



3RD BIOENERGY STUDIES SYMPOSIUM

SYMPOSIUM ABSTRACT BOOK

May 2021

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PREFACE

Dear colleagues and researchers,

We are delighted that the "3rd Bioenergy Studies Symposium", hosted by the Black Sea Agricultural Research Institute, and supported by the "Sustainable Use of Biomass to Assist the Development of Turkey's Economy Towards Green Growth" project carried out by TAGEM and UNIDO brought together a great number of academics and professionals working in the bioenergy field.

The symposium was arranged online for two days, 20-21 May 2021. The overall scope of the 3rd Bioenergy Studies Symposium was to bring together all stakeholders working in the field of bioenergy around the world came together at this symposium to share and discuss their current research and to talk about the future of bioenergy. Topics of 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.

This abstract e-book contains 75 abstracts accepted for a presentation (56 oral and 19 posters) in the symposium. 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 15 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 and symposium secretariats for helping to organize this symposium.

Last but not least, we would like to thank all the symposium participants who contributed to the 3rd Bioenergy Studies Symposium. We hope to meet you again in 2022 for the 4th Bioenergy Studies Symposium.

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Oral Presentations

Digitalization in Energy Sector and Bioenergy

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Abstract:

With the developing technology, every sector is experiencing a change and transformation. All these developments can be summarized as "digitalization", where computer programs have replaced manual applications; developed algorithms open the door to the era of artificial intelligence, and machine learning technologies increase productivity. The energy sector has also been affected by this change and transformation, and digitalization applications have come to life in the production, transmission, distribution, and end-user stages. The basic expectation in the energy sector with digitalization; access to cheaper, more efficient, and safer energy sources. Especially with the increase in the use of renewable energy resources, the issues of distributed generation, demand-side management, and predictive maintenance have come to the fore, and it is aimed to manage energy networks that contain all these efficiently. Bioenergy, which is an important title among energy resources and technologies, can follow a more efficient, more accessible, and effective course with digitalization applications. The bioenergy sector, which produces electricity, heat, and fuel output by processing industrial, agricultural, forestry, and domestic wastes, will continue to be one of the most preferred energy sources in the future, in line with the conditions of combating climate change. In this study, the method of literature research, examining the realized digitalization applications and analyzing the results in the light of the real sector experience was preferred. Scope of work; Digitalization applications in the bioenergy sector have been examined and their effects have been investigated.

Keywords: Energy, Digitalization, Energy efficiency, Bioenergy

The Effects of COVID-19 Pandemic on the World and Turkish Ethanol Sector

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Abstract:The current situation of the ethyl alcohol sector in Turkey varies according to the situation in the world. This sector is newly developing in Turkey, and the ethyl alcohol produced in Turkey does not meet the needs of our country yet, and the deficient amount is supplied through imports. Sugar beet, wheat and corn are used as raw materials in the production of ethyl alcohol in Turkey. According to the data of 2020 in Turkey, an average of 128.5 million litres of agricultural origin denatured ethyl alcohol is produced annually, and 141.7 million litres of agriculturally denatured ethyl alcohol are imported from abroad. Due to the fact that the Covid-19 epidemic increased the need for ethyl alcohol in the chemistry, health and food sectors, denatured agricultural ethyl alcohol production increased the capacity utilization rates of the facilities in our country. Although the capacity utilization rate increased by more than 20% in 2020 compared to 2019. This increment was still not sufficient, the imports made in 2020 increased by more than 160% compared to 2019 and imports exceeded domestic production for the first time since 2013. Considering that a new type and variant of virus outbreaks that affect the whole world appear every year, it is predicted that the need for ethyl alcohol in the chemistry, health and food sectors will increase even more, and in case of not establishing new production facilities in our country, ethyl alcohol will be imported in an ever-increasing trend. It is aimed to increase the ethyl alcohol production of Turkey at least 250,000,000 mA liters in the next 3 years and to reduce its imports to less than 50,000,000 mA liters, and in line with these targets, the new facility investments to be established should also be supported.

Sustainable Use of Biomass to Assist the Development of Turkey's Economy Towards Green Growth Project

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Abstract: To assess the biomass potential of agricultural residues in Turkey, TAGEM and UNIDO conduct this GEF-funded project since 2018. The aim of the project is to reduce greenhouse gas emissions while increasing energy performance and competitiveness with modern bioenergy technology applications in the agricultural industry. Four main project components serve for the transformation into high-level, adequate, domestic and clean energy: "demonstration of modern bioenergy technologies and energy efficiency measures in agro-industrial sector", "refined policy and regulatory framework to enable transformation across sub-sectors", "capacity base strengthening and awareness raising increased" and "monitoring and evaluation". The biomass materials are selected from the residues that could be used for no other purpose such as fertilizer, animal husbandry or upholstery. Chosen biomass material are

hazelnut husk (4225 kcal / kg), cotton straw (4300 kcal / kg), sunflower stalk (4040 kcal / kg), rice hull - mixed with chicken manure (3725 kcal / kg), vineyard and pruning residues (3500-5000 kcal / kg) and greenhouse residues (3000-4000 kcal / kg), and the end product will be used in bioenergy plants to generate electricity and heat to be used in industrial zones.

Project deliverables include the distribution of 2.4 Million USD to chosen bioenergy facilities with total installed capacity of 20 MWe & 70.9 MWth (min 10 MWth) as grant support; technical assessments for 22 enterprises; regulation frameworks for sustainable biomass extraction; tailored trainings and awareness work for biomass enterprises, finance institutions, engineers and technicians, local communities, academy, and public institutions.

Keywords: Biomass, Sustainability, Bioenergy, Circular bioeconomy

Sustainable Use of Biomass to Assist the Development of Turkey's Economy Towards Green Growth: the Case of Turkish Energy Feasibility Plan

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Abstract:

RINA assisted UNIDO for the Project “Sustainable use of biomass to assist the development of Turkey’s economy towards green growth”.

The project aims at demonstrating the application of modern bioenergy technologies in Turkey to reduce greenhouse gas (GHG) emissions in agro-industry, refine the policy and regulatory framework to enable transformation across sub- sectors, and strengthen the awareness about bioenergy utilization for thermal and electricity production in the Country. The project objective is to bring about sectoral transformations through application of modern bioenergy technologies to improve overall energetic performance, increase competitiveness and reduce GHG emissions in the Turkish agro-industry.

Ten biomass-to-energy potential projects were selected. Technical information on these projects were collected and analyzed and their technical and financial viability was ranked based on a set of selection criteria, focussed on measurable and analytical components like financial score, presence of permits, and licenses. 5 high-scoring projects were selected for detailed Feasibility Study. The results demonstrate the wide applicability and financial viability of biowaste-based heat and power production, which can help Turkey moving towards its decarbonization targets.

Keywords: Agro-industry, Bioenergy, Energy assessment, Feasibility study, Greenhouse gas (GHG)

Effectiveness of Incentive Policies in Bioenergy: EU and Turkish Case

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Abstract:

Increasing urbanization, industrialization, technological developments, which are the most important driver of economic growth require much more energy utilization. In order to ensure energy supply security and to mitigate the GHG emissions, there has been a trend towards renewable energy sources in the world. Hence, many incentive instruments and subsidies are being started to be ensured by the states for the promotion of renewable energy, which is an important factor in terms of sustainable development and environmental transformation. EU countries have so far consumed 80% of the total amount of fossil fuel and have emitted 67.5% of the total CO₂ emissions globally. EU countries have very enthusiastic renewable energy policies since they want to be at the leading position in research, development, and consumption of renewables in the world. Turkey, which has a high dependence on imported energy sources, aims to increase the share of renewable sources in electricity generation to at least 30% by 2023. In this study, the effectiveness of the incentive policies such as feed-in tariff, grants, and subsidies, loans, taxes, etc. in the bioenergy field in the EU and Turkey will be examined. Our results will provide important information for policymakers.

Keywords: Bioenergy, EU-Turkey, Renewable Energy incentives

Sustainability and Socio-Economic Impacts of Bioenergy

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Abstract:

Biofuels are prominent energy sources among renewable energy sources in recent years. The reasons why biofuels are preferred can be listed as follows: biofuels can improve energy security, they can reduce greenhouse gas (GHG) emissions, they are renewable, they can increase farm income, they can create new jobs, they have physical and chemical properties similar to oil, they are simple and familiar. The availability, and cost of the resources are important barriers for the effective development and spread of these technologies. There are increasing efforts to promote biomass production for industrial uses including biofuels and bio-products such as chemicals and bio-plastic. Environmental sustainability is an important factor. Sustainability principles also apply at the economic and social levels. On sustainability, bioenergy creates both positive and negative effects on various environmental and socio-economic problems. These include social welfare, economic well-being, property rights, working conditions, poverty alleviation, and more. Biofuel production can stimulate the agricultural sector and reduce poverty by increasing rural income. Fossil fuel dependence can be reduced, economic growth and jobs can be maintained, and the economic and environmental sustainability of production and processing industries can be improved by the use of bioenergy.

Keywords: Bioenergy, Renewable energy sources, Socio-economic impacts, Sustainability

Effects of Biomass Energy on Recycling From Sustainability Perspective

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Abstract:

The need for energy is increasing in parallel with the population and industrialization, which are increasing rapidly year by year in the world. Fossil based fuels have a larger share compared to other energy sources with a ratio of approximately 60% in the use of primary energy sources. Biomass, which has become an important source in terms of energy efficiency and solutions to environmental problems, stands out among the resources with the most suitable potential to be evaluated. From a sustainability perspective, biomass energy meets approximately 6.4% of total global energy demand economically and plays an important role with waste management policies to mitigate climate change environmentally. Organic waste and paper account for 65% of the global waste amount, which can be used to generate energy. In this study, the importance of biomass energy in the energy sector and its impact on the fight against climate change which has both in terms of its potential and in terms of solving environmental problems has been investigated in the focus of reducing dependence on fossil resources.

Keywords: Biomass, Climate Change, Fossil Fuels, Renewable Energy Sources, Zero Waste.

Farmers' Adoption of Switchgrass and Miscanthus for Cellulosic Ethanol Production in the United States

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Abstract:

The goal of this research is, through using the theory of new technology adoption, to analyze the socio-economic factors that impact farmers' willingness to grow switchgrass and Miscanthus in the United States. The first objective of this project is to measure the impact of farm size, education, and off-farm employment on adoption of energy crops. The second objective is to measure the impact of producers' attitudes, social acceptability, and being a minority limited resource farmer on adoption of energy crops and the last objective is to measure the impact of farmers' attitudes toward risk and uncertainty, and being a member of an agricultural cooperative on adoption of energy crops. The results of the survey conducted for this project show that current level of farmers' willingness to grow for either crop is low. Hence, there are barriers to accomplishing the goal of producing 21 billion gallons of cellulosic biofuel by 2022. It is also found that currently growing energy crops is more attractive to small farms as a source of crop diversification, rather than an alternative crop production system in the big scale by large farms.

Keywords: Adoption, Cellulosic ethanol, Miscanthus, Socio-Economic, Switchgrass

Bioenergy Generation Using Wastewater Through Traditional and Emerging Technologies in Developing Countries

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Abstract:

With a rising population and improved living standards of people in developing countries like India, wastewater generation has shown exponential growth. According to census data published every 10 years since the independence of India, there was a growth of around 100 million per decade in population. But since Economic restructuring (1991) in India, population growth has doubled its size. A huge population migrated towards the urban area for a better standard of living. Urban areas of India generate around 72,368 MLD of wastewater, out of which approximately 31,841 MLD is treated which around 50% of the overall generated wastewater. Wastewater is a major issue for many developing countries. But it has considerable potential for energy generation in the form of fuel, electricity, and heat. Processes like anaerobic digestion not only generate energy but also produce biofertilizer and manure. Similarly, by emerging technologies like bioaugmentation and biofilm not only energy can be generated also we can remove the BOD, ammonia, and phosphates, etc. This will help in decreasing the potential pathogen and high nutrients, increase in energy generation and reusability of wastewater. This paper focuses on bioenergy generation using wastewater as a source by traditional and emerging technologies.

