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Evaluation of Corncob Pellets: Drying Methods, Densification, and Energy Potential

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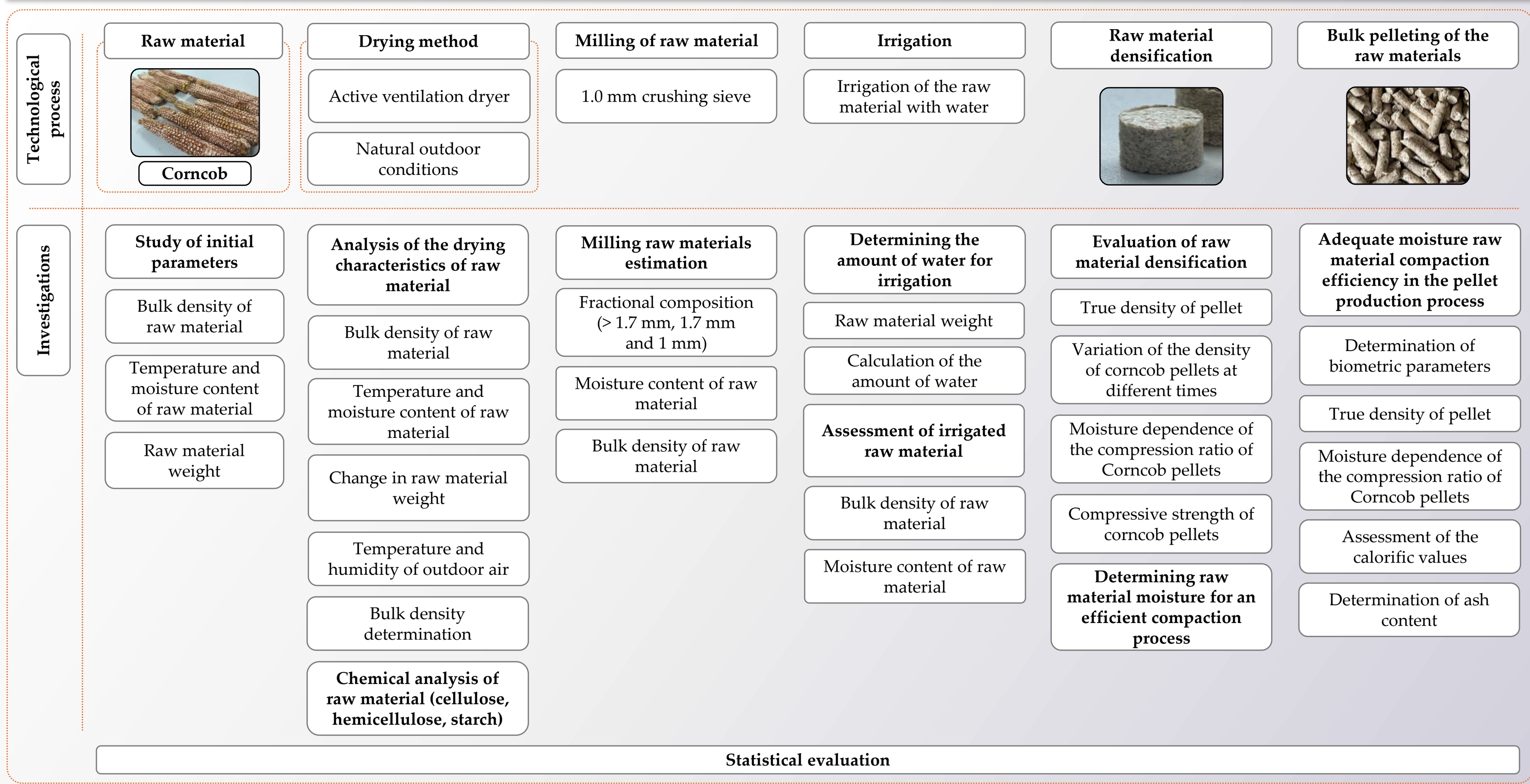
INTRODUCTION & AIM

Biomass is a key renewable energy source, widely used for producing fuels, electricity, and bioproducts, reducing greenhouse gas emissions and dependence on fossil fuels [1,2,3]. Agricultural residues, like corncobs, are a promising biomass feedstock due to their abundance and minimal impact on the food industry [4,5]. However, their low bulk density, high moisture content, and irregular shape require densification processes, such as pelletizing, to improve handling, storage, and energy efficiency [6,7].

