SIGER

INTERNATIONAL SYMPOSIUM OF AGRICULTURAL AND AGROINDUSTRIAL WASTE MANAGEMENT

Proceedings of the VII Internacional Symposium on Agricultural and Agroindustrial Waste Management

Novembre 3-5, 2021
On-line

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Sociedade Brasileira dos Especialistas em Resíduos das Produções Agropecuária e Agroindustrial

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Brazilian Agricultural Research Corporation
Embrapa Swine and Poultry
Ministry of Agriculture, Livestock and Food Supply

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PRESENTATION AND EDITORIAL COMMENTS

Sustainable alternatives that promote economic circularity through the use of agro-industrial residues is a strategic challenge for companies to remain competitive and to generate new business models. The Brazilian Society of Agricultural and Agro-industrial Waste Management (Sbera) is the result of reflection, pioneering spirit and citizen commitment of professionals who intend to contribute to the evolution of the environmental condition of two large complexes of extreme social, economic and cultural importance for Brazilian agriculture and the agro-industrial sector. Found in 2008, Sbera promotes the International Symposium on Agricultural and Agro-industrial Waste Management (SIGERA) with the objective of fostering scientific debate and presenting technological alternatives to waste from the agro-industrial chain.

The VII SIGERA, held online from 3 to 5 November 2021, was addressed the developments resulting from the Climate Conference (COP26) as the agreements made by 130 countries to cut methane emissions by 30% by the year 2030, demonstrating opportunities for biotechnology based industries for waste-to-energy use combined with the mitigation of greenhouse gas emissions. During the debates, the importance of technological alternatives based on bioprocesses to amplify aspects related to economic circularity and enable environmental, social and corporate governance were also established. The VII edition of symposium athered 460 subscriptions, including 372 paper authors and 150 attendant, including academic professors, researchers, undergraduate and graduate students from several Brazilian universities and research centers, as well as specialist professionals from Argentina, Chlie, Colombia, Germany, Mozambique, Spain, USA and Uruguay. In this edition, 120 abstracts were received. Of these, 114 are presented in this proceedings, grouped by 7 topics:

- Technologies for waste transformation, reuse and disposal
- By-products application for agricultural, forestry and livestock use
- Environmental impacts to the air, soil, water and plant system
- Waste to energy
- Refractory and persistent substances
- One health and food safety
- Cases

All approved works were invited for video presentation, which can be viewed directly through the YouTube hyperlink present in the abstract.

By the way, in this edition of SIGERA, also had a partnership with the journals Industrial Biotechnology[1], Engenharia na Agricultura[2] and Revista RedBioLAC[3]. After a careful peer review evaluation process and based on the work novelty, high scientific quality and solutions applicability for the agriculture and agroindustry, the scientific committee selected the best works and the authors were invited to share the full paper version in partner journals.

The VII SIGERA was organized by Sbera and Brazilian Agricultural Research Corporation (Embrapa Suínos e Aves), with cooperation by Embrapa Pecuária Sudeste, Embrapa Solos, Instituto Nacional de Investigación Agropecuaria (INIA from Chile), Universidad de La Frontera (UFRO from Chile), Universidade Federal de Santa Catarina (UFSC), Universidade Federal da Fronteira Sul (UFFS, by the laboratory LABIMI), Universidade de São Paulo (USP, by the LEA), Red de Biodigestores para Latino América y Caribe (RedBioLAC), the Brazilian Energy Programme (BEP, by UK Government, Adam Smith International, CLT, hubz, i17 and FGV) and Shimadzu do Brasil.

The organizing committee of SIGERA wishes you a good reading and invites you to participate in the VIII SIGERA that will take place in October 2023, in Pucón/Chile.

1 https://home.liebertpub.com/publications/industrial-biotechnology/140/overview

2 https://periodicos.ufv.br/reveng

3 http://www.revistaredbiolac.org

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BY-PRODUCTS APPLICATION FOR AGRICULTURAL, FORESTRY AND LIVESTOCK USE

PROCESSING OF POULTRY LITTER AND CATTLE MANURE THROUGH VERMICOMPOSTING

Miriam Domingues Guimarães*, Elisiane Ferreira, Gabrielli Vaz Sampaio, Gabriela Bonassa, Jean Carlos Fries, Cecília Paulina Johann Dammann, Carlos Aberto Casali, Marina Celant de Pra

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Abstract: The reuse of organic waste from poultry and dairy production activities as fertilizer becomes a viable alternative, after a previous treatment. Vermicomposting stands out as an alternative route for the stabilization of organic residues through earthworms. Therefore, the present study evaluated the processing of poultry litter and cattle manure through vermicomposting, aiming to obtain high value-added compounds with great potential to fertilizer use. The experiment was developed at UTFPR Campus Dois Vizinhos, with 300 kg of mixture at the following proportions (%, wet basis): 100 cattle manure; 75 cattle manure + 25 poultry litter; 50 cattle manure + 50 poultry litter; and 25 cattle manure + 75 poultry litter. The experimental design was executed in randomized blocks (four replications), with 1000 mL of Californian earthworm (Eisenia foetida) on each sample unit. Process was monitored (100 days) by organic carbon, nitrogen, phosphorus and potassium content. Volume and mass of compost produced, number of surviving earthworms and C and N biomass were quantified. According to the microbial activity, more than 100 days are necessary for vermicomposting acclimatization. Lower poultry litter proportions increased earthworms mortality and not affect the compost produced. Besides, poultry litter + cattle manure does not affect K contents, but increases the C, N and P contents, with a lower C/N ratio. Therewith, the availability of nutrients of the obtained compost is maximized.

Keywords: Composting, stabilization of organic residues, fertilizer, earthworms mortality.

Video presentation

STRUVITE PRECIPITATION IN COMPOSTING LEACHATE FOR USE AS FERTILIZER

Caio Teves Inácio*, Aolibama da Silva de Moraes, David Vilas Boas de Campos, Marco Antonio de Almeida Leal, Ioná Rech, Diego Macedo Veneu

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Abstract: Nutrient recovery from agro-industrial effluents as precipitate minerals for use as fertilizers in agriculture is a promising strategy to reach sustainability. Struvite precipitation ($MgNH_4PO_4.6H_2O$) is one of the most studied methods for phosphorus (P) recovery from waste waters; its use as a slow-release fertilizer has been often tested. This method also allowed the potassium (K) recovery as K-struvite ($MgKPO_4.6H_2O$). The leachate has been considered as a major threat of composting facilities to the environment - due to its high biochemical oxygen demand and nutrient content (K, N e P). The leachate from a composting of horse bedding manure and left vegetables from an agro-processing industry showed high content of K, and low levels of ammoniacal nitrogen and P. Adding soluble sources of phosphorus (H_3PO_4) and magnesium ($MgCl_2$) followed by pH adjusting (8 to 10), we reached the simultaneous formation of NH_4-struvite and K-struvite, as evidenced by X-ray diffraction. Besides composting leachate, struvite precipitation might be a feasible route to other agro-industrial waste waters with high K and N.

Keywords: Phosphate minerals, nutrient recovery, animal manure, compost.

DEGRADABLE ORGANIC CONTAINERS OBTAINED FROM AGROINDUSTRIAL WASTE FOR FOREST SEEDLINGS PRODUCTION AS AN ALTERNATIVE TO PLASTIC CONTAINERS

Gabriel Carlos Francisco*, Jéssica Franciele Kaminski Ramos, Sérgio Medeiros Cabral dos Santos, Bruna Karina da Silva Oliveira, Mariana Ribeiro Vieira, José Carlos Arthur Junior, Claudio Rocha Bastos, Vinicius de Melo Benites

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Abstract: Planting in polyethylene containers is the most used method the forest seedlings production, which results in a large amount of plastic residue. Looking for a more sustainable alternative, it is possible to produce forest seedlings in containers that use organic residues in their composition, providing an adequate destination for these residues. The objective of this work was to evaluate agronomically, under commercial nursery conditions, seedlings of the native species used for reforestation purposes, developed in organic containers produced from different agro-industrial residues compared to traditional plastic containers. Organic containers produced from 3 different mixtures of organic waste (50% poultry litter + 50% coconut shell; 50% malt bagasse + 50% coconut shell and 100% coconut shell) were evaluated and compared with plastic containers, all with 110 cm^3. All tubes were filled with commercial substrate, seeded with Pau-ferro (Libidibia ferrea), and cultivated under irrigation for 90 days. Plant height, stem diameter, shoot and root dry biomass were measured, and the shoot/root biomass ratio and Dickson quality index were calculated. Plants grown in compostable malt bagasse tubes were superior to other plants in all evaluated parameters and, in addition to providing the establishment of superior quality seedlings, are a safe destination for a waste from the brewing industry, thus proving to be a viable alternative for the solid waste management in forestry production.

Keywords: Agroindustrial waste, biodegradable containers, sustainable alternative, organic containers, malt bagasse.

Video presentation

KINETIC STUDY OF SUBCRITICAL HYDROLYSIS IN AGRICULTURAL BIOMASSES UNDER ULTRASONIC PRETREATMENT

Maicon Sérgio Nascimento dos Santos*, Amanda Rampelotto de Azevedo, Giovani Leone Zabot, Marcus Vinícius Tres

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Abstract: Lignocellulose-based materials are considered one of the promises for the bioethanol industry and a sustainable approach to biorefinery concepts. The exploration of alternatives that add value to these by-products resulted in the generation of technological strategies that promote the obtainment of highly interesting compounds. The integration of hydrothermal technologies results in the lignocellulosic matrix disintegration and facilitation of obtaining the compounds of interest for multipurpose. In this context, the subcritical water hydrolysis (SWH), which promotes the rupture of the lignocellulose-rich complex through the action of water as a solvent at pressures of approximately 22 MPa and temperatures in a range up to 374 °C, has been reported as an attractive alternative to extraction processes involving residual agricultural biomass. Accordingly, this study aimed to evaluate the effects of ultrasonic pre-treatment on the fermentable sugars yield (YRS) from different residual biomass of rice, soybean, and pecan under SWH. The experimental conditions for the pre-treatment were: energy density (50% (275 W) and 95% (522.5 W)) (up to 37.6×10^3 J/cm³) and reaction time (15 and 60 minutes). The conditions for the SWH process were: temperature (220 ºC), flow rate (10, 20, and 30 mL/min), and reaction time (0.5 to 15 minutes). Pecan shell biomass presented the highest YRS values in ultrasonic procedure conditions of 15 min and 19.8×10^3 J/cm³ (23.8 ± 2.7 g/100 g biomass).

Keywords: Biorefinery, lignocellulose-based biomasses, lignocellulosic complex degradation, hydrothermal strategies, value-added residual by-products.

Video presentation

DEVELOPMENT, CHARACTERIZATION, AND APPLICATION OF BIOFERTILIZER FROM SOYBEAN PROTEIN HYDROLYSATE IN CAULIFLOWER PLANTS

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Abstract: Soybean (Glycine max L.) is a source of oil and protein, and later agro-industrial residues. These residues are rich sources of protein but cannot be applied directly to the soil. However, these residues can be attractive sources for the formulation of plant biofertilizers, such as protein hydrolysates, which after chemical processes, resulting in amino acid compositions, with the potential to act as biofertilizers. Thus, this work aimed to develop a soybean meal protein hydrolyzate, investigating its effect on Brassica olereacea plants. The hydrolyzate was obtained by chemical methods, characterized for total amino acid content and its amino acid profile by MALDI-TOF-MS and 1H NMR spectroscopy. Seeds of B. oleracea were treated with 0% to 1% soybean meal hydrolyzate while the cabbage plants were weekly sprayed with hydrolyzed solutions from 0% to 1.4%. The chemical characterization of the hydrolyzate indicated a total amino acid content of 7.46 $mg.mL^{-1}$, as the MALDI-TOF MS-MS identified eight amino acids, confirmed by H_1-NMR spectroscopy. The highest concentrations of the hydrolyzate significantly increased ($p<0.05$) values of total chlorophylls in plantlets and height, fresh and dry biomass, and leaf contents of phenolic compounds and total flavonoids in plants. Thus, it can be concluded that the soybean meal hydrolyzate presents expressive amounts of free amino acids, demonstrating its potential as a biofertilizer for product formulations.

Keywords: Biofertilizers, protein hydrolysates, soybean meal, soy by-products.

Video presentation

STRATEGIES TO MITIGATE THE NH_3 VOLATILIZATION FROM UREA FERTILIZER: APPLICATION TOGETHER WITH VINASSE PLUS UREASE AND NITRIFICATION INHIBITORS

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Abstract: Concentrated vinasse (CV), a by-product of ethanol production, applied together with mineral N fertilizer is a strategy to reduce costs with fertilization. However, the impact of this strategy on ammonia (NH_3) volatilization and in the efficiency of urease (UI) and nitrification inhibitors (NI) are unknown. So, our goal was to evaluate the NH_3 volatilization from urea fertilizer applied together with CV in a sugarcane field, as well as to evaluate the efficiency of UI (N-(n-butyl) triamide thiophosphate) and NI (3,4-dimethylpyrazole phosphate) as a strategy to mitigate N losses. Two experiments were conduct in Piracicaba/SP. The NH_3 volatilization was evaluated for 40 days in both experiments. The treatments were: 1) Control - C; 2) Urea - U; 3) U+UI; 4) U+NI; 5) U+UI+NI; 6) VC; 7) VC+U; 8) VC+U+UI; 9) VC+U+NI; and 10) VC+U+UI+NI. The addition of UI to U (13.9 and 7,8% of N applied in exp. 1 and 2) was efficient to reduce NH_3 volatilization compared to U alone (21.4% and 11.3% of N applied in the exp.1 and 2, respectively). However, NH_3 volatilization was affected differently by NI (with or without UI), with reduction or increment depending on the experiment. The application of CV together with U (6.1 % of N applied, in average) reduced NH_3 volatilization by 3 times compared with mineral fertilizer alone (21.3% of N applied, in average), regardless of inhibitors addition. Blending CV with U was a better strategy to mitigate NH_3 volatilization than UI and NI inhibitors.

Keywords: Ammonia, NBPT, DMPP, sugarcane, organic fertilizer.

Video presentation

THE COMPOST BARN SYSTEM AS A SOURCE FOR ORGANIC FERTILIZERS AND THEIR APPLICATION IN AGRICULTURAL CROPS: A CASE STUDY AT LAGOA DO SINO CAMPUS OF FEDERAL UNIVERSITY OF SAO CARLOS - BRAZIL

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Abstract: The compost barn system is an excellent option for dairy farmers as it promotes high levels of animal welfare, less use of antibiotics and helps in the recycling of nutrients by producing a rich by-product: the composted manure (made thought aerobically fermentation of cattle manure, urine and wood shavings). In the sense of improving the recycling of agricultural residues, the aim of this work was to investigate the potential environmental impacts in the production of crops like soy, maize, and wheat using the composted manure as a source of fertilizer. Alternative scenarios for fertilizer substitution where investigated using a Life Cycle Assessment (LCA) approach. Three alternative scenarios were studied to replace the mineral fertilizer (identified as main hotspot for the crop systems). Analyzes were made for the substitution scenarios of 100%, 50% and 30% based on the nutrient of highest demand for each of the crops (NPK). The Soy cultivation showed a potential impact of 1480.6 MJ; 122.8 Kg CO_2eq; 42.6 kg 1,4-DBeq; 0.6 kg SO_2eq e; 0.4 kg PO_4eq. The production of maize had a potential impact of 1497 MJ; 176 kg CO_2eq; 43.4 kg 1,4-DBeq; 1 kg SO_2eq e; 0.8 kg PO_4eq. For the wheat cultivation, the results obtained were 5850 MJ; 631.4 kg CO_2eq; 143.2 kg 1,4-DBeq; 3.3 kg SO_2eq e; 2.4 kg PO_4eq. In conclusion, the amount of fossil fuel needed to distribute large amounts of manure in the fields limited its use to no more than 30% substitution in terms of volume.

Keywords: Compost Barn system, organic fertilizer, LCA, agriculture use, environmental impacts.

Video presentation

TOXICITY OF TREATED SOILS WITH BIOSOLIDS

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Abstract: The treatment of domestic sewage generates by-products known as biosolids, which present challenges regarding final disposal. One of the alternatives for its disposal is to utilize it in the recovery of degraded areas, because it can provide improvements in soil quality. However, disposing of high dosages may lead to contamination of groundwater causing toxic effects in plants. This study evaluated the toxic potential of disposed sewage sludge in soils by evaluating the root and seedling development of two species of oats (Avena sativa) and wild radish (Brassica rapa). 20 cm diameter and 30 cm deep pots were filled with soil from a degraded area in Irati/PR/Brazil. The experiment tested the toxicity at 3 biosolids dosages: 10 ton/ha, 20 ton/ha and 30 ton/ha in a completely randomized experimental design having 3 replications per treatment, for an incubation period of 14 days with photoperiod and temperature controlled settings. At the end of the experiment, the size of the seedlings and the roots were measured and documented. It was concluded that biosolids had a positive effect on the development of oat and wild radish with dosages of 20 tons per hectare, since these samples treated with biosolids produced better results than the control sample. Additionally, the dosages of 30 ton/ha demonstrated toxic effects. Given the above, it is suggested that dosages greater than 20 ton/ha are to be avoided, since they exerted a toxic effect on the development of seedlings.

Keywords: Sewage sludge, phytotoxicity, degraded areas, contaminated soils.

Video presentation

INFLUENCE OF BIOCHAR AND NANOPARTICLES AS ADDITIVES OF COMPOSTING IN THE PHOTOSYNTHESIS PROCESS OF RYEGRASS (*Lollium perenne L.*) IN COMPOST AMENDED-VOLCANIC SOILS

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Abstract: Composting additives are used to optimize and improve both the process and end-products. We evaluated the effect of compost supplied with biochar and nanoparticles as additives on the photosynthetic performance of ryegrass (Lolium perenne L) established in volcanic soils under greenhouse conditions. Bare soil and basal fertilization treatments were compared to soils amended with non-additive compost (NA), compost supplied with oat hull-biochar (B), iron oxide (Fe) and halloysite (HA) nanoparticles. Net photosynthesis performance (AN), the stomatal conductance (gs), the intercellular CO2 concentration (Ci) were evaluated through the utilization of an infrared gas analyzer in a closed system. The carboxylation efficiency (A/Ci) and fresh biomass were also analyzed. B and HA treatments consistently displayed increased net AN (~17 µmol CO2 $m^{-2}s^{-1}$), gs (500 and 400 mol m^{-2} s^{-1}respectively), and AN/Ci at the end of the experiment, which agrees with significantly higher values of biomass. Control and FB treatments displayed also significantly lower leaf biomass compared compost amended soil, which could be related to significantly lower AN/Ci observed across measurement times. These results suggest that the addition of compost with additives such as halloysite or biochar can improve the photosynthetic performance and plant growth of ryegrass stablished in volcanic soils. Acknowledgments to ANID for financing this research through the FONDECYT Initiation project Nº 11201107.

Keywords: Biochar, clay minerals, co-composting, metallic oxides.

USE OF A PORTABLE X-RAY FLUORESCENCE SPECTROMETRY (pXRF) FOR CHEMICAL ANALYSIS OF EUCALYPTUS (*Eucalyptus* sp.) WOOD BIOCHAR

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Abstract: Biochar (charcoal) is a product formed by the pyrolysis of biomass and has a large potential for applications in environmental sciences and use as soil conditioners. Brazil is the largest world producer of charcoal for siderurgy. The proper use of charcoal fines, waste from charcoal production, is a way to integrate waste management with environmentally friendly practices. X-ray fluorescence spectrometers have been used to determine total levels of chemical elements in rock, plant, soil and charcoal samples. The use of portable equipment (pXRF), in the evaluation of biochar samples, is still seldom studied. The objective of this study was to evaluate the total concentration of As, Pb, Cd, Hg, Ni, Fe, Zn, Cu, Mn, Sb, Ag, Ba and Cr in samples of residues of fine charcoal (biochar) produced in the traditional JG oven from Eucalyptus woods. The results of the concentrations of chemical elements were compared with guiding values defined by CONAMA 420. The levels of As, Pb, Hg, N, Fe, Zn, Cu, Mn, and Sb in eucalyptus biochar are below the threshold's values of the Conama 420, with no restrictions for its agricultural, residential, and industrial uses. The Ag and Cd contents presented concentrations higher than those allowed by the Brazilian legislation for several uses, calling for further and more precise studies to evaluate these contents. Overall, pXRF suggests good precision and accuracy in estimating some elements in biochar samples.

Keywords: pXRF, proximal sensors, biochar.

Video presentation

WATER-HOLDING CAPACITY OF BIOCHAR FROM EUCALYPTUS (*Eucalyptus* sp.) WOOD

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Abstract: Biochar (charcoal) is a product formed by the pyrolysis of biomass and has a large potential for applications in environmental problems and use as soil conditioners for agricultural purposes. Brazil is the largest world producer of charcoal for steel industry. The proper use of charcoal fines, waste from charcoal production is a way to integrate waste management with environmentally friendly practices and potentially improve the water holding capacity of growing media and soils. It may have an effect also to reduce pollutants and reduce the contamination of groundwater. This study evaluated the water holding capacity by charcoal fines produced from Eucalyptus (Eucalyptus sp) wood, pyrolyzed at 450 °C. Two particle sizes of biochar and a mixture with 0, 25, 50 and puer biochar were measured the volumetric water hold at 6, 10 and 33 kPa tension using the caolin tension table method. The values of the soil moisture at these potentials are considered to be field capacity moisture, that is the moisture when water flux is reduced to low values. Biochar samples show an increase in water-holding capacity according to a smaller particle size fraction, in comparison with sandy.

Keywords: Water-holding potential, field capacity, groundwater.

Video presentation

NEUTRALIZATION OF ACTIVE SOIL ACIDITY USING COMPOSTED AND IN NATURA CHICKEN LITTER

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Abstract: Brazil stands out as one of the largest poultry meat producers in the world, with 13.845 million tons produced in 2020. Composting is an economical, effective, and sustainable method of treating chicken litter. The aim of this study was to verify whether chicken litter composting affects its capacity to neutralize soil acidity. The experiment was carried out in the city of Londrina, Paraná, Brazil (23°23'S, 51°11'W, 566 m). The climate is Cfa - humid subtropical. The soil was classified as a Rhodic Ferralsol. The experiment was installed in a randomized block design in a 2x4+1 factorial system with four replications, with fresh and composted chicken manure and four doses (4.5, 9.0, 13.5, 18.0 Mg of dry matter ha^{-1}). Soil pH was increased as a function of chicken litter application according to the model (pH = 5.9 + 0.03 Dosage, R^2 = 0.89). However, no difference was observed between the fresh and composted chicken manure. Some studies demonstrated that organic materials initially have a slightly acidic pH value and, throughout its decomposition, it becomes alkaline, where in the end values close to neutrality are obtained, due to the stabilization of the biomass. This corroborates the data obtained in this work. The use of chicken litter reduces the soil acidity due to its alkaline characteristics.

