XXII SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

DEL 7 AL 11 DE NOVIEMBRE

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Evaluation of the application of bioles and arbuscular mycorrhizal fungi in *Helianthus annuus* for the phytoremediation of soils contaminated with zinc

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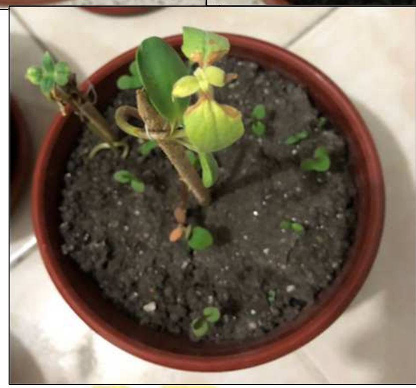
Ingeniería Ambiental

Institución Universitaria Colegio Mayor de Antioquia

Definition of the problem

Zinc is an essential micronutrient for the growth and development of plants. However, in concentrations greater than 200 mg kg -1 it becomes toxic, negatively affecting the plant and the soil.



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Definition of the problem

The presence of soils with high zinc toxicity can be the result of industrial activities, waste discharges and natural processes.

Tomado de : https://humanidades.com/mineria/

Tomado de: https://kelab.com.co/gestion-de-recursos-hidricos

Tomado de: https://www.unionjalisco.mx/2021/01/11/actividad-volcanica

General objective

To evaluate the effect of bioremediation of soils contaminated with zinc by *Helianthus annuus* with the addition of bioles and inoculation with arbuscular mycorrhizal fungi.

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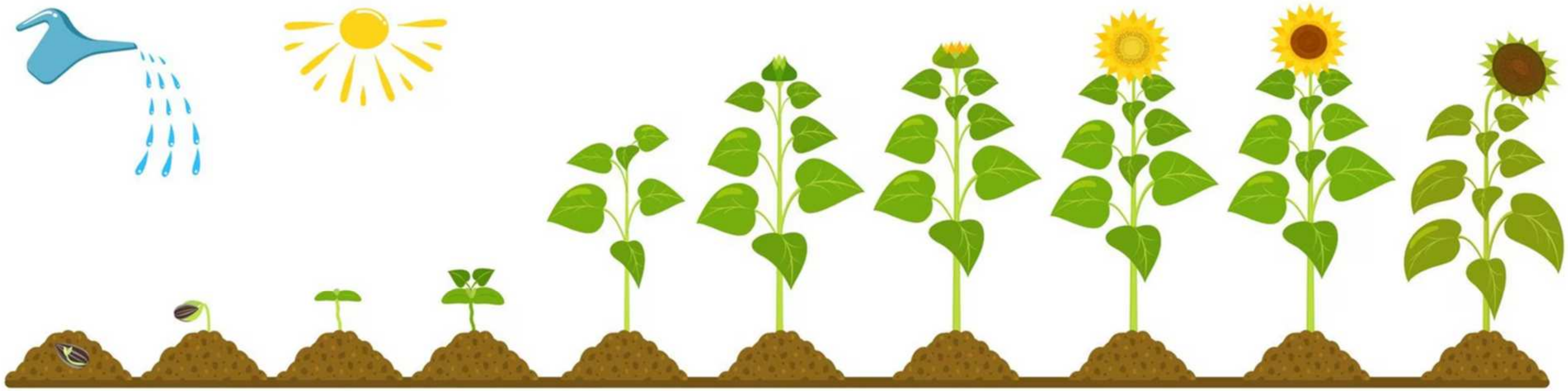
Hyperacumulator plants

Sunflower: *Helianthus annuus*, a zinc hyperaccumulator plant, has the capacity to accumulate this metal at levels 100 times higher than non-accumulator plants (Grandez, 2017).



Tomado de : https://www.freepik.es/vector-premium/infografia-ciclo-vida-crecimiento-girasol-germinacion-semillas-agricultura_31268122.htm

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Arbuscular mycorrhizal fungus

Arbuscular mycorrhizal fungi:

- They promote plant growth.
- They absorb N, P, K, Ca, S, Fe, Mn, Cu and Zn from the soil and then transfer these nutrients to the plant.
- They help bioremediate metals such as Zn, Cu, Cd, Pb among othersIncreases the root system of plants, helping to stabilize phytostabilization (Alborado, 2020)

Rhizophagus fasciculatum

Tomado de : https://www.freepik.es/vector-premium/infografia-ciclo-vida-crecimiento-girasol-germinacion-semillas-agricultura_31268122.htm

Biol (digestate)

Biol is one of the products of the anaerobic digestion of organic materials

- Management of animal or agricultural waste
- Production of thermal and electrical energy: BIOGAS
- Requires low investment
- Low-cost waste recycling
- Waste volume is reduced

Tomado de:https://terrazonet.com/biol-terrazonet/

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Methodology

Monitoring variables

Height (cm)

Diameter (mm)

Number of sheets

Final variables

Aerial biomass (mg/Kg)

Root biomass (mg/Kg)

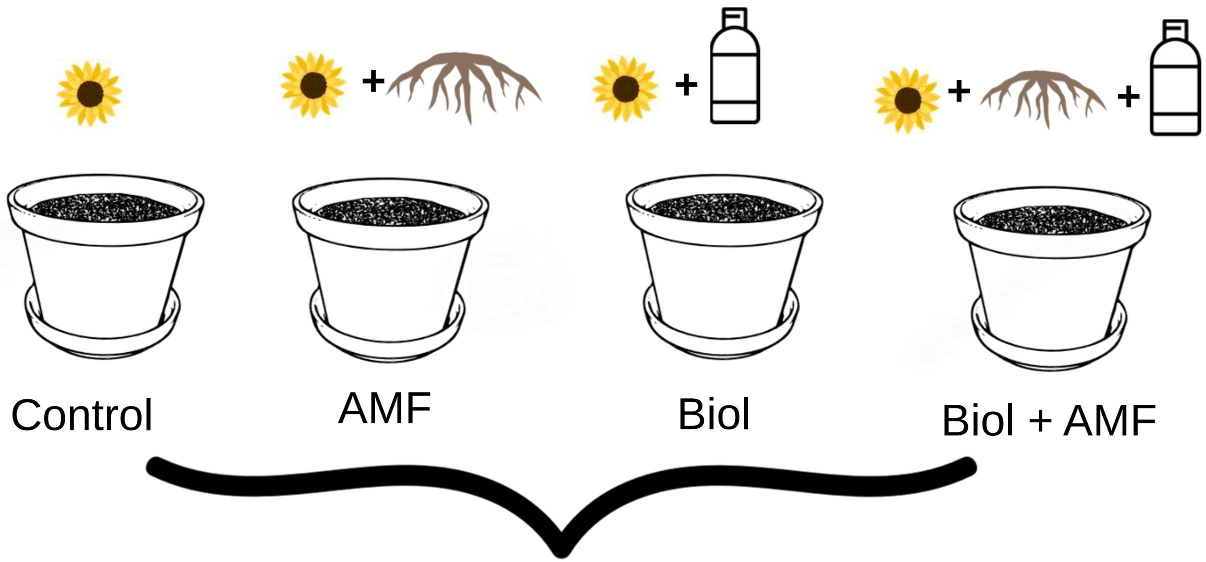
Mycorrhizal colonization (%)

Zn removal in soil (%)

Statistic analysis

Anova with mean difference by Duncan ($p<0.05$)

Statgraphics



500 mg/kgZn ($ZnSO_4$)

3 Repetitions

1000 g Soil

Results

Physically and chemically characterize the soil

The physicochemical analysis of the soil showed a pH of 5.26 and EC 204.5 µs/cm, indicating an acidic soil, which are known to be associated with aluminum toxicity



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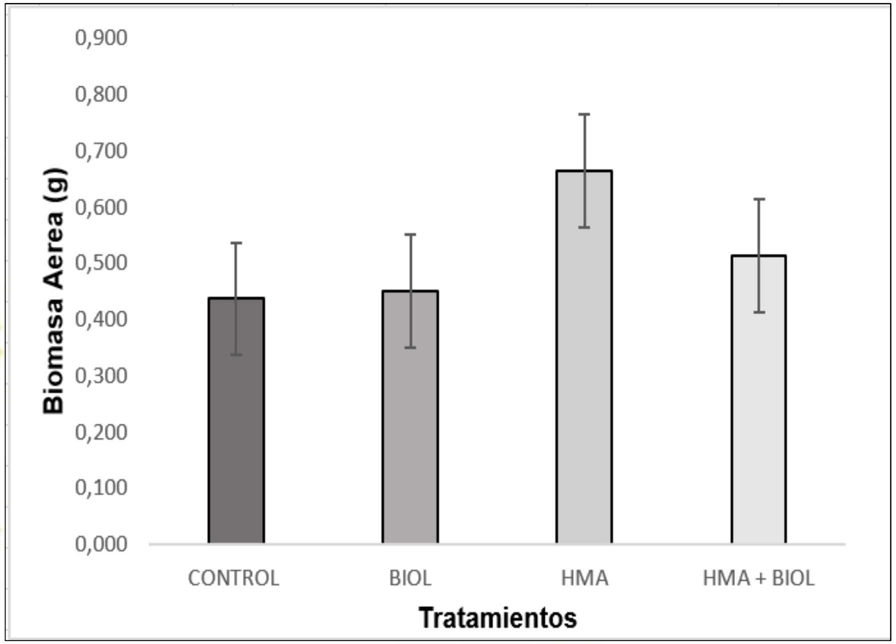
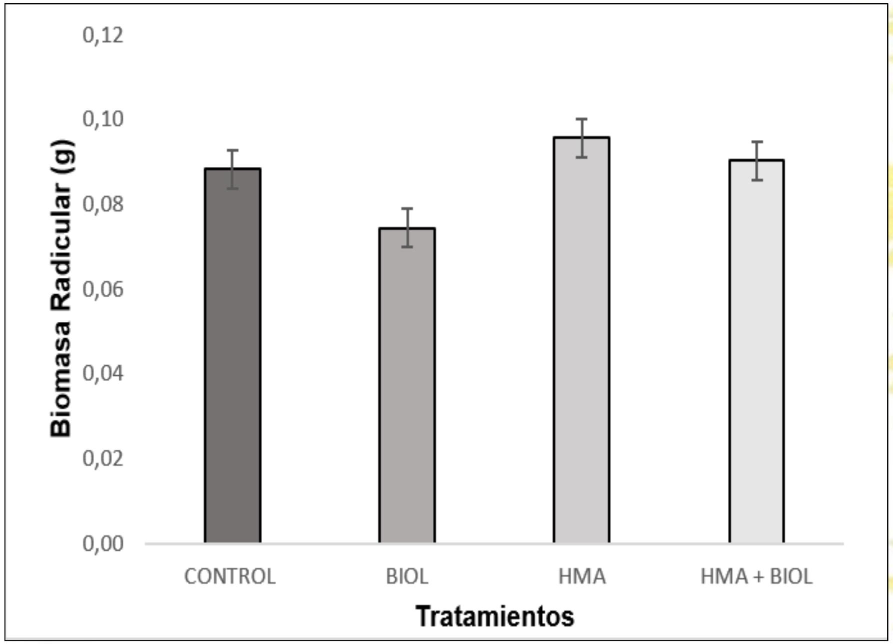
Results

RESULTS

Aerial biomass

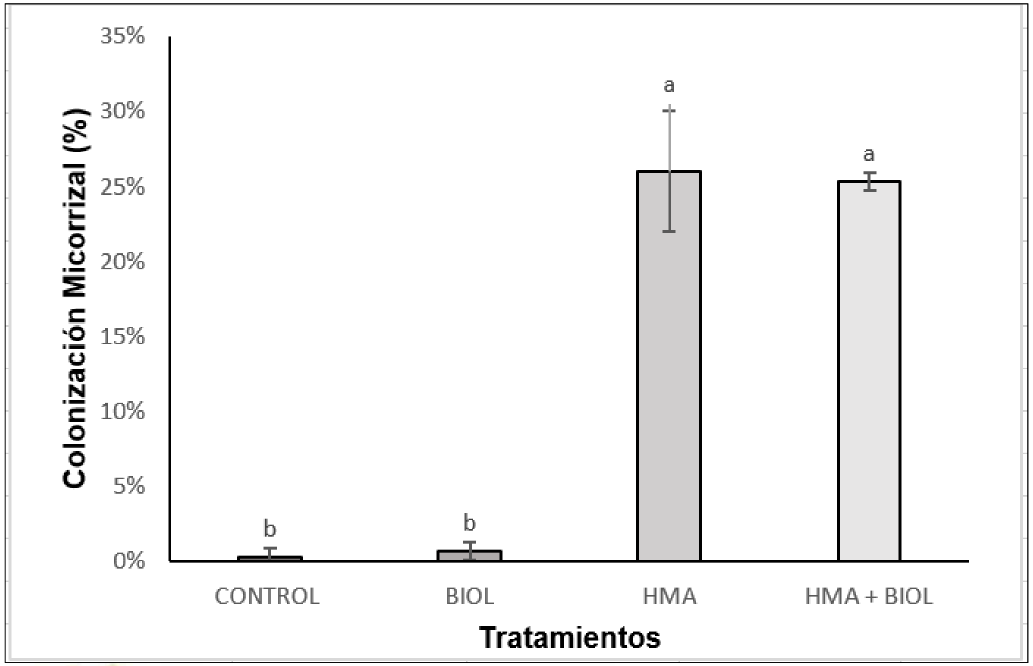


Root biomass



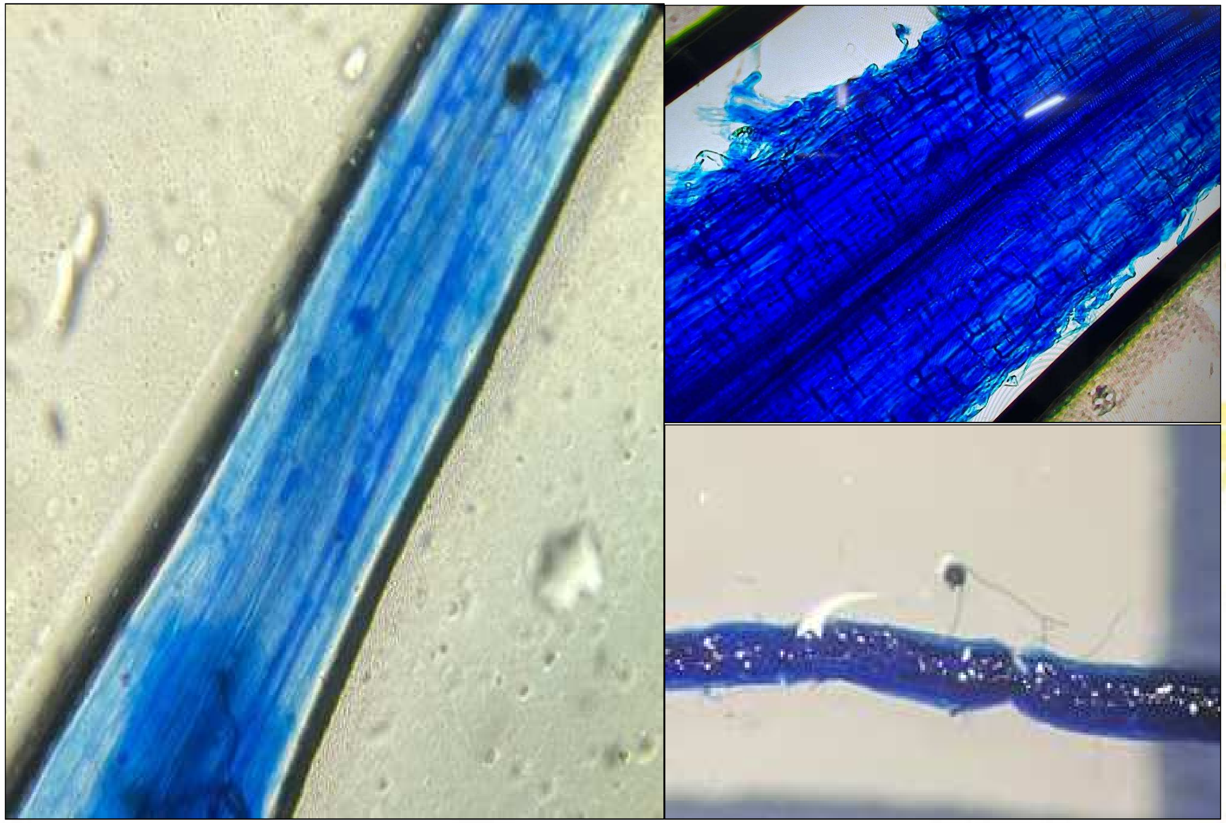
Results

Mycorrhizal colonization



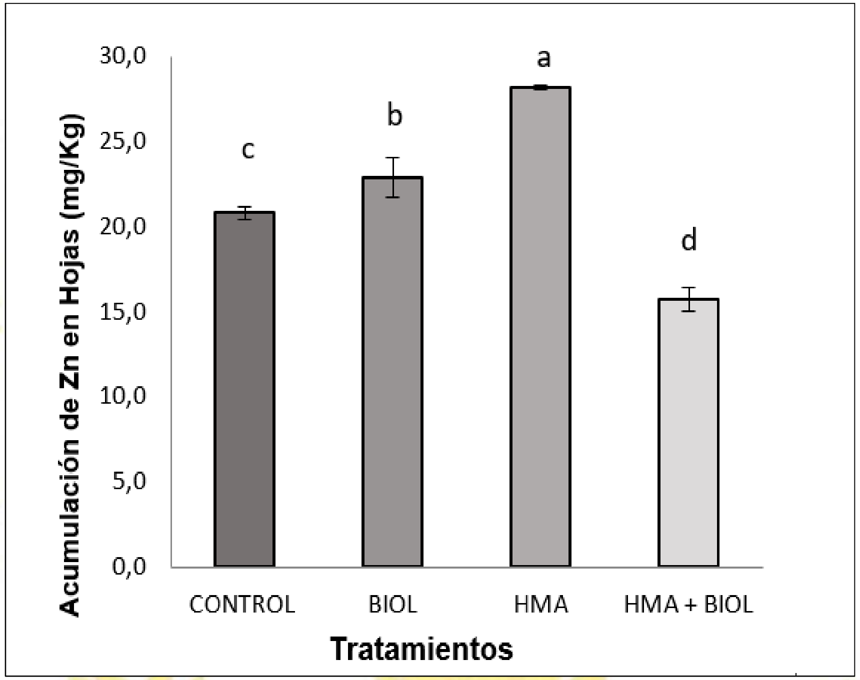
Results

Root without AMF

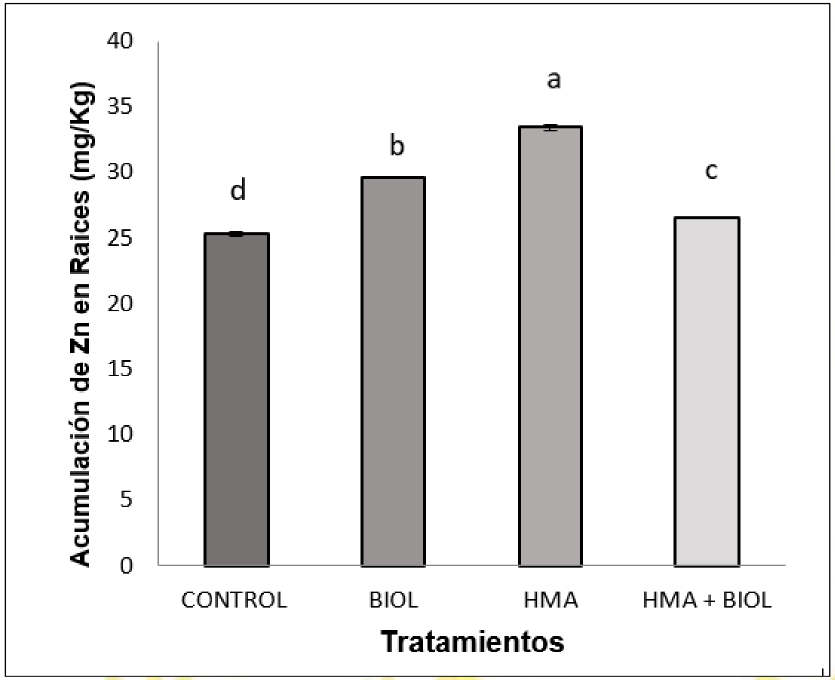


Results

Zn accumulation in leaves

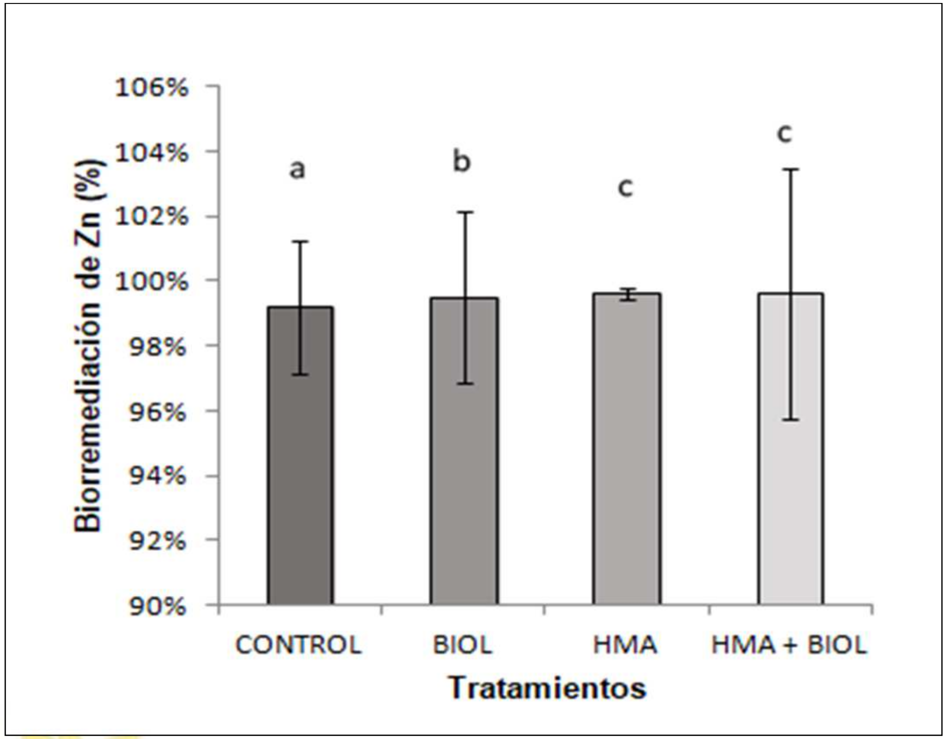


Zn accumulation in roots



Results

Zn phytoremediation



Conclusions

- The sunflower is a Zn hyper-accumulator plant and manages to have phyto-remediation percentages of up to 98% in 90 days.
- Inoculation with HMA and addition of fertilizers such as Biol improve the hyper-accumulation effect of sunflower plants, obtaining a bioremediation percentage of 99.6%.
- Arbuscular mycorrhizal fungi promote the growth of sunflower plants and mitigate the toxic effects of Zn when it is in high concentrations.

