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NATIONAL OPEN ACCESS SCIENTIFIC CENTRE FOR FUTURE ENERGY TECHNOLOGIES

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Evaluation of Multi-Crop Biofuel Pellet Properties and the Life Cycle Assessment

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Introduction (1)

The aim of this work – to determine the suitability of multi-crop plants: fibrous hemp, maize and faba bean for production of granulated biofuel, and to investigate thermal, chemical and physical-mechanical properties of biofuel pellets.

Benefits of multi-crop plants:

- improve soil fertility,
- increase soil conservation,
- provide better lodging resistance,
- reduce fertilizer and pesticide requirements.

Introduction (2)

- **Faba bean** due to their ability to introduce nitrogen into the system, they contribute to the sustainability of cropping systems.
- **Fibrous hemp** may be used in crop rotation. Stems can be used for briquetting and pelleting production. The ability of fibrous hemp is to yield more than 24 tons of green biomass per hectare (corresponding to 10.9 t ha^{-1} of dry biomass) within 140 days.
- **Maize** is high-yield commodity crop that is suitable for both food and forage, as well as for the production of bioenergy.



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Materials and Methods (1)

- Three varieties of plants: maize (*Zea mays* L.), fibrous hemp (*Cannabis sativa* L.) and faba bean (*Vicia faba* L.) were grown as mono and binary crops.

1. Maize (mono);
2. Fibrous hemp (mono);
3. Faba bean (mono);
4. Maize + Fibrous hemp (binary);
5. Maize + Faba bean (binary);
6. Fibrous hemp + Faba bean (binary);
7. Fibrous hemp + Maize + Faba bean (trinomial).

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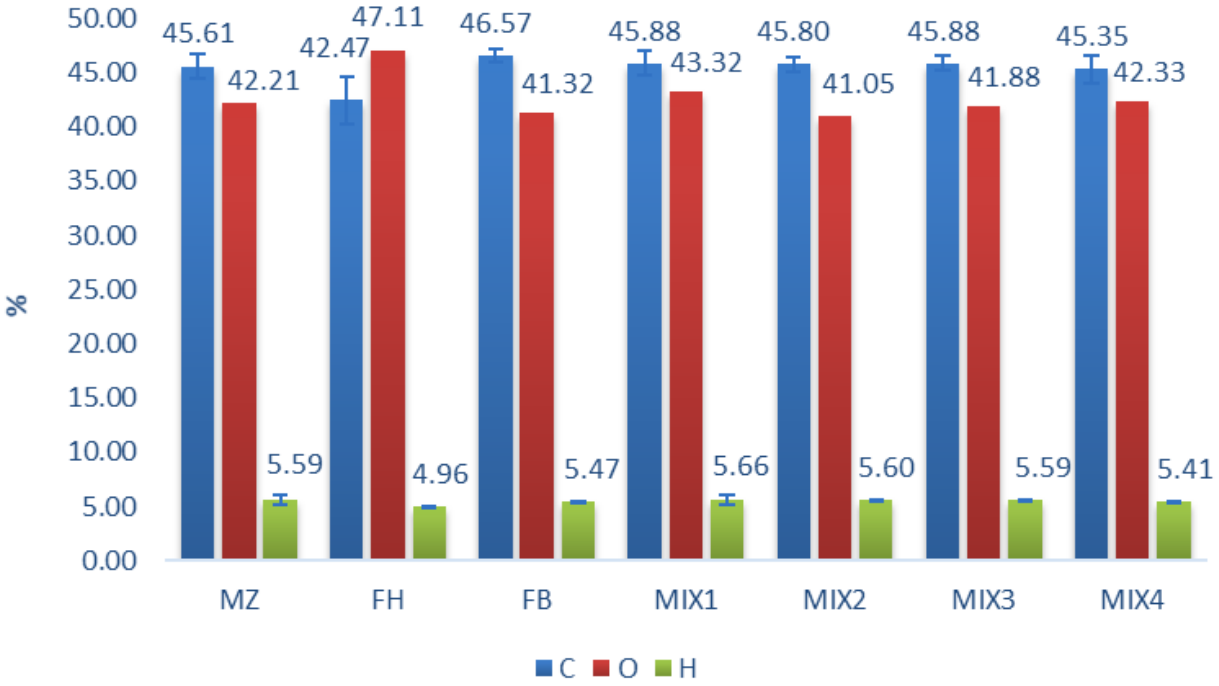
Materials and Methods (2)

- The investigations of 2020-2021:
  - ✓ the technological-technical means for the processing of plants,
  - ✓ production and usage of biofuel pellet for energy purposes,
  - ✓ physical-mechanical and thermal properties of biomass granules.

