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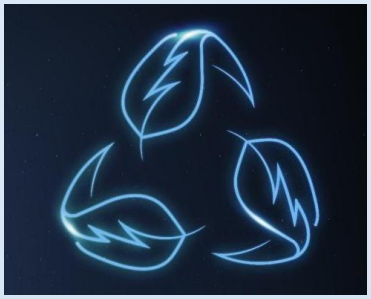

4th BIOENERGY STUDIES SYMPOSIUM

SYMPOSIUM ABSTRACT E-BOOK

May 26-27,2022

4th Bioenergy Studies Symposium

A Virtual Symposium

26-27 May 2022

Hosted by the

Black Sea Agricultural Research Institute, Samsun, TÜRKİYE

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PREFACE

Dear colleagues and researchers,

The 4th Bioenergy Studies Symposium aimed to bring together all stakeholders working in the field of bioenergy from all over the world to share and discuss their current research and talk about the future of bioenergy.

The areas of research covered in the symposium included biomass crops, biomass potentials, logistics, gasification, energy production through biofuels, bio-oil based biofuels, bio-alcohols, hydrothermal processing bioeconomy, bioenergy policies, bioenergy legislation, and beyond.

The symposium was hosted by the Black Sea Agricultural Research Institute and supported by the "Sustainable Use of Biomass to Assist the Development of Türkiye's Economy Towards Green Growth" project carried out by TAGEM and UNIDO.

The e-symposium was organized exclusively as an online symposium, and Turkish and English were the official languages of the symposium.

This abstract e-book contains 82 abstracts that were accepted and presented during the symposium (26-27 May 2022). Full texts submitted to the symposium journal, Bioenergy Studies will be published according to the functioning of the journal and the referee process. More than 800 registrations from 20 different countries were made to the symposium from universities, public institutions and organizations, the private sector, and non-governmental organizations.

We would like to thank esteemed members of the scientific committee for all their valuable contributions to the symposium. We would also like to thank our organizing committee members, symposium secretariats, and sponsors for helping to organize this symposium.

Finally, we would like to thank all the participants of the 4th Bioenergy Studies Symposium for making the e-symposium a productive experience.

We are looking forward to the **5th Bioenergy Studies Symposium** that will be held in person in 2023. We hope that it will be an interesting and enjoyable event like the previous Bioenergy Symposiums.

Symposium Chairs

İlhan AYDIN

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Süleyman YILMAZ

ORAL PRESENTATIONS

Importance of Bioenergy Production from Agricultural Wastes under the Green Deal: Net Zero Carbon Life from Waste to Value

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Abstract:

Greenhouse gases which has been increasing acceleratingly since industrial revolution changed global warming into a climate crisis. The global climate meetings held by the United Nations at the level of heads of state since the 1990s have not yielded any significant results so far. In our rapidly warming earth globe, with the increasing climate anomalies (drought, sudden precipitation and floods, epidemics, etc.), mother nature almost constantly sends a message to humankind. If human beings do not read these messages correctly and do not respect nature, unfortunately, catastrophic environmental disasters will become more likely. It is inevitable that human beings, who have the intelligence to reach Mars, use this intelligence to protect the planet with the only life potential in their hands. In this study, while The European Green Deal framework will be presented, it is also aimed to underline the importance of valorization of agricultural wastes into value added products such as bioenergy, biofuel and fertilizer for sustainable agriculture. Thereby, a roadmap for the preparation to EU Green Deal will be discussed for Turkish agricultural sector.

Keywords: European Green Deal, Agricultural waste, Bioenergy, Circular economy, Sustainable agriculture

Addition of Granular Activated Carbon (GAC) Enhances Psychrophilic Anaerobic Digestion of Cattle Manure

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Abstract:

Recently it has been reported that amendment of conductive materials enhances digestion process by improving the electron transfer between different microbial groups involved in biomethane production via leading to improved direct interspecies electron transfer. In this study, the impact of amendment of a carbon-based conductive material, namely, granular activated carbon (GAC) was investigated to determine its impact on biomethane production from cattle manure at psychrophilic (~ 18^{o}C) conditions. The impact on AD performance at different loading rates was investigated by maintaining two different food-to-microorganism (F/M) ratios of 1 and 3 (on volatile solids basis) in the reactors. Further, the benefit of pre-biofilm formation on GAC was also evaluated by comparing addition of biomass-attached GAC to the addition of virgin GAC in terms of methane yield, lag phase reduction and methane production rate. Virgin GAC amendment enhanced methane yield by 12% and 17% in comparison to conventional AD reactor for F/M ratio of 1 and 3, respectively. Similarly, supplementation of BioGAC further increased methane yield by ~22% compared to conventional AD reactor for both F/M ratios of 1 and 3. The highest methane production rate was recorded when BioGAC was added into the F/M 3 reactors; 42% increase in comparison to conventional AD. The results imply that the supplementation of GAC on AD process is a beneficial approach to enhance the performance of AD process at psychrophilic temperatures and may even account for the low temperature reactor operation when compared to typical reactor operation of 35^{o}C. Further, BioGAC amendment has further benefits for system performance and is a viable option.

Keywords: Anaerobic digestion, Biomethane, Carbon based conductive material, Biofilm formation, Direct interspecies electron transfer

Acknowledgments: The authors thank the financial support from the Scientific and Technological Research Council of Türkiye (TUBITAK) (Grant no: 218M854) and the BAGEP Award of the Science Academy.

Increasing Methane Efficiency by Machine Learning Algorithms

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Abstract:

Anaerobic digestion is one of the most important energy production processes among sustainable and renewable energy production technologies. Due to the diversity and variability of waste streams in many biogas plants, the operation of anaerobic digesters is experiencing unexpected problems in biogas production, resulting in low methane yields and high operating costs. Therefore, operational parameters need to be optimized to ensure high digestion performance. However, mechanical models of anaerobic digestion face difficulties due to a lack of comprehensive understanding of anaerobic digestion, and their application to assessing and predicting digestion performance is often inadequate. In processes that result in low methane yield, carbon dioxide emissions are higher which increases the effect on global warming by preventing sustainable energy production. Therefore, using different machine learning algorithms to predict and control the performance of anaerobic digesters will also provide sustainable and more efficient bioenergy production. The application of developments in the field of bioenergy integrated with innovative technologies is a promising field in increasing biogas yields.

Keywords: Bioenergy, Machine learning, Sustainability

Acknowledgments: This research was supported by the Yıldız Technical University, Civil Engineering Faculty, Environmental Engineering Department. This study is a part of PhD thesis of corresponding author.

Acidic Pretreatment of Corncob for Enhanced Biogas Production and Co-digestion with Cattle Manure

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Abstract:

The use of animal and agricultural wastes as garbage in landfills is no longer practiced due to the lack of space. In this study, biogas production efficiency was investigated by co-digestion of cattle manure and corncob which underwent acidic pretreatment. Corncob was pretreated by the addition of H_2SO_4 respectively with 1%, and 2% (by weight) at 60°C for 55 h using a wet-state H_2SO_4 pretreatment. After H_2SO_4 pretreatment corncobs were pretreated by ultrasound with the power of 100 W and a frequency of 55 kHz. The ultrasound tests were conducted at 50°C for 1 h. The lignocellulosic content (cellulose, hemicellulose, lignin) of the corncob also was analyzed. Pretreated corncob and cattle manure were stirred by the ratio of 1/1. In the first step %1 H2SO4 pretreated corncob and %8 and % 10 TS CM mixture, in the second step %2 H2SO4 pretreated corncob and %8, % 10 TS cattle manure mixture were evaluated. All anaerobic digestions were carried out at %37°C for 40 days. The highest biogas fermentation performance was obtained from a mixture of 2% H_2SO_4 (by weight) pretreated corncob and %10 TS CM. The highest methane yield occurred after co-digestion of 10% CM+%2 H_2SO_4 pretreated Corncob mixture. The highest biogas yield of the CM-CC co-digestion was 341 mL/g VS. After anaerobic co-digestion, TS and VS reductions were 40-55% and 60-65%, respectively, in sets. The highest biogas and methane production efficiency was 341 mL/g VS and 301 mLCH4/gVS in the mixture of %2 H_2SO_4 pretreated corncob and %10 TS cattle manure. After acidic pretreatment, it has been determined that corn cob with degraded lignocellulosic structure and high carbohydrate content is suitable for fermentation study.

Keywords: Biogas yield, Methane yield, Animal manure, Acidic pretreatment

Investigation of Kinetic Mechanism of Olive Oil Pomace in Steam Gasification for Methane Production

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Abstract:

Due to the many benefits offered by biomass, energy and chemical production have attracted a lot of interest in scientific study and industrial uses. Pyrolysis is a thermochemical technique that is frequently used to convert solid fuels into liquid, solid, and gaseous compounds. Pyrolysis is a heat treatment process in the absence of oxygen and is perceived as a fundamental step for other thermochemical methods. In this study, the thermal behavior and evolved gaseous products especially CH_4 of the pyrolysis process of studied olive oil pomace were investigated by thermogravimetric analysis with mass spectrometry (TGA-MS). The olive pomace sample was heated from ambient temperature (25°C) to 900°C at a constant rate 20°C/min in argon flows (with 65 mL/min). The kinetic study was conducted to examine the formation of CH_4 during pyrolysis by using nonlinear regression analysis which is the quite well approach to present the too complex solid-phase reaction mechanisms. The kinetics of CH_4 formation as a result of olive oil pomace pyrolysis was examined in two stages: primary pyrolysis and secondary pyrolysis zones. The results depicted that the higher amount of CH_4 was released at the primary pyrolysis zone which operated at relatively lower temperature (200-350°C) compared to secondary pyrolysis zone.

Keywords: Biomass, Pyrolysis, CH_4, Nonlinear regression kinetic, Thermogravimetric analysis

An operando analysis for catalytic char gasification by inherent AAEM species

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Abstract:

Although there were many researches on the structure evolution in carbonaceous material gasification, most of the structure characterization was completed offline. After the reaction was completed, the sample was cooled to room temperature and collected to determine structure parameters. There were few studies on the in-situ structure evolution during high temperature pyrolysis and gasification. The high-temperature stage microscope system (HTSM) was used to investigate gasification of carbonaceous materials and showed novel advantages for studying char gasification characteristics. Therefore, it is worthwhile to combine HTSM, which can reveal gasification characteristic of single particle, with Raman spectroscopy to analyze the in-situ char gasification process. In this study, an operando microscopic Raman spectroscopy, that was the micro-Raman spectroscopy equipped with a high-temperature stage, was innovatively used to characterize the morphology evolution and carbon structure evolution of single particle during in-situ char gasification. Coupling analysis of char gasification reactivity and high-temperature structural parameters was carried out to reveal different catalytic mechanisms by water-soluble AAEM and ion-exchangeable AAEM.

Keywords: Operando, Gasification, Biomass, Coal, Reactivity

Investigation of the Kinetics of Hydrogen Formed as a Result of Gasification of Hazelnut Shells by Nonlinear Regression

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Abstract:

In this study, the gasification of hazelnut shells at low heating was investigated using a thermogravimeter and the kinetics of hydrogen produced during gasification was calculated by nonlinear regression. Thermogravimetric analysis of the hazelnut shell was performed using the Netzsch STA 449 F3 instrument and the Aëolos mass spectrometer used simultaneously with this instrument. In the experiment, 10.0±2.0 mg of the hazelnut shell sample was taken in the gasification environment. Argon (80%) + steam (20%) was used as the carrier gas with a flow rate of 65 mL/min. The hazelnut shell sample was dynamically heated from 160°C to 1100°C at a heating rate of 10°C/min. Based on the profile of hydrogen formed at the end of this study, the gasification step was investigated in two stages. The reaction rate and the pre-exponential factor were calculated for both steps. It was found that hydrogen formation increased as a result of the water-gas reactions above 600°C.

Keywords: Biomass gasification, Thermogravimetric analysis, Hydrogen production, Gasification modeling

Analysis of Gasification Performance of Torrefied Cypress Cone Sample in Entrained Bed Using Aspen Plus

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Abstract:

There are many thermochemical techniques to convert biobased materials into gaseous products, but gasification is a promising option due to its high efficiency, availability of a range of solid fuels, flexibility in production capacity, and low pollutant emissions. Although biomass gasification is recognized as one of the most cost-effective and environmentally friendly methods, thermal pretreatment such as torrefaction improves the performance of thermochemical processes. entrained-flow gasifiers are often preferred for large-scale applications for both economic and technical reasons; they also have a higher cold gas efficiency and a carbon conversion rate of about 100%. However, since optimization of the gasification process is expensive and time-consuming, simulation tools are often used in process modeling. In this study, a thermodynamic analysis of the sample of a torrefied cypress cone is performed using the Aspen Plus process simulator by performing a sensitivity analysis to determine the optimal gasification conditions.

Keywords: Cypress cone, Entrained bed gasifier, Biochar, Thermodynamic analysis, Aspen Plus

Thermodynamic Analysis of Newly Proposed Downdraft Gasifier/Kalina Cycle System for Chicken Manure Gasification

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Abstract:

The biomass gasification-driven combined cycle is a complex conversion technology with various advantages, including the production of valuable syngas, the recovery of waste heat, and the generation of extra power, etc. Due to its high efficiency and the availability of a wide range of solid fuels, biomass gasification is a viable alternative. A downdraft gasifier is also suitable for small-scale power and heat generation, making it an effective tool for biomass gasification. Kalina cycles, which are among the qualified bottoming cycle technologies, have been recommended by researchers as a way to improve system efficiency and power generation. In addition, the family of Kalina cycles includes a number of other configurations with various combinations. Therefore, it is important to perform a thermodynamic analysis of the downdraft gasifier and Kalina cycle system, considering different operating variables. In this study, a thermodynamic analysis of the downdraft gasifier/Kalina cycle system for chicken manure is presented by performing a sensitivity analysis in the Aspen HYSYS process simulator.

Keywords: Chicken manure, Downdraft gasifier, Kalina cycle, Thermodynamic analysis, Aspen HYSYS

Investigation of Microalgae Gasification in a Bubbling Bed Gasifier with Integrated Solid Oxide Fuel Cell Using Aspen Plus

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Abstract:

High-temperature solid oxide fuel cells (SOFCs) provide sustainable and highly efficient distributed and modular energy conversion systems when combined with biomass gasification. Biomass gasification is an efficient alternative to the use of fossil fuels for the production of syngas containing mainly H_2, CO, and CH_4. Compared to inland biomass sources, microalgae are considered a promising source due to their more flexible cultivation methods, higher growth rate, and lower land requirements. They can be grown in the ocean, freshwater, or wastewater without requiring land for agriculture. By using steam as a gasification agent, the gasifier produces a higher hydrogen content in the syngas, resulting in a suitable fuel for SOFC. This study was conducted in Aspen Plus simulation to investigate the SOFC system integrated with gasification using microalgae as biomass source. A bubbling fluidized bed gasifier was selected and integrated into the SOFC after cleaning of the syngas. As a result, the influence of various key parameters such as energy efficiency, voltage and current density depending on the operating temperature of the gasifier and anode, and the ratio of steam to biomass of the gasifier in an integrated biomass gasification and SOFC is investigated. The results show that the efficiency of the system increases dramatically as the concentration of H_2 increases, but it decreases considerably when the concentrations of CO and CO_2 increase.