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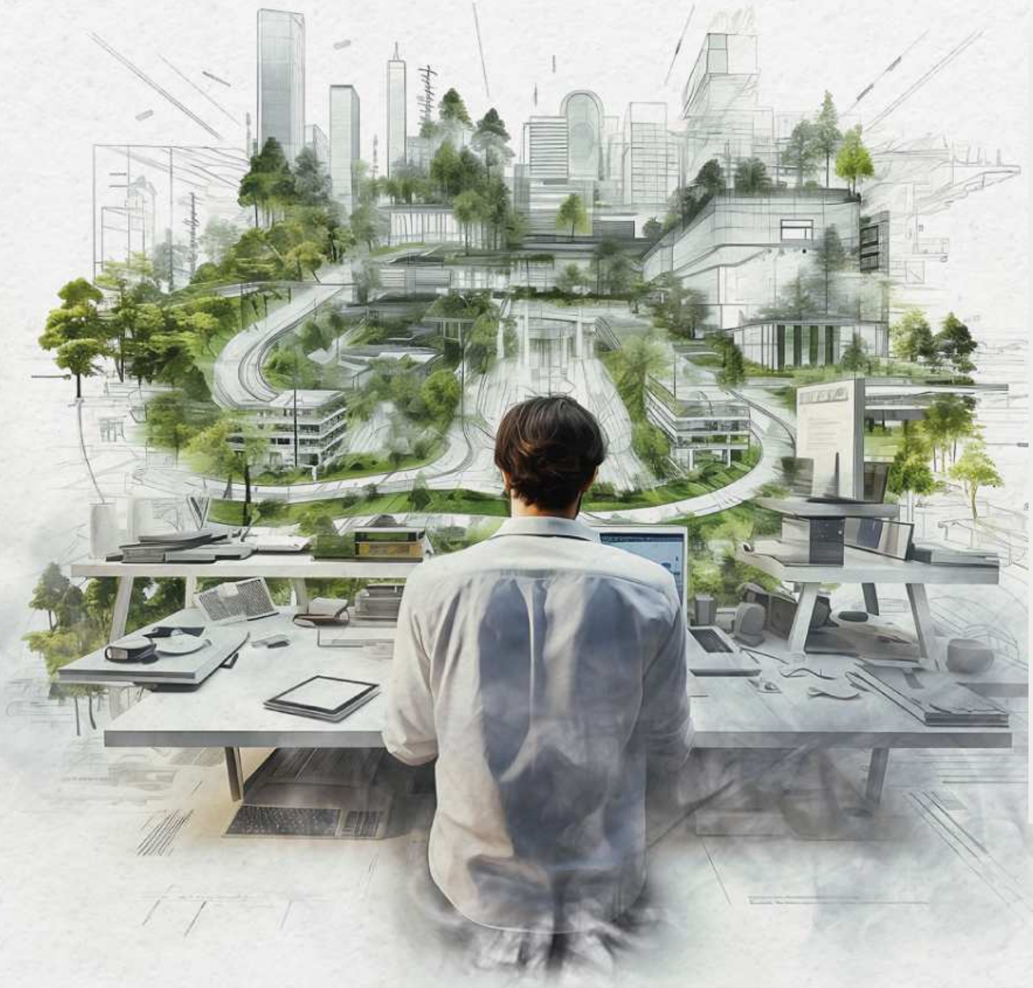

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XXII

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Evaluation of Climate Change signals in Northeastern Antioquia based on historical hydroclimatological records.

Lilia María Marín Zapata, Hernán D. Salas, Alejandro Builes-Jaramillo, Carlos Arturo Hoyos Restrepo

Semillero de Investigación en Ciencias Ambientales SICA.

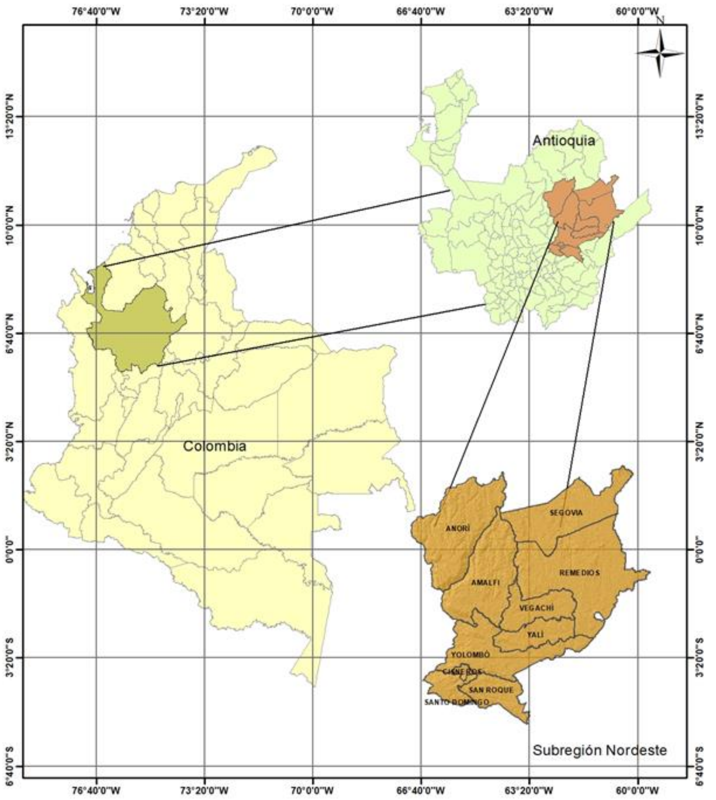
2023-2

Evaluation of Climate Change signals in Northeastern Antioquia based on historical hydroclimatological records.

Objectives

General

To examine evidence of climate change in the northeastern Antioquia subregion based on hydroclimatic measurements from the Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM).



Specific

- To quantify trends in the time series of hydroclimatic variables of the Northeastern Antioquia region.
- Identify areas of significant trends through hydroclimatic variables of the Northeastern Antioquia region.
- Analyze geospatial patterns of climate change indicators in the study region.

Introduction

Human influence on the Earth's climate has occurred at an unprecedented rate, with the last 200 years experiencing the greatest changes in simulations and historical records. In this sense, there is evidence that the average global surface temperature in the period 2011-2020 was 1.09°C higher than in the period 1850-1900, with a greater increase over continental areas of 1.59°C than over the ocean of 0.88°C [1]. This increase in temperature generates concern because a changing climate causes changes in the frequency, intensity, spatial extent, and duration of extreme weather and climate phenomena such as heat waves, droughts, and floods, among others [2]. Moreover, at the regional level, these changes in soil conditions have the potential to attenuate or intensify warming, in addition to influencing the intensity, frequency, and duration of extreme events. The nature and extent of these changes vary with geographic location and time of year [3].

Fuente: WIRE,2023

Introduction

The Northeastern subregion is located on the edge of the Central Mountain Range, southeast of the San Lucas mountain range and between the Porce, Nechí, Nus, and Alicante rivers [4], bordering the department of Bolívar and the Bajo Cauca subregion to the north, the Oriente Antioqueño subregion to the south, the Magdalena Medio subregion to the east, and the Norte subregion to the west. It has a territorial extension of 8,544 km2, 13.6% of the total area of the department, making it the second largest in the department. Its jurisdiction includes ten (10) municipalities [5], among which the municipalities of Segovia and Remedios stand out, due to their location on the San Lucas mountain range, a geostrategic location for mining extraction. The economic activity of these municipalities is concentrated in the exploration and exploitation of gold-bearing material: [6], [7].

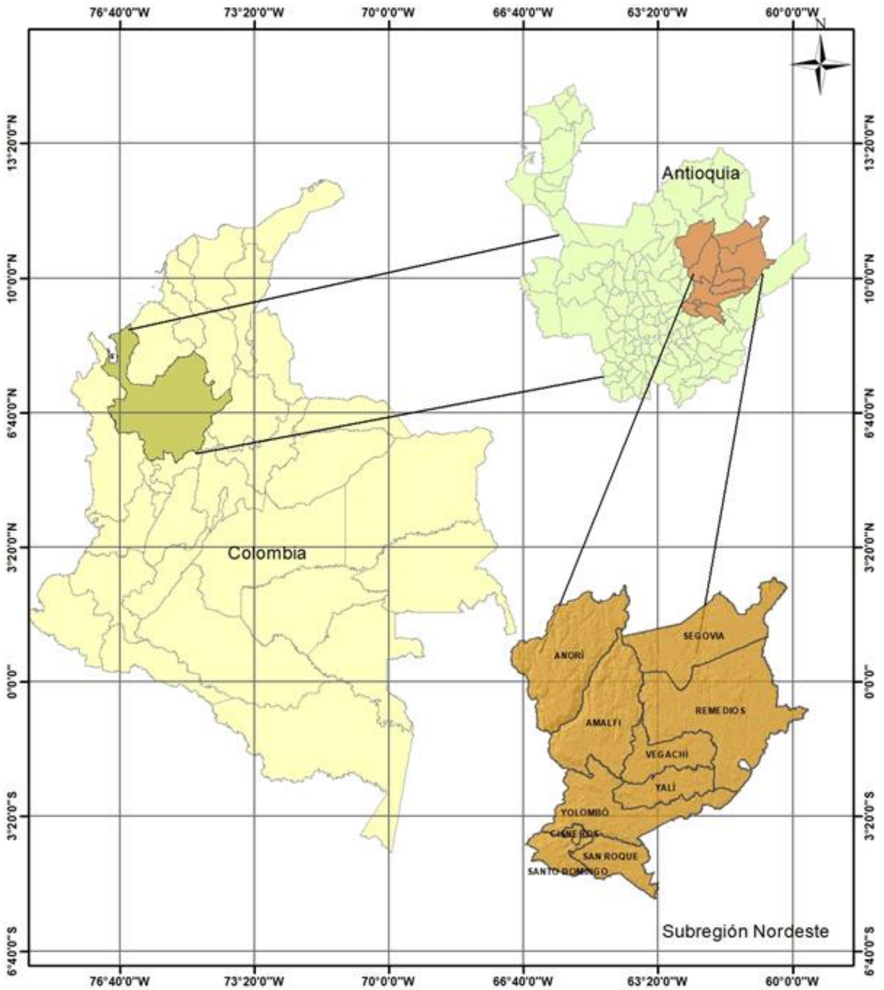
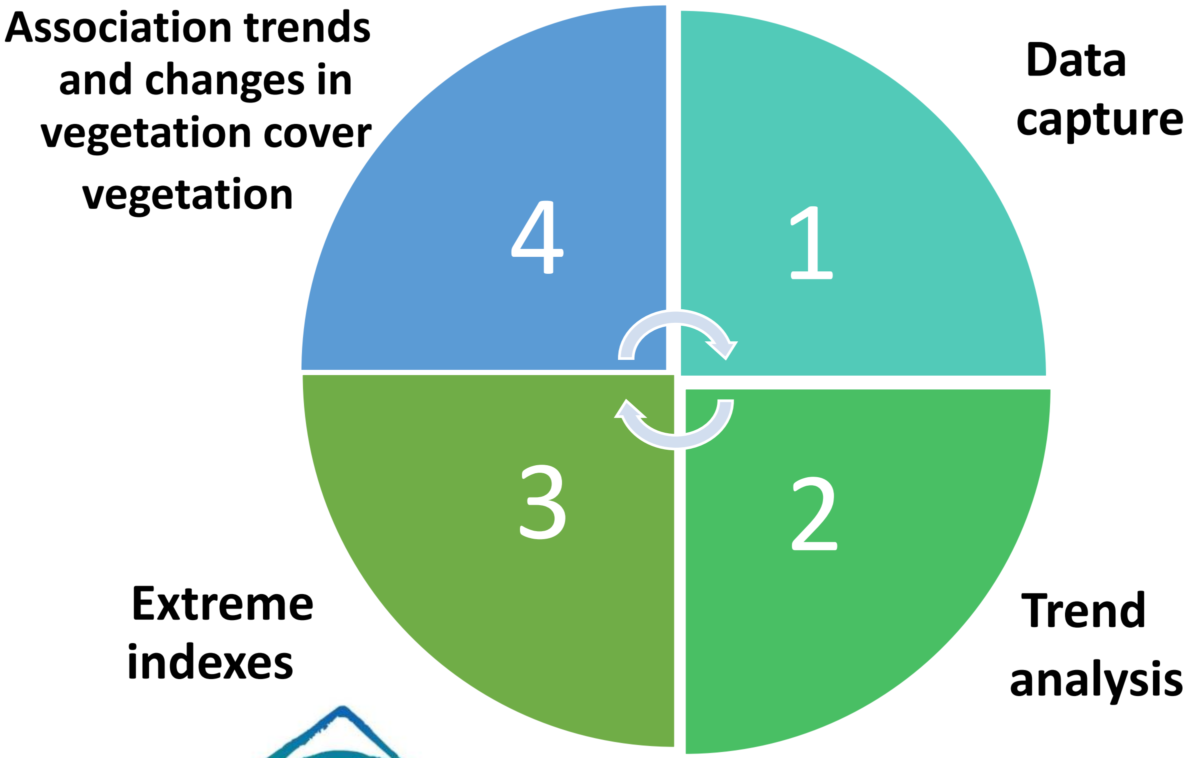


Figure 1 . Northeastern Antioquia in the national (yellow), departmental (green) and regional (ocher) context.

Methodology



Description:

1. **Data collection of hydro-climatological variables:** The time series of precipitation, flow rates, and maximum and minimum temperatures were analyzed, were analyzed (http://dhime.ideam.gov.co/atencionciudadano/).

2. **Trend analysis:** Using Theil-Sen and Mann-Kendal tests. Widely used tool to detect changes in climatic and hydrological time series [8].

3. **Extreme Indices:** trends in historical series and various ETCCDI climate extreme indices for precipitation and temperature (rx1d, rx5d, Rx95p, Rx99p and TXx, TNn, TN10p, TX90p, DTR) were analyzed [9].

4. **Association between hydroclimatic trends and land cover changes:** To analyze vegetation cover, geospatial information from IDEAM (http://www.ideam.gov.co/capas-geo)corresponding to the Non-forest Forest category was used for the period 1900 to 2018 [10].

IDEAM
Instituto de Hidrología, Meteorología y Estudios Ambientales

python

Results and discussion

1. Hydroclimatic series analysis

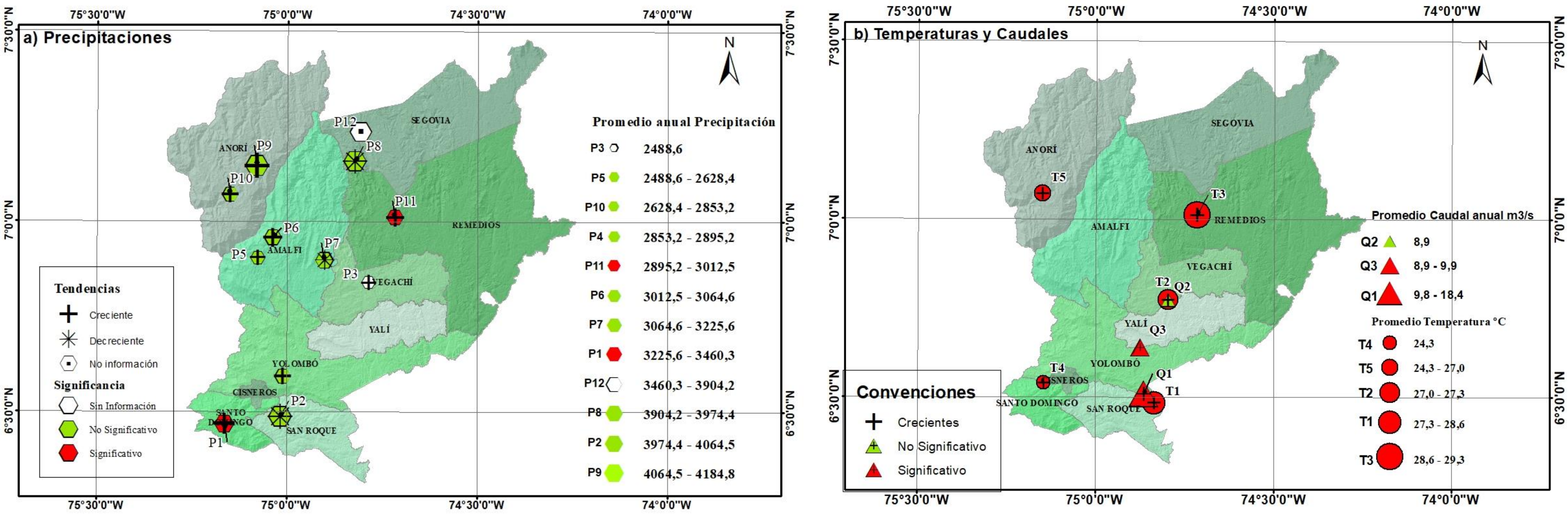


Figure 2. Map of significance and trends of rainfall, flow and temperature variables.

2. Analysis of extreme indexes

2.1 Trends in precipitation extremes

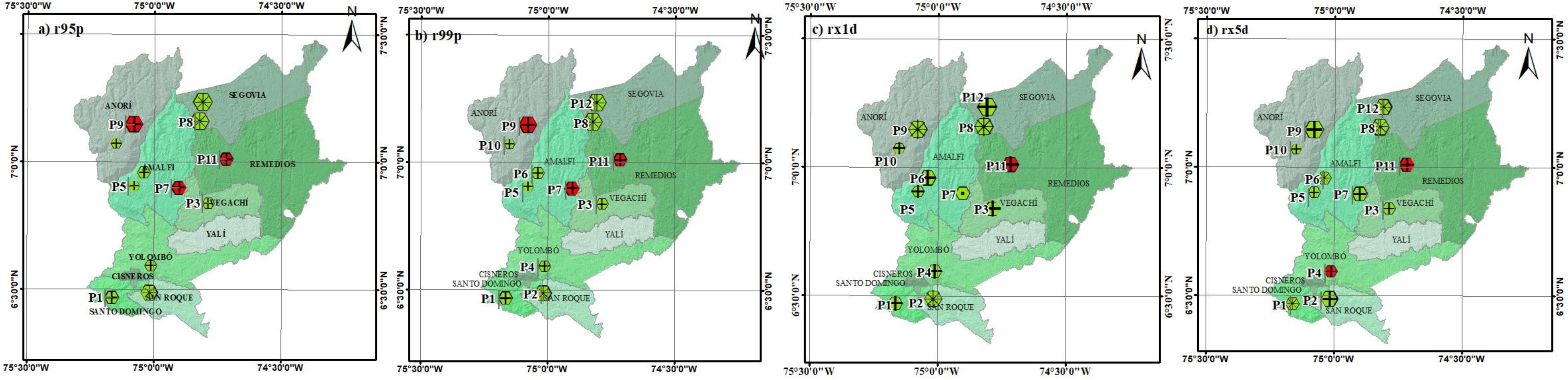


Figure 3. Map of significance and trends of extreme precipitation indices.