Corncobs, though less energy-intensive than fossil fuels, exhibit significant potential as biofuel due to their higher bulk energy content [8]. Preparing corncobs for densification involves proper drying, milling, and maintaining optimal moisture levels, which are crucial for achieving high-quality pellets. Research highlights gaps in understanding corncob preparation, especially moisture content optimization, which affects compaction efficiency, mechanical durability, calorific value, and ash content.

The aim of this research is to evaluate corncob preparation and the physical-mechanical properties of compacted material by determining optimal moisture content for pellet densification, assessing compaction efficiency, and analyzing biometric properties, mechanical durability, calorific value, and ash content.

METHOD



RESULTS

1. Analysis of the Corncob Drying Characteristics

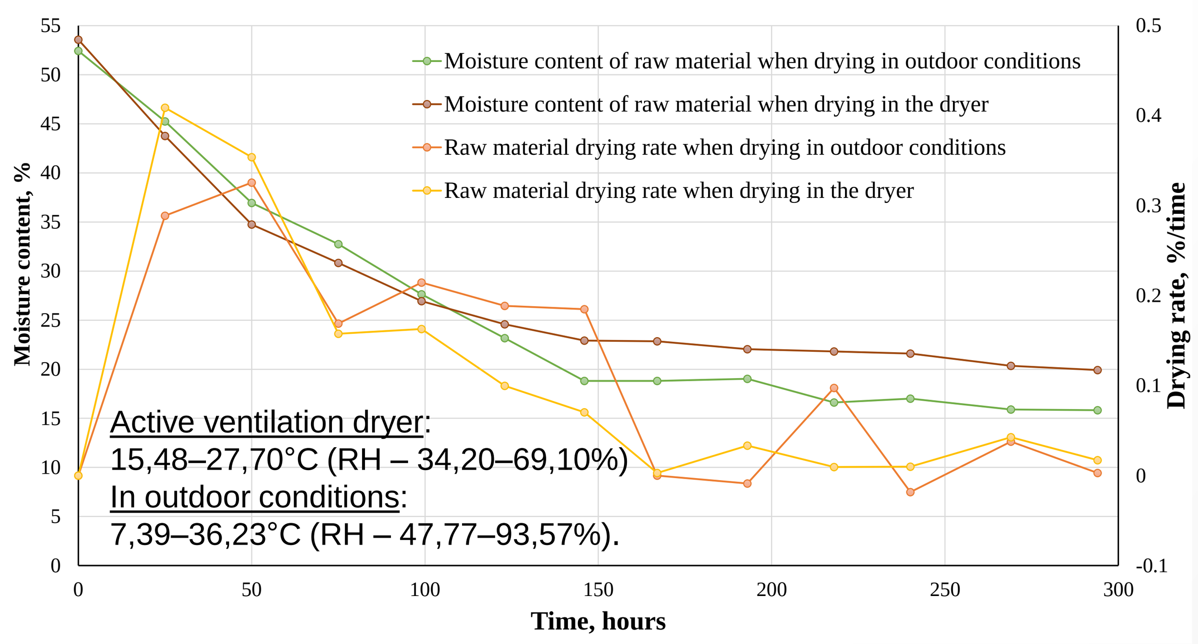


Fig 1. Corncob drying characteristics: dependence of raw material moisture content and drying rate on drying time in an active ventilation dryer and outdoor conditions. Results are presented as mean value (n = 3).