Keywords: Bioenergy, Emerging technologies, Energy generation, Wastewater, Water demand

Bioproduction of Succinic Acid from Corn Fiber Hydrolyzate By

Actinobacillus succinogenes

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Abstract:

Succinic acid (C₄H₆O₄) (SA) is a dicarboxylic acid with significant production application in the pharmaceutical, food, and agricultural industries. Bioproduction of SA represents a promising alternative to the conventional chemical route, which uses petroleum as starting material. This process is environmentally questionable due to the use of toxic catalysts. BioSA incorporates sugars and carbon dioxide (CO₂), making this process an ideal candidate for using a greenhouse gas such as CO₂ and for converting a renewable biomass into an emerging commodity bioproduct.

In this work, corn fiber (CF), a byproduct from the dry-milling ethanol process and an inexpensive source of carbohydrates, was successfully used as carbon source for bioproduction of SA. After liquid-hot-water pretreatment, the oligosaccharides present in the CF solids were hydrolyzed through enzymatic hydrolysis to obtain the corn fiber hydrolyzate (CFH) for fermentation. Results in batch fermentation with *A. succinogenes* showed that fermentation of a control solution mimicking CFH sugars produced 28.7 g/L of SA with a yield of 0.67 g SA/g sugars, while fermentation of CFH produced 27.8 g/L of SA with a yield of 0.61 g SA/g sugars. Additional data when the pretreated CF solids and liquid prehydrolyzate were recombined for the fermentation will be also presented.

Keywords: *Actinobacillus succinogenes*, Corn fiber hydrolyzate, Succinic acid

Evaluation of Hydrothermal Pretreatment on Sorghum Bagasse for Biomass Fractionation

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Abstract:

Agroindustrial wastes, such as sorghum bagasse has the potential to be exploited and produce a wide range of products, the platform which developed a strategy for recovered different wastes and reincorporate them into a process are biorefineries. Agroindustrial wastes majorly reflects the recalcitrant property and hinders the accessibility of enzymes over the internal units for that reason pretreatment is a fundamental step in the process. The objective in this investigation is evaluate the pretreatment and fermentation process to produce lactic acid using agroindustrial wastes. The methodology to be followed is: physicochemical characterization of feedstock, hydrothermal pretreatment where conditions under an isothermal regime will be evaluated (150, 170 y 190°C / 10, 30 y 50 min), to produce glucose monomers. And the enzymatic saccharification and fermentation will be evaluated in separate respectively, but there will perform an operational strategy, saccharification, and semi-simultaneous fermentation, in which both operations will carry out in one system. The expected results for this research are, achieve the optimization of the pretreatment and fermentation process for the production of lactic acid using agroindustrial residues, such as sorghum bagasse, obtain a high concentration of glucose which can be fermentable, and finally obtain a product in its pure form.

Keywords: Biorefinery, Lactic acid, Saccharification, Semi-simultaneous fermentation, Sorghum bagasse

Enhanced Bioethanol Production from Olive Tree Biomass with Different Pretreatment Methods

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Abstract:

Olive productivity is conducted in many regions of Turkey. After the harvest of olives, high amounts of olive tree biomass (OTB) waste, one of the lignocellulosic wastes, is formed. It is possible to provide bioenergy recovery from OTB biomass. In this study, the potential of bioethanol production by fermentation after different pretreatment methods was evaluated. National Renewable Energy Laboratory (NREL) procedures were used for the determination of moisture, ash, total solids, extractives, acid-soluble and acid-insoluble lignin content of the feedstock. The highest sugar recovery yield was obtained after acid pretreatment. After pretreatment, the solid-liquid phase was separated, and the liquid phase (hydrolysate) was inoculated with *Saccharomyces cerevisiae* for bioethanol fermentation. Fermentation experiments were carried out in a 4 L fermenter with a working volume of 3.5 L. The amount of ethanol formed as a result of fermentation was measured by gas chromatography. According to the fermentation results, OTB biomass was found to be a very suitable lignocellulosic waste for bioethanol production.

Keywords: Bioenergy, Fermentation, Lignocellulosic biomass, Sugar recovery

Fiber Degradation and Sugars Production by Different Chemical Pretreatment Methods of Cotton Stalk

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Abstract:

These research aims are to investigate the effect of different chemical pretreatments on sugar production and fiber content of cotton stalk. Thermal assisted alkaline pretreatment were carried out by varying temperature (60, 90, and 120 °C), NaOH concentration (3, 5, and 7%), and reaction time (1, 2, and 3 h), microwave pretreatment with sulfuric acid as solvent was tested by different temperature (80, 100, and 120 °C), reaction time (15, 30, and 45 min), and H₂SO₄ concentration (1, 1.5, and 2%), and hydrochloric acid pretreatment was performed by varying temperature (90, 105, and 120 °C), reaction time (1, 2, and 3 h), and HCL concentration (1, 3, and 5%). The results were compared to total sugar amount and cellulose content. The results show that the highest amount of total sugar for thermal assisted alkaline pretreatment was 9.98 g/L, for microwave pretreatment was 84.80 g/L, and for hydrochloric acid pretreatment was 36.58 g/L. Also, the highest amount of cellulose for thermal assisted alkaline, microwave, and hydrochloric acid pretreatment were 64.12%, 62.54%, and 64.12%, respectively. According to results, while microwave pretreatment was the most effective method for total sugar, both alkaline and hydrochloric acid pretreatment had the same highest result for cellulose.

Keywords: Hydrochloric acid pretreatment, Microwave pretreatment, Plant fiber, Sugar production, Thermal assisted alkaline pretreatment

Genetic Differentiation of European Black Poplar (*Populus nigra L.*) Clones and Populations with Respect to Sucrose Synthase and Udp-Glucose Pyrophosphorylase Enzymes Involved in Biosynthesis of Cellulose

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Abstract:

The European black poplar is economically important fast-growing trees. Its wide distribution range in northern hemisphere, easy vegetative propagation, rapid growth rate and hybridization ability, and also its biomass source potential make *P. nigra* a perfect candidate for lignocellulosic biomass and bioenergy production. In this study, specific activities of two important cellulose related enzymes (SuSy and UGPase) were evaluated in natural *P. nigra* clones. Also, cellulose, lignin, and glucose contents, as well as height and diameter of clones were examined to explore genetic variance components, heritability of traits, and relationships between these traits. Moreover, clones with lignocellulosic potential were identified to be used for future breeding studies. As a total, 285 clones (genotypes) represented by 4 ramets and replicated twice were used. The results of our study indicated that the great portion of total variation was due to clonal variation ranging from 33 to 64%. Moderate to high clonal heritabilities were estimated for traits ranging from 0.50 to 0.80. Number of clones with desired cellulose were identified. One of these clones, 62160 was among the highest 12 clones regarding UGPase, SuSy, cellulose, height, and diameter. Phenotypic correlations of cellulose content with SuSy ($r=0.184$) and UGPase ($r=0.160$) were significant.

Keywords: Bioenergy, Cellulose, Enzymes, Genetics, Populus

A Mathematical Model for Suitable Capacity and Location-Allocation of Biomass Power Plants in Turkey

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Abstract:

Turkey's imported energy demand has increased based on demographic and economic growth. Converting the agricultural and forestry residues into electricity by Biomass Power Plants (BPPs) can make a positive contribution to the energy market of Turkey. This study aims to present a mathematical model to more efficiently allocate the locations of BPPs in Turkey. The main contribution of this study is to provide a new perspective that will optimize the problem by considering raw material properties, supply chain according to economic criteria for the conversion of biomass stock to electrical power generation, geographic location, capacity, and capacity performance of a BPP from the aspects of both technological and thermodynamic analyses. The proposed model incorporates yearly annual production values for specified species from the districts of Turkey, their available energy values, transportation costs, capacity-based investment cost, bioenergy to electricity costs to determine the realistic objective functions which measure the quality of solutions for capacity-limited BPP problem. This study can exhibit a realistic scenario about the location-allocation of BPPs from various criteria which are major risks and barriers to BPP investors in Turkey.

Keywords: Capacity prediction, Forest residues, Herbaceous biomass residues, Location-allocation, Power production

Promising Resources for Bioenergy: Shrub Willows of Turkey

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Abstract:

Salix L. species are economically excellent candidates for sustainable bioenergy production. Especially, some taxa of genus *Salix L.* native to Turkey are used in forest biotechnology for their characteristic quick growth, wide distribution, and resistance to diseases and stress. The shrubs of subgenus *Salix* and *Vetrix* commonly found in riparian or wetland habitats of Turkey have great potential as bioenergy crops with high biomass yield. This review study will provide information to determine the potential of willow species in Turkey for bioenergy and to contribute to energy production by using the biomass of fast growing shrub willows as renewable energy resources. Firstly, botanical description, habitat, growth, and genetic characteristics were summarized concerning about the bioenergy potential of willows from results of existing studies. Secondly, the titles, biomass reducing the greenhouse gas emissions responsible for climate change, current breeding efforts, and production statistics of willow were reviewed in worldwide and Turkey. Lastly, the future of bioenergy potential estimation of willows were proposed so as to provide some instructions for bioenergy development in Turkey.

Keywords: Bioenergy, Review, *Salix L.*, Turkey, Willows

Synergistic Links Between Plant Metal(Oid)-Stress Regulation and Biofuel Utilization

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Abstract:

Bio-adsorbent capacity of metal(oid) tolerant eco-safe agents not only provide effective phytoremediation in adjacent agricultural areas of abandoned/active mining sites but also contribute plant development for downstream biofuel biomass utilization. To meet this end, we designated a microcosm-scale phytoextraction set up to analyze whether our genetically archived fungal agent contributes to the efficacy of photosynthesis, thus the accumulation of sugar and polysaccharide, along with several growth-related biochemistry in metal(oid)s spiked maize plants which then likely be valorized in the green chemistry. Inoculation secured the photosynthetic pigment intactness by 33% and 28% compared to 200-500mgL⁻¹ spiked As, Cd, Cu, Pb, and Zn only plants. Our novel inoculant performed better in a concentration-dependent way in the presence of metal(oid)s by increasing bioavailability. The higher the dose, the better the inoculant effect were, characterized by better shoot/root biomass, cell membrane stability, and water status. Given also that having high carbohydrate through cellulosic breakdown is a desirable trait in biofuel production for a fermentable C4 plant such as maize, using our fungus seems promising rather than application of chemical mobilizing agents for soil metal(oid)s detoxification. Thus, this concept might pave a co-favorable way for the environment via maize biowaste valorization in the biofuel processes.

Keywords: Bioenergy, Fungus, Heavy metal(oid), Maize, Phytoremediation

Use of Cannabis (*Cannabis sativa L.*) as Biofuel

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Abstract:

Biomass energy is an alternative energy source to help solve environmental and climate problems. Turkey being an agricultural country, agricultural biomass, has special importance in terms of energy production. In Turkey, agricultural residues have an important and huge potential to be used as a sustainable renewable energy source. Cannabis is a plant that can be utilized in every aspect and can be used as a feedstock source of various biofuels. In the study conducted by Black Sea Agricultural Research Institute, the solid biofuel properties of pellets produced from cannabis stalk remain after the fiber removal were examined. It has been found that the upper calorific values of the examined cannabis varieties are above the standards accepted by the European Union. As a result, it has been determined that the fuel pellet obtained from cannabis plant residues stems has the potential to be an environmentally friendly, sustainable, and renewable solid biofuel source. Cannabis oil as a feedstock for biodiesel has also been investigated by the Black Sea Agricultural Research Institute. The biodiesel's compliance with the standards was tested. According to the results of the study, it has been determined that it is biodiesel that complies with the standards.

