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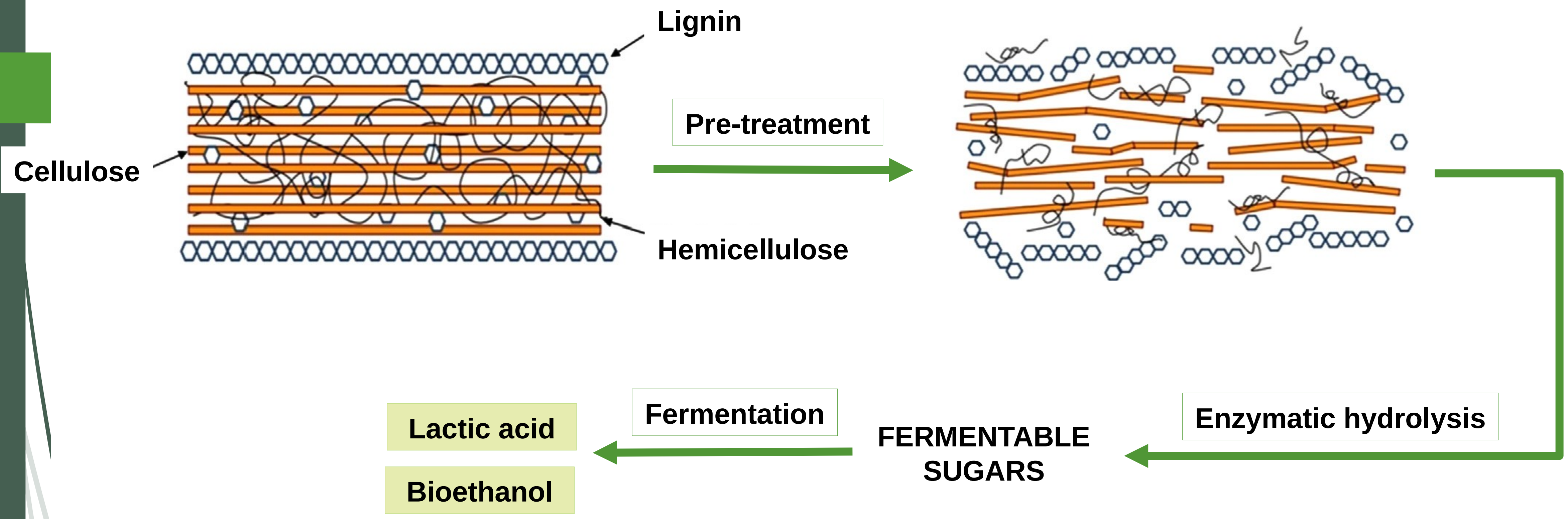
Evaluation of pre-treatment methods for improving the enzymatic hydrolysis of lignocellulosic waste

Dragana Mladenović[1], Aleksandra Djukić-Vuković[1], Saša Lazović[2], Jelena Pejin[3], Sunčica Kocić-Tanackov[3], Ljiljana Mojović[1]

[1]Faculty of Technology and Metallurgy, University of Belgrade, Serbia
[2]Institute of Physics Belgrade, University of Belgrade, Serbia
[3]Faculty of Technology, University of Novi Sad, Serbia

- **Lignocellulosic biomass** represents the most abundant renewable raw material that could be converted into high-value bioproducts

