Czech University of Life Sciences Prague

Faculty of Engineering

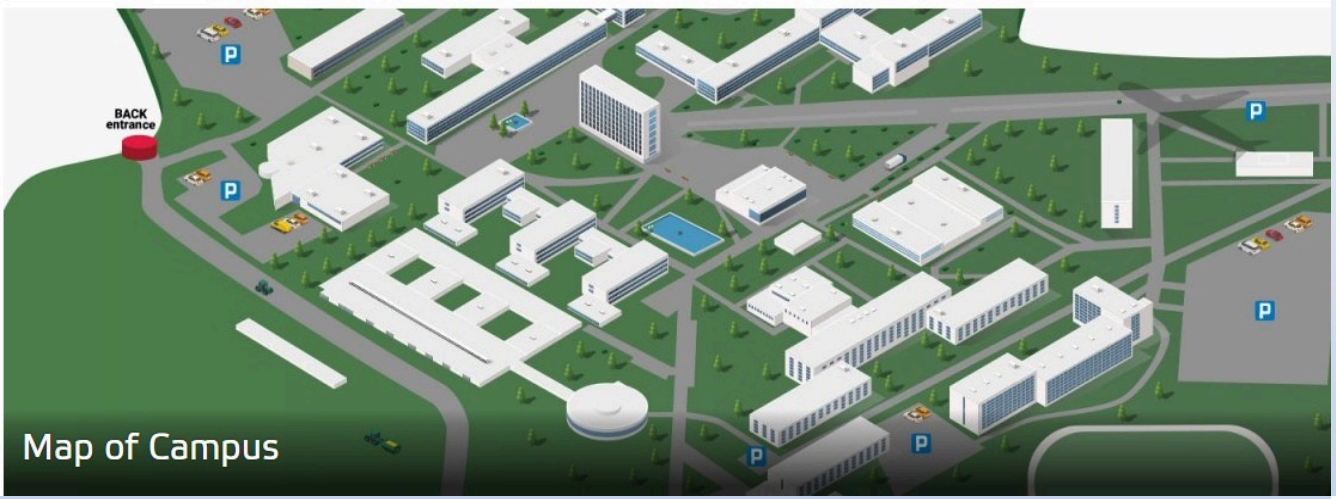
Processing of Plants Oil-based Feedstocks and Biomass

towards Renewable Energy Efficiency

doc. Ing. Abraham Kabutey, Ph.D.

Short Introduction of the Institution

Czech University of Life Sciences Prague



Faculty of Engineering

- More than 18 000 students (> 10% are international students),
- 6 Faculties and 1 Institute.
- Over 170 accredited study programmes at BSc, MSc and PhD levels (> 9 BSc, 20 MSc and 18 PhD taught programmes in English).
- Over 1 700 employees, of which more than 700 are Professors or Associate Professors.

Faculties and Other Parts

Faculties and Institute

- Faculty of Economics and Management
- Faculty of Agrobiology, Food and Natural Resources
- Faculty of Engineering
- Faculty of Forestry and Wood Sciences
- Faculty of Environmental Sciences
- Faculty of Tropical AgriSciences
- Institute of Education and Communication

Czech University of Life Sciences Prague

➢ Department of Mechanical Engineering

- Researches into energy efficiency utilization.
- Collaborates with other Faculties/Research Institutes on biomass energy processing.
- Collaborates with other EU partners and beyond for KA2 projects

❑ Collaborates with Farmet a.s. (Czech Republic) specializing in the:

- development and production of agricultural machines for soil processing and sowing,
- processing of oilseeds and production of oil processing technologies.
- Feed extrusion and production of feed mixtures.