Keywords: Biodiesel, Biofuel, Cannabis, Pellet

Investigation of Biomass Energy and Mineral Contents of Switchgrass (*Panicum virgatum L.*) Cultivars as an Alternative Biofuel Crop for Turkey

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Abstract:

This study was conducted during three vegetation seasons in Konya within the scope of TOVAG 107 O 161 project supported by TUBITAK to determine production potential of switchgrass crop (*Panicum virgatum L.*) in Turkey in which this species has not been cultivated before and which is a promising crop for energy production globally. Nine cultivars of switchgrass were tested. Energy values, crude ash ratios, Ca, Mg, Na, P, N, and S content properties of the cultivars were examined.

As a result of the research, the energy values of the biomass belonging to the varieties varied between 4296 cal / g (Dacotah) - 4458 cal / g (Carthage) as the average of two trial years. Ash rates in the study are 7.40% (Alamo) - 9.50% (Dacotah), Ca contents 3245 ppm (Kanlow) - 6531 ppm (Shawnee), Mg contents 1866 ppm (Kanlow) - 3205 ppm (Alamo), Mg contents 1866 ppm (Kanlow) - 3205 ppm (Alamo), Na contents 640 ppm (Forestburg) - 1383 ppm (Alamo), P contents 1215 ppm (Alamo) - 2295 ppm (Dacotah), S contents 254 ppm (Alamo) - 984 ppm (Dacotah) , N contents varied from 0.90% (Kanlow, Alamo) to 1.60% (Dacotah).

Keywords: Biomass, Energy, Mineral content, *Panicum virgatum L.*, Switchgrass

Effects of Different Nitrogen Doses on Forage Yield of Some Sweet Sorghum (*Sorghum bicolor* var. *saccharatum* (L.) Mohlenb.) Varieties

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Abstract:

In recent years, sweet sorghum (*Sorghum bicolor* var. *saccharatum* (L.) Mohlenb.) has gained importance both as an alternative forage and as an energy plant due to its properties, such as biomass yield and high bioethanol content.

Three different sweet sorghum genotypes (Erdurmuş, Uzun varieties, and M81-E line) and four nitrogen doses (0, 7.5, 12.5, 17.5 kg da⁻¹) were used in this research. The aim of the research to determine forage production potentials of different sweet sorghum genotypes under Bursa conditions as second crop. The field experiments were conducted in Bursa Uludağ University, Faculty of Agriculture, Agricultural Application and Research Center in 2020. Experimental design was a randomized complete block with three replications. Each plot consisted of 5 rows with 5 m long and 0.7 m apart. Two rows from center plots were harvested at soft dough-hard dough stage. Some parameters such as plant height, stem diameter, plant number per m², leaf number, leaf and stem ratio, green grass yield, and dry matter yield of sweet sorghum were investigated in the experiment.

According the research results, sweet sorghum genotypes and different nitrogen doses had significant effects on the forage yield and its characteristics.

Keywords: Forage yield, Nitrogen, Sweet sorghum

Effects of the Sustainable Productivity of American Sycamore as a Bioenergy Woody Crop on Soil Physical Properties

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Abstract:

The successful implementation woody bioenergy crops on degraded marginal lands could help avoid “food vs. fuel” issues and reduce our dependence on fossil fuels. Further, it will enhance environmental quality by improving soil health while carbon is removed from the atmosphere. However, to achieve these outcomes require a tree species that is easy to establish, tolerates environmental stress, and has reasonable productivity with low inputs. The results of our work on American sycamore in the piedmont of North Carolina, shows increasing productivity under a low silvicultural management regime (low herbicide, no fertilizer, and/or irrigation) over the first two rotations that span for 10 years. The highest planting densities (10, 000 and 5, 000 trees per hectare) had smaller individual tree diameters but produced the highest biomass of 39 Mg ha⁻¹ and 36 Mg ha⁻¹ respectively. Our results show the 10,000 tph treatment had significantly higher saturated hydraulic conductivity and higher pore volume than the other planting densities. However, it also had the lowest amount of plant available water ($p < 0.05$) of all planting density treatments. Ultimately, our results suggest that Sycamore has the potential to be effectively managed as a bioenergy feedstock with low inputs on water-logged lands.

Keywords: Biomass productivity, Low-resource input, Marginal lands, Soil health, Sustainable bioenergy

Rice Husk and Straw Potential as Biofuels in Turkey

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Abstract:

Turkey is one of the major rice producer country in the Europe. Rice has two important waste material such as husk and straw. The aim of this study is to reveal the potential use of rice wastes as biofuel. It is known that rice contains waste materials, 20% of which is husk. But the rice straw production is more complicated to calculate. Rice straw to grain ratio is mostly assessing one-to-one. But the rice straw amount is affected from cutting height and efficiency of collection. The effective collectible amount of rice straw is estimated to be 40% of rice production. Rice husk and straw potential amount of the usable waste might be at 183400 tons and 366800 tons according to last ten years rice production statistics in Turkey, respectively. In the literature, it is known that rice husk and straw have a calorific value of 3725 and 3629 kcal kg⁻¹. The energy value that can be obtained from husk and straw is 683.165.000 kcal and 1.331.117.200 kcal annually in Turkey. Rice husk and straw calorific value might be superior than domestic lignite, thus it is an important source of waste that can be used as a bio fuel.

Keywords: Husk, Rice, Straw, Waste material

Determination of Yield and Fiber Quality Characteristics of Some Cotton (*Gossypium hirsutum L.*) Varieties Produced in Sanliurfa Ecological Conditions

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Abstract:

This research is planned to determine the yield and fiber quality components of some cotton (*Gossypium hirsutum L.*) varieties produced in the ecological conditions of Harran plain. The research was carried out in the breeding season of 2019 in the research and application farm located in Eyübbiye Campus of Harran University Faculty of Agriculture in Şanlıurfa province. The trial was carried out with three replications in divided plots in randomized blocks, each plot with four rows, 70 cm between rows, and 15 cm above rows. In the experiment, the varieties grown in the region and cotton varieties that have recently entered the market as plant material; LIMA, CEYHAN, LODOS, SC 2009, SC 2079, SEZENER-76, ES-1, POYRAZ, KAIRA, BA 440, CANDIA, DP 332, EDESSA, FIONA and ST 498 cotton varieties were used. As a result of the research; The seed cotton yield varied between 360.96 kg/da and 609.26 kg/da. The highest seed cotton yield was obtained in CANDIA cotton variety with a yield of 609.26 kg/ha. The aim of this study is to research the varieties suitable for the environmental conditions of the region and to share the results with the farmers and producer organizations.

Keywords: Cotton, Ecology., Şanlıurfa, Variety, Yield

Determination of Some Physical-mechanical and Thermal Properties of Fuel Briquettes Produced from Agricultural Wastes of Tomato Post-Harvest

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Abstract:

Renewable energy sources are among the energy resources that should be prioritized because they are both an environmentally friendly power source and produce low-emission energy. In this study, agricultural wastes generated as a result of tomato cultivation in our country were evaluated and briquettes were obtained from these wastes. By determining some physical-mechanical and thermal properties of these briquettes, it has been tried to determine the possibilities to be used as an alternative energy source. Dried (10%) tomato stems were ground to 10 mm particle size and briquetted at pressures of 80, 160, and 240 MPa. Briquette densities varied between 1017.04 and 1223.26 kg.m⁻³. The highest briquette mechanical durability and shatter index were obtained at 240 MPa briquetting pressure with 98.22% and 98.99% values, respectively. The lower heating values of the briquettes varied between 15.28 and 16.43 MJ kg⁻¹ and ash contents varied between 12.3% and 17.9%. Fuel briquettes produced from tomato stalk waste were found to be suitable as biofuel in terms of physio-mechanical and thermal parameters. However, the ash content exceeded the desired standards. As a result, the properties of fuel briquettes obtained from tomato stalk waste were found to be suitable as solid biofuel.

Keywords: Agricultural waste, Briquette, Energy, Tomato

Lignite Coal Mixed with Tea Pruning Waste Biomass Improved Burning Characteristics

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Abstract:

The lignite reserves that have been known in recent years by exploration studies have exceeded 16 billion tons in our country. However, these lignite's are generally low calorie, high sulfur, moisture, and ash content. The development of unique designs and/or technologies for the effective evaluation of such coal at national and international level are needed. On the other hand, there is an important biomass potential in our country; this potential is still not being assessed effectively and efficiently. Tea pruning wastes, which are important agricultural wastes of the Eastern Black Sea region, were blended with lignite coal at certain ratios and the content of the mixture was determined for colorimetric value, ash content, sulfur content, and volatile matter content. Although the tea pruning waste thermal value was approximately 30 %lower than the lignite, 50%blended biomass with lignite coal, ash content decreased from 12%to 6%and sulfur content decreased from 1.15%to 0.69%. It was determined that these agricultural wastes, which were used as waste and not used in industry, have a high energy potential and an environmentally friendly fuel when they are homogeneously blended with lignite coal.

Keywords: Ash Content, Lignite Coal, Tea Pruning Waste Biomass, Thermal Value

Effect of Gasoline-AVGAS Blends on Engine Performance of Engine with Direct Injection

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Abstract:

Avgas is a high-octane fuel that is obtained by formulating gasoline and called aviation gasoline. Due to the high-octane level, the air-fuel mixture can be compressed at a higher rate without ignition. TSI, which consists of the initials of Turbo Supercharger Injection, is defined as a turbocharged and direct injection engine. Generally used in small volume engines such as 1.2 lt. In this study, aviation gasoline AVGAS and gasoline were mixed in certain proportions and TSI was applied in a gasoline engine.

The changes in the performance of avgas-gasoline fuel blends used in Direct Injection Engine were investigated in this experimental study. A5 (5% avgas, 95% gasoline fuel by volume), A10, and gasoline fuel were

used as fuel. The tests were performed at full-throttle valve opening and variable engine speeds. The results of the tests showed increases in engine power, engine torque values with the use of avgas- gasoline fuel blends, whereas, decrease was observed in brake specific fuel consumption values.

Keywords: Avgas, Engine Performance, Gasoline

Effect of 1-Propanol/Gasoline Fuel Blends on Engine Performance of Engine with Direct Injection

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Abstract:

In this study, the effect of 1-Propanol / Gasoline fuel mixtures on engine performance values has been experimentally investigated. 1-Propanol is a primary alcohol with the formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and sometimes represented as PrOH or n-PrOH. It is a colorless liquid and an isomer of 2-propanol. It is formed naturally in small amounts during many fermentation processes and used as a solvent in the pharmaceutical industry, mainly for resins and cellulose esters, and, sometimes, as a disinfecting agent. In this study, 1-Propanol and gasoline were mixed in certain proportions and TSI was applied in a gasoline engine.

The changes in the performance of 1-Propanol-gasoline fuel blends used in Direct Injection Engine were investigated in this experimental study. P5 (5% 1-Propanol, 95% gasoline fuel by volume), P10, and gasoline fuel were used as fuel. The tests were performed at full-throttle valve opening and variable engine speeds. The results of the tests showed increases in engine power, engine torque values with the use of 1-Propanol - gasoline fuel blends, whereas, decrease was observed in brake specific fuel consumption values.