2. Chemical Analysis of Corncob

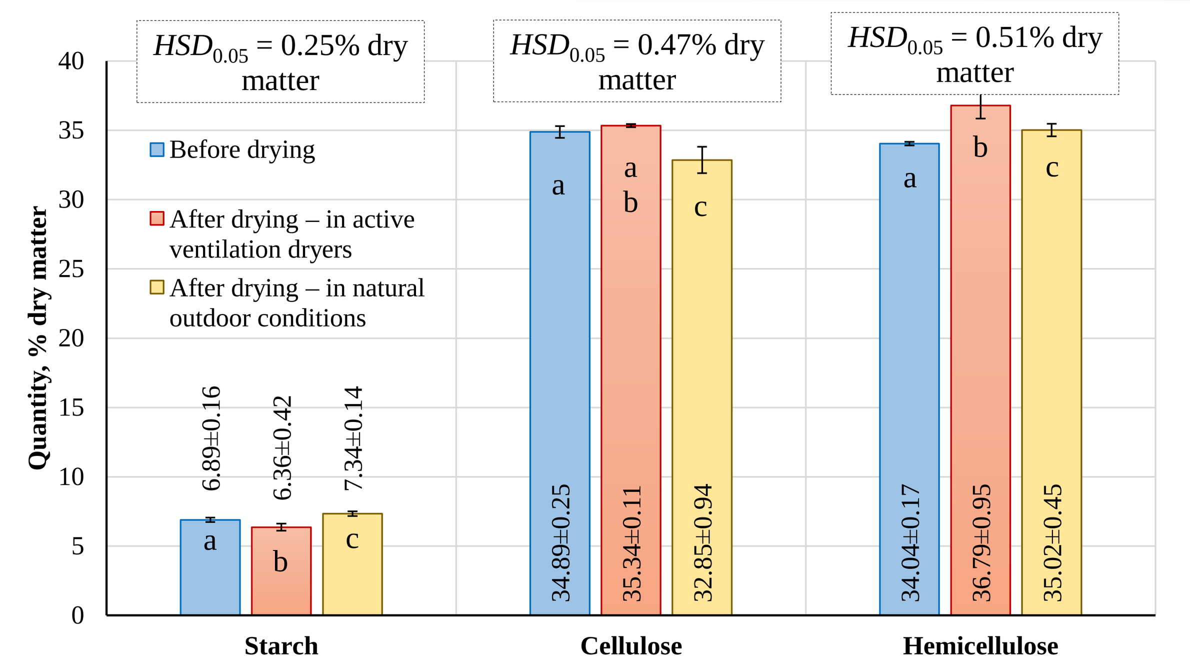


Fig 2. Starch, cellulose, and hemicellulose values in corncob before and after drying. Different lowercase letters indicate significant results at p < 0.05 based on one-way ANOVA with the Tukey HSD test (n = 3). The data are summarized as means ± standard deviations.