Faculty of Engineering

Teaching Subjects

Czech University of Life Sciences Prague

- Introduction to Scientific Methodology (PhD Level)
- Basic Applied Mechanics (Master Level)
- Engineering Mechanics (Bachelor Level)
- Biosystems Engineering (Bachelor Level)

Faculty of Engineering

Background

- General Agriculture
- Agricultural Engineering
- Technology and Environmental Engineering

Expertise

❑Post-Harvest Processing

- Edible oilseeds
- Non-edible oilseeds
- Oil extraction process
- Residual oil recovery
- Oil quality parameters
- Processing technologies
- Processing factors
- Optimization techniques
- Modelling
- Simulation
- Biomass briquettes
- Elemental analysis
- Proximate analysis
- Energy utilization
- Emission analysis
- SEM analysis

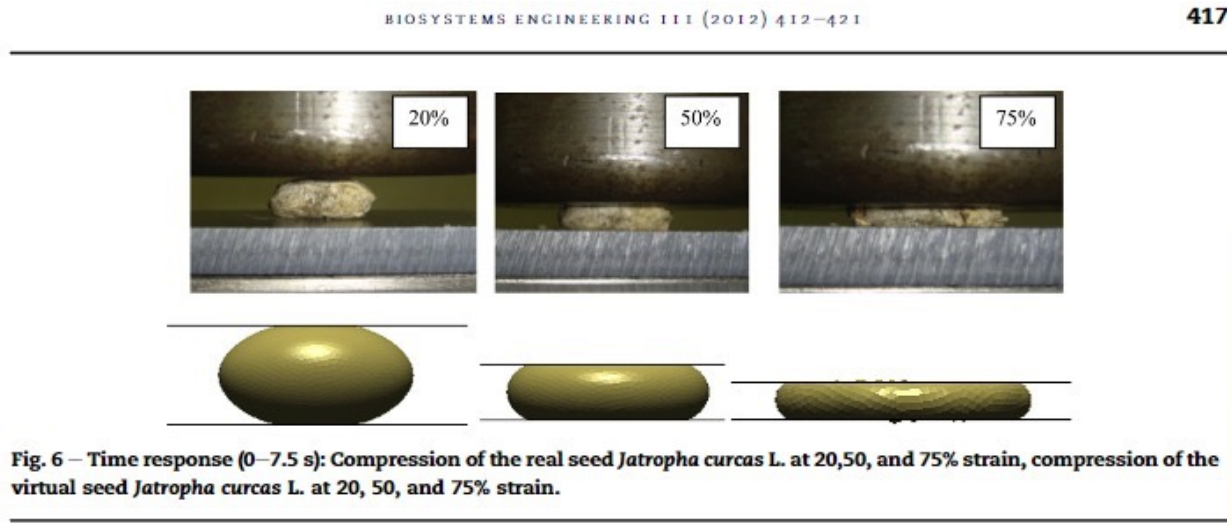
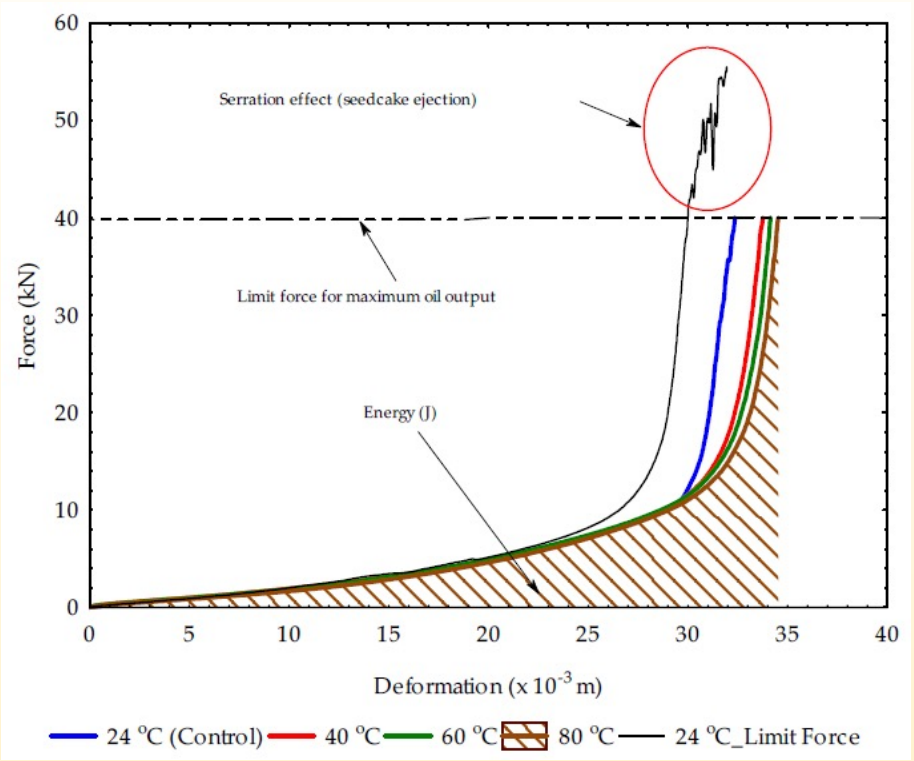