Keywords: Biomass, SOFC, Syngas, Gasifier, Energy efficiency

Performance of HZSM-5 Catalyst in Bio-Fuel Production

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Abstract:

Although, fossil fuels are the primary sources used in energy production, their negative effects on the environment and rapid depletion of reserves necessitated production of alternative and clean energy sources. Biomass energy, in the general sense, is accepted as a clean alternative fuel type due to its lower SO_2 and NOx emissions and negligible ash content compared to conventional fuels. However, direct utilization of bio-oil in motor vehicles is not possible for the time being due to its low calorific value, high oxygen content and high acidity related corrosiveness. The reduction of bio-oil's high oxygen content is addressed with present study by zeolite cracking reaction leading to bio-fuel production with high selectivity. Literature survey revealed bio zeolites as the most commonly used catalysts in the production of biofuel from bio-oil. HZSM-5 became prominent with its microporous structure, high surface area and high surface acidity containing both Lewis and Bronsted acid sites in its structure. Recent studies investigating reaction performance of HZSM-5 catalyst at 350 and 400°C and at 70/30 and 50/50 ethanol/reactant molar ratios revealed the increase of biofuel selectivity with increasing reaction temperature. Besides, higher ethanol content in the feed stream was shown to enhance bio-fuel selectivity. However, higher ethanol content lead to the increase of coke formation as a by-product. Based on literature survey optimum reaction conditions were determined as 400°C and 70/30 ethanol/reactant molar ratio. Reaction experiments conducted under these conditions revealed high amount of bio-fuel with decreased oxygen content.

Keywords: Bio-oil, HZSM-5, Zeolite cracking reaction

Development of Novel Catalysts for Bio-Fuel Production

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Abstract:

The energy need is increasing due to rapid developing technologies and growing population in today's world. Fossil based fuel demand is increasing which results in the increase of the harmful gases causing air pollution. Bio-fuels are produced as a result of the pyrolysis of biomass. They are acknowledged among clean and renewable energy sources for use as an alternative energy source to fossil-based fuels in motor vehicles. However, one of the biggest problems in biofuel production is carbon deposition during the reactions. Within the scope of this study, catalysts that are resistant to carbon formation and hence will be active for longer periods of time have been developed. Mesoporous gamma alumina support material was synthesized by hydrothermal (EISA) synthesis method and catalyst structure was achieved via wet impregnating zirconium, tantalum and nickel to increase surface acidity. The wide-angle XRD patterns and SEM-EDS analysis of the mesoporous $\gamma-Al_2O_3$ materials indicated an intact preserved structure containing the desired amount of metals. Nitrogen adsorption-desorption isotherms of the synthesized catalysts were found to be compatible with the Type IV isotherm, validating formation of a mesoporous structure according to the IUPAC classification. Active metal-containing mesoporous alumina catalysts were tested in bio-oil-to-biofuel production reactions. The reaction studies were carried out in a continuous flow packed bed reactor system with an ethanol/reactant volumetric ratio of 70/30, using 0.5 g catalyst at 400^{o}C. The highest bio-fuel selectivities and bio-oil conversions were obtained in the presence of zirconia containing catalysts. The results of the study showed that the use of mesoporous alumina material in bio-oil-to-biofuel production reactions was promising.

Keywords: Mesoporous alumina, Active metals, Biofuel, Biomass

Prediction of Thermal Degradation of Walnut Shell Biocomponents and Kinetic Analysis of Predicted Biocomponents by Nonlinear Regression

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Abstract:

Thermal-chemical conversion of biomass has been the subject of intense research in recent decades. However, due to the complexity of biomass composition, the decomposition process of most biomass types into gaseous, liquid and solid components is still unclear. In this study, a new kinetic model was developed to investigate the thermal degradation of walnut shell biocomponents (hemicellulose, cellulose, and lignin) based on the curve obtained by the thermogravimetric analyzer (TGA) during thermal cracking of walnut shell. The thermal degradation behavior of the biocomponents was determined from the thermogravimetric curves by the three-component method. These curves obtained from the three-component method were used to calculate the kinetic parameters of the biocomponents and to construct the kinetic model. In this study, the thermal interactions of hemicellulose, cellulose, and lignin in the nutshell during the thermal decomposition of the walnut shell were described for the first time using a new kinetic model.

Keywords: Waste Nutshell, Thermogravimetric Analysis, Lignocellulosic Biomass, Three Component Method

Investigation of Thermal Degradation of Cellulose in Biomass by Means of Deep Learning

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Abstract:

When compared to other renewable energy sources, biomass is the most widely used, and it provides several benefits over the course of several cycles. However, the heterogeneous nature of biomass has a number of drawbacks that prevent it from being used on a wide scale. It is thus critical to understand and characterize during thermolysis some of cellulose in biomass in order to improve process accuracy. Alternatively, thermal characterization needs a number of experimental methods that take up valuable time and money. Using the results of the elemental analysis and temperature as inputs, an artificial neural network model (ANN) as a deep learning approach was developed in this study to generate thermal degradation curves for cellulose in biomass, as well as derived thermogravimetric (DTG) curves for different biomasses. The performance of ANN is quite good. The R^2 values for both training and testing were more than 0.99.

Keywords: Artificial neural network, Biomass pyrolysis, Thermogravimetry, Cellulose degradation

Prediction of Thermal Degradation of Biomass in Pyrolysis Atmosphere by Means of Machine Learning

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Abstract:

In recent years, biomass research has evolved to become one of the most significant areas of study and investment in the energy business. The design of thermal conversion plants for biomass often involves labor-intensive and expensive analysis. The goal of this study is to show that using machine learning, which is less expensive and convenient, instead of an experimental study. The artificial neural network model, which is a machine learning approach, has a feed forward multi-layer network structure. The backpropagation algorithm is used for training the multilayer network structure. There are 5 inputs (ash content, volatile content, fixed carbon content, heating rate, and temperature) in the input layer and one output (weight loss %) in the output layer of the network. In addition, the network has two hidden layers with 24 and 18 artificial neurons, respectively. Thermogravimetric analyses were conducted using three heating rates (5, 10 and 30ºC/min) within a specified temperature range (from 25 ºC to 1000ºC) under argon atmosphere to determine weight loss of biomass samples. The artificial neural network model (ANN) was able to accurately predict 600 experimental input-output TGA data points. The ANN prediction and experimental values were in excellent agreement (R^2 > 0.9999). The generated model was also shown to perform very well with different heating rates.

Keywords: Thermogravimetric Analysis, Artificial Neural Network, Biomass, Heating Rate

Distributed Activation Energy Model (DAEM) on Co-pyrolysis of Empty Fruit Bunch and Disposable Face Mask Waste Mixtures

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Abstract:

The abundant supply of biomass generated from the palm oil processing industry has been one of the main issues faced by this industry over the years. Fortunately, energy can be produced from these lignocellulosic biomass via pyrolysis process. The recent innovative approach to improve the pyrolysis process is to introduce a high hydrogen containing feedstock, such as polyolefin plastics. Following this, the novel coronavirus (COVID-19) has greatly exacerbated the plastic waste generation, for example the surge of disposable face masks (DFM) consumption. However, this has an overlooked impact to the environment, i.e., microplastic pollution. The dominant materials to produce these DFMs are polypropylene (PP) and polyethylene (PE) plastics, which are also polyolefin plastics with high hydrogen content. Hence, this work focuses on the co-pyrolysis of empty fruit bunches (EFB) and the DFM wastes as a waste to wealth solution to enhance the pyrolysis process, while reducing the DFM wastes generated. In order to have an in-depth understanding of the thermal degradation behaviour of both of these samples, the experiments were conducted using the thermogravimetry analysis (TGA) equipment. The TGA data obtained will be used to determine kinetic and thermodynamic parameters using the distributed activation energy model (DAEM). The activation energy from the co-pyrolysis of EFB and DFM mixtures (in a weight ratio of 1:1) is revealed to be 62.71 kJ mol^{-1}, which is a 21.4 % reduction from the single EFB pyrolysis. The thermodynamic parameter triplets change in enthalpy (ΔH), change in Gibbs free energy (ΔG), and change in entropy (ΔS), were also determined as 57.37 kJ mol^{-1}, 168.08 kJ mol^{-1} and -0.1744 kJ $mol^{-1}K^{-1}$, respectively. The ΔH reduction from the single biomass feedstock pyrolysis was 22.7%, while ΔS showed a reduction of 17.5 %. On the other hand, the ΔG of single EFB pyrolysis comparable at 169.73 kJ mol^{-1}.

Keywords: Co-Pyrolysis, Empty fruit bunch, Disposal face mask, Bio-oil, Kinetic analysis

Investigation of Co-Pyrolysis by Using a Novel Multistage Kinetics Models by Means of Reaction Pathways

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Abstract:

Thermal gravimetric analysis of cypress cone biomass and biochar in an argon atmosphere at temperatures from 25°C to 1000°C was used to perform non-isothermal co-pyrolysis. Co-pyrolysis experiments were performed at four heating rates (5, 10, 20, and 40 K min^{-1}). Kinetic triplets were calculated with the use of a nonlinear regression analysis. In this work, novel multistage kinetic mechanisms for co-pyrolysis were proposed by offering pseudocomponents representing thermal decomposition products and cracking products, which were then validated. To evaluate the accuracy of the newly developed multistep kinetic pathways, the thermogravimetric behavior of the pseudocomponents was simulated and compared with experimental data to assess their robustness. Moreover, the R^2 values of the calculated TG curves for all thermochemical processes were higher than 0.99 for the majority of the investigated processes. According to the thermogravimetric data, the assigned pseudocomponents showed good behavior, which was also consistent with the TGA results.

Keywords: Biochar, Thermogravimetric analysis, Kinetic mechanism, Non-Linear regression

Kinetic Analysis for Catalytic Co-Pyrolysis of Palm Kernel Shell and HDPE using Bifunctional HZSM-5 and Limestone Catalyst

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Abstract:

The exponential surge of the human population has led to rapid demographic development which involves extensive human activities where myriad of opportunities for exploration and development has been discovered to suffice the growing demands for resources. Rapid population growth also signifies greater waste generation and thus mitigations for waste management are crucial. For instance, the high demand for palm oil for various application indicates that the palm oil industry has to deal with the abundant waste generated such as palm kernel shell. Likewise, plastics being the most convenient invention facing continuous demand has also led to the tremendous growth of plastic wastes. These wastes are potential feedstocks for biomass pyrolysis due to their high carbon content while the HDPE found in plastic mixtures can be used as a hydrogen-supplement for biomass co-pyrolysis for improved product quality. Therefore, this study is aimed at the investigation of catalytic co-pyrolysis of palm kernel shell (PKS) and high-density polyethylene (HDPE) mixtures with bifunctional HZSM-5 and limestone catalyst. The thermal degradation behaviour of pyrolysis of PKS and HDPE mixtures was studied via thermogravimetric analysis (TGA). Kinetic parameters were evaluated based on the TGA data acquired using the modified distributed activation energy model (DAEM) which adapts the matrix inversion algorithm. The average activation energy (Ea) of the pyrolysis of individual PKS and HDPE are 145.49 and 247.73 kJ mol-1 respectively. The Ea of the catalytic co-pyrolysis of HDPE and PKS (in the weight ratio of 2:8) is 129.41 kJ mol^{-1}, which is a 25% reduction when compared to the non-catalytic co-pyrolysis of the same mixtures. The average pre-exponential factor (A) of the pyrolysis of PKS, HDPE and of PKS and HDPE mixtures are 1.03×1014 s^{-1}, 1.36×1028 s^{-1} and 3.07×1020 s-1 respectively, whereas the catalytic co-pyrolysis of PKS and HDPE has an average A of 3.93×1018 s^{-1}.

Keywords: Palm Kernel Shell, High Density Polyethylene, Co-Pyrolysis, Kinetics

Production of Biochar and Biooil from *Onopordum spp*. by Pyrolysis and Determination of Fuel Properties

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Abstract:

In this study, *onopordum spp*. was selected as the biomass source and pyrolysis was carried out in a fixed bed pyrolysis reactor. The solid and liquid products obtained after these pyrolysis experiments were examined. Firstly, thermogravimetric and elemental analyzes of the biomass sample, which was made into pellets with 16 to 18 mm diameters, were made and the moisture, ash, volatile matter, sulfur, carbon oxygen amounts in their structures were determined. Using the pyrolysis method, which is one of the thermochemical methods, Onopordum spp. pyrolysis of the plant was carried out. In this pyrolysis process, the pyrolysis of biomass was carried out in a biomass fixed bed pyrolysis reactor at heating rates of 300, 350, 400 and 450ºC/min and temperatures up to 380, 400, 420 and 450ºC. As a result of the experiments, the yields of the liquid and solid products obtained were evaluated, and the GC-MS analyzes and viscosities of the liquid products were examined. In addition, elemental analyzes of solid products were carried out.

Keywords: Biomass, Clean energy, *Onopordum spp*., Pellet fuel pyrolysis

Biochar Production from Prosopis Juliflora Through Slow Pyrolysis and its Potential Application in Synthesis of Carbon Nanotubes

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Abstract:

Biochar is a carbon-rich substance which is derived from the carbonization of biomass at high temperatures. Due to the high carbon content and porous structure of the biochar, it has a variety of applications in adsorption, catalysts, medicine, cosmetics, agriculture, and biogas production. In this work, the biochar was produced from slow pyrolysis Prosopis Juliflora fuelwood at 600°C temperature with a heating rate of 10°C/min for 1 h residence time, and its potential application in carbon nanotube development through microwave irradiation has been explored. The proximate and ultimate analysis of the biochar was performed. The surface morphology of biochar was investigated through Force Emission Scanning Electron Microscopy with Energy dispersive X-ray (FESEM-EDX). The biochar yield from slow pyrolysis and the carbon percentage in biochar obtained 29.86% and 80.31%, respectively. The fixed carbon content in the feedstock was found 18.2% on a dry basis, and after pyrolysis at 600°C it increased to 85.12% in the biochar. The fuel ratio of the pyrolyzed biochar was evaluated 11.05, and the HHV was found 27.12 MJ/Kg. Due to the high carbon content of biochar, it was used as a precursor material for the development of carbon nanotubes (CNTs). Ferrocene as catalyst was mixed in half amount with respect to Prosopis Juliflora biochar to synthesize carbon nanotube. The microwave irradiation technique was used for the growth of CNTs. The synthesis experiment was conducted at three different temperatures, 80, 120, and 150°C, in the microwave reactor for 3 min residence time. The growth of CNTs was observed at 150°C only, which was identified by Transmission Electron Microscopy. The synthesized CNTs quality was also examined by FESEM-EDX and Raman spectroscopy.

