XXV SEMANA DE LA Arquitectura e Ingenieria

Muestra investigativa. Muestra de Poster Ingeniería Ambiental

Nombre de la actividad: Curso: Anteproyecto de investigación **Docente:** Carlos Fidel Granda, Andrea Tamayo Londoño **Programa:** Ingeniería Ambiental **Objetivos de la actividad:** Divulgar los avances en los proyectos de investigación

formulados por lo estudiantes de Ingeniería Ambiental. **Productos a divulgar y proceso:**

Poster con resultados parciales de los proyectos, cada poster contiene: Título, autores, problema, marco teórico, objetivos, metodología, principales resultados, conclusiones parciales y bibliografía





VIGILAD/





ANALYSIS OF THE EFFECT OF BIOCHAR IN THE TREATMENT OF DAIRY INDUSTRY WASTEWATER IN A UASB REACTOR.

AUTHORS: SARA MAYA GAVIRIA, KAREN LOPERA MONCADA, DANIELA VELAZCO AGUDELO, ISABELA JARAMILLO VALENCIA. THEMATIC ADVISOR: JUAN DAVID CORREA ESTRADA METHODOLOGICAL ADVISOR: CARLOS FIDEL GRANDA - ANDREA TAMAYO

PROBLEMATIC:

The Colombian dairy industry generates high volumes of wastewater with high organic load. In 2023, national production reached approximately 7,097 million liters of milk, consolidating its importance in the agroindustrial chain [4]. However, it is estimated that for each liter of milk processed, between 1 and 6 liters of wastewater are generated [1]. This water is characterized by its high content of organic matter, due to its richness in whey. Whey is a by-product generated in the dairy industry and its main components are lactose, proteins and some minerals, and it contains a high organic load with COD values between 50,000 and 80,000 mg/L [6], whose inadequate management limits the efficiency of conventional treatments such as UASB reactors, generating significant environmental impacts. Therefore, optimizing the treatment of dairy wastewater by incorporating biochar in UASB reactors will improve organic load removal, increase biogas production and strengthen sustainable practices in the agroindustrial sector. This project will contribute to the fulfillment of SDGs 6, 7 and 11, promoting clean technologies, circular economy and climate change mitigation.

OBJECTIVES:

GENERAL:

Evaluate the effect of biochar addition in the anaerobic digestion of dairy wastewater on methane production and organic load removal.

SPECIFIC:



THEORETICAL FRAMEWORK:

Anaerobic digestion converts organic matter in wastewater into biogas. UASB reactors are efficient in space and biogas generation, although they face limitations when its parameters are not in optimal ranges.

Biochar, a porous carbon from lignocellulosic wastes, improves microbial adhesion, direct electron transfer and stabilizes pH. Studies have only been at the scale of batch and pilot UASBs and have shown increases of up to 24% in methane production and more than 50% in COD removal. However, no studies have yet been conducted in continuous UASB with dairy effluent, so this project will evaluate the position, dosing and substitution of biochar to optimize performance and potential scalability of the treatment

- log Verify the operational stability of a UASB reactor after the implementation of hydraulic improvements and addition of dairy inoculum.
- line with the effect of biochar addition on methane yield and organic load removal from dairy wastewater.
- betermine the temporal effect of biochar addition on process operational variables and UASB reactor stability.

METHODOLOGY:



RESULTS AND ANALYSIS :

A UASB reactor was designed using rhinoceros 3D design software based on a pre-existing acrylic model and following the design parameters defined by Romero [20]. Calculations were performed to determine the reactor volume, hydraulic retention time (HRT), and feed and recirculation flow rates.

The reactor was subjected to hydraulic tests, feeding according to the feed and recirculation flow rates; in addition, gas leakage tests were carried out, which were corrected to have the reactor in correct operation.