Fig. 6 – Time response (0–7.5 s): Compression of the real seed *Jatropha curcas* L. at 20,50, and 75% strain, compression of the virtual seed *Jatropha curcas* L. at 20, 50, and 75% strain.

Petrů et al., 2012

Linear processing (Kabutey et al., 2022)



Expertise

❑Post-Harvest Processing

- Edible oilseeds
- Non-edible oilseeds
- Oil extraction process
- Residual oil recovery
- Oil quality parameters
- Processing technologies
- Processing factors
- Optimization techniques
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- Simulation
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- Proximate analysis
- Energy utilization
- Emission analysis
- SEM analysis

Non-Linear processing (Kabutey et al., 2019)

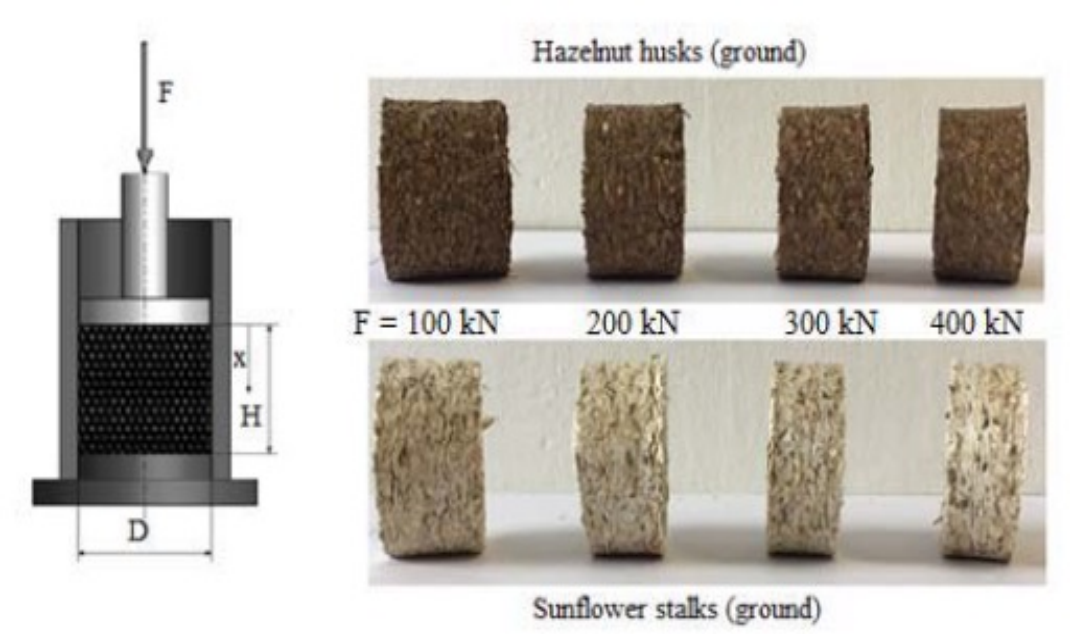
Expertise

❑Post-Harvest Processing

- Edible oilseeds
- Non-edible oilseeds
- Oil extraction process
- Residual oil recovery
- Oil quality parameters
- Processing technologies
- Processing factors
- Optimization techniques
- Modelling
- Simulation
- Biomass briquettes
- Elemental analysis
- Proximate analysis
- Energy utilization
- Emission analysis
- SEM analysis