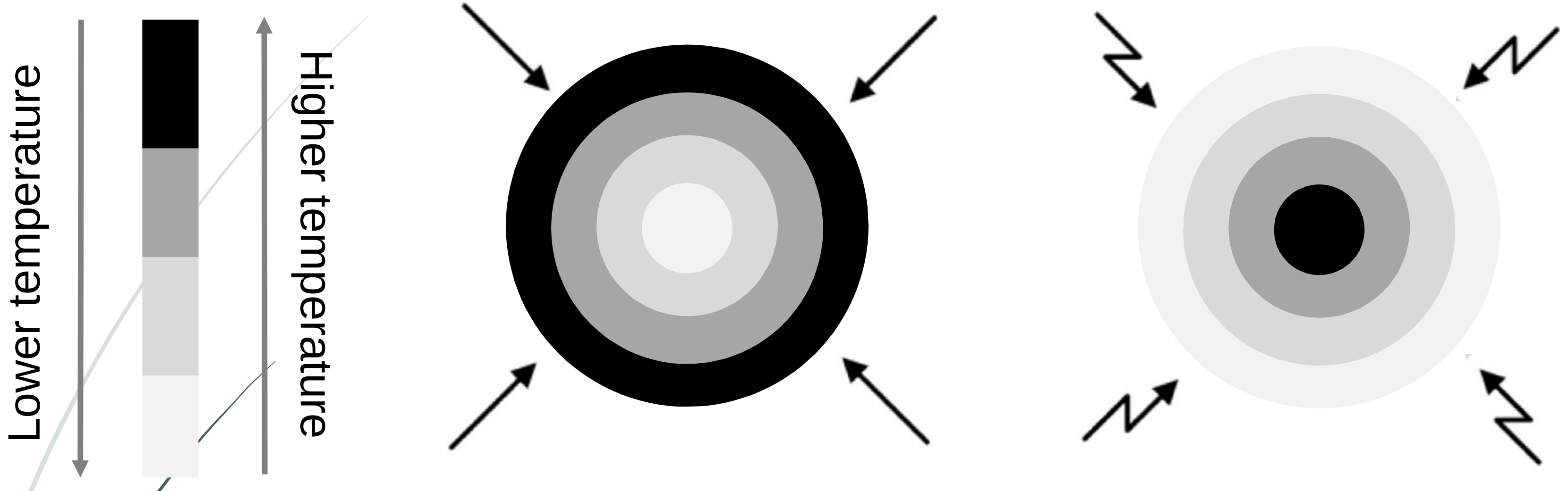
- Not fully exploited due to the low yields of bioproducts obtained
- Low yields are often attributed to incomplete hydrolysis of cellulose molecules which are protected inside the complex structure of lignocellulose (by lignin and hemicellulose)
- Other factors hinder hydrolysis of cellulose – crystallinity, porosity and extent of polymerization
- A wide range of pre-treatment strategies have been investigated, and they can be broadly categorized into physical, chemical, and biological methods



- The goal of pre-treatment is to break down the lignin protective barrier, remove hemicellulose, release cellulose and facilitate the subsequent enzymatic hydrolysis to fermentable sugars.

Pre-treatment of lignocellulosic biomass using high-temperature methods

Comparison of microwave and conventional heating – temperature distribution



Conventional heat source	Microwave
• Contact heating	• Non-contact heating
• Slow heating	• Rapid heating
• Longer reaction time	• Shorter reaction time
• Superficial heating (occurs at the surface)	• Volumetric heating (uniform heat distribution)
• Lower level of control	• Higher level of control
• Higher energy consumption	• Lower energy consumption

Renewable and Sustainable Energy Reviews. 2018;82:1149-77.

Materials and methods

Corn husk

Grounding and sieving

PRE-TREATMENT METHODS

Conventional heating			Microwave heating
Hydrothermal Deionized water 60 min at 121 °C	Dilute sulfuric acid (2%) 30 min., 60 min. 121 °C	Sodium-hydroxide (10%) 30 min., 60 min. 121 °C	Microwave assisted alkali treatment sodium-hydroxide (10%) Power of 300 W, 2 min., 4 min.

Pre-treated biomass was thoroughly washed with water

Enzymatic hydrolysis by cellulase complex Cellic® CTec2, 50 °C for 24 h

The saccharification efficiency of each pre-treatment was assessed by determining the concentration of reducing sugars.

