Volume 4, Issue 7 — July — December - 2018

E C O R F A N

Journal- Republic of Nicaragua

ISSN-On line: 2414-8830

ECORFAN®

ECORFAN Journal-Republic of Nicaragua, Volume 4, Issue 7, July-December 2018, is a journal edited semestral by ECORFAN. First Avenue Southwest, San Sebastian area, León, Republic of Nicaragua. P. C. 21000. WEB: www.ecorfan.org/republicofnicaragua/, journal@ecorfan.org. Editor in Chief: RAMOS-ESCAMILLA, María, Co-Editor: ZAPATA-MONTES, Nery Javier, PhD. ISSN On line: 2414-8830. Responsible for the latest update of this number ECORFAN Computer Unit. ESCAMILLA-BOUCHÁN, Imelda, LUNA-SOTO, Vladimir, First Avenue Southwest, San Sebastian area, León, Republic of Nicaragua. C.P. 21000, last updated December 31, 2018.

ECORFAN Journal Republic of Nicaragua

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 Agriculture-Forest, Pathology-Sustainable, Forest, Management, Horticulture, Engineering and Integrated Water Use.

ECORFAN-Mexico SC 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 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

ECORFAN Journal Republic of Nicaragua is a Journal edited by ECORFAN-Mexico S.C in its Holding with repository in Republic of Nicaragua, 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, Forest, Management, Horticulture, Engineering and Integrated Water Use 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

PARTIDA - RUVALCABA, Leopoldo. PhD
Colegio de Postgraduados

REYES - MONTES, María del Rocío. PhD
Universidad Nacional Autónoma de México

LEYVA - MIR, Santos Gerardo. PhD
Colegio de Postgraduados

Arbitration Committee

TERREROS - MECALCO, Jesús. PhD
Instituto Tecnológico de Toluca

MARTINEZ - SCOTT, Marcia Maribel. PhD
Universidad Autónoma Agraria Antonio Narro

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

Assignment of Rights

The sending of an Article to ECORFAN Journal Republic of Nicaragua 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 Republic of Nicaragua 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, Forest, Management, Horticulture, Engineering and Integrated Water Useand other topics related to Biotechnology and Agricultural Sciences.

Presentation of Content

In Volume number seven, as the first article we present, *Evaluation of the effectiveness of the technique of bioaumentation in sediments contaminated with hydrocarbons of a combustibles service station of the municipality of San Francisco Putumayo Colombia*, by GUERRA-ACOSTA, Adriana del Socorro, RODRIGUEZ-MONTENEGRO, Luis Carlos, AREVALO-LOPEZ, Judy Johana and ORTIZ-GOMEZ, Yeison Andres, whith adscripction in the Instituto Tecnológico del Putumayo, as a second article we present, *Characterization of species of Cyphomandra betacea Cav. in the community of Mazahuacán, Lolotla, Hidalgo*, by JIMÉNEZ-PELCASTRE, César, PEREA-MARTÍNEZ, Alejandro, VALENTÍN-ISLAS, Raúl and GUEVARA-HERRERA, Ricardo, whith adscripction in the Universidad Tecnológica de la Sierra Hidalguense, as third article we present, *Characterization of Municipal Solid Waste in Altamira, Tamaulipas*, by MEDINA-ALVAREZ, Juana Elizabeth, GARZA-FLORES, Rodolfo, WONG-GALLEGOS, Juan Yared and PÉREZ-BRAVO, Sheila Genoveva, whith adscription in the Universidad Politécnica de Altamira & Universidad del Noreste, as fourth article we present, *Analysis for the construction of low cost housing with recycled plastic bricks with no negative environmental impact proposed for Tijuana, B.C*, by VALENZUELA-CRUZ, Nataly Berenice, DELGADO-RENDON, Rene and CAMACHO-IXTA, Ixchel Astrid, whith adscription in the Universidad Autónoma de Baja California.

Content

Article	Page
Evaluation of the effectiveness of the technique of bioaumentation in sediments contaminated with hydrocarbons of a combustibles service station of the municipality of San Francisco Putumayo Colombia GUERRA-ACOSTA, Adriana del Socorro, RODRIGUEZ-MONTENEGRO, Luis Carlos, AREVALO-LOPEZ, Judy Johana and ORTIZ-GOMEZ, Yeison Andres *Instituto Tecnológico del Putumayo*	1-12
Characterization of species of *Cyphomandra betacea Cav*. in the community of Mazahuacán, Lolotla, Hidalgo JIMÉNEZ-PELCASTRE, César, PEREA-MARTÍNEZ, Alejandro, VALENTÍN-ISLAS, Raúl and GUEVARA-HERRERA, Ricardo *Universidad Tecnológica de la Sierra Hidalguense*	13-18
Characterization of Municipal Solid Waste in Altamira, Tamaulipas MEDINA-ALVAREZ, Juana Elizabeth, GARZA-FLORES, Rodolfo, WONG-GALLEGOS, Juan Yared and PÉREZ-BRAVO, Sheila Genoveva *Universidad Politécnica de Altamira* *Universidad del Noreste*	19-31
Analysis for the construction of low cost housing with recycled plastic bricks with no negative environmental impact proposed for Tijuana, B.C VALENZUELA-CRUZ, Nataly Berenice, DELGADO-RENDON, Rene and CAMACHO-IXTA, Ixchel Astrid *Universidad Autónoma de Baja California*	32-37

Article
ECORFAN Journal-Republic of Nicaragua
December 2018 Vol.4 No.7 1-12

Evaluation of the effectiveness of the technique of bioaumentation in sediments contaminated with hydrocarbons of a combustibles service station of the municipality of San Francisco Putumayo Colombia

Evaluación de la efectividad de la técnica de bioaumentación en sedimentos contaminados con hidrocarburos de una estación de servicio de combustibles del municipio de San Francisco Putumayo Colombia

GUERRA-ACOSTA, Adriana del Socorro†*, RODRIGUEZ-MONTENEGRO, Luis Carlos, AREVALO-LOPEZ, Judy Johana and ORTIZ-GOMEZ, Yeison Andres

Instituto Tecnológico del Putumayo, Facultad de Ingenieria y Ciencias Básicas.Programa Ingenieria Ambiental

ID 1st Author: *Adriana, Guerra-Acosta* / **ORC ID** 0000-0002-9731-8933, **Researcher ID Thomson** T-7916-2018, **CVU CONACYT ID**: 000150334320121

ID 1st Coauthor: *Luis Carlos, Rodriguez-Montenegro*

ID 2nd Coauthor: *Judy Johana, Arevalo-Lopez*

ID 3rd Coauthor: *Yeison Andres, Ortiz-Gomez*

Received July 28, 2018; Accepted November 20, 2018

Abstract

The present investigation evaluated the effect of the technique of biostimulation of sediments contaminated with hydrocarbons in a service station of San Francisco Putumayo, these sediments are product of maintenance and cleaning of the operation site or island, as it is, the grease trap, channels perimeter of the fuel distribution and sale zone, perimeter channels of the filling area of fuel storage tanks and vehicle washing desander. For the development of this research, in the technique of bioaugmentation was added to the sediments of the service station, solid organic fertilizers (vermicompost and bocashi) and liquid (pantothenate), the objective of the investigation was the evaluation of degradation of total hydrocarbons (TPH), contained in sediments of grease traps, through the technique of bioaugmentation. The experimental design used was an unrestricted randomization (DIA), with three treatments and three repetitions of each, the T1 treatment was natural attenuation, the T2 was applied organic manure humus worm, the T3 treatment was applied organic fertilizer bocashi plus pantothenate to T2 and T3

Biostimulation, Hydrocarbons, Fertilizers

Resumen

La presente investigación evaluó el efecto de la técnica de bioestimulación de sedimentos contaminados con hidrocarburos en una estación de servicios de San Francisco Putumayo, estos sedimentos son producto del mantenimiento y limpieza del sitio de operación o isla, como es, la trampa de grasa, canales perimetrales de la zona de distribución y/o venta del combustible, canales perimetrales de la zona de llenado de tanques de almacenamiento de combustible y desarenador del lavado de vehículos. Para el desarrollo de esta investigación, en la técnica de bioaumentación se adicionó a los sedimentos, abonos orgánicos de tipo sólido (lombricompost y bocashi) y líquido (pantotenato), el objetivo fue evaluar la degradación de hidrocarburos totales (TPH), contenidos en sedimentos de las trampas de grasa, a través de la técnica de bioaumentación. El diseño experimental usado fue un irrestrictamente al azar (DIA), con tres tratamientos y tres repeticiones de cada uno, el tratamiento T1 fue de atenuación natural, el T2 se le aplicó abono orgánico humus de lombriz, el tratamiento T3 se le aplicó abono orgánico bocashi más pantotenato a T2 y T3

Bioamentación, Hidrocarburos, Abonos

Citation: GUERRA-ACOSTA, Adriana del Socorro, RODRIGUEZ-MONTENEGRO, Luis Carlos, AREVALO-LOPEZ, Judy Johana and ORTIZ-GOMEZ, Yeison Andres. Evaluation of the effectiveness of the technique of bioaumentation in sediments contaminated with hydrocarbons of a combustibles service station of the municipality of San Francisco Putumayo Colombia. ECORFAN Journal-Republic of Nicaragua 2018, 4-7: 1-12.

* Correspondence to Author (email: aguerra@itp.edu.co)
† Researcher contributing first author.

Introduction

The inadequate disposal of sludge contaminated with residues of oils, lubricants, compounds by total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCB), polycyclic aromatics (PAH), metals and other pollutants cause a deterioration in the environment and human health due to their carcinogenic, toxic and poisonous effects, they are considered substances of difficult biodegradation and are classified as hazardous waste by the regulations established in the Basel Convention (Arroyo, Quesada, & Quesada, 2010).

The research was based on the use of the bioremediation technique of hydrocarbons in a service station, treating the sediments that are contaminated with their derivatives ACPM and gasoline, with organic fertilizers containing microorganisms which play an essential role to prevent and control the damages that can cause the spills or leaks of these pollutants.

Bioaugmentation was evaluated, which consisted in the application of ex situ treatments based on solid fertilizers (vermicompost) and (bocashi) and liquid (pantothenate) applied to sediments where decontamination was evidenced on a material contaminated with hydrocarbons.

The experimental design used was unrestrictedly randomized (DIA), with three treatments, the first was natural attenuation compared to two others where solid and liquid organic fertilizers were used for the decontamination of hydrocarbons, each treatment with three repetitions, for a total of nine experimental units, at the beginning of the investigation and after two months of carrying out the project, total hydrocarbon values (TPH) were taken, the other contol variables such as humidity, temperature, pH, apparent density, real density, porosity and color, were evaluated weekly.

The analysis of the total hydrocarbon values and for the control variables was carried out through an analysis of variance (Andeva) to determine if there are significant statistical differences between the three treatments evaluated and tests of significance of Tukey where ($P< 0.05$).

Finally it was determined that the technique of bioaugmentation allows the degradation of sediments contaminated by hydrocarbons and improve the physical properties evaluated in the sediments.

Objectives

General objective

To evaluate the degradation of total hydrocarbons (TPH), contained in sediments of grease traps, through the technique of bioaugmentation, in a service station of the municipality of San Francisco Putumayo.

Specific objectives

– Quantify the amount of sediment generated at the fuel service station every 15 days, both wet and dry.
– Determine the initial content of total petroleum hydrocarbons (TPH) in the sediments of the grease traps.
– Determine the percentages of total hydrocarbon degradation (TPH) and the behavior of control variables.

Methodology

The procedure was ex situ in nature, for this reason the sediment material was extracted from the grease trap and transported to a room house located in the Pablo VI neighborhood in front of the station.

The treatments evaluated were:

– T1: Contaminated sediment: 100% (25 Kg) of contaminated sediments from the service station.
– T2: 60% (15 Kg) sediments contaminated with hydrocarbons from the service station, 40% (10 Kg) of solid organic fertilizer type earthworm humus + (2L pantothenate + 4L of water).
– T3: 60% (15 Kg) sediments contaminated with hydrocarbons from the service station, 40% (10 Kg) of solid organic fertilizer type Bocashi + (2L pantothenate + 4L of water).
– T3: 60% (15 Kg) sediments contaminated with hydrocarbons from the service station, 40% (10 Kg) of solid organic fertilizer type Bocashi + (2L pantothenate + 4L of water).

ISSN-On line: 2414-8830

For the assembly of the experimental units that are the sites where the different treatments of the research were located, the following materials were required (Figure 1).

- Contaminated sediment from the service station.
- Solid organic compost humus worm and bocashi and Pantotenato liquid.
- 9 containers of high density polyethylene, this material is chosen for its low permeability and minimal absorption of hydrocarbons (Vallejo, Salgado, & Roldan, 2012).
- Garden shovels to mix the sediments.

Figure 1 Contaminated sediments and polyethylene containers
Source: This research

For the assembly of the experimental units the following steps were taken, taking as reference (Ñustez Cuartas, 2012), in their thesis "Bioremediation for the degradation of total hydrocarbons present in the sediments of a fuel service station", which pose:

1. The sediments of the grease traps were collected (Figure 2).

Figure 2 Extraction of sediments from the grease trap
Source: This research

2. The sediments were deposited in a drying bed, to lower the humidity levels, for a week (Figure 3).

Figure 3 Contaminated sediments in the drying bed
Source: This research

After this time, samples were collected according to the technical standard (ICONTEC 3656, 1994) according to Table 1 of the follow-up of variables and evaluation method.

Variable	Méthod	Frequency
TemperaturE (ºC)	Thermometer	Three times a week in triplicate in each experimental unit
Humidity	Gravimetric	Once a week
TPH (total hydrocarbons)	Extraction by soxhlet-gravimetric method	At the beginning and end of the treatment
pH (Units)	Potentiometric	At the beginning and end of the treatment
Apparent density (g / cm3)	With graduated cylinder	Once a week
Real density (g / cm3)	Pycnometer	Once a week
Porosity (%)	1 - (Apparent density / Actual density) x 100	Once a week
Color	Table Munsell	Once every two weeks

Table 1 Seguimiento de variables y método utilizado
Source: This research

3. To the experimental units (Figure 4), water is added, once a week, in order to maintain the necessary humidity for the degradation process.

ISSN-On line: 2414-8830

Figure 4 Assembly of experimental units
Source: This research

4. Manual turning was done three times a week to increase the oxygen content and application of water for a correct moisture content.

5. After two months, after this procedure, samples were collected and sent to the laboratory for taking new values of the response variables that was total hydrocarbons (TPH) (ICONTEC 3656, 1994).

Results and Discussion

Diagnosis on weekly sediment production at the San Francisco service station

The sediments were extracted during 7 weeks and they were thought in humid to do so a weekly estimate, the average production was to 9.5 Kg in humid and 5,8 Kg in dry (Table 2).

Week	Weight sediments in wet (39% humidity) (Kg)	Weight of dry sediments (0% humidity) (Kg)
1	8,5	5,185
2	9	5,49
3	10,5	6,4
4	11,3	6,9
5	8,4	5,12
6	8,1	4,9
7	10,5	6,4
Total	66,3	40,443
Average	9,5	5,8

Table 2 Weight of wet sediments
Source: This research

Initial characterization of sediments

The initial values of the control and response variables were determined (Table 3), according to the certified laboratory the extracted sediments gave an initial concentration of 0.39% w / w, that is to say that for every kilogram of extracted sediment there was 3, 9 grams corresponding to total hydrocarbons and 6.74 units for pH.

Variable or parameter	Unit of measurement or concentration	Value
Temperature	°C	20,5
Humidity	Porcentaje %	39%
Apparent density	g/cm^3	2,6
Real density	g/cm^3	2,7
Porosity	%	5,0
pH	Unidades	6,74
Total hydrocarbons	Porcentaje % p/p	0,39

Table 3 Initial values for the control and response variables
Source: This research

According to these parameters, the sediments of each experimental unit have the following characteristics: the temperature is within the optimal range of 18 and 30 ° C, which allows enzymatic activity and cell exchange (Gómez Romero, et al., 2008), the pH with a value of 6.74, is between the optimum range values between 6.0 and 8.0 units, this interval is suitable for the growth of bacteria (Ríos, 2005), humidity with 39% is in the advisable range that goes from 20% - 75% humidity, which is important because it acts as a means of transporting nutrients and oxygen to the cell (Gómez, *et al*, 2008).

Analysis of the response and control variable

Total hydrocarbons (TPH)

Source	Sum of squares	Gl	Middle Square	Reason-F	Value-P
Between groups	406904,0	2	203452,	37,22	0,0004
Intra groups	32793,3	6	5465,56		
Total (Corr.)	439698,0	8			

Table 4 Anova for concentration of total hydrocarbons by treatment
Source: This research

ISSN-On line: 2414-8830

ECORFAN Journal-Republic of Nicaragua
December 2018 Vol.4 No.7 1-12

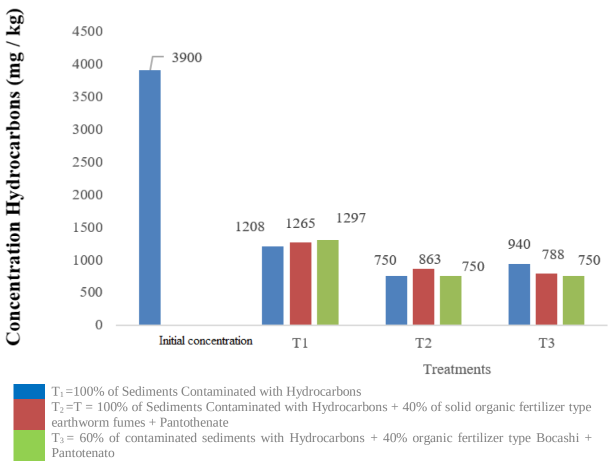
The analysis of variance in Table 4 shows highly significant statistical differences with respect to total hydrocarbons in the three evaluated treatments (P<0,05).