SEM analysis

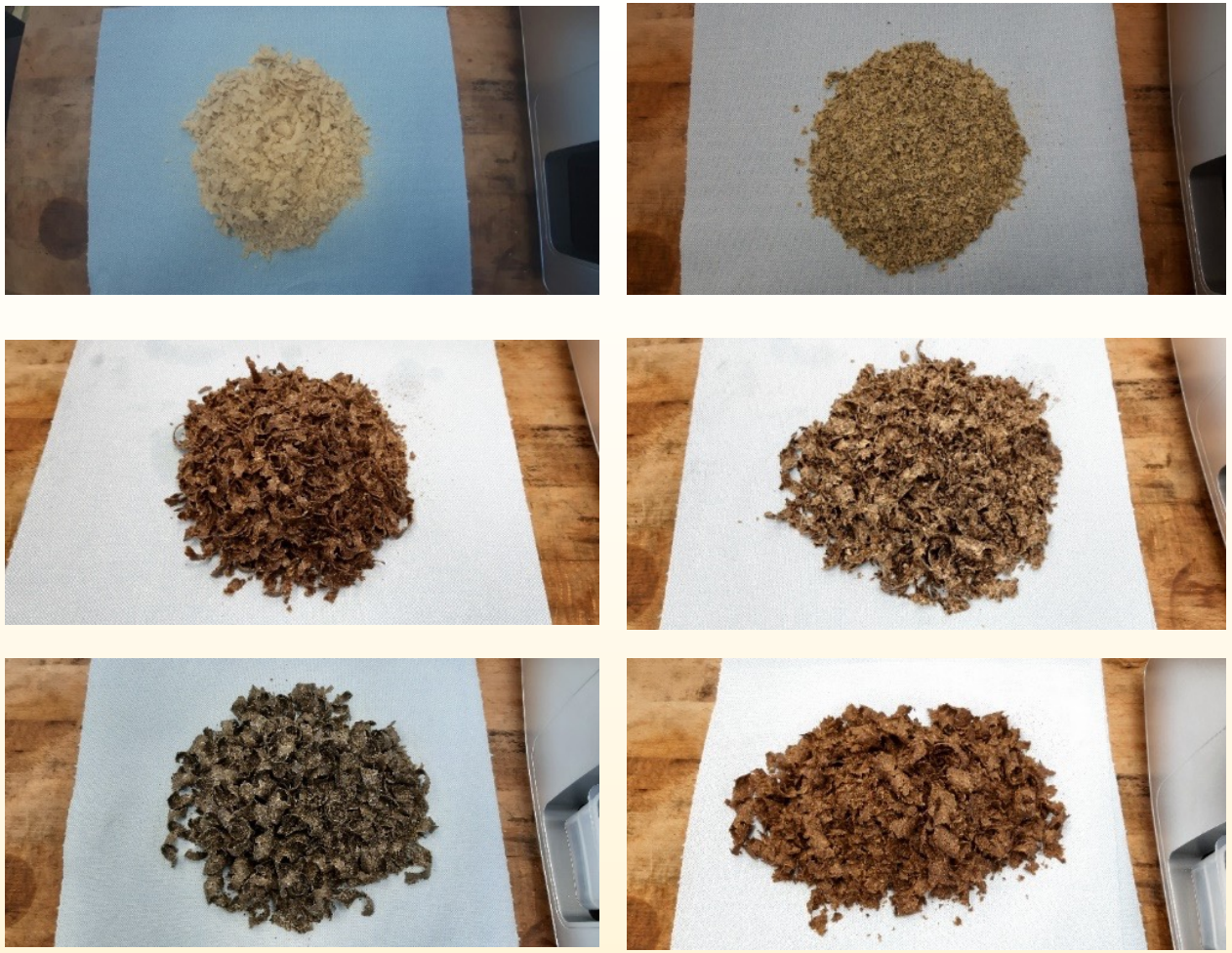
Proximate, Elemental and Calorific analyses



