliers, intermediaries, packaging, industry, chains, and logistics, among others (Figure 3).

According to the Mango Product System Master Plan (SAGARPA, 2012) in the state of Jalisco, the distribution of the actors that participate in the supply chain is distributed as shown in table 1:

Actors and activities	Quantity
Freezing fruits and vegetables	4
Dehydration of fruits and vegetables	11
Preservation of fruits and vegetables by processes other than freezing and dehydration	32
Manufacture of non-electronic equipment for medical, dental and laboratory use	94
Wholesale of fresh fruits and vegetables	778
Wholesale of canned food	20
Retail trade of fresh fruits and vegetables	5,510
Retail trade of other foods	1,889

Table 1 Actors involved in the mango supply chain in Jalisco
Source: Own elaboration with SAGARPA data (2012)

The mango supply chain represents a direct workforce of 8,338 people in the state of Jalisco, which includes 40% of the production value of the Atkins variety and 14% of Creole. Most of the labor force is concentrated in economic units of 0 to 5 people and 6 to 10 people. In this context, it is essential to strengthen related small companies through the design and implementation of public policies to increase competitiveness (INEGI, 2019).

Categories according to number of workers	Number of economic units
0 to 5 people	7,374
101 to 250 people	12
11 to 30 people	236
251 and more people	7
31 to 50 people	47
51 to 100 people	17
6 to 10 people	645
Grand Total	8338

Table 2 Number of economic units according to the number of workers
Source: Own elaboration with data from INEGI (2019)

Conclusions

The production of Barranco mango in the study location faces a problem that includes not only technical-productive aspects, but also those that involve the relations between the producer and his market.

An important point identified is that the small producers of Barranco mango have a disintegrated production chain, that is, they lack organization in their activities of primary production, chains, productive economic systems. This brings as consequences for the producer high levels of transaction costs and a reduced participation in the added value of the product. It is important to point out that the integration of chains is vital to increase marketing conditions and margins. In addition, having informal links with other members of the chain has a direct impact on the benefits that can be generated.

The lack of formal connections with the market introduces uncertainty about obtaining income for the producer. Therefore, developing strong marketing channels represents a major challenge.

The development of the Barranco mango production chain must be based on the study of what happens with other mango varieties, in order to find models that can be implemented. However, it is necessary to consider that other mango chains with greater development face other challenges, such as dependence on intermediaries, derived from their isolation conditions. These aspects must be taken into account in the design of an adequate strategy for Barranco mango producers.

ISSN: 2444-4936
ECORFAN® All rights reserved.

Annexes

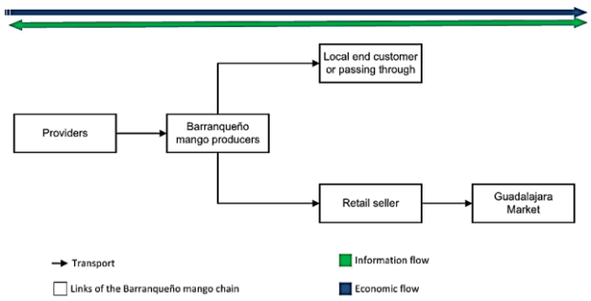


Figure 2 Barranco mango supply chain
Source: Own elaboration

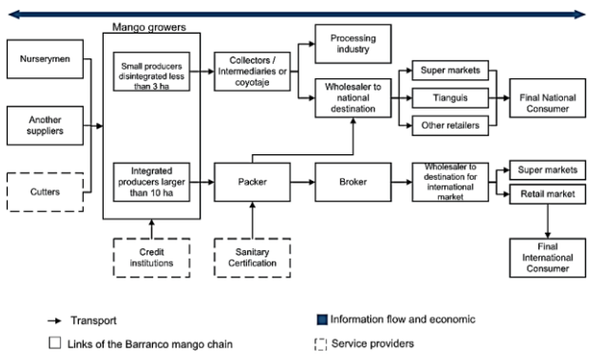


Figure 3 Tommy Atkins Mango Supply Chain
Source: Own elaboration

References

Anaya-Dyck, J. M., Hernández-Oñate, M. Á., Tafolla-Arellano, J. C., Báez-Sañudo, R., Gutiérrez-Martínez, P., & Tiznado-Hernández, M. E. (2021). La cadena productiva de guanábana: una opción para el desarrollo económico en Compostela, Nayarit. *Estudios Sociales. Revista de Alimentación Contemporánea y Desarrollo Regional*, 31(57), 1-34. https://doi.org/10.24836/es.v31i57.1048

Anand, G., & Kodali, R. (2008). Benchmarking the benchmarking models. *Benchmarking: An International Journal*, 15 (3), 257-291. https://doi.org/10.1108/14635770810876593

Ballou, H. (2004). Logística Administración De La Cadena de Suministro. México: Pearson Educación.

Calderón M.A., Roark, G., Urrutia, S., Paravié, D., & Rohvein, C. (2017). Metodología para la clasificación y diagnóstico de cadenas de suministro. *Revista Ciencias Estratégicas*, 25(38), 279-298. ISSN: 1794-8347.

CEDRSSA. (2019). El Cambio climático y el sector agropecuario en México. Recovered from: http://www.cedrssa.gob.mx/files/b/13/12El%20cambio%20clim%C3%A1tico.pdf

Chávez, H. (11 de septiembre de 2014). Alimentos son hasta 630 % más caros por intermediarios. El Financiero. Recovered from: https://www.elfinanciero.com.mx/economia/alimentos-son-hasta-630-mas-caros-por-intermediarios/

Chopra, S., & Meindl, P. (2008). *Administración de la cadena de suministro. Estrategia, planeación y operación.* México: Pearson

Gobierno del estado de Jalisco. (2020). San Cristóbal de la Barranca. México: Jalisco Gobierno del estado. Recovered from: https://www.jalisco.gob.mx/es/jalisco/municipios/san-cristobal-de-la-barranca

Gustafsson, K., Jönson, G., Smith, D., & Sparks, L. (2006). Retailling Logistics & Fresh Food Packaging. London and Philadelphia: kogan-page. Recovered from: https://www.academia.edu/4506847/Retailing_logistics_and_fresh_food_packaging

Gutiérrez-Pulido, H., & Vara-Salazar R. (2013). Control Estadístico de la calidad Seis Sigma. México: McGraw-Hill. Recovered from: https://www.academia.edu/16455512/Control_Estad%C3%ADstico_de_la_Calidad_y_Seis_Sigma_3ed

Hablemos de Campo. (15 de mayo de 2018). ¿Quiénes trabajan en el campo mexicano? Recovered from: https://www.hablemosdelcampo.com/quienes-trabajan-en-el-campo-mexicano/

Hernández Sampieri, R., & Mendoza Torres, C. P. (2018). Metodología de la investigación: las tres rutas cuantitativa, cualitativa y mixta. México: McGraw-Hill.

INEGI. (2019). Encuesta Nacional Agropecuaria 2019. México: Instituto Nacional de Estadística y Geografía. Recovered from: https://www.inegi.org.mx/programas/ena/2019/

INEGI. (2020). Población rural y urbana. México: Instituto Nacional de Estadística y Geografía. Recovered from: https://www.inegi.org.mx/temas/estructura/

ECORFAN® All rights reserved.

Jaller, S. (2010). Foro nacional de vinculación de los pequeños productores al mercado. Recovered from: http://www.fao.org/3/as343s/as343s.pdf

De León, L.F., De León, E. F., Catalano, J. A., Rodríguez, D., Neira, E., & Cuevas, R. (2004). Transporte rural de productos alimenticios en América Latina y el Caribe. Recovered from: http://www.fao.org/3/y5711s/y5711s.pdf

Moxham, C. (2004). Food Supply Chain Management. *In International Journal of Operations & Production Management*, 24 (10) 1079-1080. https://doi.org/10.1108/01443570410558085

Norton, R. D. (2010). Política del desarrollo agrícola: Conceptos y principios. Roma, Italia: Organización de las Naciones Unidas para la Alimentación y la Agricultura. Recovered from: http://www.fao.org/3/y5673s/y5673s00.htm

Ríos,V.M. (17 de febrero de 2017). Escasez de mano de obra, posible amenaza para productores mexicanos. Hortalizas. Recovered from: https://www.hortalizas.com/miscelaneos/la-posible-escacez-de-la-mano-de-obra-puede-otra-amenaza-para-los-agricultores/

Rustom J. A. (2012). Estadística Descriptiva, Probabilidad e Inferencia. Una visión conceptual aplicada. Santiago de Chile: Universidad de Chile. Recovered from: http://repositorio.uchile.cl/bitstream/handle/2250/120284/Rustom_Antonio_Estadistica_descriptiva.pdf?sequence=1

SAGARPA. (2012). Plan Rector Sistema Producto Mango. Recovered from: https://issuu.com/heribertohernandez5/docs/plan_rector_jalisco

SERMARNAT. (2016). Estadísticas históricas de México. Recovered from: https://apps1.semarnat.gob.mx:8443/dgeia/indicadores_verdes18/indicadores/archivos/pdf/01_contexto/indicadores/CSE_1.1.2.pdf

Sulbarán, L. (6 de febrero de 2019). Mexicanos en Estados Unidos: las cifras que muestran su verdadero poder económico. BBC News Mundo. Recovered from: https://www.bbc.com/mundo/noticias-internacional-46705825

(SERMARNAT, 2016).

ECORFAN® All rights reserved.

Article **Journal of Environmental Sciences and Natural Resources**
June 2021, Vol. 7 No.19 19-30

Environmental function and control of heno motita (*Tillandsia recurvata*) in the atmospheric basin of Tula de Allende Hidalgo

Función ambiental y control de heno motita (*Tillandsia recurvata)* en la cuenca atmosférica de Tula de Allende Hidalgo

RESÉNDIZ-VEGA, Marisol†*´ & SÁNCHEZ-TRUJILLO, Gabriela´´

´Universidad Tecnológica de Tula-Tepeji, Engineering and Environmental Systems from the Tula-Tepeji Technological University. Avenida Universidad Tecnológica No. 1000, Col. El 61, El Carmen, Tula de Allende Hidalgo., CP 42830. Mexico.

´´Universidad Autónoma del Estado de Hidalgo, Development of Smart and Sustainable Organizations, Senior Research Professor, Mexico.

ID 1st Author: *Marisol, Reséndiz-Vega* / **ORC ID:** 0000-0001-8199-6548, **Researcher ID Thomson:** T-7946- 2018, **CVU CONACYT ID:** 819939

ID 1st Co-author: *Gabriela, Sánchez-Trujillo* / **ORC ID:** 0000-0002-9093-1081, **CVU CONACYT ID:** 346119

DOI: 10.35429/JESN.2021.19.7.19.30 Received: January 20, 2021; Accepted June 30, 2021

Abstract

The purpose of this article is to make a proposal for the control of heno motita (*Tillandsia recurvata*), based on the analysis of its environmental function within the atmospheric basin of Tula, to contribute to the solution of a state forest problem. Its approach is quantitative experimental since it seeks to explain how the application of 5% acetic acid and 80g / l sodium bicarbonate affects the emergence of new shoots and the Hay Motita plant directly, as well as to identify the function that said plant fulfills. within the microenvironment. The findings show that heno motita is a plant that seeks a support to capture nutrients from the air, however, shading causes the host plant to decrease its efficiency in capturing energy, likewise there is mechanical damage due to its weight and a chemical one since it secretes an allelopathic substance that damages the new shoots. On the other hand, Tillandsia recurvata "sequesters" particles of different materials such as heavy metals in its trichomes, thus contributing to the sanitation of the atmosphere. Finally, the steps to follow to develop a specific management program are proposed.