Treatment	Cases	Average	Homogeneous Groups
T2	3	787,667	A
T3	3	826,0	A
T1	3	1256,67	B

Stocks with a letter in common are not significantly different (p>0,05)

Table 5 Tukey tests for total hydrocarbon concentration by treatment
Source: This research

According to the Tukey test (Table 5), there is significant statistical difference between T2 and T3 with respect to T1, but between T2 and T3 there is no statistically significant difference because this test considers it as homogeneous groups.



Graphic 1 Concentration of total hydrocarbons in each experimental unit after the bioaugmentation process
Source: This research

The response variable of this investigation was total hydrocarbons. The initial analysis made in the laboratory showed that the sediments initially had a concentration of 3900 mg / kg, on the other hand it has that if the results are lower than 750 mg / kg the total hydrocarbons become undetectable.

For the T1 treatment that was the control, it obtained the highest results, as expected to happen according to the alternative hypothesis proposed at the beginning of the investigation, thus giving a maximum concentration of 1297 mg / kg and an average concentration per treatment of 1256.6 mg / kg.

T2 differed greatly from the control since the highest result corresponds to 863 mg / kg and the other repetitions gave levels below 750 mg / kg.

The T3 results indicate that the highest value for this treatment was 940 mg / kg, on the other hand one of the replicates yielded a result of 750 mg / kg.

In all three treatments there was a decrease in total hydrocarbons compared to the initial analysis, due to factors that the three treatments share in common, such as humidity and aeration management, which directly influence bioremediation, according to Roldan & Iturbe (2002). Another control variable was the temperature that played an important role since the metabolism of the microorganisms, the enzymatic and cellular activity depend on the temperature, likewise this influences the structural and chemical changes of the oil and its derivatives (Ñustez Cuartas, 2012), for which favorable conditions were maintained for the microorganisms added by the solid organic fertilizer and the liquid as pantothenate at the beginning of the process and at the same time the bacteria have a very rapid growth and a greater capacity to adapt to contaminated media, which increases the probability of success in the biodegradation of hydrocarbons (Velasco, 2004).

Temperature (°C)

The analysis of variance of tables 6, where this variable is analyzed at the end of the process, indicates that significant differences were present (P <0.05), when observing the tests of significance of Tukey table 7, a difference was found statistic significant between T1 with average value of 20.90 ° C, with respect to T2 and T3 with averages of 20.10 ° C and 20.27 ° C respectively.

	Sum of squares	GL	Middle Square	Reason - F	Value - P
Model	1,07	2	0,53	17,18	0,0033
Treatment	1,07	2	0,53	17,18	0,033
Error	0,19	6	0,03		
Total	1,26	8			

Table 6 Anova for final temperatures
Source: This research

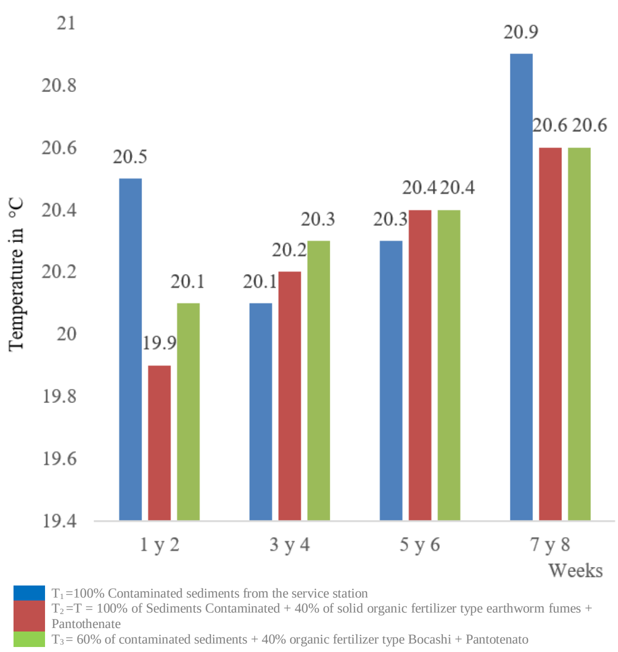
ISSN-On line: 2414-8830

Treatment	Average	Cases	Homogeneous groups	
T1	20,90	3	A	
T3	20,27	3		B
T2	20,10	3		B

Averages with a letter in comasún are not significantly different (p>0,05)

Table 7 Tukey test for final temperatures per treatment
Source: This research

Figure 2 shows that the average temperature for the first treatment ranges from 20.1ºC - 20 91ºC, presenting the highest values in the evaluation of this parameter., For the second and third treatment fluctuate between 19.9ºC - 20, 6ºC and 20.1ºC - 20.6ºC respectively in the course of two months, this is caused by the environmental conditions of the site.



Graphic 2 Average temperatures every two weeks in each treatment
Source: This research

The hydrocarbons in the soil cause changes both in the physical properties and in the chemical properties that, depending on the type and amount of oil discharged, as well as the temperature, soil texture and humidity make the processes more or less slow leads to a higher degree of toxicity (De Mesa., Quintero, Guevara, & Garcia, 2006).

In this regard (Gómez, et al., 2008) state that temperature directly influences the increase in volatility (separation) and rate of degradation of pollutants (Volke & Velasco, 2005), low values of temperature will increase the viscosity of the hydrocarbon and consequently it would increase the remediation time.

According to Maroto & Rogel (2008), who affirm that the optimum temperature for the increase of the metabolism of mesophilic microorganisms varies between 15 and 30 ° C and decreases the remediation in temperatures above 40 ° C and below 0 ° C.

Apparent density (g/cm^3)

For this variable, there was a statistically significant difference at the end of the process (p <0.05), according to tables 8 and 9, T2 and T3 with averages of 1.73 g / cm^3 and 1.57 g / cm^3, differentiated significantly from T1 that obtained an apparent density average of 2.13 g / cm^3.

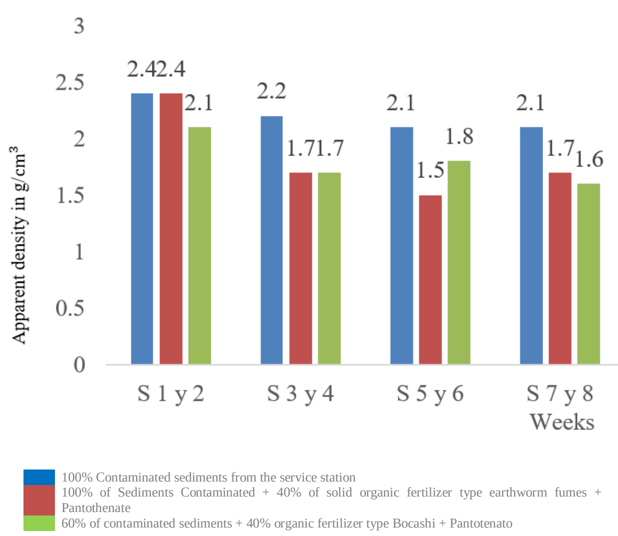
Source	Sum of squares	GL	Middle Square	Reason - F	Value – P
Model	0,51	2	0,25	25,44	0,0012
Treatment	0,51	2	0,25	25,44	0,0012
Error	0,06	6	0,01		
Total	0,57	8			

Table 8 Anova for apparent density at the end of the process
Source: This research

Treatment	Averages	Cases	Homogeneous groups	
T1	2,13	3	A	
T2	1,73	3		B
T3	1,57	3		B

Stocks with a letter in common are not significantly different (p>0,05)

Table 9 Tukey test for apparent density at the end of the process
Source: This research



Graphic 3 Average apparent density per two weeks in each treatment
Source: This research

ISSN-On line: 2414-8830

Figure 3 shows that T1 starts with an apparent density of 2.4 g / cm^3, and for reasons of biotic control (adding water for good humidity and manual turning for aeration) for the last two weeks to reach 2, 1 g / cm^3.

Figure 3 shows that T1 starts with an apparent density of 2.4g/cm^3, and for reasons of biotic control (adding water for good humidity and manual turning for aeration) for the last two weeks to reach 2,1g/cm^3 On the other hand, T2 starts with a value equal to T1 of 2.4g/cm^3 and having the same behavior of decreasing up to 1.7g/cm^3 there was a maturity of the process.

The treatment T3 had a behavior with the same tendency to lower the density values for the final weeks reached 1.6 g / cm^3.

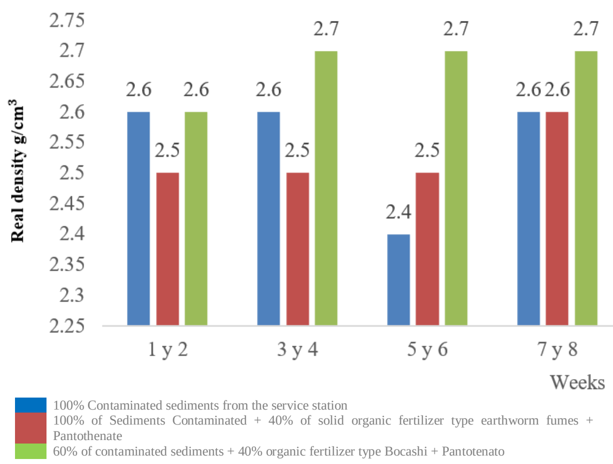
The values that the bulk density can take depend on many factors, including the texture, structure and content of organic matter, as well as its management. In contrast to the actual density, which is more or less constant, the bulk density is highly variable due to variations in the quantity / quality of the porous space (Rubio, 2010).

The changes in the apparent density reflect changes in the structure of the substrate, due to the existing relationship between bulk density and total porosity (Ingaramo, Paz Gonzales, & Dugo Paton, 2003).

In addition, the apparent density is affected by the solid particles and by the porous space, which in turn is determined mainly by the organic matter of the soil, as the organic matter and the porous space increase, the apparent density decreases and vice versa (Salamanca Jimenez & Sadeghian Khalajabadi, 2005).

The fertilizers had great direct influence, decreasing the values of apparent density, that is to say that positively affect other properties by increasing the porous spaces and improving the relationship between air and air.

Real density (g/cm^3)



Graphic 4 Average real density for every two weeks in each treatment
Source: This research

Figure 4, indicates the average values of real density of each treatment where the T1 control maintained its value of real stable density with a value of 2.6 g / cm^3 during almost all the time that the process lasted. The treatment T2 remained stable with a value of 2.5 g / cm^3 on average over the weeks 1, 2, 3, 4, 5 and 6 and finally in weeks 7 and 8 up to 2.6 g / cm^3.

The treatment T3 during weeks 1, 2, remained with a value around 2.6 g/cm^3, for already weeks 7 and 8 go up to 2.7 g/cm^3.

According to Unigarro et al. (2009), this property refers to the weight of the soil where only the solid particles of the soil are considered, this density is always greater than the apparent one. The treatments in this variable of real density remained constant since there were no major variations in it, as it is a property that does not change with the management.

Porosity (%)

According to the analysis of variance and Tukey's significance test (tables 10 and 11), there are statistically significant differences ($p < 0.05$), where T1 with an average of 17.97% porosity, differs from T2 and T3 who obtained averages of 33.67 and 42.73% respectively.

Source	Sum of squares	GL	Middle Square	Reason – F	Value – P
Model	942,08	2	471,04	13,04	0,0065
Treatment	942,08	2	471,04	13,04	0,0065
Error	216,78	6	36,13		
Total	1158,86	8			

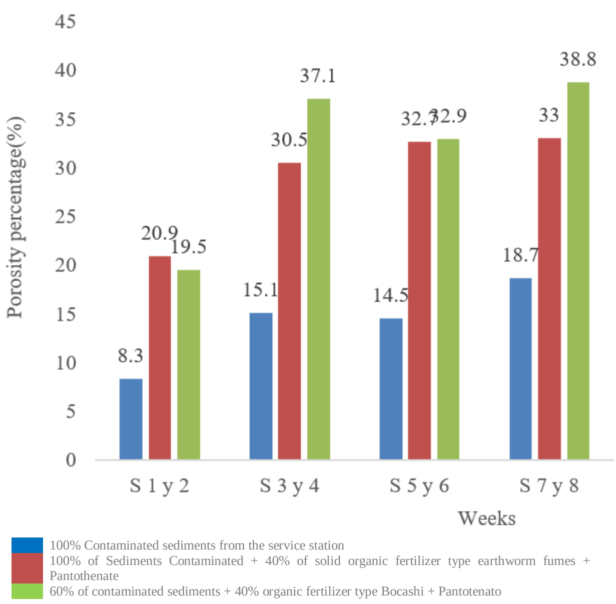
Table 10 Anova for percentage of porosity at the end of the process
Source: This research

Treatment	Average	Cases	Homogeneous groups	
T3	42,73	3	A	
T2	33,67	3	A	
T1	17,97	3		B

Stocks with a letter in common are not significantly different (p>0,05)

Table 11 Tukey test for percentage of porosity at the end of the process
Source: This research

Figure 6 shows that there is a significant difference of treatment 1 with respect to treatments 2 and 3 because these two treatments represent an increase in the percentage of porosity, this is due to the addition of organic fertilizers such as humus. of worm and bocashi, and a pantotenato liquid fertilizer for which these solid and liquid fertilizers, allow them to improve the physical and chemical properties of the sediment.



Graphic 5 Average percentage of porosity every two weeks for each treatment
Source: This research

Treatment 1 showed an increase in the percentage of porosity after the weeks of experimentation, since a percentage of porosity of 8.3% was obtained between week 1 and 2 and between weeks 7 and 8 a percentage of porosity of 18, 7%

When evaluating treatments 2 and 3, there was a significant increase in the percentage of porosity after the weeks of experimentation, since a percentage of porosity of 20.9% for treatment 2 and 19.5 was obtained between week 1 and 2. % for treatment 3, and between weeks 7 and 8 a percentage of porosity of 33% for treatment 2 and 38.8% for treatment 3, which allows establishing that if there was an understandable increase in porosity thanks to fertilizers present in these two treatments therefore these sediments maintained a good system of microorganisms.

The porosity is closely related to the real density and the apparent density, so that, if there are changes in them, there is a change in the percentage of porosity (Perez, Iturbe , & Flores, 2006). The porosity diminishes notably by the occupation of the hydrocarbon in the porous spaces, as the porosity is determined from the data of real density and apparent density, if some of these data increase or decrease (depending on the concentration and type of hydrocarbon, as well as by the type of soil), will be reflected directly in the porosity (Lopez & Martinez, 2001).

pH (Units)

Considering the analysis of variance (Table 12), where this variable is analyzed at the end of the investigation, it indicates that there were significant differences (P <0.05), in the Tukey test of significance (Table 13), a difference was found significant statistic among the three treatments, T1 with an average value of 6.63 pH units, T2 with an average of 7.33 pH units and T3 with 7.7 pH units.

Sorce	Sum of squares	Gl	Middle Square	Reason-F	Value-P
Between groups	1,96222	2	0,981111	49,06	0,0002
Intra groups	0,12	6	0,02		
Total (Corr.)	2,08222	8			

Table 12 Anova for pH at the end of the process
Source: This research

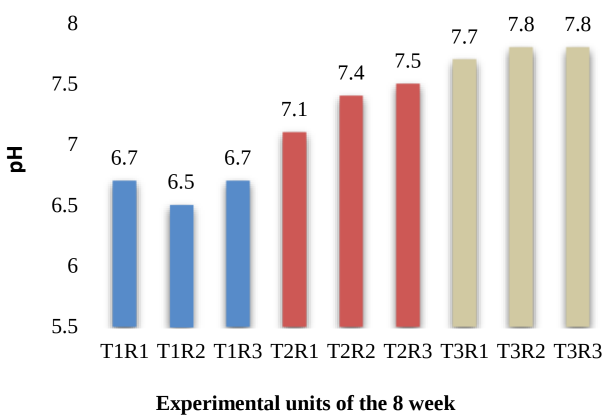
ISSN-On line: 2414-8830

Treatment	Cases	Average	Homogeneous Groups
T1	3	6,63333	A
T2	3	7,33333	B
T3	3	7,76667	C

Averages with a letter in common are not significantly different (p>0,05)

Table 13 Tukey test for pH at the end of the process
Source: This research.

Figure 6 shows that treatment 1 with its three replicates has a pH of 6.7 - 6.5 - 6.7 units, while treatment 2 has a pH of 7.1 - 7.4 - 7.5 units in its three repetitions unlike treatment 3 contains pH of 7.7 - 7.8 and 7.8 units in relation to the last week of the process that was carried out.