Results

COB **HUSK**

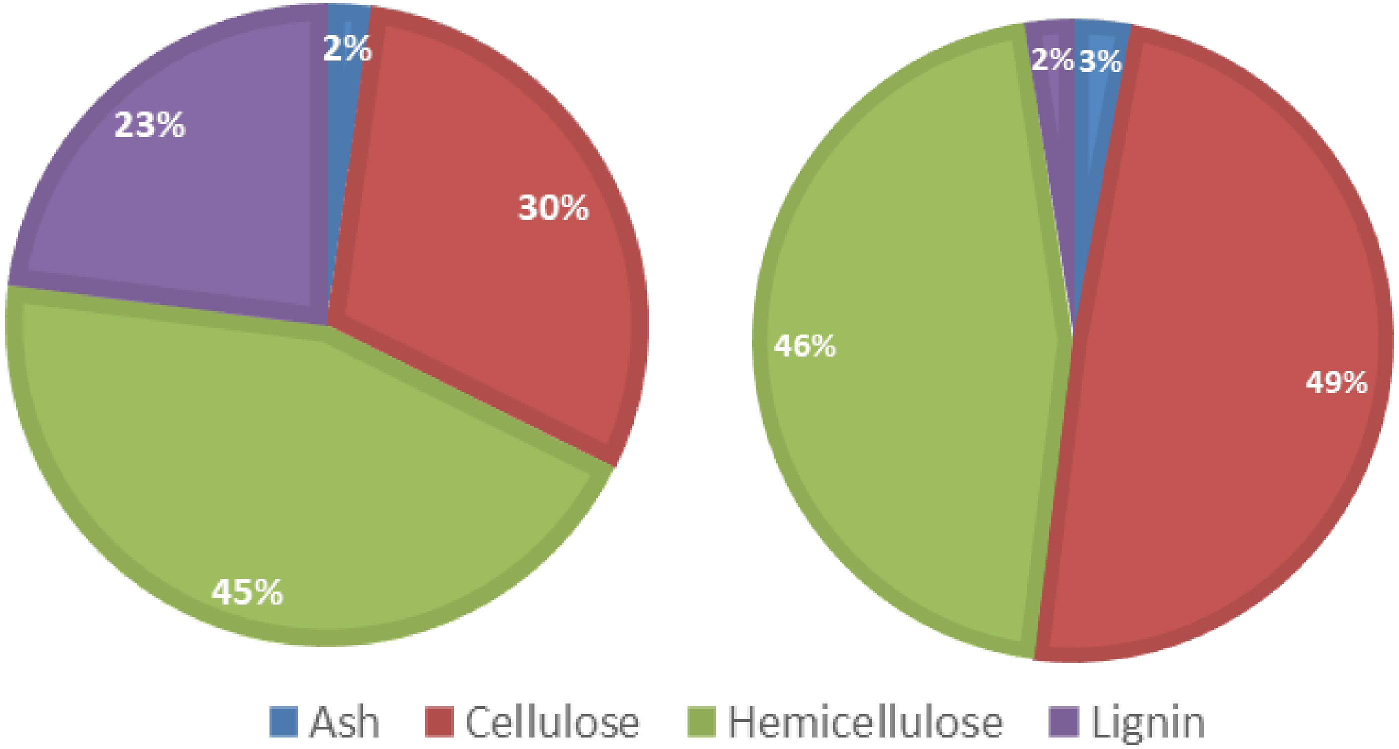


Fig. 1. Biochemical composition of corn cob and husk.