Keywords: Biochar, Slow Pyrolysis, Prosopis Juliflora, Carbon nanotubes, Microwave irradiation

Characterization of Biochar Filled Polylactic Acid Biocomposites

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Abstract:

Cotton stalk is an agricultural side product and has limited economic value. Biochar was made from cotton stalk may be used as a potential reinforcement in polymeric materials and it can provide remarkable environmental and economic benefits. In this study, biochar reinforced polylactic acid (PLA) composite materials were manufactured and characterized. Biocomposites were obtained using twin screw extruder by adding different amounts of biochar powder (4, 8, and 10% wt.) into PLA. Melt flow index and reometry properties of the biocomposites were investigated. The results showed that the incorporation of biochar increased the melt flow index and decreased the rheological properties. This study demonstrated that biochar could be a filler for PLA depending on end use of the composite.

Keywords: Biocomposite, Biopolymer, Biochar

Synthesis of Biomass-Based Porous Carbon Materials for Supercapacitors

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Abstract:

Biomass is the most abundant and best utilized renewable carbon resource on earth. The direct conversion of biomass into porous carbon materials offers a promising approach to energy storage applications. Energy storage systems have become more important in recent years in order to address the concerns of fossil energy depletion and global warming. Supercapacitors, as one type of important energy storage device, have become attractive due to their longer cycle life, higher power densities, and shorter charging/discharging time compared to batteries, and exhibit great application potentials in power sources, electric vehicles, portable electronics, and so on. Porous carbon compounds have received considerable attention as electrode materials for supercapacitors. In this study, porous carbon materials were synthesized from waste tree barks. The synthesis procedure involves four steps; first refinement of the biomass where the precursor washed to remove all impurities and then cut into small pieces, then the hydrothermal step followed by the drying step where the supercritical CO_2 drying was used and the last carbonization step. XRD, SEM and FTIR techniques were used for the characterization of the synthesized materials. XRD patterns exhibits a sharp diffraction peak at about 26.6° which corresponds to the aromatic ring carbon. This is supported by the aromatic carbon bonds seen in the FTIR study. The surface appeared to be highly homogenous, according to SEM analyses. When compared to the literature, we may conclude that supercritical CO_2 drying contributes significantly to the homogenous surface. Characterization studies have shown that biomass-based porous carbon is promising for supercapacitor applications.

Keywords: Supercritical CO_2, Biowaste, Tree bark, Energy storage

Cultivation of Microalgae for Energy Purposes in Lake Van

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Abstract:

Lake Van, which retains the title of the largest lake in Türkiye as a surface area, also has its own eco-system and living diversity. Many rare creatures of different kinds live in the lake, which cannot be used for agricultural purposes due to its water with soda. There are many types of microalgae that have been identified in the studies conducted on this water source. Of these species, *Chlorealla vulgaris*, *euglena gracilis* in particular, two have a high fat storage capacity. The color of the water, which turns green from time to time, also proves the presence of microalgae. In recent years, it has been seen that microalgae are extremely conducive to energy production with the success of studies conducted on microalgae. In this study, the feasibility of microalgae cultivation for energy production in Lake Van is examined. A serious field of energy agriculture will be created by selecting microalgae suitable for Lake Van and determining the growing conditions. The production method in this sense can be the first and only example in the world. In addition, Lake Van does not receive much snow around it compared to other regions. Another positive approach in this area is the production efficiency of energy to be produced from solar energy with geothermal deposits in the region. With the use of all these energy sources, a 100% renewable and zero carbon emission energy models will be implemented. In addition, the facilities that will be installed will make an important contribution to both the national economy and the region, and thus the microalgae agriculture in Lake Van will fill an important gap in the energy needs of our country, which is dependent on oil externally.

Keywords: Energy agriculture, Micro-algae, Biomass energy

Production and Characterization of Biofuels from Different Algae Using Hydrothermal Liquefaction Process

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Abstract:

Recently, attention to biofuels has increased due to the environmental problems of fossil fuels. The hydrothermal liquefaction (HTL) process is one of the biofuel production method from algae. In this study, a comparison was performed between biocrudes produced from Sargassum angustifolium macroalgae and two Chlorella Vulgaris and Spirulina sp. microalgae at 350°C and 9%wt. biomass concentration. The biocrude yield from Sargassum, Chlorella, and Spirulina was 26.15, 55.8, and 56.32%wt., respectively. The results indicate that the higher lipid and protein content led to the higher biocrude yield. Hence the microalgae with a high amount of lipid and protein materials make the better feedstock for HTL process. The FTIR spectra of all biocrude indicate similar functional groups. However, the relative intensities of some bands varied for each type of biocrude. The results showed that the biocrudes contained the phenols, N-containing heterocyclic, fatty acid amides, aliphatic, cyclic alkyl groups compounds, ketones, esters, aldehydes, organic acids, alcohols, and aromatics. Moreover, all biocrudes had the lowest nitrogen content, which indicated the high quality of the products. The biocrude from Chlorella had the fewer heteroatoms in the range of 1200-1700 cm^{-1} than the other biocrudes due to the lower carbohydrate content of feedstock. Also, the 2900 cm^{-1} and 750 cm^{-1} bands of this biocrude had the higher intensity due to the higher lipid and protein content of the feed, which increased the Aromatics, Aliphatic and cyclic alkyl groups compounds, and increased the biocrude quality. Therefore, the chlorella led to the production of biocrude with the higher yield and quality and is more appropriate for this process.

Keywords: Biocrude, Biomass, HTL, Macroalgae, Microalgae

Liquefaction of Biomass by Hydrothermal Method and Use of Waste Process Water in Algae and Fungi Cultivation

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Abstract:

The aim of the study is to liquefy the biomass by hydrothermal process and to use the waste process water, which cannot be recovered, for growing algae and fungi. Thus, waste process water, which contains many different chemical compounds, was evaluated with a more environmentally friendly approach. In this study, it was tried to convert biomass into liquid products at temperatures of 250, 275, 300 and 325°C in the presence of metal powder catalysts (Cu, W, Fe). According to elemental analysis results, raw material CH, N, O ratios were 43.15%; 6.49%; 0.15%; and 50.21%, respectively. According to these results, HHV is 14.24 MJ/kg with the dulong formula. In addition, according to the result of component analysis of biomass; lignin: 20.81%, cellulose: 44.20%, hemicellulose: 16.50%, moisture: 6.96%, ash: 4.23% and soxhelet extractors: 7.30% by weight as dry raw material percentage. The liquid products obtained were analyzed by GC-MS, elemental analysis. In the other part of the study, the effects of the waste process water obtained at the end of the trials on mushroom and microalgea cultivation were examined. *Trichoderma virens* and *Trichoderma harzianum* were used as beneficial fungi, and *Verticilium dahlea* was used as pathogen. *Chlorella minutissima* microalga was used to examine the effect of waste process waters on algae growth. *Chlorella minutissima* microalgae were selected to be used in the experiments. This culture was obtained from the Algae Culture Collection at the University of Göttingen. In the other part of the study, wastewater containing environmentally harmful chemical compounds was used in mushroom cultivation. According to the results obtained, the chemical components in the wastewater supported the growth of beneficial fungi (*Trichoderma harzianum*, *Trichoderma virens*) and limited the growth of pathogens (*verticillium dahliae*) by suppressing them. In another part of the study, waste process waters can be used for the growth of *Chlorella minutissima* microalgae, but it has been determined that the most suitable process waters are Cu, W, Fe and process waters belonging to the experiments without catalyst.

Keywords: Hydrotherm liquefaction, Heterogeneous catalyst, Fungi, Algea

Evaluation of Hydrothermal Liquefaction Waste Process Water in the Cultivation of Fungi

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Abstract:

Biomass is converted into liquid, solid and gaseous products by physical, chemical and biological conversion methods. The hydrothermal liquefaction method seems to be more advantageous in terms of some properties such as high liquid product yield, environmentally friendly applications among the methods used to obtain products with high energy value from biomass. In this study, biomass (Amni visnaga) was tried to be liquefied by the HTL process in the presence of metal powder catalysts. The waste process water obtained at the end of the experiments was used for the cultivation of fungi. Chemical pesticides are used to control plant diseases in conventional agriculture and crop production. The widespread use of pesticides has raised concerns about their undesirable and harmful consequences for the environment and human health. To solve these problems, microbial biocontrol agents/biopesticides have emerged as a viable alternative to chemical pesticides. In the study, the effects of the wastewater generated at the end of the hydrothermal liquefaction process on *Trichoderma harzianum, Clonostachys* and *Rhizoctonia solani* were investigated. The wastewater that it is containing harmful chemical compounds for environmental, was used for the cultivation of fungi. Thus, both environmental pollution has been prevented and the cultivation of materials that can be used for agricultural activities has been ensured. Two beneficial fungi (*Trichoderma harzianum, Clonostachys*) and one pathogen (*Rhizoctonia solani*) for fungal cultivation were investigated. Acording to experimental results, it was determined that the waste waters supported the growth of beneficial fungi and inhibited the growth of pathogen.

Keywords: Ammi visnaga, Hyrothermal liquefaction, *Trichoderma harzianum*, *Clonostachys rose*, *Rhizoctonia solani*

Kinetic Evaluation of Hydrothermal Liquefaction Process

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Abstract:

Hydrothermal liquefaction (HTL) has become a promising technology for biofuel production from biomass. The reaction kinetic model of HTL of high-lipid microalgae was examined. In this model, aqueous phase, bio-oil, and gas phase were produced at high temperature and pressure. MATLAB was performed to solve the system of ordinary differential equations. The activation energies were calculated 38.50, 32.31, and 46.99 kJ/mol for the conversion of proteins, lipids, and carbohydrates to bio-oil, respectively. Moreover, the highest bio-oil yield (53.43 %wt) was calculated by the predictive model at 800 K in 2 min.

Keywords: Microalgae, Yield prediction, Hydrothermal liquefaction

Holistic Biorefinery Approach for the Valorization of Hemp Waste

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Abstract:

Due to the escalating climate crisis all over the world, mankind was forced to seek for environmentally friendly and renewable alternative energy resources. Biomass amongst other renewables is one of the most important renewable energy sources that can be converted into various products with thermochemical and biotechnological methods. In addition to the prominent advantages of each of biochemical and thermochemical conversion methods, there are disadvantages that limit the application of these processes and the formation of environmentally problematic waste end products. Integration of biochemical and thermochemical processes is a new and sustainable approach to overcome these disadvantages. According to the Regulation on Cannabis Cultivation and Control (2016), industrial hemp cultivation is expected to increase resulting in formation of higher amount of by-products. Therefore, hemp hurd, which is the residual part after fiber processing of hemp, has been gaining considerable interest in bioenergy sector in Türkiye. Within the scope of the study, hemp hurd was evaluated as a substrate for anaerobic fermentation and biogas formation in the first stage. In the framework of the integrated approach; the digestate formed as a by-product of anaerobic fermentation was converted into hydrochars by hydrothermal carbonization (HTC) to be used in gasification processes as solid fuel. The results clearly revealed the potential of hemp hurd as a substitute of energy crops. Anaerobic fermentation of hemp hurd produced biogas containing 60% CH_4. The residual of anaerobic fermentation, so-called digestate, was successfully converted to hydrochar with a high energy yield (up to 80%). Hydrochar obtained from digestate was then gasified in presence of steam at 850°C, yielding up to 1000 mL H_2/g hydrochar. Considering the energy requirements and the environmental problems created by wastes, this study provides a promising integrated approach to convert hemp hurd into biofuel with maximum waste valorisation and minimum waste production.

Keywords: Biochar, Biomethane, Hemp hurd, Waste management

Production of Bioethanol Using Macroalgal Biomass in Terms of Biorefinery: Operating Conditions and Techno-economic Analysis

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Abstract:

Macroalgae are third-generation biomass in the concept of biorefinery. Sargassum spp. found in the coasts of México country as an accumulated biomass that can be potentially use as an alternative for bioethanol production by their rich polysaccharides content, going through processes such pretreatment and enzymatic hydrolysis. Pretreatment and enzymatic hydrolysis are process to fractionate the algae biomass into the glucan become more accesible cellulose and the use of enzymes convert into their monomeric form to obtain fermentable sugars. The objective of the experimental section was to perform pretreatment and enzymatic hydrolysis of *Sargassum spp*. Sargassum was pretreated by hydrothermal reactor carried out at 190ºC for 50 min in a 300 mL reactor work volume and this used as substrate for enzymatic hydrolysis. The EH assays were performed in flasks with a work volume of 25 mL, with a cellulase/hemicellulase enzymes Cellic CTec 2 in combination with Cellic HTec 2 at a ratio of 1:1 and 1:2 (v/v) and solid loading rate was 10 FPU/g glucan. The resulting supernatant and glucose concentration was analyzed by HPLC to calculate saccharification yield. The hydrothermal pretreatment effect in pretreated biomass obatined was 34.89% of glucan in dry basis. In enzymatic hydrolysis a concentration of 0.69 g/L of glucose was liberated from (control) non-pretreated biomass, while enzymatically hydrolysed biomass with Cellic CTec 2 and Cellic HTec 2 (1:1 and 1:2) glucose concentrations increased with pretreated biomass obtained 34.28 g/L and 44.81 g/L, respectively corresponding to 99% saccharification yield. Conclusion. The combination of enzymes increases algae fiber porosity in the obtained of glucose. This increases the availability of cellulases to act in EH to obtain glucose from macroalgae *Sargassum spp*. This macroalgae can be considered a raw material in the development of third generation of biorefinery.