2. Analysis of extreme indexes

2.2 Trends in temperature extremes

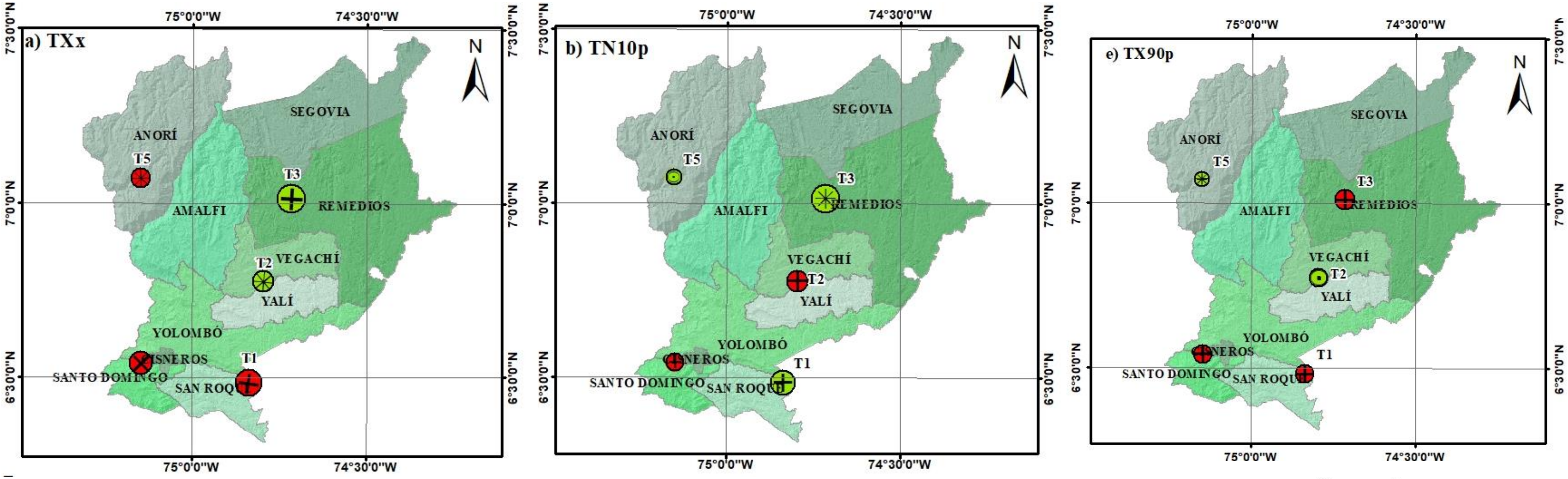


Figure 4. Significance map and extreme temperature index trends

2. Analysis of extreme indexes

2.2 Trends in temperature extremes

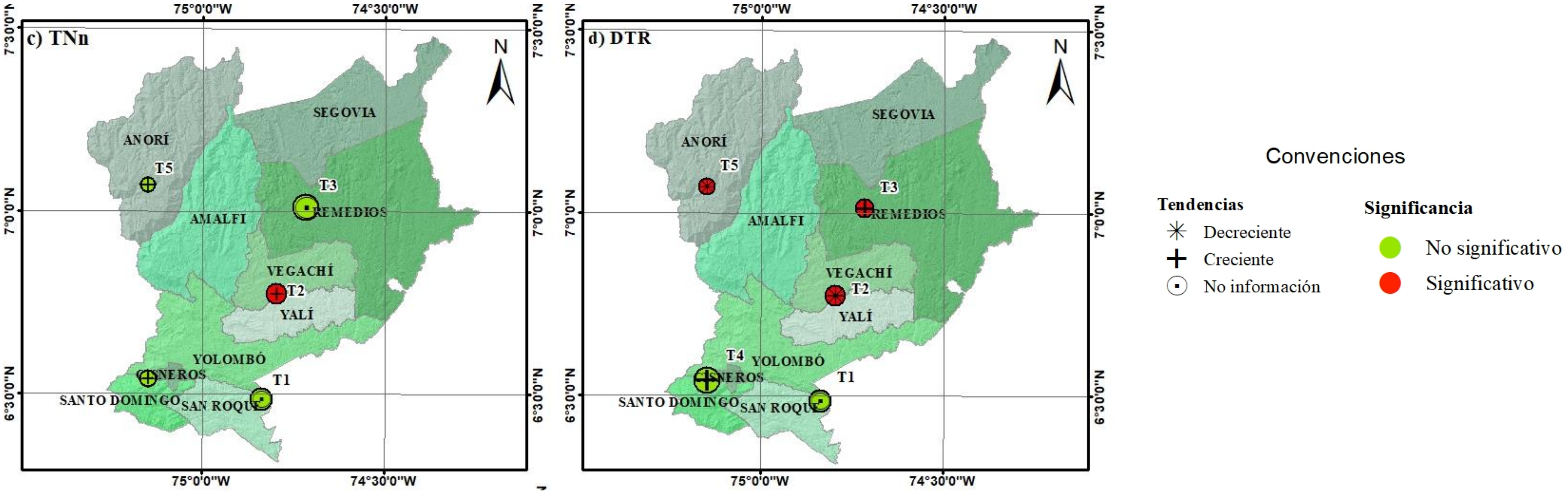


Figure 4. Significance map and extreme temperature index trends

3. Changes in vegetation cover and their association with hydroclimatic changes

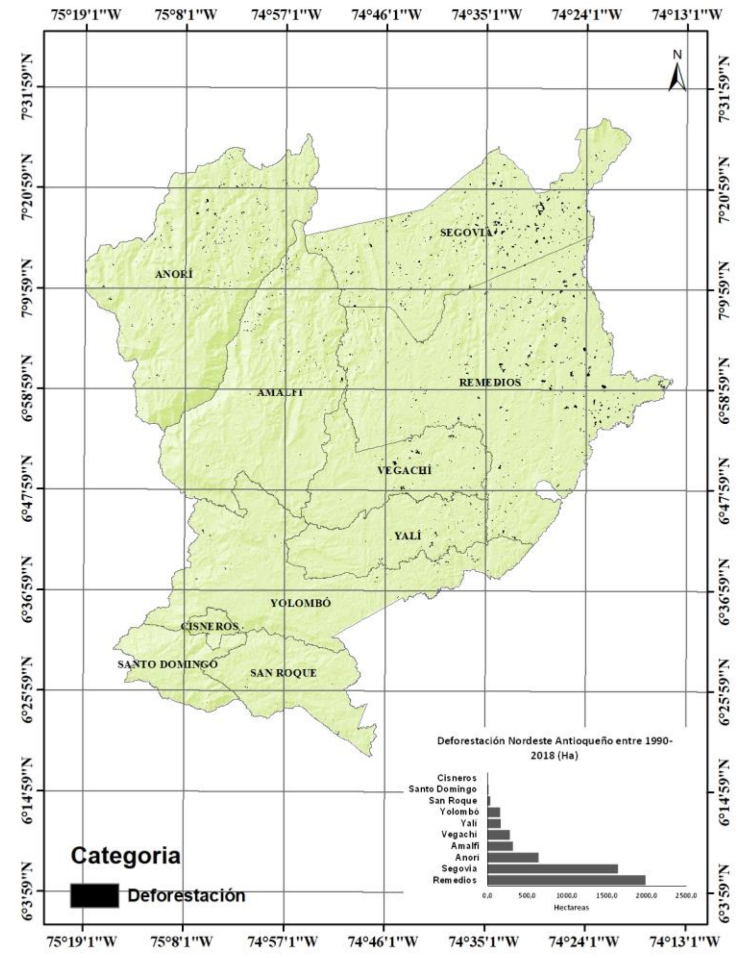


Figure 5. Vegetation cover loss map

Table 3. Loss of vegetation cover in the Northeastern Antioquia Subregion.

Municipalities	Deforestation (Ha)
Remedios	1.984,3
Segovia	1.640,5
Anorí	640,5
Amalfi	317,8
Vegachí	281,1
Yalí	164,0
Yolombó	157,5
San Roque	35,3
Santo Domingo	5,7
Cisneros	0,0
Total	5.226,8

Conclusions and future work

- For the study area, hydrological series are available for periods of more than 30 years. In addition, for the twelve precipitation series and the three flow series used in the region, it was possible to guarantee a quantity of missing data of less than 10%; however, for the temperature series, there is evidence of a greater quantity of missing data of more than 30%, data that were filled using the multiannual daily average. The latter causes a greater disturbance in the data, limiting reliability. Likewise, it was only possible to collect data from 3 flow stations, which limited the analysis of the water resources of the study area, data that are necessary for the proper management and planning of this type of natural resources [11].
- Temperature is the variable that most clearly evidences climatic alterations; this could be associated with the influences of human activities such as unsustainable use of energy and soil, changes in vegetation cover, lifestyle, and consumption and production patterns [12], [13].
- The analysis of the annual extreme indices suggests an increasing increase in precipitation for some regions, with a direct relationship in the trends of increasing temperatures [14],[15], which would follow a change in the precipitation pattern, in the increased occurrence of extreme rainfall events and this could lead to situations of long-term flooding, soil saturation, among others [16].
- The loss of vegetation cover in the study area tends to analyze in detail the impact that this can have on the results of the variables that present climatic alterations, depending on the latitudes, changes and land use of each of the municipalities, since deforestation is associated with an increase in atmospheric CO_2 and alterations in the energy and mass balances of the surface that can lead to local and global climate changes [17], [18], [19].

References

SCAN ME

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Implementation of Composting in Pallets for the Utilization of Organic Waste with Lactic Acid Bacteria in the Centenario Neighborhood of Caldas Municipality, Antioquia

A study by: Ana-Keila Tangarife, Ferney-Andrés Mazo, Madeleine Ochoa, and Tatiana Úsuga

Introduction

Problem: Organic waste management is a global problem that requires sustainable solutions.

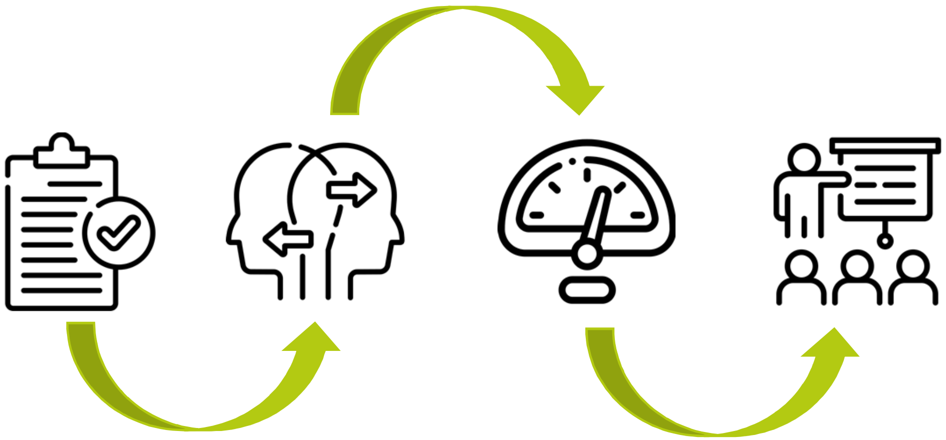
Solution: Composting is an aerobic decomposition process of organic waste that produces compost, a nutrient-rich material that can be used as a soil amendment.

Problem

The Centenario neighborhood of the municipality of Caldas, Antioquia, generates a large amount of organic waste, which represents a problem for the environment and public health.

Objectives

Develop an efficient pallet composting system using lactic acid bacteria, in order to maximize the use of organic waste generated in the Centenario neighborhood of the municipality of Caldas, Antioquia.



Specific:

Evaluate: Evaluate the existing composting system to determine its effectiveness.

Raise awareness: Educate the community on the importance of separating organic waste and how to compost.

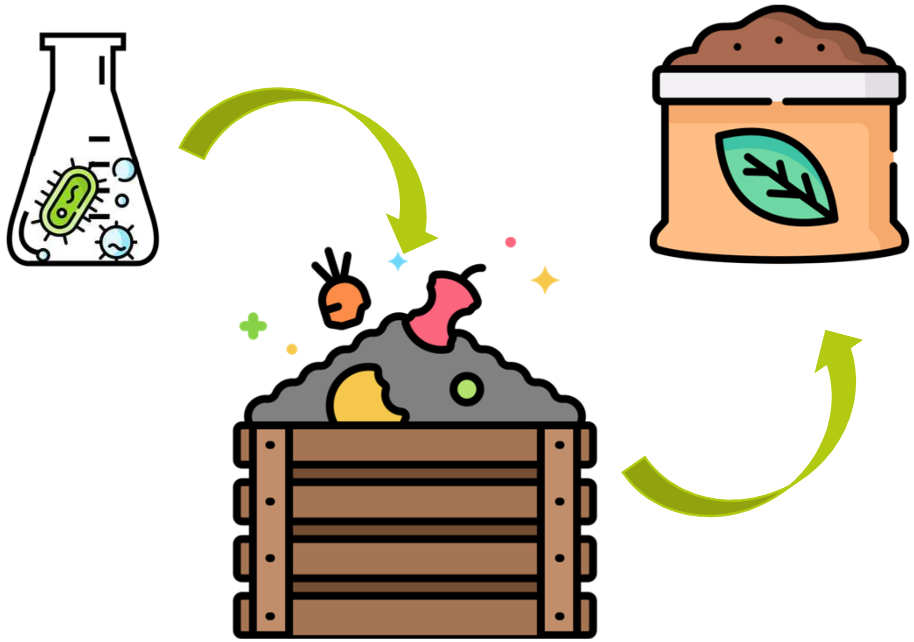
Speed up: Speed up the composting process to reduce decomposition time.

Train: Train the community on how to implement and manage the composting system.

Research Questions

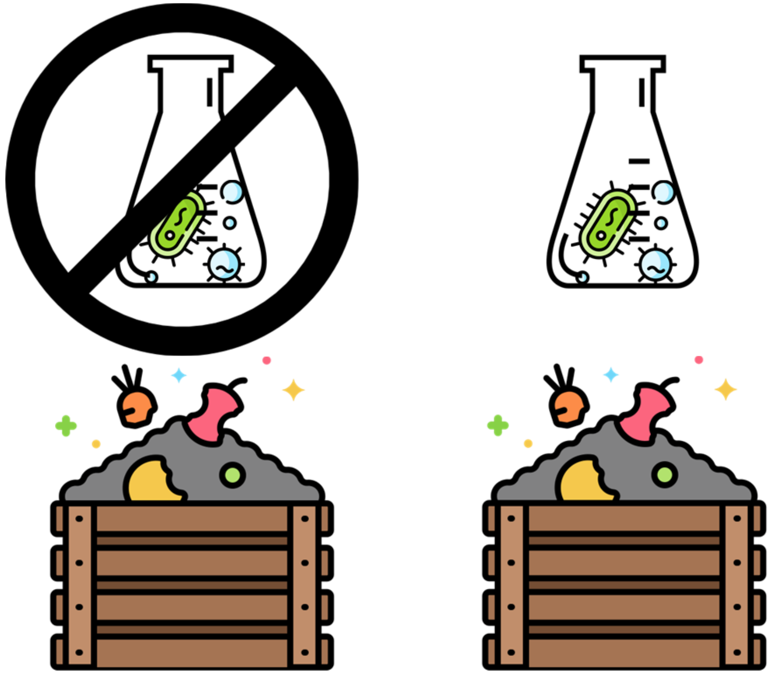
Does the addition of lactic acid bacteria to the composting process in pallet piles improve the quality of the resulting compost?

What are the effects of the addition of lactic acid bacteria on the characteristics of the resulting compost?



Methodology

The methodology proposed for the study is based on a two-level one-variable experimental design, configured in two compost piles where the biological accelerator will be applied to one of them (lactic acid bacteria) and a pile without accelerator (Control).



Diagnosis of the operation of the compost bin and characterization of solid waste management in the Centenario neighborhood

Data were collected on the amount and composition of organic waste generated in households (20) in the Centenario neighborhood.

Household inhabitants are trained to assess their perception of the existing composting system and their interest in adopting a new composting system.

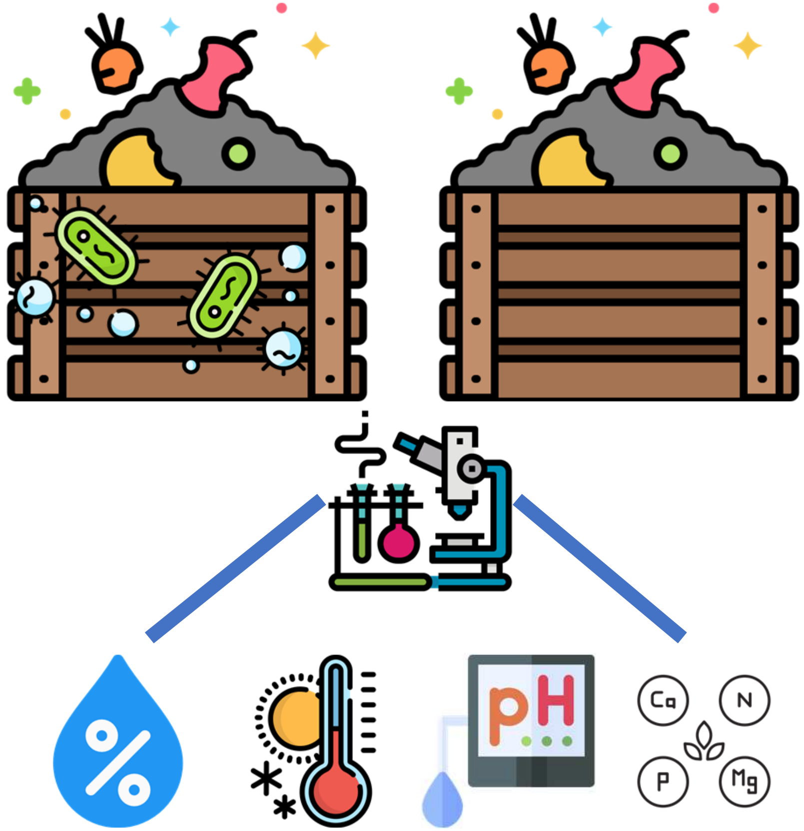
Community Awareness

Training is carried out for the community (20 users) on the proper separation of solid waste into organic and non-organic, its storage and delivery to the operators of the composting system.

Organic material collection implements are delivered to the project participants (20 users).

Acceleration by lactic acid bacteria

- Two compost bins are set up on 1 m^3 pallets, with identical substrate compositions.
- One of the compost bins is applied BAL as an accelerating agent, while the other serves as a control.
- Monitoring of the decomposition of organic waste in both compost bins of various parameters
- A laboratory analysis is carried out to evaluate the quality of the composting obtained through the acceleration process.



Results: diagnosis

The situational diagnosis of the organic waste recovery system in the Centenario neighborhood yielded the following results:

ASPECTO TÉCNICO			Valoración 60%
Criterio	**Ítem**	**Puntaje**	**Puntaje máximo**
Espacio físico	Área Terreno	3	4
	Pendiente Terreno	2	4
Infraestructura	Infraestructura	4	5
Materia orgánica para tratar	Cantidad	2	12
	Tipo	3	4
Ambiental	Ambiental	1	6
Vías de acceso	Vías de acceso	3	4
Puntaje Total		18	39
ASPECTO SOCIAL			**Valoración 40%**
Criterio	**Ítem**	**Puntaje**	**Puntaje máximo**
Interés de montaje	Si	4	4
Recurso humano	Capacitación	4	4
	Personal disponible	6	6
Puntaje Total		14	14
Porcentaje de cumplimiento			67.69%[1]

Result: characterization

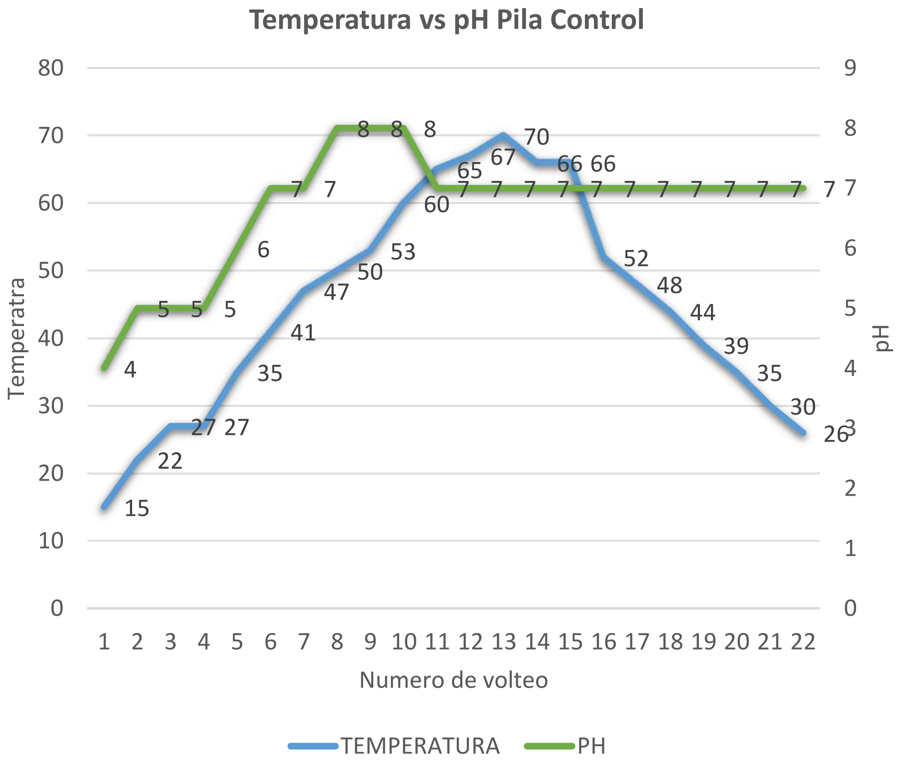
Tipo residuo	Descripción	P. I (kg)	P. F (kg)	P. I (kg)		P. F (kg)	Promedio	%
No reciclable	Barrido, empaques metalizados, empaques pasabocas, otros	22,85	2,75	23,9		3,8	3,28	5%
	Papel higiénico	28	7,90	32		11,9	9,90	16%
	Textiles (trapos)	23,3	3,20	24		3,9	3,55	6%
	Polietileno exp.	0	0,00	0		0	0,00	0%
Orgánicos	Orgánicos (Restos de alimentos, madera, follaje, Hojas	49	28,90	51,1		31	29,95	48%
Reciclables	Vidrio	23,1	3,00	29,3		9,2	6,10	10%
	Papel y Cartón	24,3	4,20	26,7		6,6	5,40	9%
	Plegadiza	21,4	1,30	0		0	0,65	1%
	PET	21,9	1,80	21,05		0,95	1,38	2%
	Plástico	21,3	1,20	21		0,9	1,05	2%
	Metales (Chatarra, Latas)	22	1,50	0		0	0,75	1%
	Tetrapak	22,2	2,10	0		0	1,05	2%
RESPEL	Pilas, Luminarias envases contaminados	0,00	0,00	0		0	0,00	0%
	Cabello, tapabocas, estopas	0	0	0		0	0,00	0%
RAEE	Residuos de aparatos eléctricos y electrónicos	0	0	0		0	0,00	0%
Peso total		278,95	57,9	229,05	68,25	63,05	100%	