Keywords: Chicken manure, organic fertilization, ferralsol.

Video presentation

INFLUENCE OF NUTRIRIGATION WITH BOVINE WASTEWATER IN BROMATOLOGICAL COMPOSITION OF VAQUERO GRASS

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Abstract: The planned disposal of wastewater in the soil-plant system provides water and nutrients for the plants, reducing their dependence on industrialized fertilizers, featuring a form of organic fertilization. The objective of this study was evaluating the influence of nutri-irrigation with bovine wastewater (BW) on the bromatological composition of Vaquero grass. The experiment was carried out using three nutrient supply forms (fertilizer, BW and fertilizer + BW) in drainage lysimeters under conditions. Crude protein (CP), neutral detergent insoluble fiber (NDF), acid detergent insoluble fiber (ADF), total digestible nutrients (TDN), calcium and forage phosphorus were evaluated. Data were submitted to Anova and SNK test (p=0.05) when there were significant differences. The application of BW promoted a significant increase in the percentage of CP and P of the forage, as well as a decrease in NDF, which is an improvement in its nutritional quality. CP increased from 23% with fertilization to 27% with CP effluent. For P the contents increased from 0.225 to 0.280 g kg^{-1}. DNF had a reduction from 71 to 67%, in the treatment with conventional fertilization and with BW, respectively. Therefore, the irrigation with BW provided improvements in Vaquero grass fodder quality compared to conventional fertilization, confirming that the bovine effluent is a source of nutrients such as N and P, and allowed better results than industrialized fertilizers.

Keywords: Bovine effluent, cynodon dactylon, fertigation, forage quality, water reuse.

Video presentation

PRODUCTION OF *Brachiaria* NUTRIRRIGATED WITH INDUSTRIAL WASTEWATER

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Abstract: The nutri-irrigation of forage plants with wastewater is a sustainable option for the management of this waste, without causing soil or water contamination. In order to study the response of *Brachiaria* grass to fertigation with industrial wastewater (IW), a completely randomized design experiment, with three treatments and four replications was conducted, being 424, 856 and 1280 m^3 ha^{-1} $year^{-1}$ of IW applied through 48 irrigations during the year. The forage mass, the forage accumulation rate, and the support capacity for one year were evaluated and the data were submitted to Anova and the Student Newnan-Keuls (SNK) test with p = 0.05. Forage mass production increased as a function of the applied IW dose, and treatments with 856 and 1280 m^3 ha^{-1} $year^{-1}$ of IW showed no significant difference producing 30 t ha^{-1} $year^{-1}$ of dry matter (DM). The treatment with 424 m^3 ha^{-1} $year^{-1}$ accumulated 73 kg ha^{-1} d^{-1} DM lower than the other treatments that presented an accumulation of 95 kg ha^{-1} d^{-1} of DM. The forage support capacity increased from 3.25 AU ha^{-1} (animal unit) with 424 m^3 ha^{-1} $year^{-1}$, to 4.25 AU ha^{-1} with 1280 m^3 ha^{-1} $year^{-1}$ IW. The application of industrial wastewater increased the production of *Brachiaria* forage and its support capacity, being a sustainable way of disposing of the effluent.

Keywords: Fertirigation, forage production, water reuse.

Video presentation

EVALUATION OF ORGANIC COMPOSTS AS SUBSTRATE FOR THE GERMINATION OF PRE-SPROUTED SUGARCANE SEEDLINGS

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Abstract: Sugarcane productivity can be increased by planting pre-sprouted seedlings (PPS) on properly stabilized substrates. Therefore, the objective of this study was to evaluate the performance of organic substrates in sugarcane PPS, coming from the composting of urban and farming wastes, such as sewage sludge (SS), restaurant organic waste (RW), swine waste (SW), tree pruning (TP) and grass clippings (GC). Small stalks containing sugarcane buds were planted in trays containing the following substrates: T1 = clayey soil; T2 = sandy soil; and organic composts from the following mixtures: T3 = SS + TP; T4 = SS + GC; T5 = RW + TP; T6 = RW + GC; T7 = SW + TP; T8 = SW + GC, for young and old buds, totaling 16 treatments. After 26 days of planting, the number of germinated seedlings was counted, and the leaves and roots were collected, washed, weighed, and extracted and quantified the total contents of N, P, K and Ca. Organic composts were more efficient in promoting the sprouting of sugarcane buds when compared to the control treatments (T1 and T2), and seedlings with a higher concentration of nutrients. Treatment T5 (RW + TP) obtained higher values for most biometric parameters, including old buds that presented 93.3% of sprouting, compared to other treatments in which sprouting was between 20% and 80%. Thus, organic composts from potentially polluting wastes and destined for sanitary landfills can be used as substrate for the production of pre-sprouted sugarcane seedlings.

Keywords: Urban waste, agricultural waste, composting process.

Video presentation

AGRO-INDUSTRIAL WASTE AS A CONTRIBUTION OF NUTRIENTS TO DEGRADED SOILS

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Abstract: Organic and inorganic amendments are commonly added to degraded soils, improving physical, chemical and biological characteristics, increasing their productivity. We evaluated the addition of diatomite earth (D) from brewery production, biochar (B) from a biomass boiler and fish waste (FW) from a fish industry, as amendment to improve water holding capacity (WHC), nutrients uptake and productivity of ryegrass in a Sandy soil (S). The soil has low organic matter content (2.0%) and available phosphorous (2 mg/kg). For ryegrass production, pots of 4 kg of the soil amended with the residues (5%) in different combinations were used. Pots were maintained at 70% WHC in greenhouse conditions during 240 days. Pot with soil with commercial fertilization (SF) equivalent to the culture requirement was used as control. Macro and microelement uptake was evaluated in roots and biomass at the end of the assay. Vegetal biomass was evaluated four times during the assay. The main results showed that WHC of the S increased (>75%), as well as, ryegrass productivity by the addition of all waste materials. The highest productivity was obtained when combination of amendment (B+D+FW) was applied, obtaining more than 45 mg/pot of vegetal biomass. Treatment with FW showed the best acummulation of phosphorous, calcium and magnesium in the biomas and roots. Contrarily potasium was better absorbed when combination of amendment (B+D+FW) was applied. ANID/FONDAP/15130015 and DIUFRO DI20-2013 projects.

Keywords: Agroindustrial waste, biomass productivity, nutrients uptake.

Video presentation

CASES

SLUDGE ANAEROBIC DIGESTION FOR ENERGY SELF-SUPPLY IN A SEWAGE TREATMENT PLANT

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Abstract: Sewage Treatment Plants (STP) based on activated sludge and extended aeration, usually produce a large amount of wet sludge, commonly destined to controlled landfills in Brazil. This sort of facility is high-energy demanding. Sewage disposal and recycling strategies require sustainable technologies to convert them into new energy sources to support environmental, social, and economic advances in the long-term. In this study, the energy recycling from sludge anaerobic digestion (AD) was assessed to present a sustainable development route to a medium-size Brazilian STP. The study was based on two scenarios: i) STP operating with “only grid” electric energy; and ii) STP operating with electricity from biogas burning and connected to the grid. The biogas produced was assumed to be burnt in a stationary engine, and from the whole sludge generated in the STP chosen for this study, a positive electricity generation was obtained. In addition to generating enough electricity for the full operation of the STP, there is a surplus for sales. Moreover, the cost of energy obtained from the adoption of sludge AD, followed by biogas burning, decreases from 0.08 USD/kWh to 0.001 USD/kWh. Finally, the investment in the AD reactor was estimated and it is similar to the current cost of the final sludge disposal in controlled landfills. The results from this case study could support decision-making towards a circular economy to achieve greener energy systems for medium-sized cities and STPs.

Keywords: Sewage sludge, energy recovery, sludge treatment.

Video presentation

BIOFILTRATION OF METHANE EMITTED BY THE LANDFILL COVER LAYER - USE OF SCUM FROM WASTEWATER TREATMENT PLANT AS AMENDMENT TO THE COVER SOIL

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Abstract: Landfills are an important antropogenic source of greenhouse gases (GHG). In this context, biobased-systems (as biofilters) have been employed as a key-technology in the mitigation of GHG (methane and carbon dioxide) emitted as fugitive emissions from these plants. This study focused on evaluating the oxidation efficiencies of methane in two experimental biofilters installed at Municipal Landfill of Guarapuava (Parana State, Brazil). The control biofilter employed only landfilll cover soil as filter bed (with a low organic matter content, 0.5%); the improved biofilter, in this work referred to as “enriched column”, used dried scum from municipal wastewater treatment plant blended with the cover soil (with a high organic matter content, 4.5%) in order to evaluate the influence of the organic matter (and nutrients) in the performance of the biosystem. Other parameters of the process, as moisture content and temperature of the packing materials, were also evaluated. Five campaigns were carried out for the two columns. Results showed a higher oxidation efficiency of methane in the enriched column (94%) compared to the control column (88%). Moisture and temperature of the packing materials didn’t show any relationship with the oxidation efficiencies (only organic matter content). In summary, this study demonstrated the use of low cost and high availability organic wastes can present a high efficiency in the mitigation of methane in landfill cover layers.

Keywords: Bio-based systems, greenhouse gases, municipal solid wastes, organic wastes valorization.

Video presentation

GPS DATA LOGGER PROTOTYPE FOR SWINE MANURE (SM) DISTRIBUTION MAPPING

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Abstract: The swine manure (SM) has a great fertilizer potential for agriculture and its disposal in soil is a widespread practice. Although precision agriculture has been developed in Brazil, this concept (technology) is still not being used to monitor practices with great polluting potential, as is the case with the distribution of SM. Thus, the objective was to build and evaluate a GPS data logger prototype for mapping the SM distribution. The device consists of an Arduino UNO R3 board, a Neo-6M GPS module plus antenna and a Shield Data Logger with SD Card memory reader. Power supply is provided by a 2200 mAh LiPO battery. The components were fixed on a plastic mounting plate in a polyethylene multipurpose control box. The software implementation took place in C++ language using Arduino's IDE. The device was loaded onto a tanker truck used for transportation and distribution of SM from a representative municipality in the intensive production of swine in the west of the Santa Catarina State, Brazil. The prototype showed efficiency in data collection and storage, as well as adequate autonomy for daily operations, proving to be a promising instrument and a low-cost alternative, especially for regions of small properties where pig farming in southern Brazil is located.

Keywords: Geoprocessing, pig rearing, environmental management.

Video presentation

PRELIMINARY ECONOMIC ANALYSIS OF THE PRODUCTION OF BANANICULTURE BIOMASS ETHANOL

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Abstract: The main objective of this work is to carry out an economic analysis creating productive scenarios verifying the appropriate logistics for the implementation of industrial plants of 2G ethanol with banana production waste in the northeastern region of Santa Catarina (micro-region of Blumenau, Itajaí and Joinville), in addition to analyzing the "new waste" resulting from the industrial plant for energy cogeneration. The estimated annual production of ethanol from the use of all the biomass generated in the three microregions of Santa Catarina (38 municipalities) was 45,080 m^3. Considering only the three municipalities with the highest production of bananas (Luiz Alves, Corupá and Massaranduba), this production is reduced to 32,712 m^3 with energy expenditure of 138.4 GJ m^{-3} and a significant reduction in transportation costs of raw material from the field to the plant. The municipality of Santa Catarina indicated as the most appropriate for the installation of a plant of this size was Massaranduba. In an optimistic proposal, where all the energy costs would be supplied by biogas from the "new residues" generated in the plant, the payback would be 10.7 years. The "new residues" generated presented a ratio of COD/BOD_5 less than 2.5 showing that they have good degradability, i.e., they have a potential application for biogas production for energy cogeneration.

Keywords: Bioethanol, cogeneration, economic analysis.

Video presentation

ENVIRONMENTAL IMPACTS TO THE AIR, SOIL, WATER AND PLANT SYSTEM

HOW MUCH DOES THE FIRST-WEEK POST-WEANING OF PIGLETS CONTRIBUTE TO GLOBAL WARMING?

Juliana Dias de Oliveira*, Ana Carolina Amorim Orrico, Carolina Obregão da Rosa, Rita Therezinha Rolim Pietramale, Clandio Ruviaro, Brenda Kelly Viana Leite, Lorrayne Pedroso da Silva

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Abstract: This study aimed to characterize the manure of weaned piglets. The primary data was obtained in the first week post-weaning of piglets to identify how much the waste from this animal category can impact the environment. The Life Cycle Assessment was applied to verify the amount of waste and the emission of nitrous oxide (N_2O) considering the piglets' gain of weight (GW) in the first week post-weaning. Collections of waste were carried out in a farm of piglets post-weaning, located in the Dourados, MS, Brazil. Chemical analyzes were conducted in the Laboratory of Agricultural Waste Management belong to the Federal University of Grande Dourados. Eight collections of waste were conducted considering two piglets' batches, which represented an average of 10,800 animals with an initial and final weight of 5.11 and 6.54 kg, respectively. The waste production was 0.126 kg of dry matter (DM) for each kilogram of GW produced. This waste production has an emission capacity of approximately $4x10^{-4}$ kg of N_2O/kg of GW in the first week post-weaning. Considering that the N_2O has a global warming potential almost 300 times more effective at trapping heat than CO_2 thus, each 1 kg of piglet produced can emit around 0.12 kg of CO_2 equivalent by the NO_2 produced. Considering the number of piglets evaluated in this study, the total emission might reach 1.85 tons of CO_2 equivalent just during the first week post-weaning.

Keywords: Emission, environment, gain of weight, greenhouse gases, swine.

Video presentation

MANAGEMENT OF WATER, WASTE, EFFLUENTS, ELECTRICITY AND QUANTIFICATION OF GREENHOUSE GAS EMISSIONS IN A FLOUR HOUSE IN ALAGOAS, BRAZIL

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Abstract: The cassava processing chain has the potential to be sustainable and can actively contribute to changes towards a circular economy. This study aimed to identify the potential for improvement in the production line of a furnace house (also known as a flour house) in Alagoas, northeastern Brazil. For this, an evaluation of the management of water, waste, effluents and electricity was carried out and the quantification of greenhouse gas emissions in the flour house based on the GHG protocol. The understanding of matter and energy flows along the production chain identified stages with some deficiency. In the improved scenario, with the application of Cleaner Production, there was a 25% reduction in electricity consumption, 67% in emissions related to burning biomass that feeds the ovens used to toast flour and 18.2% of those related to transportation of cassava. At the end of the work, difficulties were found to adapt the effluent treatment technologies proposed by the technical works to the reality of the Agreste region of Alagoas. This shows that there are still limitations in the literature related to treatment technologies applicable to small-scale production, especially in rural areas.

Keywords: Wastewater from cassava processing; furnace (flour) house; cleaner production.

Video presentation

GLOBAL WARMING POTENTIAL AND MITIGATION SCENARIOS WITH MANURE TREATMENT IN SWINE FARMS FROM SANTA CATARINA, BRAZIL

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Abstract: The Brazilian Low Carbon Agriculture (LCA) Plan promotes biodigestion and composting to mitigate 6.9 Tg CO_2e yr^{-1} by 2020 or ~30% of the global warming potential (GWP) of animal manure as estimated for 2016 in the 2020's Brazilian GHG National Inventory. Here we present an inventory of GHG emissions and mitigation scenarios from manure management in swine farms from the State of Santa Catarina, which accounts for ~31% of Brazilian production. We collected the geolocation, number and category of housed animals and manure management technology used in all swine farms (n=8,380) licensed for operation by the Environmental Institute of Santa Catarina (IMA-SC). Manure production and excretion of volatile solid and nitrogen were calculated using regional standards. Methane (CH_4) and direct and indirect nitrous oxide (N_2O) emissions were calculated using default Tier 2 IPCC factors. The GWP of swine farms was 2.85 Tg CO_2e yr^{-1} Statewide. Composting and biodigestion were used for manure treatment in 135 (1.61%) and 120 (1.43%) farms, respectively, decreasing GWP by 5.3% in comparison with a business as usual (BAU) scenario with manure stored in anaerobic lagoons (3.02 Tg CO_2e). The adoption of biodigestion for manure treatment in all large (n=506) and medium to large (n=3.049) swine farms could mitigate GWP by 23% and 59% in comparison with BAU. Further efforts should be employed to promote manure treatment to cope with the objectives of the LCA Plan.

Keywords: Biodigestion, composting, greenhouse gases, inventory, methane, nitrous oxide, soil.

Video presentation

APPLYING GEOTECHNOLOGY TO PROSPECT GREENFIELD BIOENERGY PROJECTS

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Abstract: Bioenergy is very synergic with agriculture, livestock, and forestry. In Brazil, bioelectricity is already 8% of total generation and consumption. The increase in the production and consumption of biogas from livestock waste simultaneously produces biofuel and treats waste to promote rural sanitation. The application of geotechnology in regions with a high concentration of swine producers allows knowing and sizing the best options considering the possibilities of consortia. The method presented in this research, georeferencing, is used to predict where new enterprises can be implemented based on local agriculture. The results are presented in the format of databases and mappings as a case study in the west of Santa Catarina. In an area where there are still no facilities for the energy recovery from animal residues, but which has great potential for generating bioenergy and treating waste at the same time. It also presents the possibilities to map other sources of bioenergy. Thus, results from other renewable energy sources such as sugarcane and forests are presented.

Keywords: Biogas, waste to energy, geotechnology.

Video presentation

EFFECT OF REDUCTION AGE AT FIRST CALVING AND INCREASE WEANING RATE ON EQUIVALENT CO_2 EMISSIONS ON COW-CALF OPERATION SYSTEM

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Abstract: This study aimed to evaluate the impact of using fixed-time artificial insemination (TAI) on reduction of age at first calving (AFC; 48 to 24 months) and increase of weaning rate (WR; 60% to 80%) in beef heifers and cows need for pasture areas (ha) and equivalent CO_2 emissions (CO_2eq). Data from a grazing cow-calf operation system were used: 1) Without use of reproductive biotechnology and 2) With use of TAI. Emissions data considered were methane (CH_4) and nitrous oxide (N_2O) by animals and their manure. Values were converted considering 25 for CH_4 and 298 for N_2O per unit of CO_2eq. The CO_2eq was calculated according to number of calves, heifers (age) and cows for the same male calve production (400/year). Animals were considered as international unit (1 IU=450 kg/live weight) and 1 IU per ha was used. Emission values of production system were converted to dollars (60USD per 1 ton/CO_2eq/year), considering international carbon quotation on European exchanges. The production system without adoption of reproductive biotechnology (2,475 IU in 2,475 ha) with lower WR (60%) and higher AFC (48) emitted 3.714.530 tons of CO_2eq/year, corresponding to US$ 222.871,77. The system with TAI (1,540 IU in 1,540 ha) with higher WR (80%) and lower AFC (24) emitted 2.311.263 tons of CO_2eq/year, corresponding to US$138.675,77. Adoption of TAI increased reproductive efficiency and reduced use of area (-37,7%) and CO_2eq emissions cost (-US$ 84,196.00) to produce 400 male calves for beef fattening system.

Keywords: Sustainability, productivity, beef cattle.

Video presentation

COMBINING NO-TILL AND SLURRY APPLICATION: STRATEGIES TO REDUCE AMMONIA EMISSIONS

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Abstract: Manure is an important input of nutrients to soils but also can lead to significant nitrogen (N) losses, namely ammonia (NH_3) emissions. No-till has been adopted due to its benefits to the crop and the environment. However, the slurry application on the crop residues might lead to NH_3 losses. This study aimed to assess ammonia emissions from slurry subjected to different strategies when applied on stubble-covered soil. In this pot experiment the soil was covered by wheat stubble. The treatments were: Control, and five others corresponding to an application of 0.5 g of total-nitrogen per pot: Raw slurry on the stubble (RS), Acidified Slurry, pH 5.5, on the stubble (AS), 10 mm-equivalent irrigation just after RS (IR), Raw Slurry under the stubble (UN), Mineral Nitrogen, ammonium sulphate, on the stubble (MN). A dynamic chamber system was set up for 7 days to capture ammonia emissions. The greatest NH_3-N emissions were detected in RS (~34% of the total N and ~90% of NH_4-N applied). The NH_3-N emissions from US and AS were similar and lower than RS, representing 40% and 34% of RS emissions, respectively. In the US, the stubble layer possibly protected the slurry. The lower pH in the acidified slurry affected the equilibrium in the NH_4:NH_3 ratio, increasing the NH_4 content in the slurry. In conclusion, AS and US were the management strategies that allowed most reducing the ammonia emissions from slurry application in no-till.

Keywords: Ammonia, dairy slurry, no-till, nitrogen.

Video presentation

THE BRAZILIAN SOY FOR FEEDING ANIMALS IN EUROPE: A NITROGEN FLUX APPROACH TO THE SUPPLY CHAIN

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Abstract: The trade of soy products for animal feed changes the nitrogen cycle, because the distance between crop and animals can disconnect the nutrient cycle, reducing nutrient recycling and increasing the supply of reactive nitrogen in all the productive chain. This change potentiates the cascade effect of nitrogen. Therefore, this study aimed to estimate the nitrogen fluxes of Brazilian soy intended to feed livestock in Europe, and how these fluxes impact the cascade effect of nitrogen. The hypothesis is that the trade of Brazilian soybean and soybean meal is significant to increase the reactive nitrogen and is capable to potentialize the cascade of environmental impacts of nitrogen on ecosystems. For this, the nitrogen fluxes were estimated, using the material flow analysis methodology. To quantify the cascade effect, the nitrogen cascade indicator (NCI) was used, which represents the proportion of nitrogen emissions to the environment in all supply chain by the total nitrogen on livestock products. The NCI showed a nitrogen accumulation of 30% in 2007 and 29% in 2019 when evaluated from the production of Brazilian soy to consumption by livestock in Europe. These results highlight the importance of soy as a source of protein for animals in Europe and that nitrogen emissions occur during the various sectors of the production chain, being significant and deserving consideration in analyzes of agricultural production systems impact over the environment.

Keywords: Nitrogen cascade, trade, livestock, soybean meal.