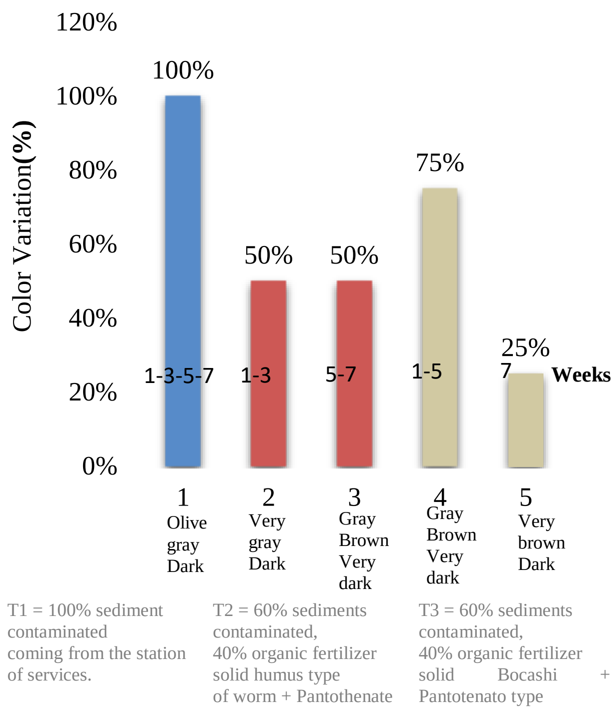
Graphic 6 PH behavior in the experimental units
Source: This research

According to (Maier, Pepper, & Gerba, 2008) they affirm that the pH influences the microbial activity of the soil. Bacteria develop best at neutral pH and filamentous fungi at acidic pH; thus, the degradation of hydrocarbons is better under conditions of neutral and alkaline pH than in acidic pH.

The pH is an important chemical factor that influences the recovery of soils contaminated by hydrocarbons, since it can mainly affect the populations of microorganisms and the bioavailability of carbon and energy sources. This factor constitutes one of the indicators of the bioremediation process and has a certain range of tolerance (Hambrick, DeLaune, & Patrick, 2008). Corroborating what was found in the research where solid organic fertilizers were used, the pH tended toward neutrality. At extremely alkaline or extremely acid pH, biodegradation becomes slow (Huertos & Romero, 2008). Generally, soils contaminated by hydrocarbons tend to be acidic, which limits growth and microbial activity.

The optimum range for biodegradation is between 6-8 pH (Alexander M., 1994). However, to maintain a better degrading capacity, for prolonged periods of time, the pH must be neutral, between 7.4-7.8, avoiding fluctuations as much as possible (Leahy & Colwell, 1990).

Color



Graphic 7 PH behavior in the experimental units at the end of the process
Source: This research

Graph 7 shows there are colorimetric differences where treatment 1 remained constant after the experimentation weeks a single color 5Y 3/2 (dark olive gray) which represents 100%, as for treatment 2 have been detonated two types of colors for which in the first weeks (1-3) a 2.5Y 3/2 color was presented (very dark gray) representing 50% and in the last two weeks (5-7) a color 10YR 3 / 2 (very dark gray brown) representing the other 50%, in terms of treatment 3 two types of colors were observed which for the weeks (1-3-5) I present a color 10YR 3/2 (very dark gray brown) which represents 75%, and for the last week (7) I present a color 10YR 2.5 / 2 (very dark brown) which represents the remaining 25%. This is due to the fact that the treatments contain solid organic fertilizers such as earthworm humus, bocashi and a liquid pantothenate type fertilizer.

Which makes it possible to establish that they are totally different sediments with respect to treatment 1 of treatments 2 and 3 are combined that allow having other physical and chemical characteristics regarding color. According to (Burbano, 1989), it states that the typical dark color is due to the contents of organic matter, its intensity influenced by the moisture content, the dark colors are an indication of high contents of organic matter.

Conclusions

– The total hydrocarbons as response variables had positive results that allude to the alternative hypothesis since the treatments T2 and T3 have significant differences compared to the T1 evidenced in the laboratory results, which yielded the following data: an average concentration of T1 of 1256 mg / Kg, T2 and T3 can not be averaged since some results were below 750 mg / Kg which is the limit of quantification.

– According to the results of the response variables, the most effective treatment was T2 containing 60% of sediments and 40% organic fertilizer solid earthworm humus plus liquid organic fertilizer pantothenate, because it showed results lower than 750 mg / kg, surpassing the levels of decontamination of T1 and T3, however, T3 was very effective since it remains outside the decontamination of T2.

– The control variables (pH, humidity, temperature, bulk density, porosity) had statistically significant differences except for the real density, because the behavior they had was due to the control of the biotic factors to which this procedure was subjected.

– Comparing the treatment T1 with T2 and T3, the behavior of the real density was not due to each treatment because the p value is greater than 0.05 which shows that there was no statistically significant difference both at the beginning and at the end of the treatment. treatment, real density is a variable that is constant and very difficult to change.

– As a result of the investigation, it was demonstrated that the alternative hypothesis proposed at the beginning of the process was the one that was evidenced in each variable, both of control and of response, having significant differences, for which it is concluded that the treatments did have a positive response in comparison to the witness. The deposition of the sediments corresponds to an open space, where there is contamination of the soil and superficial and underground waters, with the results of this research an alternative of environmentally sustainable solution was proposed for the decontamination of the sediments that the service station produces.

References

Alexander, M. (1994). Biodegradación y biorremediación. Obtenido de http://congress.cimne.com/zns09/admin/files/filepaper/p422.pdf

Arroyo, M., Quesada, M., & Quesada, R. (2010). Revista colombiana de biotecnologia. Obtenido de http://revistas.unal.edu.co/index.php/biotecnologia/article/view/15579/38076

Burbano, H. 1989. El suelo: Una visión sobre sus componentes biorganicos. Universidad de Nariño, Pasto Colombia. pp. 109-117.

De Mesa., J., Quintero, G., Guevara, A., Jaimes, D., & Garcia, J. (22 de Junio de 2006). Biorremediacion de suelos contaminados con hidrocarburos derivados del petroleo. Obtenido de "NOVA" Publicaciones cientificas en ciencia biomedicas: http://unicolmayor.edu.co/publicaciones/index.php/nova/article/view/60/119

Gómez Romero, S. E., Gutiérrez Bustos, D. C., Hernàndez Marín, A. M., Hernández Rodríguez, C. Z., Losada Casallas, M., & Mantilla Vargas, P. (25 de Abril de 2008). Factores bióticos y abíoticos que condicionan la biorremediacón por hidrocarburos. Obtenido de http://www.unicolmayor.edu.co/invest_nova/NOVA/NOVA9_ART8_PSEUDO.pdf

Hambrick , G., DeLaune, R., & Patrick, W. (2008). El pH del sedimento estuarino y el potencial de oxidacion - reduccion en degradacion microbiana de hidrocarburos. Obtenido de http://www.unicolmayor.edu.co/invest_nova/NOVA/NOVA9_ART8_PSEUDO.pdf

Huertos, E., & Romero, A. (2008). Contaminacion de suelos por metales pesados. Obtenido de http://www.ehu.eus/sem/macla_pdf/macla10/Macla10_48.pdf

ICONTEC 3656. (23 de Noviembre de 1994). Norma Tecnica Colombiana 3656. Obtenido de https://tienda.icontec.org/wp-content/uploads/pdfs/NTC3656.pdf

Ingaramo, O., Paz Gonzales, A., & Dugo Paton, M. (2003). Evaluación de la densidad aparente en diferentes sistemas de laboreos de suelo,. Obtenido de Universidad Nacional del Nordeste: http://www.unne.edu.ar/unnevieja/Web/cyt/cyt/2003/comunicaciones/05-Agrarias/A-032.pdf

Leahy, J., & Colwell, R. (1990). Degradacion microbiana de hidrocarburos en el Ambiente. Obtenido de Departamento de Microbiología, Universidad de Maryland, College Park, Maryland: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC372779/pdf/microrev00038-0103.pdf

Lopez, F., & Martinez, V. (2001). efecto de hidrocarburos en las propiedades fisicas y quimicas de suelo arcilloso. Obtenido de https://chapingo.mx/terra/contenido/19/1/art9-17.pdf

Maier, R., Pepper, I., & Gerba, C. (7 de Julio de 2008). Microbiología ambiental. Obtenido de https://booksite.elsevier.com/samplechapters/9780123705198/Sample_Chapters/01~Front_Matter.pdf

Maroto, M., & Rogel, J. (2008). Aplicación de sistemas de biorremediacion de suelos y aguas contaminadas por hidrocarburos. Obtenido de GEOCISA. Div. Protección Ambiental de Suelos.: http://aguas.igme.es/igme/publica/con_recu_acuiferos/028.pdf

Ñustez Cuartas, D. (Mayo de 2012). Biorremediacion para la degradacion de hidrocarburos totales presentes en los sedimentos de una estacion de servicio de combustible. Obtenido de http://repositorio.utp.edu.co/dspace/bitstream/handle/11059/2779/6281683N975.pdf;jsessionid=9BA80AA246B440B4DC978407696E8E88?sequence=1

Perez, G., Iturbe , R., & Flores, R. M. (2006). CAMBIO EN LAS PROPIEDADES FÍSICAS DE UN SUELO CONTAMINADO CON HIDROCARBUROS DEBIDO A LA APLICACIÓN DE UNA TECNOLOGÍA DE REMEDIACIÓN. Obtenido de 2. https://www.researchgate.net/profile/Rosario_Iturbe2/publication/267367877_CAMBIO_EN_LAS_PROPIEDADES_FISICAS_DE_UN_SUELO_CONTAMINADO_CON_HIDROCARBUROS_DEBIDO_A_LA_APLICACION_DE_UNA_TECNOLOGIA_DE_REMEDIACION/links/55df590408aecb1a7cc1a06b/CAMBIO-EN-LAS-

Roldan , A., & Iturbe, R. (2002). Saneamiento de suelos contaminados con hidrocarburos mediante biopilas. Obtenido de https://www.researchgate.net/profile/Rosario_Iturbe2/publication/237751497_SANEAMIENTO_DE_SUELOS_CONTAMINADOS_CON_HIDROCARBUROS_MEDIANTE_BIOPILAS/links/55cce69208aebebb8f577ade/SANEAMIENTO-DE-SUELOS-CONTAMINADOS-CON-HIDROCARBUROS-MEDIANTE-BIOPILAS.pdf

Rubio, A. (Julio de 2010). LA DENSIDAD APARENTE EN SUELOS FORESTALES DEL PARQUE NATURAL LOS ALCORNOQUES. Obtenido de http://digital.csic.es/bitstream/10261/57951/1/La%20densidad%20aparente%20en%20suelos%20forestales%20.pdf

Salamanca Jimenez, A., & Sadeghian Khalajabadi, S. (2005). La densidad aparene y su relacion con otras propiedades en suelos de la zona cafetera Colombiana. Obtenido de http://biblioteca.cenicafe.org/bitstream/10778/163/1/arc056(04)381-397.pdf

December 2018 Vol.4 No.7 1-12

Singh, B., Walker , A., Morgan, J., & Wright , D. (2003). Efectos del suelo pH en la biodegradación de clorpirifos y aislamiento de un bacteria que degrada el clorpirifos. Obtenido de https://www.ncbi.nlm.nih.gov/pmc/articles/PMC194978/

Unigarro, A., Insuasty, R., & Chaves, G. (2009). Manual de laboratorio de suelos generales. Obtenido de Universidad de Nariño.

Vallejo, V., Salgado, L., & Roldan , F. (2 de Diciembre de 2005). Evaluación de la bioestimulación en la biodegradación de TPHs en suelos contaminados con petroleo. Obtenido de Rev. Colomb. Biotecnol.: file:///C:/Users/Johana/Downloads/Dialnet-EvaluacionDeLaBioestimulacionEnLaBiodegradacionDeT-2351601.pdf

Vallejo, V., Salgado, L., & Roldan, F. (Mayo de 2012). Biorremediación para la degradación de hidrocarburos totales presentes en los sedimentos de una estacion de servicio de combustible. Obtenido de http://repositorio.utp.edu.co/dspace/bitstream/handle/11059/2779/6281683N975.pdf;jsessionid=9BA80AA246B440B4DC978407696E8E88?sequence=1

Velasco, N. (2004). Efecto de Pretratamientos Fisicoquímicos en la Biodegradación de Hidrocarburos del Petróleo en un Suelo Intemperizado, por Composteo. . Obtenido de Especialista en Biotecnología. Universidad Autónoma Metropolitana. Unidad Iztapalapa. México D.F.

Volke, T., & Velasco, J. A. (2005). Tecnologiasde remediacion para suelos contaminados. Obtenido de http://www.inecc.gob.mx/descargas/publicaciones/372.pdf

ISSN-On line: 2414-8830

Characterization of species of *Cyphomandra betacea Cav*. in the community of Mazahuacán, Lolotla, Hidalgo

Caracterización de especie de *Cyphomandra betacea Cav*. en la comunidad de Mazahuacán, Lolotla, Hidalgo

JIMÉNEZ-PELCASTRE, César*†, PEREA-MARTÍNEZ, Alejandro, VALENTÍN-ISLAS, Raúl and GUEVARA-HERRERA, Ricardo

Universidad Tecnológica de la Sierra Hidalguense Carretera México-Tampico, Km. 100 Colonia. Tramo Pachuca-Huejutla. Zacualtipán de Ángeles, Hidalgo, México, C.P. 43200. División de Ciencias Naturales, Carrera Recursos Naturales

ID 1st Author: *César, Jiménez-Pelcastre* / **ORC ID**: 0000-0002-4621-7358, **Researcher ID Thomson**: T-8849-2018**, CVU CONACYT-ID**: 742240

ID 1st Coauthor: *Alejandro, Perea-Martínez* / **ORC ID**: 0000-0001-8816-1252; **Researcher ID Thomson**: U-1123-2018, **CVU CONACYT-ID**: 949430

ID 2nd Coauthor: *Raúl, Valentín-Islas* / **ORC ID**: 0000-0003-0119-2481; **Researcher ID Thomson**: T-9762-2018**, CVU CONACYT-ID:** 846856

ID 3er Coauthor: *Ricardo, Guevara-Herrera* / **ORC ID**: 0000-0001-8708-9420; **Researcher ID Thomson**: T-8848-2018**, CVU CONACYT-ID**: 846829

Received September 28, 2018; Accepted December 20, 2018

Abstract

The information presented is intended to contribute to the conservation of *Cyphomandra betacea Cav*., One of many organisms that belong to the Mesophilous Mountain Forest; This work implies the knowledge its distribution and state of health of the species; To achieve this, a tour of the entire community of Mazahuacán, belonging to the municipality of Lolotla in Hidalgo, it was chosen because people are already beginning their commercialization, finding a great acceptance in the market as a natural therapeutic, thanks to its nutritional properties, so to increase its distribution and cultivation within the same space where it lives without altering its habitat, is a way to sustainably conserve the Mesophilous Mountain Forest. Being a plant of Andean origin, it likes the humidity and spaces with light, but having low temperatures at least during the night, it if was direct light it dries the leaf making it vulnerable to multiple opportunists, from insects that eat leaves, even fungi due to the great humidity that presents; The shade of trees and the warm temperatures are the best conditions to grow the plant healthy, since the direct light dehydrates the plant because of the increase of the evapotranspiration due to the size of the leaves, the distribution reflected in the present summary, is a Attempt to increase its cultivation in the community of Mazahuacán, starting with knowing where it is currently and the conditions that favor it in its growth.

***Cyphomandra betacea*, Mesophilous Mountain Forest, Mazahuacán, distribution, Lolotla**

Resumen

La información presentada está dirigida a contribuir en la conservación de *Cyphomandra betacea Cav*.**,** una de las plantas organismos propios del Bosque Mesófilo de Montaña; implica conocer su distribución y estado sanitario de la especie; para lograrlo se realizó un estudio en toda la comunidad de Mazahuacán, perteneciente al municipio de Lolotla en Hidalgo, escogido porque la gente ya inicia su comercialización, encontrando una gran aceptación en el mercado como terapéutico natural, gracias a sus propiedades nutrimentales, por lo que incrementar su distribución y cultivo dentro del mismo espacio donde vive sin alterar su hábitat, es una forma de conservar sustentablemente el Bosque Mesófilo de Montaña. Siendo una planta de origen andino, le gusta la humedad, espacios con luz pero que tengan bajas temperaturas al menos durante la noche, la luz directa seca la hoja haciéndola vulnerable a múltiples oportunistas, desde insectos que comen hojas, hasta hongos por la gran humedad; la sombra de árboles y las temperaturas templadas son las mejores condiciones para hacer crecer saludablemente la planta, ya que la luz directa deshidrata la planta por el aumento de la evapotranspiración debido al tamaño de las hojas, la distribución reflejada en el presente resumen, es un intento por acrecentar su cultivo en la comunidad de Mazahuacán, iniciando por conocer donde se encuentra actualmente y las condiciones que le favorecen en su crecimiento.

***Cyphomandra betacea*, Bosque Mesófilo de Montaña, Mazahuacán, distribución, Lolotla**

Citation: JIMÉNEZ-PELCASTRE, César, PEREA-MARTÍNEZ, Alejandro, VALENTÍN-ISLAS, Raúl and GUEVARA-HERRERA, Ricardo. Characterization of species of *Cyphomandra betacea Cav*. in the community of Mazahuacán, Lolotla, Hidalgo. ECORFAN Journal-Republic of Nicaragua. 2018, 4-7: 13-18.

* Correspondence to Author (email: cjpelcastre77@hostmail.com)
† Researcher contributing first author.