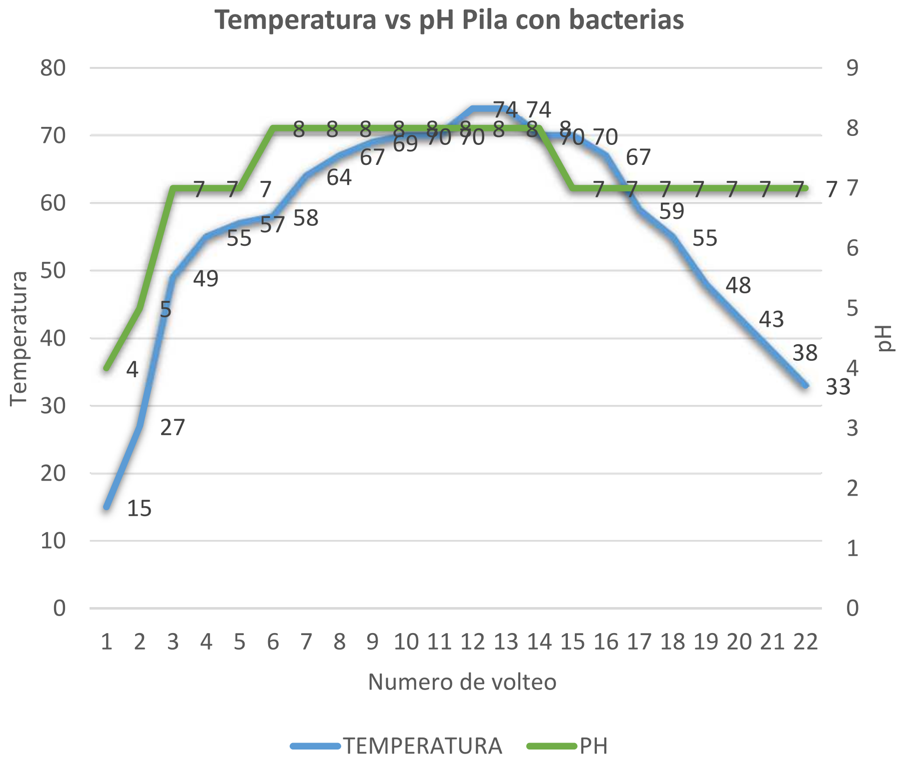
Adaptation of spaces






Result: Monitoring of variables





Characterization of the compost obtained

Código: MO1618 CONTROL			
Parámetro	Resultado	Unidad	Método analítico
pH	7.55	-	Potenciómetro
Humedad	79.85	%	-
C.E.	1.77	dS/m	Potenciómetro
C orgánico oxidable	20.19	%	Ignición
N-Total	2.02	%	Kjeldahl
$N\text{-}NO_3$	13.25	mg/kg	Ión selectivo
$N\text{-}NH_4$	100.7	mg/kg	Colorimetría
C/N	10.10	-	Relación
P_2O_5	0.65	%	Colorimetría
CaO	2.99	%	Absorción atómica
K_2O	3.05	%	Absorción atómica
MgO	1.25	%	Absorción atómica
SO_4	0.025	%	Turbimetría
B	0,15	%	Colorimetría

Código: MO1619 TRATAMIENTO			
Parámetro	Resultado	Unidad	Método analítico
pH	7.79	-	Potenciómetro
Humedad	72.02	%	-
C.E.	5.95	dS/m	Potenciómetro
C orgánico oxidable	21.56	%	Ignición
N-Total	2.16	%	Kjeldahl
$N\text{-}NO_3$	18.25	mg/kg	Ión selectivo
$N\text{-}NH_4$	184.21	mg/kg	Colorimetría
C/N	9.986	-	Relación
P_2O_5	1.02	%	Colorimetría
CaO	3.24	%	Absorción atómica
K_2O	4.58	%	Absorción atómica
MgO	1.86	%	Absorción atómica
SO_4	0.30	%	Turbimetría
B	0,18	%	Colorimetría

hallazCharacterization of the compost obtained gos

The addition of lactic acid bacteria caused an increase in temperature in the compost pile, which could accelerate the decomposition of organic materials and contribute to the elimination of pathogens and weed seeds.

The addition of lactic acid bacteria caused an increase in pH in the compost pile, which could have important implications on nutrient availability for plants and compost stability.

Conclusions

The solid waste characterization study conducted in a community in Caldas, Colombia, found that more than 45% of the solid waste generated by the 20 participating families is organic.

45%

Conclusions

The quality of the final compost is critical to its usefulness in the soil. Comparing pile compost with and without lactic acid bacteria is essential to assess whether these microorganisms improve the quality of the compost, including nutrients, stability, and the absence of harmful elements such as pathogens.

Conclusions

The community provided constant and essential support in the implementation of project activities. There were frequent meetings and trainings to strengthen knowledge about composting, in collaboration with the participating corporation.

Thanks

A special thank you to the community of Corpodil of the centenario neighborhood in the municipality of Caldas Antioquia, for their commitment, time and responsibility.

And also to each of the teachers who accompanied us in the planning, execution and evaluation of this project.

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SEMANA DE LA FACULTAD

XXII

ARQUITECTURA E INGENIERÍA

DEL 7 AL 11 DE NOVIEMBRE

Edición en Línea. ISSN 2357-5921 Volumen 11– No 2–2023 Publicación Semestral

BIOGAS PRODUCTION FROM CHEESE WHEY: EVALUATION OF THE METANOGENIC BIOCHEMICAL POTENTIAL (BMP) AND ITS KINETICS

Students: Estefanía Lopera Vásquez - Andrea Polo Muñoz.
Advisor: Andrea Tamayo Londoño.

Course: Research Project.
Teacher: Alejandro Builes Jaramillo

Edición en Línea. ISSN 2357-5921 Volumen 11- No 2-2023 Publicación Semestral

PROBLEM CASE

Whey is a byproduct of cheese production, and due to its high generation rate (9:1), it exceeds practical utilization possibilities. Furthermore, because of its complex chemical and nutritional composition, when it reaches water sources, it increases BOD and COD, leading to physicochemical imbalances due to the loss of dissolved oxygen and potential eutrophication. In soils, it causes a decrease in fertility

Imagen. Aguas alteradas.
https://www.elsoldetulancingo.com.mx/local/lactosuero-es-un-problema-que-se-seguira-heredando-4288903.html

Imagen. Perdida de vida acuatica.
Fuente: Corponor.

Imagen. Suelos infértiles.
https://eos.com/es/blog/fertilidad-del-suelo/

THEORETICAL FRAMEWORK

Whey can be classified as acidic (pH: 5) or sweet (pH: 6 - 7), depending on the procedure used in its production. It has the characteristic of containing a significant amount of organic material, primarily in the form of sugars such as lactose, which constitutes 70% of the total solids (TS) content, and proteins, which make up 10% of TS. Of all the proteins present in this medium, 50% corresponds to lactoglobulin, with lactoalbumins in a lower proportion, both of which are a significant source of nitrogen.

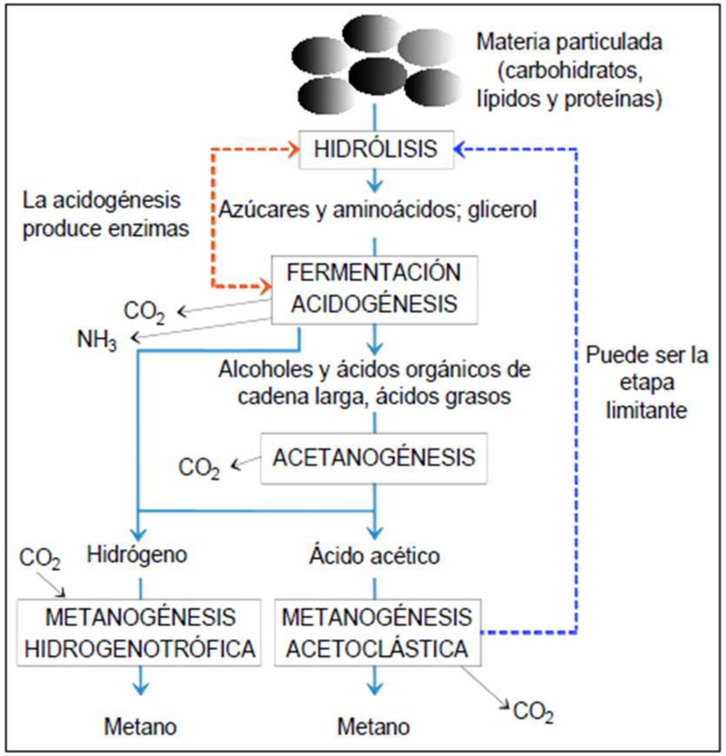
THEORETICAL FRAMEWORK

Bioenergy is considered a sustainable alternative to fossil fuel-derived energy due to its mitigation of greenhouse gases (GHGs) while diverting organic waste from landfills. It is typically focused on biogas production, where sealed systems utilizing anaerobic digestion (AD) are employed. In AD, specific microorganisms actively degrade organic matter into gaseous emissions that can be captured and converted into usable electrical and thermal energy.

Planta de biometanización Parque Tecnológico de Valdemingómez (PTV).
Fuente: https://rinconeducativo.org/es/visitas/centro-rsu-pt-valdemingomez/

THEORETICAL FRAMEWORK

Successful digestion systems rely on the proper selection of food waste, composition, mixing ratio, pH, alkalinity, etc., in order to maximize biogas production and maintain digester quality. Proper mixing and careful maintenance can prevent inhibition by ammonia, volatile fatty acids (VFAs), and intermediate products. It is reported that one of the best Inoculum-to-Substrate Ratios (ISR) for optimal biogas production is 2 based on volatile solids.



Fuente: Morales P., 2018

OBJETIVES

General

To evaluate the potential to recover energy from whey through anaerobic degradability.

Specific

1. To characterize and adapt whey and the inoculum to the anaerobic degradation process.
2. To determine the energy contribution of whey based on the BMP.
3. To identify the Biochemical Methanogenic Potential (BMP) of whey.
4. To determine the kinetic biodegradability constant

METHODOLOGY

For these batch tests, an RIS of 2 was used with a working volume of 600 mL and 400 mL of free head, stored at a temperature of 37°C (+/- 2).
The data was analyzed and graphed in Matlab to obtain the kinetic biodegradability constant of whey.

Figure. Assemble.

The parameters of interest for the assembly were pH, volatile solids and COD.

METHODOLOGY

ASSEMBLY

CHARACTERIZATION

Figure. Sludge (Inoculum)

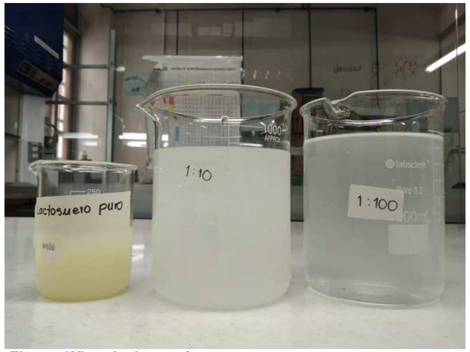


Figure. Whey (substrate)

Figure. final assembly

MEASUREMENTS

Figure. manometric measurement

Figure. volumetric measurement

ANALYSIS AND RESULTS

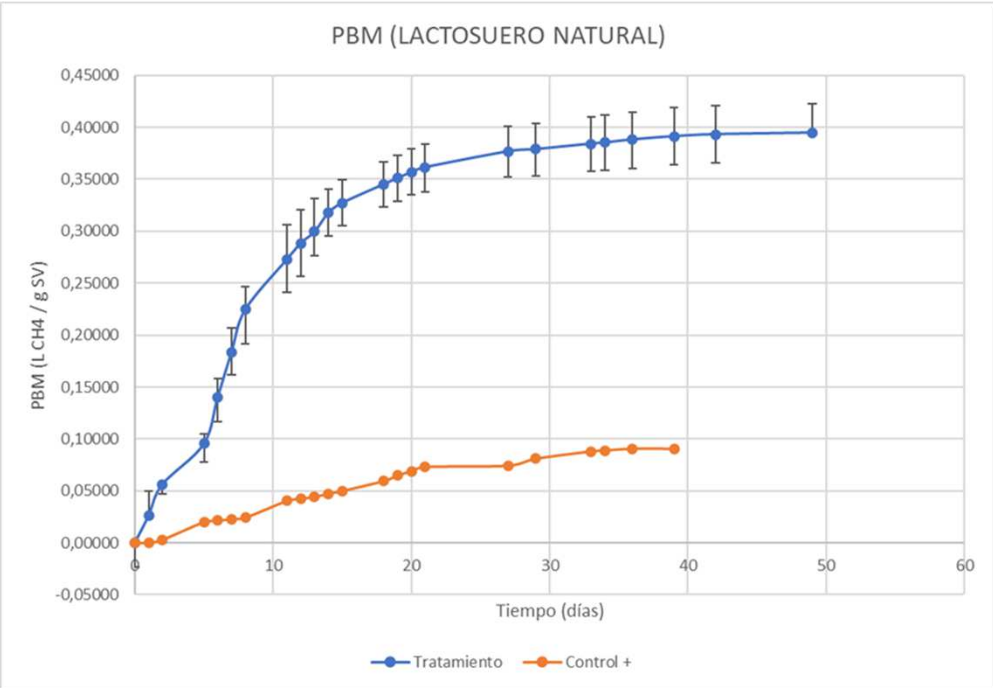


Figure BPM Natural whey

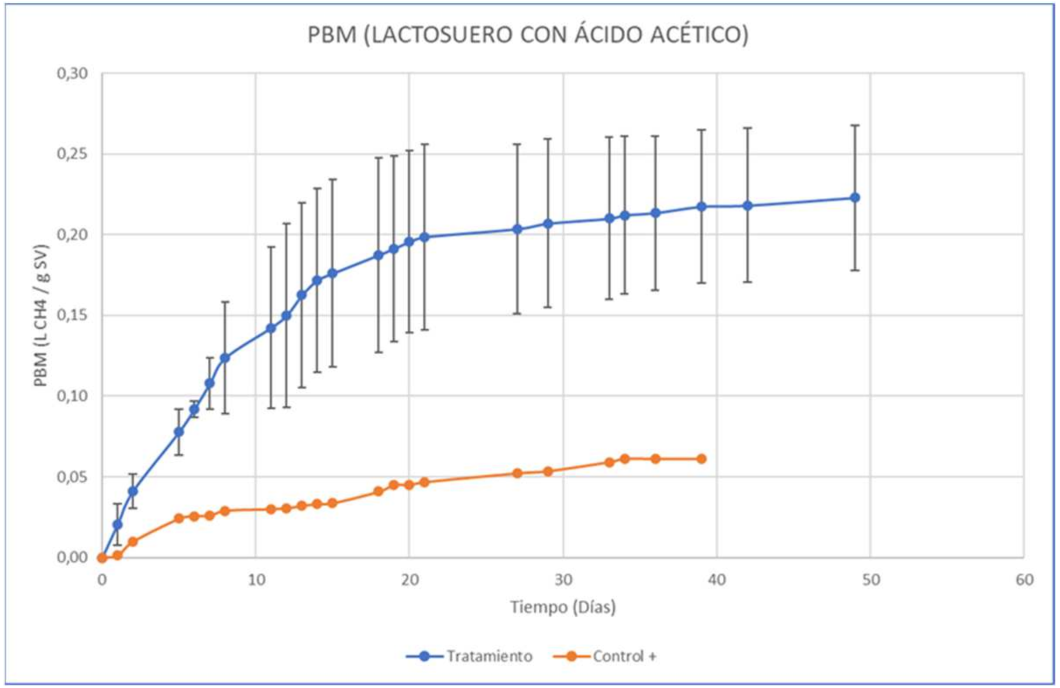
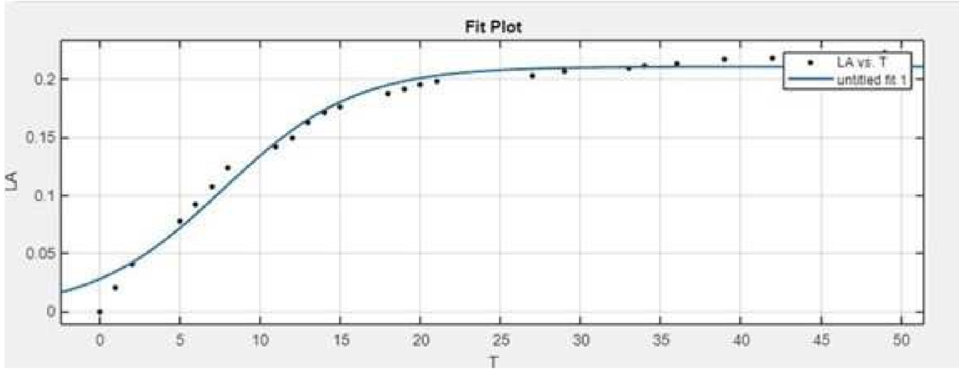
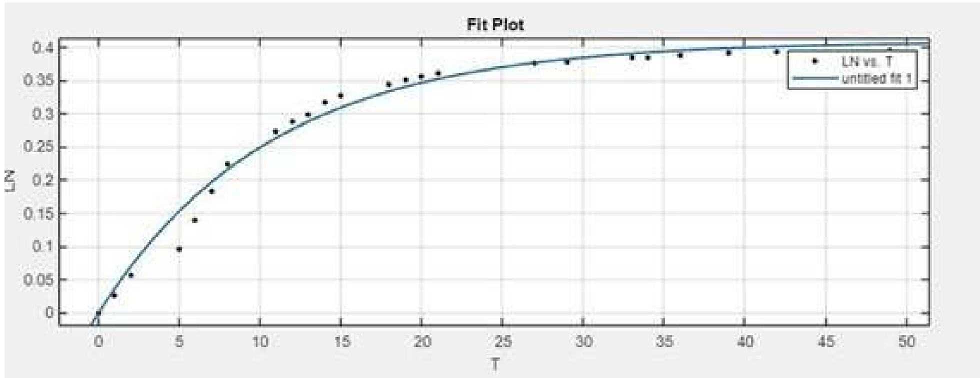


Figure BPM whey with Acetic Acid



kinetics: WHEY WITH ACETIC ACID
Logistic model
K = 0,2106
R2=0,9813



Kinetics: NATURAL WHEY
Roedinger model
K= 0,0941
R2= 0,98116

Wey	BPM (L CH4 / g SV)	Pec (kW/h)	Pee (kW/h)
Natural	0,395	67,70	33,85
Acetic	0,223	40,36	20,18

Table. Energy.

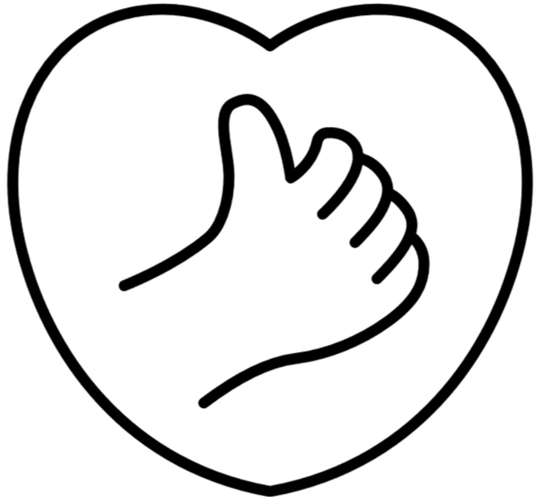
Price kW/h (level 3 Medellín)	Natural Whey	Whey with Acetic acid
Saved money ($)	26,064.78	15,539.29

Table. Saves money with BPM

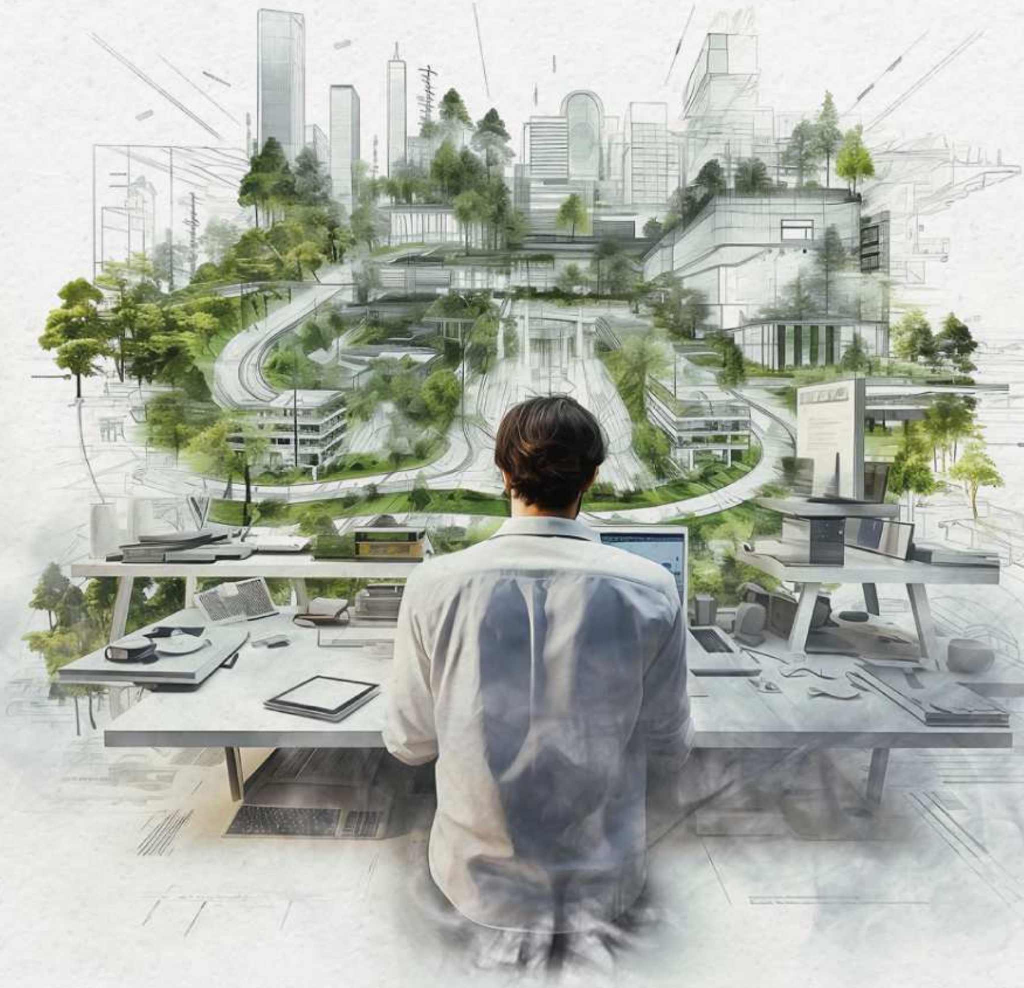
CONCLUSIONS

Whey is a substrate with a high potential for energy valorization and recovery through the biochemical methane potential (BMP), creating a sustainable alternative for dairy industries and improving their production chain. However, this BMP will depend on the type of cheese production process, as it affects its pH, organic matter content, and nutrient levels.