Video presentation

THE EFFECT OF STORAGE TIME ON THE LIFE CYCLE OF SWINE MANURE MANAGEMENT SYSTEMS

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Abstract: Waste management is essential for the maintenance of production systems and has been gaining prominence in recent years, not only considering environmental concerns but also with an economic focus. Therefore, life cycle studies stand out as allied tools to evaluate the environmental viability of activity and were used in the present study to verify the effect of swine manure storage in terms of practical implications for a treatment system. The "short term climate change" impact category of the IMPACT World+ method, was evaluated for three scenarios: baseline (stabilization of the waste in open lagoons – 120 days – and application to the soil); storage time in gutters (5 days) followed by effluent anaerobic digestion (AD), digestate storage (60 days) before apply it to the soil (scenario 2); and storage (3 days), solid-liquid separation (SLS) of the fractions to subsequent AD, digestate storage (60 days) and soil fertilization. The results demonstrate a strong impact caused by different management practices promoted in the system, the associated short term climate change impacts were 1.76 E^{+2}, 8.64 E^{+1}, and 7.71 E^{+1} kg CO_2eq (short), for baseline, scenario 1 and 2 respectively. As the storage time decreased, there was a reduction of up to 50% of the impacts the greatest environmental benefits were due to the nutrient recovery promoted by the soil application. Thus, it is evident the importance of waste management, to promote a neutral carbon chain.

Keywords: Waste management, circular economy, atmospheric emissions, solid-liquid separation.

Video presentation

AMMONIA VOLATILISATION FROM SURFACE APPLICATION OF FECES AND URINE TO A PERMANENT GRASSLAND FROM DAIRY COWS FEED WITH OR WITHOUT ALFALFA

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Abstract: Ammonia volatilization from livestock excretion is a nitrogen loss pathway to the environment. Legumes have been used in the diet to reduce gaseous emissions. The objective was to evaluate the losses due to ammonia volatilization following the surface application of feces and urine to grass from dairy cows fed with or without alfalfa. Soil lysimeters from a southern Chilean grassland were used with 7 treatments (50 kg N ha^{-1}): faeces with alfalfa (F+A), faeces without alfalfa (F-A), urine with alfalfa and with acid (U+A+A), urine without alfalfa and with acid (U-A+A), urine with alfalfa and without acid (O+A-A) and urine without alfalfa and without acid (U-A-A), and a control (0 N), in random blocks (n=4). Dynamic flow chambers were used for 21 days. For all treatments the highest emissions were in the first 72h. The accumulated losses were 7.4 cd (F+A), 8.2 cd (F-A), 12.4 bc (O-A), 16.2 b (U-A-A), 16.5 b (U+A), and 24.5 a (U+A-A) kg N-NH_3 ha^{-1}, with higher emissions for U+A-A compared to the rest of the treatments ($p < 0.05$). When calculated as a percentage of the N applied, they ranged from 13.1 to 47.4%. In feces, the inclusion of alfalfa did not affected emissions, for urine a trend of greater losses was observed with alfalfa. Although the use of legumes could reduce gaseous emissions, the urine could have a great potential for N losses which should be considered in the implementation of mitigation strategies. Acknowledgments FONTAGRO ATN / RF-16926-RG.

Keywords: Ammonia, nitrogen, losses, alfalfa.

Video presentation

INFLUENCE OF SHADE ON FEEDLOT BEEF CATTLE WATER PRODUCTIVITY

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Abstract: With increases in global temperature the use of artificial shade is a practice to keep cattle thermal comfort and welfare in feedlots. The aim of this study was evaluated the impact of artificial shade on beef cattle water productivity. Nellore steers (48) were divided into two experimental groups and four pens, two with shade (S) and two without shade (WS). The daily individual water intake was measured by automatic drinker across 85 days. Feed and water had ad libitum access. This study applied a bottom-up approach where farm specific data was used to calculate water productivity (WP). As water input the study considered only the direct technical water representing by animal drinking. Functional unit was kg Carcass Weight (CW) L^{-1} water. The average carcass weight were 341 kg and 335 kg to under shade and without shade. The average WP to animals under shade was 0.116 kg CW L^{-1} water with a maximum of 0.146 and a minimum of 0.091 kg CW L^{-1} water. These averages were 0.106, 0.134 and 0.057 kg CW L^{-1} water, respectively, for animals without shade. The WP was on average 9% higher for animals under shade when compared to WS. This is environmentally significant and gives to the farmer a better capacity under the water aspect. Animals under shade present higher WP. This is justified due to the lower average consumption of water throughout the production cycle and the higher carcass weights of these animals.

Keywords: Artificial shade, water consumption, welfare.

Video presentation

A GLANCE TO THE FIRST TEN YEARS OF SLUDGE APPLICATION TO ARABLE LANDS IN CENTRAL CHILE: IS IT A SUSTAINABLE PRACTICE?

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Abstract: The use of sewage sludge as crop fertilizer is a practice that allows nutrient recovery and sludge management at low cost. However, besides plant nutrients sludge carries pollutants that might pose a risk to the environment. In the year 2009 Chile established a regulation that allows repeated sludge applications to arable lands at high rates; was it a sustainable decision? We hypothesized that repeated sludge applications to croplands at high rates (40 Mg ha^{-1} year) increased heavy metal concentrations and saturated the soil with nutrients. We summarized the data of 1,000 laboratory reports, accounting for 317 farms where 595 sludge applications had been done between 2009 and 2017. Our results showed that the soil nutrient cycling capabilities were over-extended. Croplands where sludge was applied more than once, showed higher contents of both heavy metals and nutrients. Certain heavy metals concentrations increased at faster rates: Zn, Se, and Ni while other accumulated at slower rates: Pb, As, and Cu. There was no change observed for Cd of Hg. Concentrations of soil nutrients also increased. The leading variables were available P and N as well as electrical conductivity. Soil organic matter showed a small increase while K and pH remained almost constant. We conclude that to repeat high-rate sludge applications to croplands does increase Se, Zn, and Ni. Our study stresses the importance of considering nutrient saturation in regulations to avoid environmental liabilities.

Keywords: Sewage sludge, heavy metals, nutrient cycling, sludge-based fertilizers, soil fertility, sustainability.

Video presentation

CORN-TO-ETHANOL MILLS PRODUCTION AND POTENTIAL IN THE SOUTHERN BRAZILIAN AMAZON: ENERGY, ECONOMIC AND ENVIRONMENTAL ANALYSIS

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Abstract: Brazil is a leader in renewable energy. Public policies should keep this leadership in new ways to face the strong country's dependence on fossil fuels and hydropower for electricity. The development of corn-based ethanol in the Midwest region of Brazil could potentially contribute to the biofuels economy and better environmental management. This work aims at corn ethanol production's technological prospection, strategies, and market potential in the Southern Brazilian Amazon's region. A 'Strategic Foresight' approach was formulated and thoroughly analyzed, focusing on bioenergy and biomaterials generation from corn ethanol. From an overall point of view, the Strategic Foresight has shown that livestock conversion productivity can be improved, and the light vehicles' energy demands of anhydrous and hydrous ethanol would be enhanced. The environmental analysis results showed that the greenhouse gas emissions from corn ethanol production could be 70% lower than the corresponding gasoline production in the United States of America. The growth is the result of the off-season harvest and the international market demand. However, due to the high transportation cost of corn, from the inner part of the State of Mato Grosso to the coast for export, the ethanol production from corn in this region shows activity with great potential for this corn in a more attractive way. This theme reveals a market gap and the importance of technological matchup of already existing technologies.

Keywords: Corn and ethanol cluster, energy planning, biofuels, bioelectricity, biomaterials.

Video presentation

NUTRIENT BUDGET AND EFFICIENCY OF THREE DAIRY CATTLE PRODUCTION SYSTEMS LOCATED IN SOUTHERN BRAZIL

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Abstract: The nutrient budget (NB) assessment is an important to measure potential environmental impacts of livestock systems. The aim of the study was to evaluate the NB and nutrient efficiency of three dairy systems (grass-based, semi-confined and feedlot). The NB (input-output) was calculated on farm scale for nitrogen (N) and phosphorus (P). The input was lactating cows' feed and the output the milk produced. The feedlot system presented the higher NB for both nutrients with higher input contrition for maize silage (42.3% N; 58% P) and soya bran (42.2% N; 24.8% P). In the semi-confined system, winter pasture (36.4% N) and maize silage (41% P) presented the higher input contributions. N and P in the form of manure can be used as fertilizer as a nutrient source for crops, promoting the circular economy. The feedlot presented the higher N and P use efficiencies, 27% and 31%, respectively. The lowest nutrient efficiencies were verified for grass-based system, with 9% (N) and 8.3% (P). Achieving a higher NB use efficiency on grass-based system requires more nutritional precision because the lactating cows' diets vary from seasons. The use of NB promotes the reduction of production costs and environmental negative impacts associated with N and P consumptions. The NB as an environmental assessment on dairy cattle needs to be straightened in Brazil.

Keywords: nitrogen, phosphorus, lactating cows, environmental impact.

Video presentation

GREY WATER FOOTPRINT OF DAIRY AND PIG FARMS IN SOUTHERN BRAZIL

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Abstract: Animal production is dependent on water in quality and quantity which makes the water and effluent management crucial. The grey water footprint (GWF) assessment allows to account the freshwater required to assimilate the load of pollutants. The aim of the study was to assess the GWF of dairy and pig farms and propose mitigation practices to reduce the footprint value. The GWF was calculated to 68 dairy farms (58 grass-based, 7 semi-confined, and 3 feedlot) and 37 fattening pig farms based on the nitrate (NO_3^-) concentration in the effluent for dairy farms and the ammoniacal nitrogen (NH_3-N) for pig farms. The function units were L of water kg^{-1} milk and L of water kg^{-1} carcass. The dairy feedlot presented the highest average GWF 2.52 L of water kg^{-1} milk. The average GWF for grass-based was 0.94 L of water kg^{-1} milk and it varied from 0.34 to 2.46. Average GWF for semi-confined was 0.70 L of water kg^{-1} milk. The NO_3^- load in the feedlot effluent was the highest, so, more water was consumed. Pig farms presented a GWF of 113 L of water kg^{-1} carcass. Effluent composition has a direct relationship with the animals' nutrition. So, precise nutritional management is a mitigation practice. The GWF reduction demands organic waste management, considering the production systems. If effluents were treated, it could reduce the NH_3-N and NO_3^- loads and the GWF. Finally, how effluent is applied as fertilizer can reduce the nutrient load by run-off and contribute to the GWF reduction.

Keywords: Nitrate, ammoniacal nitrogen, nutrient load, nutritional management, effluent management.

Video presentation

ONE HEALTH AND FOOD SAFETY

IRRIGATION PONDS AS SOURCES OF ANTIMICROBIAL RESISTANT BACTERIA IN AGRICULTURAL AREAS WITH INTENSIVE USE OF POULTRY LITTER, RIO DE JANEIRO, BRAZIL

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Abstract: Poultry litter, widely used as organic fertilizer, may contain residues of antimicrobials and resistant bacteria. In soils, these contaminants can reach water resources through surface runoff and leaching, contributing to the spread of resistance genes in the environment. In this context, this study aimed to determine the bacterial community of four irrigation ponds used in agricultural crops with intensive application of poultry litter in the municipality of São José do Vale do Rio Preto, Rio de Janeiro state. Samples were collected at the end and beginning of the rainy season. The DNAs obtained from the water samples were PCR amplified using primers for genes encoding integrons and genes encoding resistance to different antimicrobials. In three ponds, genes encoding integrons (intI1 and intI2) and resistance to sulfonamides (sul1 and sul2) and ß-lactams (blaGES, blaTEM and blaSHV) were detected. Next generation sequencing of the gene encoding 16S rRNA revealed significantly different bacterial community structure and composition among the four ponds and between samplings. Bacterial strains were isolated from CHROMagar plates supplemented with antimicrobials and identified using MALDI-TOF/MS. Clinically important Enterobacteriaceae genera resistant to sulfamethoxazole and/or ceftriaxone were identified in all samples. The results point to the spread of antimicrobial resistant bacteria in agricultural areas and the potential risk to human and environmental health.

Keywords: Antimicrobial resistance genes, poultry litter, resistant bacteria, sulfonamides, ß-lactams.

Video presentation

REFRACTORY AND PERSISTENT SUBSTANCES

DEGRADATION OF AZO DYE USED IN TANNERY BY ELECTROOXIDATION

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Abstract: The tannery was one of the most pollutants industries. The excessive use of non-biodegradable dyes can cause many negative impacts on the environment. So, it is essential to degrade these dyes, and electrooxidation (EO) can be one alternative. The EO tests were carried out with graphite electrodes (50 cm^2), connected to a power supply, and immersed in 0.75 L of dye solution prepared at a concentration of 0.015 g/L with the addition of NaCl (2.5 g/L). Four treatments were applied (A, B, C, and D) with different electric current densities (4, 12, 20, and 30 mA/cm^2), with 4 repetitions in each one, with a reaction time of 10 minutes. Dye removal was evaluated by UV-visible spectroscopy at wavelengths 458 and 609 nm. The absorbance spectrum demonstrates there was a significant reduction in peaks located at 458 and 609 nm in treatments B, C, and D. Treatment D obtained the highest removals, 86% and 94% at 458 and 609 nm, respectively. Treatment A obtained the lowest mean removals. In both wavelengths, the ANOVA demonstrate that is a significant difference between the treatment. So, the Duncan test was used to compare the removal means, demonstrating that treatment D is not different statistically from treatment C. Treatment B is not different statistically from treatment C, but it is different statistically from treatment D. Analyzing the results, it is perceived that the EO was efficient for dye degradation, with removal next to 90% and an electric energy cost of around 1.19 US$/$m^3$.

Keywords: Absorbance spectrum, energy cost, graphite electrode.

Video presentation

EFFECT OF LONG-TERM EXPOSURE TO TETRACYCLINE ON THE NITRIFICATION PROCESS

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Abstract: The extensive use of antibiotics in swine food-producing, e.g., tetracycline (TC), has led to its accumulation in the environment, once conventional wastewater treatment plants (WWTP) are not able to effectively remove antibiotics. So, this pollutant is discharged to surface water and groundwater. Whether in WWTP or in the environment, antibiotics can inhibit the nitrification process leading to eutrophication and soil acidification. Therefore, the effect of TC on ammonia oxidizing bacteria culture (AOB) over time was investigated in this study. A well-established AOB culture was grown for 70 d in a 1.5 L sequential batch reactor operated in an 8 h cycle, HRT of 2.75 d and volumetric loading rate was 273 mg $N\text{-}NH_4^+$ d^{-1} L^{-1}. In each reaction hour, feed and aeration occurred during 15 min, followed by 45 min for anoxic reaction. AOB was exposed to 100 and 128 mg L^{-1} of TC and the process was monitored in respect to the nitrogen compounds and cell concentration. The exposure to 100 mg L^{-1} of TC did not harm ammonium conversion efficiency; however, at 128 mg L^{-1} of TC, the efficiency decreased from 94% to 72%. Further investigation revealed that TC reduced the final effluent quality due to the development of a resistance mechanism by AOB culture against this antibiotic. This mechanism involves increasing the excretion of extracellular polymeric substances and soluble microbial products, which probably increases BOD, and reduces ammonia consumption by the bacterial culture.

Keywords: Nitrifying bacteria, tetracycline, emerging pollutants.

Video presentation

TECHNOLOGIES FOR WASTE TRANSFORMATION, REUSE AND DISPOSAL

BIOCHAR AND CRUDE GLYCERIN AS MITIGATORS OF N LOSSES IN THE COMPOSTING OF SLAUGHTERHOUSE WASTE

Brenda Kelly Viana Leite*, Ana Carolina Amorim Orrico, Juliana Dias de Oliveira, Marco Antonio Previdelli Orrico Junior, Rusbel Raul Aspilcueta-Borquis, Janaina Freire Machado, Isabelly Alencar Macena

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Abstract: Composting is a clean alternative to dispose of solid waste, resulting in a stable product ready to be used as organic fertilizer. However, during the composting process, high N losses can happen, mainly as ammonia and, in the thermophilic phase. The research aimed to evaluate the efficiency of biochar and crude glycerin as additives in N prevention losses during the composting of cattle slaughterhouse waste (SW) in static windrows receiving forced aeration. A completely randomized design with split-plot overtime was adopted, with five additions of additives (control, 5% and 10% of biochar and 5% and 10% of glycerin) and three composting times (50, 70, and 90 days) for evaluation of biodegradation. SW has been composted in association with a bulking agent in a 3:1 ratio, adopting nylon bags to insert the mixtures between SW and tested additives inside the windrows. The windrows reached and maintained thermophilic temperatures right after started the process and followed by the 50 and 70 days of turning. The control treatment presented the highest N losses ($p<0.05$) if compared to additives groups, ending with 58.38% of N loss. The inclusions of 5 and 10% of biochar produced an average loss ($p>0.05$) of 48.47% of N, while the 10% glycerin resulted in the lowest loss ($p<0.05$) of N (44.83 %). The use of biochar and crude glycerin as additives, in the composting of SW is recommended to reduce N losses, without compromising the biodegradation of organic constituents.

Keywords: Additive, forced aeration, gas emission.

Video presentation

SOLID REDUCTION AND QUALITY OF COMPOST USING ADDITIVES IN THE COMPOSTING OF SLAUGHTERHOUSE WASTE IN STATIC WINDROWS

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Abstract: Composting is an efficient recycling way to surplus solid waste from the slaughterhouse, and additives can be used to improve the quality of the compost. This study was carried out to evaluate the degradation of solids and quality of compost using biochar (BC) and crude glycerin (GC) as additives in the composting of cattle slaughterhouse waste (SW). A completely randomized design with split-plot overtime was adopted, with five additions of additives (control, 5% and 10% of biochar and 5% and 10% of glycerin) and three composting times (50, 70, and 90 days) for evaluation of biodegradation. SW has been compounded in association with a bulking agent in a 3:1 ratio, adopting nylon bags to insert the mixtures between SW and tested additives inside the windrows. The chemical composition of compost was analyzed at 90 days. At the end of composting, the control treatment presented higher ($p<0.05$) total solid (TS) degradation (68.79%) than the average reduction reached by the additives group (65.78%). The dose of 5% of BC has had a larger ($p<0.05$) TS reduction (68.49%) than 10% of BC (64.30%), while between doses of CG there was no difference (65.16%). The use of 10% of BC improved ($p<0.05$) the amounts of P, K, Ca, S, Zn, Mn Fe, Cu, and B in the compost. The CG addition resulted in the highest concentration of Na in the compost. The use of BC and GC as additives does not affect the degradation of the solid and improves the quality of the final compost.

Keywords: Forced aeration, nutrients, recycling.

Video presentation

QUALITY OF COMPOST PRODUCED FROM SLAUGHTERHOUSE WASTE COMPOSTED IN DIFFERENT SEASONS AND USING AERATION

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Abstract: Composting is known as an effective method of waste treatment, and the quality of the organic compost is essential for its recommendation. This research aimed to evaluate the seasons and aeration influence on the quality of the compost generated from cattle slaughterhouse waste (SW). A completely randomized design has been used in a 2x2 factorial scheme (winter (W) and summer (S) x with and without aeration), with a split plot over time (50, 70, and 90 days of composting). The proportion between SW and bulking agent was 3:1 (w/w) and, the average flow for aeration of the piles was 0.6 $L.min^{-1}.kg^{-1}$ of material in composting. The N and K concentrations were influenced ($p<0.05$) by the interaction between season and aeration. The contents of N in W were benefited with the use of aeration (36.0 and 28.8 g of $N.kg^{-1}$ of total solids (TS), with and without aeration respectively), while in the S there was no influence of aeration (30.8 and 33.2 g $N.kg^{-1}$ TS). The K contents in the compost were benefited by aeration in the S (8.88 and 8.05 g of $K.kg^{-1}$ of TS, with and without aeration, respectively) and were not affected in the W (8.20 and 8.09 g of $K.kg^{-1}$ of TS, with and without aeration, respectively). The contents of P in the compost were influenced only by the season (170.92 and 131.34 $mg.kg^{-1}$ for the W and S, respectively). Aeration was beneficial to increase the N contents in the compost obtained in W and of K in S, therefore being recommended. W favors P concentrations in the compost.

Keywords: Nutrients concentration, organic fertilizer, static piles.

Video presentation

CAN CATTLE SLAUGHTERHOUSE WASTE COMPOSTING BE INFLUENCED BY SEASON AND USE OF FORCED AERATION?

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Abstract: This study aimed to evaluate the aeration and season influence during the composting of cattle slaughterhouse waste (SW) adopting static piles. A completely randomized design has been used in a 2x2 factorial scheme (winter and summer x with aeration (A) and without aeration (WA)), with a split plot over time (50, 70, and 90 days of composting). The proportion between SW and bulking agent was 3:1 (w/w) and, the average flow for aeration of the piles was 0.6 $L.min^{-1}.kg^{-1}$ of material in composting. The composting period was 90 days, with turnings carried out at 50 and 70 days. The persistence of thermophilic phase for winter piles was 66 and 53 days with average temperatures of 55.8 and 57.5°C for A and WA, respectively. This period was shorter than that verified in the summer piles, which reached 71 and 72 days for A and WA, respectively, presenting 55.9 and 53.7 °C. The A did not benefit ($p>0.05$) the total degradations of total solids (TS), C, and neutral detergent fiber (NDF) for piles conducted during the summer, resulting in similar values to the WA treatment (68.46; 78.14 and 62.53%, respectively). For winter piles, the aeration provided a lower degradation rate of TS, C, and NDF (57.86; 69.19 and 61,47%, respectively). The A did not influence on organic constituents' degradation during the summer and presented negative effects in winter piles, therefore the use of aeration is not recommended during SW composting.

Keywords: Degradation, piles, temperature, total solids.

Video presentation

REMOTING SENSE OF COMPOSTING SYSTEMS: A NEW SUSTAINABLE AND LOW-COST APPROACH TO WASTE TRANSFORMATION

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Abstract: When incorrectly disposed, agricultural wastes provide environmental impacts due to the high volume and content of toxic products. In this context, the Biobed composting system stands out as a sustainable alternative to waste management. Thus, the objective of this study was to develop a compact, simple and low-cost approach for monitoring biophysical parameters from a Biobed composting. The system consist by an ATmega8U2 microcontroller Arduino prototyping base, along with an SD card module that stores the collected data, and a real-time module, which provides the sensor the collected information in case of power failure. To validate it, humidity and temperature sensors were inserted inside a Biobed composting, to capture the value of the system variables: each 40 seconds the parameters were collected by the sensor, gathered and stored on the card. With the system, were possible to note the behavior of the parameters and fluctuations throughout the day. Besides, it is possible to change the intervals of the observations in the system and Excels graphs can be provided. The advantages of this technology, is that it can be used to provide strategies to better understanding the dynamics of the composting system to manage wastes, the low cost and the possibility to be designed and applied on large systems.

Keywords: Waste management, biobed, data storage, arduino systems.