Results and Discussion (1)



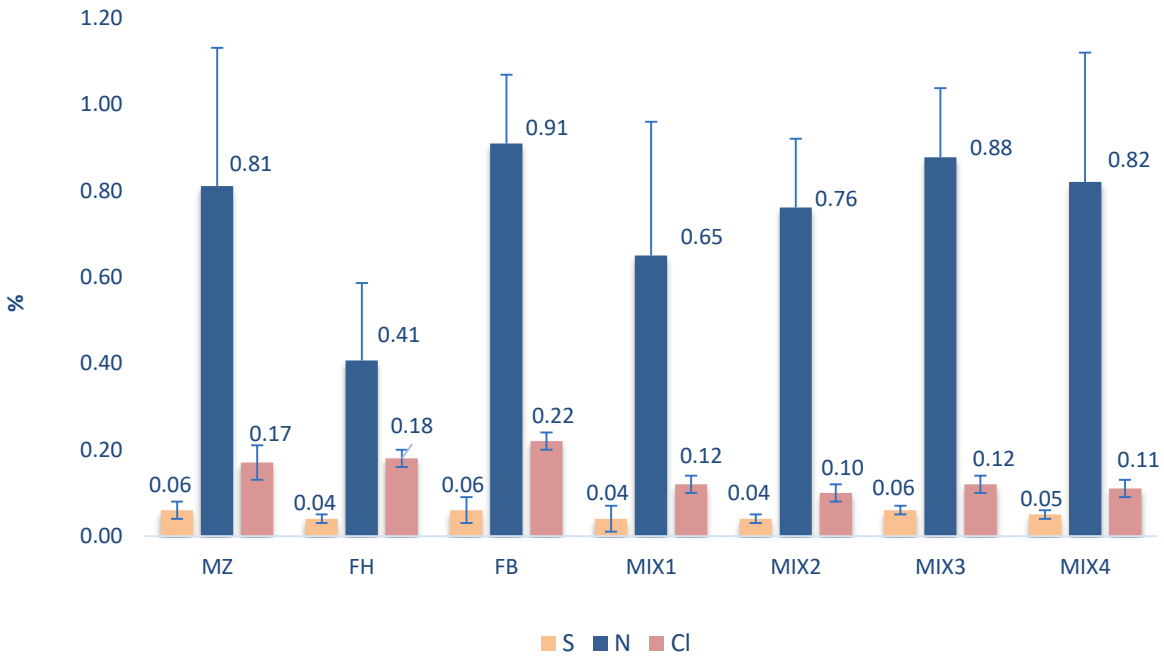


Figure 1. Chemical composition of biomass pellets.

Abbreviations: Mz – maize (mono), FH – fibrous hemp (mono), FB – faba bean (mono), MIX – maize and fibrous hemp (binary), MIX2 – maize and faba bean (binary), MIX3 – fibrous hemp and faba bean (binary), MIX4 – maize, fibrous hemp and faba bean (trinomial).

Results and Discussion (2)

Table 1. Moisture content, ash content and calorific value of biomass pellets

Type of biofuel	Humidity, %	Ash quantity, %	Higher calorific value MJ kg^{-1}	Lower calorific value MJ kg^{-1}
Maize	4.61 ± 0.59	5.78 ± 0.06	18.02 ± 0.86	16.87 ± 0.93
Fibrous hemp	3.86 ± 0.05	5.05 ± 0.04	18.16 ± 0.54	17.14 ± 0.57
Faba bean	6.15 ± 0.28	5.74 ± 0.29	18.23 ± 0.38	17.10 ± 0.41
Maize+Fibrous hemp	4.44 ± 0.22	4.49 ± 0.05	18.29 ± 0.78	16.99 ± 0.85
Maize+Faba bean	8.78 ± 0.43	6.78 ± 0.18	17.96 ± 0.32	16.80 ± 0.35
Fibrous hemp+Faba bean	8.30 ± 0.15	5.78 ± 0.06	18.17 ± 0.59	17.02 ± 0.63
Fibrous hemp+Maize+Faba bean	5.63 ± 0.23	6.08 ± 0.05	18.04 ± 0.61	16.92 ± 0.66