Introduction

This memory is an attempt to contribute in the description of the distribution of *Cyphomandra betacea Cav.*, Whose presence in the Mountain Mesophilic Forest (BMM), has been previously reported in Lolotla flora studies. The forest has decreased notably in recent years, SEMARNAT through CONABIO, reports that of the territory of the country, less than 1% of BMM are extended by 18,534 km^2; perform a sustainable management is an alternative to conservation and use.

To achieve this advantage it is necessary to know what is and where it is found, in this case Cyphomandra betacea Cav., Organisms with economic potential and that at the same time is not invasive to the already balanced Mesophilic habitat, they can be an alternative of sustainable production, the study reveals that there is *Cyphomandra betacea Cav*. in different spaces, including pastures of the community of Mazahuacán, of the municipality of Lolotla, state of Hidalgo, so the map that was generated, will be very useful to promote the cultivation of the plant creating a production, that in the short term, can be introduced as another food in the diet of the people of the sierra for its excellent nutritional level and in the long term there is a production that activates the economy in the Hidalguense mountains.

Therefore an estimation of abundance and distribution of the population of *Cyphomandra betacea Cav*. in the community of Mazahuacán; considering that the population of this plant is influenced by abiotic and biotic resources and that the influence of parameters such as temperature, humidity, height, among others, may be data, considered in this work, which will serve to establish the best productive conditions of the fruit to future.

Finally, it has been concluded that, knowing the distribution of *Cyphomandra betacea Cav*. and the conditions where it grows, it is only the beginning of the different works that must be done on the plant, these could make the difference in its commercial value, since it can be food for local consumption or a natural therapeutic fruit, considered by Europeans that they are the main market, interested in consuming foods whose natural properties without chemicals are the alternative of having a healthy, healthy and above all full of flavors of the countryside.

General Objective

Monitor the population distribution of Cyphomandra betacea Cav. in the community of Mazahuacán in the municipality of Lolotla, State of Hidalgo.

Particular Objective

a. Characterize Cyphomandra betacea Cav. for identification and monitoring in the field.
b. Make a map of population distribution of Cyphomandra betacea Cav. in the community of Mazahuacán of the municipality of Lolotla, State of Hidalgo, using Geographic Information Systems.
c. Record physical parameters related to the life cycle of Cyphomandra betacea Cav. that help in the development of the plant.

Theoretical Framework

The Organization for Agriculture and Food (FAO) for its acronym in English; of the United Nations, in collaboration with the Botanical Garden of Córdoba (Spain), as a contribution to the development of the "Ethnobotany 92" program, makes a compendium of plant species that, at other times or under other conditions, played a fundamental role in the agriculture and food of indigenous peoples and local communities. The marginalization that these species have reached has been, in many cases, the consequence of the deliberate suppression of self-sufficient ways of life that characterized traditional cultures. (León & Hernández Bermejo, 1992).

The human being has been fed different animals and plants throughout its history, many of them have ceased to be consumed product of a selective domestication, derived from an agriculture emanating from dominant cultures, considering social, political and economic aspects, leaving behind ecological aspects, increasing the vulnerability of habitats to invade with species of cosmopolitan growth that displace native species. Return to feed on the multiple plant species that were consumed in communities for many years, whose growth is not invasive, allows to increase the required nutritional variability and at the same time contribute to the diversification in food sources, conserving the habitats where they have grown organisms and have establishing a balance with their environment.

The wild pomegranate, is an exotic fruit native to the eastern slope of the Andes, specifically Peru, Ecuador and Colombia, belongs to the Solanaceae family and is known by this name in Colombia, Peru, Ecuador and Mexico; mountain tomato, wild tomato, monte cucumber and gallinazo panga in Bolivia; tomato chimango, tomateiro da serra in Brazil; "Tree tomato" in English speaking countries. At commercial level it has been known by different names in different regions, until around 1970 in New Zealand it was assigned the name "tamarillo", positioning itself as the generalized commercial designation for the tree tomato in the world market.

The soils where the tree tomato is grown in good conditions should be loose, as far as possible, sandy-loam or clay-loam, since in these there is a better growth and development of the root system; with very good drainage to avoid puddles. The pH values should be between 5.5 - 6.5 for an adequate development of the crop and for a better absorption of nutrients, a condition that is found where the leaf of deciduous trees accumulates. The cation exchange capacity (CIC) must be between 25 and 30 meq / 100 grams of soil. The content of organic matter should be in cold weather greater than 10% and in temperate climate greater than 5%. (Leon F., Viteri D., & Cevallos A., 2004)

Methodology

The academic body of Natural Resources in the Sierra Alta Hidalguense, of the Technological University of the Sierra Hidalguense, is engaged in different projects so presenting the work proposal is the first option, where the monitoring of the population of Cyphomandra betacea was selected (Cav.),

A species of Andean origin but that has existed for a long time in the Mountain Mesophilic Forest; this is demonstrated by the works on floristics of this environment carried out by (Luna Vega & Alcantara, floristic analysis of two areas with mesophilic bósque of Mountain, in the state of Hidalgo, Mexico, 2001) and (Luna Vega, Ponce Vargas, & Ruíz Jiménez , Floristry of the Mountain Mesophilic Forest of Monte Grande, Lolotla, Hidalgo, Mexico, 2006). The first step to know its distribution is to characterize Cyphomandra betacea (Cav) in its life cycle for identification and monitoring in the field.

For the monitoring, the coverage will be used, it is the variable most used to quantify the abundance of plant species, it relates the proportion of the surface sampled covered by the vertical projection of the vegetation, since the studied species does not present a homogeneous distribution and the The sampled lands have been modified for use as paddocks, so a probabilistic analysis would skew the population count, which is why the specimens were counted and, although it does not allow any inference about the surrounding population, the knowledge of the location of each plant for its completion of other studies is feasible.

Characterization of *Cyphomandra betacea (Cav)*

It is an arboreal shrub of 2.0 to 4.0 m in height, although it can reach more height, grayish bark, with an erect stem and few branches; Semi-woody or soft woody stems which makes it fragile, with thick, dense and minutely puberulent marrow, fine hairs of 0.1 mm long; It presents aromatic foliage, slightly stinking, leaves generally in pairs (Img.01), cardiform ovate between 15-30 cm long and 8-20 cm wide, stout petiole 4-8 cm long, densely hairy, alternating growth a of 1 / 3-1 / 2 the size of the other, but similarly, densely puberulent in the bundle (at least when young), the apex acuminate, the base deeply carded, the lobes generally superimposed, the nerve is marked and outstanding, less intense color.

Figure 1 Foliage of *Cyphomandra betacea (Cav)*
Source: Self Made

Cauliflower inflorescences, usually 1 cm above and next to a pair of leaves or in the dichotomies, are small flowers (Fig. 02) of white-rosy color, arranged in small, slightly fragrant terminal clusters with five petals and an equal number of petals yellow stamens, the anthers forming a cone, with dehiscence through apical pores.

ISSN-On line: 2414-8830

The inflorescences can be formed by more than five flowers each in caulinarian form, flowers between May and June. Pendulous fruits (Fig. 03), from 1 to 9 by infructescence, ovoid, 6 cm long, 3.5 cm in diameter, acute at both ends, with longitudinal marks, wax, glabrous, presents three colors (varieties) orange, orange -morado, purple.

Figure 2 Flower of *Cyphomandra betacea (Cavanilla)*
Source: Self Made

Figure 3 Immature fruit
Source: Self Made

Location map of *Cyphomandra betacea (Cav)*

Having the elements to be able to identify the species in the field, once obtained the authorization of the owners to access the land, we proceed to carry out a survey, the sampling was carried out in the community of Mazahuacán (Fig. 04) belonging to the municipality of Lolotla, State of Hidalgo, using a Garmin GPS with a margin of error of 4.0 m.

The plants whose fruits are present are georeferenced, because it is from them where the physical parameters are recorded to delimit the optimum conditions of production; helping us with Geographic Information Systems with the ArcMap 10.3 software, an image of the site where Cyphomandra betacea Cav. was found is located. (Img.05).

Figure 4 Mazahuacán, Municipality of Lolotla, Edo. from
Source: Self Made

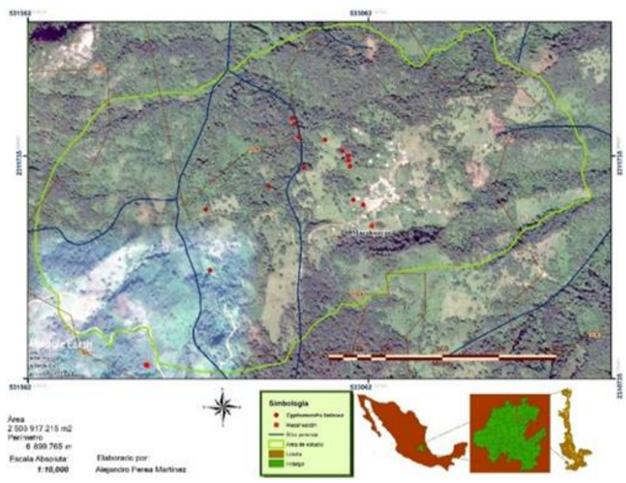


Figure 5 Distribution of C*yphomandra betacea* in the community of Mazahuacán
Source: Self Made

To monitor the development of the fruits found and the development of the plant, identification tags were made, in order to establish a continuous monitoring, especially of those specimens found in paddocks where deterioration is most likely due to the presence of cattle.

Once labeled and identified the location of the plants, we proceeded to look for the conditions of the plant, color of leaves, surrounding plants, arthropods or any other potential organism with which it could generate some kind of beneficial or harmful symbiosis.

The plants with better characteristics were found under the shade of trees, however there is no specific species of preference for that shade, in terms of herbaceous, some compete for space with the species studied, not identifying any particular; As for the animals, looking for associated arthropods, no one was found that harms the degree of plague, but the presence of grasshoppers, snails eating the leaf and vines, indicates that the plant needs to be cared for if cultivated; Several specimens were found inside the paddocks, and although the cows do not eat the shoots or the mature plant, if they represent a threat to occupy them as scrapers and because their stem is fragile because they do not have a woody body, they deteriorate or throw away the plant.

Its growth is associated with the limits of the paddocks, where the animals do not step and the shade is present, not being found in the open spaces where the grass that the animals consume prevents the growth of some other plant.

Regarding the specimens found under the shade and found in good condition, the plants already had inflorescences and some with fruits in different stages of maturation, which indicates that the harvest can be carried out at different times, giving opportunity to selling the product is fresh since the shelf life is unknown.

Physical Parameters

To record physical parameters related to the life cycle of Cyphomandra betacea (Cav), the characteristics of the region were first considered, data obtained from government official pages, specifically those of INEGI and CONABIO, serving as a starting point to establish the requirements of the plant, maintaining its characteristics (Contreras, 2011).

Conditions such as the high rainfall in Mazahuacán, the continuous presence of fog, as well as the slopes that allow an adequate drainage avoiding puddling that rot the plant, are conditions mentioned by (Revelo M., Pérez A., & Maila A., 2003) that helped in the search for the plants.

At least two specimens that were in a land enclosed by having discharges of sewage, have excellent characteristics, leaves of an intense green, with inflorescences and infrutescences, of low height and little ramification, which indicates that it has not been pruned of the apices, its presence under the shade of a *Quercus sp*. and the flow of water makes the temperature drop a couple of degrees with respect to the surroundings and that its good health is due to the large amount of nutrients provided by the sewage sludge.

Analysis and interpretation of results

By capturing the location of Cyphomandra betacea Cav. On a map occupying the Geographic Information Systems (GIS) inserted with a background image of Google Earth it was noted that the plants are located in the limits where the forest starts and the paddocks end, noting that in places where vegetation is very dense its existence is almost nil; In the places where the shade is scarce due to the lack of trees, the specimen studied is not present; during the second and third week of June a wave of heat appeared affecting the foliage of the plants found, possibly due to the increase in evapotranspiration due to the size of the leaf; the plants that were found prostrate, it was noted that they make a branch and the generation of a new axis of growth (Img 6a and 6b), ratifying the position that its reproduction by means of cuttings is feasible, only one plant has evidence of use, finds in the middle of a corn crop and neighbors report that the owner sells the fruit in the local market.

Figure 6a *Cyphomandra betacea* postrada con nuevos ejes de crecimiento
Source: Self Made

Figure 6 b *Cyphomandra betacea* prostrate with axes of growth, crushed by heat
Source: Self Made

The largest number of plants that were found in the different farms of Mazahuacán, are plants in development, which implies that the propagation is just beginning.

Contributions and Conclusions

Cyphomandra betacea Cav.

It presents serious problems due to the damage caused in its natural habitat, being a species that does not tolerate the direct exposure of sunlight, its fruit ripening is prolonged and presents flower even when mature fruits already exist, allowing multiple harvests. The wild pomegranate is harvested by hand, starting the pedicel in the abscission zone that forms 3.5-5 cm from the base of the fruit, its introduction in the community of Mazahuacán is as therapeutic because it has a high nutritional value, recommends continuity with the project in a second stage to define and identify pests and / or diseases that the species presents, a specific pollinator if there is one, an annual monitoring cycle to quantify the development progress of the seedlings found (FAO, 2011).

Acknowledgement

To the Technological University of the Sierra Hidalguense, to the members of the Academic Body of the Race of Natural Resources.

References

Contreras, J. G. (2011). Características fisicoquímicas y organolépticas de frutos de tomate de árbol (Solanum Betaceum Cav). *Ciencia y Agricultura*, 39-49.

Daniel Tejero Diez, L. L. (2010). *El Bosque Mesófilo de Montaña en México: Amenazas y Oportunidades para su Conservación y Manejo Sostenible* (Vol. 1). Ciudad de México, México: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad.

FAO. (Enero de 2011). *FAOSTAT*. Obtenido de FAOSTAT: http://www.fao.org/docrep/t0646e/T0646E0i.htm#Tree%20tomato%20(Cyphomandra%20betacea)

Garro, G. (2014). Aspectos biológicos, uso agrícola y medicinales del "tomate de palo" (Cyphomandra betacea). *Tecnología en marcha, 16*(4), 68-72.

León F., J., Viteri D., P., & Cevallos A., G. (2004). Manual de cultivo del tomate de árbol No. 61. *Programa de fruticultura y granja experimental*, 51-53.

León, J., & Hernández Bermejo, J. (1992). *Cultivos Marginados otra perspectiva de 1492.* Roma: Colección FAO: Producción y protección vegetal No. 26.

Luna Vega, I., & Alcantara, O. (2001). Análisis florístico de dos áreas con bósque mesófilo de Montaña, en el estado de Hidalgo, México. *Acta botánica Mexicana*, 54: 51-87.

Luna Vega, I., Ponce Vargas, A., & Ruíz Jiménez, C. (2006). Florística del Bosque Mesófilo de Montaña de Monte Grande, Lolotla, Hidalgo, México. *Revista Mexicana de Biodiversidad*, 77: 177-190.

Revelo M., J., Pérez A., E., & Maila A. , M. (2003). *El cultivo del tomate de árbol.* Quito-Ecuador: Instituto Nacional Autónomo de Investigaciones Agropecuarias.

Article **ECORFAN Journal- Republic of Nicaragua**
December 2018 Vol.4 No.7 19-31

Characterization of Municipal Solid Waste in Altamira, Tamaulipas

Caracterización de Residuos Sólidos Urbanos en el municipio de Altamira, Tamaulipas

MEDINA-ALVAREZ, Juana Elizabeth †*, GARZA-FLORES, Rodolfo, WONG-GALLEGOS, Juan Yared and PÉREZ-BRAVO, Sheila Genoveva

Universidad Politécnica de Altamira
Universidad del Noreste

ID 1st Author: *Juana Elizabeth, Medina-Alvarez* / **ORC ID**: 0000-0002-7081-6860, **Researcher ID Thomson**: M-9320-2018, **CVU CONACYT ID**: 404179

ID 1st Coauthor: *Rodolfo, Garza-Flores* / **ORC ID**: 0000-0002-7530-1102, **Researcher ID Thomson**: S-1199-2018

ID 2nd Coauthor: *Juan Yared, Wong-Gallegos* / **ORC ID**: 0000-0002-8204-3973, **Researcher ID Thomson**: N-4468-2018, **CVU CONACYT ID**: 658316

ID 3rd Coauthor: *Sheila Genoveva Pérez-Bravo* / **ORC ID**: 0000-0001-5333-3763, **Researcher ID Thomson**: I-5924-2018

Received September 30, 2018; Accepted December 30, 2018

Abstract

The municipal solid waste (MSW) is the waste generated in the houses by the daily consumption of the habitants; they constitute an environmental and social problem, and they are proportional to the demographic growth. Every day the demographic figures are growing, with this the rate of generation of MSW increases in spite of the efforts to the regulation in topic of MSW for the Mexican government. Therefore, it is necessary to find urgent solutions that avoid the lack of control caused by excessive and unmeasured generation of the MSW. A characterization of the MSW, first that stratifies the population, sampling is carried out in the households, a collection methodology is carried out, the separation is carried out from the generation, the results are obtained and finally the statistical treatment is elaborated, representative and significant. With the results obtained, municipalities will be helped to take decisions to carry out their responsibilities in the field of MSW, taking advantage of resources efficiently. With the characterization of the MSW, per capita generation and composition are obtained in ten categories: cardboard, other consumibles, food waste, garden waste, inert waste, metal, paper, plastics, special waste and glass.