Keywords: Sargassum, Bioethanol, Biorefinery, Hydrothermal pretreatment

Pretreatment of Paddy Husk Used for Bioethanol Production with Deep Eutectic Solvent

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Abstract:

Bioethanol is one of the most useful biofuels that can be shown as an alternative to fossil fuels. It can be produced by different types of biomass. Biomass, which can be converted into bio-products, is shown as a renewable energy source that provides sustainable environmental and economic advantages. Agricultural wastes as lignocellulosic biomass have shown good potential for producing bioethanol. There are three main steps in the production of bioethanol from lignocellulosic biomass; pretreatment, hydrolysis and fermentation. Expanding the surface area of biomass, dissolving hemicellulose and/or lignin, and reducing the particle sizes of biomass are the most important goals of the pretreatment stage. There are various methods in the literature for the recovery of lignin in the aqueous phase. These pretreatments can be classified as physical, physico-chemical, chemical, biological and combined methods. Deep eutectic solvents (DES) are used widely in the pretreatment for lignocellulosic biomass. Because DESs have some advantages such as low vapor pressure, chemical and thermal stability, low melting point, adjustable physical and chemical properties, low toxicity and biodegradability. In this study, the deep eutectic solvent (DES) was used in the pretreatment of paddy husk. The effect of the molar ratio of ChCl/Boric acid (1:1, 1:2, 2:1) on lignin removal percentage was investigated. As a result, the highest lignin removal percentage was obtained as 8.5 % by using the molar ratio of 1:1.

Keywords: Renewable energy, Bio-product, Lignocellulosic biomass, Lignin removal

Determination of Feedstock Quality and Theoretical Bioethanol Potential of Switchgrass Cultivars in Marginal Areas

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Abstract:

This study was carried out under the conditions of Konya-Karapınar, which is one of the most marginal areas of Türkiye in terms of climate and soil conditions in 2018 year. Three switchgrass cultivars (Kanlow, Cave in rock, Shawnee) were used in the study and cellulose ratio, hemicellulose ratio, Acid Detergent Fiber (ADF) ratio, Neutral Detergent Fiber (NDF) ratio, Acid Detergent Lignin (ADL) ratio as biomass quality parameters and raw ash ratio parameters were investigated. The theoretical ethanol potential (TEP) was also calculated in the study. The study was carried out in three replications according to the randomized blocks experimental design, cellulose ratios varied between 35.0% (Shawnee)- 38.4% (Kanlow), hemicellulose ratios varied between 25.9% (Shawnee)- 30.4% (Kanlow), ADL ratios varied between 5.9% (Kanlow)- 7.9%. (Shawnee), ADF ratios varied between 42.9% (Shawnee)-44.3% (Kanlow), NDF ratios varied between 68.8% (Shawnee)-74.7% (Kanlow), raw ash ratios varied between 5.6% (Kanlow)-6.9% (Cave in rock) and TEP values varied between 443 L Mg^{-1}(Shawnee) - 501 L Mg^{-1} (Kanlow).In this study, which was carried out with switchgrass varieties, which is a new energy crop for Türkiye, it was determined that the lowland ecotype Kanlow variety has high feedstock quality and ethanol potential for 2nd generation cellulosic ethanol production.

Keywords: Climate change, Cellulosic ethanol, Drought, Energy plants

Isolation of Cellulose from *Panicum Virgatum* (Switchgrass) and its Conversion into Cellulose Acetate

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Abstract:

Raising on environmental problems concerned with conventional petroleum-based polymers had forced researchers to explore biopolymers from renewable resource especially crop plants. Among the biopolymers, cellulose acetate is one of the most commercially important cellulose derivatives, which is widely used as coatings, cigarette filters, textile fibres, filtration membranes, composites, and medical and pharmaceutical products. Due to their porous and flexible inner structures and fibrous shape, energy crops play a pivotal role in the development of biodegradable products, such as biopolymers. Therefore, this study aimed to evaluate the use of energy crops such as Panicum virgatum (switchgrass) in the synthesis of cellulose acetate due to its high cellulose content and high dry biomass yield per unit area. Alkali pre-treatment and acetylation techniques were applied to obtaining cellulose acetate from Panicum virgatum (switchgrass). The effects of pre-treatment conditions including alkali (NaOH) concentration (5, 7 and 10%, w/v) and temperatures (100-120-140°C) were investigated on the cellulose content. The process parameters were optimized using a response surface methodology based on the Central Composite Designs (CCD). From the CCD analysis, the optimized pre-treatment conditions were 10% NaOH at 121°C for 2 hours with maximal cellulose, minimal hemicellulose and lignin contents of 80% (w/w), 3.07% (w/w) and 4.01% (w/w) respectively. Cellulose acetate was produced by reacting cellulose with acetic anhydride and then performing a hydrolysis process in the presence of catalysts such as sulfuric acid in a two-stage acetylation process. Cellulose acetate is characterized by Fourier transform infrared spectroscopy (FTIR), thermogravimetric analyser (TGA), and degree of substitution (DS). The FTIR spectra showed the appearance of new bands which proved that acetylation occurred.

Keywords: Switchgrass, Energy crop, Cellulose acetate, Biopolymer

Systematic Assessment of Bio-Wastes Feedstock Availability for Bioenergy Production in Zimbabwe

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Abstract:

The energy demands in Zimbabwe have increased due to the rise in population size, industrialization and improvement in the country`s economy. To meet the energy demand, Zimbabwe has been importing energy yet all bio-waste resources are not utilized. The quantities of the bio-waste in the country are currently not known and the accurate estimation of the available bio-wastes plays a crucial role in the development of bioenergy technologies. Therefore, this study assessed the bio-wastes that are available for bioenergy generation in Zimbabwe as well as estimated the amount of energy that bio-waste can produce. Data on the yield for each biomass were obtained through an intensive search of the existing databases such as Food and Agricultural Organization, which was thereafter validated by the authenticated data from national and state level departments such as the Ministry of Lands, Agriculture, and Rural Resettlement as well as Ministry of Local Government, Public-Works, and National-Housing, universities, and research institutes. The information compiled included biomass from agriculture, municipal solid waste, livestock's dung and municipal sewage sludge. Forests were not considered due to the government policies which prohibit forests exploitations. The results showed that a total of 82.5 Gtons of bio-wastes are sustainably available producing a total of 892 PJ of energy which constitute ~42.3 % of the total energy required in Zimbabwe. Among the available bio-wastes, crop residues with ~82.1 Gtons produce the largest amount of energy ~790 PJ followed by animal dung ~99.1 PJ, then MSW ~1.5 PJ and lastly by MSS ~0.8 PJ.

Keywords: Bio-wastes quantities, Energy potential, Mathematical modelling, Bioenergy, Zimbabwe

Determination of Biomass Potential Areas Using Geographical Information Systems and Remote Sensing Techniques

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Abstract:

The depletion of fossil fuels and the need to reduce foreign dependency on energy resources make the use of renewable energy increasingly necessary. Biomass, which is an important renewable energy source, is an environmentally friendly organic fuel that can be obtained from the parts of agricultural, animal, industrial and urban organic wastes that cannot be brought into the economy. In order to understand the current trend in renewable energy, it is important to analyze the spatial variations and uses of resources. With the acceleration of changes and developments in technology in recent years, GIS and Remote Sensing methods contribute to the determination of renewable energy resource areas by making analyzes. Developed countries determine their bioenergy potential areas with geospatial techniques and data. This method requires extensive spatial information is a complex process and an advanced mapping method that enables applications such as the spatial distribution of biomass potential and suitable site selection to be determined more quickly. The purpose of this study, the use of Geographic Information Systems (GIS) is to investigate in applications such as questioning biomass resources and suitable site selection. Examples will be given by mentioning what stages such a study consists of, what data is needed and the analyzes that need to be made.

Keywords: Renewable energy, GIS, Biomass, Image Processing, Analyze

Biomass Supply Chain Network Design

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Abstract:

The need for energy in the world is increasing day by day, and accordingly, the decrease in energy resources have increased the studies on renewable energy resources. One of the most important renewable energy sources is biomass. The rate of utilization of biomass from renewable energy sources compared to other sources is lower in Türkiye. This paper addresses a biomass supply chain problem consisting of the production rates of different types of plants in according to the districts in Izmir. The problem is formulated as a mixed integer linear programming (MILP) model that incorporates the effect of environmental factors, transportation and production emission values, return of the waste to the facilities according to fertilization schedule, bio-facility storage, biomass and biofuel production capacities, solid content of biomass and water usage. The aim of the mathematical model is to minimize transportation, storage and production costs while determining the decision of the biomass facility locations to be opened, the amount of biomass shipped, processed and stored, the amount of biofuel produced and stored, the amount of fertilizer and the amount of water usage. In addition, a sensitivity analysis was conducted to provide foresight for the effective management of the entire supply chain.

Keywords: Biomass supply chain, Mixed integer linear programming, Fertilizer schedule

Determination of Technical Potential Existence of Biomass and Supply Chain Parameters

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Abstract:

The use and production of renewable energy sources have been the priority of global strategies to reduce environmental pollution and energy crises in the world. Biomass production is the most important in the production of renewable fuels. While collecting raw materials for the production of these fuels provides additional benefits such as reducing some undesired agro-forest fires, some environmental risks can be eliminated. In addition, with the sale of residual products other than food and feed, farmers can be provided with additional income and reduced costs in input costs. In this study, within the scope of TURKSTAT data and the study carried out in the region, a study was conducted on the use of 5 plants with potential biomass as an electrical energy source from 5 different provinces in the Eastern Mediterranean Region. The technical potential status of the biomass in the region was calculated as 2 810 005 tons/year by reducing it to 10% moisture content, and 8 360 MWh electrical energy equivalent was estimated according to the 65% efficiency level of the combustion boiler. In addition, some parameters of biomass in the supply chain were evaluated. Determining the workflow processes of fuels such as procurement, holding and storage within the scope of the supply chain during the year has been adopted as the second objective. This study, it is aimed to provide data on the region to the subject workers and decision-makers and to contribute to the literature.

Keywords: Field Crops, Electrical energy equivalent, Eastern Mediterranean region

Determination of Environmental Impacts with Life Cycle Assessment of Switchgrass Biomass

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Abstract:

Biofuels derived from biomass; it offers a clean, safe, sustainable and environmentally friendly use. One of the plants used in the production of biofuels is switchgrass. This plant, which is drought resistant and has the potential to grow in marginal areas, is defined as an energy plant. In this study, the environmental effects of switchgrass biomass produced to obtain bioethanol were determined and these effects were evaluated by life cycle assessment. Environmental impact categories are divided into 11 categories according to the CML 2001 method. As a result, it was determined that the production of switchgrass biomass caused the marine aquatic ecotoxicity with the highest environmental impact rate of 92.06% according to the life cycle impact category. Apart from this, the production of switchgrass biomass also has positive effects on the environment. These positive effects; terrestrial ecotoxicity was determined with a rate of -10.78% and human toxicity with a rate of -5.07%. As a result of these findings, it has been determined that the switchgrass plant is a phytoremediation plant. In addition, the global warming value was calculated as 0.240 kg CO_2-eq kgbiomass^{-1} (6382.32 kg CO_2-eq ha^{-1}). It has also been determined that irrigation and fertilizer applications in aquaculture adversely affect the environmental effects.

Keywords: Biomass, Biofuels, Global warming, Environment, *Panicum virgatum*

Determination of Environmental Impacts with Life Cycle Assessment of Sorghum Sudan Grass Hybrid Biomass

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Abstract:

Renewable energy sources are the most effective and cheapest method to combat climate change. Biomass, which is one of the renewable energy sources, is also one of the raw materials of biofuels. Sorghum sudan grass hybrid, which is drought resistant and has a short vegetation period, is one of these biomass sources. In this study, the environmental effects of sorghum sudan grass hybrid biomass produced to obtain bioethanol were determined. Environmental impacts were evaluated by life cycle assessment. Environmental impact categories are divided into 11 categories according to the CML 2001 method. As a result, it was determined that the production of sorghum & sudan grass hybrid biomass caused the marine aquatic ecotoxicity with the highest environmental impact rate of 79.21% according to the life cycle impact category. According to the life cycle interpretation, it was determined that it caused a global effect with a rate of 83.87%. In addition, the global warming value was calculated as 0.195 kg CO_2-eq $kg_{biomass}^{-1}$ (9728.16 kg CO_2-eq ha^{-1}). It has also been determined that irrigation and fertilizer applications in aquaculture adversely affect the environmental effects.

Keywords: Bioenergy, Biofuels, Global warming, Climate change, Energy crops

Determination of Yield and Technological Properties of Some Safflower Cultivars in Conditions Diyarbakır

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Abstract:

Safflower is one of the potential plants that used in biodiesel production. This study was carried out to determine the high yielding new safflower cultivars in Diyarbakır. Balcı, Remzibey 05, Dinçer, Olas and Linas cultivars were used as research materials in the experiment. The experiments were conducted in the trial field of "GAP International Agricultural Research and Educational Center" with randomized complete block design with three replications in production seasons of 2016 and 2017. Seeds were planted on 16.02.2016 and 25.01.2017. The parcels, were harvested mechanically for the seed yields in July. According to the findings of experiment; the cultivars plant height (108.2-119.0 cm), head number per plant (15.2-16.1), head diameter (2.09-2.22 cm), 1000 seed weight (34.8-39.6 g), seed yield (2015-2360 kg/ha) and oil content (26.6-34.6%) ranged between. Results of this study indicated that; Balcı cultivar in respect to yield and investigated agricultural characteristics can be grown in Diyarbakır conditions.

Keywords: Biodiesel, oil content, plant height, safflower, seed yield

Understanding Transport Routes of Xylan Polysaccharide to Plant Cell Walls

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Abstract:

Plant biomass is mainly constituted by cell walls. Plant cells that are differentiated from meristematic cells with different roles are surrounded by a cell wall containing complex polysaccharides. Cell wall is necessary for many cell functions and plays role in cell integrity, signal transduction, defense and maintenance of turgor pressure. The biomass is raw material for industrial products, food and biomaterials. Recently, there are increasing number of studies using biomass for bioenergy. However, there is still many unknowns regarding the synthesis and structure of the complex biomass. Therefore, studies that can help us better understand this complex structure are of high importance.Cellulose being one of the main components of cell wall is synthesized at the plasma membrane by cellulose synthase complexes and does not require transportation. Pectin and hemicelluloses are synthesized by enzymes located in Golgi apparatus. Therefore, they need to be transported to the plasma membrane. Even though this transport mechanism is very important, it is assessed as one of the least understood part of the endomembrane system. Here, we discuss how transportation of xylan as a hemicellulose to plant cell walls might occur.