3. Corncob Milling and Evaluation

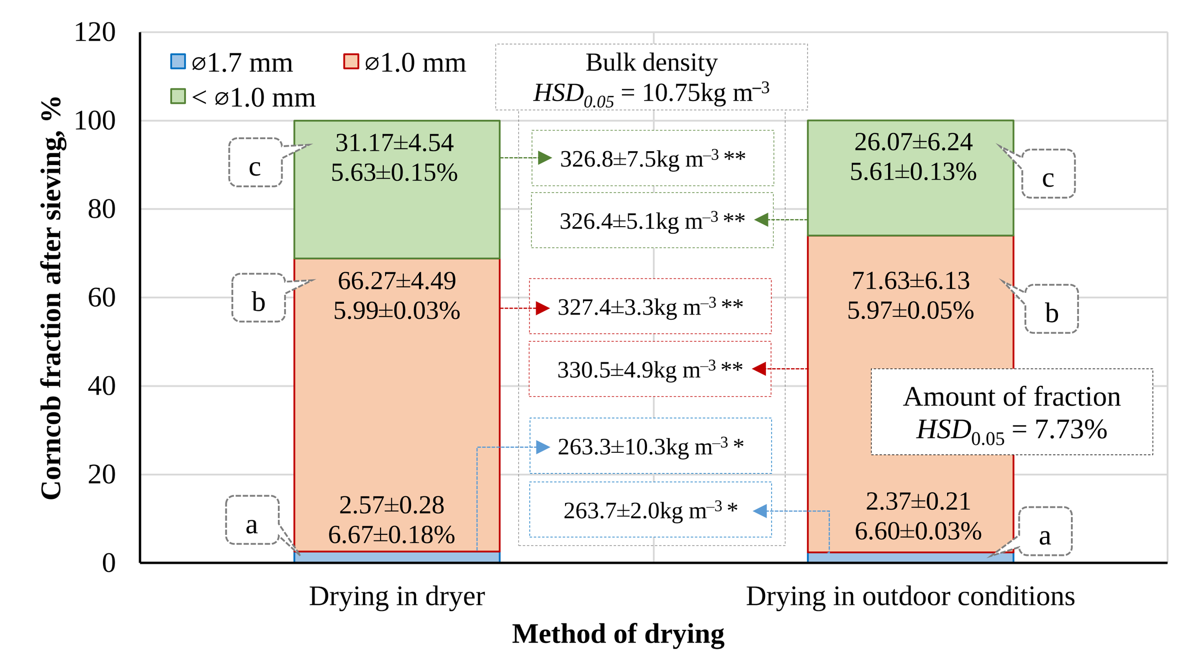


Fig 3. Fractional composition of corncob biomass. Results are significant at the p < 0.05 level, based on one-way ANOVA with the Tukey HSD test for differences between groups (fractions in lowercase letters; bulk density in asterisks "*" and "**") (n = 6). The data are summarized as means ± standard deviations.

4. Analysis of Corncob Densification

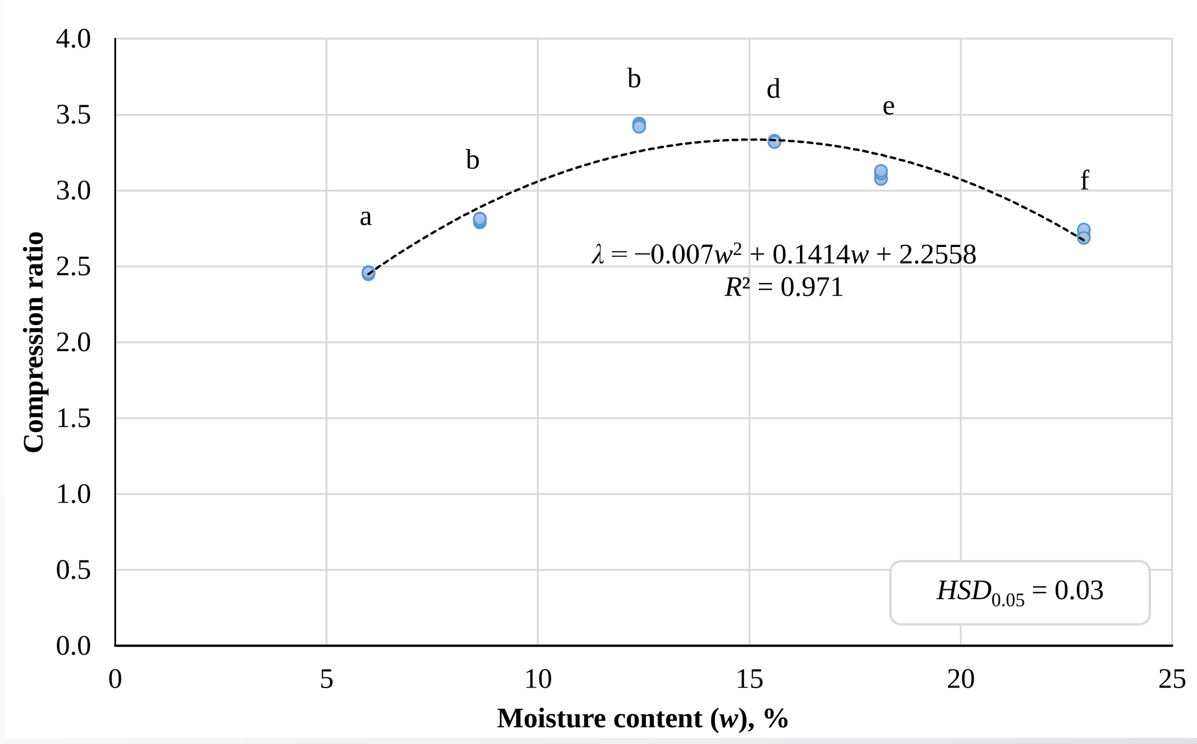


Fig 4. Dependence of the compression ratio on corncob pellet moisture. Results are significant at p < 0.05 based on one-way ANOVA with the Tukey HSD test (n = 5) for differences between groups (denoted by lowercase).

