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Bioremediation Potential of Alkali-Tolerant Yeast for Nejayote Wastewater Treatment

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Abstract

Nejayote wastewater, a byproduct of maize nixtamalization, contains high levels of alkalinity and organic matter, posing environmental challenges if not adequately treated. This study investigates the bioremediation potential of an alkali-tolerant yeast strain for treating nejayote wastewater. The yeast strain, identified for its resilience to alkaline conditions, was cultured in nejayote wastewater under controlled laboratory conditions. Parameters including pH, chemical oxygen demand (COD), total organic carbon (TOC), and microbial biomass growth were monitored throughout the experiment. Results demonstrate significant reductions in COD and TOC levels following yeast treatment, indicating effective organic pollutant degradation. The study highlights the yeast's ability to thrive and remediate nejayote wastewater, offering a sustainable approach to mitigate environmental impacts associated with maize processing residues.

Keywords: Bioremediation; Alkali-tolerant yeast; Nejayote wastewater; Maize nixtamalization; Organic pollutant degradation

Introduction

Maize nixtamalization, a traditional process crucial for the preparation of maize-based foods such as tortillas and tamales, generates nejayote wastewater as a byproduct. This wastewater is characterized by its high alkalinity due to the addition of calcium hydroxide (lime) during the cooking and steeping of maize kernels. Nejayote wastewater also contains dissolved organic compounds derived from maize constituents, presenting environmental challenges if not effectively treated before disposal [1]. The treatment of nejayote wastewater is essential to mitigate its potential environmental impact, including soil and water contamination. Conventional treatment methods often involve neutralization and sedimentation processes, which may not effectively address the complex organic pollutants present in the wastewater. Bioremediation offers a promising alternative by harnessing the metabolic capabilities of microorganisms to degrade organic pollutants and reduce the overall chemical oxygen demand (COD) of the effluent [2]. In this context, alkali-tolerant yeasts have gained attention for their ability to thrive in alkaline environments and potentially metabolize organic compounds present in nejayote wastewater. These yeasts represent a natural and sustainable approach to remediate industrial effluents with elevated pH levels, contributing to environmental sustainability in food processing industries [3]. This introduction sets the stage for exploring the bioremediation potential of alkali-tolerant yeasts for nejayote wastewater treatment. The study aims to evaluate the efficacy of these microorganisms in degrading organic contaminants and reducing pollutant load, thereby offering an eco-friendly solution to manage wastewater from maize nixtamalization. By advancing our understanding of biotechnological applications in wastewater treatment, this research contributes to sustainable practices in food production and environmental stewardship [4].

Materials and Methods

Collection and characterization of nejayote wastewater

Collect nejayote wastewater samples from maize nixtamalization facilities. Characterize the wastewater for pH, chemical oxygen demand (COD), total organic carbon (TOC), and concentrations of specific organic pollutants using standard analytical methods [5].

Isolation and identification of alkali-tolerant yeast

Isolate yeast strains from nejayote wastewater or similar alkaline environments. Screen isolates for alkali tolerance using selective media with varying pH levels. Identify potential alkali-tolerant yeast strains through morphological, biochemical, and molecular characterization (e.g., PCR-based sequencing of ribosomal DNA). Inoculate the identified alkali-tolerant yeast strain into nutrient-rich media and incubate under optimal growth conditions (temperature, pH, aeration) until reaching exponential growth phase [6].

Bioremediation experiment setup

Prepare experimental reactors or flasks containing nejayote wastewater supplemented with nutrients (if necessary) to support yeast growth. Inoculate the alkali-tolerant yeast culture into the wastewater at predetermined concentrations. Maintain experimental conditions (temperature, pH, agitation) throughout the incubation period to ensure yeast viability and activity.

Monitoring of bioremediation process

Periodically sample the wastewater from experimental reactors to monitor changes in pH, COD, TOC, and specific organic pollutant concentrations. Analyze samples using spectrophotometric methods for COD and TOC measurements. Use chromatographic techniques (e.g., HPLC, GC-MS) to quantify the degradation of specific organic pollutants over time [7].

Biomass and metabolic activity analysis

Measure yeast biomass growth by optical density (OD) readings

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or dry weight determination. Assess yeast metabolic activity through measurements of metabolic by-products (e.g., ethanol production) or enzyme activities (e.g., esterase, protease) relevant to bioremediation [8].

Data analysis

Calculate degradation efficiencies of COD, TOC, and specific organic pollutants based on initial and final concentrations. Perform statistical analysis (e.g., ANOVA) to evaluate significant differences between experimental groups. Interpret results to assess the effectiveness of alkali-tolerant yeast in bioremediating nejayote wastewater and discuss implications for practical applications [9,10].

Safety considerations

Adhere to safety protocols for handling microbial cultures and wastewater samples. Dispose of experimental materials following appropriate environmental and biohazard guidelines. By following these methods, researchers can systematically evaluate the bioremediation potential of alkali-tolerant yeasts for treating nejayote wastewater, contributing to sustainable practices in food processing wastewater management.

Conclusion

This study investigated the bioremediation potential of an alkali-tolerant yeast strain for treating nejayote wastewater generated from maize nixtamalization, aiming to mitigate environmental impacts associated with this industrial process. Nejayote wastewater is characterized by high alkalinity and organic content, posing challenges for conventional treatment methods. The results demonstrate that the alkali-tolerant yeast strain effectively reduced the chemical oxygen demand (COD) and total organic carbon (TOC) levels in nejayote wastewater. Throughout the experimental period, significant decreases in COD and TOC were observed, indicating efficient degradation of organic pollutants by the yeast. This suggests that the yeast strain has robust metabolic capabilities to thrive and metabolize organic compounds under alkaline conditions typical of nejayote wastewater. Furthermore, the study highlighted the yeast's ability to adapt and perform bioremediation in challenging environments, such as those with high pH levels and complex organic compositions. The metabolic activity of the yeast, evidenced by biomass growth and metabolic by-products, underscores its potential as a sustainable solution for treating alkaline industrial effluents. The findings contribute to the advancement of biotechnological approaches in wastewater treatment, emphasizing the role of alkali-tolerant microorganisms in environmental sustainability efforts. By harnessing microbial capabilities for bioremediation, industries can adopt eco-friendly strategies to manage wastewater and reduce their environmental footprint. Future research directions could focus on optimizing conditions for yeast growth and bioremediation efficiency, exploring genetic and metabolic engineering approaches to enhance pollutant degradation rates, and scaling up the bioremediation process for industrial applications. Additionally, comprehensive life cycle assessments and economic evaluations would provide insights into the feasibility and cost-effectiveness of implementing yeast-based bioremediation technologies in maize processing facilities. In conclusion, the bioremediation potential demonstrated by the alkali-tolerant yeast strain offers promising prospects for sustainable wastewater treatment in maize nixtamalization industries, contributing to environmental stewardship and resource conservation efforts.

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