Keywords: Biomass, Golgi apparatus, Hemicellulose, Cell wall, Xylan

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Determination of the Nutritional Effect of Sahara Dust on *Lemna minor* Living in Stagnant Waters

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Abstract:

This study, the powders brought from Southern Tunisia/Sahara Desert and the solution called “Fertile Water” prepared with water and *Lemna minor* samples taken from the lake in Hacettepe, Beytepe campus and the greenhouse in Ankara University Biology Department were used. L. minors has 24-40% protein, 4.4% fat, amino acids and high mineral content. Therefore, is the source of energy to feed aquarium creatures and poultry. A solution was prepared with soil and sterile distilled water to imitate the behavior of dust from the field in the cloud; Used for growing *L. minors* after standing in sunlight for about 120 minutes. The plants, which are the experimental material, were monitored for 21 days in containers containing " Fertile Water" solution prepared with Sahara dust and "Greenhouse Water", the natural environment water from which the samples were taken. The experiment was carried out with 3 replications and using 7 *L. minors* of equal size for each repetition. Average daily growth rate and increasing/yellowing leaf numbers were recorded in plants kept in a semi-controlled environment at 11-15 °C, 10 hours’ day/14 hours’ night cycle. As a result of the observations, it was determined that L. minors fed with " Fertile Water" solution showed a better growth of approximately 50% compared to greenhouse water; it was determined that leaf yellowing started 3 days later in this group. That's meant due to these findings, chlorophyll remained active for longer in the desert dust group, produced more energy or fixed more carbon sources.

Keywords: Sahara Dust, *Lemna minor*, Chlorophyll

Phytoremediation of Heavy Metals in Soil and Climate Change

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Abstract:

Soil, one of the most important components of the terrestrial ecosystem, plays an important role not only in food production but also in the protection of the environment, energy and biodiversity. With evolution of technology; mining, urban or industrial solid, liquid and gaseous wastes, the use of pesticides and artificial fertilizers, paint industry and exhaust gases have caused the release of excessive amounts of heavy metals to the nature. Heavy metal pollution in soil has become a worldwide environmental problem of interest to food safety. Changes and interactions cannot be noticed in a short time because the soil masks pollutant parameters by resisting toxic components. When chemical pollution is mentioned, metals and metalloids that have biologically toxic effects such as Cd, Hg, Ar, Pb and Cr come to mind. This pollution situation threatens organisms and human health through the food chain. Some heavy metals are carcinogenic, mutagenic, teratogenic and endocrine disruptors. For the solution of the problem, improvement with chemical, physical and biological methods is adopted. Phytoremediation is the use of plants and related soil microorganisms to reduce the concentrations or toxic effects of pollutants in the environment. In the method, which is a technological approach that provides on-site purification of pollutants; some plants belonging to five families are used, which absorb heavy metals from the soil, accumulate them at high levels in their tissues and neutralize them with various processes. Cleaning contaminated areas; it is a technique that is cheap, suitable for nature, and can be adopted by the public. It has been reported that some plant species are endemic to metal-dominated soils and can tolerate more than the optimum amount of heavy metals and other toxic components. In this study, the use of hyperaccumulator plants to purify the soil from heavy metals with phytoremediation techniques was investigated.

Keywords: Soil pollution, Hyperaccumulatory plants, Remediation

Ethanol Power with Carbon Capture, Utilization and Storage

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Abstract:

This study provides a new concept of negative emissions technology: the use of ethanol for power generation with carbon capture, utilization and storage (EPCCUS), as opposed to natural gas in conventional combined-cycle gas turbines. We carried out a global-scale lifecycle assessment and a local assessment of a thermopower station in Juiz de Fora, Brazil, which is a pioneering commercial facility to operate as a dual-fuel unit, through minor adaptations in its turbine system, although not having a carbon capture system yet. The assessment includes land use change effects, methane leakages, energy penalties, power stations with and without carbon capture from the flue gases, and the possibility of capturing CO2 emissions from fermentation tanks as well. EPCCUS builds on available technologies, providing major carbon removals and dispatchable power, while also increasing energy security. By simulating the use of an equivalent amount of ethanol currently produced worldwide (100 $GL.y^{-1}$), the net avoided and reduced emissions combined would range between 0.2 and 0.4 GtCO2e.y-1, displacing about 5% of the natural gas used for power generation globally. This would require a harvested area of approximately 16 Mha of sugarcane or 37 Mha of corn in single cropping, based on average crop yields. Similarly, while substituting 100% of natural gas, this reduction would range between 3.7 and 7.4 $GtCO2e.y^{-1}$, which are equivalent to 6.3% and 12.5% of the total greenhouse gas emissions of all sectors combined worldwide (59 $GtCO2e.y^{-1}$). However, the annual harvested area required to achieve this extreme mitigation scenario would be about 323 Mha of sugarcane or 733 Mha of corn, which could be reduced using lignocellulosic ethanol. Our cost estimates suggest that EPCCUS would be already viable in some market niches, especially in liquefied natural gas importing countries, but it would require major policy support to be sustainably developed at scale.

Keywords: EPCCUS, CCUS, Biofuels, Natural gas, Negative emissions technology

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Note: Preliminary results – a full version of this paper is under peer review (as of May 2022).

Determination of Biomass Priority Hybrid Renewable Energy Plants Potential Areas

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Abstract:

Urban and regional energy planning is important for defining sustainable development and post-carbon transition strategies. The integration of renewable energy sources is among the key strategies that can address climate change while accelerating the transition to a green economy. The variability problem of energy produced from renewable energy sources can be solved by providing resource diversity. Hybrid systems are widely used in many countries to ensure resource diversity. The fact that the production of the main sources of solar power plant and wind power plant is variable and intermittent, and its hybrid integration with biomass power plants with continuous production is an important alternative for the continuity of electricity production. The aim of the research is to determine the potential areas in the hybrid use of biomass energy, which has less variability problem in energy production, with wind and solar energy sources. The decision alternatives of the research include the counties located in the Statistical Regional Units Classification (NUTS) Level 2, TR21 Region. In this context, the evaluation criteria are average wind speed, number of windy days and wind power density for wind power plants, solar radiation time, total sunshine duration, snow-rain-dust conditions for solar power plants, amount of urban waste, amount of vegetable waste and amount of animal waste for biomass power plants. The mixed use of multi-criteria decision making methods in identifying potential areas was carried out in two stages. In the first stage, the CRITIC method, which is based on objective evaluation, was used to weight the criteria. In the second stage, evaluations were made with the VIKOR method, which is based on consensus in ordering the potential areas. The applied mixed method revealed that the most suitable districts for hybrid renewable energy potential areas with biomass priority are Kırklareli Center and Edirne Keşan district, respectively.

Keywords: Renewable energy, Biomass power plant, VIKOR method, CRITIC method

The Effect of Different Particle Sizes and Pelleting Molds on Physical-Mechanical and Thermal Parameters of Hazelnut Residue Fuel Pellets

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Abstract:

Biomass is an alternative energy source that can be used instead of fossil fuels. Biomass resources typically consist of forest industry residues, vineyard and garden residues, agricultural residues, animal residues and municipal residues. Biomass sources with low density and high moisture content in rough form are subjected to compression process to ensure transportation, storage and efficient combustion. Pelleting is one of the methods used to compress biomass resources with high moisture content, low density and heterogeneous structure.In this study, fuel pellets were produced by pelleting the agricultural residues of hazelnut husk obtained in 4 different grinding fineness (2mm, 4mm, 6mm, 8mm) in two different pelletizing molds (6mm, 8mm hole diameter). Some physical-mechanical and thermal parameters of the produced pellets were analyzed and the suitability of this agricultural residue was investigated along with the effect of different die diameters on the pellet parameters.The best results for physical-mechanical parameters were obtained at 6 mm particle size in 6 mm die. Pellet bulk density, mechanical duration and firmness values were 667.60 kg.m^{-3}, 94.75% and 552.98 N, respectively. As for the thermal parameters the best results were; for the ash content 9.78% at pellets with 6 mm particle size and produced in 8 mm pellet mold. For the calorific value, 17.77 MJ.kg-1 (4243.50 cal.g^{-1}) at pellets with 8 mm particle size and produced in 6 mm pellet mold. Minimum pellet moisture content was 7.32% at pellets produced in 6 mm pellet mold with 6 mm particle size.

Keywords: Biomass, Pellet, Mold, Hazelnut

Exploring the Potential Viability of Transforming Sawdust Waste into Wood and Charcoal Briquettes: Transitional Study Results of Waste Valorization in Manicaland Region

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Abstract:

This transitional study is a part of a whole project that seeks to produce wood and charcoal briquettes from the abundant sawdust and banana waste in Manicaland, Zimbabwe. Initial studies using a simple piston press proved the technical viability of using banana waste forms as binders, with combinations of the banana stem pith and ripe banana (RB) waste; fruit-bunch-stem, pith, green banana (GB) and RB performing the best. These best two formulations (with specified ratios) were then used in a more rugged manual and gravity aided machine with a heavy load, delivering a force of 0.75kN. The effective pressure on each of the 16 holes of `5.5cm diameter was 0.32MPa resulting in a denser product 685-863kg/m^{3}compared to 380kg/m3 in the piston press. The other interesting findings were the increase in quality, especially in heating rate, density (bulk and energy) and durability after using the gravity aided manual system. Comparisons were made for briquettes of the same formulation. We have also tested yet another formulation using rotten banana waste since this would be a common waste in fruits market and at plantations, finding comparable results to the previous formulation. Preliminary tests on carbonization have also been promising, showing the horizontal profile as better than the vertical reactor profile at the same carbonization temperature range (600-750°C). Initial tests on the briquettes produced using the horizontal profile char, using the best formulation and manual machine, gave briquettes with a calorific value of 24.575MJ/kg which is comparable to low heat value coal.

Keywords: Briquette, Banana waste, Sawdust waste

The Effect of Wood Based Fuels (Pellet and Briquette) on Global Warming and Environment

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Abstract:

Energy is at the center of the world's most critical environmental and economic development problems. According to the International Energy Agency (IEA), the world's primary energy demand, which is 14 billion tons of oil equivalent (TOE), is expected to reach 20.3 billion TOE levels with an increase of 45% in the next 20 years. As of 2016, 81% of the world's primary energy resources are fossil fuels. It is estimated that this figure will reach 79% in 2040. The effects of fossil fuels on climate, health and energy security encourage the conversion to green energy. The sustainable supplies of wood raw material is recognized as a critical resource for tackling climate change and securing energy demand in the global challenge by the IEA, the International Renewable Energy Agency and the Intergovernmental Panel on Climate Change. Wood pellets and briquettes are produced from biomass, and in recent years research has focused on different lignocellulose-based energy sources and ways to increase efficiency. Wood pellet becomes an increasingly crucial alternative fuel for homes, small furnaces and industries with competitive cost and carbon neutrality in producing heat and electricity versus oil or natural gas. Global pellet demand is increased significantly and is expected to reach 100 million tons in 2027.The main features that determine the quality of pellets are humidity, energy value and their effect on environmental pollution. Although wood pellets reduce greenhouse gas emissions compared to fossil fuels, the life cycle of the pellet, from raw material harvesting to ash removal, generates pollution. Wood smoke may contain more than 200 organic compounds that cause acute and chronic health effects and pollute the atmosphere. In this study, human and environmental impacts will be examined, taking into account the increasing demand for bioenergy and the key roles of woody pellets in renewable energy-related environmental policies.

Keywords: Biomass, Bioenergy, Climate Change, Wood-Based fuels, Pellet

New Sights in the Production of Biodiesel from Waste Cooking Oil Using CaO-derived from Waste Oyster shell as Heterogeneous Catalyst

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Abstract:

The production of cost effective biodiesel fuel (Fatty acid methyl ester (FAME)) from waste cooking oil (WCO) using CaO-nanoparticles derived from waste Oyster as a Heterogeneous Catalyst was investigated. The CaO nanoparticles were produced from the Oyster shell using the modified sol-gel method. A Catalytic transesterification process furnished 98.2% yield biodiesel, acid number (0.48mg KOH/g) and water and sediment (0.032vol.%) at temperature 60°C, reaction time 6hrs, 9:1 methanol to oil ratio and 1.5% catalyst dose. Physiochemical properties obtained for the produced biodiesel are within the ASTM standards. It was established that waste Oyster shell can be used as heterogeneous catalyst obtained for transesterification.

Keywords: Heterogeneous catalyst, Waste cooking oil, Oyster shell, Biodiesel properties

Improving the Quality of Biodiesel Fuel Derived from Bioresources

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Abstract:

Biodiesel is considered one of the most effective, alternatives, environmentally friendly, and carbon-neutral alternative biofuels. Produced from renewable bioresources, biodiesel is a clean, renewable, alternative to common petroleum fuel, and the production of biodiesel has been steadily developing and gaining more share in the fuel industry worldwide.The presented work is aimed at analyzing the quality of biodiesel fuel received from Used Cooking Oil (UCO), the waste product from the food industry, through the process of esterification. We have promoted an improved composition of biodiesel – the nano-biodiesel, prepared on the base of B100 produced by the plant Biodiesel Georgia LLC. The nano-biodiesel, while meeting the demands of EN 14105, ASTM D 6751, and EN 590 standards, significantly increased the long-term storage and quality stability of biodiesel fuel. The individual hydrocarbons of biodiesel fuel have been studied and identified through liquid chromatography and the functional groups of the fuel were analyzed using a Fourier IR spectrometer. The results have shown that the pure biofuel i.e. B100, produced from bioresources as well as its blends with conventional diesel fuel, B5, B10, B20, maintained the highest quality for 3+ years, fully meeting the demands of international standards, therefore they can be used in almost all kinds of internal combustion diesel-type engines serving as an alternative, renewable, and reliable fuel.

Keywords: Bio-fuel, quality, Bio-resources, Nano-composition

Biodiesel Potential from Used Cooking Oil (UCO) in Bitlis- Türkiye

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Abstract:

The increasing use of fossil fuels and the proliferation of renewable energy sources lead to the search for new energy sources. In this regard, biodiesel is highly significant in both low air emission and renewable energy sources. Biodiesel is indeed crucial for our country, Türkiye, regarding its raw characteristic of vegetable oil. Moreover, it is a non-toxic, easily degradable and environmentally friendly fuel, and this composition makes biodiesel available to be used in conventional diesel engines without any modifications. From this perspective, the economic contribution of biodiesel production to the Eastern Anatolia region of Türkiye in addition to the availability of recycling of used waste oils (used Sunflower oil, used Palm oil, etc.) in the Bitlis region of Türkiye has been researched. As a result of the experiments carried out with used cooking oil (UCO) taken from fast-food restaurants, 160 ml of biodiesel was reproduced in a laboratory environment. Within the process, 200 ml of waste vegetable oil is used along with methanol and sodium hydroxide through transesterification. What is even more crucial, 80-85% biodiesel was produced from UCO, and the remaining by-product emerged as crude glycerin. In the light of the data presented, the monthly recycling of UCO from the Bitlis/Türkiye region was calculated, and it was estimated that approximately 400 liters of biodiesel could be produced from the UCO collected per month.