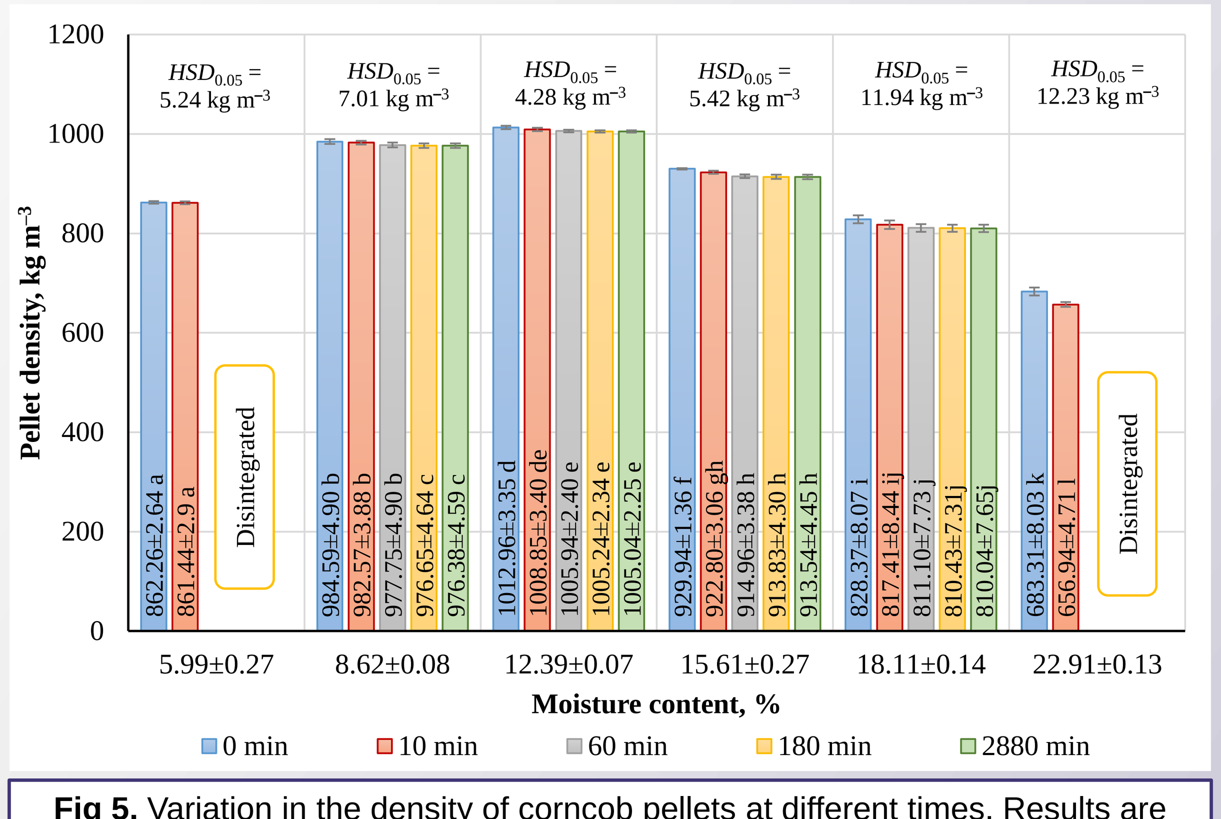


Fig 5. Variation in the density of corncob pellets at different times. Results are significant at p < 0.05 based on one-way ANOVA with the Tukey HSD test (n = 5), with differences between groups (denoted by lowercase letters). The data are summarized as means ± standard deviations.