Pressure gauge

7,062

0,1130

23,3°C





PARAMETER	VALUE	UNITY
Reactor cylinder diameter	0,05	m
Cylinder section area	0,00196	m ²
Reactor cylinder height	0,78	m
Reactor cylinder volume	1,53	L
Reactor lower cone height	0,07	m
Lower cone volume	0,18	L
Total volume	1,7	L
Holding Time Hydraulic	8,0	h
Holding Time Hydraulic	0,3	d
Reactor inlet flow rate	5,14	L/d
Reactor inlet flow rate	3,6	mL/min
Time between feedings	10,0	min
Reactor inlet flow rate	36	mL (10 min
Reactor speed	5	m/h
Reactor inlet flow rate	235,6	L/d
Recirculation flow rate	230,48	L/d
Recirculation flow rate	160,05	mL/min
Recirculation rate	45	%
Chemical Oxygen Demand	2000	mg/L
Volatile Organic Compounds	6	kg/m ³ *d

CONCLUSIONS:

VIGILAD/

The design and construction of the UASB reactor was successful, meeting hydraulic and structural important for the reactor to operate correctly.







criteria, allowing it to be installed functionally and with an adequate flow distribution, these aspects are

The characterization of the inoculum showed that it is in optimal conditions to start the anaerobic process, with pH within the optimal range for methanogenic activity, low VFA/alkalinity ratio and high **COD concentration**, ensuring a good availability of substrate to produce biogas.





XXVSEMANA DE LA Arquitectura e Ingenieria

To determine the effect of biochar from agricultural by-products on the settleability of activated sludge in a Sequencing Batch Reactor (SBR) system.

Ana Maria Villa Lozano- Maria Camila Noreña- Andrés Felipe Palacios Parra

Thematic advisor: Juan David Correa

Methodological advisor: Andrea Tamayo- Carlos Fidel Granda

PROBLEM

The inadequate treatment of some wastewater generates a significant environmental impact [1]. Poor sedimentation of activated sludge in biological systems limits the efficiency of organic matter removal in these processes. SBRs stand out as versatile systems, capable of withstanding high organic loads and adapting to the addition of additives that enable a more effective and sustainable treatment [2]. Among these additives is biochar derived from agricultural byproducts, which appears as a promising strategy to improve sludge settleability by enhancing the adhesion of microorganisms to its structure, forming larger and more stable flocs that settle properly [9] [11].

THEORETICAL FRAMEWORK



EXPERIMENTAL DESING



The organic matter present in wastewater is converted into biomass and settles during one of the phases of biological treatment, resulting in the removal of organic loads, producing activated sludge and a clarified effluent with lower pollutant concentrations. Poor settleability occurs when system conditions are not optimal, affecting the formation of stable bioflocs that do not settle properly [9].

Filling

Biochar,

the

Decanting

microorganisms,

sludge formation

system stability [9], [11].

Aeration

Anoxic

encouraging

while

the

of

also

Settling

produced from

pyrolysis of biomass, can act as a

physical support that promotes [3]

aggregation

influencing nutrient retention and

SBRs are aerobic systems that transform organic matter into less harmful products known as activated sludge [3]. They operate in cycles that include filling, aeration, sedimentation, decantation, and idle phases [5]. Sedimentation time is a key parameter for selecting dense microorganisms and promoting the formation of stable sludge[7], [8].



OBJECTIVES

GENERAL

VIGILADA

To evaluate the effect of biochar from agricultural by-products on sludge settleability in an SBR system to improve its COD removal efficiency. **SPECIFIC**



PARTIAL RESULTS AND ANALYSIS



Figure 1. % COD REMOVAL USING DIFFERENT DOSES OF QUINOA BIOCHAR (EXPERIMENT 1)





METHODOLOGY

Filling time: 15

Figure 2. % COD REMOVAL USING DIFFERENT DOSES OF QUINOA BIOCHAR (EXPERIMENT 2)

Characteristic	Quinoa	Corn
Surface Area (BET)	High	High
Macropores and	Abundant	Abundant
Mesopores		
Active Functional	Acidic (carboxyl,	Acidic (carboxyl,

- To set up an SBR reaction system with stabilized sludge and synthetic municipal wastewater.
- To analyze the effect of biochar dosage on sludge settleability and COD removal efficiency.
- To analyze the relationship between sludge settleability and the size of the resulting flocs.

