Best Practice

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Technologies for anaerobic fermentation of organic waste

AgriLoop is developing more efficient and cost-effective technologies to transform agricultural residues, such as vinasse (a byproduct of the sugar and ethanol industries) and spent mushroom substrate, into valuable resources for sustainable, biobased production.

Project activity

This project developed and optimised a process where pretreatment of agricultural waste was followed by enzymatic hydrolysis and saccharification and the subsequent production of bioethanol, lactic acid, biogas, and biofertilizer.

The study included:

- Analysis of organic waste composition (total and volatile solids, C, N, C/N, pH, cellulose, hemicellulose, lignin and ash).
- Selection and screening of over 500 microbial strains for waste conversion into biogas and biofertilizer
- Composting of corn straw, biogas slurry, and spent mushroom substrates to produce biofertilizer.
- Assessment of organic fertilizers for crop yield, soil health and food safety.

Our study found that:

- Pretreatment and enzymatic saccharification effectively broke down complex biomass structures, such as cellulose, hemicellulose and lignin, yielding 15.71–160 g/L of fermentable sugars.
- Spent mushroom substrate combined with corn straw produced up to 53.35 g/L of ethanol in 5-L fermenters.

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- Cumulative methane yield from crop straw and animal manure -reached 120 mL/g volatile solids, a 6.5% improvement over the control.
- Ethanol fermentation residues were repurposed for anaerobic digestion, improving process efficiency by producing up to 37.75 g/L ethanol and achieving a biogas yield of 337.38 mL/g total solids.
- Selective breeding of Bacillus coagulans produced improved strains for lactic acid fermentation, achieving 1 ton of lactic acid from 3 tons of corn straw.
- Composts produced from corn straw, biogas slurry, and spent mushroom substrates were found to significantly promote plant growth, crop yield and grain weight.

Key findings and recommendations

This study has developed promising technologies that should be considered as possible routes to more efficient, cost-effective conversion of agricultural residues into high-value products.

- Enzymatic hydrolysis and saccharification of cellulose and hemicellulose are critical for sugar release and the subsequent production of ethanol, lactic acid, and other bio-based products.
- High titre ethanol production from spent mushroom substrate combined with corn straw has been established.
- Biogas production from ethanol fermentation residues enhances overall process efficiency, with higher ethanol and biogas yields.
- Biofertilizer derived from composted residues improves soil organic matter and provides essential nutrients, contributing to sustainable agriculture.

References

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For more information about the AgriLoop Project, visit:

agriloop-project.eu

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