Keywords: 1-Propanol, Engine Performance, Gasoline

A Carbon Footprint Analysis of Rapeseed Biodiesel

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Abstract:

Biofuels have the potential to enable more sustainable fuel and chemical production. However, the long-term implications of biofuels are still unknown. As a result, the purpose of this work is to provide an analysis of the carbon footprint of rapeseed biodiesel production. The carbon footprint of the studied system was assessed using life cycle assessment (LCA), in accordance with the ISO 14040/44 standards. 1 ton of rapeseed biofuel was chosen as the functional unit. The system boundaries have been covered from start to finish, including rape plantation, rapeseed oil production, and rapeseed biodiesel manufacturing. The CCalc2 LCA software was used to model the system and calculate the life-cycle carbon footprint in this study. According to the findings, the total carbon footprint per ton of rapeseed biodiesel is estimated to be 2585 kg CO₂ eq. The most significant hotspot is the production stage, which accounts for 55% of the total, owing to fertilizer use in the cultivation stage. The raw material stage is the second most significant contributor to carbon footprint, accounting for 44% of total GHG emissions. Fertilizer use and energy consumption reduction in production are critical for lowering GHG emissions and maximizing the benefits of biodiesel use.

Keywords: Biofuel, Environmental sustainability, Greenhouse gas, Life cycle assessment, Rapeseed

Empowering an Emerging Market with Biogas: The case of Turkey

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Abstract:

Exhaustion of conventional energy resources and the current level of environmental degradation force nations across to globe to shift towards renewable energies. One of the most championed alternatives to conventional ones has emerged as biofuels, especially biogas. Advanced countries and emerging markets alike have adopted biogas due to its green and clean nature. While in advanced countries, biogas is refined up until the biomethane as well as biohydrogen and graphite production stage and utilized as an alternative to natural gas, bioelectric, or fossil fuel substitute at the industrial level; in emerging markets, biogas only refined to the point to be useable for simple chores like cooking. This creates an efficiency disparity and value creation problems between advanced countries and emerging markets. This manuscript aims to address these discrepancies in the context of Turkey by utilizing exploratory and trend research approaches. In addition, by illustrating the current trends in the given topic, this study contributes to the engineering field by exemplifying contemporary biogas production techniques and addressing their possible economic impacts via value creation in Turkey.

Keywords: Biogas, Biohydrogen, Biomethane, Emerging market, Value creation

Effect of Various Thermal-Chemical Pretreatment on Bio-Methanization of Hemp (*Cannabis sativa*) Hurd and Kinetic Analysis

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Abstract:

In this study, the effect of various thermal and acidic & alkaline chemical pretreatment on biochemical methane potential (BMP) of at two variety of hemp hurd, Narlısaray (NS; local plant species) and Futura 75 (F) was investigated including the change in cellulosic structure (component analysis of hemicellulose, cellulose, lignin). In addition, first-order kinetic model and the modified Gompertz kinetic models were simultaneously used to estimate the methane yield results of the hurd and the model parameters. Narlısaray which is the specific variety of Turkey was used in the first time for biogas production from hurd in this study.

The highest BMP yields, F 272 mL CH₄/g VS and NS 218 mL CH₄/g VS, were observed when the combined alkaline and thermal pretreatment was applied. These are 143% and 74% higher than their untreated raw control, respectively. Methane potential of NS and F species were measured to be 123 m³ CH₄/da and F was 97 m³ CH₄/da, respectively. The best fit ($R^2 \geq 0.96$, RMSE ≤ 0.225) with predicted yields for untreated raw hurd control form was observed in the first order kinetic model.

Keywords: Biochemical methane potential (BMP), Biogas production, Dry fermentation, Hemp (*Cannabis sativa*) hurd, Lignocellulosic material

Evaluation of Applying Pretreatment with Electroporation to Enhance the Quality of Feedstock for Biogas Production as Biofuel

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Abstract:

Biofuels have gained more attention because they can be accepted as a sustainable fuel resource and their several environmental-friendly properties such as biodegradability, and renewability. They are generally categorized as first, second, and third-generation biofuels based on raw materials and their production technologies. Second-generation biofuels have been developed to overcome the disadvantages of first-generation biofuels. One of the ways to produce second-generation biofuels is anaerobic digestion, and the use of lignocellulosic biomass in this process makes it almost impossible due to its stubborn nature. Therefore, pretreatment is an important step in the process of converting lignocellulosic biomass to energy. Electroporation pretreatment is a promising method that can be applied to degrade lignocellulosic biomass.

In this study, 5 kV high voltage and 500 kHz frequency was applied as an electroporation pretreatment for 5 minutes to spent coffee grounds as lignocellulosic biomass. The result showed that their cellulose, hemicellulose, and lignin components were changed. sCOD of treated SCG (3245 mg/L) was increased by 590% compared to the control group (550 mg/L). These results reveal that it has been determined that the pre-treated raw material will produce faster and higher biogas if it is used in biogas production as a second-generation biofuel.

Keywords: Biofuels, Biogas, Biomass, Electroporation pretreatment

Optimization of Dilute-Acid Pre-treatments of *Cynara cardunculus L.* Residues for Biogas Production

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Abstract:

Due to its features, *Cynara cardunculus L.* is a productive energy crop for biogas production, especially in the Mediterranean Basin. Various dilute-acid applications on *Cynara cardunculus L.* residues were investigated in this study in order to improve biogas and methane yield in biogas production through anaerobic fermentation. With this approach, *Cynara cardunculus L.* biomass was pretreated with various acid (H₂SO₄, HCl, HNO₃ and H₃BO₃). Using Design Expert 7.0.0 software, the Box-Behnken experiment design was used for statistical modeling and optimization of thermo-chemical pretreatments. The amounts of monomeric sugar content (cellobiose, glucose, xylose, and arabinose) in liquid samples obtained from acid pretreatments applied to lignocellulosic biomass was determined using high performance liquid chromatography (HPLC). By means of statistical modeling and experimental design, the effects of different parameters (temperature, reaction time, and acid concentration) on sugar yield were evaluated. The optimum pre-treatment conditions with the highest sugar yield in pre-treatment applications were identified. Besides, sugar yields obtained from optimized conditions were compared to data obtained from validation studies conducted after pre-treatment applications. According to the experimental results, the highest total sugar (50 mg/ml) and the lowest total sugar (33,69 mg/ml) amounts were obtained from the 1% HNO₃ and 1% H₃BO₃ treatment, respectively.

Keywords: Biogas Production, *Cynara cardunculus L.*, Lignocellulosic Biomass, Pretreatment, Surface-Response Methodology

Biodegradability of Low Biodegradable Agricultural Waste in Bioreactors: Sunflower Stalk Example

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Abstract:

Recently, bioreactor landfills have been increased to gain methane gas using high organic content waste. Bioreactors are generally operated by anaerobic conditions. Anaerobic process is a slow biodegradable procedure. In addition to this, high lignin content wastes are barely degraded in anaerobic condition, especially with moisture deficit.

The aim of this study, investigation of biodegradability and methane production using only waste sunflower stalk that low biodegradable agricultural waste and mixed with domestic waste.

For this aim, two simulated lab-scale landfill stainless-steel reactors were used. Bioreactors were operated mesophilic conditions. Two set-up models were realized in the scope of the study. At the first experimental study, the bioreactors were operated anaerobically. One of the bioreactors was filled up 20% of domestic waste and 80% of sunflower stalk. The second bioreactor was operated 50% of domestic waste and 65% of sunflower stalk. Bioreactors in the other set-up firstly are operated aerobic and then anaerobic conditions. The results of the study showed that aerobic operations have high COD removal efficiently and high methane quantity. For example, while organic matter removal efficiently is 50% at the anaerobic study, but 65% in aerobic study.

Keywords: Agricultural waste, Bioreactor, Methane, Sunflower stalk

Biomass Processing and Valorization with Protic Ionic Liquids

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Abstract:

Processing of lignocellulosic biomass, as an abundant and inexpensive source of bioenergy, with ionic liquids (ILs) has been very popular in the last twenty years. Interaction of cellulose with the aprotic ionic liquid (APIL), 1-butyl-3-methylimidazolium chloride (BMIMCl) was shown by Richard P. Swatloski in 2002. Since then, the research in this field has gained significant momentum and the researchers have explored beneficial effects regarding the pretreatment of a diversity of feedstocks with a wide range ILs. Among these benefits, cellulose decrystallization and delignification have been recognized to enhance the accessibility of cellulose to enzymatic digestion and the yields related to the biofuel generation such as bioethanol and biogas. In this study, we report the interaction of forest residues with low cost protic ionic liquids (PILs) under cost-effective conditions. PILs were shown very effective at biomass loadings as high as 30% and towards large biomass particle sizes >1 mm. Besides, reuse of PILs up to five times did not exhibit adverse effects on their performance and chemical structure. Delignification up to 80% was achieved and the cellulose in the untreated biomass was converted into glucose with yields over 90%.

Keywords: Cellulose, Lignin, Lignocellulosic biomass, Protic ionic liquids, Recycling

Enhanced Biogas Production and Recent Innovations in Biogas Technologies

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Abstract:

In this study, presentation of recent innovations which are developed to enhance biogas production and related technologies is aimed. In this regard, wide variety of new technologies and approaches used for the enhanced biogas production will be shared. Amongst the renewable energy sources, biogas has remarkable share. For example, as leading country, Germany's biogas production capacity has increased at tremendous rate reaching to 5,458 MW with 9300 biogas plants. Biogas plants in Turkey has been started to be promoted by YEKDEM 10 years ago and the total number of current biogas plants in Turkey is only around 60. The potential number of biogas plants to be built is estimated to be around 2800 in Turkey (assuming that each has 0.5 MWe installed capacity). The new incentive which is lower now needs extra motivation to increase the efficiency and enhanced biogas production in Turkey. In this study, new technologies for enhanced biogas productions (solid state fermentation; novel pretreatment processes such as sonication, steam explosion; novel additives; utilization of CO₂ for extra CH₄ production) will discussed and some field application examples will be shared. Last not but least, additional discussions in relation to bioenergy will be made through European Green Deal.

Keywords: Biofuel, Biogas, Biotechnology, Enhancement, Innovations

Biogas Formation Stages and Use

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Abstract:

With the rapid population growth, industrialization, and urbanization, and the decrease in fossil energy reserves, the interest in new energy sources has increased. Renewable energy sources have gained importance due to their benefits and contributions. Biomass, which has an important place among renewable energy sources, consists of organic materials of vegetable and animal origin. Biomass can be converted into useful, environmentally friendly, and energy-efficient biofuels with different processes. Biogas, which is a useful biofuel form of biomass, enables the use of waste as energy and organic fertilizers by anaerobic fermentation. Biogas consists of stages in which the synthesis and decomposition processes of many microbial species occur. Biogas formation consists of Hydrolysis, Acitogenesis, Acetogenesis, and Methanogenesis stages. Biogas formation is affected by temperature, pH, hydraulic holding time, toxicity, loading rate, solid matter ratio, C/N ratio, and mixing. Biogas is used in direct burning and heating, motor fuel, electricity generation, fuel cells, in addition to existing natural gas and production of chemicals. In this study, biogas, biogas formation, parameters affecting biogas production, and usage areas were investigated and suggestions were made.