Environmental sanitation, environmental pollution, heavy metals

Resumen

El presente artículo tiene como propósito realizar una propuesta de control del heno motita (*Tillandsia recurvata*), con base en el análisis de su función ambiental dentro de la cuenca atmosférica de Tula, para contribuir en la solución de un problema forestal estatal. Su enfoque es cuantitativo experimental dado que se busca explicar cómo afecta la aplicación de ácido acético al 5% y Bicarbonato de sodio 80g/l, al surgimiento de nuevos brotes y a la planta de Heno Motita directamente, así como identificar la función que cumple dicha planta dentro del microambiente. Los hallazgos muestran que el heno motita es una planta que busca un soporte para captar los nutrientes del aire, sin embargo, al hacer sombra genera que la planta huésped disminuya su eficiencia en la captación de energía, así mismo existe un daño mecánico por su peso y uno químico ya que, segrega una sustancia alelopática que daña a los nuevos brotes. Por otro lado, Tillandsia recurvata "secuestra" en sus tricomas partículas de diferentes materiales como por ejemplo metales pesados contribuyendo de esta manera al saneamiento de la atmósfera. Finalmente, se proponen los pasos a seguir para elaborar un programa de manejo específico.

Saneamiento ambiental, Contaminación ambiental, Metales pesados

Citation: RESÉNDIZ-VEGA, Marisol & SÁNCHEZ-TRUJILLO, Gabriela. Environmental function and control of heno motita (*Tillandsia recurvata*) in the atmospheric basin of Tula de Allende Hidalgo. Journal of Environmental Sciences and Natural Resources. 2021. 7-19:19-30.

* Correspondence of the Author (E-mail: marisol.resendiz@uttt.edu.mx)
† Researcher contributing first author.

Introduction

According to data from Semarnat (2020), the state of Hidalgo has an area of 20.8 thousand km^2 (the 1.1% of the national territory) and in 2015 there were 2.86 million inhabitants (2.4% of the national population) and it has three main atmospheric basins, in which 1.5 million inhabitants are concentrated.

The Tula atmospheric basin (see figure 1), made up of 12 municipalities, has 58 local and federal companies, is home to a refinery, two electricity generation plants (one conventional thermoelectric and one combined cycle with natural gas), six cement plants, four lime scale, industries of the metal-mechanic and chemical industry, among others.

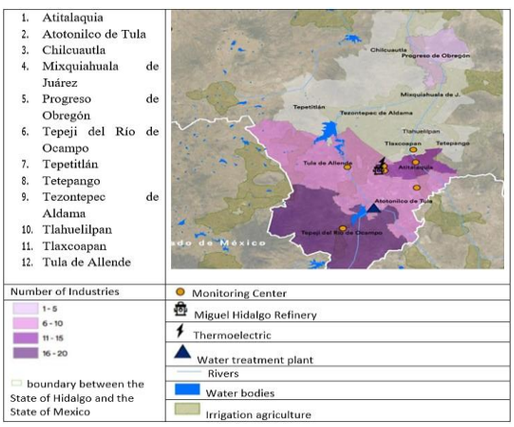


Figure 1 Atmospheric basin of Tula
Source: SEMARNAT, 2020

The Tula Atmospheric Basin (CAT) is the largest generator of pollutants in Hidalgo (see table 1), since it contributes 97% of the sulfur dioxide (SO2), 45% of the PM2.5 particles and 43% of the nitrogen oxides (NOx) emitted in the state.

Fountain	P.M10	P.M 2.5	SWtwo	CO	NOx	VOC	NH_3
Fixed	12,062	8,498	148,339	9,838	31,605	4,039	258
Area	24,859	9,807	248	67,341	11,305	34,379	18,887
Road mobiles	2,546	2,335	762	95,887	30,770	10,820	152
No mobiles roads	195	189	80	1,025	1,976	194	two
Total	**39,662**	**20,829**	**149,429**	**174,091**	**75,656**	**49,432**	**19,297**

Table 1 Emission of pollutants into the atmosphere of the Tula de Allende basin, Hgo (2016)
Source: Inventory of emissions of criteria pollutants, Semarnath, INEM (to be published)

In turn, a higher incidence of parasitic plants and epiphytic plants is observed in disturbed areas and has caused concern among the general population, especially in the Tula-Tepeji and Mezquital Valley Regions (National Forestry Commission, State Management of Hidalgo, 2017).

The Secretariat of the Environment and Natural Resources in Hidalgo (Semarnath), reports the impact on the Mezquital Valley, in the municipalities of Actopan, Alfajayucan, El Arenal, Atitalaquia, Atotonilco de Tula, Chapantongo, Francisco I. Madero, Huichapan, Ixmiquilpan, Mixquiahuala, Nopala, Progreso, San Agustín Tlaxiaca. As well as in Santiago de Anaya, San Salvador, Tasquillo, Tecozautla, Tepejí del Río, Tepetitlán, Tetepango, Tezontepec de Aldama, Tlahuelilpan, Tlaxcoapan and Tula de Allende. (Wheel S., 2017 and Sánchez, J. 2017).

According to the National Forestry Commission, State Management of Hidalgo, (2017), parasitic plants and epiphytes represent one of the greatest management and control challenges in the state of Hidalgo. Focusing its greatest incidence on the Sierra Gorda, Sierra Alta, La Altiplanicie Pulquera and the TulaTepeji Zone and the Mezquital Valley. The owners and possessors of forest land have requested to give attention, especially to heno motita (Tillandsia recurvata) since its abundant presence and infestation has caused the inhabitants of urban areas to show greater interest and concern in its management and control, all Once it is possible to observe its presence in urban parks, and in areas of common use and small owners with properties abandoned by actions of agriculture and livestock,

This problem has also been observed in the Tula-Tepeji industrial zone, affecting 1,200 hectares according to the National Forestry Commission (Conafor, 2018). Among the trees most affected within the study area we find mesquite and huizaches that represent 45% of the total. This affectation brings as a consequence: decrease of the vegetal cover, decrease in the capture of CO_2. Likewise, the Huizache (Acacia farnesiana), is of great importance in its flowering season for the bees that collect pollen as well, it has a high nutritional value due to its crude protein content (23%) and is a plant resource of wide Bioavailability that has not been fully exploited, which could be a low-cost option to feed livestock in critical times.

ISSN: 2444-4936
ECORFAN® All rights reserved.

According to Edison A. Diáz-Álvarez (2018), heno motita (Tillandsia recurvata) is ideal for studying the traces of air pollution because it absorbs pollutants in a different way through the air and rain. Hay absorbs nitrogen oxides directly from the air and facilitates its monitoring through its tissues, and they are effective since they show the same pattern detected by electronic monitors used to evaluate air quality.

Due to the problems presented, it is the purpose of this study to analyze the environmental function of heno motita and find, where appropriate, a way to control its population, through a proposal in order to mitigate the affectation of trees in the atmospheric basin of Tula in the Hidalgo state, Mexico.

Theoretical framework

Background

Motita hay (Tillandsia recurvata) is one of the best known epiphytic species in Mexico, even by the urban population, since it is very easy to find it commonly attached to power lines, poles and trees (huizaches and mesquite). It is a common plant in humid places, both in temperate and tropical regions. Although it may not seem like it, these plants are not parasites, but through millions of years of evolution they learned to grow on other plants to achieve sunlight. That is, these plants obtain their food from the wind and the sun, in addition the wind encourages the movement of dust which is retained in the hairs of your body and in this way they capture minerals and nutrients,

Unlike parasitic plants, these are called epiphytes (epi = on top and phytos = plant); with the characteristic that its roots do not develop within the host plant and therefore do not feed on it, although if they proliferate too much, they can limit the sprouting of the trees and contribute to their weakening and can be damaged by fungi or true parasitic plants.

Epiphytes are plants that grow on other plants, without having direct contact with the vascular bundles of their hosts (Lüttge U. 1989 and Benzing DH, 1998), therefore, as they do not have roots in the soil, epiphytes have an extraordinary dependence on the atmosphere for the acquisition of the nutrients and water they need, which makes them sensitive to air humidity (Benzing DH 1990) and therefore according to Lugo and Scatena (1992) and (Helliker, Griffiths. 2007), are useful for measuring the response to changes in climate.

Thus, epiphytic bromeliads are one of the most threatened groups, since the root system only adheres them to the host, and the nutrients and water necessary for their growth are absorbed by the leaves.

One of the main evolutionary responses of plants growing in epiphytic habitats is crassulaceae acid metabolism (CAM), which is present in many species of epiphytic bromeliads. This is a photosynthetic pathway that allows plants to use water efficiently. (Andrade, Cervera, Graham, 2009, De la Barrera, Reyes-García, Ricalde, Vargas-Soto and Cervera 2007, Benzing, 2000 and Martin, 1994).

Type of photosynthesis of Tillandsia recurvata. Approximately 89% of the plants that inhabit the planet carry out C_3-type photosynthesis, 10% are CAM and the remaining 1% are C_4; additionally, a few species are known to be C_3-C_4 intermediates.

Unlike C_3 and C_4 plants, CAM plants assimilate atmospheric CO_2 into four-carbon acids, predominantly at night and subsequently prefix it during the following day via the Calvin cycle. The stomata of CAM plants remain open at night and closed for most of the day, thus resulting in minimal water loss and reduced photorespiration (Herppich and Peckmann, 2000).

Therefore, CAM plants exhibit rates of water use efficiency five to ten times higher than C4 plants, resulting in considerable competitive advantage in environments where water is the limiting factor, such as deserts or environments. epiphytes (Cushman, 2001). Furthermore, CAM plants are further distinguished from C_3 or C_4 plants by a considerable number of unique characteristics (Cushman and Bohnert, 1997).

ECORFAN® All rights reserved.

First, CAM plants accumulate organic acids in the vacuole during the night phase, predominantly in the form of malic acid, and undergo a reciprocal accumulation of reserve carbohydrates such as soluble starch, glucans or hexoses during the day phase. Second, to accommodate these large diurnal changes in four-carbon acids and carbohydrates, CAM plants display large amounts of PEPC for nocturnal CO fixation.two and have active decarboxylase enzyme systems to provide diurnal CO refixationtwo through the Calvin cycle. Third, PEPC is activated at night by phosphorylation and inactivated during the day by phosphorylation, a pattern opposite to that found in C_3 or C_4 plants. In addition to these unique biochemical characteristics, CAM plants have evolved in a number of morphological and anatomical aspects (see table 2).

Kind	Separation of fixation inicial from CO_2 and cycle by Calvin	Open stomata	Better adapted to
C_3	There is no separation	Day	Environments fresh and damp
C_4	Between the mesophyll and day cells of the vascular bun (in space)		Environments warm and sunny
CAM	Between day and night	Night	Very hot and dry environments

Table 2 Comparison of Types of Photosynthesis: C_3, C_4 and CAM
Source: Adapted from (Guralnick, Lonnie, Cline, Smith and Rowan 2008)

In CAM photosynthesis, gas exchange takes place at night, (See table 1), when the demand for evaporation to the atmosphere is low, which reduces the loss of water through transpiration.