Characterization, Municipal solid waste, Sustainable Development

Resumen

Los residuos sólidos urbanos (USW) son los desechos generados en los hogares por el consumo diario; constituyen un problema ambiental y social, son proporcionales al crecimiento demográfico. Las cifras demográficas van en crecimiento, con ello la tasa de generación de USW incrementa a pesar de los esfuerzos realizados por la regulación en materia de USW por parte del gobierno mexicano. Por ello es necesario encontrar soluciones urgentes que eviten el descontrol que provoca la generación excesiva y sin medida de los USW. Una caracterización de los USW, primeramente que estratifique la población, se realice el muestreo en los hogares, se lleve a cabo una metodología de recolección, se realice la separación desde la generación, se obtengan los resultados y finalmente se elabore el tratamiento estadístico de forma representativa y significativa. Con los resultados obtenidos se ayudará a los municipios a tomar decisiones para llevar a cabo sus responsabilidades en materia de USW, aprovechando los recursos eficientemente. Con la caracterización de los USW se obtiene la generación per cápita y la composición en diez categorías: cartón, consumibles diversos, desechos de comida, desechos de jardinería, desechos inertes, metal, papel, plásticos, residuos especiales y vidrio.

Caracterización, Residuos sólidos urbanos, Desarrollo Sustentable

Citation: MEDINA-ALVAREZ, Juana Elizabeth, GARZA-FLORES, Rodolfo, WONG-GALLEGOS, Juan Yared and PÉREZ-BRAVO, Sheila Genoveva. Characterization of Municipal Solid Waste in Altamira, Tamaulipas. ECORFAN Journal-Republic of Nicaragua. 2018, 4-7: 19-31.

* Correspondence to Author (email: juana.medina@upalt.edu.mx)
† Researcher contributing first author.

1. Introduction

Waste is also a social problem, a problem to the environment, whose environmental and economic management needs to find urgent solutions that avoid its negative environmental impact (Barradas, 2009). Throughout the national territory there are different consumption patterns, for this reason the waste varies in its composition and quantity, depending on the region, the season, the way of life and the economic income.

According to the State Program for the Prevention and Integral Management of Wastes in Tamaulipas (SEMARNAT, 2016), it divides the state into regions, the southern region that includes the municipalities of Tampico, Ciudad Madero, Altamira, González and Aldama, has a population of 846,922 inhabitants (INEGI, 2010) of which 29.58% of inhabitants belong to Altamira, as well as a daily generation of 788 tons / day in the southern region and a generation of 233 tons / day in the municipality of Altamira. In Altamira, there are still no studies on characterization and composition of Urban Solid Waste (USW).

In this PEPGIRT a projection of the municipal solid waste generation of 8% is estimated, for 2023. Altamira has a sweeping system during the seven days of the week in the main avenues of the city, for this it has an employee seven people. It also specifies that 91.7% of Altamira's population receives the collection service, while 90.98% of the waste generated is collected. Regarding the collection units, for 2016 Altamira had 25 collection units, each with a capacity of 7 tons, distributed in 42 routes during the seven days of the week. For the collection of municipal solid waste, Altamira has 328 containers of 240 liters and 20 containers with a capacity of 1.5 tons.

For the final disposal, Altamira has a private sanitary landfill with a reception capacity of 694 tons / day, where the final disposal of the USWs of the metropolitan area is made, together with the municipalities of Tampico and Ciudad Madero. It also has an open-air dump, not controlled by the municipality, but which is out of operation. Regarding the waste of special handling (RME), which are reported by the industries and establishments in the Annual Operation Certificate (COA), 49 COA's are reported that generate a monthly volume of 9197 ton / year.

Within the strategic planning of PEPGIRT, Objective 1, Strategy 3, Line of action 1.2, the separation and differentiated collection of the USWs will begin to be implemented at the source, in the short term in the municipality of Altamira. It is also proposed to promote the closure and sanitation of final disposal sites without operating, in the short term for the municipality of Altamira, as well as to reduce greenhouse gas emissions in sanitary landfills and to promote the use of methane gas (SEMARNAT, 2016).

1.1 Integrated management of municipal solid waste

Martínez (2015) identifies a comprehensive management system for USW such as generation, composition, management, collection, separation, use, recycling and final disposal. Liu, et al. (2016), seeks to achieve the maximum practical benefits of investments and ensure the minimum environmental impacts of waste streams based on collection and transport rates from variable sources, comparing four USW treatment systems, including collection and transport separately.

USW management is a complex task that requires simultaneous modeling of collection, transport, disposal and recycling (Liu, et al., 2016). There are also non-generalized stages, whether due to the socioeconomic level of the population or the characteristics of the place, these can be:

a. Selection, storage and sale of usable materials.
b. Combustion of waste for water heating or for food preparation.
c. Combustion of gardening waste.
d. Accumulation of edible organic waste in small containers.

For the countries of Latin America and the Caribbean, the conservation of the environment takes a back seat to the number of basic needs they must cover; For this reason, in most of these countries, government entities participate in the management of solid waste by carrying out the minimum required for the system and allocating very little financial resources for the sector. This has as a consequence that the processes of collection, treatment, use and final disposal of solid waste are carried out with inadequate technologies.

ISSN-On line: 2414-8830

The rates of waste generation per inhabitant in these countries continue to rise, reflecting the lack of awareness of citizens about how their consumption patterns influence the volume of waste generated. It requires willingness on the part of government agencies to educate their residents (Sáez y Urdaneta, 2014).

1.2 Impacts generated by excessive production of solid waste

Barradas (2009) identifies three aspects of the problem of USW, firstly identifies the health risk, which is the risk of contracting or transmitting diseases or injuries through contact with garbage, if not collected and disposed of properly; the second aspect is uncontrolled garbage dumps and dumps, since they produce negative impacts on the bodies of water in the environment, leached liquids can reach and contaminate superficial or underground sources of drinking water or agricultural irrigation, as well as bodies of water from interest for aquaculture and tourism; a third aspect is the deterioration and contamination of the environment that produce the large accumulations of garbage dispersed in the territory in an uncontrolled manner in such a way that the landscape is contaminated.

The lack of an adequate service of collection of the USW causes the accumulations without control of garbage that appear by cities, field, gutters of the roads and zones of recreation. Barradas (2009), also explains that the production, collection, transport and elimination of garbage should not be a problem in any country, because there are techniques that are adaptable and adaptable to any municipality, but the scarcity of economic resources in the large Most municipalities prevent adoption of the most appropriate solutions.

Regarding the recovery of recoverable materials, as are all those that can be recovered and from them obtain an extra value: cardboard, glass, metal, paper, battery; There is growing interest in certain groups to separate them from garbage, as this yields profits and undoubtedly generates economy among a small stratum of the population called pepenadores.

1.3 Problematic

Over time, the generation of USW is growing as the population grows, according to statistics from the International Residue Association (ISWA) (Modak, Wilson & Veils, 2015), each inhabitant of the planet generates approximately one kilogram of USW per day average. In areas such as the municipality of Altamira, where population growth has soared by an average of 7% per year in the last 15 years (INEGI, 2015) and, moreover, the economic growth of the area due to port activity contributes to the generation of USW, either domiciliary or of special management, are detonating so that the municipal collection services of the USW can not serve the population as a whole.

The integral management of the waste is the responsibility of the municipal government and the administration of these are of biannual periods which complicates the follow-up of programs for the improvement of the integral management of the residues, nevertheless, considering that the behavior in the growth of the municipal population has the same trend over the next few years, it can estimate the demand that will be required by the inhabitants of the municipality, as well as the characterization of the USW in the area. Currently the collection of USW is done with established routes not separating those waste that can be recycled or that can generate some economic value before reaching the final disposal.

Another problem is not knowing what type of waste and what generation rate there is in Altamira, in order to plan and program the operation of the integral management of the USW in the municipality.

For the government, it is extremely useful to know indicators that show the quality of the integral management of waste, which will help in the management of resources and in the implementation of programs that bring benefits to society.

The objective of this research is to propose a methodology to characterize and determine the generation and composition of the USW and thus evaluate the efficiency of the Integral Management of the USW in the municipalities based on sustainability indicators in the characterization of the USW.

ISSN-On line: 2414-8830

Through the compilation, analysis and synthesis of the literature corresponding to USW in the international, national, state and municipal spheres, as well as the methodologies that have been applied in the characterization of the USW, subsequently the characterization of the municipal USW and finally define a methodological strategy for the study of the situation in which the management of USW operates, with an adequate database. In this work we try to verify the hypothesis that the characterization is significant with the national statisticians.

Currently, there are several international norms and standards that try to implement integral management models of the USW, so that each time these models must be more sustainable by the demands of international standards, it is difficult to select a guide for the implementation of a model that ensures the sustainability of the integral management of urban waste. For this reason, it is necessary to carry out an investigation that considers all the aspects of the international, national, state and municipal norms and guides to carry out the adaptation to municipal solid waste.

This will benefit the entire value chain of the integral management of municipal solid waste, obtaining a useful tool to measure the sustainability of this activity. The companies and / or municipalities that are dedicated to provide services in any of these stages may know the level of quality in the service they provide and with this being able to plan the realization of their work and may even justify the expenses that are generated in the improvement of the service, the optimization of the resources they currently have, since they will carry out their activities in a sustainable manner.

With all the above benefits the population to have a quality service and thus improve the quality of life of the inhabitants of the municipality, more health, less proliferation of diseases and epidemics, will also be indirectly benefited and of course, the families of pepenadores that subsist from the recycling of materials to which they can be given a value before reaching final disposal.

2. Methodology

To carry out the characterization of the USW in the municipality of Altamira, a primary and secondary information search was carried out, as well as the regulations and sustainability guidelines. Subsequently it was agreed with the municipality of Altamira, the provision of USW volume data collected over a period of time.

2.1. Population and calculation of the sample

The population studied is the 235,000 inhabitants of the municipality of Altamira who inhabit 66,229 homes, which are the generators of USW and receive the collection service of USW through Public Services of the municipality. A stratified probabilistic sampling was carried out, where each stratum is determined by the income of each household, according to AMAI (2010), to determine how many households would be part of the sample for characterization using the formula when the population is known (Torres, et al., 2006), you have to:

$$n = \frac{k^2 * \mathrm{N} * \mathrm{p} * \mathrm{q}}{e^2(N-1) + k^2 * \mathrm{p} * \mathrm{q}} \quad (1)$$

where:
k = 1.65, value of the constant for the 90% confidence level
N= 66,229 Total number of homes in the municipality of Altamira, Tamaulipas
p = proportion of households receiving the USW collection service, 50% is assumed.
q= proportion of individuals who do not receive the USW collection service, 50% is assumed
e = sample error, for this case of 10%

With these data, the sample must be at least 76 homes. The volume generated by the 76 homes will be the sample that will be used for the generation and characterization of the USW. When referring to the sample size, Tchobanoglous, et. to the. (1994), explains that the samples taken from 90 kg do not vary significantly from those taken in samples of up to 770 kg, obtained from the same load of waste. However, in other investigations carried out by Jiménez (2002), Cotton and Pielke (1998) and Zeng, et. to the. (2005), it is mentioned that the samples taken for analysis can be between 90 and 180 kg.

For their part, Chung and Poon (2001) report that the ranges of sample sizes range from 20 to 30 kg, 90 kg, 100 to 200 kg to samples around five to seven tons of household waste per week. In Mexico, the Mexican standard NMX-AA-015-1985 proposes samples of 50 kg. In this research, the sample used for the quantification of components was 205,985 kg per week, less than the amount proposed in the Mexican standard NMX-AA-015-1985, but according to other research (Chung y Poon (2001); Gidarakos, et. al., (2006); Tchobanoglous, et. al., (1994); Zeng, et. al., (2005)).

2.2. Measuring instrument

A database was designed, where the information obtained from the samples was stored through the measurement instrument that was occupied. A data collection form presented in Annex A was used. The data was analyzed in a general way with the support of the statistical software Minitab 16, emphasizing the variables: total weight of the sample, number of inhabitants in each dwelling, income per household, frequency of receiving the service, type of recipient they use for the collection of the USW, second alternative to dispose of the USW. For the composition part of the USW, they were divided into ten types: 1) Food waste, 2) Garden waste, 3) Paper, 4) Cardboard, 5) Plastics, 6) Metal, 7) Glass, 8) Consumables various, 9) Inert waste and 10) Special waste.

2.3. Data collection technique

The sample was collected in the domicile of the selected dwellings, by economic strata according to the AMAI (2010), during 24 hours of collection of the USW, the USW was separated into the ten categories mentioned in the previous section, then proceeded to weigh with a precision scale each of them with the objective of obtaining the total weight of the sample and the composition percentage of the USW. The process was carried out in three steps, as explained in figure 1.

The list of staggered fractions is shown in Annex A and consists of 10 fractions in Level I, 32 fractions in Level II and 24 fractions in Level III. This nomenclature allowed an easy and transparent classification, facilitating at the same time the flexible grouping of waste fractions and the comparison between the individual areas.

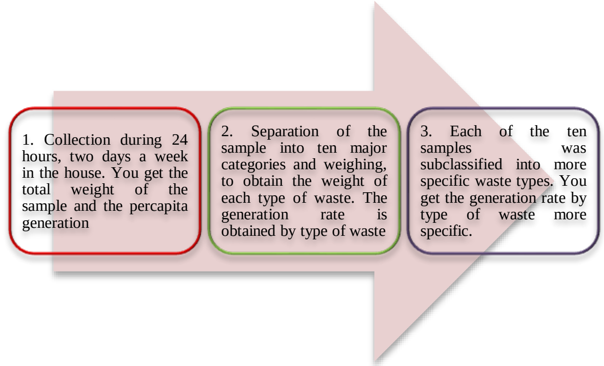


Figure 1 Proceso de recolección de datos
Source: Own design

To be precise in the classification instead of organic material, it was classified as: food waste and gardening waste; For food waste, consumable and non-consumable materials were included, such as vegetable waste and bone waste (vegetable waste could be consumed, while bones were not).

The paper was divided into advertising, books and pamphlets, magazines, newspapers, office paper, telephone directories and miscellaneous paper. Next, the paper was subdivided into envelopes, kraft paper, paper, receipts, stickers, tissue paper and wrapping paper.

The plastic waste was subdivided according to the type of resin (PET, PVC, perishable food packaging and cleaning products packaging) (Avella et al., 2001). Special waste was classified as batteries (individual batteries and specific batteries that are not from the device).

2.4 Methodology of the characterization of urban solid waste

In figure 2, the steps of the characterization methodology are presented.
of the source of generation, which is the result of this thesis. In this section the methodology is explained in detail. See figure 2.

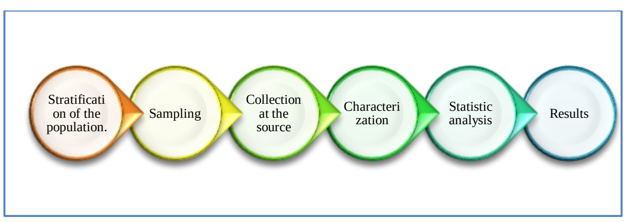


Figure 2 Characterization Methodology from the generation source
Source: Own design

ISSN-On line: 2414-8830

Population stratification

As a first step, the population is stratified according to the socioeconomic levels (SEL), provided by the AMAI, then the representative sample of each one of the SEL is calculated. The data used are the number of total homes in the municipality and the number of inhabitants of the municipality. Then the sample is calculated with statistical formula when the population is known. Once calculating the representative sample, the dwellings that will be sampled in the municipality are determined, trying to cover the study area, for the reliability of the study.

Sampling

Sampling is carried out two alternate days per week to obtain diversity of USW and the sample is more representative, alternates two days since in tests performed the same results are obtained by sampling the whole week in each of the selected homes. To carry out the sampling, materials such as: dark colored polyethylene bag, ten plastic bags to perform a previous separation, precision scale, markers, leagues are used. The safety equipment that is used for this purpose is: gown, safety shoes, lenses, mouth covers, latex gloves, tweezers, shovel.

The sample is first identified by recording in section I. Identification of the sample of the field sheet, with the address of the dwelling, the number of inhabitants, the monthly income, from the monthly income the socioeconomic level (SEL) of the dwelling, the date of sampling, the USW collection route number, in addition to data such as the frequency of collection in the home and the type of container used to collect the USW. The question is also asked: What do you do with the waste in case the truck does not pass? This will serve to evaluate how the inhabitants get rid of the USW.

In section II. Volumetric characteristics of the field sheet, the volumetric weight of the sample is calculated; this refers to the weight of the USW in a cubic meter; to calculate it, it is enough to divide the weight of the sample between the capacity of the sampling container, in this case the black polyethylene bag, which has a capacity of 0.115 m3, if there were two or more bags it is calculated by adding the weight of the bags and dividing between 0.115 times the number of bags used.

Finally, the obtained results are recorded and captured in a statistical software.

Once the sample has been collected; it is separated into ten types of USW, as noted in section III. Classification of by-products, once the sample is separated, the sub-classified products are weighed, the results obtained are recorded again and captured in a statistical software, the total sum of the weights of the ten types of waste must be equal to the weight Total sample.

Collection Methodology

In this stage the houses are provided with the equipment and material so that during two alternate days they collect the waste that is generated in the homes, in this stage a pre-classification is carried out according to the ten categories of the first level of the field technical data sheet. It is important to indicate how many inhabitants are in the house, since this will allow knowing the generation per capita.