Keywords: Biogas, Energy, Formation, Use

Potential of Biogas Production from Mushroom Compost Waste (MCW) in Turkey

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Abstract:

Biomass resources containing a wide range of organic matter are divided into six groups such as wood, waste (forest and agriculture), municipal solid wastes, wastewater, livestock wastes, and organic waste of industries (especially food). Direct usage of these resources can produce heat and, in the case of using them to produce biofuel such as biogas, which can be used in motor-generators to produce electricity. Mushroom compost wastes (MCW) are also agricultural wastes and one of biomass (especially biogas) resources. These wastes from cultivation can cause problems for people and the environment in mushroom production plants.

This study was aimed to determine the potential of biogas production from MCW in Turkey. According to TUIK data in 2020, 55 455 tons per year of mushroom production in Turkey was carried out. As a result of this production, 277 275 tons per year of mushroom compost wastes was occurred. Biogas production potential from MCW for Turkey has been calculated as 15 416 230 m³ year⁻¹.

Keywords: Biogas, Mushroom compost waste (MCW), Turkey

Effects of Solid Biogas Digestate Doses on Yield and Quality of Italian Ryegrass (*Lolium multiflorum* Lam.)

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Abstract:

This study was conducted between 2016 and 2018 to examine the effects of solid biogas digestate applications on forage yield and quality in Italian ryegrass (*Lolium multiflorum* Lam.). The experiment included the following treatments: (control)—no fertilization, 5 t ha⁻¹, 10 t ha⁻¹, 15 t ha⁻¹, 20 t ha⁻¹. The effects of digestate applications were observed with parameters that characterize both yield and quality, such as plant height (cm), stem diameter (mm), hay yield (t ha⁻¹), Ca (%), Mg (%), crude ash ratio (%), ADF (%), NDF (%), crude protein ratio (%), crude protein yield (t ha⁻¹) and relative feed value. As a result of the applications, it has been determined that digestate applications have no negative effects on the quality of forage as well as increasing the hay yield. At the same time, when the averages of the years are examined, it is seen that there is a significant increase in yield and quality compared to the first year. Considering the average of all applications for 2 years in terms of hay yield, it was determined that the values varied between 7.90 t ha⁻¹ and 11.10 t ha⁻¹, and the highest value was obtained from 15 t ha⁻¹ digestate application.

Keywords: Annual ryegrass, Biogas digestate, Fertilizer, Forage yield, Sustainable agriculture

Effects of Liquid Biogas Digestate Doses on Yield and Quality of Italian Ryegrass (*Lolium multiflorum* Lam.)

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Abstract:

This study was conducted between 2016 and 2018 to examine the effects of liquid biogas digestate applications on forage yield and quality in Italian ryegrass (*Lolium multiflorum* Lam.). The experiment included 5 different treatments: 0, 10 t ha⁻¹, 20 t ha⁻¹, 30 t ha⁻¹, 40 t ha⁻¹. The effects of digestate applications were observed with parameters of plant height (cm), stem diameter (mm), hay yield (t ha⁻¹), Ca (%), Mg (%), crude ash ratio (%), ADF (%), NDF (%), crude protein ratio (%), crude protein yield (t ha⁻¹) and relative feed value. As a result of the applications, it has been determined that liquid biogas digestate has positive effects on yield and quality. At the same time, when the averages of the years are examined, it is seen that there is a significant increase in yield and quality compared to the first year in the evaluation made in the 2nd year. Considering the average of all applications for 2 years in terms of hay yield, it was determined that the values varied between 5.72 t ha⁻¹ and 11,20 t ha⁻¹, and the highest value was obtained from 30 t ha⁻¹ liquid biogas digestate application.

Keywords: Annual ryegrass, Fertilizer, Forage yield, Liquid biogas digestate, Sustainable agriculture

Estimated on Gains by the Use of Bio-fertilizers Instead of Chemical Fertilizer in Turkey

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Abstract:

In present study, the population of Turkey between the years 2002-2020, using data from the agricultural areas and chemical fertilizers, the gains obtained with the use of cattle manure in biogas instead of chemical fertilizers were discussed. In the study, Ministry of Agriculture and Forestry, TURKSTAT, BEPA, and literature data were used. Over the years, the variation of the agricultural lands ($24.490.105 \pm 1.203.002$) ha, the chemical fertilizer consumed ($5.352.716 \pm 600.762$) tons and, N and P containing biofertilizers (434.826 ± 90.520) tons has been estimated in terms of average and standard deviation. In addition, it has been estimated that 40% of the chemical fertilizer is imported and an average of 20% of this amount can be met with biofertilizer substitution. We have estimated that biogas has the potential to use 5% of the annual energy consumption in Turkey. As a result, the estimates the gains obtained in terms of energy, economy, and ecology with the imported chemical fertilizer substitution of bio-fertilizer were shown statistically.

Keywords: Biofertilizer, Chemical fertilizer Renewable energy, Data analysis, TURKEY

Energy and Raw Material Recovery from Treatment Sludge as a Conceptual of Zero Waste

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Abstract:

Number of wastewater treatment plants are increasing rapidly along with human population and growing cities. This has been increasing large quantities of treatment sludge. In Turkey, treatment sludge are generally deposited in landfills after dewatering processes. Also it is used as soil conditioner which has adverse environmental effects such as odor and pollution in groundwater. It is indicated that 4500 tons/day of treatment sludge (dried bases) are produced in Turkey. Anaerobic digestion process is one of the most promising uses of treatment sludge, by converting organic waste into stable organic soil conditioners or liquid fertilizers, and reducing the environmental impact of organic waste products prior to their disposal, resolving ecological and agrochemical issues. Also anaerobic treatment regarded as a source of renewable energy in the form of methane gas.

In this study, before anaerobic digestion process, disintegration process is applied to the treatment sludge. At the end of the process, the big particulates and long chain molecules are ruptured. Therefore, enhancing microbial decomposition, biodegradable level of sludge, and biogas recovery is increased. At the same time for this application, it is known that disintegration of treatment sludge fed to anaerobic digester cause more phosphor and nitrogen releasing in the effluent of discharge (supernatant). This effluent can be used in liquid fertilizer production for a commercial based. In this study, it is aimed that increasing of biogas production will be performed by using disintegrating process before anaerobic digestion process and amount of sludge will be decreased. Liquid fertilizer/struvite can be recovered from digested and supernatant. There are several types of processes that accomplish as disintegration methods. These processes are typically mechanical, pressure-based, chemical, thermal, ultrasonic, electrical, or a combination of these. In this study, hydro dynamical type coupled with ultrasonic process that is developed by our institute and private company with together is implemented as the most efficient application.

The objectives of this study can be summarized as follow;

- Determination of physical and chemical characterization of treatment sludge, digested sludge and supernatant
- Determination of increasing potential of biogas production after implementing disintegration process in lab scale,
- Production of liquid fertilizer/struvite from supernatant coming from anaerobic digestion of sludge in lab scale

Keywords: Anaerobic digestion, Sludge disintegration, Biogas production, Liquid fertilizer/struvite production, Hydrodynamic cavitation

Presented on 20/05/2021 17:10 in “Hall-2 Session-2” by Özgür Doğan.

New Generation Reactor Design for Hydrogen Production from Biomass

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Abstract:

Today, hydrogen used in industry is obtained in large quantities from fossil fuels such as natural gas, petroleum products, or coal. In this study, a new generation reactor has been designed to obtain H₂ gas from biomass. Hydrogen is not a natural fuel, but a synthetic fuel that can be produced from different raw materials by using primary energy sources. All energy sources can be used in hydrogen production. The raw materials used are water, fossil fuels, and biomass. A new generation reactor has been designed and manufactured to produce H₂ using fast growing plants, forest waste, and existing biomass.

Keywords: Biomass, H₂, Reactor

High Temperature Biomass Thermal Conversion to Produce Sustainable Hydrogen

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Abstract:

The cleaner and renewable resources replaces fossil fuels recently. In this paper potential of different type biomass pyrolyzed at high temperature. Pyrolysis process occurs in the oxygen free medium, between 350°C- 500 °C in literature. However, in our experiments pyrolysis was occurred 850°C and 950°C residence time 40-60 minutes. The purpose of experiments is to produce high-quality tar-free gas, includes H₂ and CO at high temperatures and low residence time. The wood chip and manure was used as raw material. These results were compared with experiments performed at high temperature in an oxygenated environment in the literature. For the both systems, optimum production conditions were found to be 950 °C of temperature and 40 minutes of residence time in the oxygen-free medium. Hydrogen in the syngas was measured as 34 % and 52 % for wood chip and manure and LHV was calculated as 3372 kcal/kg and 3529 kcal/kg respectively in the oxygen-free pyrolysis at 950 °C and 40 minutes. So, the manure was chosen the major raw materials for H₂ production. The main objective of study is to product hydrogen and tar-free gas from renewable raw materials. Hydrogen production obtained from biomass resources is very important for future.

Keywords: Biomass, Hydrogen production, Syngas

Technology Development for Hydrogen Production from Biomass

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Abstract:

In this study, development of a hydrogen production technology based on gasification of biomass at pilot scale is presented. Biomass is a renewable energy source that captures carbon dioxide that leads to the greenhouse effect in the atmosphere, through photosynthesis and keeps it within the carbon cycle. Biomass resources can be directly used as fuel or converted into gaseous fuel. Energy conversion of biomass is more economic when carried out at its source because of its storage and transportation costs. A solid biomass fuel can be converted into a gas fuel through either a biochemical or a thermochemical process. Since a great majority of the biomass resources of our country are lignocellulosic, a thermochemical method is chosen in this study. Biomass is gasified to obtain synthesis gas. This is mainly composed of hydrogen, carbon monoxide, carbon dioxide, methane, and nitrogen. A catalyst is developed, and then coated on ceramic candle filters in order to remove tar compounds in the synthesis gas. The methane content of the syngas is reformed and the carbon monoxide content is shifted. Then, hydrogen is produced through pressure swing adsorption. The development of catalyst and filter, and also gasification, gas cleaning, and separation units are presented.

Keywords: Biomass, Catalytic filter, Gasification, Hydrogen production, Pressure swing adsorption

Hydrogen Production from Agricultural Waste Using Bentonite-Supported Catalyst

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Abstract:

Hydrogen is an environmentally friendly and significant energy carrier that can be obtained from biomass. Agriculture is one of the most important sectors in Turkey and agricultural waste is annually obtained about 46.280.000 tons. The aim of this research is to evaluate agricultural waste as a renewable energy source which is obtained after the harvesting and from the manufacturing processes of facilities. For this purpose, the biomass mixture (The mixture of sunflower seed pulp, tea, and tobacco waste) was gasified using a Bentonite supported Ni catalyst.

The catalyst was prepared with the impregnation method by loading 10 wt.% Ni over Bentonite then characterized by; thermogravimetric analysis (TGA), Fourier transforms infrared spectroscopy (FTIR) X-ray diffraction (XRD), and X-ray fluorescence (XRF).

Gasification of biomass was carried out by updraft gasifier unit using air as a gasification agent, at the temperature range of 650-850 °C, for 15-30 minutes, under catalytic and non-catalytic conditions using. The highest hydrogen yield was obtained as 5.26 mol H₂/kg biomass at 650 °C, for 15 minutes by using Ni/Bentonite. While the maximum hydrogen yield was reached at 850 °C without catalyst, the same hydrogen yield was obtained at 650 °C when the catalyst was used.

Keywords: Bentonite, Biomass, Catalyst, Gasification, Hydrogen

Evaluation of Pyrolytic Oil to Produce Bio-Carbon Materials

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Abstract:

Lignocellulosic biomass is considered to be a renewable and sustainable energy source directed towards running out of fossil fuel resources. Various thermochemical conversion processes are used to convert biomass into energy products among which, the pyrolysis method is the most preferred one. The characterization of pyrolytic oil reveals that it can be utilized as a synthetic fuel or a chemical feedstock for the production of carbonaceous materials.