Plants that have CAM photosynthesis do not owe their production to the use of water, only to the temporary nocturnal fixation of CO_2, since the enzyme phosphoenol pyruvate carboxylase (PEPc), responsible for the primary uptake of COtwo, has a higher affinity for this gas than the enzyme ribulose bisphosphate carboxylase / oxygenase (RUBISCO), the CO-binding agenttwo, in the Calvin cycle[1]; so the plants with CAM can fix higher amount of CO_2 in relation to the amount of water lost during gas exchange.

A combination of stress due to low water availability and high solar radiation can cause photo inhibition. For this reason, epiphytic bromeliads have evolved in their structures and physiological mechanisms (formation of tanks for water uptake, foliar succulence, foliar trichomes specialized in the absorption of water and nutrients, as well as CAM photosynthesis), which have allowed them to adapt successfully to the environment with low amounts of water, high light densities and instability of the branches of the phorophytes (trees on which they grow) in the face of strong winds.

Description of *Tillandsia recurvata*

Next, a general diagram and description of the main structures of heno motita are presented (see figure 2).

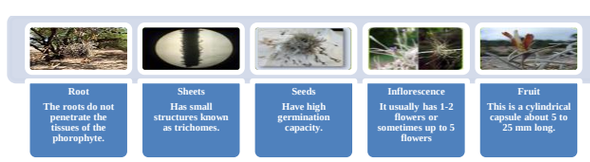


Figure 2 Structures of *T. recurvata*
Source: Own elaboration based on Padilla and Gardner, 1977

Root

It is used mainly for anchoring and supporting the plant. The roots do not penetrate the tissues of the phorophyte (host), only the development of a suber not greater than 400 µm thick is observed, with dead cells, radially dilated and with crystalline inclusions, thin walls and wide lumen, alternating with cells radially tablets with thick walls that contain substances that are observed in a dark tone which are also found above the suber (Páez *et al*., 2005).

[1] The reactions of the Calvin cycle belong to the so-called independent phase of light, which is responsible for fixing CO_2.

ISSN: 2444-4936
ECORFAN® All rights reserved.

Sheets

According to Kamila (2005), this species has small structures known as trichomes, which replace the roots in the function of absorbing nutrients and water. Distinct orderly, 3-17 cm long, densely pruinous-scaly with ashen or iron-like scales; sheaths elliptical-ovate, thin, multinveined with a wide hyaline enervated margin, with the extreme base glabrous, and in the rest densely scaly and with a ciliated margin of elongated scales, imbricated and completely hiding the caule; blades typically recurved, sometimes only patent or still erect, linear, plump, 0.5-2 mm in diameter, a little soft with a weak point (Matuda, 1957).

Inflorescence

It usually has 1-2 flowers or sometimes up to 5 flowers, dense; floral bracts like scape bracts, but smaller, equal to or longer than sepals, but often distinctly shorter, varionervative, densely scaly. Flowers erect, sub-sesile. Sepals lanceolate, usually acute, 4-9 mm long, slender, with 3 or more prominent nerves, up to 13 cm long, about 0.5 mm in diameter; scape bracts, somewhat scaly species in a growing proportion of specimens.

Petals narrow, pale-violet or white. Stamens deeply exceeding the pistil. Slender cylindrical capsule, abruptly short-beaked, up to 3 cm (Matuda, 1957).

Fruit

This is a cylindrical capsule about 5 to 25 mm long, with two or more carpels, with a variable number of cavities and lines of dehiscence, abruptly ending in a short beak. Inside it houses several seeds of a viscous consistency (Villarreal, 1994).

Seeds

The seeds contained in capsules, open with maturity and have high germination capacity, are disseminated by the wind and some birds after the dehiscence or natural opening of the capsules; In addition, the seeds have trichomes, a characteristic that gives them a greater possibility of adherence to the bark of the host trees and shrubs (Crow, 2000).

Vegetative and reproductive phenology Reproduction

They reproduce in two ways. The first and most common is by pollination and seed production. They do not self-fertilize and the pollen has to come from another plant of the same species. The other way is the reproduction of seedlings called “suckers”. New plants emerge from the mother plant, often on the stem. This usually happens after flowering. A plant can have several suckers that can be removed and developed alone separately or left together with the mother plant, to form a colony (Páez *et al*., 2005).

Biological cycle

According to Arellano *et al*., (2007) begins with the fertilization of the ovules by pollen and the consequent formation of numerous seeds in the chamose fruits called capsules. The numerous seeds are dispersed by the wind or by animals germinate in trees, rocks or soil that meet the conditions for their development, such as light, humidity and temperature. A small percentage of the total released seeds germinate and give rise to seedlings. After several days of development, the species blooms, bears fruit and dies, thus closing its life cycle. Its reproduction by shoots are suckers that are born next to the mother plant, (this method is used to keep the species perpetuated in cultivation places proper when the plant finally blooms and will soon dry up (Ceja, 2008).

Effect of *Tillandsia recurvata* towards the phorophyte

According to Neumann (2004) affirms that *T. recurvata* secretes an allelopathic substance called hydroperoxycycloartan through its rhizoids, said substance according to this author causes the death of buds and the absition of the foliage.

In turn, (Barbosa *et al*., 2004), point out that *T. recurvata* absorbs heavy metals that are found in the air as a product of environmental pollution, and could exert a toxic effect on the host tree.

ECORFAN® All rights reserved.

According to (Páez *et al*., 2005), the roots do not penetrate the tissues, the presence of hay causes the plant to develop a suber response no greater than 400 µm thick, with dead cells, radially dilated and with crystalline inclusions, alternating with cells with thick walls that contain substances that are observed in a dark tone which are also found above the suber[2].

Thus, *T. recurvata* also damages its host through the accumulated weight that they generate on the branches and shading (Ruiz and Coronado, 2012). According to Crow (2000), it blooms in summer and reproduces both sexually and asexually. The seeds are spread by wind, birds, insects, and other organisms; germinates easily.

With the force of the wind, the *Tillandsia* shoots are detached and when they settle on another branch or any other structure, they form a new individual. These plants do not tolerate direct contact with the sun, preferring an indirect but abundant light. Given their anatomical structure with rosette and waxy branches, they retain a lot of humidity so they resist long periods of drought and strong frosts.

All these advantages such as: CAM photosynthesis, development of trichomes for water uptake, uptake of nutrients from the air, allelopathic phenomenon, asexual and sexual reproduction and the ease of dissemination of both seeds and suckers makes *T. recurvata* have advantages competitive with respect to the host plant, which although it cannot be considered a parasite because it does not absorb nutrients from the host, if there is a relationship in which the hay benefits and the tree is harmed, so we can consider the Hay motita as an epiparasite, for being on the tree and damaging it.

Objective

Carry out a proposal for the control of heno motita (*Tillandsia recurvata*), based on the analysis of its environmental function within the Tula-Tepeji industrial corridor, to be implemented in the surrounding communities and thus contribute to the solution of a state forest problem.

Based on the objective, the following working hypotheses are established:

Hypothesis

The application of 5% acetic acid and 80g / l sodium bicarbonate on the heno motita controls its spread by 100%.

Methodology

The focus of the study is quantitative with experimental design since the study manipulates the variables, measures and controls in comparison groups to explain the recovery of infected plants that receive treatment, as well as the role that the heno motita fulfills within the microenvironment.

According to Labrada *et al*. (2021), the participation of university students in attending to environmental problems in their municipalities allows: the construction of knowledge, integration of personal experiences and contributes to the development of their own modes of professional performance.

In the development of the field and experimental work, a group of 30 Environmental Engineering students to the Universidad Tecnológica de Tula-Tepeji.

Variables

Dependent: treatment.

Independent: tree involvement.

Show

At the state level, the affectation of plants by heno motita is approximately 1,200 hectares in the state of Hidalgo, the study area corresponds to the Tula Atmospheric Basin, which is made up of 12 municipalities. In order to carry out a punctual monitoring and control of the plants, only 3 municipalities, Tula, Tepeji del Rio and Atitalaquia, were considered at the discretion of the researchers since these localities are the most important industrial corridors in the state and therefore where they are located. generates a higher level of environmental pollution. The inclusion criteria were.

[2] Variety of protective or epidermal tissue, formed by dead cells, which externally covers plants over a year old, especially trees.

ECORFAN® All rights reserved.

- Location.
- Number of specimens affected.
- Degree of infestation.
- Plant height and size.

Being distributed as follows (see tabla 3)

Parameter / Type Mezquites	Tree	Huizaches	Capulin	Jacaranda	Others
Grade of Infestation (%), average	90	70	3	1	1
Height (meters)	2-10	1-4	3-10	4-8	2-8
Size (Diameter from shadow on meters)	8	3	4	4-6	2-6

Table 3 Trees affected by heno motitay, within the study areas in Tula de Allende, Tepeji del Río and Atitalaquia Hidalgo
Source: Own elaboration

Huizache trees were selected mainly for their ease of handling since they are shorter in stature and have second place in degree of infestation and number of affected individuals (45%); likewise for its environmental importance in the region.

To determine the degree of infestation, the procedure of Hawksworth, (1980) is followed.

- Divide the tree crown into 3 parts, each third is evaluated separately and the ratings that will be given are 0.1 and 2, where: 0 is not visible, 1 light infection (half of the branches infected), and 2 severe infection (more than half of the branches infected).
- Finally, the qualifications of each third are added, to know their level of infestation and also take the necessary measures.

The selected trees were labeled to identify the type of treatment

Control sample

A control sample of Heno motita was collected in the community of Villa del Carbón, state of Mexico, as a reference, since it is an area far from the industry and with an important population of trees.

Types of Treatment and grouping

The selected trees were classified in two groups: Group 1 was applied treatment with acetic acid 5% Group 2 with sodium bicarbonate 80g / l.

In each group, the degree of infestation was identified, making 4 subgroups: 70%, 50%, 20% and controls.

From each subgroup, 3 types of treatment were applied:

3 (in triplicate), trees received chemical treatment,

3 (in triplicate) first received manual removal of the heno motita and chemical treatment, only in the sprouts and the last ones did not receive chemical treatment (see summary table 4).

The trees received different treatments, following the NOM-011-RECNAT-1996 standard.

Group 1. Treatment with acetic acid 5% Group 2. Treatment with sodium bicarbonate 80g / l			
70% of infestation	50% of infestation	20% of infestation	Witness No treatment
3 trees (in triplicate) 5% acetic acid was applied directly on the heno motita			
3 trees (in triplicate) the hay heno motitas removed manually and chemical control was applied only on the sprouts			
3 trees (in triplicate) the hay heno motita removed manually and no chemical control was applied.			

Table 4 Chemical treatment to control Hay speck (*Tylandsia recurvata*)
Source: Own elaboration

For the identification of contaminants in the infected plants, the following steps were carried out:

Observation under the light microscope

The collected hay was observed under the light microscope with a magnification of 10X.

Hay treated with both vinegar and bicarbonate was observed to identify changes on exposure to treatment.

ECORFAN® All rights reserved.

Determination of heavy metals

- A sample was taken from the collected hay in a simple random manner.
- The hay sample was dried in an oven at 40 °C for 72 hr.
- Once dry, digestion with nitric acid was carried out for 4 hr.
- The determination of heavy metals was carried out under NMX-AA-051-SCFI-2016.