Video presentation

PRODUCTION OF BIOCOMPOST FROM WINE WASTE

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Abstract: The viticulture is one of the most important sectors of the Brazilian agribusiness, being the bagasse (seeds, skins and stalks) the main residue produced, in which, the composting can transform them into stabilized biocompost for agricultural use. The objective of this work was to produce biocompost from the composting of vineyard waste and to evaluate its physicochemical characteristics. A pile was assembled with dimensions (1 x 1 x 1 m) and proportion 1:1 (bagasse/waste). The procedure lasted 120 days, in which moisture maintenance, turning, and analysis of moisture, temperature, C/N ratio and pH were performed. It was noted that the initial moisture content was high (92.68%) suffering a decrease at the end of the process (55%), staying within the range considered ideal. The temperature increased to a maximum of 60º C in the first weeks, ensuring the minimum thermophilic period required for pathogen reduction, according to CONAMA Resolution 481/2017. The C/N ratio obtained at the beginning of composting was 30/1, while at the end it decreased considerably reaching 17/1, remaining during most of the study according to CONAMA Resolution 481/17 (less than or equal to 20:1). The pH value measured at the beginning of composting was 7.25 and at the end 6.76. The control and environmental quality of the composting process are necessary for the biocompost produced to be a viable alternative for the treatment of vineyard waste for use as organic fertilizer in agricultural crops.

Keywords: Bio-fertilizer, composting, winegrowing.

Video presentation

CHEMICAL AND THERMAL CHARACTERIZATION OF BANANA PSEUDOSTEM, COIR AND PEACH PALM FIBERS

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Abstract: Fibers from renewable sources are increasingly being used to reinforce thermoplastic and thermoset composites. The main advantages of using fibers in polymers are their renewable origin; easy handling; and lower density in relation to other inorganic material, making them less abrasive in processing machines. As such, fibers were submitted to chemical and thermal characterization. Chemical characterization was performed in accordance with TAPPI standard T19 to quantify holocellulose and a-cellulose. Lignin content was determined using the Klason method. The following characterizations were also carried out: moisture and ash content, Fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA). Holocellulose content was 60%m for banana pseudostem, 67%m for coir and 68%m for peach palm. The fiber with the highest a-cellulose percentage was peach palm (60%m) and the lowest, coir (46%m), while the latter exhibited the largest hemicellulose content (21%m) and the former the lowest (8%m). Coir also displayed the highest lignin content (30%m). The FTIR peaks obtained are characteristic of lignin, hemicellulose and cellulose absorption. The TGA results are consistent with those reported in the literature for the degradation of the constituent fibers. The values of the first degradation peak varied from 273 to 342 °C, corresponding to hemicellulose degradation, and the second from 325 to 507 °C, reflecting the degradation of cellulose and part of lignin.

Keywords: Characterization, fibers, banana pseudostem, coir, peach palm.

Video presentation

DRYING PROCESS OF PINHÃO SEED COATS AND ITS FLOUR CHARACTERIZATION FOR FOOD PRODUCTS APPLICATION

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Abstract: The seeds from Araucaria angustifolia, regionally named pinhão, are an important source of income in the south of Brazil. The pinhão seed coats are considered solid waste. Nevertheless, these seed coats are important sources of dietary fiber and phenolic compounds and can be a potential ingredient for function products. Therefore, this study aimed to investigate the drying kinetics of pinhão seed coats to obtain and characterize a flour to food application. The drying temperature of 70 °C and air velocity of 1.0 m s^{-1} were applied to construct the drying curves. These curves were fitted to five empirical and semiempirical mathematical models to establish predictive equations for the drying process. After drying, the seed coats were ground (30-mesh sieve) to obtain flour, which was nutritionally characterized, and its antioxidant activity was quantified. The equilibrium humidity value was 2.90% and the Page and the Overhults models provided the best results (R^2=0.9996; χ^2=0.1926). The nutritional composition was following the legislation standards and it was obtained a flour for human consumption with high content of dietary fiber (84.91%), high content of phenolic compounds (39.53 mgEC g^{-1}), and DPPH radical scavenging activity of 93.23%. Thus, it could be a strategy to promote environmental impacts mitigation from the Araucaria angustifolia waste by recovering the pinhão seed coats as a food ingredient, enhancing human health as well as environmental sustainability.

Keywords: Araucaria angustifolia, agro-industrial by-product, dietary fiber, phenolic compounds.

Video presentation

LABORATORY SCALE BIOREACTOR FOR COMPOSTING EXPERIMENTS: TEMPERATURE AND RESPIROMETRY MONITORING

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Abstract: Composting is a predominantly aerobic and thermophilic bioprocess whose end product (compost) is an organic fertilizer and soil conditioner. However, there are still opportunities to improve composting processes, such as: nitrogen loss reduction and the quick degradation of lignocellulolytic materials (bulking agents). Full-scale composting experiments demand large volumes of materials making the search for a laboratory scale tool to reproduce this bioprocess a challenge. In this regard, a 3 L bioreactor was developed and tested - made of polypropylene, aerobic, controlled by differential temperature, with respirometry by sensors. The test was carried out with a mixture of swine manure + sugar cane bagasse + malt bagasse (327 g dw; C:N = 30; moisture = 60%). Temperature was continuously measured and exit air was monitored by an O_2 sensor. Air flow rate was maintained at 0.37 mL min^{-1} g^{-1} during seven days. A typical thermophilic curve was found and it was strongly related to O_2 status -- an evidence of the aerobic biological activity (O_2 > 10% at 96% of the test). O_2 % dropped sharply in the first hours following a fast increase in temperature (O_2 = 7.5%; T_{max} = 57 °C). A low point of O_2 = 4% was reached; followed by a consistent recovery along the thermophilic phase. In addition to the small volume of feedstock, we highlight the simultaneous monitoring of temperature and oxygen as a relevant advantage of this set up for composting experiments.

Keywords: Agro-industrial waste; lignin; ammonia; green-house gases.

Video presentation

BIBLIOMETRIC ANALYSIS OF TECHNOLOGIES FOR AGRICULTURAL WASTE VALORIZATION

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Abstract: Faced with resource limitations, discussions about sustainability, circular economy, and bioeconomy are gaining relevance. In livestock farming, the waste starts to be seen as a problem, but there is also the possibility of adding value to this waste. The potential of livestock waste treatment technologies is well explored in the literature, but it is necessary to systematize the knowledge on the subject and determine which technologies are more consolidated to know the real impact that these technologies have on livestock. Thus, this study aims to present a mapping of the research on waste treatment technologies in livestock farming and highlight which technologies are more consolidated and used. The method adopted was bibliometric analysis. Consistent growth in publications on the topic was observed. Preliminary results show that the United States and China are the countries that have explored the subject the most. The main technologies found were anaerobic digestion and composting. This study contributes to the systematization of knowledge, and the main technologies found can be considered a benchmark for comparison with other waste management technologies that are being developed.

Keywords: Agribusiness, waste, bibliometrics.

Video presentation

THE CHARACTERISTICS OF ANAEROBIC DIGESTION IN AGRICULTURE AND CATTLE RAISING IN BRAZIL

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Abstract: Among the discussions about sustainability, attempts to produce alternative materials and fuels, is the challenge of agriculture, which is to produce more while consuming fewer natural resources. In this dynamic, technologies emerge, such as anaerobic digestion, capable of adding value to agricultural residues. But, the studies carried out in Brazil on the subject were focused on technical aspects or estimates of the potential energy production through waste management technologies. The purpose of this study is to identify the main characteristics of anaerobic digestion plants in animal agriculture. We performed a descriptive statistical analysis of the data published by the Cibiogás association. We have established a generic profile for Brazilian livestock biogas plants. The number of plants increased exponentially in the last decade. Most agricultural biogas plants are small (78% produce less than 500,000 Nm^3/year of biogas). Almost 90% of plants produce electricity. It is necessary to study different technological and productive arrangements. We need to create viable business models for the reality of Brazilian agriculture. Knowing the profile of biogas plants in Brazil is essential for the development of new strategies for sustainable agriculture.

Keywords: Anaerobic digestion, circular economy, bioeconomy, energy, fertilizers.

Video presentation

PHYSICOCHEMICAL CHARACTERIZATION OF GRAPE POMACE (*Vitis vinifera* L.) AND POTENTIAL APPLICATION AS AN ADSORBENT MATERIAL FOR PERSISTENT SUBSTANCES

Luiz Eduardo Nochi de Castro*, Francisco W. Maciel-Silva, William Gustavo Sganzerla, Mauricio A. Rostagno, Tânia Forster-Carneiro

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Abstract: Grape pomace (GP) is a solid by-product generated during the grape industrialization process. Approximately 30% of all the grape's mass destined for industrial production reaches the end of the process as residue, which is a persistent waste without practical application. Thus, it is necessary to develop technologies to reuse this waste. This study conducted the physicochemical characterization of GP and its adsorptive capacity test in the removal of Allura Red dye. The GP samples were characterized by moisture, ash, protein, fat, reducing and non-reducing sugar content, and titratable acidity. For the adsorption test, 0.1 g of GP was added to 50 mL of an aqueous Allura Red food dye solution at a concentration of 10 ppm. The adsorption reaction occurs in an incubator with orbital shaking at a temperature of 25 °C for 18 h. The results demonstrate that GP presents 10.30 g moisture 100 g^{-1} dry weight (d.w.), 7.13 g ash 100 g^{-1} d.w., 11.86 g protein 100 g^{-1} d.w., 7.10 g lipids 100 g^{-1} d.w., 3.44 g glucose 100 g^{-1} d.w., 18.17 g sucrose 100 g^{-1} d.w. and 1.10 g tartaric acid 100 g^{-1} d.w. An adsorptive capacity of GP of 1.28 mg dye g^{-1} of adsorbent was obtained for the adsorption test. In conclusion, this study shows that GP can be used to treat persistent pollutants such as dyes.

Keywords: Biomass, adsorption, bioenergy.

Video presentation

SUBCRITICAL WATER HYDROLYSIS OF GRAPE POMACE (VITIS VINIFERA L.) FOR THE RECOVERY OF FERMENTABLE SUGARS AND ORGANIC ACIDS

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Abstract: The use of green technologies for waste treatment has been widely discussed in recent years. Among these technologies, the use of subcritical water hydrolysis (SWH) has been a promising eco-friendly process for biomass treatment. This technique can recover compounds with high added value, such as sugars and organic acids. This study aimed to analyze SWH for the recovery of fermentable sugars and organic acids from grape pomace (GP). The SWH was conducted in a semi-continuous flow-through reactor, fed with 10 g of GP. The experiments were carried out at 150 °C, 150 bar, and water flow of 5 mL min-1. Kinetics to obtain the hydrolysates were performed for 60 min. The determination of the sugars and organic acids in the hydrolysate occurred by high-performance liquid chromatography coupled to a refractive index detector, where 10 µL of the sample was injected into the system in a run time of 20 min, using a 0.01 mol L^{-1} H_2SO_4 solution as mobile phase. The results demonstrate that cellobiose (0.08 mg mL^{-1}), glucose (1.25 mg mL^{-1}), citric acid (0.11 mg mL^{-1}), and succinic acid (0.07 mg mL^{-1}) were obtained from SWH of grape pomace. The high glucose content present in the hydrolysate suggests that the breakdown of hemicellulose in the sample through hydrolysis was effective, and this monosaccharide can be used to produce ethanol 2G. Finally, this study demonstrated that SWH is an effective technique for waste valorization and biomass recovery, generating value-added products.

Keywords: Biomass, green technology, bioproducts.

Video presentation

INTEGRATING BIOLOGICAL NITROGEN REMOVAL WITH PHOSPHORUS AND POTASSIUM RECOVERY AS K-STRUVITE IN SWINE MANURE TREATMENT

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Abstract: In areas very active in swine rearing, biological nitrogen (N) removal by nitrification-denitrification (NDN) is applicable to manure liquid fractions to reduce N-surplus. Otherwise, manure treatment offers good opportunities for nutrient recovery. The liquid effluent obtained after NDN is usually rich in phosphorus (P) but especially in potassium (K). According to its particularities (low organics, alkalinity and ammonium), simultaneous recovery of both nutrients (P&K) as struvite-type salt has been addressed, i.e. K-struvite ($MgKPO_4 \cdot 6H_2O$). Experiments were conducted to gain experience on the precipitation process in view of its scaling-up to field conditions in the near future using a jar-test device and an air-lift crystallizer. The composition of the NDN effluent used was unbalanced (1.6 g K^+/L; $Mg^{2+}/K^+/PO_4$-P molar ratio as 1.4/9.5/1) with respect to the formula of the K-struvite (Mg/K/P as 1/1/1) so that external sources of Mg ($MgCl_2$, MgO) and PO_4 were considered when targeting high K-recovery. In the crystallizer, K-recovery efficiency increased from 6% up to 48% when adding external reagents. Thus, although the impossibility to obtain a pure salt, co-precipitation of K-struvite with other phosphate salts such as cattiite, Na-struvite, and struvite resulted in a multi-nutrient product potentially usable as a fertilizer. The sludge purged from the bioreactor (1 g total-P/L; total-Mg/K/P as 0.7/1.2/1) was also tested as an alternative source of PO_4 and K-struvite.

Keywords: Liquid fraction of pig slurry, nitrification-denitrification, thickened sludge, magnesium-potassium-phosphate salt, biofertilizer, circular economy.

Video presentation

QUANTIFICATION OF FUNCTIONAL BACTERIA INVOLVED IN THE DEAMMONIFICATION PROCESS ON A NITRAMMOX® REACTOR

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Abstract: Anaerobic ammonium oxidation (ANAMMOX) is the process of oxidizing ammonia into nitrogen gas through the reduction of nitrite. Even though the bacteria involved in the ANAMMOX process are not found pure in the environment, they are always in consortium with other bacteria, especially those involved in the nitrogen cycle. ANAMMOX shows a granular shape, which allows the nitrifying bacteria to form a biofilm around them. Furthermore, they have a unique characteristic that is an intracytoplasmic compartment called the anammoxosome, which is believed to be a barrier against diffusion, enabling the transformation of the substrate into nitrogen gas, by specific enzymes. Fluorescent in situ Hybridization (FISH) is a quantification technique through the incorporation of oligonucleotide probes to determine the species present in the analyzed process. Therefore, the objective of the present work was to evaluate the functional bacteria existing in samples from a deammonification reactor called NITRAMMOX® operating on a lab-scale. Samples were collected and performed as described by standard protocols, and slides were analyzed under a fluorescence microscope. Following, the images were treated in the ImageJ software, where it was possible to observe the presence of nitrifying bacteria and ANAMMOX, elucidating the symbiosis between these two species. In brief, the FISH technique proves to be useful for the determination of the microbiota involved in the deammonification process.

Keywords: FISH, quantification, ANAMMOX, probes, microbiota.

Video presentation

MICROALGAE-BASED PROCESS FOR THE DEPLETION OF TETRACYCLINES IN SWINE WASTEWATER

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Abstract: Antibiotics (ATB) have been used to treat animal diseases and, in some countries, to promote animal growth in livestock industry. The use of ATB in food-producing brings up an environmental trouble once it is known that a significant amount of the ATB is excreted and reach the environment. This study evaluated the degradation efficiency of four tetracyclines (TCs) by a consortium of indigenous microalgae (mainly Chlorella spp.) cultivated in swine wastewater. Reactors containing chlorine-free water (64% v v^{-1}), effluents from an UASB reactor (6% v v^{-1}), microalgae consortium (30% v v^{-1}) and 1 mg L^{-1} of ATB were exposed to white light (21.6 W m^{-2}) in a 12h:12h light:dark cycle, temperature of 23 °C and continuous agitation for 11 days. TCs were extracted from culture samples using pre-conditioned Oasis HLB SPE cartridge and after elution they were analyzed by ESI(+)-LC-MS/MS. The results of biomass growth showed no significant difference among the experiments and the control ($p>0.05$), showing that concentration of the TCs did not inhibit the growth rate. ATB depletion was around 98% for tetracycline, 91% for doxycycline, 89% for oxytetracycline and 87% for chlortetracycline by the phycoremediation process (considering 0% at time zero) after 11 days of treatment. This work concludes that the microalgae-based process is an efficient technology for tetracycline degradation in swine wastewater.

Keywords: Veterinary antibiotics, phycoremediation, biomass.

Video presentation

RECIRCULATED PACKED BED REACTOR FOR COD AND TN REMOVAL FROM MICROBREWERY EFFLUENT

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Abstract: Brewery effluent has high concentrations of COD (Chemical Oxygen Demand) and nitrogen. Microbreweries, due to the lack of resources or space, do not always have an effluent treatment plant, often needing to hire companies to collect and properly dispose of them or dispose of them in the sewage system. Thus, the objective of this work was to evaluate a fixed-bed biological reactor with intermittent aeration in the removal of COD and total nitrogen from microbrewery effluent. The reactor was provided with recirculation and had a batch feed. Mini BioBobs® was used as a support medium for fixing the bacteria, which allowed the formation of aerobic and anoxic zones in the reactor. The reactor was operated at 30 °C and HDT of 16 h, with total aeration varying between 4, 8 and 12 h and the COD/TKN ratio of 40 and 100. It was possible to obtain values from 86% to 98% for COD removal and from 76% to 95% for TN removal. Due to the high denitrification rates, above 98%, nitrate was not detected in the effluent of any of the evaluated conditions. The results showed that the analyzed reactor was efficient in the joint removal of COD and TN, being a compact alternative for secondary and tertiary treatment in microbreweries.

Keywords: Intermittent aeration, simultaneous nitrification and denitrification, biological treatment.

Video presentation

COMPARISON OF THE ADSORPTION EFFICIENCIES BETWEEN AÇAÍ AND WOOD WASTES BIOCHARS IN THE REMOVAL OF METHYLENE BLUE

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Abstract: The gasification of biomass wastes is a feasible alternative to produce clean energy. Beyond the generation of synthesis gas, also produces charcoals as residue. In this work, two biomass wastes – wood scraps from furniture, and açaí cores (Euterpe oleracea) – were fed into a gasifier to generate synthesis gas and biochar. The biochar materials were characterized and then applied in the adsorption of the cationic dye Methylene Blue (MB). X-ray diffraction analysis evidenced the amorphous character of both biochars, whilst nitrogen adsorption-desorption technique (BET) showed that both materials can be classified as mesoporous materials and type II isotherm, in agreement to IUPAC classification. Specific surface area of açaí waste biochar (AWB) was 1.94 m^2/g, and for wood scraps biochar (WSB) was 181.70 m^2/g. WSB, by its turn, exhibited a more heterogeneous morphology, with broken pieces of grains. Therefore, adsorption assays showed that WSB was more efficient than AWB, since the experimental maximum adsorption capacity was 34.70 mg/g (WSB), and 27.50 mg/g for AWB. From kinetics and equilibrium experiments, it was observed that both samples showed quick adsorption (equilibrium state reached within 20 min). Furthermore, the isotherm which best represented the adsorption of MB by both biochars was the Langmuir-Freundlich model (R^2 > 0.99). This way, their employment in wastewater treatment can be furtherly optimized by employing the chemical activation of WSB and AWB.

Keywords: Gasification, biomass, adsorption.

Video presentation

SOYBEAN PROCESSING RESIDUE: AN ALTERNATIVE TO FOR NUTRITIONAL SUPPLEMENTATION FOR CULTIVATION PROBIOTIC MICRO-ORGANISM

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Abstract: Probiotics are live microorganisms that help balance the intestinal microbiota benefiting those who consume them. Considering that the culture media traditionally used to obtain them are expensive, the search for raw materials from alternative sources awakens interest in research. In this perspective and linked to Brazil's position as the world's second largest soybean producer, there is great interest in the by-products generated by the processing of its harvest, since large amounts of lignocellulosic materials are produced. This kind of materials are rich in protein, minerals and nitrogen, potential sources for use in formulations of microbiological culture media. The present work aimed to evaluate the effect of using different proportions of soybean residue extract in commercial medium (synthetic) as a medium to supplement the growth of Saccharomyces boulardii yeast in order to produce probiotic biomass. For this the material from soybean processing was heat treated and the extract obtained showed a concentration of 43.7mg/L of nitrogen. Fermentations were performed using different proportions of commercial medium and extract and the best condition to probiotic biomass production of was achieved in 48 hours, corresponding to a 11.60 g/L, using 10% in volume of extract and 90% of commercial medium. The results obtained illustrate the promising character of the use of materials from soybean processing residue, thus promoting greater added value to a by-product.

Keywords: Biomass, soybean, alternative culture medium, Saccharomyces boulardii.

Video presentation

DEAMMONIFICATION OF POULTRY SLAUGHTERHOUSE WASTEWATER IN MEMBRANE AERATED BIOFILM REACTOR (MABR) IN CONTINUOUS FLOW

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Abstract: Poultry slaughterhouses generate a significant volume of wastewater rich in nitrogen with high polluting potential, and in this context, this research aimed to treat poultry slaughter effluent in an Anammox MABR continuous single reactor. The reactor had a cylindrical shape made in acrylic with a working volume of 2.0 L, it has a tubular inner membrane in silicone, where one output is connected to the aerator and the other is immersed in a 75 cm water column that generates a negative pressure allowing that the air to go out through the porosity of the membrane, forming a nitrifying biofilm on its external face. The reactor Inoculation occurred with nitrifying/Anammox biomass from another MABR reactor (the Candidatus Anamoxoglobus Propionicus bacteria was detected by PCR). Were tested the conditions: NLR = 0.13; 0.20; and 0.26 $kgN.m^{-3}.d^{-1}$ corresponding to HRT = 24 h, 16 h and 12 h, intermittent aeration = 1 minute of air (Q = 1 $L.min^{-1}$), with an interval of 9, 6 and 4.5 minutes for the HRT of 24 h, 16 h and 12 h, respectively. The 24h and 16h HRT were conducted for 20 days and 12 h HRT for 26 days. The poultry slaughter wastewater had as initial parameters: TKN = 131.60 $mg.L^{-1}$; NH_4^+-N = 70.84 $mg.L^{-1}$; and C/N= 0.97. The averages nitrogen removals were 95% and 85% for the 24 h and 16 h HRT, respectively, and 12 h HRT had an irregular behavior, but after 20 operation days was achieved N removal above 80%, showing the viability of MABR reactor in the treatment of poultry slaughter wastewater.

Keywords: Anammox, nitrifying bacteria biofilm, nitrogen removal.