Then identify the plastic bags with the ten different types of waste that are shown in the data sheet: 1) Food waste, 2) Garden waste, 3) Paper, 4) Cardboard, 5) Plastics, 6) Metal, 7) Glass, 8) Miscellaneous consumables, 9) Inert waste and 10) Special waste. The USW is separated from generation to facilitate weight. Once each different type of waste has been classified in Level I, each of these levels is separated into 34 subcategories of Level II and finally into 26 categories of solid waste.

Characterization

In this stage the types of waste are weighed starting from the 24 categories of Level III, later they are reunited with the 34 categories of Level II, and finally when gathering all the residues in the ten main categories of Level I. The weights are registered in the technical field sheets and this is how the percentage of composition of solid waste is obtained for each of the categories detailed in the field technical data sheet. It is important to be clear about the types of waste that go into each category in order to make the data reliable.

ISSN-On line: 2414-8830

December 2018 Vol.4 No.7 19-31

Statistic analysis

Once the data recorded in the field technical data sheets is obtained, a database with the information of all the samples taken is elaborated, to facilitate the analysis it can be done in a statistical software, this information allows to obtain results as; the generation per capita, the composition of the USW by municipality, the correlation between socioeconomic level (determined by the income of the household, according to AMAI) and the type of waste that is generated and the correlation between the different types of waste. It also allows the comparison between other studies, since most of them measure the first ten categories that are shown in Level I of the field data sheet. With these and other data provided by national databases such as INEGI, composite indicators can be constructed to show synthesized information on the integral management of solid waste in the area under study.

Results

The results obtained with the application of this methodology are:

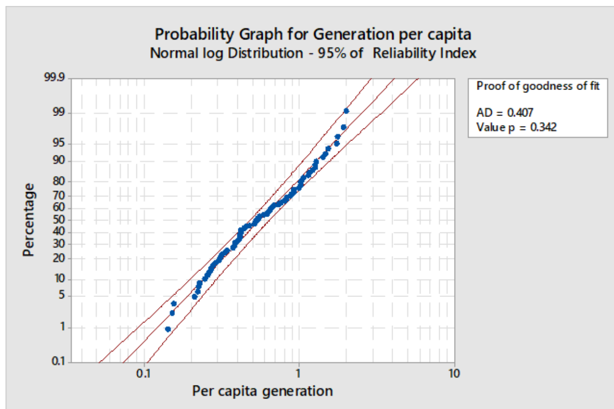
a. Percapita generation of USW
b. Projection of the generation volume
c. Percentage of generation of each type of USW, first in its ten categories of level I and later in the 35 different categories of level III, finally in the 24 categories of level III.

3. Results

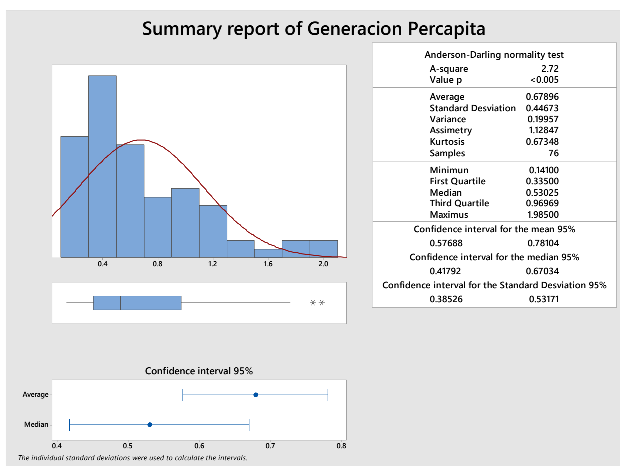
A statistical study was carried out to determine which probability distribution follows the behavior of the data based on the per capita generation of USW, at a level of significance of 95%. The hypotheses proposed for this analysis were the following:

– H_0: The data have behavior of a normal distribution.
– H_1: The data does not have behavior of a normal distribution.

The analysis of the data was done with the statistical software Minitab, in which 16 probability distributions were tested, it is determined that the data of the per capita generation of USW, behave under a normal log distribution as shown in graph 1 and in graph 2, given that the p-value is 0.342, which is why the hypothesis H0 is accepted: the data have a behavior of a normal distribution, with a mean of 0.67896 kg / per capita, and a standard deviation of 0.44673. That is, the logarithmic transformation was applied, since "the logarithmic transformation is in most cases advantageous for the analysis of environmental data, which are characterized by the existence of atypical data and the more asymmetric data distribution" (Reimann, et. al., 2008).



Graphic 1 Test of normality of the samples
Source: Own elaboration from samples



Graphic 2 Summary report of the normality test for the generation per capita of the USW
Source: Own elaboration from samples

Student t test statistical means

To validate the accuracy of the analysis, the samples were analyzed by means of an inferential statistical hypothesis test using the one-half test with the Student's t-statistic.

ISSN-On line: 2414-8830

December 2018 Vol.4 No.7 19-31

This was used to determine that despite the fact that there is a minimum per capita increase from 2014 to 2017, the means of the samples are statistically equal

.

The hypotheses proposed are:

Null hypothesis: The average of the daily per capita generation of USW for the samples analyzed is equal to the average generation per capita in Altamira, 0.6347 kg / per capita (INEGI, 2014). That is to say:

H_0: $\mu = \mu_0$

Alternative hypothesis: The average of the daily per capita generation of USW for the samples analyzed is different to the average generation per capita in Altamira, that is:

H_1: $\mu \neq \mu_0$

donde:

μ = The average of the daily per capita generation of USW for the observed samples. Which is 0.67896 kg / per capita.

μ_0 = The average of the daily per capita generation of USW during 2014 for the municipality of Altamira; 0.6347 kg / per capita. At 95% confidence level, this percentage being the most commonly performed in hypothesis tests of inferential statistics.

The test was performed with Minitab and the results presented in figure 4 were obtained, where it can be seen that the p value is 0.39, which is greater than 0.05, so that the H0 is accepted: the average of the The per capita generation of USW per day for the analyzed samples (0.6347 kg / per capita) is equal to the average generation per capita in Altamira, 0.6347 kg / per capita (INEGI, 2014), and its 95% confidence interval is 0.5769 to 0.7810 kg / per capita.

T of a sample: percapita generation

Test of $\mu = 0.6347$ vs. $\neq 0.6347$

Variable	N	Average	Standard deviation	Standard error of the mean	IC de 95%	I	P
Percapita generation	76	0.679		0.0512	(0.5769, 0.7810)	0.86	0.39

Figure 3 Summary of the means test with the Student's t-statistic
Source: Own elaboration from sampling

Socioeconomic classification of housing

76 dwellings were sampled, of which the proportion of each of the SELs is shown in graph 3, where it can be seen that the sample is 17% Level E, 34% Level D, 30% Level D +, 16% Level C and 3% Level C +, with this we can assure that the sample is representative since there are SEL of all which allows the confidence of the work done.

Comparison of results with world statistics according to the International Solid Waste Association

Modak, Wilson, & Velis (2015), propose in the report presented to the ISWA in 2016, the linear equation y = 109.67 ln (x) - 651.45, with a R2 = 0.72, where; y = annual generation per capita of USW (kg / day) and x = Gross Domestic Product per capita in USD.

Table 1 shows the values of the application of the equation proposed in the ISWA report, which allows us to conclude that occupying this equation Tamaulipas is below the National indicator of generation per capita of USW.
With the application of the methodology described for the characterization of the USW, the results summarized in Table 2 were obtained.

Year	National		State	
	GDP per capita (USD)	Generation per capita in kg / day *	GDP per capita (USD)	Generation per capita in kg / day *
2010	9,421.68	0.93742	9,421.68	0.96470
2015	7,148.64	0.85715	7,148.64	0.88174

Table 1 Calculation of the USW generation per capita
*Source: Own elaboration based on INEGI 2010, 2015. * The generation per capita was calculated with the linear equation y = 109.67 ln (x) - 651.45 (ISWA, 2016)*

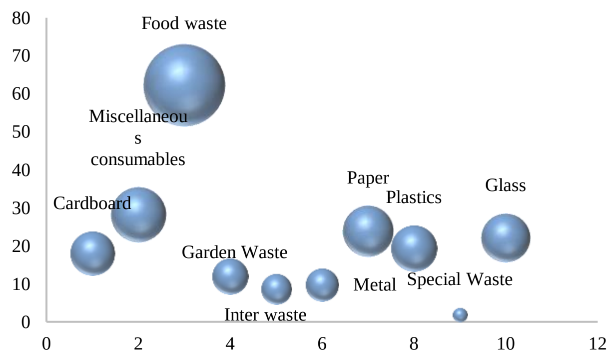
Type of waste	Socioeconomic level					Grand Total	%
	C	C+	D	D+	E		
Paperboard	2.427	1.32	4.616	4.255	5.376	17.994	8.74%
Miscellaneous consumables	2.661	1.35	5.647	9.317	9.231	28.206	13.69 %
Disposal of food	8.185	2.9	27.909	16.543	6.73	62.267	30.23 %
Garden waste	3.718	0	4.02	3.558	0.695	11.991	5.82%
Inert waste	0.602	0	3.198	3.714	1.092	8.606	4.18%
Metal	1.638	0	3.675	3.706	0.754	9.773	4.74%
Paper	4.933	0.41	6.987	8.764	2.748	23.842	11.57 %
Plastics	3.096	1.546	4.961	5.306	4.464	19.373	9.41%
Special waste	0.8	0	0.06	0	1.01	1.87	0.91%
Glass	1.054	0	7.645	7.869	5.495	22.063	10.71 %
Grand Total	**29.114**	**7.526**	**68.718**	**63.032**	**37.595**	**205.985**	**100%**

Table 2 Type of waste generated by SEL in the municipality of Altamira
Source: Own elaboration from samples

Article **ECORFAN Journal- Republic of Nicaragua**
December 2018 Vol.4 No.7 19-31

To better understand the results, figure 3 shows that food waste is the type of waste that most generates the population of Altamira, followed by paper and glass with 11.57% and 10.71%.

Regarding special waste, the percentage of composition is very low, because this type of waste usually have another type of handling, that is, they are disposed to their final destination through the old iron carts or are left lying in a landfill not controlled. Another of the recoverable materials is metal, with 4.74%, since it is considered a recoverable material in the USW it does not represent much percentage, however in the special waste that is generated from the construction it could be more representative.



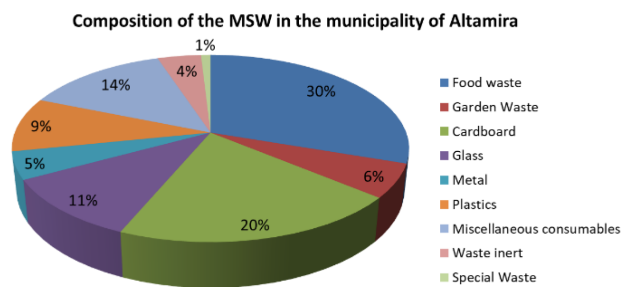
Graphic 3 Composition of the USW in the municipality of Altamira, Tamaulipas
Fuente: Elaboración a partir de muestras (2017)

Determination of the USW generation rate

The USW generation rate was determined in the municipality of Altamira, the results are shown in table 3, where they also complement the information presented by Edjabou (2014) by complementing their work and making comparisons between national and global data; as well as the composition of the USW generation, which can be seen in graph 4, having 30.2% of the total waste generated as food waste, in all countries where a USW characterization study has been carried out. , the percentage of food waste is the highest, followed by paper and cardboard, in this case in Altamira it occupies the second position with 20.3%, as in the other countries studied. Another finding is that in Altamira 10.7% of the total USW glass is generated, a very high figure as in the United Kingdom, however it has a low percentage in plastics occupying the 12th place among the countries studied.

Country	Food waste	Garden waste	Paper and paperboard	Glass	Metal	Plastics	Other consumable waste	Inert waste	Special waste	Others	Total
Mexico [a]	30.2	5.8	20.3	10.7	4.7	9.4	13.7	4.2	0.9		100
Denmark [b]	42.2	3.5	15.8	2.1	2.3	12.6	17.6	3.3	0.7	–	100
Denmark [c]	41.0	4.1	23.2	2.9	3.3	9.2	12.2	3.5	0.7	–	100
Spain [d]	56.2	1.8	19.0	3.3	3.0	10.7	4.9	0.7	0.1		100
Finland [e]	23.9	–	15.3	2.5	3.8	21.4	19.9	10.4	1.7	–	100
Italy [f]	30.1	3.9	23.2	5.7	3.3	10.8	4.5	1.3	8.7	9.4	100
Italy [g]	12.6	–	39.2	5.9	2.4	27.6	14.2				100
Poland [h]	23.7		14.1	9.2	2.1	10.8	10.6	4.5	1.0	24.1	100
Sweden [i]	33.0	9.4	24.0	2.4	2.2	11.7	9.6	7.0	0.6	–	100
United kingdom [j]	32.8	–	21.5	10.6	4.8	6.9	9.3	12.5	1.5	–	100
United Kingdom [k]	20.2	–	33.2	9.3	7.3	10.2	12.0	1.8		6.8	100
Turkey [l]	67.0	-	10.1	2.5	1.3	5.6	9.7	3.9	–	–	100
Korea [m]	12.0	–	33.0	–	–	17.0	32.0	6.0	–	–	100
Canada [n]	18.8	5.6	32.3	3.1	3.4	13.1	14.0	2.9	5.9		100
Malaysia [o]	44.8		16.0	3.0	3.3	15.0	9.5	8.4	–	–	100
China [p]	61.2	1.8	9.6	2.1	1.1	9.8	4.5	6.2	1.2	2.5	100

Table 3 Percentage of composition of the USW in different countries
Source: a Current study Altamira, Tamaulipas, Mexico, Adaptation of bEdjabou (2014), cRiber et al., 2009. dMontejo et al., 2011.e Horttanainen et al., 2013.f Arena et al., 2003.g AMSA , 2008. h Boer et al., 2010. i Petersen, 2005. j Burnley, 2007. k Burnley et al., 2007. l Banar et al., 2009. m Choi et al., 2008. n Sharma and McBean, 2007. o Moh and Abd Manaf, 2014. p B. Gu et al, 2016



Graphic 4 Percentage of composition of the USW in the municipality of Altamira, Tamaulipas
Source: Elaboration from samples (2017)

Variance analysis

The analysis of the variance allowed to contrast the null hypothesis that the means of K populations (K> 2) are equal, where the populations refer to the SELs, in front of the alternative hypothesis that at least one of the populations differs from the others in terms of their expected value. This contrast is fundamental in the analysis of experimental results of this thesis, in which it is interesting to compare the results of the socioeconomic levels with respect to the variable type of waste.

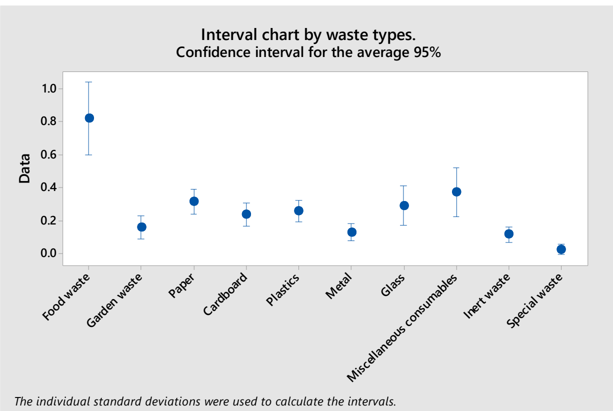
To this end, the following hypotheses were established:

μ_1 = The average of the USW generation for the observed samples is the same in the SELs

μ_0 = The average of the USW generation for the observed samples has at least one variation with respect to the SEL.

ISSN-On line: 2414-8830

At 95% confidence level, this percentage being the most commonly performed in tests of inferential statistics hypotheses. Graph 5 shows the confidence intervals for the average weight of the different types of waste, where food waste stands out with an average of 0.819 kg / day, well above the average of the rest of the types of waste. In second position are the various consumables with the average of 0.317 kg / day. With the lowest averages are inert waste and special waste 0.113 kg / day and 0.024 kg / day, respectively.



Graphic 5 Confidence intervals for the types of USW generated in the municipality of Altamira
Source: Own elaboration from samples. Minitab

In Figure 4, the Analysis of Variance for two factors is shown, with which it can be concluded that the SEL does not influence the type of waste generated in them, since it has a p-value of 0.777, greater than 0.05 and very close to 1. So statistically it is not a representative factor. On the other hand, the type of waste individually if it influences the average generation of USW, since in this ANOVA has a p-value practically null means that there is variation, between the socioeconomic levels with respect to the USW, being the residues with more variation food waste and special waste.

In the combination of SEL and type of residual does not influence, therefore it can be concluded that the null hypothesis is accepted, because it presents the p-value less than 0.05.