Results

To respond to the objective, the comparison results to explain the recovery of infected plants that receive treatment, the following was obtained:

Treatment

Manual Removal of heno motita

Once the heno motita is removed and the sprouts are treated with either 5% acetic acid or 80g / l sodium bicarbonate, the tree improves by 80%, but the speed at which the heno motita sprouts and is regenerates is a fast process since they appear on the second day after the hay has been removed. Therefore, the tree returns to the degree of initial infestation in a few weeks. Due to this situation, it is not feasible to withdraw manually without any treatment.

To remove Hay from a tree with more than 70% infestation; The option is to cut down the affected parts and apply manual removal on the less affected branches, adding the chemical treatment of the sprouts with either 5% vinegar or 80g / l bicarbonate.

To completely remove Hay speck from a tree with 70% or less infestation; the option is: manual removal of 100% of the hay rosettes and treatment of the sprouts by applying vinegar or bicarbonate directly on the sprout, for at least 10 days.

In figure 3 we can see that when applying vinegar with an acidic pH (pH = 3.0) or sodium bicarbonate (pH = 8.0), the trichomes, being very thin structures, are destroyed and the plant loses its ability to capture the trichomes. water and nutrients; since it is the trichomes that retain particles of different sizes PM 2.5, PM 5.0, PM 10, etc., and composition.

These particles that get trapped in the trichomes are some of them; dissolved and used as nutrients and others are simply retained.

Figure 3 Destruction of trichomes from the application of 5% acetic acid
Source: Own source

Macroscopically, the plant deteriorated by the application of the chemicals can be seen on the left side and the damage caused to the trichomes can be seen on the right side.

In addition, during the collection of the sample it was observed that heno motita is an ecological niche for insects, arachnids, reptiles, rodents and birds; of different sizes since when carrying out the removal they came out of the hay rosettes, likewise they retain a diversity of particles from the environment, as additional data, bird nests were found built with heno motita where cobwebs and growth of various fungi appear, which presents another micro ecosystem (see figure 4).

Figure 4 "Rosettes" of heno motita that function environmentally as: ecological niche of arachnids, insects, reptiles, birds and rodents
Source: Own elaboration

ECORFAN® All rights reserved.

Identification of contaminants

In the digest of heno motitacollected in the Tula atmospheric basin, the presence of Pb, Fe, Cr, Cu and Cd was detected. In table 5 we can see the results obtained in duplicate, having an average of 0.06m / l of Pb, 4.62 mg / l of Fe, 0.031mg / l of Cr and 0.0515 mg / l of Cu; all of them metals, possibly products of the different emissions from fixed and mobile sources in the basin.

Villa del Carbón			Study zone		
Sample number	Heavy Metal	Reading mg/L	Sample number	Heavy metal	Reading mg/L
1	Pb	0.085	1	Pb	0.04
2	Pb	0.1	2	Pb	0.08
Sample blank	Pb	0.0	3	Pb	0.00
1	Fe	12.37	1	Fe	4.04
2	Fe	13.2	2	Fe	5.2
Sample Blank	Fe	0.0	3	Fe	0.0
1	Cr	0.043	1	Cr	0.029
2	Cr	0.046	2	Cr	0.033
Sample blank	Cr	0.000	3	Cr	0.000
1	Cu	0.091	1	Cu	0.047
2	Cu	0.078	2	Cu	0.056
Sample blank	Cu	0.0	3	Cu	0.0
1	Cd	0	1	Cd	0
2	Cd	0	2	Cd	0
Sample blank	Cd	0	3	Cd	0

Table 5 Heavy metal concentration in collected heno motita
Source: Self made

Likewise, in the digests of heno motita collected in Villa del Carbón, a lower concentration of these metals was detected: 0.095mg / l of Pb, 12.78mg / l of Fe, 0.044mg / l of Cr and 0.084mg / l of Cu and Cd was not detected.

The samples from Villa del Carbón are used comparatively since the settlement of fixed and mobile sources is less than that found in Tula, however; heno motita contaminated with heavy metals was also detected. The foregoing suggests carrying out another study to identify sources of pollution that could be carried by the winds, for which it would be necessary to study the dynamics of the Tula air basin and the direction of the winds.

Proposal for use for Hay speck

Due to the microscopic observation of the leaves, we can see that the trichomes are "trapping" particles of different composition, including heavy metals; It is proposed to use heno motita as a filter material. That is, it can be fixed to inert materials in the construction of fences outdoors as "green filtering walls" (see figure 5) and indoors for the same purpose and even as a decorative plant (see figure 6).

Figure 5 Use of Hay speck as a biofiltering material in green walls
Source: Own Elaboration

Figure 6 Use of heno motita in interior decoration and purification
Source: Own Elaboration

Because it has embedded in its trichomes particles of different composition that depend on the pollutants of the environment in which it is found; being able to find pollen, minerals, parasite eggs, heavy metals, etc. Not recommended as: soil improver, animal feed or for composting. In Figure 7 we observe a proposal for the elaboration of a management program for heno motita (*Tillandsia recurvata*) for the air basin of Tula de Allende, Hidalgo, Mexico. Consists in:

ISSN: 2444-4936
ECORFAN® All rights reserved.

- Carry out a diagnosis that includes a sensing of the area to be controlled. Know the quantity and type of trees, as well as their degree of infestation and review of the applicable legal framework.

- With the above information, choose the type of control to apply: preventive, removal with equipment such as pressurized air or water, or manual removal; as well as chemical regrowth treatment. Budgeting: materials, protective equipment, transportation, personnel, consumables, etc.

- Identify follow-up actions and their corresponding budget; evaluate the experience and its results. Disseminate the experience and results, provide feedback and train.

- Analyze the contaminants "trapped" by the heno motita to determine the proper final disposal and / or the use that will be applied to the collected.

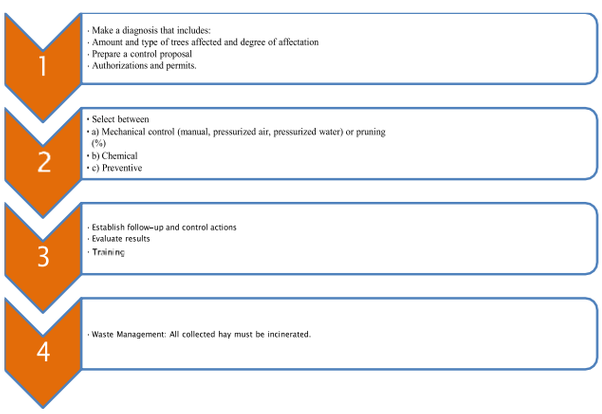


Figure 7 Proposal for the next step to formulate and implement a control and monitoring program for heno motita
Source: Own elaboration

Conclusions

Speck hay is a plant that seeks support from which it can capture nutrients from the air, since it does not absorb nutrients from the plant it uses, it has developed the ability to hold better and better and ensure its survival. Unfortunately, by shading its host, its efficiency in capturing light energy decreases, suffering a deterioration that adds to the allelopathic effect, even causing the total loss of the affected tree.

It is observed that the proximity to contaminants facilitates the spread of heno motita; It is possible to indicate that the levels of contamination favor the proliferation of heno motita, since the hay completely depends on absorbing all its nutrients from the air (C, H, O, N, S and P), mainly CO_2.

Similarly, the control sample of hay collected in Villa del Carbón, state of Mexico, presented almost the same amounts of heavy metals in relation to what was observed in the study region. The treatment of 5% acetic acid and 80mg / l sodium bicarbonate if it manages to damage the integrity of the trichome structure and therefore affect the survival of the heno motita. On the other hand, the separation of important amounts of heavy metals from the atmosphere (Pb, Cr, Cu and Fe) was observed, thus contributing to improve air quality.

In addition, the study made it possible to study the environmental function of Hay motita, since it is possible to carry out tests to place the collected hay on alternate supports, even inert ones, and provide the hay with a space at a height equal to that of the infested trees so that it complies with the environmental functions detected which are:

- Ecological niche.

- Capture of particles of different composition, including heavy metals.

- Contribution of material for nests of birds and rodents.

- Particle collector of different sizes and materials.

- Biomonitor.

- Efficient CO_2 collector.

- CAM photosynthesis.

It is recommended to remove the Hay speck, and to apply the treatment of the sprouts either with acetic acid or with sodium bicarbonate to avoid reinfestation.

ISSN: 2444-4936
ECORFAN® All rights reserved.

Environmental education plays a fundamental role in the construction of a society more aware of the complexity, relationships and interdependencies of each of the organisms that inhabit the planet (Manzanares, 2021). The participation of students in experimental and field work contributed to the articulation of the knowledge acquired in the classrooms and managed to involve them in addressing environmental problems.

Another line of study remains open, where the direction of the wind and the pollutants that can be carried from industrial areas to green areas are analyzed.

References

Andrade J. L., Cervera J. C. Graham E. A. (2009). Microenvironments, water relations and productivity of CAM plants. De la Barrera E., Smith W. K., Eds. Perspectives in Biophysical Plant Ecophysiology: A Tribute to Park S. Nobel, pp. 95-120. Universidad Nacional Autónoma de México. Centro de Enseñanza para Extranjeros, Centro de Investigaciones en Ecosistemas, Campus Morelia, México. D. F.

Andrade J. L., De la Barrera E., Reyes-García C., Ricalde M. F., Vargas-Soto G y Cervera J. C. (2007). El metabolismo ácido de las crasuláceas: diversidad, fisiología ambiental y productividad. Boletín de la Sociedad Botánica de México, 81 pp.37-50.

Arellano, M. J.J.; M. E. Miranda. J.; B. Z. Salazar A.; F. Hernández. M.; R. Quero. C.; L. Pérez. S. 2007. Colección Manejo Campesino de Recursos Naturales, Bases para el manejo comunitario de bromelias ornamentales. Grupo Autónomo para la Investigación Ambiental A.C. México D.F. Pp. 98.

Benzing D. H. (2000). Bromeliaceaoe: Profile of an Adaptative Radiation. Cambridge University Press. Cambridge.

Benzing D. H. (1998). Vulnerabilities of tropical forest to climate change: The significance of resident epiphytes. Climate Change 39, pp. 19-540.

Benzing D. H. (1990). Vascular Epiphytes. General Biology and Related Biota. Cambridge University Press. Nueva York.

Comisión Nacional Forestal (CONAFOR). (2018). Pinus cembroides Zuuk. http://www.conafor.gob.mx:8080/documentos/docs/13/955Pinus%20cembr oides.pdf

Comisión Nacional Forestal Gerencia Estatal de Hidalgo (2017), Diagnóstico Fitosanitario del Estado de Hidalgo https://iefectividad.conanp.gob.mx

Crow, W. y Ball. M. (2000). The Texas Agricultural Extension Service. http://agrilifebookstore.org/tmppdfs/viewpdf1206.pdf

Cushman J, Bohnert HJ. (1997). Molecular Genetics of Crassulacean Acid Metabolism. Plant Physiol. 113, pp. 667-676.

Cushman, J. (2001). Crassulacean Acid Metabolism. A Plastic Photosynthetic Adaptation to Arid Environments. Plant Physiol, 127, pp. 1439-1448.

Edison A. Diáz-Álvarez, Roberto lindig-Cisneros, Erick de la Barrera (2018), Biomonitors of atmospheric nitrogen deposition: potential uses and limitations, Conservation, Physiology, Volumen 6, Issue 1,coy011, https://doi.org/10.1093/conphys/coy011

Ghirardi, R., Fosco, M. E., Gervasio, S. G., Imbert, D., Enrique, C. y Pacheco, C.G. (2010). Líquenes y claveles del aire como bioindicadores de contaminación atmosférica por metales pesados en el microcentro Santafesino. Revista FABICIB. 14, pp.165-173.