THANKS!



REFERENCES



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SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

DEL 7 AL 11 DE NOVIEMBRE

Edición en Línea. ISSN 2357-5921 Volumen 11- No 2-2023 Publicación Semestral

INSTITUCIÓN UNIVERSITARIA COLEGIO MAYOR DE ANTIOQUIA®

Acreditados en ALTA CALIDAD

Alcaldía de Medellín
Distrito de
Ciencia, Tecnología e Innovación

DEGRADATION OF METFORMIN HYDROCHLORIDE IN AQUEOUS MEDIUM APPLYING HETEROGENEOUS PHOTOCATALYSIS WITH TIO_2 IN THE PRESENCE OF H_2O_2

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Course Proyecto de Investigación
Ingeniería Ambiental

Thematic Advisor: Fidel Granda-Ramirez
Methodological Advisor: Gina Hincapié Mejía

SICA
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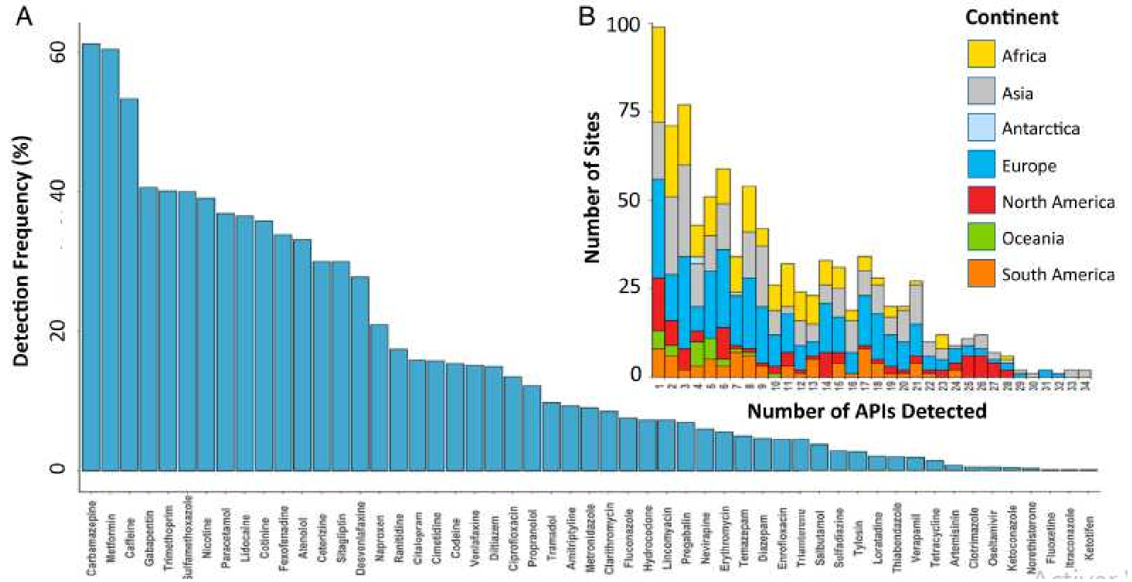
PROBLEM

- Studies have identified the presence of ibuprofen, naproxen, and diclofenac in surface waters (Miriam et al., 2021). These emerging concern compounds may have significant adverse effects on the health of living organisms, affecting some hormonal functions (Wilkinson et al., 2022).

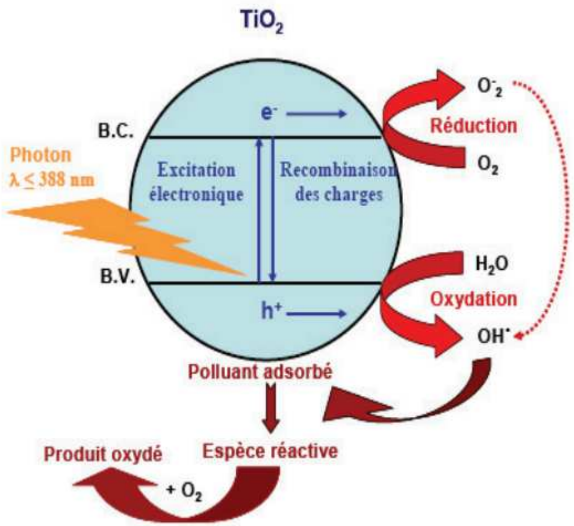


source: Pharmaceutical pollution of the world’s rivers. (Wilkinson et al., 2022)

THEORETICAL FRAMEWORK

Advanced oxidation processes (AOPs) involve the in situ generation of highly reactive radicals with low selectivity and a high capacity to react with most organic compounds (Taoufik et al., 2020).

Heterogeneous photocatalysis with TiO_2 has shown efficiency in the degradation of pharmaceutical compounds (Kanakaraju et al., 2015)



$$TiO_2 + h\nu\ (<387\ nm) \rightarrow e_{CB}^- + h_{VB}^+ \quad (1)$$

$$h_{VB}^+ + R \rightarrow \text{intermediates} \rightarrow CO_2 + H_2O \quad (2)$$

$$H_2O + h_{VB}^+ \rightarrow {}^{\bullet}OH + H^+ \quad (3)$$

$${}^{\bullet}OH + R \rightarrow \text{intermediates} \rightarrow CO_2 + H_2O \quad (4)$$

Source: Photocatalytic mineralization of wastewater polluted with commercial dicloxacillin in a pilot-scale solar CPC reactor. (Colina et al., 2023)

OBJECTIVES

Overall Objective:

- To assess the degradation of metformin hydrochloride in an aqueous medium through heterogeneous photocatalysis with TiO_2 in the presence of H_2O_2.

Specific objectives

- Analyze the impact of TiO_2 catalyst variation on the degradation of MET.
- Evaluate the influence of H_2O_2 presence in the TiO_2 photocatalytic degradation.
- Determine the optimal levels of TiO_2 for MET photodegradation using the response surface methodology (RSM).

METHODOLOGY

Solutions at 10 mg/L of MET were prepared, the amount of TiO_2 catalyst was varied from 0.1 to 1 g/L, and the presence of H_2O_2 was assessed at a concentration of 1 mM.

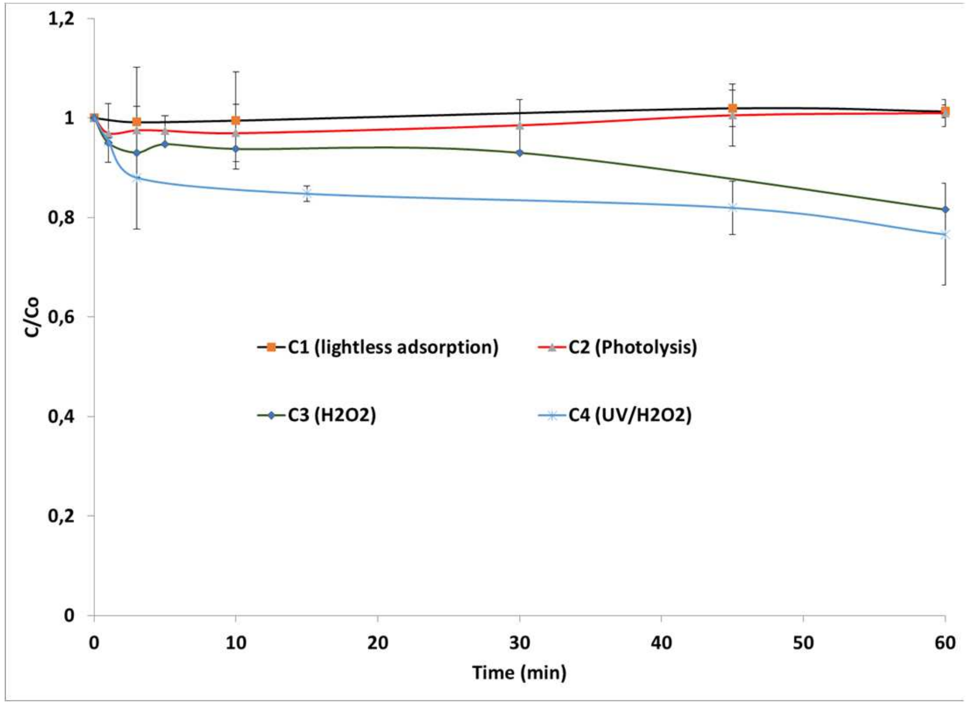
The reactions were carried out in a photochemical reaction system illuminated with 5 LuxTech lamps of 15 Watts each at 254 nm and were in constant stirring (600 rpm) for 60 minutes.

The variation in the concentration of metformin hydrochloride over time was analyzed using high-performance liquid chromatography (HPLC), with an isocratic method using a mobile phase of 0.1% phosphoric acid/acetonitrile, with a flow rate of 0.4 mL/min and an injection volume of 20 µL. Detection was performed at a wavelength of 226 nm, utilizing a Restek Raptor® C18 column, 3 mm x 150 mm, 2.7 µm octadecylsilane, at a temperature of 40°C, with a runtime of 1.3 minutes and a total analysis time of 5 minutes.

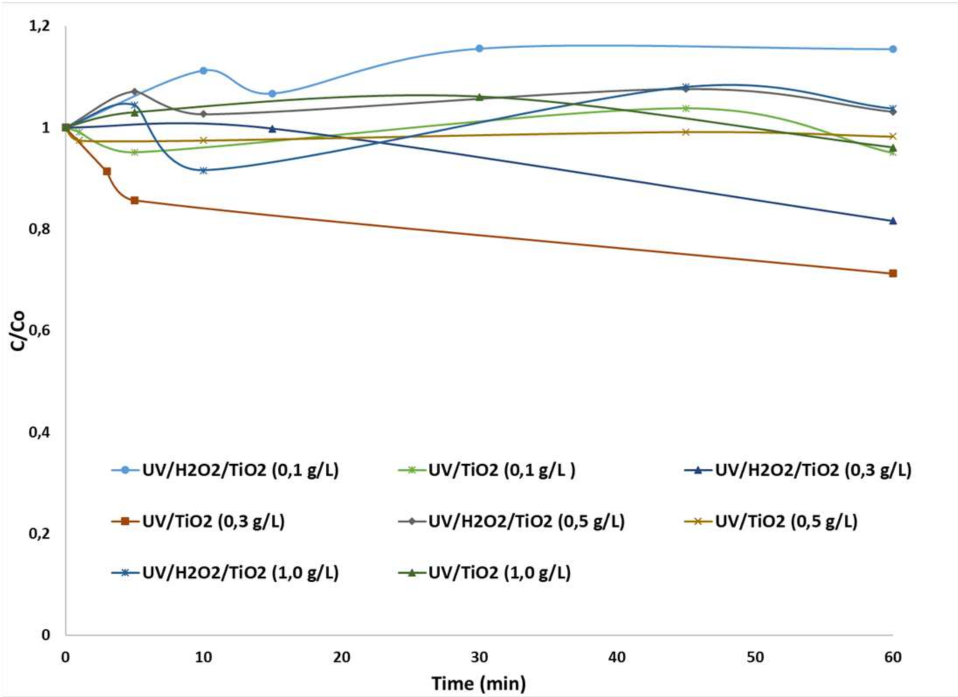
Experiment	TiO_2 (gL^{-1})	H_2O_2 (mM)	Rad (254 nm)
1	0,1	1,0	YES
2	0,3	1,0	YES
3	0,5	1,0	YES
4	1,0	1,0	YES
5	0,1	0,0	YES
6	0,3	0,0	YES
7	0,5	0,0	YES
8	1,0	0,0	YES
C1	0,5	0,0	NO
C2	0,0	0,0	YES
C3	0,0	1,0	NO
C4	0,0	1,0	YES

RESULTS AND ANALYSIS

Degradation graphs of MET for controls and treatments.



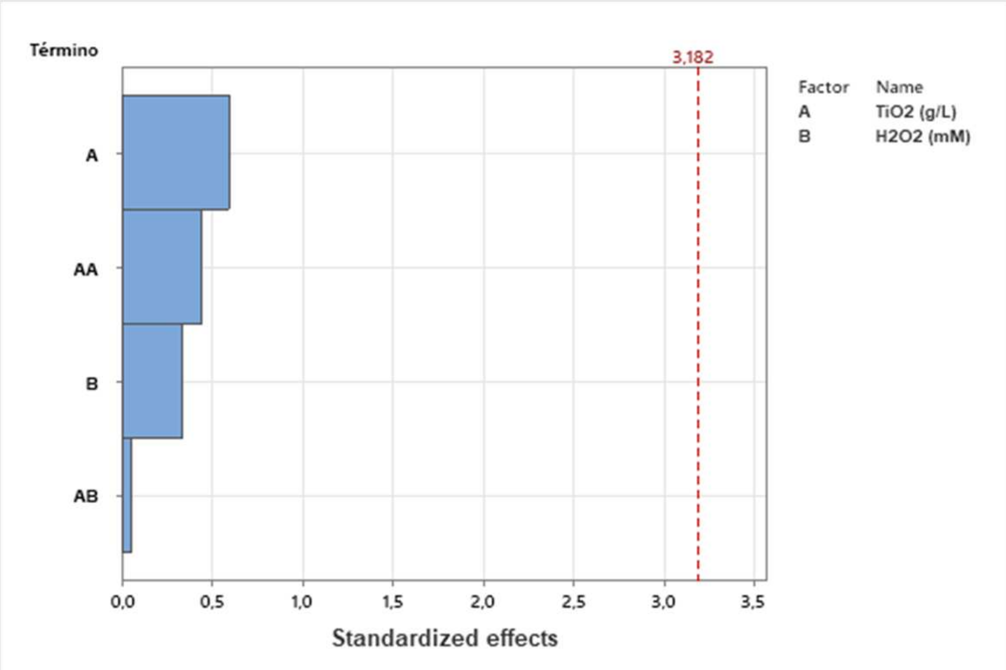
Controls



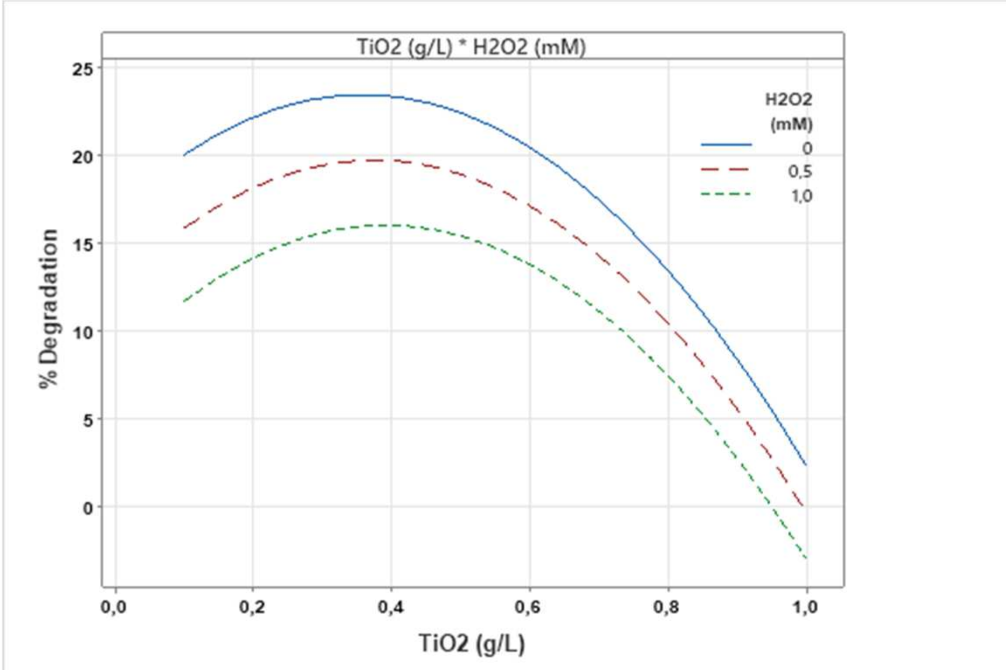
Treatments

RESULTS AND ANALYSIS

Pareto chart and interaction plot.



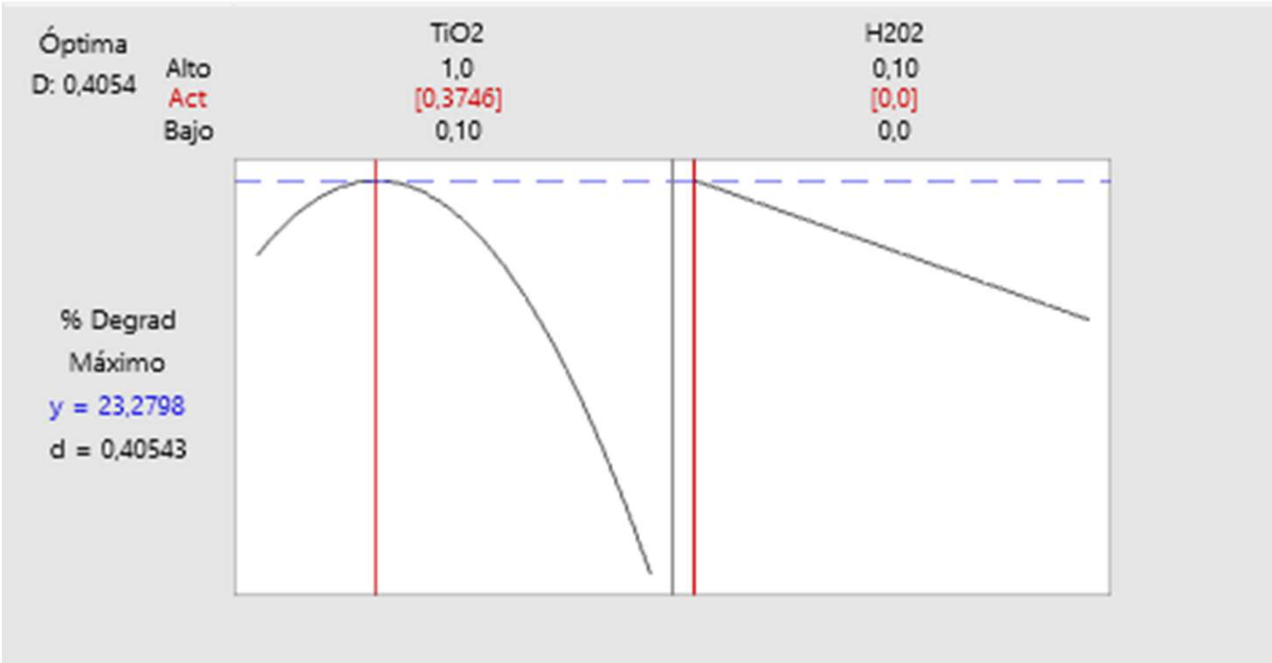
Pareto



interaction

RESULTS AND ANALYSIS

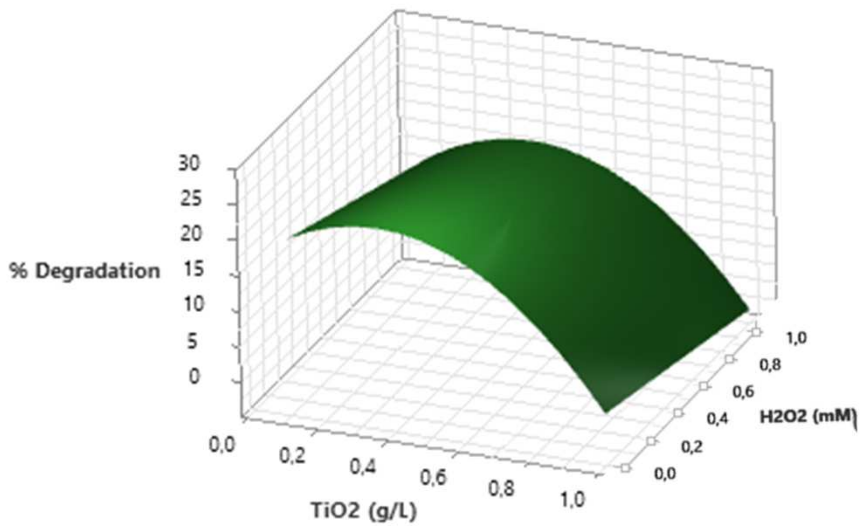
Optimization of MET degradation.



RESULTS AND ANALYSIS

Response surface diagram for MET degradation

The regression model fitted was a second-order linear model. Equation 1 presents the result for the corrected model generated by Minitab®21 software.



$$\%DEGRADATION\ (MET) = \beta_0 + \beta_1[TiO_2] - \beta_2[H_2O_2] - \beta_3[TiO_2 * TiO_2] \quad \text{(Equation 1)}$$

CONCLUSIONS

- In the case of control 4 that combined UV/H_2O_2, a decrease of metformin was observed close to 24%, which shows that hydrogen peroxide can have a direct impact on the metformin degradation reaction.

- It can be evidenced that at low concentrations of TiO_2 there is an interaction with the hydroxyl radicals of H_2O_2 that does not favor the degradation of metformin, Similarly, as the concentration of TiO_2 increases, the reaction is higher when the percentage of degradation is increased from 5 % to 20 %.