Variance analysis

Source :	GL	SC Adjust.	MC Adjust.	Value F	Value p
Model	49	43.503	0.88782	4.190	0.000
Lineal	13	19.352	1.48862	7.030	0.000
SEL	4	0.375	0.09382	0.440	0.777
Waste type	9	18.977	2.10853	9.960	0.000
Interactions of 2 terms	36	10.221	0.28392	1.340	0.090
SEL * TYPE OF RESIDUE	36	10.221	0.28392	1.340	0.090
Error	710	150.329	0.21173		
Total	759	193.832			

Model summary

S	R-square.	R-square. (tight)	R-square. (pred)
0.460142	0.2244	0.1709	0.1079

Coefficients

Finished	Coef	EE of the coef.	Value T	Value p
Constant	0.2893	0.0251	11.54	0

Figure 4 Summary of the Analysis of the Variance for two factors (SEL and Type of RSE)
Source: Own elaboration from samples.Minitab 2017

4. Conclusions

The methodological proposal of characterization of USW from the source presented in this research work, if it is technically feasible, since it has been adapted and modified from more than 16 works carried out in different countries, in which, as in Mexico, the standardization for the characterization of the USW, lacks updates. The modifications have allowed an adaptation to a methodology that allows to save costs and also can be easy to perform.

The results obtained are significantly similar to those reported in government instances, since they were statistically tested according to the characteristics of the study area, showing that the methodology is effective and valid.

This methodology of characterization of the USW from the source of generation, allows to evaluate the efficiency of the GIUSW, in the municipalities from the sustainability indicators in the characterization of the USW. The characterization of the USW is very important in any municipality, a good characterization of the waste allows, plan, act and decide on the resources that are destined to the programs of integral management of the waste, including allows to distribute the budget better.

It will also allow to know what are the projections of the generation by type of waste in a certain period of time. According to the results obtained in the application of the characterization methodology of the USW, municipalities of the State of Tamaulipas, can resume the work done in this doctoral thesis to have two important data, generation per capita and generation rates of ten different types of USW and thus promote the rationalization and efficient use of technologies by taking advantage of organic waste that represents, as in most countries, the largest percentage of USW generation.

In the case of the Municipality of Altamira, where the demographic growth trend is at an accelerated rate of seven percent per year in the last ten years, so it is expected that in 2030 there will be a population of almost one million inhabitants in the Tampico-Madero and Altamira Conurbation Zone, in which Altamira will have more than 316,000 inhabitants. This being the case and according to the results presented in this paper in which it is concluded that the per capita generation rate of USW is 232 kg / year, by the year 2030 more than 200,000 kilograms of USW will be generated per day, which it is alarming, since the capacity of the sanitary landfill that gives the service to the population reaches its limit.

On the other hand, in a positive context, in which the population has been maturing regarding issues of conscious consumption would be expected a generation of 180,000 kilograms per day of USW as a minimum and in the negative end, 247,000 kilograms per day maximum.

There is evidence that in the colonies and central streets the collection service of the USW is continuous, while the colonies in the periphery or far from the center of the city receive the service in an irregular manner. It is considered that, the method followed, showed acceptable prediction capacity, according to the objective pursued and the results obtained, given the tests performed and comparing the results with international and national statistics.

5. References

AMAI. 2010. Asociación Mexicana de Agencias de Investigación de Mercado y Opinión Pública. Datos, diagnósticos y tendencias, Abril-Junio 2011, Año 2011, p.p. 8-12.

AMSA, 2008. 2, Dichiarazione Ambientale Termovalorizzatore Silla.

ARENA, U., Mastellone, M., Perugini, F., 2003. The environmental performance of alternative solid waste management options: a life cycle assessment study. Chem. Eng. J. 96, 207–222.

AVELLA, M., Bonadies, E., Martuscelli, E., Rimedio, R., 2001. European current standardization for plastic packaging recoverable through composting and biodegradation. Polym. Test.

BANAR, M., Cokaygil, Z., Ozkan, A., 2009. Life cycle assessment of solid waste management options for Eskisehir, Turkey. Waste Manage. 29, 54–62.

BARRADAS REBOLLEDO, A. (2009). Gestión integral de residuos sólidos municipales: estado del arte.

BOER, E..DEN., Jedrczak, A., Kowalski, Z., Kulczycka, J., Szpadt, R., 2010. A review of municipal solid waste composition and quantities in Poland. Waste Manage. 30, 369–377.

BURNLEY, S.J., Ellis, J.C., Flowerdew, R., Poll, a.J., Prosser, H., 2007. Assessing the composition of municipal solid waste in Wales. Resour. Conserv. Recycl. 49, 264–283.

CHOI, K.-I., LEE, S.-H., LEE, D.-H., OSAKO, M., 2008. Fundamental characteristics of input waste of small MSW incinerators in Korea. Waste Manage. 28, 2293– 2300.

CHUNG, S. S., & POON, C. S. (2001). A comparison of waste-reduction practices and new environmental paradigm of rural and urban Chinese citizens. Journal of Environmental Management, 62(1), 3-19.

COTTON, W. R., & PIELKE, R. A. (1998). Human impacts on weather and climate. Meteorologie, 9(22), 83-84.

EDJABOU, M.E., et al. Municipal solid waste composition: Sampling methodology, statistical analyses, and case study evaluation. Waste Management (2014), http://dx.doi.org/10.1016/j.wasman.2014.11.009

GIDARAKOS, E., HAVAS, G., & NTZAMILIS, P. (2006). Municipal solid waste composition determination supporting the integrated solid waste management system in the island of Crete. Waste management, 26(6), 668-679.

GU, B., ET AL. 2016. Characterization, quantification and management of China's municipal solid waste in spatiotemporal distributions: A review. Waste Management (2016), http://dx.doi.org/10.1016/j.wasman.2016.11.039

HORTTANAINEN, M., TEIRASVUO, N., KAPUSTINA, V., HUPPONEN, M., LUORANEN, M., 2013. The composition, heating value and renewable share of the energy content of mixed municipal solid waste in Finland. Waste Manage. 33, 2680–2686.

INEGI. (2015). Dirección General de Estadísticas Sociodemográficas. Encuesta Intercensal 2015. Consultada en: www.inegi.org.mx (2 de febrero de 2016).

INEGI. (2010). Censo Nacional de Población y Vivienda 2010. Consultado en http://www.beta.inegi.org.mx/temas/estructura/ (2 de febrero de 2016).

INEGI. (2014). Sistema de Cuentas Nacionales de México. México. 2014. Disponible en: http://dgcnesyp.inegi.org.mx/cgi-win/bdieintsi.exe/Consultar. Fecha de consulta: julio de 2017.

ISWA. (2016). INTERNATIONAL SOLID WASTE ASOCIATION. Annual Report. Young Professional Report.

JIMÉNEZ, CISNEROS B. E. 2002 La contaminación ambiental en México: causas, efectos y tecnología apropiada. Colegio de Ingenieros Ambientales de México, A.C., Instituto de Ingeniería, UNAM, Limusa Noriega Editores, Federación Mexicana de Ingeniería Sanitaria y Ciencias Ambientales, A.C., México. 911p

LIU, G., et al., An emergy-LCA analysis of municipal solid waste management. Resour Conserv Recy (2016), http://dx.doi.org/10.1016/j.resconrec.2016.12.003

SÁEZ, ALEJANDRINA; URDANETA G., JOHENI A.; (2014). Manejo de residuos sólidos en América Latina y el Caribe. Omnia, Septiembre-Diciembre, 121-135.

MARTÍNEZ, N. M. J. (2015). La gestión integral de residuos sólidos urbanos en México: entre la intención y la realidad. Letras Verdes. Revista Latinoamericana de Estudios Socioambientales, (17), 29-56

MODAK, P., WILSON, D. C., & VELIS, C. (2015). Waste Management: Global Status. Global Waste Management Outlook. https://doi.org/10.1177/0734242X15616055

MOH, Y.C., ABD MANAF, L., 2014. Overview of household solid waste recycling policy status and challenges in Malaysia. Resour. Conserv. Recycl. 82, 50–61.

MONTEJO, C., COSTA, C., RAMOS, P., MÁRQUEZ, M.D.C., 2011. Analysis and comparison of municipal solid waste and reject fraction as fuels for incineration plants. Appl. Therm. Eng. 31, 2135–2140

PETERSEN, C.M., 2005. Quality control of waste to incineration – waste composition analysis in Lidkoping, Sweden. Waste Manage. Res. 23, 527–533.

REIMANN, C., FILZMOSER, P., GARRETT, R.G., DUTTER, R., 2008. Statistical Data Analysis Explained, Statistical Data Analysis Explained: Applied Environmental Statistics With R. John Wiley & Sons Ltd, Chichester, UK.

RIBER, C., PETERSEN, C., CHRISTESELN, T.H., 2009. Chemical composition of material fractions in Danish household waste. Waste Manage. 29, 1251–1257.

SEMARNAT. (2016).Programa Estatal para la Prevención y Gestión Integral de los Residuos en Tamaulipas (PEPGIRT). Consultado en: http://www.semarnat.gob.mx/sites/default/files/documentos/gestionresiduos/pepgir_tamaulipas.pdf

SHARMA, M., MCBEAN, E., 2007. A methodology for solid waste characterization based on diminishing marginal returns. Waste Manage. 27, 337–344

TCHOBANOGLOUS, G.; THEISEN, H.; VIGIL, S. (1994); Gestión Integral de Residuos Sólidos, 1º ed. Madrid, España, McGraw-Hill, 1107p.

TORRES, M., PAZ, K., & SALAZAR, F. (2006). Tamaño de una muestra para una investigación de mercado. Universidad Rafael Landívar: Boletín electrónico [en línea].[consultado 6.04. 2015] Disponible en: http://www. tec. url. edu. gt/boletin/URL_02_BAS02. pdf.

ZENG, Y.; TRAUTH, K.M.; PEYTON, R.L.; BANERJI, S.K. (2005); Characterization of solid waste disposed at Columbia Sanitary Landfill in Missouri , Waste Management & Research: 23(1), 62-71.

Article **ECORFAN Journal- Republic of Nicaragua**
December 2018 Vol.4 No.7 32-37

Analysis for the construction of low cost housing with recycled plastic bricks with no negative environmental impact proposed for Tijuana, B.C

Análisis para la construcción de vivienda de bajos ingresos con ladrillos de plástico reciclado sin impacto ambiental negativo propuesta para Tijuana, B.C

VALENZUELA-CRUZ, Nataly Berenice†*, DELGADO-RENDON, Rene and CAMACHO-IXTA, Ixchel Astrid

Universidad Autónoma de Baja California

ID 1st Author: *Nataly Berenice, Valenzuela-Cruz* / **ORC ID**: 0000-0002-0368-3789, **Researcher ID Thomson**: G-3161-2018, **CVU CONACYT ID**: 904681

ID 1st Coauthor: *Rene, Delgado-Rendon* / **ORC ID**: 0000-0002-5504-3513, **Researcher ID Thomson**: G-3111-2018, **CVU CONACYT ID**: 217938

ID 2nd Coauthor: *Ixchel Astrid, Camacho-Ixta* / **ORC ID**: 0000-0002-2985-6705, **Researcher ID Thomson**: G-3112-2018, **CVU CONACYT ID**: 893810

Received September 30, 2018; Accepted November 30, 2018

Abstract

In the city of Tijuana, there is inefficient planning and settlements, due to strong migratory currents coming from the interior region of the country (Corona, 2018). Citizens buy social interest houses and acquire mortgages of up to 30 years or carry out self-construction without a proper planning. In Colombia, the possibility of building with recycled plastic bricks is possible. Being the plastic one of the main polluters in the world, the creator and director of the construction system project Brickarp, Fernando Llanos, explains that the degradation time of this material is an advantage for this brick, composed of polypropylene, polyethylene and plastic. The construction with recycled plastic, is an ecological housing construction method with a lifetime up of 500 years according to Fernando Llanos and being a material rescued from landfills and oceans that also has no negative environmental impact in its fabrication. This document analyzes the viability of the use of this alternative construction system for the construction of inexpensive and accessible housing in Tijuana, considering the environmental factors and the needs of the population, and the analysis of the potential use of the PET material that is recycled in the region.

Plastic Recycling, Ecological, Low Cost

Resumen

En la ciudad de Tijuana, hay mala planificación urbana y asentamientos acelerados de vivienda debido a las fuertes corrientes migratorias provenientes del interior del país (Corona, 2018). Los ciudadanos compran casas de interés social y adquieren una deuda de hasta 30 años o realizan la auto-construcción sin planificación previa. En Colombia, la posibilidad de construir con ladrillos provenientes del reciclaje del plástico es posible. Siendo el plástico uno de los principales contaminantes en el mundo, el creador y director del proyecto del sistema constructivo brickarp, Fernando Llanos, explica que el tiempo de degradación de este material es una ventaja para este ladrillo, compuesto por polipropileno, polietileno y plástico. La construcción con plástico reciclado, es una vivienda ecológica y con un tiempo de vida de hasta 500 años según Fernando Llanos y siendo un material rescatado de vertederos y mares que además no tiene impacto ambiental negativo en su elaboración. En este trabajo se analiza la viabilidad de la utilización de este sistema constructivo alternativo para la construcción de viviendas económicas y accesibles en Tijuana, considerando los factores ambientales y necesidades del habitante, y el análisis del potencial de uso de material PET que se recicla en la región.

Reciclaje De Plástico, Ecológico, Bajo Costo

Citation: VALENZUELA-CRUZ, Nataly Berenice, DELGADO-RENDON, Rene and CAMACHO-IXTA, Ixchel Astrid. Analysis for the construction of low cost housing with recycled plastic bricks with no negative environmental impact proposed for Tijuana, B.C. ECORFAN Journal-Republic of Nicaragua. 2018, 4-7: 32-37.

* Correspondence to Author (email: nataly.valenzuela@uabc.edu.mx)
† Researcher contributing first author.

Article ECORFAN Journal- Republic of Nicaragua
December 2018 Vol.4 No.7 32-37

Introduction

The construction materials are obtained from natural resources, which are exploited and never return to their natural state. The price of these materials continues to rise and this will not stop, that is why despite the increase in global demand for plastic (El Sol de Tijuana, 2018), it is proposed to use this material for the construction sector.

Developing

In Tijuana, B.C. we have seen the accelerated increase of poorly planned settlements due to the migration of people seeking to cross to the border and in their failed attempt they decide to reside in this city. As the population grows, with this the needs and demands of the city grow, the city council of Tijuana has not been able to effectively control the garbage collection that ends at the beaches of Tijuana, Rosarito and Imperial Beach where the call to the International Boundary and Water Commission for the high levels of pollution that these beaches present (Martínez, G. 2018). In the streets of any urban area the contamination by plastic trash has caused a hygiene problem for the inhabitants and in the rainy season the sewage lines do not fulfill their function since they are full of garbage and would make impossible the free automobile traffic.

Looking for a solution to reduce the exploitation of natural resources for the construction industry that only degrades ecosystems, a project was found that proposes recycled plastic as the raw material to achieve the obtaining of plastic bricks that can be recycled again and again. The brick "brickarp" patented by Fernando Llanos, founder of the FICIDET project and company, and the architect Oscar Andres Mendez, co-founder of the company Concenptos Plásticos, managed to obtain a brick with zero environmental impact and uses plastic bottles, bags and other elements facts based on this material.

Value added

The preparation of this material has no environmental impact, avoiding the emission of CO2 (Casa de Plastico, s.f.), does not use mortars for the adhesion of the blocks and beams since they are assembled and drilled with screws and fastened with metal plates.

It does not require specialized labor and a house can be built in 5 days with the help of 4 people. A house with this system recycles 6000 plastic bottles per 40 m^2 of construction with two rooms, a living room, a dining room, a bathroom and a kitchen. This construction system is 30% cheaper than traditional systems in rural areas, around $ 6,800 USD (Valencia, 2016).

The raw material is cheap compared to the price increase of 9% to 12% in the cement that was presented in Mexico this year, which is affecting the public and private construction sector (Expansión, 2018).

Characteristic

Brick and recycled plastic beams contain polyolefins of high rigidity, crystallinity, high melting point and excellent chemical resistance (Ficidet, s.f.). Additives are added to make them resistant to fire (Ecoinventos, 2017), in addition that the structure of the plastic makes it naturally resistant and is accredited by Colombian regulations.

Problem and solution

There is a high level of environmental pollution caused by the consumption of single-use plastic packaging, the emission of CO_2 when extracting traditional construction materials and the erosion of natural ecosystems. The production of this recycled plastic brick could be the solution for a city (Tijuana) that does not know what to do with 2 tons of garbage that is collected every day and that its only function until now is to be a pollutant that will exist for more of 3000 years (Ficidet, sf). Low-income people could acquire these recycled plastic construction materials that are efficient and affordable for decent housing, in addition there would be a reduction in the demand for materials from sources of natural resources.

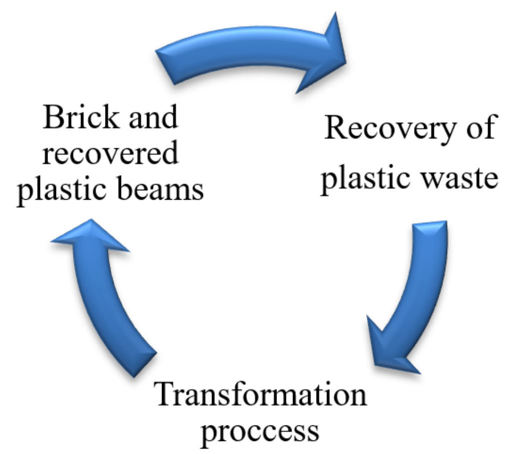
Methodology

An analysis was carried out with the Ener-habit program to evaluate the behavior of the walls made of plastic bricks according to the average temperature of the hot month and cold month of Tijuana with the components of the recovered plastic brick compared with other traditional systems of construction as a house of wood and another of concrete.