Video presentation

RESPIROMETRY TEST IN A SEQUENTIAL BATCH MEMBRANE AERATED BIOFILM REACTOR (MABR-BS) INOCULATED WITH NITRIFYING/ANAMMOX BIOMASS OBTAINED FROM THE ENRICHMENT OF ANAEROBIC SLUDGE FROM SWINE SLAUGHTERHOUSE

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Abstract: The removal of N by Anammox bacteria has been widely studied, but the balance between ammonia-oxidizing bacteria (AOB) and Anammox, which depends on the dosage of dissolved oxygen, is still a challenge. In this context, this work aims to demonstrate the efficiency of the MABR reactor in sequential batch, in providing adequate DO for partial nitritation/Anammox ratio. The reactor was made of glass with a useful volume = 0,3 L, where inside there was a silicone membrane with a length = 30 cm, one end being connected to an aerator, and the outlet immersed in a water column with a pressure of 75 mbar corresponding to a KLA = 1.13 d^{-1}. The test was carried out with a 2:3 (v:v) ratio between enriched Anammox biomass from WWTP anaerobic sludge from a swine slaughterhouse and synthetic effluent with NH_4^+-N initial of 100 $mg.L^{-1}$; the reactor was kept at 32 ºC and agitated at 30 rpm. For the respirometry test, a DO measuring probe was inserted into the reactor, and then the reactor was completely sealed, the DO readings were taken every 15 minutes for 24 hours. The VSS during the assay was 3.82 $mg.L^{-1}$. In the first two hours, the DO in the liquid phase decreased from 0.45 to 0.05 $mg.L^{-1}$, after 6 hours the oxygen consumption was total, and all DO readings were equal to zero until the end of the test. All the substrate was consumed with 15.77 $mg.L^{-1}$ residual nitrate generation. The respirometry assay proved that MABR-BS was efficient in offering a synergic environment between AOB and Anammox.

Keywords: Deamonification, partial nitritation, sinergy AOB/anammox.

Video presentation

SYNTHETIC EFFLUENT DEAMMONIFICATION IN A BIOFILM AERATED MEMBRANE REACTOR (MABR) IN SEQUENTIAL BATCH AS AN ALTERNATIVE TO TREAT EFFLUENTS WITH A HIGH NITROGEN LOAD RATE

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Abstract: Based on the environmental nitrogen effluents problems, the Anammox route has been used for economic advantages in energy and infrastructure resources. This research aims to evaluate the efficiency of N removal from synthetic effluent in an Anammox MABR batch reactor. The reactor was built in a cylindrical PVC shape, 30cm high and D(internal) = 20 cm, work volume was 2.5 L, kept at 32 ºC, with a 1:1 recycle rate. A tubular silicone membrane was used for air conduction, which was coupled to an aerator with a flowmeter, where was injected air into the membrane, and the end immersed in a 75 cm water column, forcing, by negative pressure, the output of the DO through the membrane porosity, where a biofilm is formed. The reactor was fed with synthetic effluent, with a concentration of 200 $mg.L^{-1}$ $N\text{-}NH_4^+$. For inoculation was used biomass from another Anammox MABR reactor. 3 and 2 HTR days were tested during 289 days of the experiment. In the 3-day TRH (operation time 76 days), the reactor was in the adaptation phase with an N removal average of 20.1% and a maximum of 77.7%. In the second reactor period of 147 days, N removal was 33.75%, with a maximum of 82%. Reactor instability is attributed to high DO rates identified throughout the experiment. In the third reactor period, which lasted 31 days, the reactor improved, with an N removal efficiency of 51.3% and maximum N removal of 75.3%. It is concluded that the reactor had a satisfactory behavior with a progressive efficiency increase.

Keywords: Anammox, partial nitritation, nitrifying biofilm.

Video presentation

ALKALINITY CONSUMPTION IN MABR REACTOR OPERATED IN SEQUENTIAL BATCH WITH SYNTHETIC FEED

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Abstract: In biological nitrogen removal, alkalinity develops an important function such as buffering the medium and supplying inorganic carbon for cell growth. Especially in Anammox reactors, this function is even more important as the correct dosage helps to inhibit nitrate-forming in the medium. Thus, this work aims to estimate the value of alkalinity consumption in an Anammox MABR reactor in sequential batch. The reactor was built in a cylindrical PVC shape, 30 cm high and D(internal) = 20 cm, work volume was 2.5 L, kept at 32 ºC, with a 1:1 recycling rate. A tubular silicone membrane was used for air conduction, which was coupled to an aerator with a flowmeter, which injects air into the membrane, with its end immersed in a 75 cm water column, forcing, by negative pressure, the output of the DO through the pores of the membrane where a biofilm is formed. The reactor was fed synthetically, with 200 $mg.L^{-1}$ $N\text{-}NH_4^+$ and 1500 $mg.L^{-1}$ NaCO3 supply. On average, during the 268 days of operation of the reactor, 1306.58 $mg.L^{-1}$ of sodium bicarbonate was consumed. The reactor consumed per mg of $N\text{-}NH_4^+$ oxidized or removed to N_2 the average value of 11.18 mg of $NaCO_3$. The relationship between the highest N removal efficiency, which was 82%, and the rate alkalinity/$N\text{-}NH_4^+$ consumption, was 7.99 and when there was only nitrate formation, this ratio reached the maximum value of 49.62. Alkalinity is an important factor in reactor balance and it has the potential to be reduced in the reactor under study.

Keywords: Inorganic carbon; anammox; single reactor.

Video presentation

OPTIMIZATION OF BACTERIOCIN PRODUCTION IN CASSAVA STARCH WASTEWATER USING CRCD DESIGN

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Abstract: The growing trend of biopreservation in food has stimulated the search for alternative antimicrobials. Lactic Acid Bacteria (BAL) and / or its metabolites, such as bacteriocins, represent a biotechnological form for food security. The objective of this work was to isolate, characterize and evaluate the biopreservative potential of a lactic acid bacterial strain with bacteriocin production, using the cassava starch industry wastewater as a culture medium, as well as optimizing the production process. Initially, the isolation of strains from the residue of the cassava processing agroindustry with potential for the production of bacteriocins was carried out. Once the strain was obtained, identification was carried out by 16s genetic sequencing, finding BAL Lactobacillus fermentum. In order to optimize the production of bacteriocins, the Central composite rotational design (CCRD) was carried out using the pre-selected independent variables (sucrose, yeast extract and Tween 80), with an incubation time of 20 h. All factors were significant in the CCRD at 90%, but Tween 80 had a greater influence. The maximum bacteriocin production was 11751.03 AU/mL in the assay containing 12.50 g/L of sucrose, 10.00 g/L of yeast extract and 8.0 mL/L of Tween 80. In addition, there was a production of 9.22 g/L of lactic acid, 5.14 g/L of dry mass, 33.34% COD removal efficiency and 73.63% of sugars.

Keywords: Bacteriocin, cassava starch wastewater, Lactobacillus fermentum, CRCD design.

Video presentation

PRODUCTION OF BACTERIOCINS BY LEUCONOSTOC MESENTEROIDES AND TREATMENT OF CASSAVA STARCH WASTEWATER

Aruani Letícia da Silva Tomoto*, Raquel Minuceli Vilvert, Tatiane Martins de Assis, Fernando Celio Monte Freire Filho, Thays Majara Silva Araujo, Simone Damasceno Gomes

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Abstract: The waste from the cassava starch processing industry has a ample variety of molecules that can be converted into value-added products. Cassava starch wastewater (CSW) has a high nutritional value and can be used as a substrate in biological processes, in addition to providing microorganisms of biotechnological interest, due to the rich native biota present. Bacteriocins are peptides synthesized ribosomically, capable of inactivating or inhibiting the growth of pathogenic bacteria and used to preserve food, and can be isolated from CSW. Therefore, the objective of this work was to evaluate the growth conditions for the production of bacteriocins from a lactic acid bacterium Leuconostoc mesenteroides isolated from ARF, using residues from the cassava processing agroindustry as substrate. The experimental planning Plackett & Burman (PB) was carried out to evaluate the effects of the variables sucrose, yeast extract, potassium phosphate, magnesium sulfate and Tween 80, with 15 assays, 36 h of incubation and agitation at 100 rpm. Only sucrose, yeast extract and tween 80 were found to be significant at 90%. The results indicated a maximum bacteriocin production of 1990.47 AU/mL (assay 14), COD removal efficiency of 59.99 % (assay 11), sugar removal efficiency of 55.89 (assay 14) and production of lactic acid 21.41 g/L (assay 6). Thus, this experiment may indicate that, in addition to the generation of a biotechnological product, there was an efficiency in the treatment of CSW.

Keywords: Cassava starch wastewater, bacteriocin, Leuconostoc mesenteroides.

Video presentation

PHOSPHORUS AND NITROGEN REDUCTION IN LOW-COST ORGANIC FILTERS FOR SWINE WASTEWATER TREATMENT

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Abstract: Most of the swine wastewater (SW) treatment needs a relatively high initial investment that makes it difficult to be implemented by small farms. The filtration process using organic materials has advantages as the lowest investment cost since the filter column can be made of recyclable material and agricultural residues found on the farm. We evaluated the potential of a filtration system, consisting of different proportions of sawdust (WS), sugarcane bagasse (SB), and compost (C) to remove total phosphorus (TP) and ammoniacal nitrogen (TAN) contents from SW. SW was from Swine Sector in Rural University of Rio de Janeiro, Seropédica (Brazil). The evaluated treatments were organic filters filled with: i) 30% of WS and 70% of SB; ii) 70% WS and 30% SB; iii) 15% WS, 55% SB, and 30% C and; iv) 55% WS, 15% SB and 30% C. Filtration process occurred until 100 L. Crude and filtered SW were evaluated for total solids, total suspended solids (SST), sedimentable solids (SS), TP, TAN. All organic filters proved to be efficient in the removal of physical parameters, especially in SST and SS reduction (91% and 100%, respectively). Organic filters retained TP and TAN (60 and 30%, respectively) and this is an advantage as has the possibility of filters reuse after composting as an organic fertilizer. The filtration process using agricultural residues proved to be an effective low-cost technology and can be implemented not only in rural farms but also in water treatment units.

Keywords: Total solids, total suspended solids, sedimentable solids, water reuse.

Video presentation

AEROBIC DIGESTION PERFORMANCE IN REMOVING COLIFORMS AND METALS FROM SWINE WASTEWATER

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Abstract: The swine sector is the fourth largest segment of animal production in Brazil. However, it generates a large amount of wastewater with pathogenic microorganisms and metals. The aerobic digestion (AED) process is spread in temperate climate countries due to its efficiency in solids stabilization. For tropical regions, information is scarce. The study aimed to define the right AED time for SW treatment and to evaluate AED performance for coliforms and metals removals. An amount of 20 L of SW was added in 3 AED reactors with a coupled air compressor. AED process finished when SW stabilization was reached and this was evaluated through the volatile (VS) and total solids contents (TS) ratio. SW was kept to settle to separate the liquid (LF) and solid (SF) fractions. Those fractions were characterized for thermotolerant coliforms and Cu, Zn, Mn, Pb, and Cd metals. Results were submitted to Student's test ($p < 5\%$). VS/TS ratio reached stability in 32 days of AED. After the AED process, LF and SF fractions showed a significant reduction (99%) for thermotolerant coliforms in relation to crude SW. It meets the restrictive limits for horticulture production. The amount of metals removal from LF was higher than 87%. Metals were transferred from the LF to SF. Nevertheless, both fractions also attended the requirements to be dumped into the water body or be used in agriculture. AED process proved to be an efficient treatment for SW stabilization and coliforms and metals removals.

Keywords: SV/ST ratio, solids stabilization, clarification, heavy metals.

Video presentation

A BIOTECHNOLOGICAL ALTERNATIVE FOR POTATO WASTE BIOTRANSFORMATION INTO HIGH VALUE ADDED BIOPRODUCTS

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Abstract: Valorisation of nutrient-rich agricultural wastes would allow decreasing the environmental pollution and, at the same time, obtaining high added-value bio-products. These wastes can be transformed by microorganisms into useful molecules, including antimicrobials, pigments, enzymes and biofuels. The genus Streptomyces stand out for their ability to synthesize a wide range of these bioproducts. The objective of this study was to evaluate the effect of different potato solid waste concentrations on the pigment production by Streptomyces sp strain SO6. Potato solid wastes (discarded potato) were processed to obtain a dehydrated powder for formulating liquid culture media at different concentrations (4 g to 32 g of potato solid waste L^{-1}) without pH adjustment and addition of supplements. The ISP2 medium was used as control treatment. The media were inoculated aseptically with 104 spores mL^{-1} of Streptomyces sp. After incubation for 18 days at 28 °C and 120 rpm, the pigments were extracted using ethyl acetate and measured by spectrophotometry at 525 nm to determine pigment concentrations. The results indicated that the Streptomyces pigment production is directly related to the potato waste concentration with the highest pigment concentration values at the maximum potato waste concentration on day 18 of incubation. In comparison to the control, a 7-fold increase of Streptomyces pigment production was induced by use potato solid waste as sole substrate at 32 g L^{-1}.

Keywords: Potato wastes, microbial pigments, actinobacteria.

Video presentation

ACIDIFICATION OF MANURE SUPPLEMENTED WITH CARBOHYDRATES AS ACID PRECURSORS

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Abstract: Acidification of manure conserves nitrogen (N), reducing ammonia (NH3) emissions from animal wastes. This approach is also practical to solubilize manure phosphorus (P) for further phosphate recovery. However, a significant barrier to the widespread adoption of acidification for animal waste is the cost of the commercial acid and the specialized equipment for handling concentrated acid. An alternative to commercial acids is the acidification of manure by adding carbohydrates as acid precursors to produce organic acids by fermentation. Our objective was to test carbohydrates to promote manure acidification as a more cost-effective alternative than commercial acids. We conducted bench experiments to evaluate the effectiveness of acidifying manure and selectively extract P using glucose, sucrose, starch, and cellulose. The tests consisted of suspensions of swine manure solids in deionized water (1:10 solid/liquid) with varying concentrations of each acid precursor (from 12.5 to 100 g/kg manure) incubated in the laboratory for up to 7 days, including one treatment control at room temperature. Significant manure acidification from pH 7.7 to about 5.5 occurred using glucose, sucrose, and starch at an application rate of 50 g/kg and five days of incubation. Simultaneously, the concentration of soluble P rose to 1500 mg/L. Food processing waste (e.g., molasses, potato starch, or fruit waste) can provide carbohydrates to reduce the cost of manure acidification treatment.

Keywords: Manure, nitrogen, phosphorus, acidification, carbohydrates, acid precursors.

Video presentation

ANAEROBIC DIGESTION IN COMPOST BARN SYSTEM OF MILK-CATTLE: COMPARISON BETWEEN PROCESS PARAMETERS

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Abstract: Negative aspects related to confined dairy cattle system are due to the accumulation of high volumes of waste generated in small territorial areas, such as waste deposited into feeding facilities. Anaerobic digestion (AD) is a key alternative for waste disposal, reinforced by adding value to biogas and to the chosen digestate. Thus, this study aimed to compare AD processes for the treatment of confined dairy cattle manure on the compost barn system in two properties, (a) and (b) in southwestern Paraná. The parameters selected for comparison were Chemical Oxygen Demand (COD), Total Volatile Solids and Total Solids ratio (TVS/TS) and the Hydraulic Retention Time (HRT). COD and TVS/TS were evaluated on the reactor's inlet and outlet. It was analyzed that: (a): 53,473 and 31,015 mg O_2 L^{-1}; 0.84 and 0.77; 35 days; (b): 59,845 and 22,872 mg O_2 L^{-1}; 0.83 and 0.68; 45 days. COD values in the reactor digestates were similar, with minimal differences in relation to effluents. The COD reductions for (a) and (b) were 41.9% and 61.8%, respectively. The smallest reduction in (a) was consistent with the smallest HRT and higher in relation to TVS/TS at the reactor's outlet. In both cases, these values were lower than the expected COD removal efficiency for AD processes. These wastes showed to have a high level of lignocellulosic material, requiring pre-treatment processes and a high HRT, which, therefore, justifies the low efficiency of organic matter removal.

Keywords: HRT, cattle manure, COD, anaerobic digestion.

Video presentation

BIOSURFACTANT PRODUCTION BY ASPERGILLUS SP USING ANIMAL FAT AS SUBSTRATE IN SUBMERGED FERMENTATION

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Abstract: Surfactants are compounds widely used in the food, pharmaceutical, textile, and oil industries due to their surface-active properties. However, its use causes several environmental problems. Biosurfactants produced by microorganisms are an alternative to synthetic surfactants, as, in addition to being biodegradable and non-toxic, they can be making from renewable and low-cost sources. The intense livestock activity in Brazil generates a large amount of waste that can be used in processes with high added value. The production of pork generates effluents with high levels of fat. This fat has potential application in the production of biosurfactants. Thus, the objective of this study was to investigate the ability of the Aspergillus sp fungus to produce biosurfactants using pork fat as a substrate. For this, submerged fermentation was carried out for seven days in a shaker at 30 °C and 121 rpm. To evaluate biosurfactant production, the E24 emulsification index and collapse tests were performed. On the sixth day of fermentation, the highest emulsification index was obtained (50.86%), and the drop collapse test was positive. The results obtained demonstrate the ability of Aspergillus sp to produce biosurfactants with good emulsifying characteristics using a renewable and cheap carbon source as a substrate. Thus, this work presents a promising study of the application of residual animal fat in obtaining high added value bioproducts.

Keywords: Biosurfactants, residues valuation, animal fat, industrial effluents.

Video presentation

BEST AMMONIA RECOVERY FROM WASTEWATER USING GAS-PERMEABLE MEMBRANES BASED ON NATURAL ALKALINITY SUPPLY

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Abstract: Conservation and recovery of nitrogen (N) from animal wastes and industrial effluents is important because of economic and environmental reasons. This research determined the role of natural alkalinity on the effectiveness of ammonia recovery using gas-permeable membrane technology and low-rate aeration. There were two distinct and interconnected mechanisms involved: One was the release of hydroxide from the natural carbonates that increased pH and NH_3 uptake by the membrane. The other was the release of acidity and consumption of alkalinity by the N recovery process that can completely halt the N recovery process. Therefore, an abundant alkalinity supply in balance with the ammonia content in wastewater is needed for a successful operation of the technology. The relationship between alkalinity consumption and ammonia recovery using gas-permeable membranes was determined using three types of wastewater: anaerobically digested swine wastewater, raw swine wastewater and anaerobically digested side-stream municipal wastewater. Fortunately, most swine manures contain ample supply of alkalinity and the new process can be used there to more economically recover ammonia using the natural inorganic carbon instead of expensive alkali chemicals. The process can be combined with phosphorus precipitation and therefore it can produce two recovered nutrient steams: ammonia and phosphate concentrates.

Keywords: Ammonia recovery, waste transformation and valorization, beneficial byproducts, nitrogen reuse.

Video presentation

LONG TIME STORAGE OF ANAMMOX BIOMASS AS AN APPROACH TO REACTOR START-UP

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Abstract: The ANAMMOX (Anaerobic Ammonium Oxidation) process is a shortcut to the natural cycle of nitrogen, using bacteria with ANAMMOX activity to converts ammonium (NH_4^+) and nitrite (NO_2^-) into nitrogen gas (N_2). The low rate of bacterial duplication can be a limiting factor to the implementation of full-scale ANAMMOX reactors to wastewater treatment plant, since the low production of biomass results in a long startup period. One alternative to this impediment is the use of biomass preservation and reactivation methods. Thus, the present work evaluated the viability of preserving bacteria with ANAMMOX activity through freezing (-2 °C) in a potassium nitrate solution (100 mgN L^{-1}) for eleven months. Approximately 20 L of biomass were taken from a continuous scale bioreactor with ascendant flow that was feeding with 200 mgN L^{-1} (100 mgNH_3-N L^{-1} and 100 mgNO_2^--N L^{-1}) at Embrapa Suínos e Aves (microorganism bank BRMSA 0323). The stored biomass was re-inoculated with culture medium at a concentration of 100 mgN L^{-1} (50 mgNH_3-N L^{-1} and 50 mgNO_2^--N L^{-1}). The 55 first days after the startup was analyzed. Until the twentieth day, the nitrogen removal rate (NRR) was below 4% indicating that there was no anammox activity. On subsequent days was observed an increase on NRR with an efficiency of up to 57%. In this way, the storage method presented is promising in the preservation of biomass and enables to restart-up the ANAMMOX process with efficiency.

Keywords: Potassium nitrate solution, preservation and reactivation, freezing.

Video presentation

NITROGEN LOADING RATE AS FEASIBLE STRATEGY TO ANAMMOX SLUDGE PRODUCTION

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Abstract: Anammox bacteria are autotrophic organisms that use NH_3 as their energy source to directly reduce NO_2^- into N_2, with NO_3^- as a by-product, therefore an alternative to wastewater treatment plants conventional. However, short doubling time and sensitivity to environmental alterations are some of the weaknesses of the Anammox process. Historically, studies relate that the doubling time of Anammox cells (intrinsic) been around 11 days (d) and according with the reactor operation, it can be reduced or extended. Values are quite varied and different strategies can be applied to reduce the doubling time increase Anammox sludge production in reactors. In the present work was evaluated the effect of the increment of nitrogen loading rate (NLR) in continuous Anammox reactor, as an approach to reduce the sludge apparent doubling time it and produce biomass granular. For such, in expanded granular sludge bed reactor were evaluated the NLR of 0.8, 2.4, 3.7 and 4.9 g-N d^{-1} Lreactor $^{-1}$. According with the obtained results, with the increment of the NLR, the sludge doubling time were reduced (211, 89, 67 and 58 d, respectively), quantified by the increase of biomass mass in the reactor. The Monod model was predictive for these values, being suitable to describe the growth of the reactor sludge, with a high affinity for the substrate (Ks = 5.12 g-N L^{-1} and the theoretical minimum doubling time of 28 d). The increase in NLR (519%) caused a 73% decrease in Anammox sludge doubling time.

Keywords: Sludge apparent doubling time, expanded granular sludge bed reactor, high affinity for the substrate.

Video presentation

EXTRACELLULAR POLYMERIC SUBSTANCES: ARE THEY PRESERVED DURING ANAMMOX GRANULES STORAGE BY FREEZING?

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Abstract: Anaerobic ammonium oxidation (Anammox) is an effective biological route to nitrogen removal under anoxic conditions. Despite the advantages when compared with Nitrification/denitrification process, the slow growth of Anammox and high sensitive to environmental conditions are some of the drawbacks of this technology. Anammox granules preservation (low-temperature (4 ºC) and freezing (-2 ºC) with $NaNO_3$) stand-outs as technique for fast reactor start-up and improvement of it performance. However, the integrity of granules by the amount of Extracellular Polymeric Substances (EPS) must also be maintained during the preservation period. At the present work was evaluated the amounts of EPS (protein (PN) and polysaccharides (PS) ratio) from Anammox granules preserved under 2 to -2 ºC with $NaNO_3$ (100 mg L^{-1}), to evaluate the stability of it to be used to inoculate full-scale reactors. The PN/PS ratios from the preserved sludge (0.07) were 79 times lower then Anammox sludge from continuous reactor (5.53), with high amounts of PS (43.59 mg L^{-1}). The lower PN/PS ratio can be associated with bacteria starvation, cell lysis and dissolution of cellular compounds into the liquid phase. With higher PS and lower PN, granules show low stability for reactors start-up. Denitrification reactions can also occurs in parallel during the preservation period, due to the high PS concentration. Thus, freezing conditions do not show feasibility to Anammox granules preservation and stability.