Results and Discussion (3)

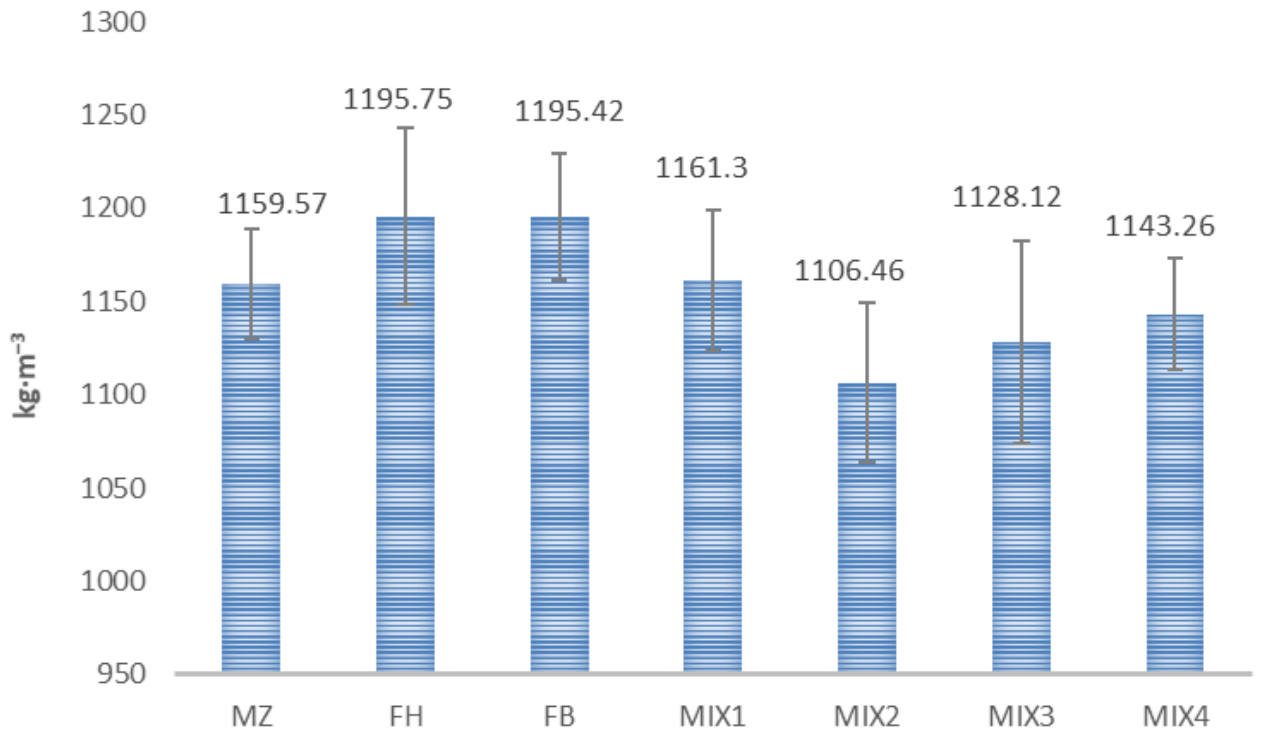


Figure 2. Pellets density

Abbreviations: Mz – maize (mono), FH – fibrous hemp (mono), FB – faba bean (mono), MIX – maize and fibrous hemp (binary), MIX2 – maize and faba bean (binary), MIX3 – fibrous hemp and faba bean (binary), MIX4 – maize, fibrous hemp and faba bean (trinomial).