Keywords: Bitlis waste oil recycle, Bitlis biodiesel production, Vegetable oil fuel, Waste utilization

Kinetic Studies of Biodiesel Production Catalyzed by Magnetic Palm Kernel Shell-Potassium Hydroxide

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Abstract:

Biodiesel was prepared by transesterification process using heterogeneous catalysts has received a lot of interest lately as a sustainable source of biofuel. Hence, there is a need to study a generalized reaction kinetic model that can be used for all the reactions involved in biodiesel production. This study produces biodiesel by transesterifying palm oil using magnetic palm kernel shell-potassium hydroxide. FTIR analysis showed the presence of Fe-O and –OH stretching, which indicated the successful attachment of the active site. The maximum biodiesel yield, 95.78%, was obtained when reaction temperature and time were 55°C and 2 hours, respectively. The kinetics study shows that the activation energy is 36.075 kJ/mol for the pseudo-first-order kinetics transesterification reaction.

Keywords: Biodiesel, Kinetic studies, Palm kernel shell-KOH

Influence of Esterification and Neutralization in the Production of Biodiesel: A Comparison Study

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Abstract:

The challenges of emission of greenhouse gases (GHG) have triggered researchers all over the world to come up with alternative fuel sources that reduce greenhouse gas emissions. One of such alternatives is Biodiesel production from Neem and Jatropha seed oils. However, the presence of Free Fatty Acids (FFA) in the oil obtained from these seeds reduces the yield of produced biodiesel. Two common methods proposed in previous literature to reduce the free fatty acids value are the Esterification and Neutralisation methods. This study focused on comparing the esterification and neutralization method as a preliminary stage of biodiesel production from Neem seed and Jatropha seed oils, in an effort to advance biodiesel production in terms of yield from its process. The Neem and Jatropha seed oils were esterified with concentrated Sulphuric acid and were tested for free fatty acids. Both seed oils were then refined via the degumming process, after which they were neutralized with sodium hydroxide. The study shows the neutralization method with a yield of 96 % and 94 % for Neem seed oil and Jatropha seed oil respectively to be more efficient than the Esterification method which produced a yield of 93.2 % for Neem seed oil and 91.4% for Jatropha seed oil.

Keywords: Biofuel, Environment, Yield, Green chemistry, Biomass

The Groundwork for Bioenergy Planning in Denizli: Forecasting and Spatial Analysis

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Abstract:

Increasing population and industrial activities lead to drastic rise in global energy demand. Today, the most prominent source to compensate energy need is fossil fuels which may cause environmental problems constituting acid rains and emissions. Therefore, there is an energy transition from fossil fuels to zero-emission renewable energy sources all over the world. Efficient conversion technologies, incentives related to usage of renewable sources and green energy policies have been introduced to facilitate this transition. There is also substantial need for effective planning of renewable energy systems. To deal with sustainable energy planning problem, this study proposes a two-step approach focusing on estimating available biomass sources and determining suitable locations for biogas facilities. The proposed approach starts with forecasting biomass resources precisely with minimum error rate using an artificial intelligence-based method, support vector regression. Then, using geographic information systems and a multi criteria decision making technique, Decision Making Trial and Evaluation Laboratory (DEMATEL), suitable points for biogas facilities have been determined. The integrated framework has been applied in Denizli province where agricultural residues and animal wastes of the area have been used as biomass feedstocks. As a result, five-year forecasts of agricultural residues and animal wastes and total sixteen suitable points for facility siting have been determined. The proposed methodology can improve the efficiency of forecasting biomass raw materials and the precision of locating biogas plants.

Keywords: Biomass forecasting, Facility siting, Support vector regression, Geographic information systems, Multi-criteria decision making

A Geographic Information Systems (GIS) - Based Decision Support System for Siting of the Biomass Power Plants - A Case Study for Bergama

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Abstract:

The energy and agriculture sectors, having the largest share of greenhouse gas emissions, need a rapid transformation to achieve climate targets. The low-carbon energy supply by renewable energy and the circular agriculture a vision for sustainability will form the basis of these transformations. At this point, biomass energy plants, which play a crucial role, are the only technology that will enable the decarbonisation of the energy sector and the transition of agriculture to a circular agriculture model and establish a symbiosis relationship between the two sectors. The net biomass potential of Türkiye has not been fully revealed. As a result of various approaches, Türkiye is one of the countries with the largest biomass potential in the world. Despite this potential, the installed power capacity for electricity generation from biomass constitutes only 1.8% of the total installed power capacity. The main reason is that biomass power plants cannot plan with a one-dimensional approach like other energy and renewable energy plants. Biomass energy conversion plant should be made with a multidimensional planning approach such as evaluating raw materials and resources, determining output products (excess heat, digested, etc.), deciding suitable biomass energy conversion technology, and legal processes during the planning also operation phases. In addition, it should be designed to establish a circular structure in the region where it will be applied. In order to make these plans, a decision support structure that can analyze all dimensions at the upper scale is needed. This study evaluates raw material quantity, property and spatial, energy conversion method of biomass, and site selection dimensions in the decision support system, which is developed based on geographic information systems (GIS). Bergama district of İzmir province was chosen as the case study.

Keywords: Biomass, Renewable energy, GIS

Spatial Modelling Tools to Identify Potential Bioenergy Hotspots for Deployment in UK

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Abstract:

Committee on Climate Change recommended that the UK should aim to be net zero on all greenhouse gases by 2050 as part of the 2016 Paris Agreement to keep global warming under 2 degrees. Getting to net zero is technically feasible but highly challenging. Bioenergy from dedicated crops or biological waste streams is widely recognized as a key tool in can help to achieve UK net zero target. The supply of both these resource streams, however, have a geographical component, requiring an understanding of the spatial distribution and constraints of supply. For bioenergy crops here is an urgent need to develop better landscape decision tools keeping in view the biodiversity and food security. Whilst the waste streams, challenges are around quantification of the future availability of food and garden waste and energy recovery from waste. Within the Supergen Bioenergy Hub we have seeked to address these challenges utilising spatial modelling tools to support land use decision-making. Facilitating evidencebased decisions through research collaboration with policymakers, industry and research institute partners, and identifying hotspots for bioenergy development or deployment throughout the UK.

Keywords: Bioenergy, Climate Change, Net Zero

Evaluation of Biomass Gasification Plants in the view of Their Products and Their Technology Readiness Level (TRL)

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Abstract:

The increasing demand for energy and the negative effects of climate change have led us to rethink our resources for energy supply. Therefore, bioenergy has gained importance in the last decades. Biomass is one of the renewable energy sources that can be converted into biofuel, chemicals, electricity, and heat using thermochemical processes. In terms of producing diversified products, biomass gasification plays a key role in improving both the economy and the environment. Even though biomass gasification is a very well-researched study and a mature technology, it still needs further development from biomass handling to the end of the process. In this study, biomass gasification plants and their process products were investigated worldwide. Their level of technological development was evaluated for the entire process. In order to create a bioeconomy, Türkiye's biomass potential and biomass power plants were evaluated. The targets set for biomass power plants and the status achieved so far were evaluated.

Keywords: Bioeconomy, Biomass, Gasification, Technology maturity

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Biogas Awareness of Livestock Farm: The Example of Çanakkale Province

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Abstract:

As long as humanity exists, energy will always be needed. There are two sources in meeting the energy need. These sources are fossil energy sources and renewable energy sources. Renewable energies consist of energies that can feed themselves. Renewable energy consists of renewable and natural processes (heat, water, light and hydrogen etc.). Waste materials are produced as a result of human production and consumption. The majority of these vast are organic based wastes. Organic based wastes have a great energy potential. This potential can be evaluated with bioenergy production. Türkiye is a rich country in bioenergy potential. Biogas, which is one of the renewable energy types, provides waste recovery. Bioenergy is environmentally friendly. In addition, bioenergy is an inexpensive source of energy and fertilizer. As a result of biogas production, the smell that can be found in animal fertilizer disappear. The wastes processed during biogas production do not disappear. These wastes turn into a valuable organic fertilizer. This study was made in Örtülüce village (Biga district), where livestock enterprises are the most in Çanakkale. With the survey study, the awareness of livestock farms about biogas energy was examined. According to the findings, 97.3% of the farmers have heard the biogas before. 17.8% of farmers know that biogas power generation facilities pollute the environment. 25.3% of the farmers know that only electricity is produced from biogas.

Keywords: Livestock farms, Energy, Biogas, Organic waste, Çanakkale

Affordable Energy Generation for The Small Producers: From Biogas to Greenhouse

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Abstract:

In recent years, the increase in energy costs has adversely affected agricultural producers. In particular, energy needed in greenhouse cultivation has an important place in agricultural input costs. On the other hand, climate change issues necessitate environmentally friendly agricultural practices for less fossil energy use and less pollution in production. From this point of view, biogas not only meets the energy need for agricultural production in rural areas, but also contributes to environmentally friendly practices with the treatment of waste. However, today the investment costs of biogas plants are quite high. It is not financially possible for each small producer to invest in these facilities. One of the objectives of this study is to enable small producers to take advantage of biogas and to contribute to reduce input costs in agricultural production. In our country, animal breeding and plant production are generally carried out together in small family farms. In recent years, greenhouse activities have been intensely preferred by these producers due to the easy adaptation of the developing technology, the diversity in production and the high product marketing opportunities. In this case, it is necessary to solve the producer's high energy cost problem, who wants to get a family income from agricultural production with small investments. In this study, it was tried to determine the proper biogas plants that will provide the energy requirements for heating and other mechanization in greenhouses, by targeting small-scale family farms. Energy requirements, minimum livestock capacities and biogas facility costs were calculated in greenhouses with different types and characteristics in selected small-scale family farms during the conditions of Ankara. The use of clean energy can both reduce input costs in agricultural production and prevent environmental pollution. Thus, it will be possible to reduce the negative effects of climate change starting from point source pollutants.

Keywords: Bioenergy, Waste, Agriculture, Livestock, Methane

Phytoremediation and Bioenergy

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Abstract:

Phytoremediation (phytoextraction, phytotransformation, phytostabilization, phytodegradation, rhizofiltration and phytovolatilization) is an appealing strategy for cleaning polluted soils. Among these pollutants, organic and inorganic contaminants such as permanent organic pollutants (POPs), polycyclic aromatic hydrocarbons (PAHs), atrazine, chromium (Cr), copper (Cu), cadmium (Cd), lead (Pb), nickel (Ni), mercury (Hg), and zinc (Zn) have attracted global attention due to their negative effects on human health and terrestrial ecosystems. On the other hand, the negative impacts of fossil fuel-based energy use have exacerbated concerns over a high level of air, water, and land pollution that an alternative energy source becomes ever more critical along with efficient remediation measures to recover the situation. At the same time, many annual and perennial energy crops including corn, castor oil, canola, jatropha, wild artichoke, jojoba, miscanthus, poplar, eucalyptus, cotton, sunflower, sugarcane, sugar beet, soybean, branched millet, kenaf, and millet could be cultivated on these lands for bioenergy production to achieve economic, social, and environmental sustainability because contaminated lands are not suitable for agricultural production. In the relationship between phytoremediation and energy, energy crops can be transformed into biofuels including biogas, biochar, syngas and bio-oil with the biomass conversion methods mentioned. In this way, energy crops can play a role in embedding themselves in global energy policies as they provide a sustainable energy system alongside other environmental services such as pollutant management and waste recycling.

Keywords: Biofuel, Energy crops, Sustainability, Pollution, Environment

Generating Economic Value from City Waste and Marketing of Biomass

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Abstract:

Today, the need for energy is increasing day by day and mankind is turning to bioenergy sources. City waste is a source of bioenergy and these wastes are not adequately marketed. The conversion of city waste into energy and marketing as biomass will contribute to keeping cities clean as a habitat. The emission standards of large cities reach dangerous levels for human health. Aware of this situation, cities are building facilities such as waste processing and waste gas. While generating energy from wastes, it is ensured that the city remains clean, and on the other hand, it contributes to meeting the energy needs of human beings. This study focuses on the conversion of city waste into energy and marketing as a source of bioenergy. Cities need to grow decently, contribute to employment and evaluate waste in the name of employment and economy for sustainable city. Bioenergy sources are increasingly important and biomass trade is being carried out that exceeds the borders of the city and country. Biomass trading is also an opportunity to evaluate vegetable wastes that have not yet gained economic value in and around the city. In this study, the literature has been examined and observations related to city wastes in Sinop province and its districts and vegetable wastes in Gökırmak and Kızılırmak deposits are included. The findings show that more research and studies on bioenergy resources should be done and marketed.

Keywords: Marketing, City marketing, Biomass, Waste, Energy

Predictive Modeling for Paper Price Using Artificial Neural Network with Levenberg Optimization

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Abstract:

One of the most used items by humans is paper. Although inflation appears to be the cause of recent price fluctuations in products and commodities, supply and demand shocks continue to have a stronger impact. Aim of the study is to predict the price of paper by using various commodity prices in machine learning model. This study applies a Levenberg optimization-based backpropagation neural network method to forecast pulp prices. In the developed artificial neural network model, there are 4 inputs (gold prices, Brent oil prices, timber prices, and the world population) in the input layer and one output (pulp price) in the output layer of the network. In addition, the network has two hidden layers with 16 and 4 artificial neurons, respectively. Our results show the impact of commodity prices, including gold, oil, and timber prices on pulp prices. In addition, it has been shown that population is an important parameter in the formation of prices of basic products such as paper. As a result of this study, we have created an exemplary model for pulp prices.

Keywords: Deep learning, Pulp price, Back propagation, Levenberg model, Commodity

The Relationship between Sustainable Development Index and Energy Resources: The Case of Türkiye

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Abstract:

The sustainable development index (SDI) was developed by taking into account the criticisms that the Human Development Index (HDI) does not take into account ecological impacts by Hickel (2020). Countries with a high SDI value are interpreted as countries that achieve human development with the most negligible environmental impact. Türkiye ranks 49th in the world in the SDI ranking with an index value of 0.739. The primary purpose of this study is to reveal the relationship between Türkiye's Sustainable Development Index value and the energy sources in the country. In the research, an answer was sought to the question of which sources Türkiye should obtain the energy it needs to increase its SDI value. The SDI index values used in the research were obtained from the website https://www.sustainabledevelopmentindex.org/, and the shares of the produced energy in Türkiye according to its sources were obtained from the databases of the Turkish Statistical Institute and cover the years 1990-2019. In the regression analysis, the SDI index was the dependent variable, and the shares of renewable energy, Coal, Liquid fuels, Natural Gas, and Hydraulic energy sources were the explanatory variable. The R^2 value of the model is 0.874, and the independent variables predict 87.4% of the changes in the dependent variable. A one-unit increase in the produced energy using renewable resources and natural gas in Türkiye increases the SDI value by 0.095 and 0.192 units. A one-unit increase in the produced energy using liquid fuels reduces Türkiye's SDI value by 0.089 units. Türkiye needs to obtain the energy it needs from renewable energy sources in the process of both human and environmentally sustainable development. In addition, increasing the share of renewable and natural gas resources in energy production will carry Türkiye to rank high in the world on the sustainable development index.