Keywords: Nitrogen removal process, process stability, fast start-up, bacteria starvation.

Video presentation

EVALUATION OF BIOGAS PRODUCTION IN ANAEROBIC REACTORS FED WITH FOOD WASTE AND CRUDE GLYCEROL

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Abstract: Biodiesel is a renewable alternative fuel to fossil resources. However, its production generates large amounts of glycerol. Another environmental problem is organic solid food waste. So, a good alternative for these problems is the co-digestion between food residue and raw glycerol, through an anaerobic process capable of degrading organic matter and producing interesting compounds such as methane (biogas). Thus, the objective of this work was to quantify the production of biogas in addition to the consumption of organic matter and glycerol during anaerobic co-digestion between food waste and raw glycerol. Batch tests were carried out in duplicate, in reactors with a volume of 500 mL. The inoculum was granular sludge from a reactor previously used for co-digestion between citrus vinasse and crude glycerol. The reactors were subjected to an N_2 atmosphere, kept at 37 ºC, and biogas was measured by volume displacement. Analyzes of total, fixed and volatile solids, COD and carbohydrates were carried out in the residues and in the inoculum. The COD of the food residue was 188.20 g/L and the crude glycerol 607.04 g/L. The glucose content in the food residue was 61.830 g/L and fructose 58.43 g/L. Total, and volatile inoculum solids were respectively 55.68 mg/mL and 47.89 mg/mL. The COD removal for 0% and 3% glycerol respectively was 81.12% and 68.26%. In the absence of glycerol, the reactors produced 112.60 mL and 256.30 mL of biogas, and with 3% of glycerol, 259.60 mL and 336.60 mL.

Keywords: Codigestion, biodiesel, crude glycerol, methane.

Video presentation

SYNTHESIS OF NaA ZEOLITE FROM RICE HUSK ASH

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Abstract: The research aiming at the use of agricultural residues in products of commercial interest plays an increasingly important role in the world, which has a growing source of income in agribusiness. Rice husk is an abundant by-product of the rice processing industries and is recognized as a potential source of energy generation through incineration. The burning of the rice husk with air results in the formation of rice husk ash (RHA), a solid waste who has a high silica content. The current study investigates the potential use of RHA as an alternative source of silica for the synthesis of NaA zeolites. RHA used in this work did not undergo any previous treatments and the zeolite synthesis was performed on the absence of an organic structure directing agent. It was used RHA obtained from two different burning processes, with grill grate (RHA01) and fluidized bed (RHA02). Zeolite A (NaA) was prepared via dissolution of the rice husk ashes in the presence of NaOH and sodium aluminate solution by hydrothermal synthesis at 100 °C for 4 h. The obtained zeolite material was characterized by X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM). According to the XRD and SEM analyses zeolite with LTA framework structure was obtained using both types of RHA, with additional peaks, that may correspond to zeolite SOD, a concurrent phase that is commonly found in syntheses of LTA zeolites. And a third concurrent phase, zeolite with FAU framework, was observed with the use of RHA02.

Keywords: Rice husk ash, LTA, NaA zeolites, hydrothermal synthesis.

Video presentation

PHYSICOCHEMICAL PARAMETERS IN THE ACCELERATED COMPOSTING PROCESS OF POULTRY CARCASSES IN ROTARY DRUM REACTOR

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Abstract: In Brazil, rotary drum reactors (RDR) have been implemented as a composting technology for the destination of dead poultry carcasses. The study aimed to evaluate physicochemical parameters of biomass in the accelerated composting process of dead poultry carcasses using RDR. The research was carried out with four simultaneous repetitions, using RCRs with 3.6 m^3 volume, which worked with 24 minutes rotation time and 4 hours rest time between aerations (drum rotations). Initially, 130 kg of poultry carcasses and 300 kg of sawdust were placed. The experiment has been developed for 94 days, from the first materials insertion into the reactors to compost removal. During this period, new poultry carcasses were added, totalizing 560 kg insertion of this material. The evaluated parameters were temperature, Carbon (C) and Total Nitrogen (TN), and C:N ratio. The biomass temperature has been above 50 °C in 30% of the period. There was nearly 5% reduction in the C concentration during the process, reaching 43.58±0.35% of DM at the end of the study. The initial TN was 1.65% of the DM, decreasing to 2.85±0.048% at the end of the experiment. The biomass C:N ratio was 29.26 at the beginning, and changed to 15.26±0.31 at the end of the process. The physicochemical parameters evaluated in the produced substrate comply with current legislation, showing that the use of RDRs is promising for the destination and treatment of dead poultry carcasses.

Keywords: Poultry carcasses, accelerated composting, rotary drum reactors.

Video presentation

ENHANCING THE DURABILITY OF CONCRETE EXPOSED TO PIG MANURE USING SILICA FUME AND NANOSILICA

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Abstract: Concrete is one of the most used materials in farm environment for manure storage tanks and treatment systems, however the acids present in manure may cause wear, loss of strength and damage to concrete structures. Ways to reduce the carbon footprint of concrete include minimizing construction defects as well as making concrete last longer. Thus, since the use of supplementary cementitious materials may enhance concrete durability, this study evaluated the behavior of concretes with silica fume and nanosilica to an acid attack, simulating the effects of the acids present in pig manure. The use of 5% and 10% of cement replacement by silica fume in concrete as well as the incorporation of nanosilica as an additive was investigated. The samples were subjected to dry-wet cycles in acidic solution and in saturated limewater. Variation of mass and water absorption were measured along the cycles. The compressive strength at 28, 56 and 84 days was also determined. Results indicated that the combined use of silica fume and nanosilica enhanced the compressive strength of concrete. Concretes with 10% of cement replacement by silica fume presented the best resistance to the acidic solution, presenting less mass loss, less water absorption and less loss of compressive strength.

Keywords: Pig manure, concrete, durability.

Video presentation

HYDROTHERMAL CARBONIZATION OF RICE HUSK AND EXHAUSTED BLACK WATTLE BARK

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Abstract: Biomass can be transformed into carbon-rich materials through hydrothermal carbonization (HTC), which consists of a treatment with water, for a few hours, at mild temperatures, and autogenous pressure. This carbonization method is considered environmentally friendly as compared to pyrolysis or gasification. Exhausted black wattle bark (BW) and rice husks (RH) are widely generated lignocellulosic biomass wastes in southern Brazil. However, both are underexplored and usually burned for energy generation. Therefore, in the current work, the influence of temperature and time in HTC of exhausted black wattle bark and rice husks was studied, aiming the synthesis of carbon-rich hydrochars. HTC was carried out at a ratio of waste to water constant (0,1 g mL^{-1}) at 180 °C, 200 °C, and 220 °C during 5 h or 15 h for each waste. The yield of each synthesis was calculated, and ultimate analysis for each waste and hydrochar was performed. The influence of time and temperature were analyzed statistically by two-way ANOVA and Tukey's post-hoc test. For increasing the carbon content of the material, all treatments for BW were significant, whereas, for RH, only the treatments at 220 °C were significant. It was observed that carbon and nitrogen content were maximal while yield minimal in the harshest synthesis conditions (220 °C, 15 h). Therefore, for the preparation of carbon-rich material, extreme conditions showed better results.

Keywords: Hydrothermal carbonization, waste treatment, exhausted black wattle bark, rice husk.

Video presentation

MICROSCOPY AS A TOOL OF PERFORMANCE EVALUATION IN A NITRIFICATION TANK OF A MODIFIED LUDZACK ETTINGER PROCESS TREATING SWINE WASTEWATER

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Abstract: Microscopic examination of wastewater is a useful tool for a bioreactor evaluation since protozoa and metazoa are bioindicators of the biological process. The aim of this research was to establish the relation between physico-chemical parameters and the microorganisms present in a swine wastewater treatment aerobic tank since no data for this kind of effluent is available in literature. Samples (n = 41) were collected directly from the nitrification tank of a Modified Ludzack Ettinger process, once or twice a month. Samples were analyzed using an optical microscope, with an objective lens of 10X and ocular lenses of 10X. After the microscopic examination, the data were statistically evaluated by Spearman Correlation against the following parameters: dissolved oxygen (DO), pH, temperature (T), total organic carbon (TOC), settling solids (SS), sludge age (SA), total and volatile suspended solids (TSS and VSS), volumetric sludge index (VSI), alkalinity, total ammonia nitrogen (TAN), nitrite, nitrate, free ammonia (FA). TOC, TAN and nitrate showed negative correlation (Spearman Correlation) with attached ciliates (significance level of 95%, p = 0.05), while T, TOC, TAN, nitrite and nitrate showed negative correlation with crawling ciliates. It was concluded that swine wastewater has a different microbiology compared to sanitary wastewater since even at relatively high concentrations of N (low C/N ratio) attached and crawling ciliates were observed.

Keywords: Microscopy, swine wastewater, protozoa, metazoa, bioindicators.

Video presentation

PILOT-SCALE WASTEWATER TREATMENT BASED ON AGRO-INDUSTRIAL WASTES WITH APPLICATION IN WOOD PROCESSING INDUSTRY

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Abstract: Wood processing industry (pressed boards) produce large quantity of wastewater with organic contaminants that can be recirculated after an adequate treatment. Besides, this industry produces a biochar as residue from the biomass boiler. We design a pilot plant for the wastewater treatment including adsorption step onto biochar as primary treatment (reactor 1) followed by a biopurification system (BPS) as secondary treatment (reactor 2). The pilot plant was installed in the industry located in La Araucania Region, Chile. Reactor 1 was packed with the biochar and reactor 2 was packed with the organic biomixture of the BPS formulated with soil, peat and wheat straw. Wastewater was previously filtered before feed to reactor 1 and then sprayed at a flow rate of 3.33 L s^{-1} in reactor 2. The physicochemical characterization of this wastewater was: pH 7.20, Chemical Oxygen Demand (COD) of 765 mgL^{-1}, Biological Oxygen Demand (BOD) of 310 mg L^{-1}, Turbidity 648 NTU and Total Suspended Solids (TTS) of 267 mg L^{-1}. The results indicated that the proposed wastewater treatment system remove >90% of BOD, COD and turbidity, allowing discharge according to normative valid in Chile. Also, the treated water could be recirculated to the production process without problems. The valorization of low cost agro-industrial wastes as biochar and wheat straw would allow diminished environmental pollution and generate new alternatives for the treatment of complex industrial wastewaters. ANID/FONDAP/15130015.

Keywords: Wastewater treatment, agro-industrial waste, valorization.

Video presentation

INFLUENCE OF ORGANIC LOADING RATE ON ARCHEA COMMUNITY CONCENTRATION IN A CSTR REACTOR TREATING SWINE MANURE

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Abstract: This study aimed to evaluate the influence of organic loading rate on microorganism acclimation in a CSTR reactor fed with swine manure. The organic loading rate progression was performed by hydraulic retention time (HRT) reduction at the reactor CSTR during 4 steps: Step 1 HRT 35 d, OLR 0.62 $gVSL^{-1}d^{-1}$; Step 2 HRT 30 d, OLR 0.73 $g_{VS}L^{-1}d^{-1}$ Step 3 HRT 25 d, OLR 0.56 $gVSL^{-1}d^{-1}$ and Step 4 HRT 20 d, OLR 1.06 $g_{VS}L^{-1}$ d^{-1}. Genomic DNA was extracted from CSTR sludge in each studied step using a PowerSoil DNA Isolation kit. Total Archaea, Methanosarcinales and Methanomicrobiales methanogenic 16S rRNA gene copy concentration was estimated by real-time quantitative PCR analysis. The analysis revealed differences in microbial community concentration among the different studied steps. The step 4 presented the greatest biodigester stability (total archaea concentration $1.11x10^{12}$ $copies.g^{-1}$). Methane production in the CSTR reactor was predominantly associated with the hydrogenotrophic methanogens (Methanobacteriales reaching concentration $8.28x10^{10}$ $copies.g^{-1}$). The hydrogenotrophic methanogens predominance can also be explained by the inhibitory effects by ammonia (Methanosarcinales reaching concentration $5.16x10^{10}$ $copies.g^{-1}$). There is a correlation between the acclimation process and the increase in the concentration of methanogenic archaea.

Keywords: biogas, archea, CSTR.

Video presentation

REMOVAL OF NITRATES FROM AGRICULTURAL DRAINAGE WATER IN BIOREACTORS WITH CORN COB SUPPORT AND POLYURETHANE FOAM

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Abstract: This work aimed to evaluate the removal of nitrates in fixed bed bioreactors. Two bench scale reactors were used: Reactor 1, filled only with pieces of corn cob, and Reactor 2, filled with two types of support, pieces of cob and Mini Biobobs®. The reactors were fed with agricultural drainage water enriched with 20 mg L^{-1} of $N\text{-}NO_3$ and operated with different hydraulic retention times (HRT), from 4 to 0.67 days. The removal of nitrate was observed in all phases studied in the two reactors. In Reactor 1, with 1 day HRT, the $N\text{-}NO_3$ removal efficiency reached 81.9% and the average concentration found in the treated water was 3.95 mg L^{-1} of $N\text{-}NO_3$. In Reactor 2, with HRT for 2 days, the $N\text{-}NO_3$ removal efficiency was 92.3%, and it was possible to obtain effluent with an average concentration of 1.66 mg L^{-1} of $N\text{-}NO_3$. The lowest removal rates were obtained with the lowest HRT studied, 0.67 day, with 42.9% nitrate removal for Reactor 1 and 48.9% for Reactor 2. In the analysis of the Most Probable Number (MPN) of denitrifying bacteria, it was observed the presence of these bacteria in both reactors, proving the occurrence of heterotrophic denitrification in the removal of nitrates. It can be concluded that the studied reactors can remove nitrate from agricultural drainage water.

Keywords: Denitrification, Biobob®, MPN, eutrophication.

Video presentation

WASTE TO ENERGY

BIOENERGY RECOVERY FROM DRY ANAEROBIC DIGESTION OF AGROINDUSTRIAL WASTES

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Abstract: Anaerobic digestion (AD) can be a suitable alternative for industrial waste treatment and energy recovery. In this study, the AD of açaí seeds and brewer's spent grains was evaluated under mesophilic temperature and dry regime. The stirred tank AD reactor was composed of 25% total solids (dry type), inoculum (40%), and water (35%). The biogas generated was used to calculate the potential for electric energy and heat, assuming the combustion in heat and power unit. The results demonstrated that the solid's biodegradation reached approximately 60% for açaí seeds and 75% for brewer's spent grains. Beyond, the accumulated biogas produced was around 5 and 10 L, respectively to açaí seeds and brewer's spent grains. A stable methane content was obtained after ten (10) days of digestion, with a composition of approximately 60%. Considering the biogas combustion produced from 1 ton of brewer's spent grains submitted to AD, the potential of electric energy and heat was close to 100 kWh and 450 MJ, respectively. However, only 15 kWh of electricity and 65 MJ of heat can be generated from the AD of 1 ton of açaí seeds. In conclusion, the AD treatment of solid agroindustrial waste can be an alternative technological route for bioenergy recovery. The energy produced can be used on-site or sold back to the energy grid, contributing to reducing the carbon footprint in the agroindustrial sector.

Keywords: Food waste, bioenergy, biofuel, methane, açaí seeds, brewer's spent grains.

Video presentation

RECOVERY OF CRUDE GLYCEROL AND CITRUS VINASSE IN ANAEROBIC DIGESTION BY TWO-STAGE FOR LACTIC ACID AND BIOMETHANE PRODUCTION

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Abstract: The global biodiesel production has increased, being generated as co-product 10 kg of crude glycerol (CG) for each 100 kg of biodiesel produced. Brazil corresponds to the main citrus producing country in the world, generating highly fermentable carbohydrates that are used for the second-generation ethanol production, generating citrus vinasse (CV), it's an excellent substrate for anaerobic co-digestion, providing complementary and synergistic effects that compensate the lack of nutrients in CG. The goal of this study was the application of CG from the biodiesel production, co-digested in CV through a biosystem in two-sequential stages: the first one acidogenic, for the lactic acid generation and the second one methanogenic, for the CH_4 production, maintaining the sustainable industry of biodiesel production. For the first stage, anaerobic bacteria consortium, heat pre-treated, was used in anaerobic batch reactors composed by 5 g COD L^{-1} GB with 5 g COD L^{-1} VN, pH 5.5, headspace with N_2, at 37 °C, generating 1,517 mg L^{-1} of lactic acid in 164 h of operation. The liquid fraction generated in the first phase was used as substrate by a mixed culture in natura in anaerobic methanogenic reactors, headspace filled with N_2, pH 7.0, at 37 °C, generating 259.39 mmol CH4 L^{-1}, removing COD (93.46%) and methanol (100%) in 622 h of operation. Integrated systems are an innovative strategy of recovery wastes from agroindustry's to aggregated bioproducts and bioenergy.

Keywords: Biofuels, biogas, dark fermentantion, metanogenesis, volatile fatty acids.

Video presentation

MICROBIAL CONVERSION OF CRUDE GLYCEROL TO AGGREGATED BIO PRODUCTS AND BIOFUELS IN HORIZONTAL ANAEROBIC REACTORS INSTALLED IN SERIES

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Abstract: Biodiesel being one of the most promising renewable biofuels with an increasing demand. However, crude glycerol (CG) as a by-product in biodiesel production has been generated and oversupplied. Due to the impurities present in the CG, expensive refining processes are often necessary for its use in the same applications as pure glycerol. Developing new industrial usage for CG is essential to defray the cost and sustainability of biodiesel chain production. This research evaluated the co-digestion of CG with sanitary sewage (SS) (CG 1.5% SS 98.5%, v/v) in three in-series horizontal anaerobic reactors with fixed bed (HARFB) installed in series (R1 R2 and R3). The high organic loading rate applied in the first reactor (R1) favored the production route of propionic acid (787 mg L^{-1} ± 983) and ethanol (254 mg L^{-1} ± 237) by fermentation of CG producing 44.7 L H_2 (m^3 d)$^{-1}$ ± 53.4. All acids produced were subsequently consumed in the second (R2) and third (R3) reactors converted to methane 103.1 L CH_4 (m^3 d)$^{-1}$ ± 85.9 and 94.3 L CH_4 (m3 d)$^{-1}$ ± 60.3, respectively. COD removals were 14%, 37% and 98% in the reactor R1, R2 and R3, respectively. Overall, this study provided comprehensive and insightful information on microbial conversion of crude glycerol to high value-added bio products and biofuels H_2 and CH_4.

Keywords: Alcohols, anaerobic bacteria, methanogenic archaea, volatile fatty acids.

Video presentation

ANAEROBIC CO-DIGESTION OF CATTLE MANURE AND SUGARCANE BAGASSE PRE-TREATED WITH ALKALINE IN SEMI-CONTINUOUS FEEDING

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Abstract: Brazil produced 654 million tons of sugarcane (SC) in 2020/21 and bagasse (SCB) represents 28% of the processed material, being a hard degradable lignocellulosic residue. This study evaluated the effect of alkaline pre-treatment applied to SCB and the co-digestion with cattle manure (CM) for biogas production in semi-continuous feeding. CM and SCB were collected in the Parana state and a fraction of the SCB was pretreated with 5% NaOH (PSCB). The anaerobic co-digestion was performed in a CSTR with 5 L capacity with daily feeding. Different organic loading rate (OLR) was tested, being 0.4 (phase 1), 1.0 (phase 2) and 2.0 g_{VS} $L_{reactor}^{-1}$ d^{-1} (phase 3). The hydraulic retention time (HRT) was 20 days during phase 1 and 40 days during phases 2 and 3. The mono-digestion of CM (phase 1) resulted in a productivity was 0.17 L_{biogas} $L_{reactor}^{-1}$ d^{-1}. The co-digestion of CM with SCB/PSCB during phase 2 resulted in productivity of 0.45 and 0.49 L_{biogas} $L_{reactor}^{-1}$ d^{-1}, respectively, while the productivity during the co-digestion of CM with SCB/PSCB during phase 3 was 0.75 and 0.64 L_{biogas} $L_{reactor}^{-1}$ d^{-1}, but clog due to biomass floating was observed in the last phase. However, the best operational condition in terms of productivity was obtained with phase 3, with 67% increase in biogas productivity from the co-digestion of CM with untreated SCB, while only 31% of increase was observed with pretreated SCB when the OLR was increased from 1.0 to 2.0 gVS $L_{reactor}^{-1}$ d^{-1}.

Keywords: Semicontinuous reactor, alkaline pretreatment, lignocellulosic substrate.

Video presentation

ESTIMATION OF MAXIMUM THEORETICAL METHANE BIOCHEMICAL POTENTIAL FROM *Eichhornia crassipes*

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Abstract: Biomass is an important element in the diversification of the energy matrix, due to its versatility. In 2017, around 3500 tons of *Eichhornia crassipes* (water hyacinth) were removed from the banks of the São Francisco River in the city of Petrolina Pernambuco, as a result of the high proliferation, thus becoming an environmental liability. One option for the disposal of excess water hyacinth removed from the river is its energy use through the production of biogas. The evaluation of biomass energy recovery potential depends on the knowledge of its physical and chemical properties. This article aims to estimate the theoretical potential of biogas from water hyacinth in the city of Petrolina, using the Boyle equation. For this purpose, moisture, solids series and elemental composition data available in the literature were used. According to Gonçalves (2019), water hyacinth has a moisture content of 95.19% (4.81% of total solids); 30% fixed solids; 70.01% volatile solids; 40.24% carbon; 5.03% hydrogen; 5.71% nitrogen; 35.28% oxygen and 16.07% ash. The results indicated a theoretical production potential of 334,396,972 m^3CH_4 from the anaerobic digestion of the residual water hyacinth collected in the city of Petrolina. Considering the equivalent of 1 m^3 of biogas representing 1.43 kWh in energy terms, the biogas produced would supply around 331 homes, with an average monthly consumption of 120 kWh, for one year, showing that this route is a viable option for the city.

Keywords: Biomass, energy use, *Eichhornia crassipes*, biogas.