In this study, pyrolytic oil (bio-oil) was produced from beechwood sawdust via slow pyrolysis at 500°C in a fixed bed reactor under nitrogen atmosphere. Bio-oil was characterized in terms of FT-IR, elemental analysis, GC-MS, and ¹H-NMR. The bio-oil having a high phenolic content was then carbonized at different final temperatures to obtain bio-carbon materials, which can be considered as powder vitreous carbon. The characterization of bio-carbon materials was carried out by XRD, FTIR, BET surface area, TGA, and elemental analysis. Bio-carbon with around 90 wt. % elemental C content was obtained at 500 °C carbonization temperature with a yield of about 8 wt. %.

To conclude, the pyrolytic oil obtained from beechwood sawdust seems to be a suitable feedstock for bio-carbon material production and can be a promising alternative source to phenolic resin.

Keywords: Beechwood sawdust, Bio-carbon, Bio-oil, Carbonization, Pyrolysis

Acknowledgment: The authors thank Eskisehir Technical University Department of Coordination for Scientific Research Projects for providing financial support with the Grant No: 19ADP133.

Effect of Temperature and Heating Rate on Catalytic Fast Pyrolysis of Walnut Shell and the Cobalt Catalyst Effect on Energy Content

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Abstract:

Liquids obtained from biomass by fast pyrolysis are products with higher energy content than its raw materials. These liquid products can be used to obtain chemical raw materials as well as as an energy source. Pyrolysis experiments were conducted at a constant 100 cm³/min inert nitrogen gas flow rate, at temperatures of 400, 500, 600 °C and at heating rates of 400, 500, 600 °C/min. Cobalt (Co) is used as catalyst in experiments. In addition, in order to examine the effect of the catalyst on the energy content of liquid products, a comparison was made by performing tests without catalyst under the conditions where the highest liquid products were obtained. The highest liquid products were obtained at 500 °C temperature and 400 °C/min heating rate, and as in all experiments, the amount of solid and gaseous products obtained under these conditions was also calculated. The catalyst used increased the energy content of the biomass liquid under conditions where the highest liquid product was obtained compared to experiments without catalyst.

Keywords: Catalyst, Fast pyrolysis, Heating rate, Temperature, Walnut Shell

Modification of Pore and Surface Characteristics of Biochar Produced from Raw Tea Waste

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Abstract:

The main objective of this study is to determine the effectiveness of various activation methods on the characteristics on biochar characteristics. The feedstock for producing biochar was used raw tea waste (RTW) that is extensively produced in Turkey, a cheap and sustainable source. The biochar was physically modified by low-frequency ultrasound (US) waves, chemically treated with phosphoric acid (H_3PO_4), and functionalized by potassium hydroxide (KOH). Biochar with high surface area and microporous structure was obtained by pyrolysis at 500 °C with the treatment of H_3PO_4 . On the other hand, treatment with KOH led to the formation of meso- and macroporous structures along with the remaining functional groups on the surface. Before chemical activation, US treatment increased the surface area and permeability of samples by the formation of open pores. However, the duration of US treatment is critical. Namely, above 60 min US treatment, the pore walls of biochar become thinner and breakage occurs, resulting in decreasing surface area and pore volume. The biochar samples with different characteristics have great use potential in many areas such as catalyst, adsorption, energy storage.

Keywords: Biochar, Chemical activation, Raw tea waste, Ultrasound activation

Acknowledgment: The author acknowledges the financial support of Sivas Cumhuriyet University Scientific Research Fund (CUBAP) (M-784)

Conversion of Defatted Spent Coffee Ground (DSCG) to Activated Carbon with High Activation by Carbonization Method

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Abstract:

Coffee is the most consumed beverage in the world. Therefore, there is plenty of coffee waste. Activated carbon production from organic wastes forms the basis of this study. In this study, defatted spent coffee ground (DSCG) was chosen as the source of organic waste. The aim of this study is to obtain activated carbon with high absorbance feature by increasing the carbonization temperature. In the first stage of the study, DSCG treated with 40% ZnCl₂ was kept at different temperatures for different periods of time. Then, the carbonization process was applied by burning at different times (30, 45, 60, 90, and 120 minutes) in the ash furnace at 1000°C. The iodine number of each activated carbon obtained was calculated. Iodine value is defined as the amount of iodine adsorbed per gram of activated carbon. It is also an indicator of the degree of activation (a high iodine number is an indication of a high degree of activation), expressed in mg/g. To obtain activated carbon from DSCG with high activation; DSCG treated with 40% ZnCl₂ is turned into activated carbon by burning at 1000°C for 120 minutes after being kept at 75°C for 24 hours. The iodine number of the activated carbon obtained was calculated as 718.3.

Keywords: Activated Carbon, DSCG, Organic Waste

Valorization of Olive Mill Solid Waste via Catalytic Hydrothermal Liquefaction

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Abstract:

Biomass is certainly the most reasonable and readily available source of a carbon-based fuel. For sustainable production of biofuels from biomass only land based lignocellulosic biomass may not be sufficient and other alternative lignocellulosic biomass feedstocks need to be valorized for biofuels and chemicals production. Olive oil production is an important agro-industrial sector in the Turkey. Olive oil extraction results in the production of a large amount of organic rich waste named as olive mill solid waste (OMSW). Hydrothermal liquefaction is a medium-temperature, high-pressure thermochemical process and can produce a liquid product, often called bio-oil or bio-crude. Catalytic hydrothermal liquefaction of OMWS to bio-oil was performed under various metal modified Montmorillonite (MMT) catalyst at 300 °C for 30 min. Synthesized catalyst were characterized with XRD, BET, and SEM techniques. After hydrothermal liquefaction light and heavy bio oil, solid product and aqueous phase was obtained. Products were characterized with elemental analysis for determining higher heating value (HHV) and GC/MS for bio-oil quality. Maximum total bio oil yield (38.06%) was found with Nickel modified MMT. Also results indicate that modified catalysts were improved the higher heating value (HHV) of the obtained bio-oil.

Keywords: Bio-oil, Biorefinery, Catalyst, Hydrothermal liquefaction

Evaluation of Electrode Properties of Activated Carbon Produced from Biomass Waste

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Abstract:

Energy and energy storage materials are being more essential as the conventional energy sources deplete day after day. Biomass wastes can be used as an energy source as well as a component of energy storage materials such as supercapacitors, batteries, and so on. In this study, the activated carbon from biomass waste was produced by using the chemical activation method. The electrochemical properties of the activated carbon were investigated by cyclic voltammetry technique. The large potential window was determined in the range from -1.2 to 0.0 V. Several potential scan rates from 5 to 100 mV/s were implemented to obtain the specific capacitance of the activated carbon electrode. The results indicated that the quasi-rectangular shape of the cyclic voltammograms was maintained at the scan rates between 5 and 100 mV/s. The highest calculated specific capacitance was 71.65 F/g at a scan rate of 5 mV/s. The specific capacitance decayed with increasing the scan rate. Consequently, the activated carbon produced from biomass waste can be used in supercapacitors as electrode materials.

Keywords: Activated carbon, Biomass waste, Cyclic voltammetry, Specific capacitance

Preparation and Characterization of Boron- Doped Nutshell Biochar for Li-S Battery

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Abstract:

Carbonaceous materials produced from natural biomass have attracted the attention of all because of their wide and sustainable sources, their low cost, and their innocuous environment. Moreover, the carbonaceous materials produced from biomass have several characteristics such as chemical stability, high specific surface area, hierarchical pore structure, abundant surface functional groups, and regeneration ability. These benefits make it extensively used in the fields of electrochemical energy storage devices. When the various heteroatoms (B, S, P, N, etc.) is doped carbonaceous materials, larger electronegativities in the field of Li-S battery can be obtained. In this work, biochar samples were prepared from a nutshell by different activation methods (acid and microwave activation) and boron-doped biochar samples were prepared using different boron precursors (boric acid, boron hydride, boron nitride). Acid and microwave activation resulted in the production of biochar samples with microporous structure and high surface area (1200-1700 m²/g). In addition, nitrogen and boron-doped biochar samples were produced using boron nitride. Surface area and pore characteristics of boron-doped biochar samples can be controlled by activation and pyrolysis conditions, boron precursors, and preparation methods.

Keywords: Biochar, Boron-doped biochar, Chemical activation, Nutshell

Acknowledgment: The study was supported by the Sivas Cumhuriyet University Research fund (M-795)

Decentralised Biomass Gasification System for Electricity Generation: Hindu Kush Himalayan Region of India

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Abstract:

Hindu Kush Himalayan region of India is home to nearly 88 million people and stretches over 11 states and the Darjeeling district of West Bengal. The major challenges of this area are unavailability of clean cooking fuel technology, constant forest fires, Himalayan meltdown, and lack of access to electricity. It is a paradox that this region generates more than 30 MT of biomass surplus annually and has a power potential of around 4.2 GW. On the contrary, biomass has inherent flaws that render it unfit for direct use in its original state. Therefore, thermochemical conversion route such as gasification, pyrolysis, and torrefaction, which outperforms other pathways in terms of conversion efficiency and capability to handle a variety of biomass could be used to convert biomass into fuels and energy. Thus, a decentralised biomass gasification system is a viable alternative for generating electricity in areas where grid connectivity is inaccessible, and it also produces biochar as a by-product, which can be used as cooking fuel. This system could be significantly contributing to the mitigation of environmental degradation and enhancement of the livelihoods and well-being of mountain communities by creating employment opportunities, reducing pollution and fire hazards, and ensuring clean, sustainable energy.

Keywords: Biomass, Gasification, Hindu Kush Himalayan, Power generation

Investigation of Oak Wood Biochar Gasification in Downdraft Gasifier Using Aspen Plus Simulation

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Abstract:

Continuous growing of energy demand and unstoppable release of greenhouse gasses into the atmosphere have motivated researchers to study on the biomass-based energy production. Biomass has many advantages over fossil fuels, however its calorific value is relatively low due to its higher moisture and volatile matter contents. Biomass can be carbonized to eliminate this disadvantage and obtain it as biochar with higher carbon content. Gasification is considered as the most promising thermochemical conversion method in terms of efficiency and exit gas composition for the carbonaceous materials. In the present study, biochar from oak wood is gasified under steam atmosphere using Aspen Plus simulation. The downdraft gasifier model along with the pyrolysis, gasification, oxidation zones as in real gasification steps is developed under steady-state equilibrium conditions based on the minimization of Gibbs free energy. The model was validated with the experimental work. The validation results showed that the model can perform the gasification process in accordance with the real case. A parametric analysis was performed to investigate the influence of the operating parameters (temperature, steam/biochar ratio) on the composition of the produced gas using sensitivity analysis. The obtained results showed a similarity with those found in the published literature.

Keywords: Aspen Plus, Biochar, Downdraft Gasifier, Gasification, Oak Wood

Investigation of Wheat Straw Gasification in CO₂ Atmosphere via Thermogravimetric Analysis

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Abstract:

Due to the depletion and adverse effects to the environment and the health of living things of fossil fuels, the orientation to alternative renewable energy sources has become an increasingly important issue worldwide. Biomass, as a renewable, is the most used energy resource after fossil fuels and can be found in various forms such as agricultural crops, forest wastes, animal residues, and municipal solid wastes in the environment. Gasification of biomass, that is obtained from thermochemical processing of biomass, is very attractive method for energy sustainability. Gasification process offers a promising way to remove carbon dioxide emissions from the atmosphere and utilize biomass effectively for energy production. In this study, wheat straw gasification process was investigated by using the thermogravimetric analysis (TGA). CO₂ (Carbon dioxide) atmosphere was used as a gasifying agent to investigate the gasification behavior. The kinetics of the wheat straw gasification was studied by Coats Redfern method which is based on Kissinger method. Results obtained from the study provided a good agreement with the literature.