ISSN-On line: 2414-8830

It should be noted that this program shows results in conditions without air conditioning implementation. As shown in graph 1, the cycle begins with the recovery of plastic waste by means of collection in clean-up campaigns, as is the case in Mexico City; that began to sensitize the citizens by incentivizing them by means of electric money for cultural and social use each time they recycle PET bottles in machines destined for their collection. Subsequently, a transformation process is carried out.

With the use of crushing machines, a particularized material (polyethylene and polypropylene) is obtained from the plastic collected for an extruder to create it and finally, the different elements necessary for the construction are manufactured, such as beams and bricks. The plastic can be transformed into different elements according to the need. The same material can be reused to have other forms of use each time it is recycled (graph 1).



Graphic 1 *Cycle of recycled plastic*
Own elaboration

Properties and characteristics of materials

The Ener-Habit program asks to add the materials that make up each constructive system by layers whether it is a wall or a ceiling. In the constructive system of recycled plastic brick as the first material, it is proposed: a layer of polyethylene and another layer of polypropylene (table 1) with a thickness of 0.15 m, these components being plastic by nature. (Ficidet, s.f.).

Registered materials					
#	Material	Thermal conductivity (W / mK)	Density (kg / m3)	Specific heat (J / kgK)	Source
1	Polyethylene	0.465	970	19000	Goodfellow.com
2	Polypropylene	0.22	930	1800	

Table 1 Registration of materials
Source: Goodfellow.com

In the same program the materials (table 2) of the traditional housing construction systems in Tijuana were selected, it is common to see houses made of wood and those of social interest made with concrete.

In the system of recovered plastic brick, the material 1 and 2 (polyethylene and polypropylene), have a better performance and thermal insulation compared to concrete constructions.

Construction systems			
	Brick Recovered plastic S.C.1	Wood S.C.2	Concrete S.C.3
Absorption	0.2	0.2	0.2
Material 1 [W / m2k]	0.465 Polyethylene	Triplay Denso 0.15	Mortar High Density 0.88
Thickness 1 [cm]	0.075	0.025	0.025
Material 2 [W / m2k]	Polypropylene 0.22	Wood 0.14	High Density Concrete Two
Thickness 2 [cm]	0.075	0.075	0.10
Material 3 [W / m2k]		Material 3 Vermiculite 0.19 [W / m2k]	Mortar High Density 0.88
Thickness 3 [cm]		0.05	0.025
Material 4 [W / m2k]		Plaster 0.16	
Thickness 4 [cm]		0.025	

Table 2 Construction systems
Source: Ener-habitat

Results

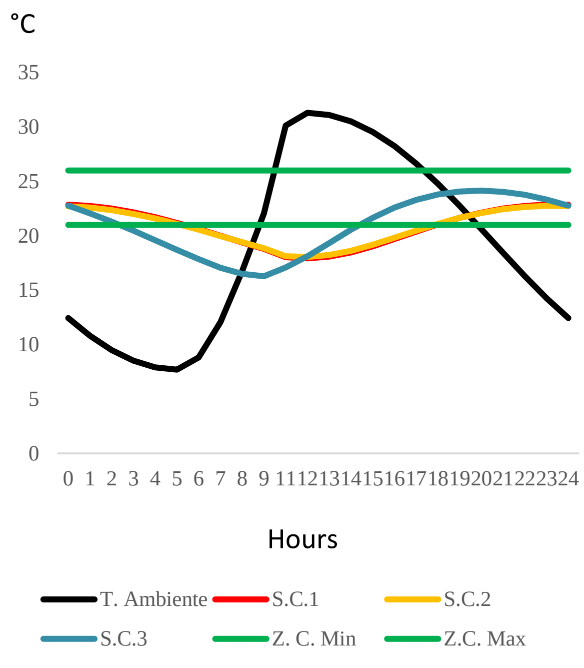
The best construction system is the one with the lowest decrement factor, this parameter indicates that the oscillation of the air temperature in the interior has been damped so much with respect to the sun-air temperature.

ISSN-On line: 2414-8830

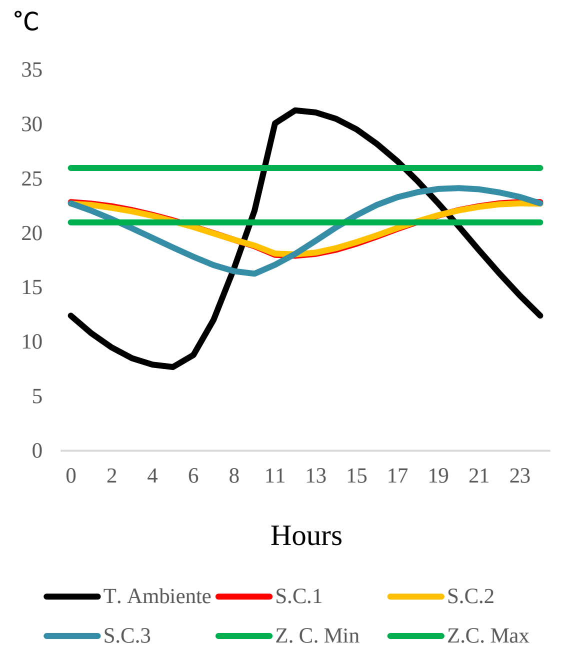
The factor of decrease, takes into account the absorptance of the material and the global solar radiation incident on the construction system, and has no dimensions. The decrement factor is a value between 0 and 1 (Ener-Habitat, 2014). In this case, the wooden walls have the lowest factor in all the orientations and the concrete walls have the highest decrement factor. The construction system of recycled plastic brick is similar to that of wood, varying by only one unit (table 3).

Walls in the warm month (July)				
	North	East	South	West
S.C.1	0.19	0.17	0.18	0.2
S.C.2	0.18	0.16	0.17	0.19
S.C.3	0.29	0.28	0.29	0.32

Table 3 Warm month decrement factor
Source: Ener-Habitat



Graphic 2 Indoor temperature behavior of the construction systems of the North Wall (warm month)
Source: Ener-Habitat



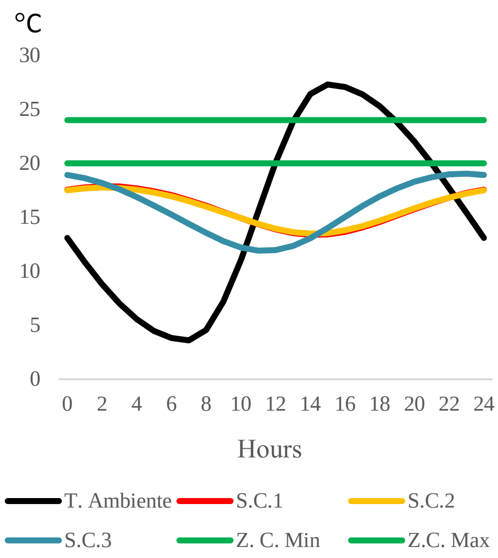
Graphic 3 Indoor temperature behavior of the south wall construction systems (warm month)
Source: Ener-Habitat

It is possible to observe the behavior of the materials (graph 2 and 3) that the construction system 1 and 2 have a very similar behavior, with one line joining another with a minimum variation. The green lines indicate the comfort zone of the interior temperature of the home in the approximate range of 21 ° C to 26 ° C for the warm month. It is appreciated that these two systems (S.C.1 and S.C.2) are stable and enter the comfort zone at 6:00 pm and leave at 6 a.m. being these hours in which they usually perform activities at home. On the other hand, the construction system with concrete walls (S.C.3) has no stability and is prone to make sudden changes in temperature, it enters the comfort zone in the 3 p.m. at 12 a.m. approximately according to the graphs.

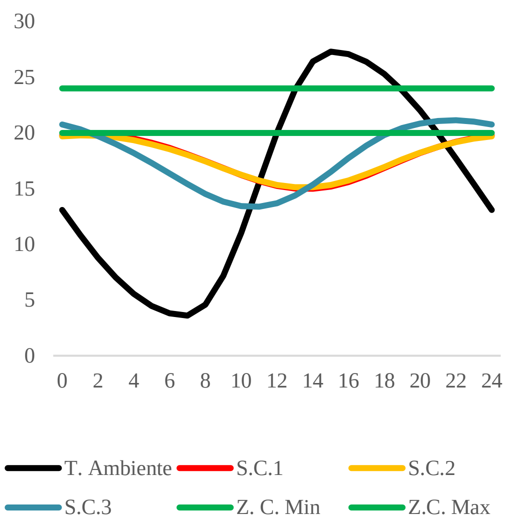
Wall in the cold month (January)				
	North	East	South	West
S.C.1	0.18	0.17	0.17	0.17
S.C.2	0.17	0.16	0.16	0.16
S.C.3	0.29	0.27	0.27	0.27

Table 4 Cold month decrement factor
Source: Ener-Habitat

The decrease factor in the month of January (table 4) is similar to the month of summer (table 3).



Graphic 4 Interior temperature behavior of the construction systems of the North Wall (cold month)
Source: Ener-Habitat



Graphic 5 Indoor temperature behavior of the construction systems south wall (cold month)
Source: Ener-Habitat

In the cold month (January) the comfort zone within the dwelling is from a range of 20 ° C to 24 ° C. It can be seen that no building system analyzed in this simulation enters the comfort zone (graph 4), it should be noted that the wooden and brick construction system recovered plastic have more stability and the temperature change within the home is moderate with respect to concrete. In Figure 5 the S.C.1 and S.C.2 enter the comfort zone from the hours of 23 hours until 3 a.m. and S.C.3 enters the comfort zone at 6:00 p.m. until 2 a.m.

Conclusions

The recovered plastic brick is an efficient material for the construction of decent housing due to the decrease factor (0.17 - 0.20) which is very close to that of the wood, with a more accessible price up to 30 % compared to traditional materials. It has the characteristics that make it safe for building structures, and this alternative construction system can be successfully replicated in the city of Tijuana according to the analysis of the Ener-Habit program.

The manufacture is made with non-biodegradable waste materials, thus preventing them from ending up in the sea. In addition to motivating society to want to implement it in their homes and contribute to the preservation of ecosystems. By implementing this alternative construction system will recover plastic debris polluting the environment, reducing the emission of CO_2, generator of climate change and the greenhouse effect, in addition this plastic brick does not need to consume water and any other material from natural resources for its elaboration.

Acknowledgement

To the Autonomous University of Baja California Tijuana Valle de las Palmas Unit ECITEC and to the teachers Arq. Ixchel Camacho and Dr. Rene Delgado.

References

El Sol de Tijuana. (2018). *El mundo se rinde ante al plástico: PET y PVC aumentaron en demanda*. Recuperado de https://www.elsoldetijuana.com.mx/doble-via/el-mundo-se-rinde-ante-el-plastico-pet-y-pvc-aumentaron-en-demanda-1828539.html

Valencia, N. (2016) *Esta vivienda se construyó en cinco días con ladrillo de plástico reciclado.* Recuperado de https://www.archdaily.mx/mx/792028/en-5-dias-se-construyo-esta-vivienda-con-ladrillos-de-plastico-reciclado.html

Martínez, G. (2018). *Tijuana y San Diego se enfrentan por la basura*. Recuperado de http://www.eluniversal.com.mx/estados/tijuana-y-san-diego-se-enfrentan-por-la-basura.html

Casa de Plástico. (s.f.). *¿Por qué reciclar?*. Recuperado de http://casadeplastico.org/index.php/por-que-reciclar.html

Expansión. (2018). *Qué le espera a la construcción en 2018*. Recuperado de https://expansion.mx/empresas/2018/01/19/que-le-espera-a-la-construccion-en-2018

Ficidet. (2018). *BRICKARP*. Recuperado de http://ficidet.org/brickarp/

Ecoinventos. (2018). *Las casas de ladrillos de plástico tipo LEGO que podrás construir tu mismo*. Recuperado de https://ecoinventos.com/casas-de-ladrillos-de-plastico/

Goodfellow. (s.f.). *Polietileno – U.H.M.W. (UHMW PE) Informacion sobre el Material*. Recuperado de http://www.goodfellow.com/S/Polietileno-UHMW.html

Goodfellow. (s.f.). *Polipropileno (PP) Información sobre el Material*. Recuperado de http://www.goodfellow.com/S/Polipropileno.html

Ener-Habitat, 2014. *Manual de uso*. Recuperado de http://www.enerhabitat.unam.mx/Cie2/pdfs/Manual_de_uso_Ener-Habitat.pdf

ISSN-On line: 2414-8830

[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. ECORFAN Journal-Republic of Nicaragua.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

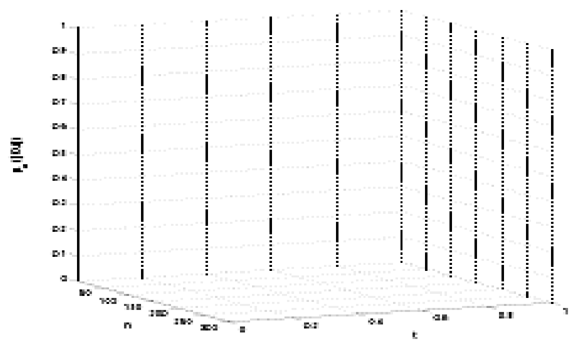
[Title No.12 in Times New Roman, single spaced and bold]

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.

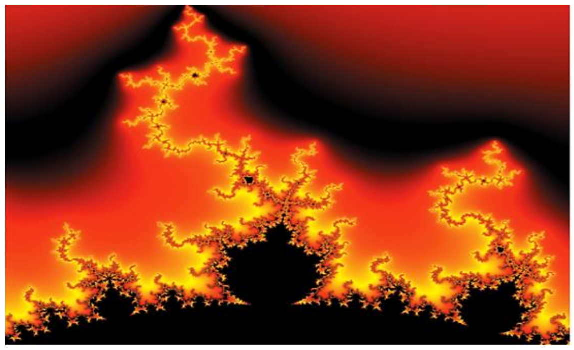


Figure 1 Title and *Source (in italics)*

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 to indicate if were funded by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

ISSN: 2414-8830

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

ISSN: 2414-8830

Reservation to Editorial Policy

ECORFAN Journal Republic of Nicaragua 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 ECORFAN Journal Republic of Nicaragua 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 Republic of Nicaragua 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 Republic of Nicaragua for its ECORFAN Journal Republic of Nicaragua, 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

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

244 – 2 Itzopan Street La Florida, Ecatepec Municipality Mexico State, 55120 Zipcode, MX. Phones: +52 1 55 2024 3918, +52 1 55 6159 2296, +52 1 55 4640 1298; Email: contact@ecorfan.org www.ecorfan.org

Advertising & Sponsorship
(ECORFAN® -Mexico – Bolivia – Spain – Ecuador – Cameroon – Colombia - El Salvador – Guatemala -Nicaragua-Peru-Paraguay-Democratic Republic of The Congo, Taiwan), 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
244 Itzopan, Ecatepec de Morelos–México.
21 Santa Lucía, CP-5220. Libertadores -Sucre–Bolivia.
38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España.
18 Marcial Romero, CP-241550. Avenue, Salinas l - Santa Elena-Ecuador.
1047 La Raza Avenue -Santa Ana, Cusco-Peru.
Boulevard de la Liberté, Immeuble Kassap, CP-5963.Akwa- Douala-Cameroon.
Southwest Avenue, San Sebastian – León-Nicaragua.
6593 Kinshasa 31 – Republique Démocratique du Congo.
San Quentin Avenue, R 1-17 Miralvalle - San Salvador-El Salvador.
16 Kilometro, American Highway, House Terra Alta, D7 Mixco Zona 1-Guatemala.
105 Alberdi Rivarola Captain, CP-2060. Luque City- Paraguay.
YongHe district, ZhongXin, Street 69. Taipei-Taiwan..

ECORFAN Journal-Republic of Nicaragua

"Evaluation of the effectiveness of the technique of bioaumentation in sediments contaminated with hydrocarbons of a combustibles service station of the municipality of San Francisco Putumayo Colombia"

GUERRA-ACOSTA, Adriana del Socorro, RODRIGUEZ-MONTENEGRO, Luis Carlos, **AREVALO-LOPEZ, Judy Johana and ORTIZ-GOMEZ, Yeison Andres**
Instituto Tecnológico del Putumayo

"Characterization of species of *Cyphomandra betacea Cav*. in the community of Mazahuacán, Lolotla, Hidalgo"

JIMÉNEZ-PELCASTRE, César, PEREA-MARTÍNEZ, Alejandro, VALENTÍN-ISLAS, Raúl and GUEVARA-HERRERA, Ricardo
Universidad Tecnológica de la Sierra Hidalguense

"Characterization of Municipal Solid Waste in Altamira, Tamaulipas"

MEDINA-ALVAREZ, Juana Elizabeth, GARZA-FLORES, Rodolfo, WONG-GALLEGOS, Juan Yared and PÉREZ-BRAVO, Sheila Genoveva
Universidad Politécnica de Altamira
Universidad del Noreste

"Analysis for the construction of low cost housing with recycled plastic bricks with no negative environmental impact proposed for Tijuana, B.C"

VALENZUELA-CRUZ, Nataly Berenice, DELGADO-RENDON, Rene and CAMACHO-IXTA, Ixchel Astrid
Universidad Autónoma de Baja California

ISSN 2414-8830

www.ecorfan.org