- On the response surface for metformin degradation, a second order linear regression model is observed for the catalyst ranges used. Regarding the concentration of catalyst that obtained the most degradation was 0.3 g/L with a percentage of degradation of 23%, this was the one that yielded the best results with the methodology used.

source: Pharmaceutical pollution of the world's rivers. (Wilkinson et al., 2022)

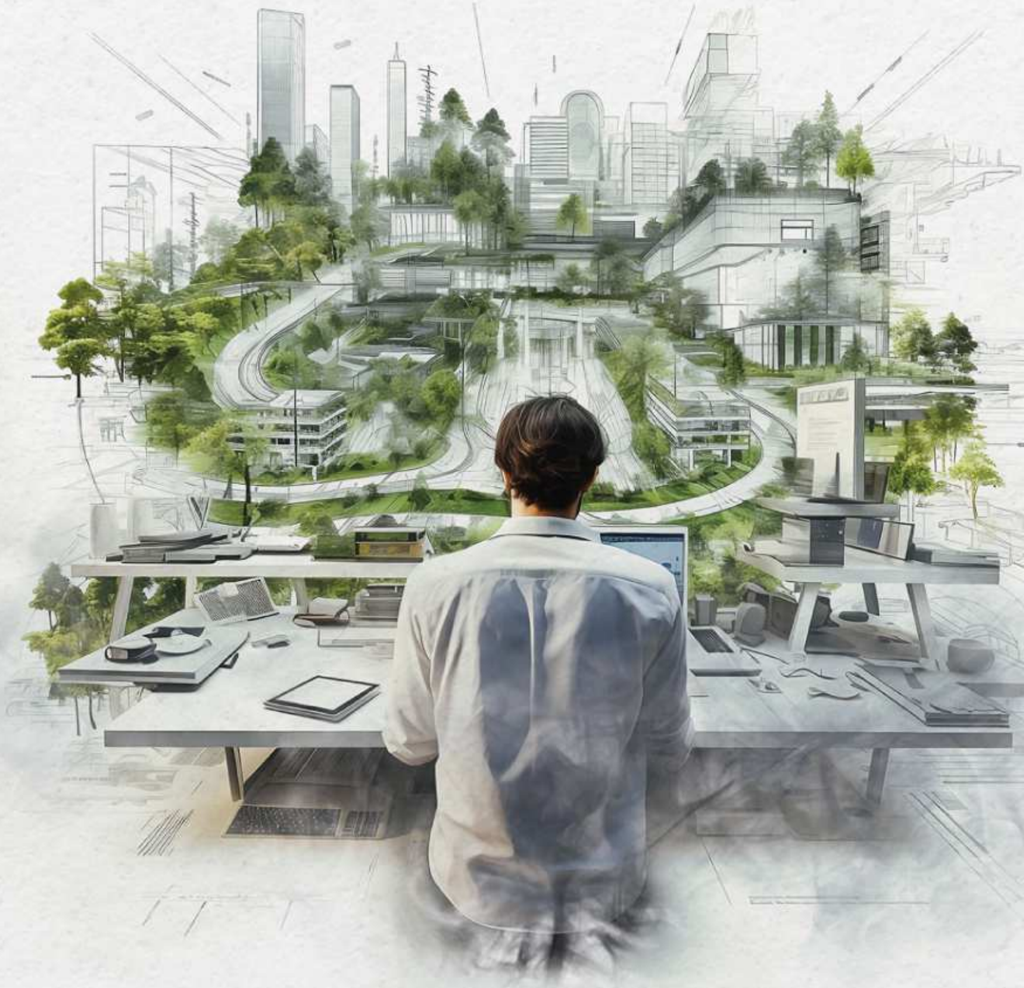
ACKNOWLEDGEMENT

Thanks to the Institución Universitaria Colegio Mayor de Antioquia for the financial support.

To adviser Fidel Granda for his support in every step of this project.

THANKS

QUESTIONS



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SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

DEL 7 AL 11 DE NOVIEMBRE

Edición en Línea. ISSN 2357-5921 Volumen 11- No 2-2023 Publicación Semestral

Compressed earth blocks using biosolids as a sustainable construction alternative.

María Alejandra Bedoya Restrepo.
Sara Valentina Ramírez Arboleda.
Luisa Fernanda Bedoya López.
Yesica Eliana David Úsuga.

Research Project Course
Environmental engineering

Advisors: Ubany Zuluaga, Joan Amir Arroyave and María Elena González.
Methodological Advisor : Gina Hincapié Mejía

November, 2023

SICA
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Institución Universitaria Colegio Mayor de Antioquia

Research Problem

Source: Self made

Edición en Línea. ISSN 2357-5921 Volumen 11- No 2-2023 Publicación Semestral

Theoretical framework

Special and Dangerous Waste

Fuente: https://medioambiente.uexternado.edu.co/algunas-disposiciones-sobre-el-manejo-de-residuos-de-construccion-y-demolicion-en-colombia/

Inadequate disposal

Fuente: https://www.ucr.ac.cr/noticias/2018/11/13/rellenos-sanitarios-una-bomba-de-tiempo-para-el-ambiente.html

BIOSOLIDS

Raw material

Fuente:https://www.areatecnologia.com/TUTORIALES/MATERIALES%20PARA%20LA%20CONSTRUCCION.htm#google_vignette

Contributing to the sustainability of the SDGs

Circular economy

Objectives

General

Evaluate the potential use of biosolids from the wastewater treatment plant of the municipality of Gómez Plata manufacturing BTC as a sustainable construction alternative.

Objectives

Specific

- To characterise physicochemically and microbiologically the biosolid of the PTAR in accordance with Resolution 1287 of 2014.
- Characterize soil and biosolid mixture under INV-E 123, INV-E 133 and NTC 127 standards.
- Manufacture the BTC with the addition of the biosolid of the PTAR of Gómez Plata.
- To evaluate the performance of the BTC applying mechanical strength and density tests, according to the current Colombian standard NTC 5324.
- Verify the safety of microorganisms in BTC.

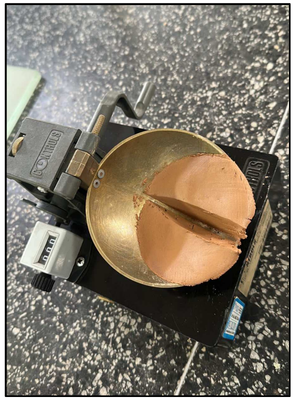
Methodology

1. Biosolid characterization

- Decree 1287 of 2014

2. Characterization of the materials

- Organic Matter Content. (NTC 127 of 2000).
- Soil composition field test.
- Consistency Limits (INV-E-125; INV-E-126)
- Sand equivalent (INV-E-133-07).
- Granulometry (NTC 77 of 2007).



Consistency Limits

Sand equivalent

Granulometry

Organic Matter Content.

Methodology

3. BTC manufacturing

- Definition of replacement percentages: 0% 5% 10%
- Cementing material used: Lime and cement
- 5 BTC units per dosage.
- Total BTC 45
- 7 days of curing.
- 28 days of drying.

4. Compression resistance test

- Simple Compression Tests in BTC (NTC 5324 of 2004).
- Classification analysis within the standa rd (NTC 5324 of 2004).
- Identification of uses and application.

Materials

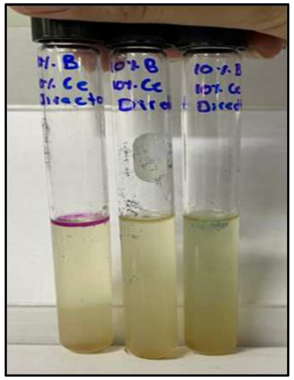
Manufacturing in Cinva Ram

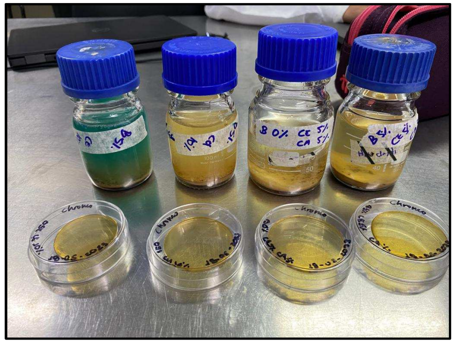
Compression resistance test

Methodology

5. Microbiological analysis

- Analysis by multibes tubes and presence-absence
- Analysis by fungal culture.





Presence-absence

Analysis by multible tubes

Fungal culture

Results and Analysis

BIOSOLID CHARACTERIZATION

Convenciones; CO: Carbono orgánico, CRA: Capacidad de Retención de Agua, CIC: Capacidad de Intercambio Catiónico, CIC/CO. CIC en términos de CO, EC: Electroforesis capilar, PDP: Polarografía diferencial de pulso, ND: No Detectado, NC: No cuantificable, de: desviación estándar, C/N: carbono/nitrógeno, g: gramos, meq: miliequivalentes, mS: milisimens, cm: centímetros, cm^3: centímetro cúbico, LD: Límite de detección, NTC: Norma Técnica Colombiana, SSLMM-42-2-92: Soil Survey Laboratory Methods Manual Reporte Nº42, Versión 2.0, 1992, SM: Standard Methods, APHA: American Public Health Association, AWWA: American Water Works Association, WPCF: Water Pollution Control Federation, AOAC: Association of Oficial Analytical Chemists, FAO:food and agriculture organization. A.A. Absorción Atómica

Parámetro	Expresado como	Técnica	Norma	Resultado	d.e	Unid.
Cadmio total	Cd	A.A	NTC 5167	< 0.1	-	ppm
Cromo total	Cr	A.A	NTC 5167	< 1.0	-	ppm
Níquel total	Ni	A.A	NTC 5167	52.45	0.07	ppm
Plomo total	Pb	A.A	NTC 5167	24.1	0.1	ppm
Zinc total	Zn	A.A	NTC 5167	0.272	0.001	%
Mercurio	Hg	A.A vapor frío	SM 3112A	< 0.01	-	ppm
Arsénico	As	A.A generador de hidruros	SM 3114C	< 0.01	-	ppm
Cobre	Cu	A.A	NTC 5167	0.01345	0.00004	%

Convenciones: ufc. unidades formadoras de colonias. NMP número más probable

Código de la muestra	NMP Coliformes totales / 100 ml	NMP Coliformes fecales / 100 ml	Huevos de Helmintos viables / 4 g	Salmonella / 25 g
16feb2304	> 2400	> 2400	Negativo	Negativo

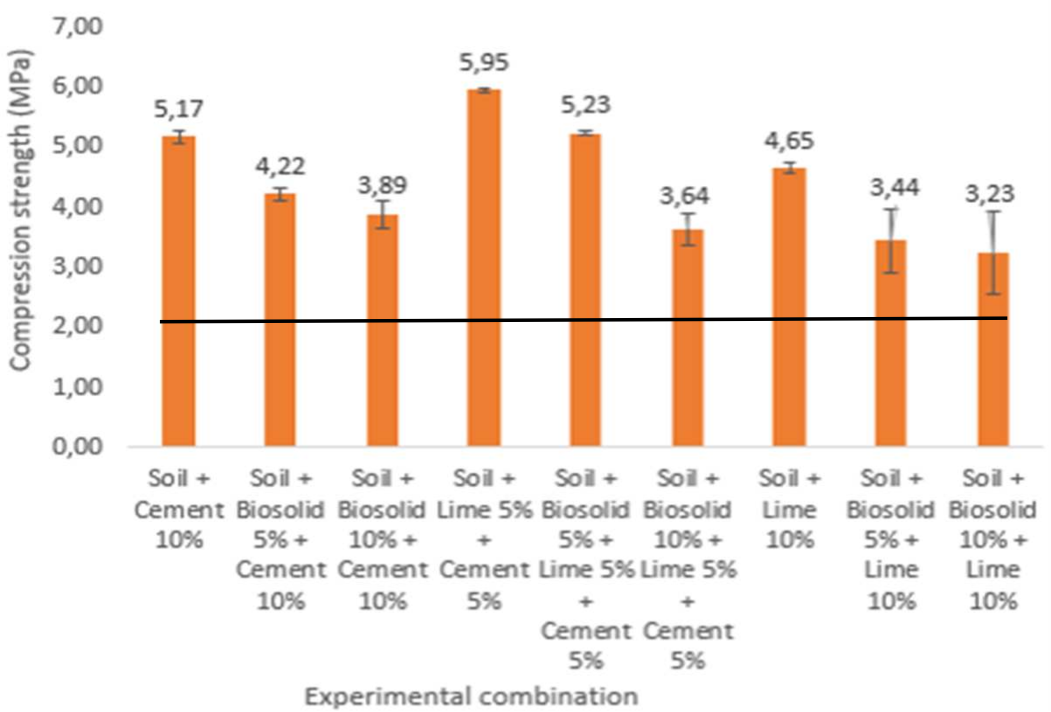
Tabla 2. Valores máximos permisibles de categorización de biosólidos para su uso

Criterio	Variable	Unidad de Medida	Categoría Biosólido Valores máximos permisibles	
			A	B
Químicos– Metales Concentraciones máximas	Arsénico (As)	mg/kg de biosólido (base seca)	20,0	40,0
	Cadmio (Cd)		8,0	40,0
	Cobre (Cu)		1.000,0	1.750,0
	Cromo (Cr)		1.000,0	1.500,0
	Mercurio (Hg)		10,0	20,0
	Molibdeno (Mb)		18,0	75,0
	Níquel (Ni)		80,0	420,0
	Plomo (Pb)		300,0	400,0
	Selenio (Se)		36,0	100,0
	Zinc (Zn)		2.000,0	2.800,0
Microbiológicos	Coliformes fecales	Unidades Formadoras de Colonias - UFC/g de biosólido (base seca)	<1,00 E (+3)	<2,00 E (+6)
	Huevos de Helmintos Viables	Huevos de Helmintos viables/4 g de biosólido (base seca)	<1,0	<10,0
	Salmonella sp.	Unidades Formadoras de	Ausencia	<1,00 E (+3)

Maximum permissible values according to decree 1287/2014

Results and Analysis

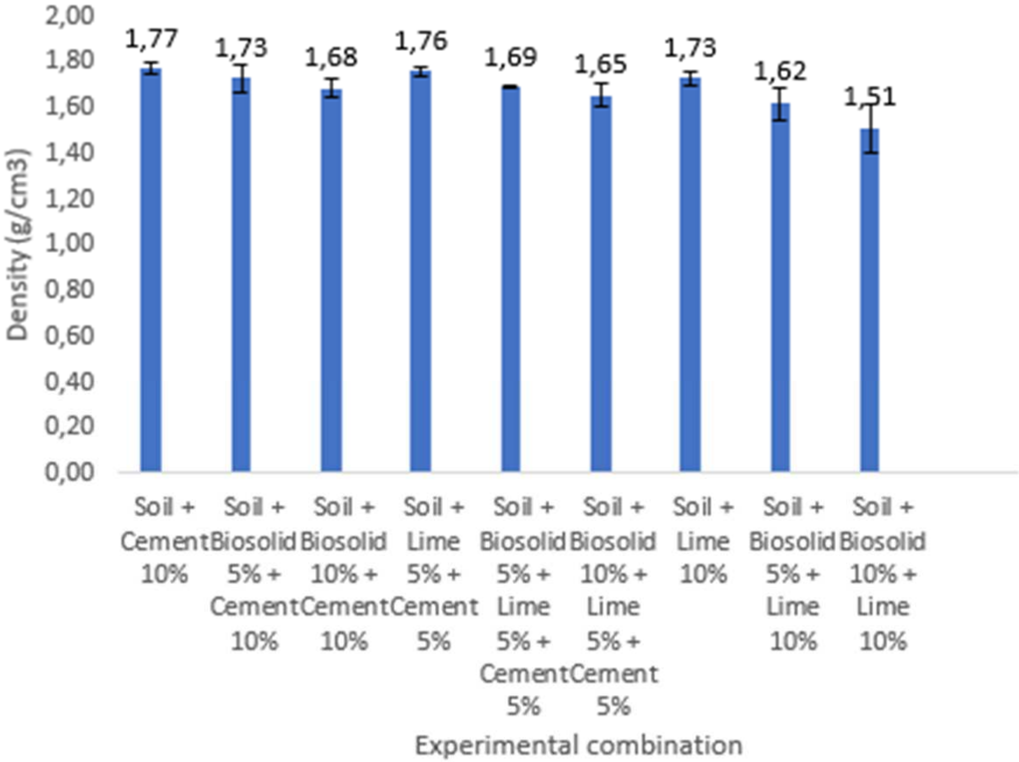
STRENGTH



BTCs exceed the minimum resistance required by NTC 5324 of 2004.

Results and Analysis

DENSITY



The density decreases when the percentage of biosolid increases, reflecting a lower effort in the structure.

Results and Analysis

COLIFORMS

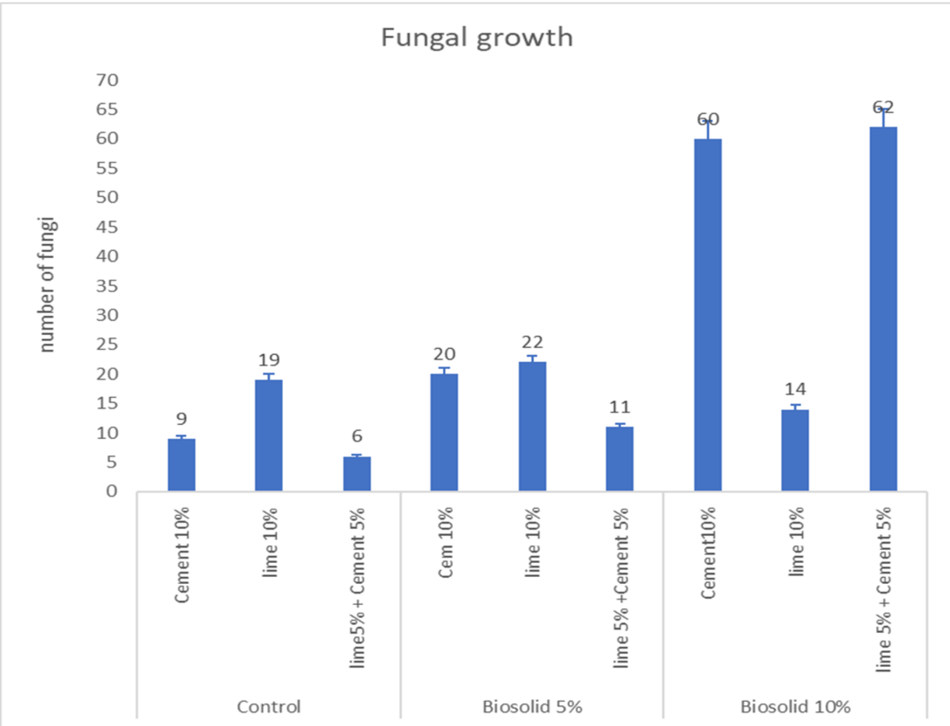
Experimental design	TOTAL COLIFORMS				FECAL COLIFORMS			
	MPN			MPN/g	MPN			MPN/g
	D	-1	-2	RESULT	D	-1	-2	RESULT
Soil + Cement 10%	0-0-0	0-0-0	0-0-0	<0	0-0-0	0-0-0	0-0-0	<0
Biosolid 5%+Cement 10%	0-0-0	0-0-0	0-0-0	<0	0-0-0	0-0-0	0-0-0	<0
Biosolid 10%+ Cement 10%	0-0-0	0-0-0	0-0-0	<0	0-0-0	0-0-0	0-0-0	<0
Biosolid 5% + Lime 5%-Cemento 5%	0-0-0	0-0-0	0-0-0	<0	0-0-0	0-0-0	0-0-0	<0
Biosolid 10%+ Lime 5% -Cement 5%	0-0-0	0-0-0	0-0-0	<0	0-0-0	0-0-0	0-0-0	<0
Biosolid 10% + Lime 10%	1-0-0	0-0-0	0-0-0	2	1	0	0	2

Experimental design	TOTAL COLIFORMS	FECAL COLIFORMS
	RESULT	RESULT
Soil + Lime 5%-Cement 5%	Absence	Absence
Soil + Lime 10%	Absence	Absence
Biosolid 5% + Lime 10%	Absence	Absence

The combination of soil, lime, cement and biosolid have an inhibitory effect on total coliforms and fecal coliforms.

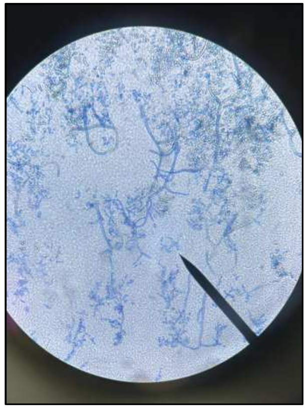
Results and Analysis

FUNGI

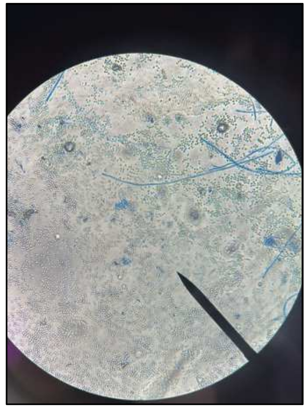


The higher the concentration of biosolid, the lime has an effect on the growth of fungi.

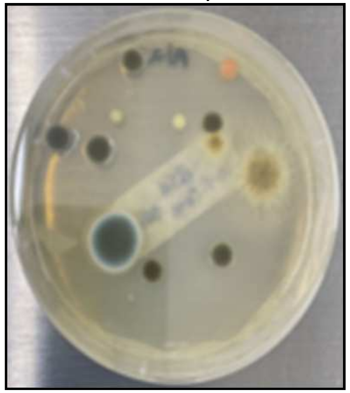
Cladosporium sp (5% bio- 10%cem)



Penicillium sp (5% bio- 10%cem)



Molds and yeasts



Conclusions

- The biosolid of the PTAR of the municipality of Gómez Plata presents an optimal characterization for the elaboration of BTC, according to parameters established by the standard.

- For the construction of BTC, the amount of organic matter for mixing biosolid and sand, the optimal percentages are 5% and 10%.

Conclusions

- It is evident that the combination of lime and cement in equal proportions as cementing material, presented better results for the aspect of compressibility resistance.

- Stabilizers such as lime and cement were effective when mixed with the biosolid.