Results

Enzymatic hydrolysis of pre-treated corn husk

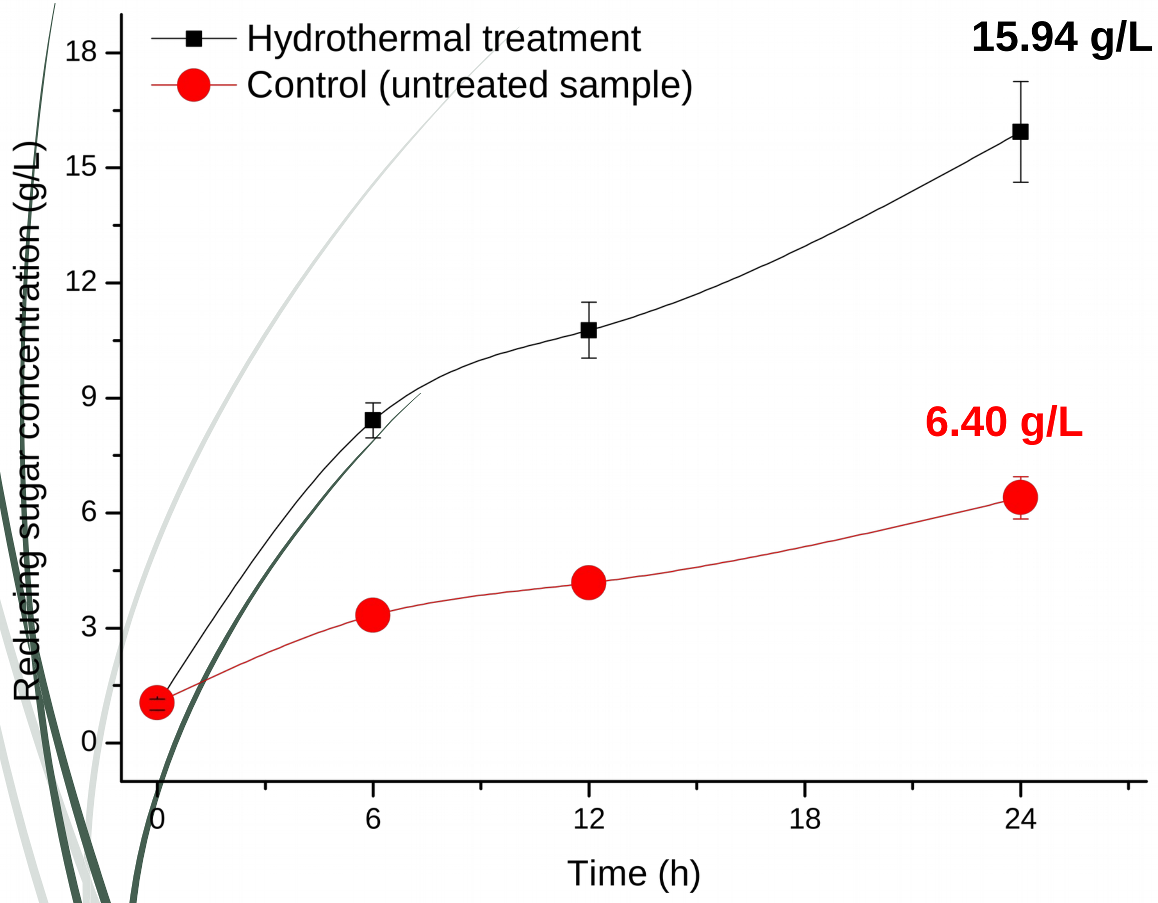


Fig. 2. Hydrothermal pre-treatment.