Guralnick, Lonnie J., Amanda Cline, Monica Smith y Rowan F. Sage. (2008). Evolutionary physiology: the extent of C4 and CAM photosynthesis in the genera Anacampseros and Grahamia of the Portulacaceae (Fisiología evolutiva: el alcance de la fotosíntesis de plantas C4 y CAM en los géneros Anacampseros y Grahamia de las portulacáceas). Journal of Experimental Botany, 59(7), 1735-1742. http://dx.doi.org/10,1093/jxb/ern081.

Hawksworth, F.G, (1980). Memoria, primer simposio nacional sobre parasitología forestal, Uruapan Michoacán. Pp. 239-251

ECORFAN® All rights reserved.

Helliker B. R., Griffiths H. (2007). Toward a plant-based proxy for the isotope ratio of atmospheric water vapor. Global Change Biology 13, pp. 273-733.

Herppich, W., Peckmann. K. (2000). Influence of Drought on Mitochondrial Activity, Photosynthesis, Nocturnal Acid Accumulation and Water Relations in the CAM Plants Prenia sladeniana (me-type) and Crassula lycopodioides (pepck-type). Ann Bot. 2000; 86, pp. 611-620.

Kamila, P.G. (2005). Clavel del aire, una planta que afecta a árboles y arbustos, métodos de control. Argentina. Disponible en: http://riie.com.ar/?a=28067

Labrada, Y. R. V., Benítez, M. P., Rodríguez, G. P., & Hopkins, R. D. (2021). La educación ambiental ante el cambio climático en la formación del profesional universitario: experiencias desde la Universidad de Oriente. Universidad y Sociedad, 13(1), 331-339

Lugo A. E., Scatena F. N. (1992). Epiphytes and climate change research in the Caribbean: a proposal. Selbyana 13, pp.123-130.

Lüttge U. (1989). Vascular Plants as Epiphytes. Evolution and Ecophysiology. Springer-Verlag. Berlín.

Manzanares Días, C. J. (2021). Percepción de la comunidad universitaria sobre la ejecución del Plan de Gestión Ambiental en la Universidad Nacional Agraria, 2019-2020 (Doctoral dissertation, Universidad Nacional Agraria).

Martin C. E. (1994). Physiological ecology of the Bromeliaceae. The Botanical Review 60, pp. -82.

Matuda, E. (1957). Bromeliáceas y Aráceas del Estado de México. Impreso en talleres gráficos de la nación, México D.F. Pp. 63.

Neumann, R. (2004). Clavel del aire (Tillandsia recurvata) y su control. Trabajo presentado en el XIII Congreso Latinoamericano de Malezas 17,18 y 19 de Septiembre de 1997.Buenos Aries Argentina Boletín Técnico N.º 17. Buenos Aires, Argentina, p. 22.

Páez L., Aguilar., T., Terrazas, M. Huidobro S. y Aguirre, E. (2005). Cambios anatómicos en la corteza de Parkinsonia praecox (Ruiz y Pavon) Hawkins causados por la epifita Tillandsia recurvata L. (Bromeliaceae). Boletín de la Sociedad Botánica de México. 077, pp. 59-64.

Páez, G. L. (2005). Biología de Tillandsia recurvata L. (Bromeliaceae) y su importancia en aplicaciones prácticas y ecológicas. Tesis profesional. Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, Tlalnepantla, Estado de México. p. 82.

Raya, P., J. C.; Aguirre, M., C. L. (2009). Composición elemental de algunas especies de plantas silvestres mexicanas. Redalyc. México. Pp, 95-98.

Rueda S. (2017). Atiende Semarnath plagas en el Valle del Mezquital. Recuperado de: https://www.elindependientedehidalgo.com.mx/ atiende-semarnath-plagas-en-valle-del-mezquital]

Ruíz, E., Coronado J. (2012). Are epiphytic plants parasites of the trees? Evidence of mechanisms of direct and indirect damage. Recursos naturales, p.26.

Sánchez, J. (2017). Plaga de heno afecta 25 municipios del Valle de Mezquital. https://www.am.com.mx/hidalgo/noticias/Plaga-de-heno-afecta-25-municipios-del-Valle-del-Mezquital-20180307-0034.html.

Villareal, Q. J.A, (1994). Flora vascular de la sierra la paila Coahuila, Boletín Técnico Informativo. 16(1). Pp.109-138.

ECORFAN® All rights reserved.

Article **Journal of Environmental Sciences and Natural Resources**
June 2021, Vol. 7 No.19 31-39

Proposal to treat leachate from the open-air dump of the Municipality of Zacatecas

Propuesta de tratamiento del lixiviado proveniente del tiradero a cielo abierto del Municipio de Zacatecas

SOSA-VÁZQUEZ, Olga Lidia†, VILLEGAS-MARTÍNEZ, Rodrigo Cervando, CONEJO-FLORES, Ricardo and GARCÍA-GONZÁLEZ, Juan Manuel*

Universidad Autónoma de Zacatecas, Academic Program of Chemical Engineering. Unidad Académica de Ciencias Químicas, Campus UAZ Siglo XXI Edificio 6, Km 6 s/n carretera Zacatecas- Guadalajara, Ejido "la Escondida", C.P 98160, Zacatecas, México.

ID 1st Author: *Olga Lidia, Sosa-Vázquez* / **ORC ID:** 0000-0003-4544-4732

ID 1st Co-author: *Rodrigo Cervando, Villegas-Martínez* / **ORC ID:** 0000-0003-0474-6734

ID 2nd Co-author: *Ricardo, Conejo-Flores* / **ORC ID:** 0000-0002-8513-1821

ID 3rd Co-author: *Juan Manuel, García-González* / **ORC ID:** 0000-0001-7259-5021, **CVU CONACYT ID:** 346241

DOI: 10.35429/JESN.2021.19.7.31.39 Received: January 25, 2021; Accepted June 30, 2021

Abstract

In this work, a feasible proposal is generated for the treatment of leachate from the municipal dump of the city of Zacatecas. Solid waste disposal sites that were not technically planned are commonly known as "open-air" dumps. These sites are basically landing where municipal solid waste is deposited and accumulated without any technical, sanitary and operational control, as well as the absence of infrastructure works to minimize negative impacts on the environment. The waste that ends up in these final disposal sites is decomposed by the presence of water, forming leachate. Due to the above, different pollutants are produced, which makes proper management necessary to preserve the environment, as well as public health. Current leachate treatment options include recycling, re-injection, on-site treatment, discharge to a municipal water treatment plant, or a combination of several.

Leachate treatment, Garbage dump, Contamination

Resumen

En este trabajo se genera una propuesta factible para el tratamiento del lixiviado proveniente del tiradero municipal de la ciudad de Zacatecas. Los sitios de disposición final de residuos sólidos que no fueron planeados técnicamente se conocen comúnmente como tiraderos "a cielo abierto". Estos sitios básicamente son terrenos en donde se depositan y acumulan los residuos sólidos municipales sin ningún control técnico sanitario y operativo, así como la ausencia de obras de infraestructura para minimizar los impactos negativos al ambiente. Los residuos que terminan en estos sitios de disposición final se descomponen por la presencia de agua, formándose el lixiviado. Debido a lo anterior se producen diferentes contaminantes, lo que hace necesario un manejo adecuado, para preservar el medio ambiente, así como, la salud pública. Las opciones actuales del tratamiento de lixiviado incluyen el reciclaje, la re-inyección, el tratamiento in situ, la descarga a una planta municipal de tratamiento de aguas o una combinación de varias.

Tratamiento de lixiviado, Tiradero de basura, Contaminaciós

Citation: SOSA-VÁZQUEZ, Olga Lidia, VILLEGAS-MARTÍNEZ, Rodrigo Cervando, CONEJO-FLORES, Ricardo and GARCÍA-GONZÁLEZ, Juan Manuel. Proposal to treat leachate from the open-air dump of the Municipality of Zacatecas. Journal of Environmental Sciences and Natural Resources. 2021. 7-19:31-39.

* Correspondence of the Author (E-mail: marisol.resendiz@uttt.edu.mx)
† Researcher contributing first author.

Introduction

One of the most important problems in designing and maintaining an open-air dump is in the management of the leachate that is generated after the passage of water through the garbage. An important factor to consider is the climate in the landfill, as well as, rainfall, atmospheric humidity, temperature, evaporation, evapotranspiration, runoff, infiltration, the topography of the landfill that influences the leachate output patterns, as well degree of compaction of the wastes, degree of initial humidity of the garbage, the covering material of the cells, field capacity of the landfill, etc. (Ticante *et al.*, 2015). Currently the landfill located in the municipality of Zacatecas has no control over the leachate that is generated or the treatment that is given to it. So it is vitally important to stop this process and have control over the leachate. For this, the terrain and the conditions in which the dump is located were examined in detail and, in turn, the physicochemical characteristics were analyzed in order to provide the appropriate treatment.

The objective of this research is to propose a process for the treatment of leachate from the open-air dump of the municipality of Zacatecas, based on physicochemical techniques.

Background

The final disposal of urban solid waste has evolved from open-air landfills to highly technical landfills where liquid and gaseous emissions potentially dangerous to the environment are controlled. Both in the open-air landfills and in the first sanitary landfills, liquid emissions (called leachates) were not controlled and these drained to surface water sources or infiltrated to the lower layers of the ground and in many cases contaminated the underlying aquifers them (Novelo *et al.*, 2002).

In Mexico, the most common practices for the final disposal of solid waste on the ground are: sanitary landfill (RS), controlled landfill (RC) and open-air dump (TCA). A RS is an infrastructure work that involves engineering methods and works for the final disposal of urban solid waste (MSW) and special management, in order to control, through compaction and additional infrastructure, environmental impacts.

A landfill of this type must fully comply with the regulations indicated in NOM-083-SEMARNAT-2003. The Ministry of Environment and Natural Resources reported that, in 2010, there were 186 RS. An RC is an inappropriate final disposal site that meets the specifications of a sanitary landfill in terms of infrastructure and operation works but does not meet the waterproofing specifications or the technical conditions and requirements, in accordance with the legal provisions and sanitary facilities, the National Institute of Geographic Statistics and Informatics reported 23 sites of this type in 2006, there are no more recent data. In a TCA, the waste is dumped directly and daily on the ground without covering it with soil (Figure 1), an inappropriate practice due to the health and environmental problems it causes, but it is the most used in the country because it is the most economical and easy to operate for municipalities. Most TCAs are clandestine and can be family or municipal. Due to their diversity and irregularity, there is no record of most of these sites.

To implement the ATTs, it is not customary to carry out a preliminary study, they are only created arbitrarily in the different states of the Mexican Republic and, for this purpose, canyons and riverbeds, lakes and lagoons, abandoned mines, swampy areas, are used vacant lots and geologically unstable areas. This unconscious final disposal of solid waste has caused problems of water, air and soil pollution, as well as the proliferation of harmful fauna, so the negative effects on public health and the environment could be enormous, but the dimension is unknown exact problem.

Regarding this solid urban waste, INEGI reported that, in 2010, 10,211.5 tons were deposited in TCA. To this is added the social problems among the groups of scavengers, due to the inadequate conditions in which they live and carry out their activities; However, the fear of losing their only source of work causes them to oppose any alternative aimed at improving the techniques of final disposal and / or closure and sanitation of the TCAs.