Video presentation

EVOLUTION OF THE CO-DIGESTION PROCESS OF FRESH FLOTATION SLUDGE WITH RAW POULTRY SLAUGHTERHOUSE EFFLUENT

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Abstract: The slaughterhouses are responsible for a large production of industrial effluents. Anaerobic digestion provides an alternative to stabilize these wastes, generating energy in the form of methane. The objective of this work was to monitor the process of anaerobic co-digestion of fresh flotation sludge with raw poultry slaughterhouse effluent. The tests were in batch reactors with a total volume of 500 mL and a useful volume of 300 mL. The dosages of fresh sludge added were (26.67; 34.97; 55.42; 75.87; 83.19 % v/v) and the values of the F/M ratio (0.3; 0.5; 1 .0; 1.5 and 1.7), nine treatments in a CCRD. The process was monitored for 5 weeks and 43 days of incubation, samples were taken to evaluate the physicochemical parameters (pH, alkalinity, acidity, COD, series of solids). The effects of dosage and F/M ratio were verified through a descriptive analysis. There was an effect of the F/M ratio on the parameters: volatile acidity, biogas production, total and volatile solids. The different dosages only influenced the AI/AP ratio. The reactors R1 35% of flotation sludge and 65% of raw effluent and A/M ratio = 1 and R7 55% of flotation sludge and 45% of raw effluent and A/M ratio = 0.3 had greater potential in the production of methane and removal of solids at preset time. The 5-week period was not enough to complete the co-digestion process. With the exception of R1 and R7, in all other reactors there was no expected biogas production and solids removal.

Keywords: Waste treatment, physical-chemical parameters, F/M ratio, biogas.

Video presentation

POTENTIAL OF BIOGAS PRODUCTION FROM ANAEROBIC CO-DIGESTION OF FRESH FLOTATION SLUDGE AND RAW EFFLUENT FROM A POULTRY SLAUGHTERHOUSE

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Abstract: Poultry slaughterhouses generate large volumes of effluents with a high content of organic matter and lipids. Among the available alternatives, anaerobic digestion provides the transformation of these effluents into biogas. The objective of this work was to evaluate the anaerobic co-digestion of fresh flotation sludge from and raw effluent from a poultry slaughterhouse. Codigestion assays were carried out in reactors (500 mL of total volume and 300 mL of useful volume), operated in batch under mesophilic conditions (30 ± 1 °C), with an incubation time of 108 days. Five levels of addition of fresh flotation sludge and to raw effluent (26.67; 34.97; 55.42; 75.87; 83.19 % v/v) and five levels of food/microorganism ratio (F/M) (0.3; 0.5; 1.0; 1.5 and 1.7) were adopted in a Central Composite Rotational Design (CCRD). The response variables used were cumulative CH_4 production (L) and CH_4 yield (L CH_4/g SV added). The results indicated a significant effect for the response variable cumulative production of CH_4 (L) with a confidence interval of 90% ($p<0.10$). The addition of fresh sludge from the floater by 34.97% resulted in the accumulated production of methane 0.35 L and in the yield 0.83 (L CH_4/g SV added). The condition that provided the best result was 34.97% of fresh flotation sludge and 65.03% of raw effluent with a W/M ratio of 0.5 (gCOD/gSSV).

Keywords: Agroindustry, wastewater treatment, methane, anaerobic digestion.

Video presentation

TEMPERATURE AND SUBSTRATE INFLUENCE IN THE CO-DIGESTION OF SWINE MANURE AND POULTRY LITTER FOR BIOGAS PRODUCTION

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Abstract: In 2020, Brazil was considered the 4th largest consumer of pigs in the world. In addition, the country reached the highest historical production of egg´s consumption. Taking this into account, alternatives to treat the manure are of great importance. Anaerobic digestion (AD) stands out as a relevant route of manures treatment in rural areas. This study aimed at evaluating the biogas production of manure co-digestion from swine manure (SM) and poultry litter (PL) under different temperature conditions (psychrophilic x mesophilic). The research was carried out in laboratory scale by using batch anaerobic reactors of 1.25 L for a period of 60 days. For this purpose, three treatments were evaluated, such as: 25/75, 50/50 e 75/25 of SM/PL (volumetric proportion, %). The TS, TVS and COD were analyzed in the influent (manure) and in the digestate (treated). Each treatment was performed at 18 °C and 36 °C in quadruplicate. The biogas production was monitored daily due to the vertical displacement of the gasometers and calculated according to Gay-Lussac's laws. The biogas production considering the TS, TVS and COD applied was higher at 36 °C for all treatments in comparison with psychrophilic condition. The best biogas yields were found for the proportion 25/75 (SM/PL) with 0,49 m^3 e 0,86 m^3. $kgCOD_{applied}^{-1}$ at 18 °C e 36 °C, respectively. The co-digestion between SM and PL is a promising energetic recovery alternative, especially in mesophilic conditions with predominance of PL substrate.

Keywords: Anaerobic digestion, energy recovery, co-digestion.

Video presentation

METHANE PRODUCTION FROM CASSAVA RESIDUES USING LIGNOCELLULOSIC MATERIAL INTO CELL IMMOBILIZATION

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Abstract: Cassava is a common agriculture product in tropical countries. This industry generates residues rich in carbohydrates as cassava starch wastewater (CSW) and cassava stem (CS), which have the potential to be used as energy source in anaerobic digestion. In this context, this study aimed to evaluate the methane production from a reactor fed with CSW using CS acid hydrolyzed as cosubstrate and material support to microorganisms adhesion. The assays were carried out in 2 L Duran bottles inoculated with the biomass immobilized in the CS (~10 $gVSS.L^{-1}$) varying the influent concentration in 3.5 and 4.5 $gCOD.L^{-1}$ (Assays 1 and 2, respectively). The assays 1 and 2 were incubated by 144 h at temperature of 36 ºC and stirring of 200 rpm. The bottles were fed with fresh substrate every 24 h. The increase in the influent concentration leading to reduction in the COD efficiency removal from 70% (assay I) to 60% in assay II, while the volumetric productivity and methane yield remained in the range of 1.1 $LCH_4.L^{-1}.d^{-1}$ and 0.27 $LCH_4.g^{-1}COD$, respectively. According to electron microscopy images the CS addition provided cellular immobilization of methanogenic archaea, and enabled the CS codigestion, increasing the substrate availability to microorganisms and reducing the cellular washout in the system.

Keywords: Cassava starch wastewater, cassava stem, biogás, bioenergy, methane.

Video presentation

ANAEROBIC CODIGESTION OF ELEPHANT GRASS JUICE AND SUGARCANE VINASSE FOR BIOMETHAN PRODUCTION

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Abstract: Elephant grass is a semiperennial specie that as emerged as a viable option as an energy crop due attractive characteristics like their high-yield potential (above 45 Mg ha^{-1} in some brazilian regions). The practice of extracting elephant grass juice (EGJ) can increase significantly the energy density of elephant grass bagasse, enabling the transport of this material, in addition to producing nutrient-rich juice that can be used in industry or applied directly in the field. Extraction process results in a bagasse with significantly reduced moisture compared to fresh material. The process of extracting juice from the stalks of elephant grass is the same as that carried out by sugarcane plants. In this study, the EGJ was obtained by pressing stalks of the variety Madeira, from the Active Elephant Grass Germplasm Bank of the Embrapa Dairly Cattle. The present study investigated the co-digestion of EGJ and sugarcane vinasse using batch reactor. In the Environmental Sanitation Laboratory of the Technology Center of Alagoas Federal University were observed inicial pH, inoculum and susbtrate concentrations. The tested sugarcane vinasse/EGJ proportions were: A - 25/75, B - 50/50, C - 75/25, D - 100/0, E - 0/100 (%v/v). The biogas production varied between 7.63 and 370.94 $mLCH_4$ gSV^{-1} and it was possible to verify that the highest accumulated biomethan production was observed for the proportion 1:1 corresponding to 50% of EGJ and 50% of vinasse (370.94 $mLCH_4$ gSV^{-1})

Keywords: Pennisetum purpureum, extracted juice, bagasse, biogas.

Video presentation

BIOMETHANE PRODUCTION FROM ELEPHANT GRASS JUICE AND SUGARCANE VINASSE AFTER AN ALKALINE PREATREAMENT

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Abstract: Sugarcane vinasse is the main agro-industrial residue in Brazil. Furthermore, currently, there is a growing interest in the use of perennial forage grasses as raw material sources for energy production. Elephant grass (*Pennisetum purpureum Schum.*) as a high-yield potential, with annual dry matter yields above 45 Mg ha^{-1}. The process of elephant grass juice extraction produce a nutrient-rich juice and is the same as that carried out by sugarcane mills. The present study investigated the use of sodium bicarbonate ($NaHCO_3$) as alkalinizer of elephant grass juice (EGJ) and sugarcane vinasse aim to the biomethan production throug anaerobic codigestion process using a batch reactor. The EGJ chemical oxygen demand (COD) was 8,534 mgO_2 L^{-1}, initial pH of 4.3, SVT of 21,400 mg L^{-1}. Vinasse presents COD of 31,955.34 mgO_2 L^{-1}, initial pH of 3.76 and SVT of 7,400 mg L^{-1}. The tested sugarcane vinasse/EGJ proportions was 50/50 (%v/v), which biomethane production in the experimental condition was of 370.94 $mLCH_4$ gSV^{-1}. In, a positive effect of the alkalinizer addition [0.05 $gCa(HCO_3)_2$ (gO_2 L^{-1}) $^{-1}$] was observed with a substantial increase on biomethan production in this share proportion of EGJ and vinasse (1:1), reaching a maximum of 836.18 mL CH_4 gSV^{-1}. It represents a 125% increase in methane production as a positive effect of the alkalinizer on pH control. This indicates that the alkaline preatreatment can became EGJ and sugarcane vinasse more valued as substrates for the biomethane production.

Keywords: Pennisetum purpureum juice, sugarcane vinasse, sodium bicarbonate, biogas production.

ENHANCEMENT OF BIOGAS PRODUCTION IN BIODIGESTERS: USE OF SOLAR ENERGY TO HEAT PIG MANURE

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Abstract: Covered lagoon biodigesters (CLB) are widely used in treatments of pig manure, once they promote the generation of biogas, a by-product with high energy potential. Biogas production and system efficiency depends on optimal temperatures. The literature reports the mesophilic temperature range (optimization at 35 ºC) as indicated to the process. This study aimed to simulate and evaluate an effluent heating system in a pig farm using solar energy. The monitored farm is in Teixeiras-MG and it has two CLBs in parallel. The effluent temperature (Et) without heating was obtained through sensors from Sep./18 to Aug./19. The software Energy-Plus was used to simulate the heating system. The procedure consisted of heating the water using solar panels, exchanging heat with the effluent inside an equalization tank and directing the heated effluent to the CLBs. Biogas production (Bp) was determined from the Chen-Hashimoto model (1983). The Et without heating was 23 °C (Bp = 734 $m^3\ d^{-1}$). The installation of 1 solar panel would raise Et to 26 ºC (Bp = 759 $m^3\ d^{-1}$), while the temperature of 35 °C was reached with 17 panels (Bp = 802 $m^3\ d^{-1}$). However, it was recommended the installation of 6 solar panels as an optimization point (Et = 30 ºC and Bp = 781 $m^3\ d^{-1}$) since the gain of biogas production above this temperature was insignificant. The recovery of solar energy is a promising alternative for heating pig effluent and can contribute to energy sustainability in farms.

Keywords: Biogas, effluent heating, pig manure, solar energy.

Video presentation

OBTENTION OF ENERGY FROM GLYCEROL USING *Pseudomonas aeruginosa* STRAINS AS BIOCATALYSTS IN MICROBIAL FUEL CELL

Ana Clara Bonizol Zani*, Lucca Bonjy Kikuti Mancilio, Erica Janaina Rodrigues de Almeida, João Pedro Rueda Furlan, Adalgisa Rodrigues de Andrade, Eliana Guedes Stehling, Valeria Reginatto Spiller

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Abstract: Microbial Fuel Cells (MFC) are bioelectrochemical systems that convert chemical energy, contained in waste, into electrical energy by means of microorganisms. *Pseudomonas aeruginosa* are promising biocatalysts for these systems, as they synthesize phenazine-type pigments, which help in the external transfer of electrons. In this research, energy production was evaluated using EW603 and EW819 *P. aeruginosa* strains from the by-product of the biodiesel industry, glycerol. Both strains were grown in medium containing 10.85 mmol/L glycerol. The anode compartment of the MFC is separated from the cathode by a proton exchange membrane (Nafion® 117/DuPont/USA) and the external circuit consists of a 1000 O resistance. The voltages generated by the MFC were measured by Arduino® software. The EW603 strain demonstrated stability in the generated current, reaching 120 µA (± 10) after 22 days of operation. Preliminary studies have shown that EW819 strain has current values of 54.9 µA (± 4.5), that is, lower than EW603 strain. Cyclic voltammetry analyzes of MFC biofilms with EW603 and EW819 strains suggest that, while EW603 presents direct electron transfer, EW819 occurs indirectly, probably through its natural mediator, pyoverdine. This research has revealed that both P. aeruginosa strains are potential biocatalysts for the oxidation of glycerol, a by-product, in MFC for energy production.

Keywords: Mediator, pyoverdine, bioelectricity.

Video presentation

COMPARISON OF THE KINETIC STUDY AND BIOMETHANE PRODUCTION BY ANAEROBIC DIGESTION OF FOOD WASTE AND SEWAGE SLUDGE

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Abstract: Food production generates more than a third of global greenhouse emissions. In this context, the policies and management strategies of the circular bioeconomy are fundamental to promote research focused on the valorization of biomass. Thus, the food waste and domestic sewage sludge (DSS) were tested for potential methane production. In this study, it was carried out by the volumetric method which is determined by the volume of methane. Such procedure was performed in the Automatic Methane Potential Test System (AMPTS) II or Automatic Methane Potential System. In addition, in this study, kinetic assays were performed and the models of first order, modified cone, and Gompertz were adopted to fit the experimental data and predict the production of methane for DSS and food waste. Therefore, the production of methane from the sludge + food residue co-digestion had a specific production of 0.06 and 0.14 Nm^3/kgVS methane, respectively. Therefore, among the three kinetic models evaluated, the cone and first order models were the most suitable (R^2 0.99), and the ones that best adjusted to the methane yield. With this, the first order and the cone models can be furtherly used to optimize the parameters of anaerobic digestion (AD) process in large scale. These data are significant in face of the lack of kinetic data reported in brazilian database for AD of food wastes.

Keywords: Biomass, co-digestion, methane.

Video presentation

USAGE OF BIOGÁS IN DAIRY FARMS: A TECHNICAL AND ECONOMIC FEASIBILITY ANALYSIS

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Abstract: Brazil has one of the biggest dairy herds worldwide, as result, great amounts of manure are generated due to the size of the herd. This paper has the hypothesis that generating energy off of manure could become a viable option environmentally and economically. In that manner, the objectives of this paper are: To analyze the economic viability of using biogas as an energy source, and create indicators that allow to use the results obtained in other farms with similar aspects. Then, 3 fieldworks were realized willing to quantify the generation of manure and milk production in a day. The research was realized in a dairy farm with 134 animals raised in Compost Barn's system and milked by machine. Analyzes of total, fixed and volatile solids were realized in triplicate. Data of generation and solids content in manure were used in mathematical models that estimate the generation of methane which later would be converted into energy. Partial results showed a potential energy generation of 15212.78 kWh/y, corresponding to 52% of the energy consumption of the property, and savings of R$ 4,563.83/y. The data collection allowed the creation of the following indicators: 0.012 kWh/liter of milk; 0.370 kWh/cow and 0.010 kWh/Kg of manure. Next, the research will evaluate the economic feasibility of acquisition and maintenance costs of a biodigester and a generator system. Alongside of it, public policies and credit lines that could foster the use of the technology will be investigated.

Keywords: Manure, dairy, energy, biodigester.

Video presentation

LIFE CYCLE ASSESSMENT OF BRAZILIAN LIVESTOCK RESIDUES FOR TWO ENERGETIC STRATEGIES: ELECTRICITY AND BIOMETHANE PRODUCTION

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Abstract: The global changes promoted in various sectors have reflected mainly in consumption patterns, which has fostered discussions about the future viability of human activities. The growing need for energy is one of the current concerns and allied to waste management, has promoted the adoption of circular approaches to meet these requirements. In this sense, anaerobic digestion, has been the technology used to concomitantly enable waste management, value addition, nutrient recovery, and energy recovery, in favor of the sustainability of production chains. Thus, this study evaluates the environmental viability of different agricultural residues through a life cycle assessment, comparing electricity generation and biomethane as critical pathways to promote decarbonization in the agricultural sector. Based on the results, the two strategies prove to be environmentally favorable for mitigating the environmental impacts caused during waste handling. The scenarios with biomethane production (BP) were shown to be more environmentally favorable compared to the scenarios for electricity generation (EG), with pig farming being the activity with the best results for the mitigation of greenhouse gas emissions (107% EG and 121% BP), followed by beef (104% EG and 108% BP), sheep (103% EG and 106% BP) and dairy (74% EG and 77% BP). This demonstrates the great potential that these residues have and how the appropriate management can ensure the environmental viability of agricultural practices.

Keywords: Waste management, circular economy, atmospheric emissions, waste to energy.

Video presentation

PRODUCTION OF HYDROGEN AND VOLATILE FATTY ACIDS BY MICROBIAL CONSORTIUM AFTER APPLICATION OF DIFFERENT PRE-TREATMENT METHODS

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Abstract: Biological hydrogen production, using industrial waste, is a renewable energy alternative. Hydrogen production is carried out by microbial consortia that simultaneously generate other value-added co-products such as methane and volatile fatty acids. In microbial consortia there are hydrogen consuming organisms. Pretreatment methods are needed to inhibit hydrogenotrophics. The study evaluated four pretreatments of a microbial consortium, using sugarcane vinasse as substrate. Bioassays containing granular inoculum of Effluent Treatment Plant, with different pre-treatments, were compared to control and glucose assays. The 24-h pretreatments were: freezing (-20 °C), acid treatment (pH 3), basic treatment (pH 10) and heat treatment (90°C for 10 min). All bioassays produced hydrogen in a medium containing vinasse, but the highest production was 20.73 mmol after thermal pretreatment with a purity of 98.75% hydrogen. In the vinasse experiments, more acids were produced than in the glucose experiments. The cold treatment stood out for the butyric production, acetic and propionic acids (151.5 mg/L, 139.2 mg/L and 77.4 mg/L respectively). Cold and basic treatments were not efficient in inhibiting the methane formation and, in acid, there was a 3.5 times reduction of substrate COD. The results indicate the applicability of treatments to select the metabolic routes of microorganisms to improve the production of hydrogen, volatile fatty acids contributing to sustainable energy generation.

Keywords: Hydrogen, vinasse, pretreatment, fermentation, volatile fatty acids.

Video presentation

AGROINDUSTRIAL CITRUS WASTEWATER AS RAW MATERIAL TO BIOHYDROGEN PRODUCTION BY DARK FERMENTATION

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Abstract: Citrus residues generated in orange processing are an important environmental concern for the agribusiness sector. Among its valorization possibilities, dark fermentation is a promising alternative in the generation of renewable biofuels, such as hydrogen. This study evaluated the anaerobic digestion of wastewater from orange processing, aiming at the biological production of hydrogen from inocula: (1) *Clostridium acetobutylicum* ATCC824, (2) *Clostridium beijerinckii* ATCC 10132 and (3) an anaerobic citrus consortium obtained from citrus wastewater. The anaerobic batch reactors were filled with mixtures of Reinforced Clostridium Medium (RCM) and citrus effluent (EC) under the conditions: (I) 100% RCM; (II) 80% RCM + 20% EC; (III) 50% RCM + 50% EC; (IV) 20% RCM + 80% EC and (V) 100% EC, initial pH 6.0 at 37 °C in a static mode. Generations of H_2 were verified with all tested inocula. Final pH remained in the range of 4 to 6 indicating alcohols and volatile fatty acids as the main co-products generated. Yields (mol H_2/mol glucose) were high with inoculum 3, with values of 1.95; 1.47 and 1.93 under conditions 2, 3 and 4, respectively. The efficiency of anaerobic digestion in the treatment of citrus wastewater has high potential in hydrogen production and its recovery as sustainable bioenergy.

Keywords: Agroindustry, anaerobic digestion, biofuel, citrus effluents, pure cultures.

Video presentation

APPLICATION OF A TWO-STAGE ANAEROBIC SYSTEM: FROM GUAVA PROCESSING WASTE TO ADDED-VALUE BIOPRODUCTS

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Abstract: Brazil is the third-largest fruit producer in the world. It is estimated that 47% are destined for agro-industrial processing. Guava has considerable production and industrial use. However, some materials are rejected along the operational chain. H_2 and CH_4 can be obtained in a two-stage anaerobic system providing energy recovery. This study evaluated added value bioproducts production from guava processing waste. Four essays, with different S/I - substrate/inoculum ratio (0.67, 1.0, 2.0, 3.0 gCOD/gVS) were carried out in triplicate of anaerobic batch reactors (1 L), headspace (0.3 L, N_2 99.99%), 0.7 L of volume work, at 37 °C, at 120 rpm, 5 g L^{-1} $NaHCO_3$ in two stages. First stage: guava processing waste and sewage, granular sludge from UASB reactor heat-treated previously, initial pH 5.5. Second stage: effluent from the first stage, granular sludge from UASB reactor, initial pH 7.0. Accumulated biogas production increased with the increase of S/I ratios, except for the second stage with S/I 3.0, which suggested inhibition of the microbiological activity. Best biogas composition was verified with S/I 2.0; 29% of H_2 and 78% of CH_4 for the first and second stages, respectively. Best yields (mL/gVS) were obtained in S/I 0.67; 5.3 H_2 and 266.3 CH_4. Propionic acid and ethanol were the main metabolites generated. New possibilities are open for applying recovery guava waste by a two-stage anaerobic system.

Keywords: Biogas, volatile fatty acids, alcohols, fruit processing waste.

Video presentation

COMPARISON OF CO-DIGESTION GASES AND ANAEROBIC BIODIGESTION FROM DIFFERENT TYPES OF AGRICULTURAL REACTORS

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Abstract: Anaerobic digestion (AD) stands out in the rural scenario as an alternative for managing the high volume of waste from confined animal feeding operation by reducing the environmental impact on this chain. This technological alternative features an operational simplicity, high efficiency and biogas generation, in which can be converted into electrical energy and be applied on its own process. In light of the foregoing, this study aimed to compare the biogas composition, collected from distinct agricultural residues from three different properties, consisting of (a) co-digestion of poultry litter and swine manure, (b) AD of dairy cattle manure and (c) AD of swine manure. According to the composition evaluated, CH_4, CO_2, NH_3 and H_2S in proportion rates, it was noted that: (a): 64.4%; 32%; 0.04%; 0.1%. (b): 56.3%; 41.5%; <0.01%; <0.01%; and (c): 68.4%; 25.9%; 0.01%; 0.02%. (a) and (b) are a complete mix digester, and (c) is a covered lagoon type. The (c) presented a superior gas quality, which is expected for swine effluents. Although for cattle effluents, the lower percentage of CH_4 can be attributed to its own characteristics. Furthermore, higher NH_3 concentrations were assessed in the co-digestion of swine effluents with poultry litter, and this is commonly observed in gaseous fractions of poultry biogas due to the feeding and production system of the fowls. In short, the discrepancy in (a), compared to (b) and (c) was presumably related to sulfur supplementation in bird feed.