PARTIAL CONCLUSIONS

- The jar test was successfully adapted to perform as an SBR by adjusting its organic loads and maintaining adequate parameters for its development.
 The variables measured in the pre-experiments made it possible to understand the conditions under which the system was found and thus be able to determine possible failures and the measures to be implemented to improve the system.
- It was found that with the pre-experiments carried out, the addition of biochar in the reaction system yielded positive results in some of these treatments, indicating that two types of biochar such as quinoa and corn present better removal compared to the others.

Figure 3. % COD REMOVAL USING DIFFERENT TYPES OF BIOCHAR (EXPERIMENT 3)

Groups	phenol)	hydroxyl)
Particle Size and	Fine and	Fine and
Shape	homogeneous	homogeneous
pН	Slightly acidic	Neutral to slightly
		basic
Chemical Stability	High	High
(Fixed Carbon)		
Floc Formation	High (porosity +	High (structure and
Capacity	functionality)	function)

Table 1. Biochar analysis (characteristics)









XXVSEMANA DE LA Arquitectura e Ingenieria

Analysis of the effect of biofertilizers with Arbuscular Mycorrhizal Fungi and Mountain Microorganisms compared to conventional methods in organic agriculture

> Daniela Alexa Ramirez & Lisardo Sánchez & Luz Alderis Vélez & Sofia Cano Mendez Thematic advisor: Juan David Correa - Laura Osorno Bedoya - David Saldarriaga Methodological advisor: Carlos Fidel Granda Ramirez

Problem definition

The accelerated growth of the world population projected for 2050 requires a significant increase in food production, estimated at 70%. This challenge has encouraged the intensive use of synthetic chemical fertilizers, which, although they have contributed to increased agricultural yields, have negatively impacted soil health, biodiversity, and water systems. In this context, evolution to more sustainable production that maintain productivity without systems compromising environmental integrity is urgently needed. Organic fertilization, specifically through arbuscular mycorrhizal fungi (AMF) and mountain microorganisms (MM), emerges as a promising alternative to improve nutrient use efficiency and promote the restoration of degraded soils. However, more experimental evidence is still needed to support their efficacy in fruit crops of emerging interest.



Evaluation of results

Theoretical framework







Partial results

After planting, the bushes were checked weekly, measuring height variables and visually evaluating the condition of the bushes by means of leaves.



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Week 5

AÑOS

Evaluate the effect of biofertilization with Arbuscular mountain mycorrhizal fungi (AMF) and microorganisms (MM) on Synsepalum dulcificum plants.

Specific objectives



Partial conclusions

Limited fruit development in S. dulcificum with AMF/MM biofertilizers was observed. Initial soil nutrient deficiency explanations were insufficient due to a lack of local agronomic characterization. Potential factors include: specific edaphoclimatic requirements (soil, temperature, water, altitude not fully assessed), heavy rainfall (causing waterlogging/asphyxiation), and advanced shrub stage. While other studies show AMF/MM benefits, future research should prioritize crop characterization under local conditions..

Week 4



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Evaluation of the allelopathic effect of *Mint sp.* and *Artemisia vulgaris*. on the invasive species Thunbergia alata.

Elaborated by: Laura Andrea Moreno Chaparro, Fabian Jiménez Vásquez, Leidy Johana Caro Pulgarín Asesor Metodológico: Andrea Tamayo, Fidel Granda Asesor Temático: María Isabel Aristizábal

Problematic Methodology Dehiscenc nytosani Collection Transport Invasive species pose a significant threat to the Preliminary Manual ary e and of plant and evaluation harvesting classificatic biodiversity of ecosystems, both in Colombia and survey storage material globally. Globally, they are the second leading cause of biodiversity loss, driving native species to extinction, negatively impacting ecosystem services and reducing

the quality of human life. [1] [2].



Artemisia vulgaris.



Invasión of Thunbergia Alata.

This work is relevant and motivating, as it seeks sustainable alternatives for the biological control of invasive species and sets a precedent through allelopathy.

Theoretical framework

Allelopathy is a strategy that Mint has been widely used in agriculture for biological weed control [3] [4] [5].



Allelopathy

and Artemisia sp. vulgaris. species are aromatic plants whose essential oils are great importance in of medicine, pharmaceuticals, food and agriculture [6][7].

In this process, plants release secondary metabolites or allelochemicals the into environment through volatilisation, leaching, root exudation and decomposition of plant residues [8].