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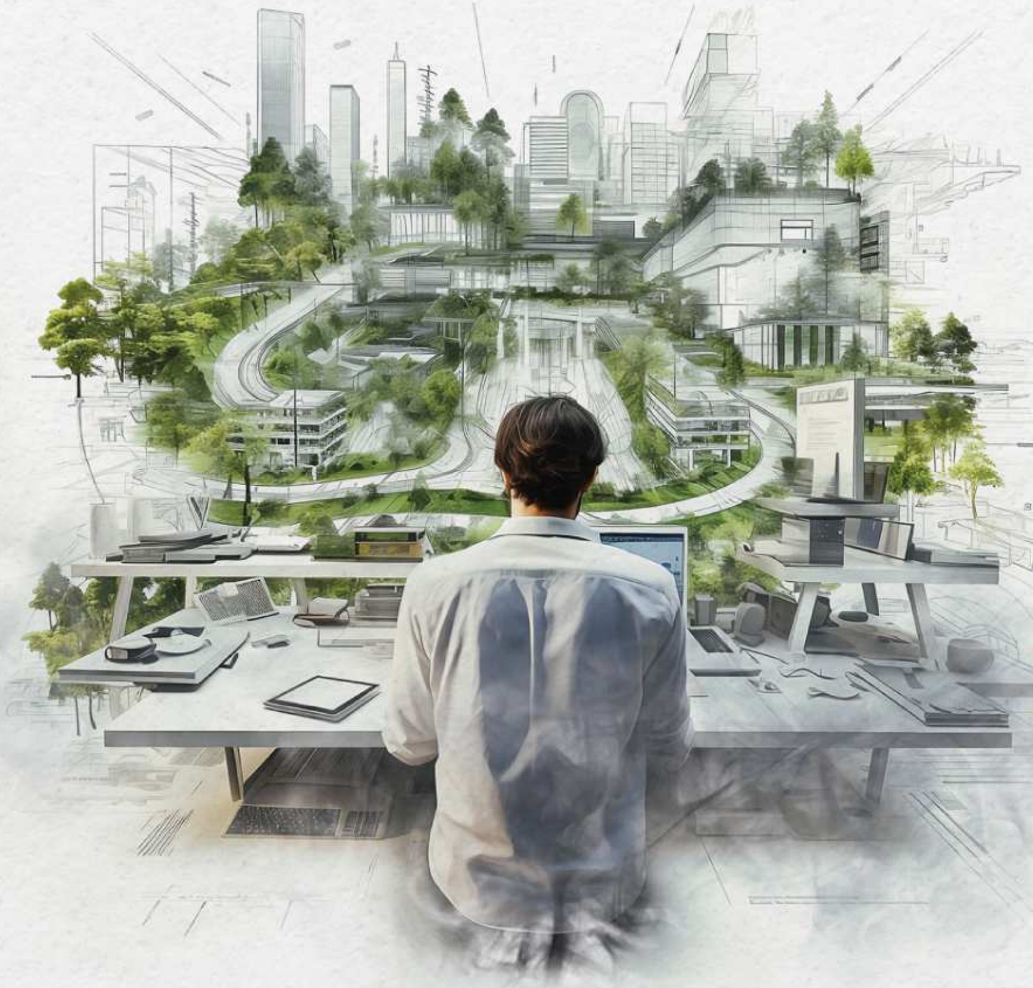

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SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

DEL 7 AL 11 DE NOVIEMBRE

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Edición en Línea. ISSN 2357-5921 Volumen 11- No 2-2023 Publicación Semestral

Methylene blue adsorption in aqueous medium with coking carbon

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WILMER STEVEN MUÑOZ VARGAS

Curso Proyecto de Investigación
Ingeniería Ambiental

Asesor Temático: Julián Esteban López Correa, Joan Amir Arroyave
Asesor Metodológico: Gina Hincapié Mejía

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Introduction

The industry is a global economic engine, but its growth has triggered a significant environmental challenge.

production processes generate wastewater contaminated with toxic chemicals and dyes.

* Impact
* Human Health
* Compliance
* Sustainability and Corporate Responsibility

Environmental Problem

- **Impact of Liquid Effluents:** Textile effluents contain toxic substances and dyes.

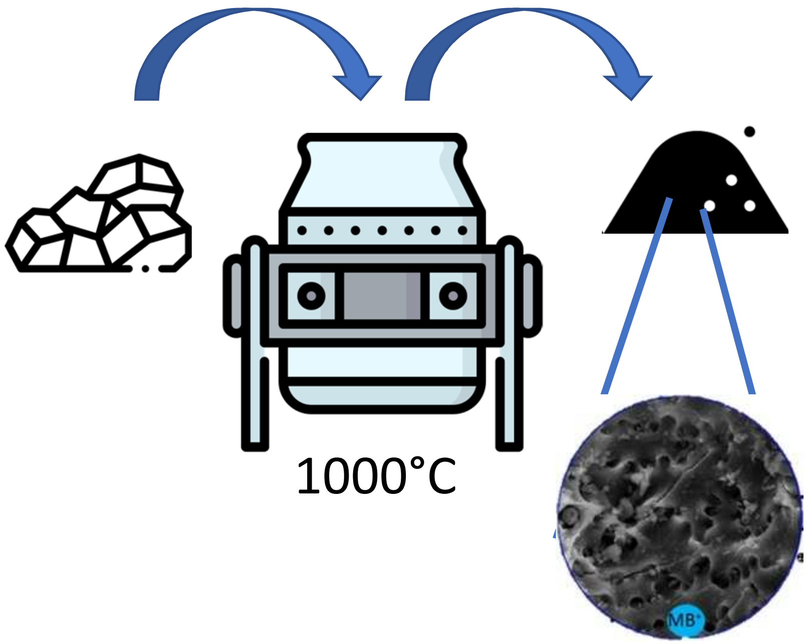
* **Threat to the Environment:** Danger to aquatic ecosystems and biodiversity.

* **Regulatory control:** Local regulations regulate this parameter through the "Metropolitan Agreement N° 21".

Obtaining and properties of coke coal

Coking bituminous coal at 1000°C for 24 hours involves heating it in the absence of air to remove volatile compounds and obtain coke, a solid, porous material.

the coking coal was obtained from an agricultural products store called Colombian happy.



Objectives

To evaluate the percentage removal of methylene blue in water by adsorption with coke coal.

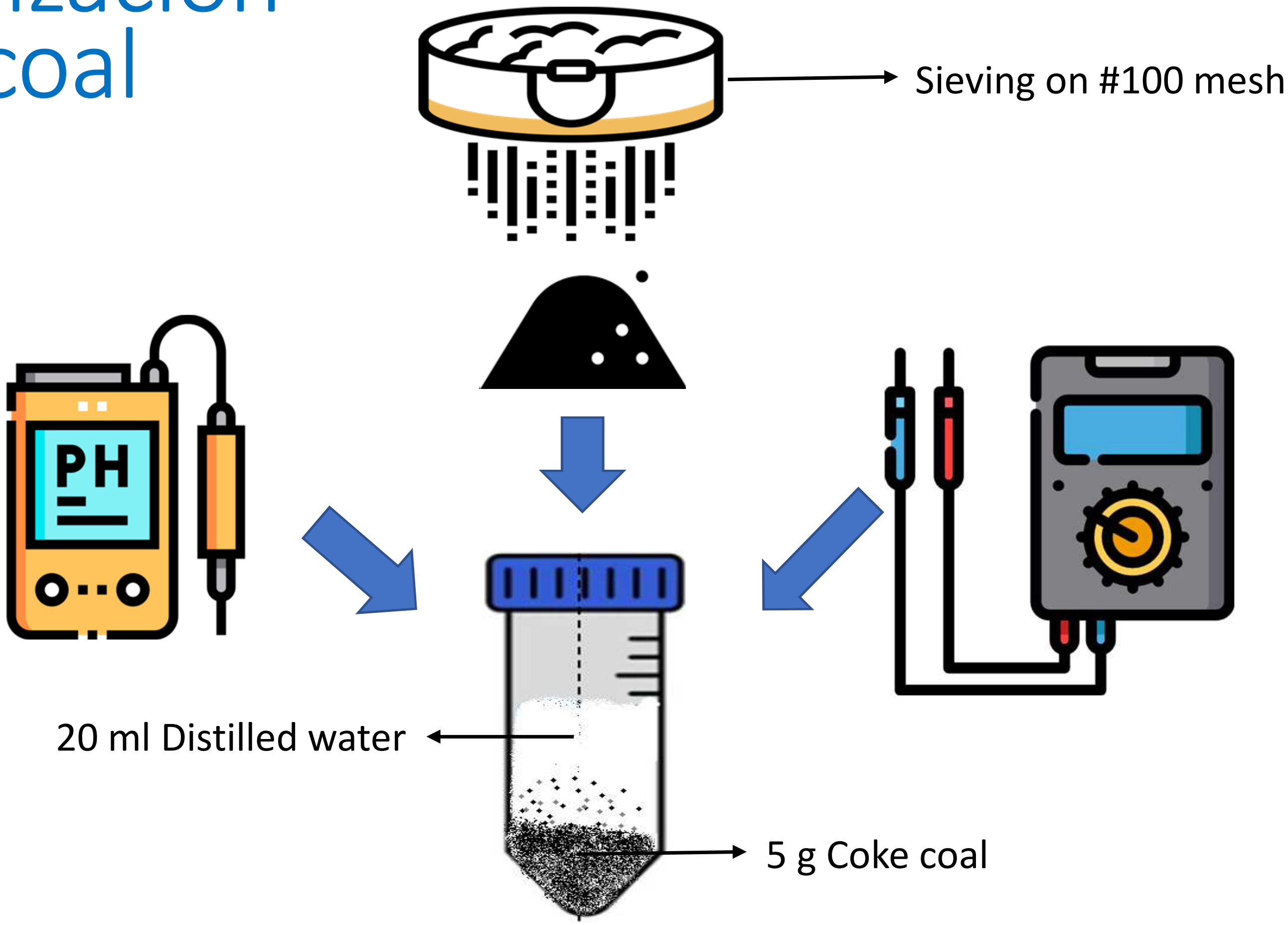
- Determine the physicochemical and surface properties of coke coal to understand its sorption capacity.

- Quantify the percentage of methylene blue removal with coke coal

- Calculate the Langmuir isotherm model on experimental data to determine the maximum holding capacity of coke coal.

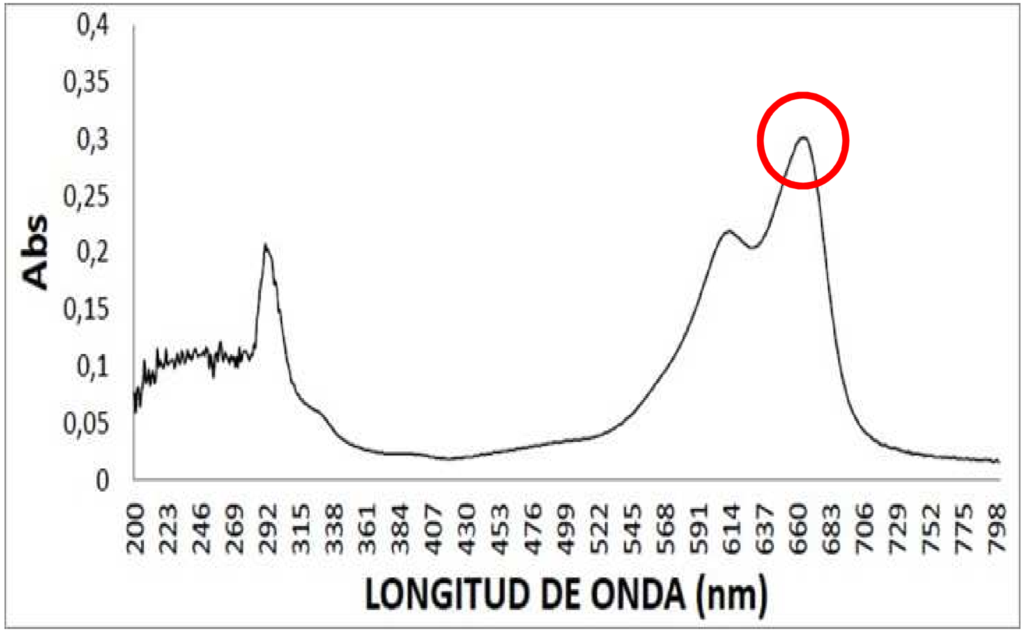
Methodology

Caracterización of coke coal



Calibration Curve

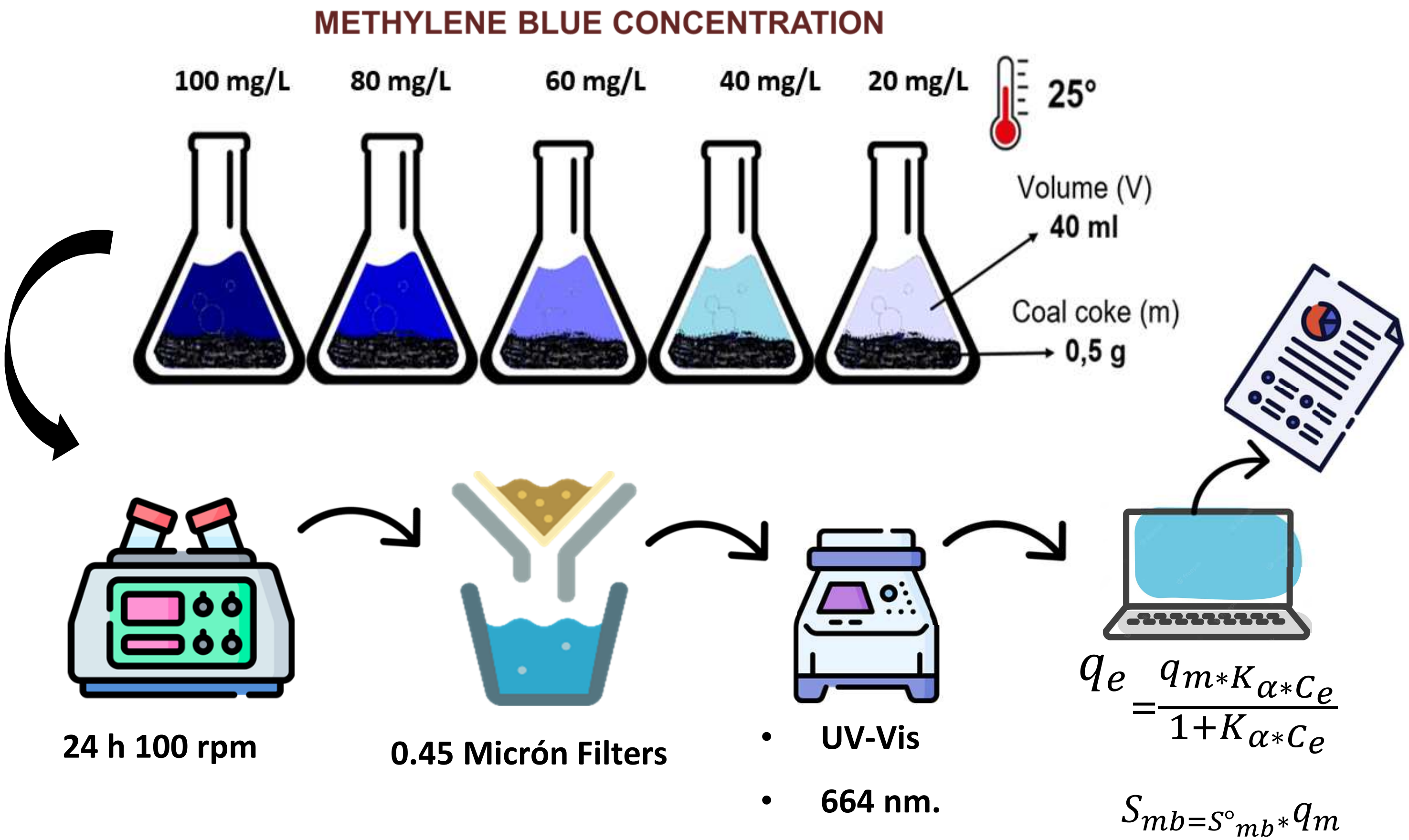
Methylene blue solutions with concentrations 1, 2, 4, 8 and 16 was prepared and the absorbance of each solution was measured at an optimal wavelength 664 nm.



Adsorption of Methylene Blue with Coking Carbon

Randomized experimental design

Number of replicates: 2
Variable Factor:
Concentration of Methylene Blue
Fixed Factor: Dose of Coke Coal



Analysis and results

Characterization of coal coke

These data are critical to understanding the adsorption capacity of coal and its suitability as an adsorbent for pollutant removal.

parameter	value	unit
Particle Size Max.	150	µm
Electrical Conductivity	521.33	µS/cm
pH	6.4	-
Surface área stimated estimada	34.2806	$m^2\ mg^{-1}$

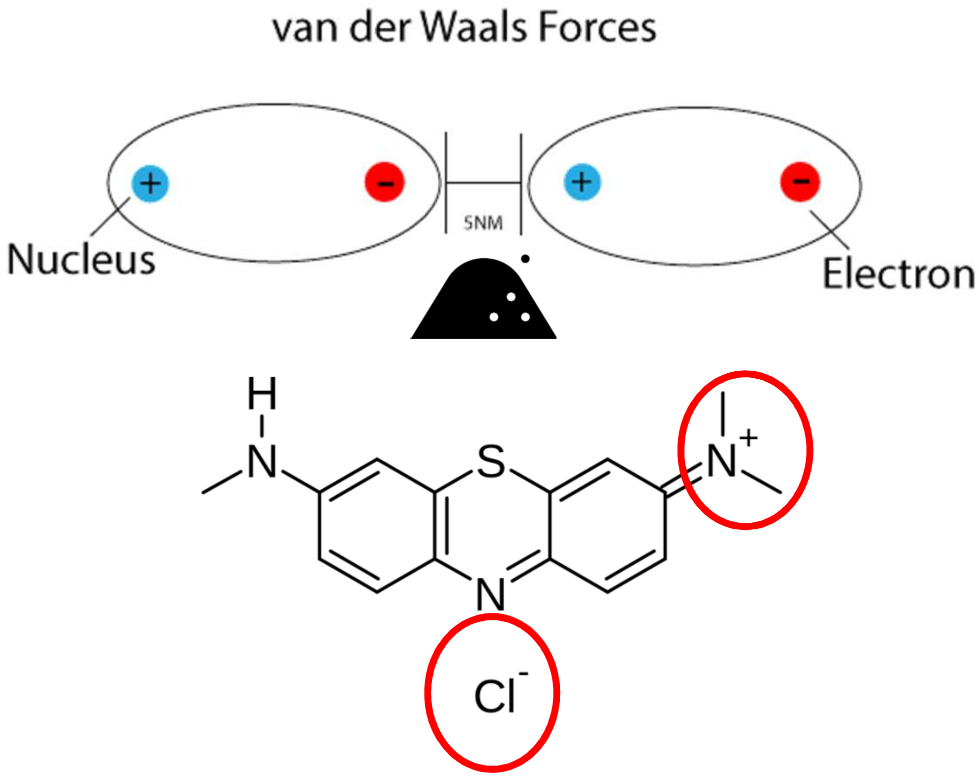
Properties of coal and Effects on pH

Concentration	pH
0	6,99
20	6.26
40	6.48
60	6.97
80	7.37
100	7.80
0d	7.27
20d	7.45
40d	7.23
60d	7.66
80d	7.55
100d	7.74

Coke coal does not appear to have a significant impact on the acid-base balance. pH values remained within an acceptable range as the concentration of coke coal increased.

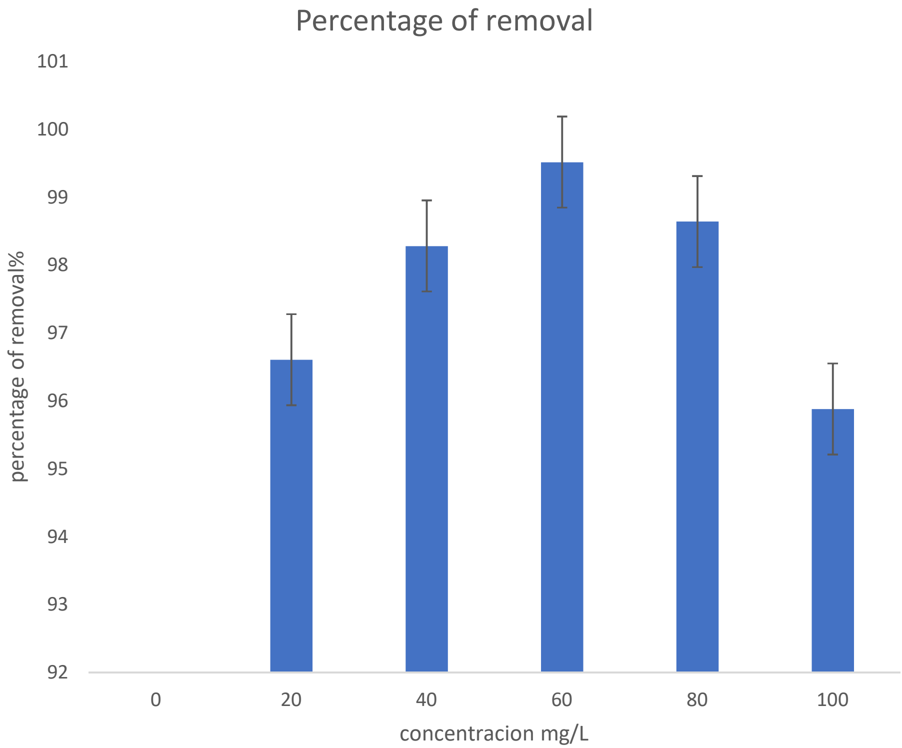
Properties of Coke coal

Coke coal is an effective adsorbent for methylene blue. The combination of its porous structure, positive charge and functional groups makes it an ideal material for the removal of this dye from wastewater.