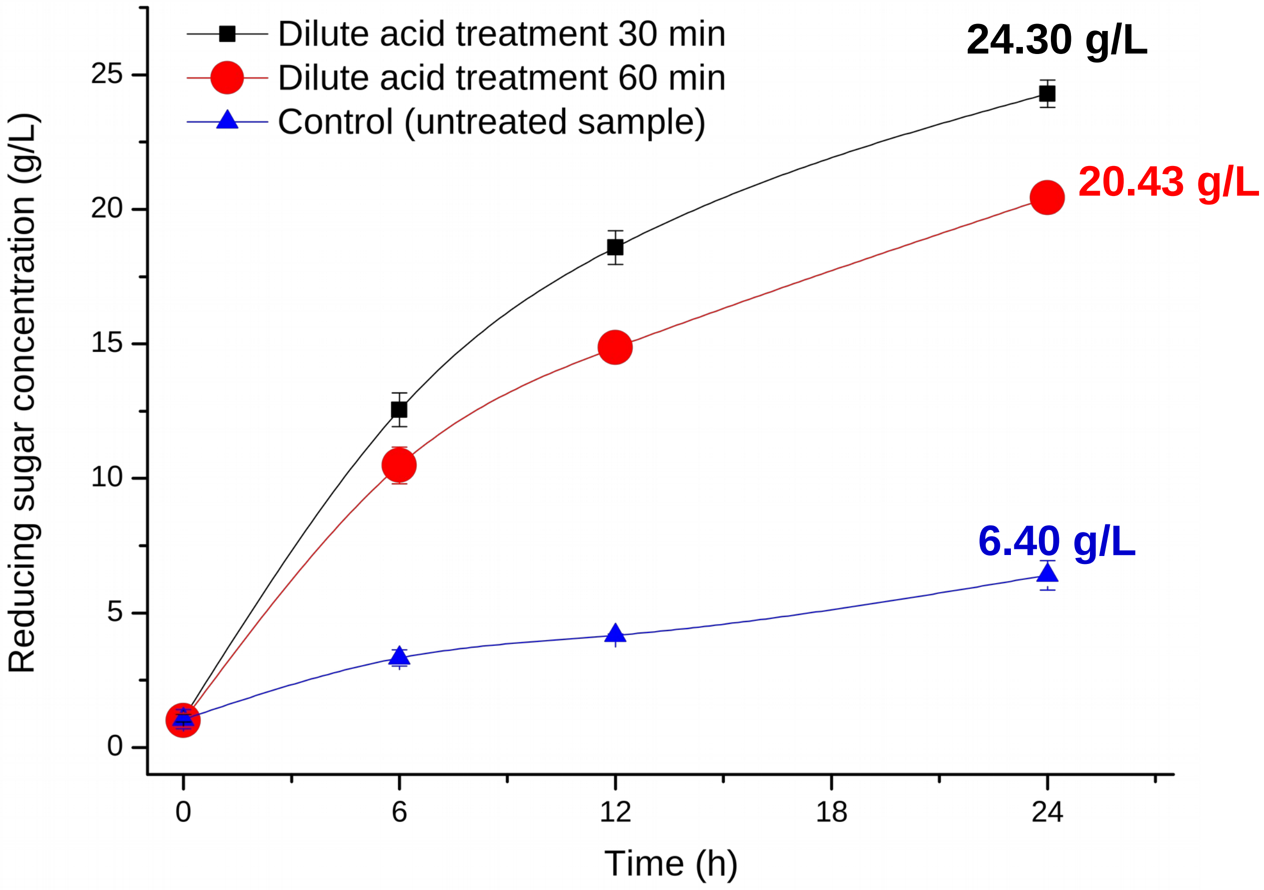


Fig. 3. Dilute acid pre-treatment.

Results

Enzymatic hydrolysis of pre-treated corn husk

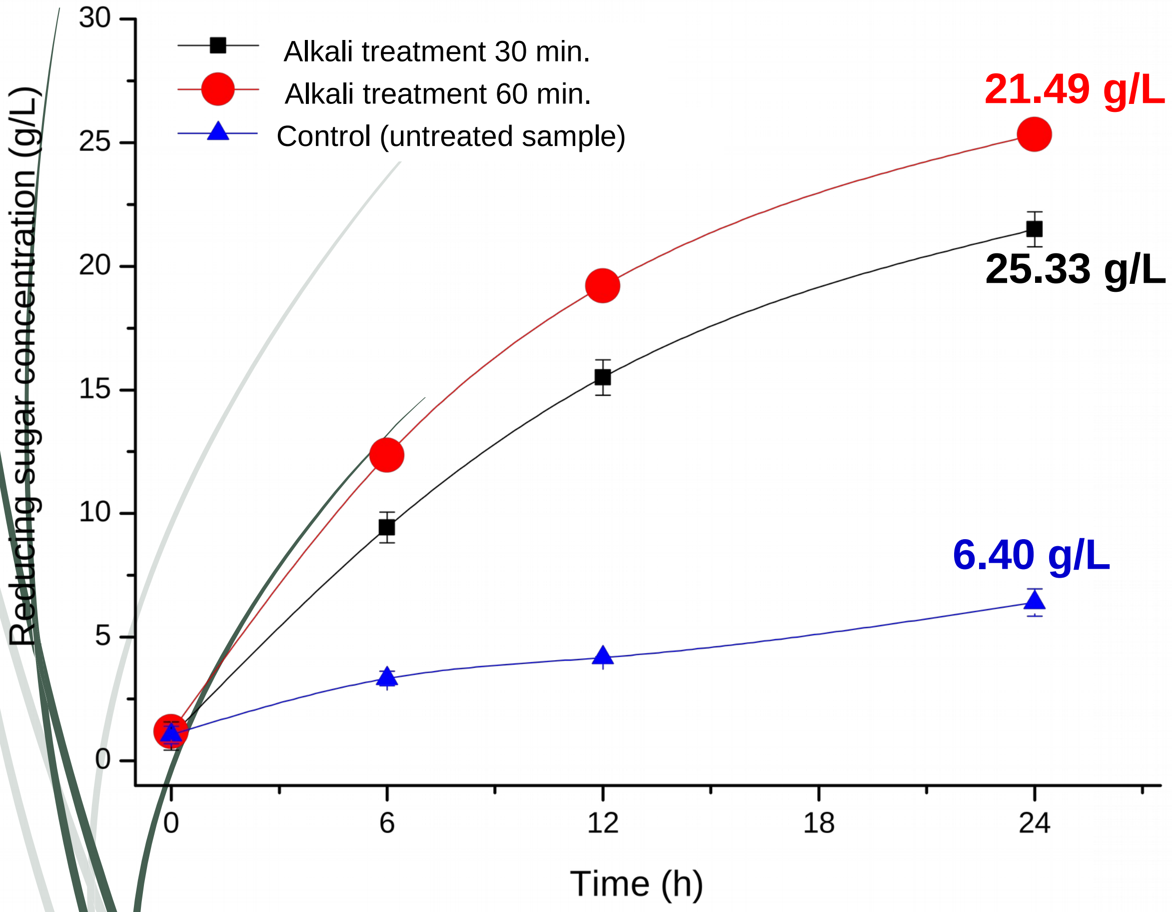


Fig. 4. Alkali pre-treatment.