ECORFAN® All rights reserved.

Figure 1 Landfill
Source: https://energiasrenovablessolar.blogspot.com/2017/11/relleno-sanitario.html), Relleno controlado (Fuente: https://www.laestrella.com.pa/nacional/150509/primer-relleno-vertedero-controlado-inaugurado) y Tiradero a cielo abierto (Fuente: http://www.centuria.mx/denuncian-tiradero-a-cielo-abierto-en-el-riego-pvem

Cortes, (2021), carried out a study on the management of solid waste in the region of the upper basin of the Apatlaco River, in the State of Morelos, due to the effect that these have on the nearby population (Cortes, 2021). Arce, DJF and Guerrero, MY (2021), designed an environmental management strategy for the management and use of solid waste in the San Fermín sector of the municipality of Ocaña, N. de S., due to the high pollution due to Solid waste. Zuloaga (2021), generated a Sustainable Prevention and Comprehensive Waste Management Strategy (ESPGIR), whose purpose was to prevent the generation of waste and promote its proper management by community members, through environmental education and infrastructure. Engumenta (2021), made a diagnosis and proposed optimal sites for the relocation of the final disposal site of solid waste in the community of Jesús María Garza, municipality of Villaflores, Chiapas.

Effects on health and the environment

One of the aspects that must be taken into special consideration are those related to the effects that the interaction of leached liquids with surface or groundwater can potentially generate on health.

The effects that leachates produce on human health during the decomposition of organic solid waste in a humid sanitary landfill range from: Effects on the cardiovascular, respiratory, peripheral nervous and reproductive systems, damage to the liver, kidney, etc. (Corena, 2008).

The final disposal of urban solid waste in sanitary landfills or open dumps gives rise to the generation of different polluting products, derived from the processes of microbial decomposition and release of waste components. Certain materials commonly used in the home and disposed of in landfills may contain hazardous chemicals. As waste is deposited in landfills, it begins to break down through a series of complex chemical processes. The main decomposition products are leached liquids and gases. Both liquids and gases can affect the health of the surrounding populations. The waste is usually dumped in Open Pit Landfills (BCA). BCAs produce harmful actions on the environment and the economy: Contamination of water resources; Atmospheric pollution; Soil contamination; Impact on flora and fauna. Associated with the removal of a flora specimen and the disturbance of native fauna during the construction phase. The existence of vectors (animals that feed on discarded waste) cause the modification of the ecosystem of the surrounding area; Social and economic costs. Devaluation of properties, loss of tourism, increase of non-formal waste management systems; Impact on public health due to disease transmission (Recovery Plants, 2018).

For this, the importance of treating leachates from a landfill must be better understood. There are several studies around the world that account for the impact that landfills can have on the health of the nearby population. Here is a brief summary of some of them: Those carried out in the Tuscany region, Italy between 1995-2000 and found excess mortality from cardiovascular diseases, cerebrovascular diseases, non-Hodgkin's lymphoma and from liver and bladder cancer (Minichilli et al. 2005). In 1995 a study was published on families living near the municipal landfill "The Miron Quarry", in the City of Montreal, Canada, the landfill was used between 1968 and 1990 (third largest landfill in North America). The study revealed a high incidence of stomach, liver, prostate, and lung cancer among men, and uterine-cervical cancer among women. In Helsinki, Finland, incidence of risk of cancer and asthma was found in people who lived in houses on landfills. In 1998 the New York State Department of Health examined the incidence of seven types of cancer in men and women living near 38 landfills where gas is thought to be released.

ECORFAN® All rights reserved.

Of the 14 types of cancer studied (7 in men and 7 in women), it was found that in 10 cases, the values were high, but in only two types of cancer (bladder cancer and leukemia in women) were they statistically significant. The seven types of cancer studied were leukemia; non-Hodgkin lymphomas; cancer of the liver, lung, kidney, bladder and brain. In 1998 the Environmental Research Foundation presented a report mentioning several studies carried out both in the United States and Canada, as well as in Europe of populations living near landfills. From these it is concluded the most common types of cancer related to fillers are leukemia and bladder cancer. In Delhi, India, in a waste disposal center, the people who worked there presented symptoms of the respiratory system, inflammation of the airways, affected lungs and a series of associated problems. In Belo Horizonte, Brazil, the same symptoms were found in people living near landfills. The proximity of landfills or open dumps affects people with dermatological, neurological, hearing, respiratory problems, pain and itchy throat (Green Peace, 2008).

Main contaminants

One of the most important problems in designing and maintaining a sanitary landfill is in the management of the leachate that is generated after the passage of water through the garbage. The leachate consists of several diverse organic and inorganic compounds that can be found either dissolved or suspended. Regardless of the nature of the compounds, they pose a potential contamination problem for local land and surface waters. Many factors influence the production and composition of the leachate.

Leachate can be defined as the liquid that seeps through the decomposing solid waste and that extracts dissolved materials in suspension, the leachate is formed by the liquid that enters the landfill from external sources (surface drains, rain, etc.). As water seeps through decomposing solid waste, biological materials and chemical constituents are leached into solution.

Table 1 shows some of the physical, chemical and biological parameters that are monitored in the leachate.

Physical	Organic Constituents	Inorganic Constituents	Biological Constituents
Aspect	Organic Chemicals	Suspended solids, Total dissolved solids	Biochemical Oxygen Demand
pH	Phenols	Volatile solids in suspension, volatile dissolved solids, chlorides.	Bacteria, Total Coliforms
Reduction / oxidation potential	Chemical Oxygen Demand	Sulfates	Counting on standard plates
Conductivity	Total Organic Carbon	Phosphates	
Color Total	Total Acids	Alkalinity and Acidity	
Turbidity	Tannins, lignins	N-nitrate	
Temperature	N- Organic	N-nitrite	
Odor	Soluble in ether		

Table 1 Sampling parameters for leachate
Source: *http: //tesis.uson.mx/digital/tesis/docs/9952/Capitulo6.pdf*

The open-air dump in question is located in Lomas de Bracho, Zacatecas with geographic coordinates, Latitude: 23.0529 and Longitude: -102.6152. In 2014, the closure works began to be carried out, giving way to the use of the sanitary landfill (Empresa Jioresa). The open-air dump which is located on one side of the Bracho hills, in Figure 2, we have the satellite location of the dump where it is observed that it is only the land without any control. The dump currently has two gondolas that help transport the waste to the sanitary landfill located in the city of Guadalupe, Zacatecas.

Figure 2 Location of the open-air dump in the municipality of Zacatecas
Source: (Google Maps, 2018)

ECORFAN® All rights reserved.

The conditions of the municipal landfill are shown in Figure 3 where the real conditions of the landfill are observed, in which it can be seen that there is no control over the leachate generated or the waste that is still there.

Figure 3 View of the Bracho dump.

Materials and equipment

Three stages were proposed to carry out this work. For the first stage, a review of the open-air dump of the municipality of Zacatecas was carried out: where possible physical risks and verification of the sampling area were analyzed for a better analysis of the data. In addition, the leachate is sampled to determine the concentration or load of pollutants in wastewater streams, generally over a long period of time. In a second stage, the samples were characterized in the laboratory, determining: pH (NMX, 2016), Temperature (NMX, 2013), Electrolytic Conductivity (NMX, 2001), Biochemical Oxygen Demand (BOD5) (NMX, 2012), Chemical Oxygen Demand (total and soluble) (NMX, 2015), Total suspended solids (SST) (NMX, 2001), Nitrates NO3 (NMX, 2014), Sulfates SO4 (NMX, 2001), Color (NMX, 2016), Metals (Na, K, Ca, Cd, Cr, Hg, Pb, Cu) (NMX, 2016) and Total Coliforms (TOC) (NMX, 1994). In the third stage, the experimentation was carried out under the following scheme: First is that for the treatment of the leachate, it is passed through an activated carbon filter, to reduce the color and some odors present in the sample. the leachate is passed through an ion exchange resin filter. Finally, a partial evaporation (approx. 90%) of the leachate was carried out in order to reduce pathogenic microorganisms and that the treated leachate can be re-sent to a wastewater treatment.

Analysis and discussion of results

The characterization of the leachate began with a sampling in which 5 samples with a volume of one gallon each were taken, three of these samples were for the characterization of the physicochemical and microbiological parameters, and two more samples, for experimentation with activated carbon, ion exchange resins and total evaporation.

The characterization of the leachate samples was carried out in the Special Studies Laboratory of the Academic Unit of Chemical Sciences, obtaining the following results for the physicochemical parameters (Table 2) and for the microbiological parameters (Table 3):

Parameter	Method	Results	Units
pH	NMX-AA-008-SCFI	8.13	-
Temperature	NMX-AA-007-SCFI	19.0	˚C
C.E	NMX-AA-093-SCFI	3,050	mS/m
BDO_5	NMX-AA-028-SCFI	504	mg/L
CDO	NMX-AA-030-SCFI	887.33	mg/L
Total Suspended Solids	NMX-AA-034-SCFI	5,476	mg/L
NO_3	NMX-AA-079-SCFI	2.0	mg/L
SO_4	NMX-AA-074-SCFI	7.0	mg/L
Colour	NMX-AA-045-SCFI	66	Pt/Co
Sodium	NMX-AA-051-SCFI	1,010	mg/L
Potassium	NMX-AA-051-SCFI	745	mg/L
Calcium	NMX-AA-051-SCFI	256	mg/L
Cadmium	NMX-AA-051-SCFI	0.01	mg/L
Chrome	NMX-AA-051-SCFI	4.3	mg/L
Mercury	NMX-AA-051-SCFI	1.8	mg/L
Lead	NMX-AA-051-SCFI	0.08	mg/L
Copper	NMX-AA-051-SCFI	0.08	mg/L

Table 2 Results of the physicochemical characterization of the leachate

Total Coliforms NMP/1ml	Fecal Coliforms NPM/1 ml	Aerobic Mesophils UFC/ 1ml
23	Not detectable	1500

Table 3 Results of the microbiological characterization of the leachate

In the first stage of the leachate treatment, the liquid passes through an activated carbon filter. Three samples of 25 ml each were placed, with 1 g, 2 g, and 3 g respectively of activated carbon. They were kept under stirring for 4 hours. Subsequently, each of the samples were filtered to remove the activated carbon and verify the color change in each sample (Figure 4).

ECORFAN® All rights reserved.

Figure 4 Color difference in samples after shaking

It was concluded that the sample containing 3 g of activated carbon was the one that best reduced the color.

The quality of leachate is influenced by the biological, chemical and physical processes that occur within the landfill. Generally, as indicator parameters, the relationship BOD_5 and COD are considered, which vary within the acetic and methanogenic phase of a sanitary landfill or open dump.

The sampled leachates correspond to the storage tanks of the landfill, where leachates of different ages are mixed, so there is a mixture of the characteristics of acid fermentation and methanogenic fermentation (Table 4).

BDO_5	504	mg/L
CDO	887.33	mg/L
BDO_5/CDO	0.568	mg/L

Tabla 4 Relationship BDO_5/CDO

According to the BOD_5/COD ratio, it is concluded that the dump in question is mainly in the acetic phase.