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Results and Discussion (4)

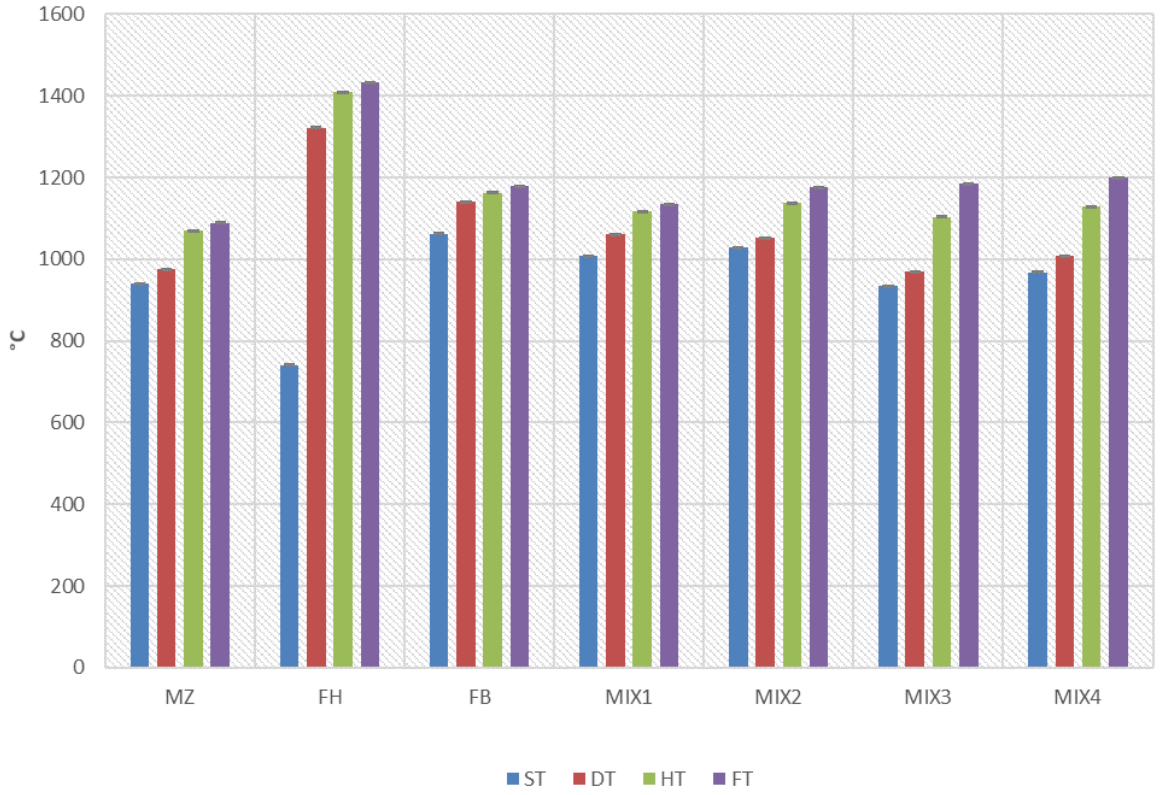

Figure 3. Ash melting temperatures of biomass pellets

Abbreviations: Mz – maize (mono), FH – fibrous hemp (mono), FB – faba bean (mono), MIX – maize and fibrous hemp (binary), MIX2 – maize and faba bean (binary), MIX3 – fibrous hemp and faba bean (binary), MIX4 – maize, fibrous hemp and faba bean (trinomial).

Conclusions

- The research results of biometrical parameters of pellets showed that mono and multi-crops plants had different moisture content. The moisture of maize and faba bean mixture biomass granules was the highest – 8.78 ± 0.43 %, whereas that of fibrous hemp pellets was 2.3 times lower – 3.86 ± 0.05 %.
- After the investigation of chemical composition and the biofuel calorific value of mono and multi-crops plants pellets it can be stated, that the calorific value was sufficiently high and accounted for about 17 MJ kg^{-1}, which is only 4 % less than wood pellets.
- Pressed multi-crop plants meet the quality characteristics and standard requirements for solid biofuel pellets.

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Thank you for the attention

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