Keywords: Biomass, Coats-Redfern Method, Gasification Process, TGA

Investigation of Cattle Manure in Steam Gasification from Bubbling Bed Reactor

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Abstract:

Among the various types of animal-based wastes, cattle manure is an alternative source for different applications. Excess cattle manure causes air and water pollution, so recycling of this waste is an important issue especially in rural areas. Gasification is the process that converts the waste into synthesis gas (syngas) to produce energy or higher value chemicals. In this work, cattle manure sample was used as feedstock for steam promoted gasification process in bubbling bed reactor by using Aspen Plus simulation. The developed bubbling fluidized bed gasifier model was validated with two experimental studies from the literature. The performance of the gasification process and the quality of syngas were investigated by means of lower heating value (LHV), the exergy value, and the composition of syngas. Sensitivity analysis was performed for the changing operating conditions such as temperature and steam/biomass ratio. The results showed good correlation with the literature works.

Keywords: Aspen Plus, Bubbling Bed Reactor, Cattle Manure, Exergy Analysis, Gasification

Poster Presentations

Prediction Of Biomass Gasification System Performance Using Machine Learning Tools

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Abstract:

The biomass gasification process is an effective way for obtaining synthesis gas from carbon-containing materials such as biomass. The gasification process is carried out at high temperatures and in different reactor types for different durations from various feedstocks. As a result, experimentally determining optimal conditions is a time-consuming, labor-intensive and costly process. Thus, it is very important to estimate the optimum product amount and composition with appropriate methods. For this purpose, in this study, we used artificial intelligence tools to predict the performance of a biomass gasification system. We used two regression techniques (support vector regression, Gaussian process regression) and an artificial neural network to predict the composition and properties of evolved synthesis gas. To carry out the prediction process, 325 data points for gasification of various biomass from the literature were collected. The performance of the three techniques is evaluated utilizing statistical tools. The performance of GPR technology was the best among the three technologies for all outputs by achieving (0.0007, 0.008, 0.001, 0.0006) MSE for H₂, CO, HHV, and LHV, respectively. The R-value was R 0.94 for the majority of the outputs. Therefore, GPR can be said to be the best modeling method used.

Keywords: Artificial Neural Networks, Biomass Gasification, gaussian process regression, Machine Learning Technics, Support Vector Machines

Biofuels and the Energy-Water Nexus: Perspectives for the United States

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Abstract:

This study provides an assessment on the production of biofuels, such as ethanol and biodiesel, and the energy-water nexus in the United States. This assessment was based on literature review and stakeholder consultation. We examined how some biofuel policy choices may affect water quantity and developed some corn-based ethanol production scenarios by 2030 for policy discussion. To date, biofuel production in the U.S. has not been limited by water availability. Nonetheless, recent data suggest that feedstock crop acres have expanded into some water stressed areas and that further expansion of biofuel production could exacerbate water scarcity in some areas, if precautionary measures are not addressed. Some simulations show, however, that it is possible to expand corn-based ethanol nationwide over the next ten years, without causing an additional use of water and land resources, based on yield growth on existing acreage. We recommend that policies and regulations should establish clear incentives to reduce agricultural water withdrawals in critical zones in favor of rainfed crops. Future policies should support sustainable water management and develop markets for advanced biofuels, aiming to minimize both irrigation and carbon intensity.

Keywords: Biofuels, Corn Ethanol, Energy-Water Nexus, EISA, Bioeconomy.

Acknowledgments: The authors acknowledge POET Biorefining LLC and the Roy Family Fund for their support of the Environment and Natural Resources Program (ENRP) at the Belfer Center for Science and International Affairs, Harvard Kennedy School. The company had no role in the preparation of this paper and the opinions here shown do not necessarily represent the views of POET. The authors also thank the valuable comments made by Keith Kline from the Oak Ridge National Laboratory (ORNL) in this study, which is available as a Belfer Center Working Paper (in press) at: www.belfercenter.org/enrp.

Determination of The Solid Fuel Pellet Characteristics of the Cannabis (*Cannabis sativa L.*)Hurds

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Abstract:

This study was carried out in the land of the Black Sea Agricultural Research Institute in Gelemen in 2019. In the study, the industrial cannabis varieties USO-31, Santhica-27, Ferimon, Fedora 17, and Futura 75, which are registered in Europe, as well as Narlısaray population, which has been cultivated by its producers for many years in Vezirköprü, were used as the material in the study. In the study, plant height and stem yield (kg/da) characters of cannabis varieties were examined. In addition, solid fuel pellets were made from the residues of the stalks after fiber removal, and the calorific value, moisture, ash, pellet diameter, pellet length, pellet durability, and flue gas emission values (O₂, CO₂, CO, NO, NO_x, SO₂) were examined. As a result of the study, the highest data in terms of stem yield, plant height, and calorific value were obtained from Narlısaray population. According to the results of the analyzed data, it was concluded that other cannabis varieties, especially Narlısaray population, can be considered as a solid fuel source.

Keywords: Hemp stalk, Renewable energy, Solid fuel pellets

Biodegradable Food Packaging Materials

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Abstract:

The production of packaging material has been increasing every year. Packaging is a key component for food industry to improve food storage, transportation, protection, handling, and preventing food waste. Synthetic plastics, which are produced from petrochemicals, have good thermal, barrier and mechanical properties but they can be non-biodegradable and cause serious environmental problems. Development of biodegradable or compostable packaging materials is required to help reduce solid waste disposal problems. Biopolymers are produced from biomass such as animals, plants, microorganisms and chemically synthesis using renewable bio-based monomers such as starch. Biodegradability of a material means that it is capable of being broken down into smaller compounds with the help of microorganisms. The biodegradation process is affected by the environmental conditions such as moisture, temperature, pH, nutrients. In recent years, the studies have been focused on new raw materials which are bio-based to replace synthetic polymers. However, bio-based materials for food packaging application have higher cost compared with synthetic polymers derived from petroleum resources. In this study, the benefits and drawbacks of biodegradable polymers are assessed. The current use and promising trend of biodegradable plastics for food packaging industry in the future are summarized.

Keywords: Biodegradation, Biopolymer, Food packaging, Sustainable

Effect of Natural Minerals on Oleic Acid Deoxygenation Reactions

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Abstract:

Due to the rapid increase in energy consumption and the environmental problems caused by primary energy sources, research on renewable and alternative energy sources is increasing. Also, because of the increasing population and consumption habits, the amount of waste becomes an important problem. Thus, transforming waste into energy sources is a promising issue. Converting waste vegetable oils to biodiesel is an effective method for these purposes. However, problems occur in biodiesel quality due to impurities in waste oil composition. Thus, catalytic the conversion of waste oils into hydrocarbon fuels with high calorific value through deoxygenation reactions carried out in recent years. Catalysts used for this purpose increase the cost. This study aims to examine the potential use of natural clay and minerals in deoxygenation reactions of waste cooking oil, which are inexpensive and abundant and have application possibilities in various industries. Oleic acid was chosen as the model compound and the reactions were carried out in the high temperature-pressure reactor in the presence of 1% catalyst at 300°C for 2 hours. The products obtained were characterized by different analytical instruments. The minerals especially with MgO and CaO content promoted deoxygenation reactions.

Keywords: Catalyst, Deoxygenation, Minerals, Oleic acid

Land Use Change and the European Biofuels Policy: The expansion of oilseed feedstocks on lands with high carbon stocks

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Abstract:

The objective this research was to provide a technical assessment of potential land use change arising from the growth of three major oil crops (soybean, oilseed rape, and oil palm), which have been partially used for biodiesel production globally. The assessment was based on a broad country-level analysis for major producing countries of these crops, such as, Argentina, Brazil, Canada, China, the European Union, India, Indonesia, Malaysia, and the United States. The methodology was based on historical time-series data analysis. The interactions between the expansion and contraction of these three crops over the last three decades were evaluated together with the carbon stock changes to the land. For oil palm and soy, we estimated an average expansion of 29% and 19% respectively, on high carbon stock land. The greenhouse gas emissions associated with these crops were found to be significant in terms of indirect land use change (ILUC) risk, 56 gCO₂eq/MJ for soy oil, and 108 gCO₂eq/MJ for palm oil, although future projections suggest that these values could drop significantly. These results are average figures and subject to large variations at national and sub-national levels. We did not find evidence for high ILUC-risk expansion of oilseed rape.

Keywords: Biodiesel, Land use change, Soybean, Palm oil, Rapeseed oil.

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Analyzing Some Relationships Between Physical-mechanical and Thermal Parameters of Bio-briquettes Produced from Persimmon Pruning Residues for Bioenergy

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Abstract:

Turkey imports a considerable part of its energy means from abroad. This creates a huge burden on the national economy. Turkey can be considered as poor in fossil fuel resources, but rich in renewable energy sources. Biomass is one these renewable energy sources which comes from various agricultural production lasting whole year due to four seasons richness of the climate in Turkey. In this study, solid cylindrical briquettes produced from persimmon tree pruning wastes under 2 different moisture contents (12% -15%), with 3 different particle sizes (3mm-5mm-8mm) and under 4 different briquetting pressures (80 - 120 - 160 - 200 MPa) were analyzed for its solid fuel properties. The lowest lower heating value was found as 18.46 MJ/kg where the highest lower heating value was 18.90 MJ/kg. The lowest ash content was obtained as 1.73% at 15% moisture content, 3 mm particle size under 200 MPa briquetting pressure while the highest was 2.47% at 12% moisture content, 5 mm particle size under 120 MPa briquetting pressure. The relationships between some physical-mechanical and thermal parameters of the produced briquettes were also analyzed.

Keywords: Agricultural waste, Briquette, Energy, Pruning, Solid bio-fuel

An Overview of Change in Pellet Fuel Properties by Torrefaction Process

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Abstract:

In recent years, in the biomass sourced solid fuel sector, there has been an increase in the use of such residues as solid fuel in the form of chips, ground products, or pellets to meet the thermal needs. The use of pellet fuel is the fastest growing sector among solid biomass fuel production. Due to this growth, the search for pellet raw materials has arisen, such as agricultural, forest industry, product processing, and urban residues. Increasing the variety of raw materials causes differences in pellet fuel quality. For this reason, torrefaction process, one of the thermochemical conversion technologies, has been applied in recent years to maximize the fuel quality of pellets produced from alternative raw materials. Torrefaction is the process of roasting biomass for certain residence times in an oxygen-free or low-oxygen environment at 200-300 °C temperature. Studies have reported that the calorific values of various torrefied pellets increased up to 30% according to untreated pellets. In addition, the torrefaction process improves the storage and transportation efficiency of pellets, and their energy density increases. In this study, the torrefaction conditions and fuel qualities of pellets produced from different biomass raw materials presented by researchers were investigated.