Keywords: Anaerobic digestion, farming waste, biogas, co-digestion.

Video presentation

ENERGETIC POTENTIAL OF BIOGAS MADE OF ANAEROBIC DIGESTION OF THIN STILLAGE AT CORN TO ETHANOL MILLS

Henrique Di Domenico Ziero*, Victor Oliani Trevisan, Larissa Castro Ampese, Míriam Tvrzská de Gouvêa, Maria Thereza de Moraes Gomes Rosa, Mauro Donizeti Berni, Tânia Forster-Carneiro

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Abstract: Corn-Ethanol mills have subproducts that could be used as the energetic source to the factory itself. That's the case of thin stillage, a subproduct from the corn ethanol production process that can be fermented to generate biogas. This work aims to analyze the production process of a corn ethanol mill located in the State of Mato Grosso in Brazil in order to analyze the viability of using thin stillage as fuel for gerating steam and consequently reducing the energy consumption of the mill. Simulation results show that for each ton of corn used as raw material 1.83 tons of thin stillage are produced, which may yield 591.96 Nm^3/h of biogas, considering a composition fraction of 65% of methane in the biogas, resultant from an anaerobic digestion process. Considering the energy conversion of the biogas into steam, the biogas obtained froem the thin stillage could produce around 5.4 ton/h of steam at 2.5 bar, which corresponds to about 15% of the total thermal energy demand of the entire ethanol. However, it is still necessary to use other fuels to achieve energy demand like native forest wood or reforested wood such as eucalyptus trees. This work concluded that anaerobic digestion of thin stillage can be the first step to make the corn ethanol mills auto sufficient, and new research perspectives regarding the combined usage of corn and wood need to be evaluated.

Keywords: Biogas, corn ethanol, thin stillage, waste to energy, bioenergy.

Video presentation

RECOVERY OF DAIRY WASTE AND SEWAGE IN BIOGAS PRODUCTION BY ANAEROBIC DIGESTION

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Abstract: Dairy sector is one of the most relevant components of the agroindustry, with global production of 852 million tons of milk. Several dairy products are throwed away due its high perishability. An alternative for reducing this waste would be its use in anaerobic digestion aiming biogas production. This study evaluated the co-digestion of dairy waste with sewage in assays composed by Chemistry Oxygen Demand (gO_2 L^{-1}): (1) 9.0; (2)15.0 and (3) 21.0 to evaluate the effect of dairy waste increasing in the digester performance. Anaerobic batch reactors (1.0 L) were assembled in duplicates with 0.5 L headspace (N_2 99.99%), working volume of 0.5 L filled with 19 gVS L^{-1} of granular sludge from UASB reactor, 5 g L^{-1} $NaHCO_3$, initial pH 8.0, at 37 °C, in a static mode. The operation monitoring was made by analysis of biogas generation, total volatile solids; carbohydrates and COD removals. The cumulative CH_4 productions in 22 days of operation were (mL) 1851.0; 2815.7 and 3533.0 for the assays (1); (2) and (3) respectively, demonstrating concentrations were not inhibitory for anaerobic digestion. Equivalent CH_4 yields were obtained for the assays ($mLCH_4$ gVS_{add}^{-1}) (1) 771.3; (2) 761.0 and; (3) 721.0. COD removals were 85.8%, 90.0% and 89.2% for the assays (1); (2) and (3), respectively. The co-digestion of dairy waste with sewage was effective to CH_4 production with removal of organic matter. These results encourage new strategies for recovery of dairy waste by anaerobic digestion.

Keywords: Dairy waste, anaerobic digestion, methane, biogas.

Video presentation

CHARACTERIZATION OF FRUIT AND VEGETABLES WASTE GENERATED AT A CENTRAL HORTICULTURAL WHOLESALER: CASE STUDY FOR PRODUCTION OF ENERGY VIA BIOGAS

Francisco das Chagas Gomes da Silva Júnior, Camila Aparecida de Menezes*, Willame de Araújo Cavalcante, Oscar Pedreira Aragão, Marcelo Zaiat, Renato Carrhá Leitão

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Abstract: Fruit and vegetables waste (FVW) generated in the Central Wholesale Market of Ceará State/Brazil (CEASA-CE) can be used as a substrate for biogas production, which would be an environmental-friendly option for recovery of resources. CEASA-CE generates around 24.5 t/d of solid waste, which is sent to the landfill without any characterization. To quantify and qualify the FVW it was necessary to interview all the 1200 permit holders in CEASA-CE. Further, the amount of FVW obtained from the questionaries was adjusted to the total amount of food that enters in CEASA-CE, and the total waste discharged to the landfill. The result of such calculation is an average composition of the FVW (percentage of total waste): orange (42%), onion (7%), corn (5%), papaya (5%), avocado (4%), watermelon (3%), banana (3%), melon (3%), potato (3%), pineapple (3%), cabbage (2%), guava (1%), tomato (1%), and the sum of others (18%). This composition was used to simulate FVW, which was characterized in terms of COD (172 g COD/kg FVW), TS (8%), and VS (92%). Biomethane potential tests resulted in a 55% methane content and 270 Nm^3 CH_4/g COD (46,440 Nm^3 CH_4/kg FVW). Therefore, it is estimated that the FVW from CEASA-CE yields a methane-based energy recovery potential of 2,101 MWh/year. The estimate of savings in the final disposal of waste (€ 180,000.00/year) and with electricity (€ 250,179.00/year) may result in a reasonable internal rate of return for a full-scale anaerobic digestion plant on CEASA-CE.

Keywords: Fruit and vegetables waste, organic waste, energy recovery potential, anaerobic digestion, methane.

Video presentation

USE OF COMMERCIAL ENZYME FOR OPTIMIZATION IN METHANE PRODUCTION IN TURKEY BED WASTE APPRECIATION

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Abstract: Turkey breeding stands out in Brazil with a production of 172 thousand of tons in 2019, generating a great amount of waste that needs management. The lignocellulosic material found in turkey bed requires the use of pre-treatments to facilitate its degradation and the autochthonous microorganisms access to the substrate. Anaerobic digestion is a way of reusing the substrate for energy production, such as methane, which is an environmentally friendly biofuel. The use of commercial enzymes aims to facilitate hydrolysis, enhancing methane production. Therefore, the objective of the study was to analyze the efficiency of a commercial enzyme with the purpose of optimizing the methane production of turkey bed biodigestion. The assays were carried out in small reactors with different enzyme concentrations and turkey bed at 25.5 $gVS.L^{-1}$, with and without pre-treatment. Nitrogen was used to maintain anaerobiosis, the pH was set to 7.2 and a duplicate was set to pH 5.0; the assays were kept in orbital shaking at 140 rpm and 37 ºC for 32 days. A pre-treatment with commercial enzyme was carried out in different concentrations, at 55 ºC during 18 h. As result, there was CO_2 production and total acid accumulation (6106.5 $mg.L^{-1}$) in the final sample, which may have led to methane production inhibition. Only the assay set to pH 5 produced methane (81 mL $CH_4.L^{-1}$). Enzymes can improve the methane production of turkey bed biodigestion, as long as the pre-treatment is performed at an ideal pH.

Keywords: Anaerobic digestion, methane, turkey bed, enzyme.

Video presentation

COMPARISON OF METHANE PRODUCTION FROM PIG MANURE FROM A SEDIMENTATION POND AND PIG BEDDING

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Abstract: Pig farming is an important economic activity, generating residues that need management. The pig bedding, composed of wood shavings and pig manure, can be used as a substrate and microorganism source in methane production, an environmentally friendly gas. The sedimentation pond maintains the pig manure accumulated in rearing and requires proper management. Thus, this study aims to compare methane production from sedimentation pond pig manure and pig bedding. The bioassays were conducted in batch, in small reactors containing pig manure (DS) and pig bedding (CS) at 20% and 40%. The glass bottles were kept in anaerobic conditions under orbital shaking (ShakerCientec) for 60 days at 140 rpm and 37 ºC, and the pH was set to 7.0. The maximum accumulated methane production, production speed and lag phase were evaluated according to the modified Gompertz model. Volatile fatty acid analysis was performed. The methane production in DS 20% was 386.5 $mLCH_4.L^{-1}$ in a lag phase of 27.5 h, while DS 40% produced 505.38 $mLCH_4.L^{-1}$ in an 8.88 h lag phase. Pig bedding showed methane production of 572.64 $mLCH_4.L^{-1}$ (20%) and 592.25 $mLCH_4.L^{-1}$ (40%). The acids were partially consumed in all conditions, with higher amount of total acids produced in CS 40%. The results showed the potential of pig residue for methane production, especially when using pig bedding.

Keywords: Anaerobic digestion, methane, pig bedding.

Video presentation

ANALYSIS OF THE TECHNICAL FEASIBILITY OF PRODUCING BIOGAS FROM RURAL SUBSTRATES

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Abstract: The Vassouras city has a territorial area of 538,129 km² and is located in the Center-South region of the state of Rio de Janeiro with land use predominantly focused on pastures (62%). Rural regions with an emphasis on agriculture and livestock have potential for the construction of energy generating plants, as they have large amounts of dairy manure and vegetable straw. The use of these materials can inhibit the decomposition of these wastes, in addition to contributing to an alternative in the scenario of biofuels and organic fertilizers. The generation of biomethane involves an enzymatic process subdivided into heterogeneous and homogeneous reactions, where there is conversion of residues into gases of interest and by-products. Biomethane produced from animal waste has advantages, due to its destination for by-products, as the material not converted during the generation process has application in agriculture as an organic fertilizer on the farms in the region. This study aimed to evaluate the technical feasibility of biogas production from a rural substrate using a process simulator (SuperPro Designer®). A bioreactor (max. capacity of 6000 kg) for the treatment of 225 kg of rural substrate daily was considered in the evaluation of the process. The composition of the rural substrate consisted of 80% dry manure and 20% vegetable straw. After the process simulation, the results obtained indicated a promising technical viability from the generation of 90 m^3 of biogas per day.

Keywords: Biomethane, process simulation, superpro designer®, bioprocess.

Video presentation

ANALYSIS OF FERMENTATIVE PARAMETERS FOR THE PRODUCTION OF 2G ETHANOL FROM COCONUT HYDROLYSATE

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Abstract: Brazil stands out in fuel ethanol production from rich-sucrose sugarcane juice, but in terms of water-food-environmental safety, this feedstock should be replaced by agricultural waste, giving rise to second-generation (2G) ethanol. Among these residues, the coconut husk is a potential feedstock due to its high percentage of holocellulose to be converted into fermentable sugar. In this context, we analyzed fermentative parameters aiming at 2G ethanol production from it. We submitted the coconut husk to alkaline pretreatment with 20% $Ca(OH)_2$ and carried out its hydrolysis with the enzymes Ctec2 (2%) and Htec2 (0.5%). The conversion efficiency of the polymers into sugars was 19.3% for cellulose and 7.3% for hemicellulose, and fermentation inhibitors were also detected. In the fermentation assays, the strains *Wickerhamomyces* sp. UFFS-CE-3.1.2 and *Saccharomyces cerevisae* PE-2 were employed. Considering the biomass production and the percentage of total reducing sugar (TRS) consumed, the best condition was defined through Central Composite Design (CCD) as pH 7.0 and 40 ºC. The yeast UFFS-CE-3.1.2 showed the highest biomass production and TRS consumption, but it did not produce ethanol. In contrast, the strain PE-2 fermented the sugars, showing an ethanol yield of 0.24 g/g (ethanol/sugar). Therefore, coconut husk can be considered for 2G ethanol production, as long as pretreatment and hydrolysis processes are optimized to increase sugar and reduce inhibitors in the hydrolysate.

Keywords: Yeast, *Saccharomyces cerevisiae*, *Wickerhamomyces*, experimental design, reducing sugars.

Video presentation

TURKEY LITTER CHARACTERIZATION AIMING THE ENERGETIC VALORIZATION THROUGH BIOGAS PRODUCTION

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Abstract: Waste from the production of turkeys in confinement can present as an alternative source of energy through anaerobic digestion. Turkey meat production was about 159,000 tons in 2019, and currently, 74% of its production is destined for the domestic market and 26% for exports. This research was aimed to i) perform the physical, chemical, and Biochemical Methane Potential (BMP) characterization of turkey litter, ii) obtain indicators for the Brazilian potential of methane generation from turkey litter, and iii) evaluate the influence of different turkey litter management with 50, 120 and above 400 days of litter used in bird production. The kinetic tests to evaluate the PBM of the three samples were conducted at batch and mesophilic temperatures. The highest concentration of volatile solids was found for the 50-day turkey litter (32.2%, m m^{-1}), which also resulted in higher energy potential (BMP = 289±14 L_N CH_4.kgSV $adic^{-1}$, 34.3 Nm^3 CH_4 day^{-1} corresponding to electricity generation of 71.3 kWh day^{-1}). The indicators obtained from turkey litter for the Brazilian methane generation potential were from 7.5 to 31 million m^3 of CH_4 with the reuse of waste from different days of housing from turkey meat production in the years 2010 to 2017.

Keywords: Turkey litter, alternative source, biochemical methane potential.

Video presentation

PREDICTION OF METHANE POTENTIAL FROM POULTRY WASTE THROUGH MACROMOLECULAR COMPOSITION

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Abstract: The energy use of poultry waste through methane production is a green solution that also contributes with the generation of renewable energy. However, biochemical methane potential (BMP) from biowastes are determined by using specialized structure, which requires considerable time. This study aimed to develop statistical models to estimate the BMP of poultry waste from the macromolecular composition in order to reduce the time to obtain data. BMP was determined in batch tests at 37ºC and inoculum/substrate ratio of 2:1. Regression models were determined from the CH_4 yields and macromolecular composition, considering crude proteins (CP), crude lipids (CL) and total carbohydrates (TC) by using Minitab 17 software. The BMP of broiler poultry manure was 294±30 NL CH_4 $kgVS^{-1}$ with 56% CH_4 in the biogas while the BMP of the layer poultry manure was 282±34 NL CH_4 kg VS^{-1} with 55% CH_4 in the biogas. The best regression models from the combined manure (broiler + layer) (1), only broiler (2) and only layer were (3): PBM = 162 + 1.62 CP + 8.8 CL + 1.43 TC; PBM = 111 + 2.8 CP + 13.9 CL + 2.09 TC and PBM = 104 + 2.94 CP + 9.3 CL + 1.69 TC, respectively. The coefficient of determination of the regression models was 0.347, 0.457 and 0.691 for combined broiler and layer poultry manure, only broiler and only layer manure, respectively. Therefore, regression analysis proves to be an interesting method to estimate the BMP of poultry manure, aiming to assist in decision-making on a full scale.

Keywords: Anaerobic digestion, BMP, statistical models, batch tests, biogas.

Video presentation

ANALYSIS OF THE QUANTITY OF SOLID WASTE GENERATED BY THE WINE INDUSTRIES OF THE STATE OF RIOGRANDE DO SUL - BR

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Abstract: The State of Rio Grande do Sul-BR is internationally renowned for its products made from grapes. According to the 2020 report, there are 665 wineries, which arouse interest in collecting data on the generation of waste in the wine industry for analysis of environmental impacts and energy use. For this, the delimitation of the study area was carried out considering the representativeness in number of wineries (minimum of 4 enterprises per municipality) and the presence of large, medium, and exceptional-sized wineries. For these, primary data were obtained through the operating licenses (LO) made available by the Municipal Environmental Secretariats and the State Environmental Agency. 271 wineries with LO in force were delimited. From these, the maximum production capacity of final products (wine, sparkling wine, juice) was obtained. The conversion of production into waste generation was through the definition of a factor using real data on waste generated in 45 wineries in the state, between 2016/2017. Using statistical analysis tools, a conversion factor of 0.4 (waste generated (kg)/average production (L)) was obtained. A total production of 579,467,587.0 L/year was reached, and this value expressed in solid waste generated is equal to 231,787,034.8 kg/year. As the main final destination is the disposal on the ground, technical studies that enable new ways of reusing this waste are essential, in which the generation of energy through pyrolysis is studied, especially.

Keywords: Winery waste, waste energy generation.

Video presentation

EFFECTS OF INOCULUM PRETREATMENT ON HYDROGEN PRODUCTION FROM CASSAVA BAGASSE

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Abstract: The cassava industrialization process generates residues that have the potential to generate bioenergy, due to the high content of starch and carbohydrates. Among these residues is the bagasse, generated in the process of obtaining starch, which is attractive for hydrogen production. Evaluate the effect of two inoculum pretreatment methods (chemical and thermal) on the production of hydrogen from cassava bagasse (CB). Two pretreatments were applied to the inoculum: 1) thermal pretreatment: 95 °C for 15 minutes; 2) acid pretreatment: acidification up to pH 3.0 (HCl 1 mol L^{-1}) and later increase pH up to 6.0 (NaOH 1 mol L^{-1}). The tests were carried out in 500 mL vials, with 200 mL of useful volume at 31 ± 1 °C. For each condition, two carbon sources were tested (CB 1,63 gVS. L^{-1} and sucrose 5g L^{-1}), in total 4 treatments in duplicate. Two control vials, without an external C source, were used to quantify the H_2 production of inoculum. Ten bottles were monitored, with H_2 production readings every 24 hours, for 7 days. Using Chemical pretreatment and CB, the largest accumulated volume of hydrogen was obtained (103 mL), 5% higher than using thermal pretreatment (98 mL). The acid treatment maintained better hydrogen yield (88 mL), even changing the carbon source. The largest volume of hydrogen production occurred with Chemical pretreatment. It was verified that the best results used cassava bagasse as a carbon source.

Keywords: Cassava, bioenergy, residue.

Video presentation

ENERGY EVALUATION OF BIOGAS FROM PIG FARMS: GENERATION POTENTIAL, CONSUMPTION RANGES AND ALTERNATIVES FOR ELECTRICITY DESTINATION

Pedro Henrique Gonçalves Rigueira Pinheiro Castro, Raphael Rivadávia Mendes Oliveira*, Guilherme Henrique da Silva, Larissa Almeida Nascimento, André Pereira Rosa

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Abstract: This study evaluated electricity generation (EG) feasibility from biogas generated in swine manure anaerobic digestion, and compared different electricity destination alternatives for different consumption scenarios. Biogas yield estimation was based on the model proposed by CETESB. The Monte Carlo simulation was performed to evaluate uncertainties, considering the biodigester efficiency and methane content in biogas. For EG estimation, technical data from generators were considered. In the economic feasibility study, four alternatives for electricity destination were evaluated, considering three consumption ranges determined based on literature data: (i) local self-consumption, (ii) remote self-consumption, (iii) sale of energy during peak hours in medium voltage, and (iv) sale of energy in low voltage. For the minimum and medium consumption scenarios, it is possible to obtain profit with 260 animals in all alternatives, being the minimum necessary to make EG viable. In the case of maximum consumption, alternative (iii) allows for profit from 260 animals, while alternative (iv) demands 2,760 animals and for alternatives (i) and (ii), energy independence is only achieved after 9,020 animals. The alternatives in ascending order of economic profitability were: (i), (iv), (ii) and (iii), regardless of the number of animals. Therefore, the alternatives presented can indicate the best EG destination depending on the number of animals and the consumption of the farms.

Keywords: Monte Carlo, renewable energy, energy independence, methane, swine manure.

TECHNICAL FEASIBILITY ASSESSMENT OF ELECTRICITY GENERATION FROM BIOGAS IN PIG FARMS: A CASE STUDY FROM MINAS GERAIS/BRAZIL

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Abstract: Covered Lagoon Biodigesters (CLB) are widely used for treating swine manure, being biogas an important by-product of high energy potential. This study aims to evaluate the technical feasibility of using biogas for electricity generation (EG) in pig farms with CLB installed in the state of Minas Gerais (MG), Brazil. Data was obtained from the Instituto Mineiro de Agropecuária inventory for 2019. Methane volumetric production (PCH_4) estimation was based on CETESB (2006) adapted by Lopes et al. (2021). Data input were: 2.5 kg of animal manure^{-1}.d^{-1}, 65% CH_4 content in the biogas and 47% COD removal efficiency in CLB (Viancelli et al., 2013). EG was considered technically feasible to pig farms with enough PCH_4 to operate at least one ER-BR motor generator (minimum biogas flow of 14 Nm³.h^{-1} and 3 h.d^{-1} of operation, considering the generator main operating mode). Biogas production ranged from 21.75 to 7,667.52 m³.d^{-1} among pig farms, with an average of 0.11 m³ biogas. animal^{-1}.d^{-1} EG is technically feasible for pig farms with a CLB installed with at least 396 animals. Although 717 out of 847 (84.6%) pig farms in MG presented technical feasibility for EG from biogas, only 295 of them (34.8%) have a CLB installed, from which 279 (94.6%) presented technical feasibility. EG from biogas derived from swine manure treatment is a great source of decentralized energy and a promising alternative to diversify the Brazilian energy matrix, but its potential is still underexplored.

Keywords: Swine manure, renewable energy, anaerobic digestion, covered lagoon biodigester.

Video presentation

MANAGEMENT AND VALORIZATION OF AGRO-INDUSTRIAL WASTES THROUGH ANAEROBIC DIGESTION: SUGARCANE, CHEESE WHEY, AND SLAUGHTER RESIDUES

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Abstract: Anaerobic digestion (AD) is a technology that allows waste management. For this process to be carried out correctly, an appropriate inoculum is required to degrade organic matter to produce biogas and digestate. However, in rural areas of developing countries, an inoculum from an anaerobic treatment plant is not available. In addition, various agricultural and agro-industrial wastes are generated in these areas, but there are also low-cost digesters that operate mainly with cattle manure. Therefore, this study aimed to determine the energy potential of agro-industrial waste using cattle slurry as inoculum in the AD. The substrates used were sugarcane residues, cheese whey, and slaughterhouse waters. Biomethane potential (BMP) tests were conducted in 500 mL glass flasks, at 35±2 °C, ISR of 2, and volume displacement measured methane production. Organic matter removal (based on volatile solids) and buffer capacity (VFA/TA ratio) were determined. Sugarcane residues showed a BMP ranged between 0.21-0.28 $Nm^3CH_4/kgVS_{ad}$, cheese whey between 0.42-0.59 $Nm^3CH_4/kgVS_{ad}$, and slaughterhouse wastewater 0.15-0.50 $Nm^3CH_4/kgVS_{ad}$. For the three cases, buffer capacity was < 0.8 mg eq acetic ac/mg$CaCO_3$), evidencing low inhibition risks and removing greater than 65% of organic matter. Cattle slurry was suitable as an inoculum for the AD of agro-industrial and agricultural residues, which could boost the bioeconomy of rural areas in developing countries.

Keywords: Agroindustrial wastes, biomethane potential, cattle slurry, circular bioeconomy.

Video presentation

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