The biodegradability of the leachate also varies with time, which is reflected in the BOD_5/COD ratio. In a new landfill the relationship will be in a range of 0.5 or more, the indicator that the organic matter in the leachates is easily biodegradable (0.4 to 0.6), while in old landfills the relationship is in a range of 0.05 to 0.2, indicating that leachates contain humic and fulvic acids that are not easy to biodegrade. The presence of dissolved metals indicates that there are anaerobic conditions (mainly acidogenic stage), for which the metals are solubilized, but when passing through the layers of the covering material, the pH rises again without reaching the values at which they precipitate.

Mass balance for container 1:

$$M_{LE1} - M_{LS1} = \frac{dM_{LS1}}{dt} \quad (1)$$

Where; M_{LE1} is the initial mass of the leachate [=] kg, M_{LS1} is the output mass of the leachate after treatment with activated carbon [=] kg, t = time [=] s.

Mass balance for container 2:

$$M_{LS1} - M_{LS2} = \frac{dM_{LS2}}{dt} \quad (2)$$

Where; M_{LS2} is the leachate exit mass after treatment with ion exchange resins [=] kg.

Material balance for the evaporator:

$$M_{LS2} = M_{LV} + M_{LL} \quad (3)$$

Where; M_{LV} is the mass of vapor in the distillate [=] kg, M_{LL} is the mass of the liquid [=] kg.

Energy balance for the evaporator:

$$Q_E = h_v M_{LV} + M_{LL} H_L \quad (4)$$

$$Q_E = M_{LS2}\, \lambda_{vap} \quad (6)$$

Where; Q_E is the energy required to evaporate the leachate [=] kJ, h_v is the enthalpy of vapor [=] kJ, H_L is the enthalpy of liquid [=] kJ, and λ_{vap} is the latent heat of vaporization of water.

Energy balance in the condenser (auxiliary equipment not included in the diagram)

$$Q_C = M_{H2O}\, cp\, (T_F - T_A) \quad (6)$$

Where; Q_C is the heat that must be removed from the condenser [=] kJ, M_{H2O} amount of water required to condense the steam; cp is the heat capacity of the water [=] kJ/kg K, T_F is the water leaving temperature [=] °C, T_A is the cooling water temperature [=] °C.

In Figure 5, the flow diagram and the results obtained in the experimentation are presented, which can be scaled by the storage volume of the open-air dump tanks.

ECORFAN® All rights reserved.

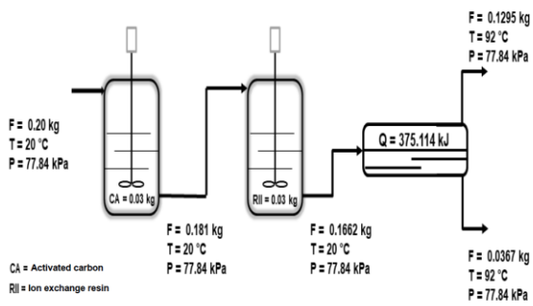


Figure 5 Flow diagram of the proposed treatment plant

According to the information provided by the workers at the dump, the mass of leachate received is 25,000 kg.

There is cooling water @ 21 °C, which according to the energy balance, requires 1,793.09 kg of water for the phase change and to condense the steam. Consideration should be given to using another refrigerant due to the large volume of water required for condensation. The condensed steam cooling water ratio is 13,846.25, if it is scaled to 25,000 kg, that's a great deal.

Conclusions

Municipal solid waste that ends up at a final disposal site decomposes, forming leachate. With the decomposition of the waste and the leaching of its components, different polluting materials are produced that could be dangerous, which makes it important to give it proper handling.

One of the main problems associated with the presence of open-air dumps is that due to the lack of control of the entry of waste, in most cases, these sites become key points for the illegal deposit of hazardous waste, which causes that in these places the effects of environmental contamination and risk to human health are further aggravated.

In this research, an alternative treatment was presented for the leachates that are generated, specifically in the open-air dump located in the municipality of Zacatecas, where when carrying out the entire experimental procedure, it is concluded that activated carbon filters, resins and evaporation are techniques that could represent a feasible treatment for the leachate that is produced. In this way, it is possible to contribute to the elimination of some pollutants that affect the environment, and to the health of the population around the dump.

Making a projection to the handling of 25000 kg of leachate (which is what is collected in the dump deposits), an amount of energy is required to evaporate it of 5.6 x 106 kJ. In the city of Zacatecas there is 5.4 kWh / m² of irradiance, which can facilitate the use of solar energy for the evaporation of the treated leachate.

References

Arce, D. J. F. y Guerrero, M. Y. Diseño de una estrategia de gestión ambiental para el manejo y aprovechamiento de los residuos sólidos en el sector de san Fermín del municipio de Ocaña N. de S. *Tesis para obtener el título de Ingeniero ambiental.* Universidad Francisco de Paula Santander Ocaña

Bernabeu Alejandro, Cabrera Mauro, Pino Ana Laura, Groppeli Eduardo. (2010).” Evaluación de la localidad de los líquidos lixiviados y contaminación de las napas durante la vida útil del relleno sanitario de la ciudad de Santa Fe.” *Ciencia y Tecnología 10***.** Pág. 53-64.

Composición del lixiviado (s.f.). Retrieved from: http://tesis.uson.mx/digital/tesis/docs/9952/Capitulo6.pdf (May 12, 2018).

Corena Luna Mironel de Jesús. (2008) “Sistemas de tratamientos para lixiviados generados en rellenos sanitarios.” Universidad de Sucre, Facultad de Ingeniería, Departamento de Ingeniería Civil.

Cortes, D. A. (2021). Manejo de residuos en la región de la cuenca alta del río Apatlaco: tres realidades en Cuernavaca. *Tesis de Grado*. Universidad Autónoma del Estado de Morelos

Engumeta Zambrano, M. G. (2021). Diagnósticoy propuesta de sitios óptimos para la reubicación del sitio de disposición final de residuos sólidos en la comunidad de Jesús María Garza municipio de Villaflores, Chiapas. Universidad de Ciencias y Artes de Chiapas.

Google Maps (2018), Ubicación relleno sanitario Lomas de Bracho, Zacatecas. Date of consultation (May 12, 2018): https://www.google.com.mx/maps/place/Lomas+De+Bracho/@22.7918242,-102.5622104,17z/data=!3m1!4b1!4m5!3m4!1s0x86824c26951485b5:0xbc2faf532f240f88!8m2!3d22.7918193!4d-102.5600217?hl=es.

ECORFAN® All rights reserved.

Green Peace (2008) Resumen de los impactos ambientales y sobre la salud de los rellenos sanitarios.

Martinez-Lopez A.G., Padrón-Hernández W., Rodríguez-Bernal O. F., Chiquito Coyotl O., Escarola- Rosas M. A, Hernández-Lara J.M., Elvira-Hernández E. A., Méndez G. A., Tinoco-Magaña, J.C., Martínez-Castillo J. (2014). "Alternativas actuales del manejo de lixiviados." *Redalyc.* Pág. 1-10.

Minichilli F, Bartolacci S, Buiatti E, Pallante V, Scala D, Bianchi F. "A study on mortality around six municipal solid waste landfills in Tuscany Region. Epidemiol Prev. 2005 Sep - Dec;29 (5-6 Suppl) :53-56

NMX-AA-007-SCFI-2013: ANÁLISIS DE AGUA. - MEDICIÓN DE LA TEMPERATURA EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS - MÉTODO DE PRUEBA.

NMX-AA-008-SCFI-2016: ANÁLISIS DE AGUA - MEDICIÓN DEL pH EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS- MÉTODO DE PRUEBA.

NMX-AA-028-SCFI-2001: ANÁLISIS DE AGUA - DETERMINACIÓN DE LADEMANDA BIOQUÍMICA DE OXÍGENO EN AGUAS NATURALES,

NMX-AA-030/1-SCFI-2012: ANÁLISIS DE AGUA - MEDICIÓN DE LA DEMANDA QUÍMICA DE OXÍGENO EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS.- MÉTODO DE PRUEBA - PARTE 1 - MÉTODO DE REFLUJO ABIERTO.

NMX-AA-034-SCFI-2015: ANÁLISIS DE AGUA - MEDICIÓN DE SÓLIDOS Y SALES DISUELTAS EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS.

NMX-AA-045-SCFI-2001: ANÁLISIS DE AGUA - DETERMINACIÓN DE COLOR PLATINO COBALTO EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS - MÉTODO DE PRUEBA.

NMX-AA-051-SCFI-2016: ANÁLISIS DE AGUA -MEDICIÓN DE METALES POR ABSORCIÓN ATÓMICA EN AGUAS NATURALES, POTABLES, RESIDUALES Y RESIDUALES TRATADAS.

NMX-AA-074-SCFI-2014: ANÁLISIS DE AGUA – MEDICIÓN DEL ION SULFATO EN AGUAS NATURALES, RESIDUALES Y RESIDUALES TRATADAS – MÉTODO DE PRUEBA.

NMX-AA-079-SCFI-2001: ANÁLISIS DE AGUAS - DETERMINACIÓN DE NITRATOS EN AGUAS NATURALES, POTABLES, RESIDUALES Y RESIDUALES TRATADAS - MÉTODO DE PRUEBA.

NMX-AA-102-SCFI-2006: CALIDAD DEL AGUA – DETECCIÓN Y ENUMERACIÓN DE ORGANISMOS COLIFORMES, ORGANIS-MOS COLIFORMES TERMOTOLERANTES *Y ESCHERICHIACOLI* PRESUNTIVA – MÉTODO DE FILTRACIÓN EN MEMBRANA.

NORMA OFICIAL MEXICANA NOM-092-SSA1-1994, BIENES Y SERVICIOS. MÉTODO PARA LA CUENTA DE BACTERIAS AEROBIAS EN PLACA.

NORMA OFICIAL MEXICANA NOM-112-SSA1-1994, BIENES Y SERVICIOS. DETERMINACIÓN DE BACTERIAS COLIFORMES. TÉCNICA DEL NÚMERO MÁS PROBABLE.

Novelo, M., Iván, R., Hernández, M., Franco, Q., & Borges, C. (2002). Tratamiento de lixiviados con carbón activado. *Ingeniería*, *6*(3), 19–27.

Otero, N. (2006). Filtración de aguas residuales para reutilización. In *Ciencias Y Tecnologías/29* (Vol. 29). https://riull.ull.es/xmlui/bitstream/handle/915/10239/cp273.pdf?sequence=1&isAllowed=y

Peiró A. M., (2003), "Nuevas aportaciones al desarrollo de metodologías en Química Verde:- Eliminación fotocatalítica de contaminantes fenólicos- Preparación de fotocatalizadores mediante procesos químicos suaves", Tesis de doctorado en Química, Universidad Autónoma de Barcelona.

ECORFAN® All rights reserved.

Plantas de Recuperación / Tratamiento de Residuos Sólidos Urbanos. (May 12, 2018).Retrieved from: http://www.ecopuerto.com/Bicentenario/informes/PLANTATRATAMIENTOSCUDEL.pdf

PROY-NMX-AA-003/3-SCFI-2008: AGUAS RESI-DUALES – MUESTREO.

RESIDUALES (DBO5) Y RESIDUALES TRATADAS.

SEMARNAT, (2003), Guía de Cumplimiento de la NOM-083- SEMARNAT-2003.

Ticante Roldán J. Antonio, Velasco Hernández Ma. De los Ángeles, Montellanos Pérez Raúl O., Saldaña Munive J. Adrián, Hidalgo Aguirre Mariana. (2015). Implementación del Colector Solar Parabólico para tratamiento de lixiviados del relleno sanitario de Chiltepeque Puebla, México." *Revista Iberoamericana de Ciencias.* Vol. 2 No. 7. Pág.51-59.