Keywords: Biochar, Biocoal, Biomass, Green coal, Mild pyrolysis

Biodiesel in Brazil: Challenges and Opportunities for a Sustainable Energy Transition

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Abstract:

The objective of this research was to assess the Brazil's National Program for Biodiesel Production and Use (PNPB), started in 2005. This program established a compulsory market for biodiesel blends, which gradually expanded to current B13 (temporarily B10) with a forecast of B15 by 2023, including targets for regional development and social inclusion. Petrobras plays a central role in the commercialization of biodiesel through public auctions, but this company made a significant divestment in this sector in recent years. In addition, fleet electrification trends and innovation in the production of advanced biofuels for diesel engines imply revisions in regulation. We suggest that no barriers to improvements should be imposed on those that reduce greenhouse gas emissions and that increase the overall efficiency of the biodiesel production processes. This sector has already achieved the necessary maturity level to move from the current auction system to a fully open market, which would enable greater competitiveness through free negotiations between distributors and processing facilities. Equally important is to improve the effectiveness of the "social fuel seal" program. This transition should occur through a systems perspective, not only looking at the biodiesel economic viability, but also at social inclusion, rural development, environmental services, and future technologies.

Keywords: Biodiesel, Biofuels, Brazil, Energy Policy, PNPB

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An Overview of Agricultural and Forestry Wastes That Can Be Used as Biomass Resources and Investigation of the Utilization Potential of Olives in This Area

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Abstract:

Turkey has a very rich agricultural potential, with 23.07 million hectares of arable agricultural land. 18.11 million hectares are cultivated, the remainder is fallow. The fact that Turkey is located in a favorable climate increase the geographical reach as product design and Her. Many products grown in our country, which is divided into .7 geographical regions, require energy production from biomass. Domestic organic wastes such as sunflower and soybean plants, wheat straw, hazelnut ash, agricultural wastes, tea wastes, olive seed and pulp, fruit and vegetable husk, herbs; Other plant wastes such as stems and roots, algae, algae in the sea, animal feces, fertilizer, and industrial wastes, wastewater treatment plant sludges offer a great deal of richness as a biomass source. Olive, the most precious product of the Aegean region, appears as a very valuable product with pruning wastes at the field stage and with its seed, black water, and pomace during processing into oil.

Keywords: Agricultural Waste, Biomass, Forest Waste, Olive

The Thermodynamic Behavior Investigation of Adsorption Mechanism for Removal of Cationic Dye by Hazelnut Shell Biomass

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Abstract:

Hazelnut shells, which were crushed in size by pulverization, were used as a bio-based adsorbent for studies on the removal of methylene blue (MB) dye from an aqueous solution. The effects of different operating parameters on adsorption were examined. The adsorbent showed high adsorption efficiency in a wide range of pH and temperature conditions. Furthermore, the Langmuir isotherm results are well-matched with the behavior of the adsorption process. The thermodynamic studies showed that the removal mechanism of MB dye was applicable and occurred spontaneously. The adsorption of MB dye on the adsorbent surface was confirmed by the structural and morphological analysis of the adsorbent before and after adsorption. This study showed that the hazelnut shell adsorbent could be considered as an ideal candidate for the removal of cationic dye pollutants from aqueous

Keywords: Adsorption, Hazelnut Shell, Methylene Blue Dye, Wastewater Treatment

The Kinetic Investigation of Cationic Dyes Removal Mechanism By Using Cypress Cone As Biomass-Based Adsorbent

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Abstract:

Cypress cones collected from Marmara University campus were pulverized to be used as bio-based adsorption material for the studies on the removal of methylene blue (MB) dye from wastewater. During the batch adsorption studies, we examined the effects of different operating parameters on adsorption performance under the specified optimum conditions. The outcomes obtained regarding the kinetic investigation were able to explain the adsorption behavior. The adsorption kinetics in accordance with the pseudo-second order model showed that the removal mechanism of the MB dye was applicable and occurred spontaneously. In conclusion, cypress cone adsorbent can be considered as an optimal alternative source for the removal of cationic dye pollutants from wastewater due to its advantageous properties, such as porous structure, large specific surface area, and excellent adsorption efficiency (100% removal), as well as its basic and environmentally friendly nature.

Keywords: Adsorption, Cypress cone, Dyestuff removal from wastewater, Methylene Blue Dye

As Bioenergy Source; Industrial Hemp

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Abstract:

Since fossil fuels are limited in energy production, human beings are in search of sustainable environmental energy. Today, although the need for sustainable clean energy is mostly met by wind and solar energy, these numbers are not enough to meet the consumption. Our country remains dependent on foreign sources due to insufficient energy resources. Today is obtained from 80% of fossil fuel energy production in Turkey and in our country this reason, the greenhouse gas emissions are greater than the world average. While per capita energy consumption in the world is 1.87 tons of oil equivalent, it is 1.59 tons of oil equivalent in our country. Since the carbon found in biofuels is obtained by the plant breaking down CO₂ in the air, it does not cause a net increase in CO₂ in the atmosphere. Biofuels have attracted the attention of researchers and producers in recent years because they are low-cost, economical, biodegradable, and sustainable. As biofuel production increases, research on more economical plants increases. In this article, the usability of industrial hemp, which produces high dry matter per unit area and has adapted to a wide area in our country, as a bioenergy source has been investigated.

Keywords: Biodiesel, Industrial hemp, Sustainable

Use of Chitosan in Food Packaging and Agricultural Applications

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Abstract:

Chitosan, which is obtained by deacetylation of chitin, one of the most abundant biopolymers in the world, has a wide application area with its biodegradable, biocompatible, and bioactive properties. Films with antimicrobial properties can be formed with chitosan, a cationic biopolymer capable of interacting with other polymeric fractions through high charge density, the presence of reactive hydroxyl and amine groups, and hydrogen bonds. In addition to applications in medicine, Chitosan films are used in combination with synthetic polymers to produce packaging films to maintain the quality of various food products. Chitosan-based nanocomposites are being developed for biosensors, packaging materials, separation processes, food or agriculture industry applications. As a safe alternative to hazardous pesticides, chitosan, which has negligible risk to human health and the environment, is also preferred for preserving crop yield and quality, reducing plant disease levels, and preventing the growth and spread of pathogens. It is aimed to develop green solutions to replace synthetic polymers with biopolymers derived from naturally renewable sources such as chitosan and other polysaccharides and to improve their barrier properties. In this study, the structure, properties, usage areas, and applications of chitosan were tried to be discussed.

Keywords: Biocompatible, Biodegradable, Biopolymer

Environmental Eschatology: How Might the Circular Bioeconomy Models Help to Rebuild a Post-Open Future?

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Abstract:

Eschatology is the part of theology concerned with the final destiny of the soul and humankind. It created the “pre-historic” perception of time and the future, and was highly defamed after The Industrial Revolution. Standing back to 16th century, massive migration waves from the rural areas to urban industrial zones has caused irreversible social changes, which eventually breed to perceive time as an “open-future”. The idea of open-future had led people to question identities as well as blurring the borders around the world and creating global economic systems. Nevertheless, the mass scale of production in these industrial zones has caused several negative effects on the climate, and this destruction caused by the global production has become one of the hottest issues in the political agendas. To mitigate the effects of the climate change and to reduce the destruction on the environment, circular economy models were designed to reduce the consumption levels and to promote efficiency in plenty of sectors. Amongst all, circular bioeconomy models are tremendously significant for the open-future theory, as for the first time it has the potential to recreate the balance between the urban and the rural areas, and would portrait a less irresolute future for societies.

Keywords: Bioeconomy, Environment, Eschatology, Open-future, Society

Prediction of Hemicellulose Content of Biomass By Means of Adaptive Neuro-Fuzzy Inference System

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Abstract:

It has become a global responsibility to reduce the damage of fossil fuels on the environment and human health, such as greenhouse gas emissions, particulate matter emissions, formation of harmful gases like SO_x and NO_x, etc. On the other hand, biomass proves to be a sustainable solution as it is carbon neutral, cheaply available in various forms, and is a renewable fuel. Although biomasses have various compounds, their organic structures are mainly composed of three biopolymers: Hemicellulose, Cellulose, and Lignin. Hemicellulose is an essential component of plant cell walls and consists of glucose along with several water-soluble sugars. Hemicellulose is converted into various forms of biorenewable chemicals, pharmaceuticals, fuels, and other materials in industrial applications. Therefore, determining the amount of hemicellulose in biomass is valuable in determining fuel efficiency. In this paper, the hemicellulose content of biomass is predicted using an adaptive neuro-fuzzy inference system (ANFIS) which uses the results of biomass proximity analysis. The results demonstrated that the ANFIS model can be operated effortlessly in hemicellulose prediction.

Keywords: Artificial Intelligence, Machine Learning, Proximate Analysis, Renewable Energy, Supervised Learning

Examination of Microalgal Pyrolytic Bio-char Properties

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Abstract:

Pyrolysis products of microalgae are bio-oil, bio-char, and bio-syngas. Bio-char is the main product of microalgae slow pyrolysis. Compared to fossil fuels, microalgal bio-char gives more energy and releases less CO₂ after its combustion. Bio-char can be used as fertilizer or in the production of nanotubes, activated carbon, carbon fibers. Bio-char retains its stability under most conditions and it has high C content. Under slow pyrolysis conditions at 500 °C, it has been known that *Spirulina* sp. bio-char has more C content and High Heating Value (HHV) compared to bio-char of *Chlorella vulgaris* sp. microalgae. In this study, pyrolysis of *Spirulina* was carried out in semi-batch reactor, at 25 mL/min N₂ gas flow rate, at 10 °C/min heating rate, with 60 min residence time and 15 g feedstock. Temperature was altered from 470 to 620 °C during the experiments. Yields of products were computed. Nitrogen adsorption, Scanning electron microscope, and elemental analysis were done for the bio-char. It was detected that C content of bio-chars was between 56-58 % by weight.

Keywords: Bio-char characterization, Biomass, Spirulina, Thermal degradation

Biomass Derived Carbon for Electrical Energy Storage

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Abstract:

Electrical energy storage is playing an increasing role for the portable systems such as electronics-electronic devices (laptops, cell phones, etc.), electrical transport vehicles (cars, airplanes, busses, etc.) that it is later converted to light, heat, or kinetic energy. The energy storage systems used in power systems store the energy mechanically, thermally, or electrically. Direct electrical energy storage is ineluctable issues of the energy storage technologies and material engineering that the performance of electrical energy storage devices mostly depends upon the material constituents.

Carbon is the preferred material for its high surface area, electrical conductivity, porosity, thermal stability, low cost, and eco-friendship and used in energy storage is very diverse such as nano materials (graphene, nanotubes, nano fibers, etc.), polymers, aerogels and biomass based ones.

Carbon materials are mostly originated from fossil fuels which are diminishing and cause climate change. On the other hand, biomass can be the only alternative, sustainable, economic, and environmental friendly carbon resource for resolving many of the challenges. In this work, the energy storage capacity of biomass derived carbon from industrial tea waste was examined. The sample exhibits tunable physical and chemical properties which are favorable in terms of advanced electrochemical energy storage.

Keywords: Biomass, Carbon, Energy storage, Tea waste

Forecast of Lower Heating Value of Municipal Solid Waste Via Adaptive Neuro-Fuzzy Inference System

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Abstract:

The rapid increment of world population and modern civilization have been causing to increase the amount of municipal solid waste (MSW) every year. In addition to emitting disturbing odor, the MSW poses great risks to the environment and human health, and requires an efficient utilization. Before evaluating MSW in any application, determining the energy content is critical for process efficiency. However, ingredients of MSW varies considerably and is influenced by the socio-economic conditions of the urban area. Therefore, in this study, the lower heating value (LHV) of MSW is calculated via adaptive neuro-fuzzy inference system (ANFIS) that is an advanced artificial intelligence method. Food, paper, plastic, wood, textile, and moisture content of MSW were assigned as input parameters. The LHV of MSW can be easily calculated via the newly developed ANFIS model without the need for any experimental procedure.

Keywords: Artificial intelligence, Deep learning, Modeling study, Urban waste, Waste utilization

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