Briquettes densification
(Demirel et al., 2018)

Expertise

Extracted oils from oil-bearing plants/crops



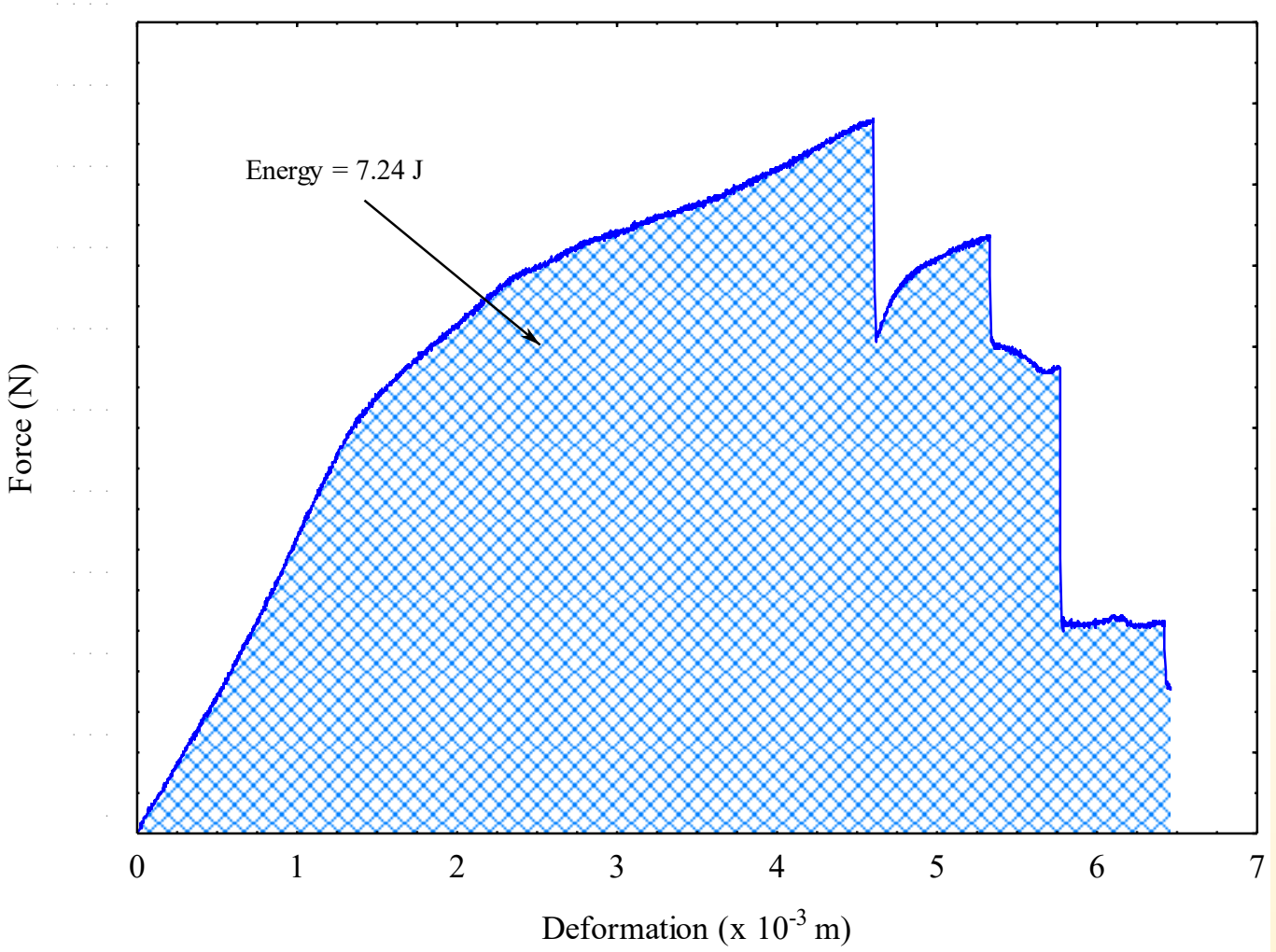
Oilseeds cakes for densification processing