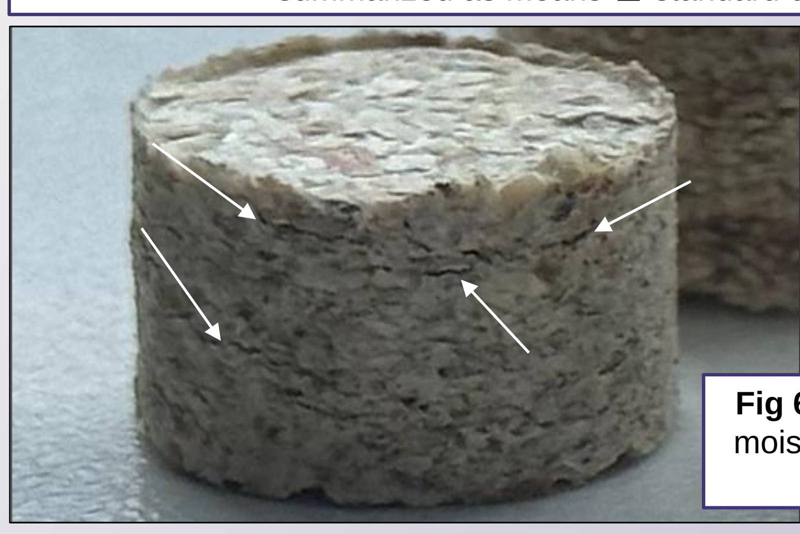


Fig 6. Side view of the 8.62% moisture pellet (cracks shown by arrows).

4. Evaluation of Mass Production of Pellets

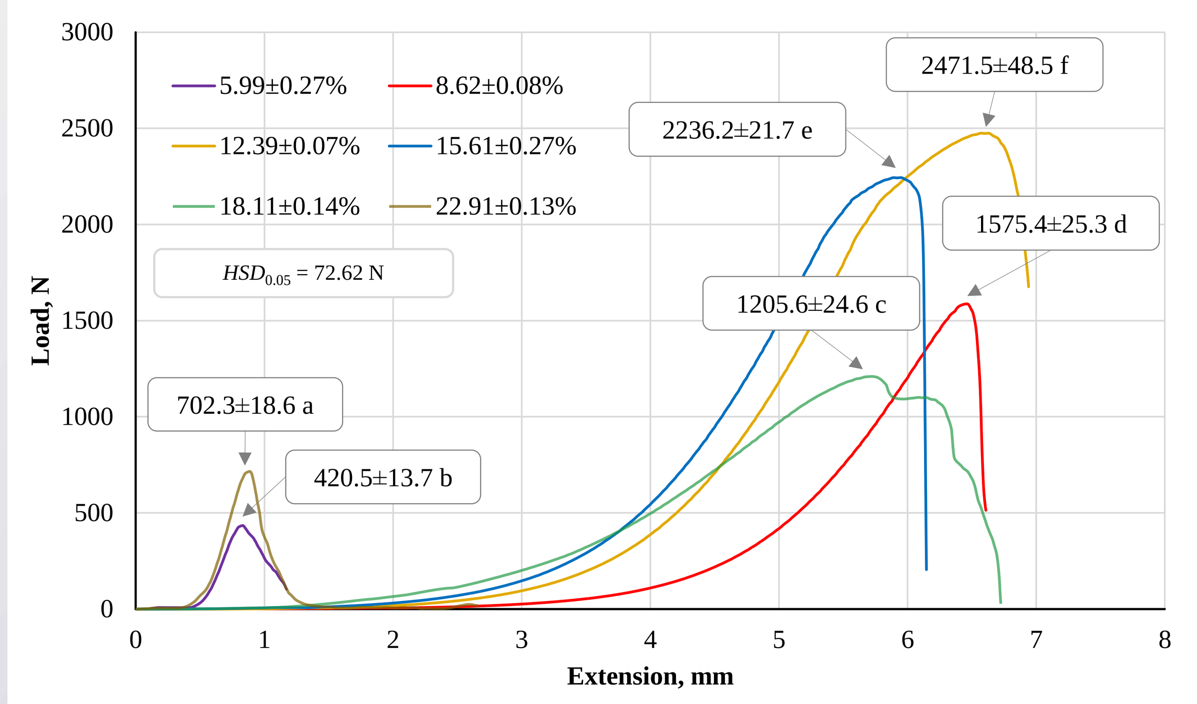


Fig 7. Compressive strength of corncob pellets. Results are significant at p < 0.05 based on one-way ANOVA with the Tukey HSD test (n = 5), with differences between groups (denoted by lowercase letters). The data are summarized as means ± standard deviations.