Keywords: Sustainable development, Energy resources, Renewable energy, Türkiye

POSTER PRESENTATIONS

Calculation of Bioethanol Production Yield of Some Agricultural Residues

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Abstract:

As in the world, agricultural sector produces huge amount of waste material in our country. Although a part of these wastes produced as a result of agricultural production is evaluated as animal feed; the other part (such as hazelnut husk and tea wastes) is not used. The removal of these wastes causes not only additional charge but also environmental problems. The aim of this study is to determine the bioethanol efficiencies of agricultural wastes (corn stalk, cotton stalk, sugar beet leaves, wheat stalk, sunflower stalk, paddy hull, paddy stalk, hazelnut husk, tea powder and olive wastes) occurred in consequence of plant production activities in Türkiye. For that purpose, after obtaining the materials and undergoing various physical processes (crushing, grinding, etc.), cellulose and hemicellulose contents of the materials were determined by NDF, ADF and ADL analyzes, first. Secondly, by using the conversion rates of cellulose and hemicellulose to bioethanol, the amount of bioethanol used as fuel to be obtained from 1 ton of raw material was calculated as L. According to the data obtained, the highest and the lowest amount of bioethanol used as fuel were obtained from wheat stalk (221.2 L/ton raw material) and sugar beet leaves (71.2 L/raw material), respectively.

Keywords: Agricultural Waste, Lignocellulose, Tea Wastes, Biofuel

Effects of Binder Concentrations and Soaking Time On Performance Characteristics of Briquettes Produced from Fermented *Gmelina Arborea* (Roxb) Sawdust

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Abstract:

Appropriate technological solutions to the improvement of undesirable characteristics of low-density briquettes such as smokiness, excessive yellow flame etc. through feedstock pretreatment before densification and binder concentration could proffer an attractive solution which this study investigate. Fermented sawdust of Gmelina arborea at four soaking time of 12hrs, 24hrs, 36hrs and 48hrs and used print paper (UPP) binder at 10, 20, 30, 40, 50 % (w/w) concentrations to produce briquettes which were statistically characterized at $p< 0.05$ significance levels. From the results, particle density of fermented briquettes (158.0 – 165.0) kg/m^3 at different soaking times were slightly higher than the untreated G. arborea, 159.0 kg/m^3 at 9.41% MC. The proximate analysis results revealed that volatile matter, ash, fixed carbon and heating value of untreated sawdust (72.93, 2.19, 17.10, and 17.38) % were not significantly different from fermented sawdust samples. The briquettes produced are durable and has unit densities 2-3 times higher than loose biomass. Statistical analysis showed the interactive effects of binders, binder concentration and treatment conditions on briquettes performance. There was a strong significant positive correlations between test variables and densities for fermented briquettes of same binder and concentration, which suggested that the effects of different binders were less significant at ($p < 0.05$) on the untreated briquettes. Increase in binder concentration positively enhanced the combustion characteristics of fermented briquettes.

Keywords: Gmelina arborea, Briquettes, Fermentation, Used print paper, Binder

Kinetic Studies on the Catalytic Co-Pyrolysis Palm Kernel Shell and Surgical Face Mask Waste Mixtures using Kissinger-Akahira-Sunose (KAS) Method

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Abstract:

A thermogravimetric analyzer (EXSTAR TG/DTA 6300) was utilized to investigate the kinetic parameters and thermal behavior of palm kernel shell (PKS) biomass and surgical face mask (SGM) with and without powdered Al_2O_3 catalyst. The pyrolysis process was carried out under temperatures between 323 K to 1173 K, with an atmosphere of inert nitrogen injected at a flowrate of 100 mL.min^{-1} for the complete removal of unwanted gas compositions. Four different heating rates of 10, 20, 30 and 50 K min^{-1} were employed in this study. There are different techniques exist for analyzing solid-state reactions kinetics, and are usually classified into two main categories: Model-free and Model-fitting methods. Model-fitting techniques have been widely used in the analysis of solid-state kinetics and have showed an excellent fit to experimental data however it is not considered to be suitable for non-isothermal conditions. In this work, iso-conversional methods of Kissinger-Akahira-Sunose (KAS) is used to analyze the thermal behavior and kinetic data of PKS/SGM Mixture with and without Al2O3 catalyst. Experimental results showed that the R^2>95% with average activation energy (EA) and pre-exponential factor (A) values of 10.216 kJ.mol^{-1} and 4.202 x 107 min^{-1} respectively for 0.8wt% SGM, 0.2wt% PKS samples. The 0.2wt% SGM, 0.8wt% PKS samples have a value of 5.011x106 min^{-1} and an EA value of 9.829 kJ.mol^{-1} for the KAS model. With the presence of Al2O3 powdered catalyst, the values of EA and A for 0.8wt % SGM, 0.2wt% PKS samples are 10.031 kJ.mol-1 and 6.754x106 min-1 respectively and the 0.2wt% SGM, 0.8wt% PKS w/Al_2O_3 catalyst showed an EA and A of 10.10 kJ.mol^{-1} and 7.066x106 min^{-1}, respectively.

Keywords: Co-Pyrolysis, Catalytic, Kissinger-Akahira-Sunose, Palm kernel shell, Surgical mask waste

The Renewable Energy Cooperativeness in Management of Bioenergy as a Renewable Energy

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Abstract:

Today, the increasing population, industrialization and global competition increase the demand for energy day by day. However, the limited number of fossil fuels that meet the energy demand in the world and the damage they cause to the environment affect the whole world deeply and alternative solutions are sought. The first thing that comes to mind in solving the problem is, of course, renewable energy sources and being able to benefit from these sources effectively. However, the understanding of both the public and the monopolistic private sector is also considered as a problem in itself in the management of the generation, transmission and distribution of renewable energy. In short, the security and sustainability of renewable energy supply is expressed as a problem in itself. The rural area relationship of a renewable energy source such as bioenergy, its ties with agriculture and the environment may lead to the development of a cooperative idea in this area as well. In this study, it is aimed to deal with the phenomenon of cooperatives in various aspects in the management of the supply and demand of bioenergy as a renewable energy source in the world in general. In the study, the infrastructure of the study was created by giving examples of renewable energy cooperatives in the world and their application areas.

Keywords: Bioenergy, Cooperatives, Renewable energy, Renewable energy cooperatives

Hydrothermal Process On *Spirulina Platensis* to Evaluate the Obtaining of Carbohydrates and Proteins

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Abstract:

Hydrothermal process is a promising technology for a microalgae biorefinery since this technology takes advantage of the moisture content in microalgal biomass and the water in culture medium to break down the cell walls and releasing the biocompounds inside microalgae biomass. Spirulina platensis was cultured in synthetic wastewater with an air flux of 373 ml/min, a light intensity of 72 umol/m2 s, and at room temperature. It was harvested on 16 days and its final concentration biomass in culture was of 1.558 g/L. The hydrothermal hydrolysis of spirulina platensis was made at 120, 140, 160 °C by 15, 30, 45, and 60 min. The thermal degradation kinetic shows that the higher carbohydrates concentration was obtained at 140 °C on 30 min (316.80 mg/L) and the higher proteins concentration was obtained 120 °C on 30 min (215 mg/L). These results reveal that hydrothermal treatment is a promising technology to recovery value compounds to the inside non-edible microalgae biomass to produce biofuels.

Keywords: Renewable energy, Microalgae, Biofuels

Wastewater Biorefinery: New Generation Wastewater Treatment Plant

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Abstract:

There is a need to develop sustainable technologies to ensure a continuous supply of food, clean water and energy because of The ever-increasing human population, food, energy and water needs and various pollutants are the biggest threats to the environment and humanity. On the other hand wastes generated as a result of human activities have the potential to be converted into raw materials and energy. However, this potential shows up depending on the selection of the right technology and the appropriate process, the type and generation of waste and the desired economies of scale. Therefore, the concept of biorefinery has emerged to recover energy and produce various value-added products. While the amount of final waste is minimized with the biorefinery, the biomass contained in the waste is used as a raw material source for the production of a sustainable product and byproduct. In wastewater biorefinery, the gap between the concepts of biorefinery and wastewater treatment is filled. In this way, wastewater treatment plants are operated within the framework of the concept of zero waste and circular economy, instead of the "end-of-pipe treatment" process of wastewater treatment as in its current situation. Thus, wastewater treatment plants turn into natural resource and energy factories where the gap in the water cycle is closed, energy and valuable biochemicals are recovered, a sustainable ecosystem is developed by reducing greenhouse gases, and new business opportunities are created. Firstly, with the conversion of the Billund wastewater treatment plant into a wastewater biorefinery plant in Denmark, the transformation process of wastewater treatment plants into wastewater biorefinery plants has started.

Keywords: Circular economy, Zero waste, Greenhouse gases, Biochemicals

Determination of Some Physical and Chemical Properties of Roasted and 10% Glycerol Added Hazelnut Firing Pellet

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Abstract:

Industrialization, population growth and urbanization cause an increase in energy demand. Since fossil fuels both harm the environment and are not sustainable, there is a need for alternative energy sources. In this study, hazelnut husk, which is an alternative energy source, was chosen. The hazelnut husk was roasted at 220-250°C for 1 hour, and 10% glycerine was added to the roasted hazelnut husk and turned into pellet fuel. Physical and chemical analyzes of these obtained pellets (Hazelnut husk, Roasted hazelnut husk and 10% glycerine added hazelnut husk) were made. The best calorific value and ash ratio were obtained in hazelnut husk with 10% glycerin (4298 cal/g -8.6%). When the elemental analysis results were examined, it was determined that there was no sulfur in any of the pellets.

Keywords: Energy, Biomass, Waste

Renewable and Fossil Fuel Energy Sources: Overview and Assessment of Sustainability Potential

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Abstract:

The industrial revolution translated into an abrupt increase in global population, causing huge rise in energy demand. A sustainable energy source is therefore required to cater for this increasing population. Being a major energy source for decades, in order to curtail the fossil fuel emission challenges, several control technologies are being developed. These technologies are however presently in their early stages. On the other hand, the call for low emitting energy sources has brought about gradual transition into renewable energy, an example of which is bioenergy. Considering the present technological interventions in the energy industry and using the major sustainability requirements as yardstick, this paper looked into the sustainability potential of fossil fuels and renewable energy sources. Both were examined on the concerns of depletion, social acceptability, impacts on climatic conditions and environmental degradation. The vast unconventional resources available coupled with the emerging clean technology will have huge roles to play in the relevance of fossil fuels. For renewables, cost, availability, intermittency and social acceptability are key challenges that need to be addressed. In general, the extent of research breakthrough in the technologies associated with both energy sources will be major determinant in them meeting global energy demand sustainably.

Keywords: Sustainability, Environmental degradation, Emission

Analyzing of Biochar Production Potential and Pyrolytic Behavior of *Aloe vera* Solid Wastes

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Abstract:

The large waste potential of biomass, which is used extensively industrially, is a problem that needs to be solved both environmentally and economically. In this context, conversion of these wastes into valuable solid products by thermochemical conversion processes is considered a very important alternative. In this study, it was aimed to examine the pyrolytic behavior of Aloe vera plant solid waste, to determine the pyrolysis kinetic parameters and to characterize the biochars obtained as a result of pyrolysis. The pyrolytic behavior of this waste at temperatures between 25–600 °C and heating rates of 5, 10, 20 and 40 °C/min was investigated by thermogravimetric method. Then, biochar was produced from this waste at temperatures of 400, 500 and 600 °C and the characterizations of the obtained biochars were made. The pyrolysis kinetic parameters of these wastes were calculated using the Kissinger-Akahira-Sunosa (KAS) and Flynn-Wall-Ozawa (FWO) methods. According to the results obtained, the pyrolysis of Aloe vera waste took place in 3 stages (moisture removal, devolatilization and char formation) and approximately 65% of the mass was removed from the structure. The activation energy values calculated by KAS and FWO methods for the devolatilization and char formation stages were found to be approximately 185 kJ/mol and 335 kJ/mol, respectively. According to the kinetic and characterization results obtained, it has been understood that aloe vera wastes are a very suitable source for use in biochar production and they can be evaluated in combustion or co-combustion systems in the future.

Keywords: Biomass, Solid biofuel, Pyrolysis, Thermogravimetry, Kinetic

Utilization of Fungal Biyoprocess for Biodiesel Production as a Green Energy Source

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Abstract:

The trend toward new research studies focused on searching for sustainable sources of clean energy has increased to ensure the sustainability of energy worldwide due to reasons such as the scarcity of fossil-based fuels and the environmental impact of conventional sources. Biofuel is a good candidate to become a world leader in the development and deployment of renewable energy sources among other green energy sources. Biodiesel is an alternative fuel produced from renewable biological resources and can be produced using microbial resources such as algae, bacteria, and fungi. Biodiesel produced from microbial lipids is an important and effective green energy source. Fungi exhibit a high capacity for biodiesel production by accumulating more than 70 percent of intracellular lipids in their biomass during metabolic stress periods. This study aims to examine the studies focused on the use of fungal lipids as a source of biodiesel in recent years. In addition, the conditions in which the highest biodiesel production efficiency was obtained, including preliminary information that will guide further studies on large-scale production of biodiesel from fungi were reviewed.

Keywords: Biofuel, Fungi, Renewable energy

A More Livable Environment with Nursing Initiatives

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Abstract:

Medical waste is the output of hospitals that can damage or damage many areas, especially human health, animal health and the environment. In this study, we discussed how bioenergy can be achieved in the field of Medicine, especially in the field of Nursing. In this study, it was emphasized that nurses can also contribute to bioenergy. If nurses do not know waste management to separate medical waste and other waste, it is essential to learn if they know, practice and teach the team around them to achieve bioenergy. It is important for bioenergy that Nurses who are in frequent communication with the patient decompose the patient's food that is thrown into a red garbage bag, which is medical waste. A lot of medical waste is thrown into the red garbage bag. Blood tubes, blood serum and sets, pathology waste, where waste products such as surgical gloves and dressings of red thrown in a garbage bag thrown their meals in 2 patients with infectious diseases red medical waste bags have a separate bag case it is essential to be a new source of bioenergy. It is essential to raise awareness of environmental protection hospital managers by expressing the concept of 'green hospital' that exists in the literature but is not enough and on this path. Benefits such as medical waste management, hazardous materials management, energy and water management can be provided with green hospitals. Medical waste management begins with identifying and classifying hazardous substances. This type of management minimizes the damage that can be caused by potential hazards such as hospitals, patients, nurses and the environment.