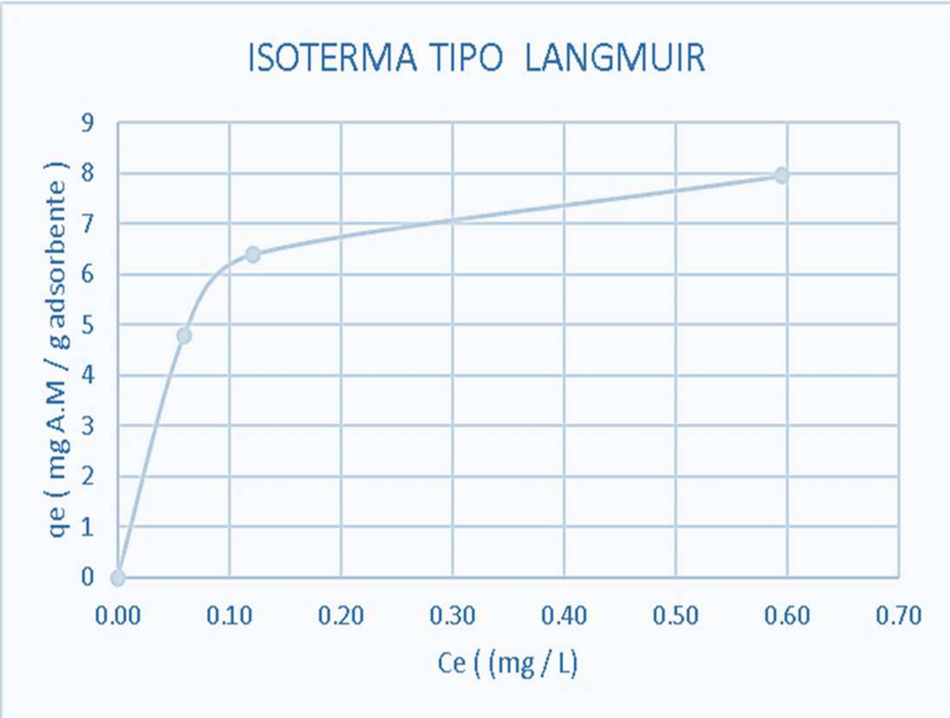


Removal of methylene blue

the results of the adsorption experiments of Methylene Blue (MB) with coking carbon. The results show a high adsorption efficiency of coking carbon, with removal percentages ranging from 96% to 99.50%, depending on the initial concentration of MB.



Langmuir Isotherm



The concentrations of 60 mg/L, 80 mg/L and 100 mg/L of AM were taken from the adsorption isotherm because they present an increase and decrease in the percentage of elimination, which is necessary to find the maximum adsorption capacity (qmax) of the coking coal, identifying that the coal is saturated from the concentration of 60 mg/L.

Conclusions

* Coke carbon is a good adsorbent for methylene blue because of its proper particle size, slightly acidic pH, and an electrical conductivity that suggests chemical interactions. Its high surface area makes it effective in removing methylene blue from industrial discharges, helping to reduce environmental pollution.

* The results show that coke coal is highly effective in removing methylene blue, reaching a removal of 99.90% in solutions with 60 ppm. This supports its efficiency in reducing pollution from industrial discharges.

* The adsorption isotherm of coking carbon reveals that its maximum capacity is achieved at 60 mg/L of methylene blue, with a qmax of 17.76 mg/g, which shows a moderate adsorption capacity compared to activated carbon, highlighting its limitations in terms of adsorption capacity.

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SEMANA DE LA FACULTAD
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DEL 7 AL 11 DE NOVIEMBRE

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Contamined Soil Phytoremediation with cupper using *Helianthus annus* (Sunflower) associated to Arbuscular Mycorrhizal Fungi

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Thematic Advisor: Laura Osorno Bedoya
Methodological Advisor : Gina Hincapié Mejía

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Research Problem

The overabundance of copper in the soil causes stress and damages plants, this causes impediments in their development and chlorosis, producing oxidative pressure on them.

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Theoretical framework

Phytoremediation uses plants to eliminate heavy metal contaminants from the soil; it has great potential to remediate soils contaminated with heavy metals, due to its low cost and efficiency.

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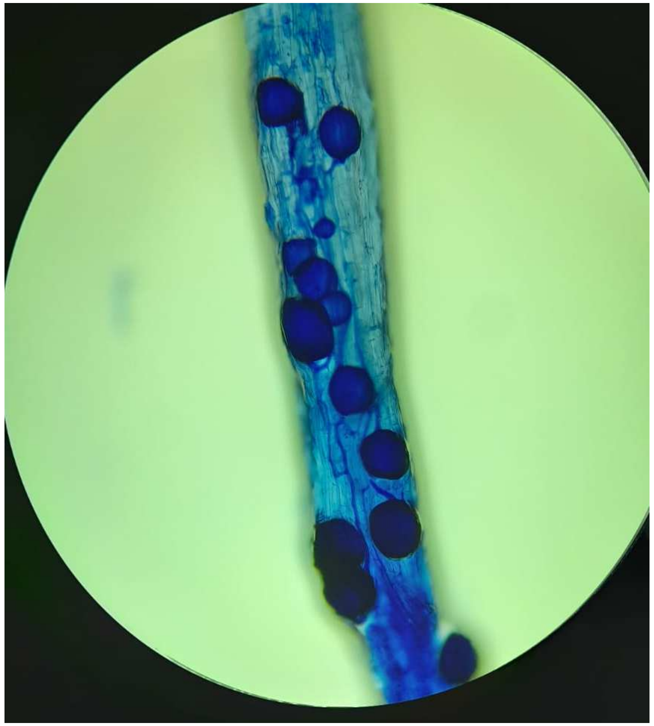
Theoretical framework



Arbuscular Mycorrhizal Fungi (AMF) can effectively colonize within the roots of some species of hyperaccumulator plants and exhibit a mechanism of tolerance and accumulation of heavy metals.

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Goals

General

To evaluate the efficiency of phytoremediation of soils contaminated with Cu(II), using the Sunflower plant (*Helianthus annuus*) with the addition of Arbuscular Mycorrhizal Fungi as adjuvants of the hyperaccumulation of the micronutrient..

Specific

1. Evaluate the initial physicochemical characteristics of a standard soil selected for experimentation.
2. To evaluate the growth of Sunflower (*Helianthus annuus*) in a soil contaminated with Cu(II), and with Arbuscular Mycorrhizal Fungi.
3. Analyze the effect of phytotreatment with the Sunflower plant and Arbuscular Mycorrhizal Fungi on the percentage of Cu(II) removal in the contaminated soil.

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Methodology

Figure 1. Treatment of Arbuscular Mycorrhizal Fungi for a soil contaminated with Cu

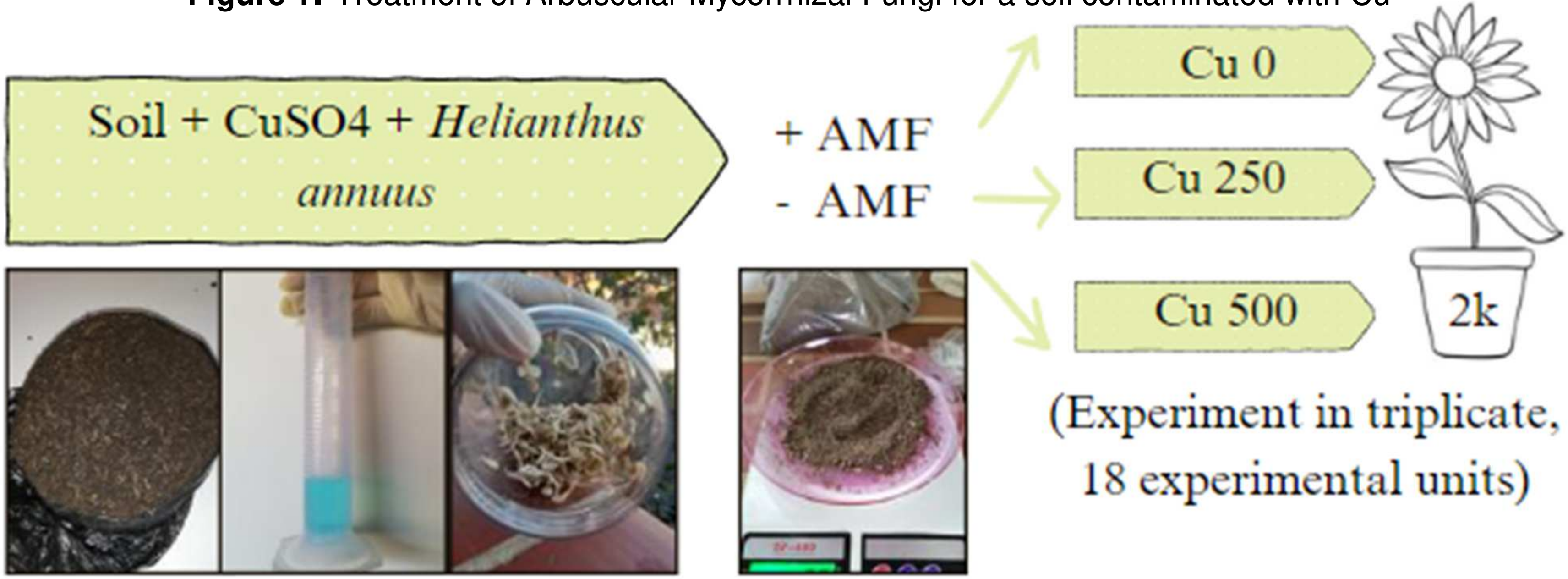

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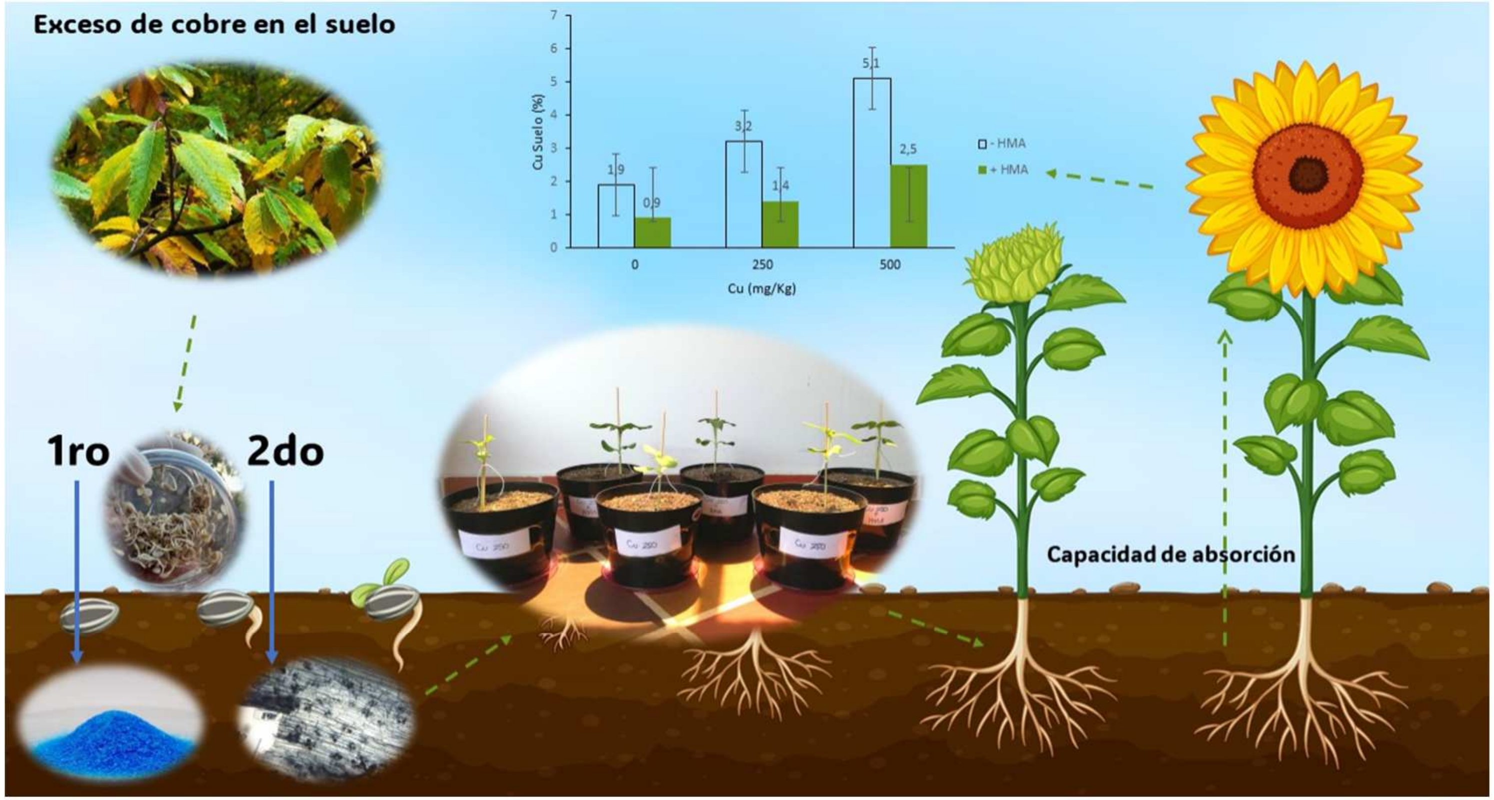
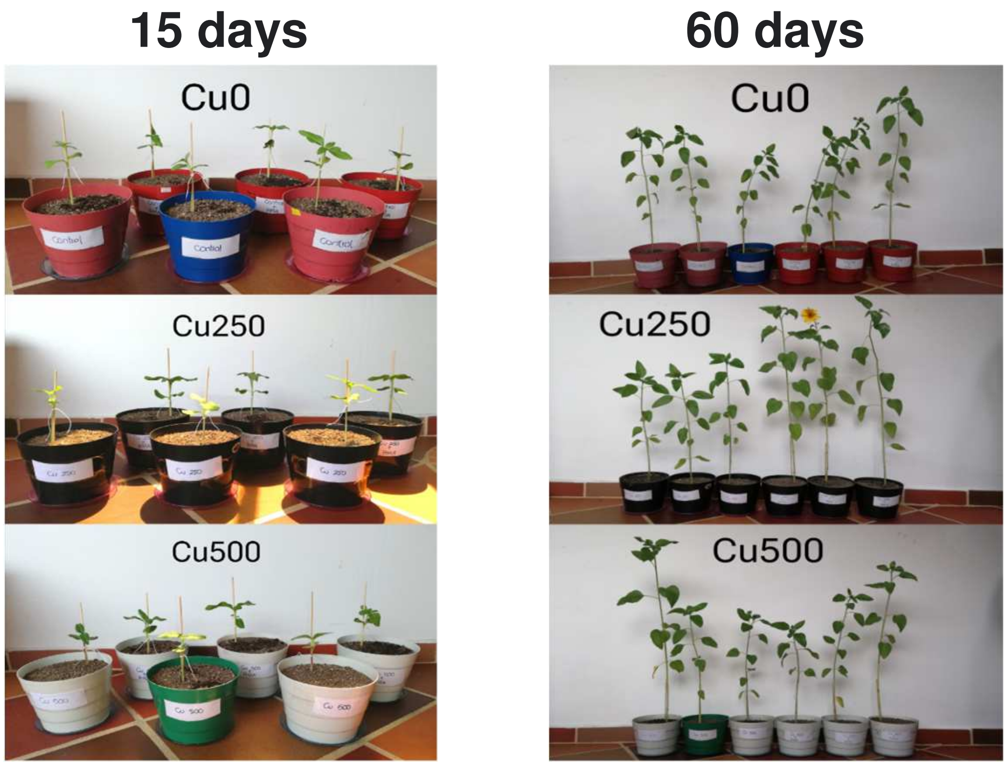
Figure 2. Graphic summary.



Source: authors

Results and analysis



Source: authors

Figure 2. Monitoring of plant development, 15 days of germination and 60 days of germination.

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Results and analysis

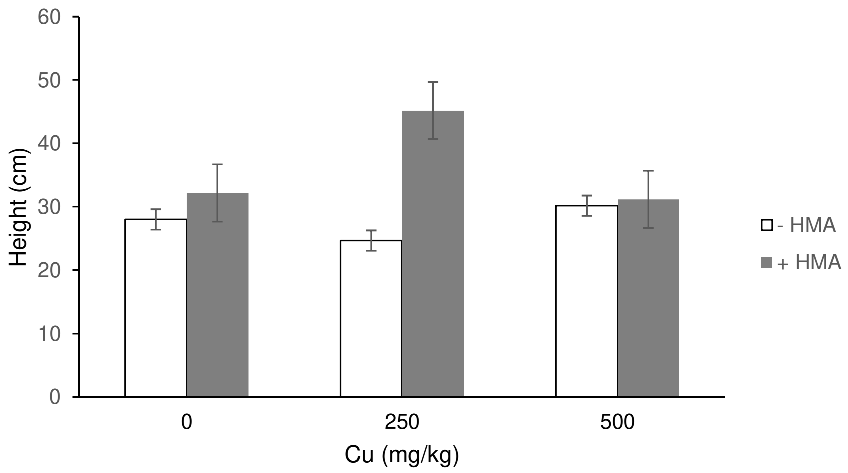

Figure 3. Height of *Helianthus anuus* plants, growing at different doses of Cu 0, 250 and 500, inoculated or not with AMF**.**

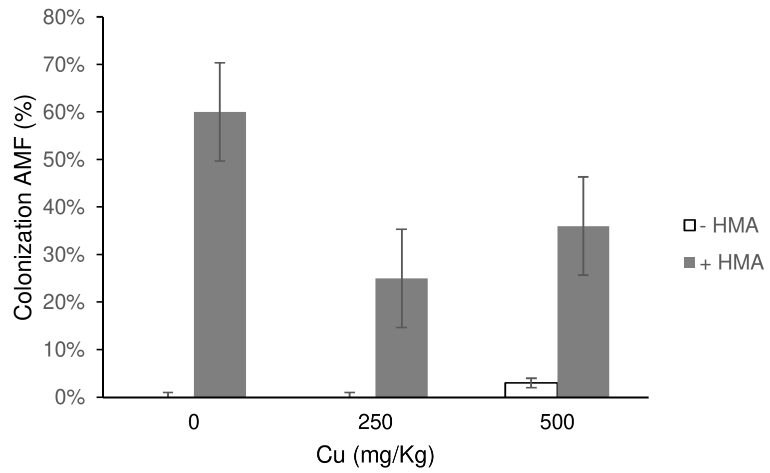

Figure 4. Colonization of *Helianthus anuus* roots, inoculated or not with AMF.

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Results and analysis

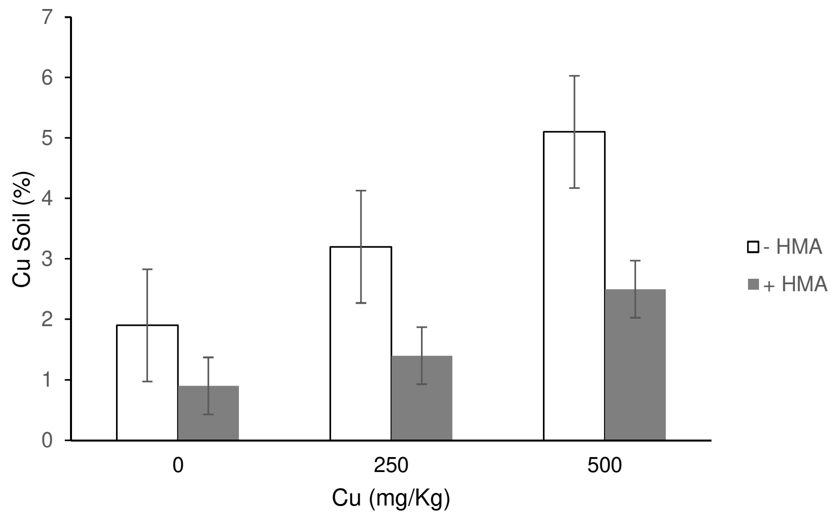

Figure 5. Percentage of Cu remediating in the soil at different doses of Cu 0, 250 and 500 inoculated or not with AMF.

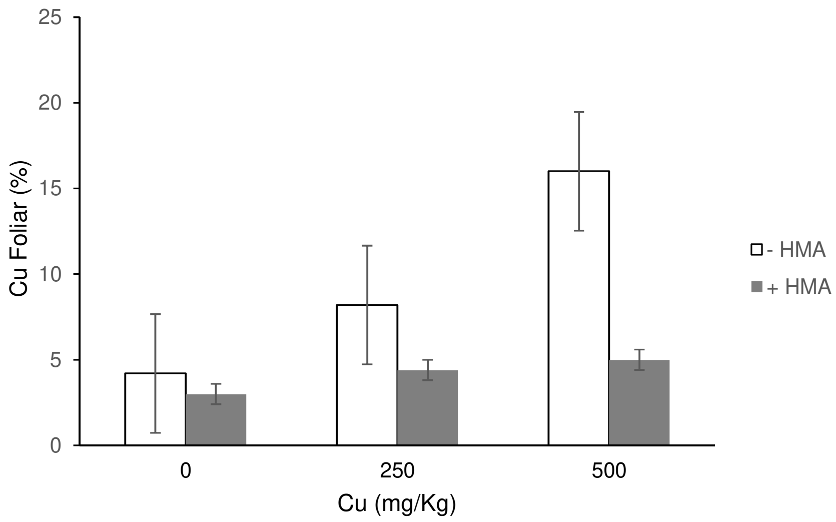

Figure 6. Percentage of Cu remediated in *Helianthus anuus* plants, inoculated or not with AMF.

Conclusions

- The sunflower is a hyperaccumulator plant that presents phytoremediation of Cu, accumulating a large amount in its roots, stem and leaves, which makes it a viable option to recover soils contaminated with heavy metals.

- AMF improve the ability to sequester and accumulate heavy metals in their biomass and in the roots of the host plant. Additionally, they can tolerate a wider range of heavy metal concentrations and other adverse soil conditions.

- Cu is an essential metal for the growth and development of plants, it is a micronutrient that participates in many physiological processes and an essential cofactor for many metalloproteins. But in high concentrations it is potentially toxic to microorganisms.

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