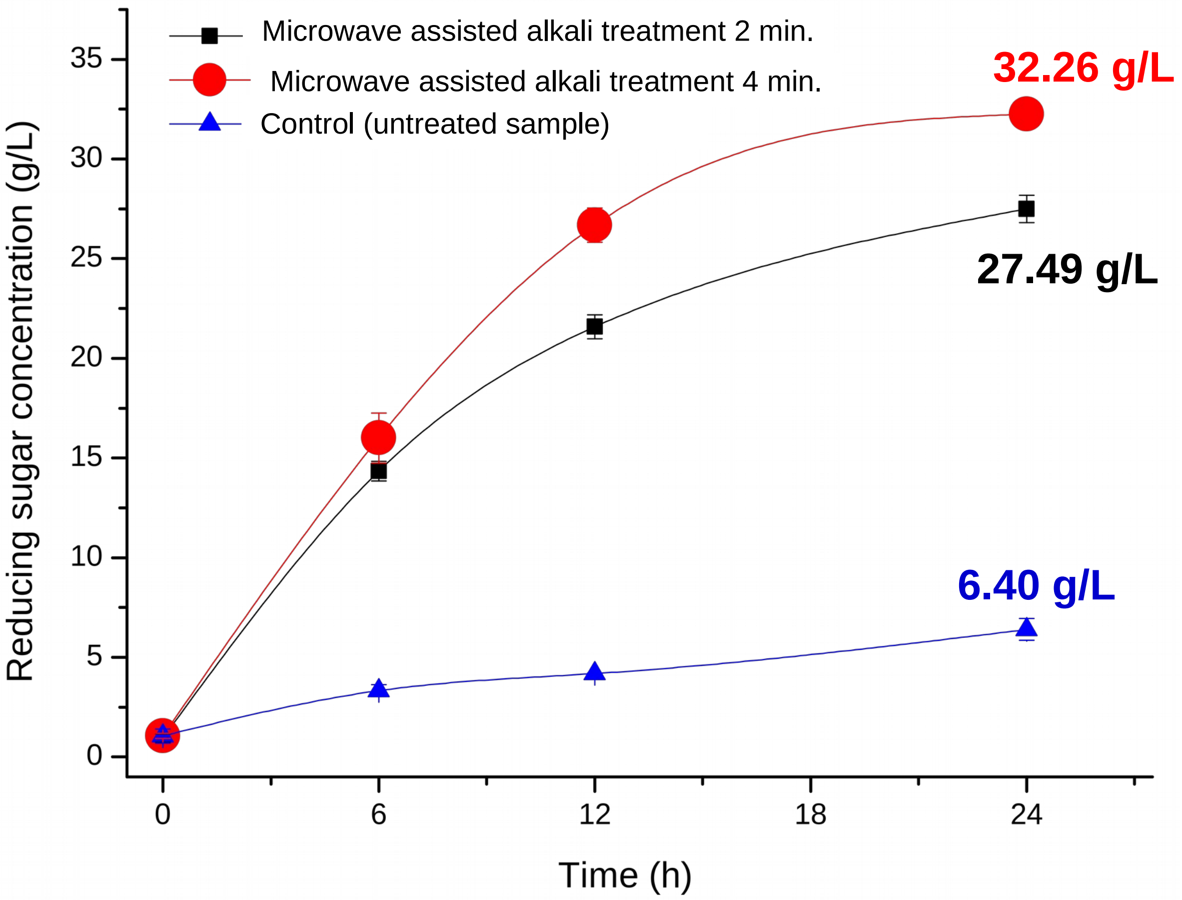


Fig. 5. Microwave assisted alkali pre-treatment.