Expertise

Compression test of coconut husks

(a)

(b)



Ivanova and Philip, 2023

Ongoing Master's Theses – Topics

- Evaluation of mechanical properties of mixtures of de-oiled seedcakes briquettes under linear compaction (Raj Akshay)
- Determination of oil-points and compression parameters of bulk pumpkin and sesame oilseeds under axial loading (Woldemichael Kiros Asmerom)
- Analyses of oil output indicators of selected bulk oilseeds under linear and non-linear compression processes (Abraham Afework Meseret)

- Investigation of pretreatment methods and processing factors of particular oil crop bulk oilseeds under uniaxial compression loading (Kibret Sonia habtamu)
- Processing of desiccated coconut medium under uniaxial compression loading (Tsogoo Amarsanaa)
- Drying kinetics of common agricultural products under different processing factors and methods (Onwuka Michael)

Interested Project Calls

CALL - FAIR, HEALTHY AND ENVIRONMENTALLY-FRIENDLY FOOD SYSTEMS FROM PRIMARY PRODUCTION TO CONSUMPTION (HORIZON-CL6-2023-FARM2FORK-01)

HORIZON-CL6-2023-FARM2FORK-01-3: Improving yields in organic cropping systems

CALL - CLEAN ENVIRONMENT AND ZERO POLLUTION (HORIZON-CL6-2023-ZEROPOLLUTION-01)

HORIZON-CL6-2023-ZEROPOLLUTION-01-4: Environmental sustainability and circularity criteria for industrial bio-based systems

CALL - CLEAN ENVIRONMENT AND ZERO POLLUTION (HORIZON-CL6-2023-ZEROPOLLUTION-02-TWO-STAGE)

HORIZON-CL6-2023-ZEROPOLLUTION-02-1-two-stage: Optimisation of manure use along the management chain to mitigate GHG emissions and minimize nutrients/contaminants dispersion in the environment

CALL - LAND, OCEAN AND WATER FOR CLIMATE ACTION (HORIZON-CL6-2023-CLIMATE-01)

HORIZON-CL6-2023-CLIMATE-01-6: Analysing fossil-energy dependence in agriculture to increase resilience against input price fluctuations

HORIZON-CL6-2023-CLIMATE-01-7: Enhancing the sustainable production of renewable energy at farm-level

CALL -RESILIENT, INCLUSIVE, HEALTHY AND GREEN RURAL, COASTAL AND URBAN COMMUNITIES (HORIZON-CL6-2023-COMMUNITIES-01)

HORIZON-CL6-2023-COMMUNITIES-01-6: Inclusive and smart ways to communicate sustainability of food

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Interested Project Calls

DESTINATION 1. CLIMATE SCIENCES AND RESPONSES FOR THE TRANSFORMATION TOWARDS CLIMATE NEUTRALITY

HORIZON-CL5-2023-D1-01-10: Improving the evidence base regarding the impact of sustainability and climate change education and related learning outcomes

HORIZON-CL5-2023-D1-01-11: Needs-based adaptation to climate change in AfricaHORIZON-CL5-2023-D1-01-11:

DESTINATION 3. SUSTAINABLE, SECURE AND COMPETITIVE ENERGY SUPPLY

HORIZON-CL5-2023-D3-01-01: Renewable Energy Valleys to increase energy security while accelerating the green transition in Europe

HORIZON-CL5-2023-D3-02-07: Development of next generation advanced biofuel technologies

HORIZON-CL5-2023-D3-02-16: Accelerating the green transition and energy access in Africa

Processing of Plants Oil-based Feedstocks and Biomass

towards Renewable Energy Efficiency

ScienceDirect

Journal of Food Engineering
Volume 360, January 2024, 111719

Evaluation of percentage oil yield, energy requirement and mechanical properties of selected bulk oilseeds under compression loading