Zuloaga-Cano, A. (2021). Estrategia sustentable de prevención y gestión integral de residuos sólidos urbanos en San Isidro Mazatepec, Jalisco. *Tesis de Grado.* ITESO.

ECORFAN® All rights reserved.

[Title in Times New Roman and Bold No. 14 in English and Spanish]

Surname (IN UPPERCASE), Name 1st Author†*, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor

Institutional Affiliation of Author including Dependency (No.10 Times New Roman and Italic)

International Identification of Science - Technology and Innovation

ID 1st Author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st author: (Scholar-PNPC or SNI-CONACYT) (No.10 Times New Roman)

ID 1st Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 2nd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 2nd coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 3rd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 3rd coauthor: (Scholar or SNI) (No.10 Times New Roman)

(Report Submission Date: Month, Day, and Year); Accepted (Insert date of Acceptance: Use Only ECORFAN)

Abstract (In English, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In English)

Indicate 3 keywords in Times New Roman and Bold No. 10

Abstract (In Spanish, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In Spanish)

Indicate 3 keywords in Times New Roman and Bold No. 10

Citation: Surname (IN UPPERCASE), Name 1st Author, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor. Paper Title. Journal of Enviromental Sciences and Natural Resources. Year 1-1: 1-11 [Times New Roman No.10]

* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

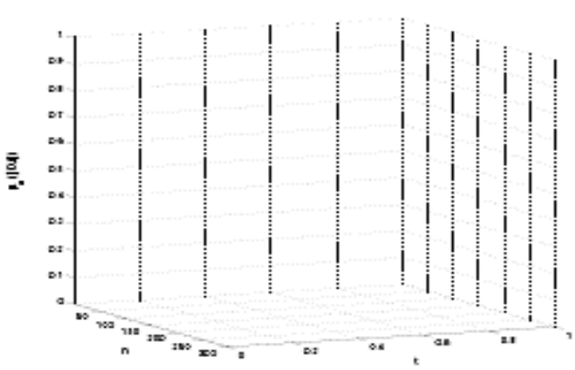
[Title No.12 in Times New Roman, single spaced and bold]

Products in development No.12 Times New Roman, single spaced.

Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



Graphic 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

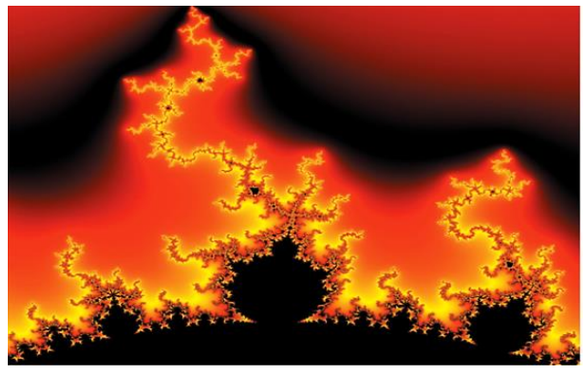


Figure 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Table 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Each article shall present separately in **3 folders**: a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \qquad (1)$$

Must be editable and number aligned on the right side.

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

Thanks

Indicate if they were financed by any institution, University or company.

ECORFAN® All rights reserved

Conclusions

Explain clearly the results and possibilities of improvement.

References

Use APA system. Should not be numbered, nor with bullets, however if necessary, numbering will be because reference or mention is made somewhere in the Article.

Use Roman Alphabet, all references you have used must be in the Roman Alphabet, even if you have quoted an article, book in any of the official languages of the United Nations (English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic), you must write the reference in Roman script and not in any of the official languages.

Technical Specifications

Each article must submit your dates into a Word document (.docx):

Journal Name
Article title
Abstract
Keywords
Article sections, for example:

1. Introduction
2. Description of the method
3. Analysis from the regression demand curve
4. Results
5. Thanks
6. Conclusions
7. References

Author Name (s)
Email Correspondence to Author
References

Intellectual Property Requirements for editing:

-Authentic Signature in Color of Originality Format Author and Coauthors.

-Authentic Signature in Color of the Acceptance Format of Author and Coauthors.

ECORFAN® All rights reserved

Reservation to Editorial Policy

Journal of Enviromental Sciences and Natural Resources reserves the right to make editorial changes required to adapt the Articles to the Editorial Policy of the Journal. Once the Article is accepted in its final version, the Journal will send the author the proofs for review. ECORFAN® will only accept the correction of errata and errors or omissions arising from the editing process of the Journal, reserving in full the copyrights and content dissemination. No deletions, substitutions or additions that alter the formation of the Article will be accepted.

Code of Ethics - Good Practices and Declaration of Solution to Editorial Conflicts

Declaration of Originality and unpublished character of the Article, of Authors, on the obtaining of data and interpretation of results, Acknowledgments, Conflict of interests, Assignment of rights and Distribution

The ECORFAN-Mexico, S.C Management claims to Authors of Articles that its content must be original, unpublished and of Scientific, Technological and Innovation content to be submitted for evaluation.

The Authors signing the Article must be the same that have contributed to its conception, realization and development, as well as obtaining the data, interpreting the results, drafting and reviewing it. The Corresponding Author of the proposed Article will request the form that follows.

Article title:

– The sending of an Article to Journal of Enviromental Sciences and Natural Resources emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Format of Originality for its Article, unless it is rejected by the Arbitration Committee, it may be withdrawn.

– None of the data presented in this article has been plagiarized or invented. The original data are clearly distinguished from those already published. And it is known of the test in PLAGSCAN if a level of plagiarism is detected Positive will not proceed to arbitrate.

– References are cited on which the information contained in the Article is based, as well as theories and data from other previously published Articles.

– The authors sign the Format of Authorization for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.

– Consent has been obtained from those who have contributed unpublished data obtained through verbal or written communication, and such communication and Authorship are adequately identified.

– The Author and Co-Authors who sign this work have participated in its planning, design and execution, as well as in the interpretation of the results. They also critically reviewed the paper, approved its final version and agreed with its publication.

– No signature responsible for the work has been omitted and the criteria of Scientific Authorization are satisfied.

– The results of this Article have been interpreted objectively. Any results contrary to the point of view of those who sign are exposed and discussed in the Article.

Copyright and Access

The publication of this Article supposes the transfer of the copyright to ECORFAN-Mexico, SC in its Holding Spain for its Journal of Enviromental Sciences and Natural Resources, which reserves the right to distribute on the Web the published version of the Article and the making available of the Article in This format supposes for its Authors the fulfilment of what is established in the Law of Science and Technology of the United Mexican States, regarding the obligation to allow access to the results of Scientific Research.

Article Title:

Name and Surnames of the Contact Author and the Coauthors	Signature
1.	
2.	
3.	
4.	

Principles of Ethics and Declaration of Solution to Editorial Conflicts

Editor Responsibilities

The Publisher undertakes to guarantee the confidentiality of the evaluation process, it may not disclose to the Arbitrators the identity of the Authors, nor may it reveal the identity of the Arbitrators at any time.

The Editor assumes the responsibility to properly inform the Author of the stage of the editorial process in which the text is sent, as well as the resolutions of Double-Blind Review.

The Editor should evaluate manuscripts and their intellectual content without distinction of race, gender, sexual orientation, religious beliefs, ethnicity, nationality, or the political philosophy of the Authors.

The Editor and his editing team of ECORFAN® Holdings will not disclose any information about Articles submitted to anyone other than the corresponding Author.

The Editor should make fair and impartial decisions and ensure a fair Double-Blind Review.

Responsibilities of the Editorial Board

The description of the peer review processes is made known by the Editorial Board in order that the Authors know what the evaluation criteria are and will always be willing to justify any controversy in the evaluation process. In case of Plagiarism Detection to the Article the Committee notifies the Authors for Violation to the Right of Scientific, Technological and Innovation Authorization.

Responsibilities of the Arbitration Committee

The Arbitrators undertake to notify about any unethical conduct by the Authors and to indicate all the information that may be reason to reject the publication of the Articles. In addition, they must undertake to keep confidential information related to the Articles they evaluate.

Any manuscript received for your arbitration must be treated as confidential, should not be displayed or discussed with other experts, except with the permission of the Editor.

The Arbitrators must be conducted objectively, any personal criticism of the Author is inappropriate.

The Arbitrators must express their points of view with clarity and with valid arguments that contribute to the Scientific, Technological and Innovation of the Author.

The Arbitrators should not evaluate manuscripts in which they have conflicts of interest and have been notified to the Editor before submitting the Article for Double-Blind Review.

Responsibilities of the Authors

Authors must guarantee that their articles are the product of their original work and that the data has been obtained ethically.

Authors must ensure that they have not been previously published or that they are not considered in another serial publication.

Authors must strictly follow the rules for the publication of Defined Articles by the Editorial Board.

The authors have requested that the text in all its forms be an unethical editorial behavior and is unacceptable, consequently, any manuscript that incurs in plagiarism is eliminated and not considered for publication.

Authors should cite publications that have been influential in the nature of the Article submitted to arbitration.

Information services

Indexation - Bases and Repositories

LATINDEX (Scientific Journals of Latin America, Spain and Portugal)
RESEARCH GATE (Germany)
GOOGLE SCHOLAR (Citation indices-Google)
REDIB (Ibero-American Network of Innovation and Scientific Knowledge- CSIC)
MENDELEY (Bibliographic References Manager)

Publishing Services

Citation and Index Identification H
Management of Originality Format and Authorization
Testing Article with PLAGSCAN
Article Evaluation
Certificate of Double-Blind Review
Article Edition
Web layout
Indexing and Repository
ArticleTranslation
Article Publication
Certificate of Article
Service Billing

Editorial Policy and Management

38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: contact@ecorfan.org www.ecorfan.org

ECORFAN®

Chief Editor
VILLASANTE, Sebastián. PhD

Executive Director
RAMOS-ESCAMILLA, María. PhD

Editorial Director
PERALTA-CASTRO, Enrique. MsC

Web Designer
ESCAMILLA-BOUCHAN, Imelda. PhD

Web Diagrammer
LUNA-SOTO, Vladimir. PhD

Editorial Assistant
TREJO-RAMOS, Iván. BsC

Translator
DÍAZ-OCAMPO, Javier. BsC

Philologist
RAMOS-ARANCIBIA, Alejandra. BsC

Advertising & Sponsorship

(ECORFAN® Spain), sponsorships@ecorfan.org

Site Licences

03-2010-032610094200-01-For printed material ,03-2010-031613323600-01-For Electronic material,03-2010-032610105200-01-For Photographic material,03-2010-032610115700-14-For the facts Compilation,04-2010-031613323600-01-For its Web page,19502-For the Iberoamerican and Caribbean Indexation,20-281 HB9-For its indexation in Latin-American in Social Sciences and Humanities,671-For its indexing in Electronic Scientific Journals Spanish and Latin-America,7045008-For its divulgation and edition in the Ministry of Education and Culture-Spain,25409-For its repository in the Biblioteca Universitaria-Madrid,16258-For its indexing in the Dialnet,20589-For its indexing in the edited Journals in the countries of Iberian-America and the Caribbean, 15048-For the international registration of Congress and Colloquiums. financingprograms@ecorfan.org

Management Offices

38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España.

2444 4936
ISSN 2444 - 4936
www.ecorfan.org