Several studies have focused on the toxic effects of aromatic species on example the weeds, for study Mahdavikia by et [9] in which essential oils and aqueous extract of used were mint to determine phytotoxicity on difficult to treat weeds such as bindweed, purslane and jungle rice.

Objectives

General

To evaluate the allelopathic effect of Menta sp. and Artemisia vulgaris. on the in vitro and substrate germination of Thunbergia alata.

Specific

• To determine the impact of • To determine the effect • To compare the allelopathic



the application of Mint sp.	of <i>Mint sp.</i> and
and Artemisia vulgaris	Artemisia vulgaris
extracts on the in vitro	extracts on the
germination of T. alata	germination of T. alata
seeds.	under substrate sowing.

Mint sp. and effects of Artemisia vulgaris. extracts on the inhibition of T. alata germination in vitro and on substrate.



Partial results and analysis

Germination percentage of T. alata.



Fig. 1. Germination percentage of T. alata. Values are mean ± SD for three replicates. (TA5) Treatment with EA Artemisia at a ratio of 1:50. (TA2) Treatment with EA Artemisia vulgaris. at a ratio of 1:20. (TA10) Treatment with EA Artemisia at a ratio of 1:10. (TM5) Treatment with EA Menta in a ratio of 1:50. (TM2) Treatment with EA Menta in a ratio of 1:20. (TM10) Treatment with EA Menta in a ratio of 1:10.

Figure 1 shows that after 17 days, the germination percentage of *T. alata* seeds did not exceed 30% in any of the treatments or in the control. Treatments TA5 and TM10 had the highest germination percentages, while TA10 and TA2 had the lowest values of about 14%.

In terms of variability, the TM5 treatment showed the highest standard deviation, indicating greater dispersion in the results, while TA5 showed the lowest standard deviation, reflecting greater consistency in germination.



Fig. 2. Germination speed index of T. alata. Values are mean ± SD for three replicates. (TA5) Treatment with EA Artemisia at a ratio of 1:50. (TA2) Treatment with EA Artemisia at a ratio of 1:20. (TA10) Treatment with EA Artemisia vulgaris. at a ratio of 1:10. (TM5) Treatment with EA Menta in a ratio of 1:50. (TM2) Treatment with EA Menta in a ratio of 1:20. (TM10) Treatment with EA *Menta* in a ratio of 1:10.

Figure 2 shows that treatments TA5, TM10 and TM5 showed the highest germination speed indices with values between 0.3 and 0.5. Treatments TM2 and EC showed intermediate values, between 0.2 and 0.3. On the other hand, TA10 and TA2 showed the lowest between 0.1 and 0.2. values,

In terms of variability, TM5 had the highest standard deviation, followed by TM2, while TA2 had the lowest standard deviation, indicating greater consistency in its results.

Partial conclusions

In general, the application of Mint sp. and Artemisia sp. extracts had a moderate effect on the *in vitro* germination of *T. alata* seeds, without significantly increasing the total germination percentage. However, some treatments showed a positive effect on the speed and percentage of germination, suggesting that these extracts may influence certain aspects of the germination process.

The compounds of the extract obtained from *mint* and *Artemisia vulgaris*. may not contain the metabolites necessary to produce the effect on germination of Thunbergia alata, as no chromatographic studies were carried out to identify the components present in the extracts. In addition, the secondary metabolites of plants depend on the stage of development and the factors to which they are exposed, such as biotic or abiotic stress, which induce

Bibliographical references









Literature Review on Environmental Sustainability with a Focus on Businesses Dennis Calderón Ospina Thematic advisor: Carlos Fidel Granda Ramírez Methodological advisor: Carlos Fidel Granda Ramírez

Problem definition

Today, sustainability has become a fundamental pillar for both society and businesses, driven by growing concerns about climate change, resource scarcity, and the need for a more equitable and responsible model of economic development. Sustainability encompasses not only the environmental dimension but also the social and economic ones, promoting a balance between production, consumption, and environmental conservation. In this context, the present work literature provides a review environmental on sustainability in the business sector, highlighting its importance, the main challenges companies face, and the strategies to promote a more sustainable economic model.