Results

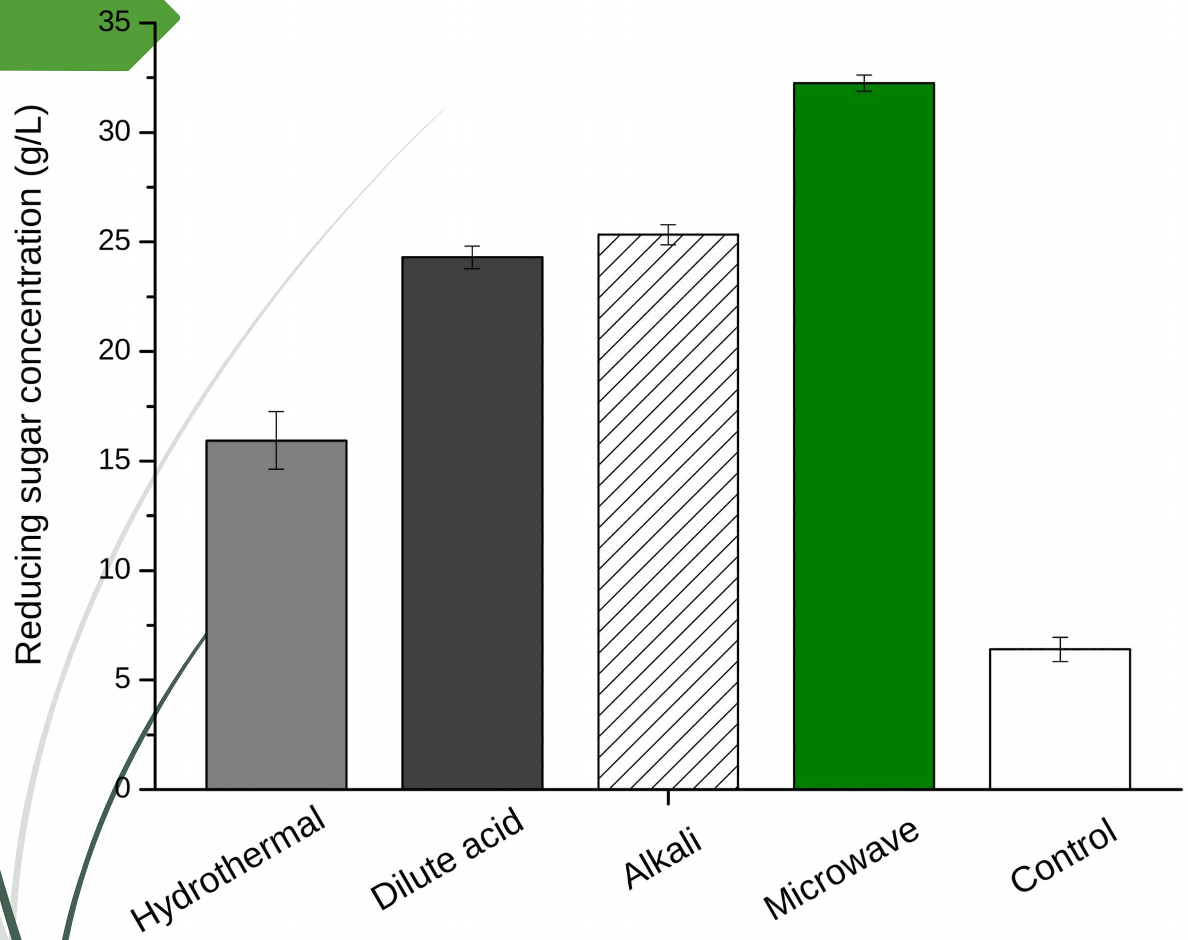


Fig. 6. Reducing sugar concentration after enzymatic hydrolysis of pre-treated corn husk.

Table 1. Glucose yield after enzymatic hydrolysis of pre-treated corn husk.

Pre-treatment type	Glucose yield (%)
Hydrothermal	33.79 ± 2.78
Dilute acid	51.51 ± 1.07
Alkali	53.79 ± 0.95
Microwave	68.37 ± 1.12
Control	13.56 ± 1.17

Conclusions

- Microwave assisted alkali treatment was found to be highly efficient in increasing the reducing sugar yield.

- A 4-fold increase in reducing sugar yield was obtained after enzymatic hydrolysis of pre-treated corn husk as compared to untreated sample.

- In this way pre-treated corn husk could be used as carbohydrate source for the production of lactic acid or other valuable products.

Thank you for your attention!

University of Belgrade, Faculty of Technology and Metallurgy
e-mail: dmladenovic@tmf.bg.ac.rs

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