A. Kabutey, Č. Mizera, D. Herák

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Abstract

The present study examined the percentage oil output, energy and mechanical properties of selected bulk oilseeds namely pumpkin, hemp, sesame, milk thistle, cumin and flax by a uniaxial compression process of a maximum load capacity of 500 kN and a preset speed of 5 mm/min. Each sample was measured at 60 mm pressing height with a plunger using the pressing vessel of diameter 60 mm. The results show that milk thistle seeds required the highest force corresponding to the highest stress and energy demand for recovering the oil in both the bulk oilseeds and seedcakes. However, pumpkin seeds produced the maximum residual oil yield of 24.99±0.04%, followed by sesame seeds at 21.29±1.82% and then flax seeds at 22.61±0.31%. The study revealed that higher energy is required to produce the maximum oil yield with minimum residual oil in the seedcake by continuous pressing.

Introduction

Oilseeds are derived from oil-bearing crops/plants seeds which are used for the extraction of vegetable oils and are a highly valuable source of proteins, lipids, carbohydrates and functional components such as phytosterols, tocopherols, lignans and polyunsaturated fatty acids (Wittkop et al., 2009; Sa et al., 2022; Bakhytkyzy et al., 2023; Wen et al., 2023). During the last four years, global vegetable oil production has exceeded 200 million metric tons/year, where palm, soybean and rapeseed are the most consumed oils (Dunford, 2022). The utilization of vegetable oils ranges from cooking, food, biofuel, animal feed, and pharmaceuticals to industrial products (Dunford, 2022). Many oilseeds with high oil contents or abundant bioactive compounds are potential for consumption and industrial purposes, but, they have not been adequately processed (Zhang et al., 2021). With the growing demand and supply of vegetable oils, promising oil processing techniques are required to utilize different oilseeds fully and improve the oil

Current Publications

https://www.mdpi.com/search?authors=kabutey&journal=foods

Previous Publications on Biomass Briquettes

https://www.mdpi.com/1996-1073/13/10/2542

https://www.mdpi.com/1996-1073/11/8/1980

https://www.mdpi.com/1996-1073/11/2/331

Internal Collaboration & Experts

doc. Ing. Bc. Tatiana Alexiou Ivanova, Ph.D.

http://wp.czu.cz/cs/index.php/?r=1071&mp=person.info&idClovek=8315

doc. Ing. Jan Malaťák, Ph.D.

http://wp.czu.cz/cs/index.php/?r=1071&mp=person.info&idClovek=2463

Jan Velebil

http://wp.czu.cz/cs/index.php/?r=1071&mp=person.info&idClovek=18042

ScienceDirect

Renewable Energy

Volume 211, July 2023, Pages 248-258

Physico-mechanical and energy properties of pellets made from ground walnut shells, coniferous tree cones and their mixtures

Arkadiusz Gendek [a], Monika Aniszewska [a], Danuta Owoc [b], Barbora Tamelová [c], Jan Malaťák [c], Jan Velebil [c], Jozef Krilek [d]

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https://doi.org/10.1016/j.renene.2023.04.122

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Abstract

The aim of this study was to verify the possibility of obtaining good-quality pellets from mixtures of materials with different particle structures and shapes. The paper describes the pressure agglomeration of ground walnut shells and coniferous tree cones as well as their three mixtures. The process involved the production of pellets with a diameter of 6 and 8 mm at the temperatures of 95 and 120°C by applying the force of 5 and 6 kN. The fraction distribution of the particles from which the pellets were made was assessed. It was found that the pellets made only of cones, as opposed to those made only of nutshells, have a fairly even distribution, i.e. the particles were of similar size. The size parameters of the pellets (length and diameter) were measured, on the basis of which the density of individual pellets was calculated. Compressive stresses of the pellets were tested on an endurance testing machine. It was found that the pellets with a greater share of nut shells were less durable than those made with the addition of ground cones. The pellets with a diameter of 6 mm and formed at a temperature of 120°C also showed a higher strength than those with a diameter of 8 mm and compacted at a temperature of 95°C. Increasing the force did not statistically significantly improve the compressive strength of the pellets. Tests of the elemental composition and the amount of ash allowed for concluding that pellets are a good energy material, as evidenced by their average calorific value of about 19 MJ kg^{-1}. Due to exceeding the permissible limit of nitrogen content (ISO 17225), the pellets made solely of cones were classified as quality class B, while the addition of ground walnut shells shifted them to class A2.