Methodology



Theoretical framework

Sustainability is defined as the ability to meet present needs without compromising the ability of future generations to meet their own. In this context, the United Nations' Sustainable Development Goals (SDGs) provide a global framework for addressing major environmental, social, and economic challenges. Among the SDGs most relevant to the business sector are Goal 12 on responsible consumption and production, Goal 13 on climate action, and Goal 9 on industry, innovation, and infrastructure. Environmental sustainability requires companies to adopt practices that reduce their environmental impact, such as efficient resource use and the transition toward circular economy models. To assess sustainable performance, indicators like those from the Global Reporting offering (GRI) have been developed, Initiative structured and comparable ways to evaluate environmental, social, and economic impacts.

Graph of the temporal evolution of publications on environmental sustainability in businesses.



Gráfico de distribución temática de publicaciones.

Partial results

The partial results of the research reveal steady growth in publications on environmental sustainability in businesses from 2015 to 2025, with a significant increase after 2020 driven by the adoption of GRI standards and new regulations. Circular economy emerged as the most addressed topic, followed by environmental strategies and sustainability reporting, while key terms such as "sustainability," "circular economy," "GRI," and "carbon neutrality" were the most prominent in the literature. Major challenges identified include the lack of standardized indicators, high initial costs, resistance to change, and the risk of greenwashing. Furthermore, there was an increase in the use of GRI and IFRS standards as key methodologies for measuring sustainable performance in organizations.

General objective

To analyze the importance of sustainability in the business and social context, identifying its main strategies, indicators, and reporting methodologies to promote more sustainable development. Partial conclusions

Business sustainability is progressing, but still faces in challenges like unclear indicators and low social in integration. Circular economy is essential, yet its real implementation is limited. More innovation, transparency, and alignment with the SDGs are needed.





STRATEGIES FOR THE VALORIZATION OF BYPRODUCTS FROM MUNICIPAL WASTEWATER TREATMENT PLANTS WITH A CIRCULAR ECONOMY APPROACH- A REVIEW

Thematic Advisor Juan David Correa

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INTRODUCTION

Within the internal operation of **Wastewater Treatment Plants (WWTPs)**, a significant amount of **byproducts** is produced [1]. Often, the management of these materials ends in their simple disposal, which means that their added value is being wasted [2]. The adoption of **circular economy** principles in the context of WWTPs opens a field of possibilities to leverage these materials [3]

OBJECTIVE

To review strategies for the valorization of WWTP byproducts with a circular economy approach.

METHODOLOGY

This state of the art was carried out through a Systematic Literature Review (SLR) which is based on the application of a structured protocol.



Fig 4. Analysis of search results for the keywords. *Range of years in publications and countries*. Scopus.

Research in the field of wastewater treatment has had a remarkable development over time. Although initially it was little explored between 1987 and 2002, scientific interest in this topic grew significantly between 2002 and 2023, and, in general, research has decreased in the last year. China, the United States, and Spain stand out as the main contributors to research in this area.

FOUND BYPRODUCTS IN ARTICLES

RESULTS ANALYSIS



- The **filtering** process in the keyword search was delimited as follows: • Year Range: 2021-2025 • Subject Area: Environmental Science
- Document Type: Review
 Language: English

The document was thereafter exported as a CSV file to undergo analysis and filtering in accordance with the research's thematic orientation*

Fig 1. Flowchart of the proposed methodology



Fig. 2. Circular Economy Principles Advance Built Environment Sustainability," WSP.



Fig 3. Wastewater treatment plant diagram," Water Institute.

- Biogas
- Nutrients: Phosphorus (P) and Nitrogen (N)
- Ammonia (NH3)
- Biochar from biomass
- Bioplastics
- Volatile fatty acids
- Precious metals: gold, silver, copper, and platinum

CONCLUSIONS



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The relationship between wastewater treatment plants and the circular economy is a nascent concept. Given the increasing emphasis on resource optimization within the 10R strategies of the circular economy in recent years, literature analyzing the byproducts of WWTPs is emerging. However, there remains a paucity of bibliography that elucidates the valorization of these byproducts, as such processes often entail significant financial investment. The present review is ongoing

14.0067

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