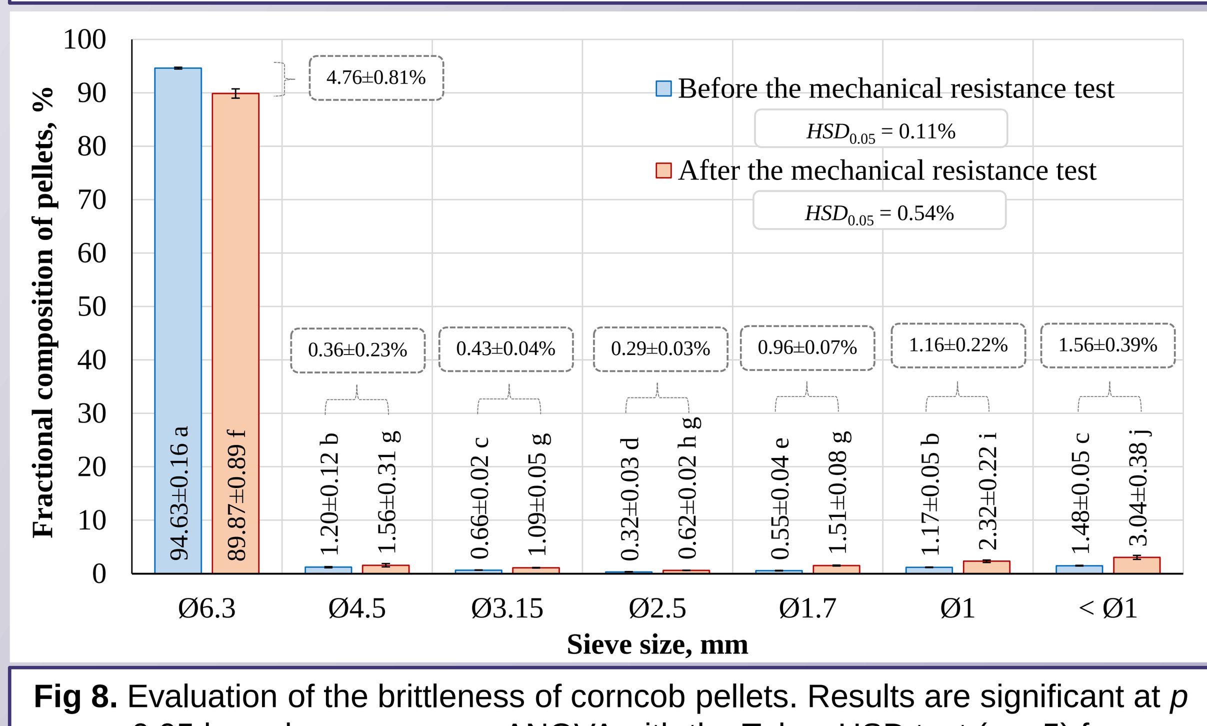


Fig 8. Evaluation of the brittleness of corncob pellets. Results are significant at p < 0.05 based on a one-way ANOVA with the Tukey HSD test (n = 5) for differences between groups (denoted by lowercase letters). The data are summarized as means ± standard deviations.

Table 1. Indicators of lower calorific value and ash content. Note: * $HSD_{0.05}$ = 0.65. Results are significant at p < 0.05 based on a one-way ANOVA with the Tukey HSD test (n = 16) for differences between groups (denoted by lowercase letters). The data are summarized as means ± standard deviations.

Indicators	Initial Milled Biomass of Corncob	Fraction Composition of Pellets (>3.15 mm)	Fraction Composition of Pellets (<3.15 mm)
Moisture content, %	5.99±0.03	7.88±0.16	8.48±0.21%
Lower calorific value after considering moisture content, MJ kg⁻¹ *	17.20±0.16 a	17.35±0.14 a	17.03±0.34 a
Ash content, %	1.78±0.24	-	-

CONCLUSION AND FUTURE WORK

Drying corncob biomass using an active ventilation dryer proved more effective than outdoor drying, with minimal changes in dry matter and no significant impact on fractional composition. The optimal moisture content for corncob compaction was determined to be 12–15%, ensuring sufficient pellet strength for combustion. Pellets produced with 12.39 ± 0.07% moisture content demonstrated adequate durability and energy potential, highlighting corncob's suitability as a biofuel feedstock.

Future research will focus on analyzing chemical composition changes during combustion, ash fusibility, and conducting comparative assessments of the environmental and energy impacts of different treatment technologies to enhance the efficiency and sustainability of corncob utilization.

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