Introduction

As part of the EU climate and energy policy, the Member States, including Poland, have been obliged to reduce greenhouse gas emissions by 40% by year 2030 compared to the level in 1990. It also requires

Contact details

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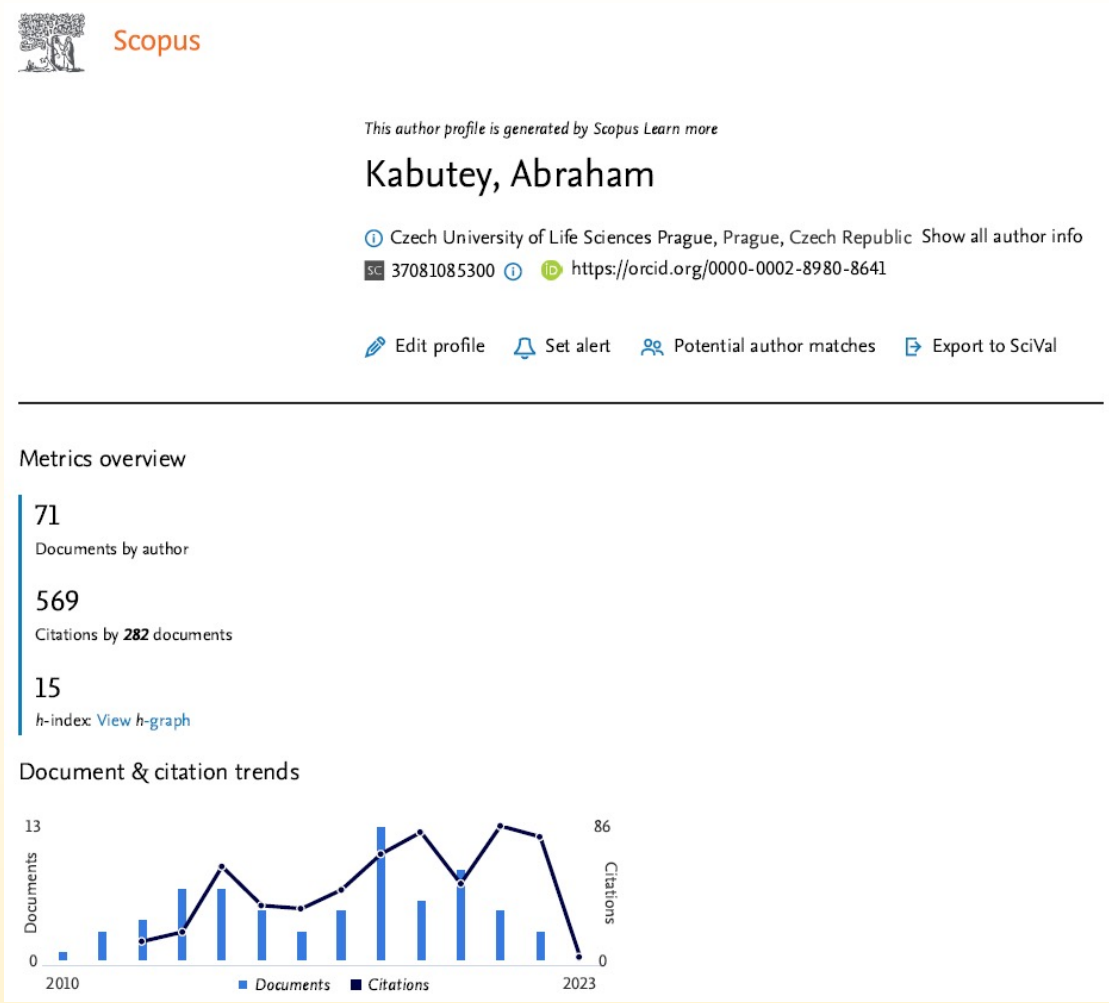

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