Keywords: Bioenergy, Environment, Nursing

A Review: The Determination of Suitable Areas for Renewable Energy Resources by Using Geographical Information Systems and Remote Sensing Technologies

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Abstract:

Today, energy has become an indispensable element for sustaining our lives in all areas of life such as health, transportation, and nutrition. It is among the predictions that another major disaster to be encountered after the pandemic will be the energy supply, where the demand cannot be met in the face of the increasing population. Energy derived from fossil fuels is decreasing day by day, and it is also causing climate change by harming nature. As long as countries depend on fossil fuels and external sources of energy, costs and environmental pollution will increase, and they may become inadequate for development. For this reason, each country needs to produce its energy and reduce its costs while minimizing the damage to the environment during this production. While many countries have been researching and using renewable energy sources for a long time to cope with these problems, with the 5346 numbered law that released in 2005 "Use of Renewable Energy Resources for Electricity Generation" investments in renewable energy are increasing day by day also in Türkiye. At this point, it is also critical to determine the areas of renewable energy sources and to conduct research on which energy source will be more appropriate in which area, to conduct efficiency-efficiency analyses. Through Geographic Information Systems (GIS), remote sensing, multiple decision-making methods and artificial intelligence algorithms; criteria are determined for all renewable energy sources and analyzes are made, and also suitable areas for renewable energy types with high efficiency can be determined. In this study, geographical Information systems and remote sensing technologies and renewable energy sources are mentioned. In addition, the methods used in researches to determine investment areas, decision-making systems, criteria for data on artificial intelligence, GIS, remote sensing applications are mentioned, and the interaction of ecology and renewable energy sources is discussed.

Keywords: Renewable Energy, Analyze, Suitable Areas

Intensification of Glucose Production from High-Pressure Treated Agave Bagasse at High Solid Loading Biomass Under Biorefinery

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Abstract:

Agave bagasse is a promising and interesting raw material for the development of second-generation biorefineries. However, the intrinsic resistance (recalcitrance) of lignocellulose biomass to enzymatic hydrolysis is a barrier to its effective conversion into fermentable sugars. Therefore, an autohydrolysis process under subcritical conditions is an alternative to provide the fractionation of biomass in terms of biorefinery concept. In this work, agave bagasse as a feedstock was subjected to the autohydrolysis pretreatment at controlled operational conditions (180°C — 50 min), providing fractionation of biomass > 37.5 % glucan content in the pretreated solid phase (cellulose+lignin fraction). Also, a kinetic modeling of hemicellulose fraction (liquid phase after the pretreatment) for the depolymerization has been studied, considering a linear kinetic mechanism. Kinetic modelling of hemicellulose fractionation during the autohydrolysis process predicted the fractionation of the hemicellulose which state the highest concentration of xylan reported at 160 °C was 6.4 g/L, on moving to the high temperature scale it reduces to the 4.59 g/L at 180 °C for 50 min. At high temperature and long severity, 200 °C for 50 min was able to solubilize the maximum concentration of xylan into oligosaccharides, which was reported only to be 0.65 g/L. The cellulolytic hydrolysis process improved the glucose concentration by 40.98 g/L at 72 h with a saccharification yield conversion of 82.58%. The energy efficiency (η) during the autohydrolysis pretreatment was determined (1.039 gsugars/MJ). The design and development of this process will allow establishing optimal operating conditions and energy efficiency for the development of biorefineries with an impact on the circular bioeconomy.

Keywords: Subcritical pretreatment, Biomass, Biorefinery, Xylooligosaccharides, Circular bioeconomy

Alternative Source for Olefin Production: Bio Methanol

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Abstract:

Light olefins, namely ethylene and propylene, are the key monomers for the petrochemical and plastic industry, which are used in the form of polymers. These vital monomers could be obtained via several sources like dimethyl ether or syngas but reaction kinetics together with light olefin selectivity and conversion favor the production from methanol. In this study, light olefins are to be obtained from bio-based methanol. Bio methanol, derived from waste digestion plants, will then react to produce mainly ethylene and propylene under atmospheric pressure and 400ºC in the presence of suitable catalysts. Thus, the production of a crucial monomer for plastic industry will be done in an environmentally-benign way without using any petroleum source but methanol. This reaction is known as Methanol to Olefins (MTO). Generally, SAPO-34 type of zeolites are preferred for MTO due to their adjustable pore sizes but these catalysts suffer quickly from coke formation and get deactivated. Hence, an alternative to SAPO-34 structure, known as silica microsphere, was synthesized and characterized for this study using XRD, N_2 Adsorption/Desorption, ATR, and DRIFTS techniques. Ca, Mg, and Mn metals were then impregnated (5 wt%) to silica microspheres to adjust acidity and obtain ethylene and propylene at a higher selectivity. XRD spectra showed an amorphous silica peak at 2θ 22.8° in all catalysts, as well as a Mn2O3 characteristic peak at 2θ 32.92° in Mn loaded catalyst. The multipoint BET surface areas of the support material and the Ca, Mg, and Mn loaded catalysts were found to be 227, 255, 184, and 308 m^2/g, respectively. Si-O bond was observed in the 1100-1200 cm^{-1} band in the ATR spectrum of the silica microspheres. The DRIFTS spectrum shows the presence of Lewis acid sites in the 1445 and 1605 cm^{-1} regions of the catalysts.

Keywords: Ethylene, Propylene, Silica Microsphere

A Review of Application of Nanotechnology to Improve Performance, Combustion and Emission Characteristics of Biodiesel

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Abstract:

Energy plays a vital role in the development of any anthropogenic activities. Nature has gifted earth with various energy sources; fossil fuels, renewable energies and nuclear energy have been selected by users due to their availability, calorific value, safety, easy adaptability with fewer technological changes and even political issues. Considering the operational challenges faced by bioenergy production, green energies have a limited share of primary energy consumption worldwide. Newly-emerged nanoprocessing approaches are exploiting to enhance bioenergy production efficiency. The potential of nano-particles and nano-additives supplementation in biodiesel have been introduced during the present study. It could lead to more power output, less fuel consumption as well as fewer emissions, higher thermal efficiency, decreased cost of operation and enhanced reliability and durability for diesel engines. Biodiesel is a non-toxic, clean-burning, eco-friendly and completely biodegradable biofuel, completely miscible with diesel. It has similar properties to petrodiesel which could be combusted in routine diesel engines without notable modification, in pure form, or blended with petrodiesel. However, poor physicochemical properties of biodiesel at low temperature, higher fuel consumption and lower energy content as well as problems with heat releasing during combustion in engines fueled with biodiesel are also negative points that could be disappeared using nanotechnology in the processing of biodiesel. Most of the practical works to mask the shortcomings of pure biodiesel have focused on fuel modification methods through further blending and feedstock screening and engineering of the oily feedstock. The application of fuel nano-additives bring meaningful improvement in thermophysical and chemical properties of biodiesel such as high reactive medium for combustion, enhanced heat transfer rate, stabilization of fuel mixtures, increased mass transport properties, improved flash point, fire point, pour point, elevated engine performance and decreased exhaust emissions, depending upon the type of nanoparticles, their size and techniques during implementation in biodiesel.

Keywords: Nanoparticles, Fuel characteristics, Engine performance, Additive, Biodiesel

Light Olefin Production Using Bio-Based Methanol

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Abstract:

Olefins are hydrocarbons that contain carbon-carbon double bonds. Light olefins are a subgroup of olefins that contain 2-4 carbons. Ethylene and propylene, which are the most known light olefins, are important monomers for plastics production. Light olefins are produced from oil-dependent methods such as the thermal cracking of naphtha. However, diminishing the oil resources, over-energy consumption, and high CO_2 emissions led researchers to find alternative production routes. One of these production methods is the "Methanol to Olefins (MTO)" reaction. In this reaction, light olefins, which are important monomers for the petrochemical sector, are produced using bio-based methanol under atmospheric conditions in an environmentally-benign way without depleting oil. HZSM-5 catalyst with high acidity and zeolitic structure is frequently preferred for MTO reaction due to the adjustable pore size. In this study, Ca (3-6 wt%) incorporated commercial HZSM-5 catalysts were synthesized using a wet impregnation. Prior to reaction, XRD, SEM, and N_2 Adsorption/Desorption analyses were performed for synthesized catalysts. XRD results showed the characteristic peaks of HZSM-5 (2θ= 23.11, 23.96, 24.43˚). XRD and SEM-EDS analyses showed consistent morphology and desired metal contents were reached. N_2 Adsorption/Desorption isotherms of the synthesized catalysts were compatible with the Type IV isotherm and H_4 hysteresis indicating mesoporous structure. Surface areas of HZSM-5, 3-Ca- HZSM-5, 6-Ca-HZSM-5 were 373.8, 348 and 220 m^2/g,respectively. Activity tests of HZSM-5 (Si/Al:23) were performed under atmospheric pressure at 400°C in a continuous flow-packed bed reactor system. Complete methanol conversion together with 35% light olefin selectivity was reached as a result of consecutive activity tests.

Keywords: Alcohols, Propylene, Ethylene, HZSM-5

The Acquisition of Natural Pine Cones as an Industrial Biofuel

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Abstract:

Because the energy demand is gradually increasing, the search for raw materials that will be used as bioenergy fuel has also become important because the demand for bioenergy among energy sources is decreasing. For this reason, the heat energy resulting from combustion, called biomass, can be converted into different forms of energy thanks to different systems. Although the natural pine cones are the organs that are also present in coniferous trees and their geometric shapes and macrostructures are different according to the tree species they are found in, their internal structures and material structures are similar to each other. It can be used as an alternative biofuel by recycling the pine cone due to its hard, woody, and immediately flammable structure thanks to the natural materials contained in it. This usage can be used for heating or heat energy production bypassing the collected pine cones through the mill and reducing the humidity to a certain extent by pressing the pine cone under high pressure and turning it into briquettes, chips, or pellets for use as biofuel at the end of packaging. As a result of the operations carried out in this way, thanks to the introduction of an alternative to natural pine cone as a biofuel, the energy needs for industrial use can be met and economic gains can be achieved

Keywords: Industrial biofuel, Pine cone pellet, Pine cone briquette, Biofuel pine cones, Pine cone shavings

Determination of Some Characteristic Properties of Biochar Materials Obtained from Different Agricultural Wastes

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Abstract:

Recycling of post-harvest waste, which does not have input characteristics in agricultural activities, is a very important issue. In this study, biochar materials were obtained from five different agricultural wastes (Corn cob (CC), Cotton stalk (CS), Tobacco stalk (TS), Piscation shells (PS) and Olive pulp (pomace) (OP)) by carbonization method at 300°C temperature. Scanning Electron Microscopy (SEM), Energy Dispersive Index (EDX), Total C, N, H/C and mineral element contents (Ca, Na, Mg, K, Cu, Zn, Fe, Mn, B, Al, Ni, P, Pb) were determined. When the results were evaluated in this study, SEM images of different biochar materials showed that their surface area and porous structure increased after their conversion to biochar form. It was observed that the total C contents also increased (58.06-80.29%), H/C ratios were determined to be between 0.04-0.09 values, and it is seen that these values are above the limits for agricultural use for five materials. It was determined that there was an increase in the mineral element content. According to the results of the five different biochar materials, the more porous structure and richer elemental content of the corn cob, it has been evaluated that the potential of use in agricultural areas will be more effective in soil improver and increasing plant production.

Keywords: Raw material, Surface morphology, Biochar, Carbonization

Using Industrial Hemp as a Renewable Energy Source

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Abstract:

Industrial hemp is grown mainly for its fiber, seed and oil. Hemp, which is one of the important plants of our country's agriculture and industry, has lost its importance in recent years and has come to the point of extinction in recent years. Cannabis production, whose cultivation area has decreased to 10 decares in our country, has gained importance again with the statements made by our President on increasing hemp production in 2019. Since industrial hemp is a renewable and sustainable product, it is gaining importance day by day in terms of scientific, sectoral and economic aspects. When hemp is evaluated industrially, it has the potential to be used as a raw material source for approximately 25 thousand alternative products. With the diversification of the use of industrial hemp in different fields with each passing day, hemp is an alternative fiber source for the textile industry thanks to its long, high quality and durable fiber, Due to the high content of cellulose and lignin , the high energy value of the stems and seeds for the paper and biopolymer industry, our country as a renewable energy source. has significant potential forIn this review, information about the use of industrial hemp as a renewable energy source will be shared.

Keywords: Biodiesel, Bioethanol, Biomass

Future Forecast of Bioethanol and Biodiesel Production in The World and Türkiye

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Abstract:

The rapid increase in population around the world, the ever-increasing energy need for intensive industrial production, and the negative effect of greenhouse gases in the atmosphere due to the use of fossil fuels make it necessary to benefit from renewable energy sources and the need for clean energy is increasing. For this reason, the production of bioethanol and biodiesel, which is produced as an alternative to fossil fuels, is becoming increasingly common in the world. The primary purpose of this study is to make a general assessment of the current situation and possible future situation of bioethanol and biodiesel production in the world and Türkiye. In the research, production estimates for the years 2020-2025 were made with the Double Exponential Correction method using the bioethanol and biodiesel production time series data for the years 2006-2019. The data used in the research were obtained from the US Energy Administration. According to the results of the research, bioethanol production in the world will increase by 18.5% in 2025 to 130 billion liters; biodiesel production is expected to increase by 35.9% to reach 63 billion liters. It is predicted that bioethanol production will increase by 34.7% (131 million liters) and biodiesel production will increase by 29.3% (178 million liters) during the same period. Considering that bioethanol and biodiesel production is obtained from energy plants and agricultural wastes, it is predicted that the increase in bioethanol and biodiesel production will contribute positively to the country's economy in the evaluation of agricultural wastes and the production of energy agriculture plants will become widespread. It is important for the development of bioethanol and biodiesel production in Türkiye that the areas where crops that can be used as human food are not cultivated an idle agricultural lands are allocated to the production of energy crops and producers are encouraged in this regard.

Keywords: Bioethanol, Biodiesel, Double exponential smoothing, Projection

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