

COMPARISON OF HEMP PRETREATMENT METHODS FOR SUGARS PRODUCTION

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INTRODUCTION

Non-wood lignocellulosic residuals are promising raw materials for production of sugars for bioethanol and value-added products. Among them, industrial hemp has great potential with its high biomass yield per hectare. At present from hemp plants, mainly the long fibers are separated from the stems. This remains a residue of hemp particles, which are characterized by a hardwood-like content of cellulose, hemicellulose and lignin, but with a very low bulk density of the material.

EXPERIMENTAL

Industrial hemp biomass (hemp fraction - the residue after mechanical separation of long fibers from hemp stems) was provided by a Bulgarian company.

Acid hydrolysis was performed in a 2 L stainless steel laboratory autoclaves at the following conditions: charge of acid 1%; 10% mass concentration; an internal temperature - 100°C; a maximum temperature of 130°C to 160°C and heating time of 60 min.; followed by additional of 30 to 60 min at maximum temperature.

The steam explosion was performed in a 2 L stainless steel laboratory installation at the following conditions: a hydromodul ratio 1:40; an initial temperature is room; a maximum temperature of 190° and 200°C and heating time of 60 min, followed by additional 10 min at maximum temperature. The steam explosion experiment was repeated with the same conditions by added 4 bar CO₂.

The aim of the present study is to compare pretreatment methods of industrial hemp biomass in order to achieve the highest total sugars yield after enzymatic hydrolysis.

RESULTS AND DISCUSSION

Diluted sulfuric acid hydrolysis and steam pretreatment with and without CO₂ impregnation were performed under different temperatures and durations. The efficiency of the pretreatment was evaluated after cellulase hydrolysis. The diluted acid hydrolysis method provides the highest total glucose yield, but also significant furfural formation (fig.1 and fig.2).

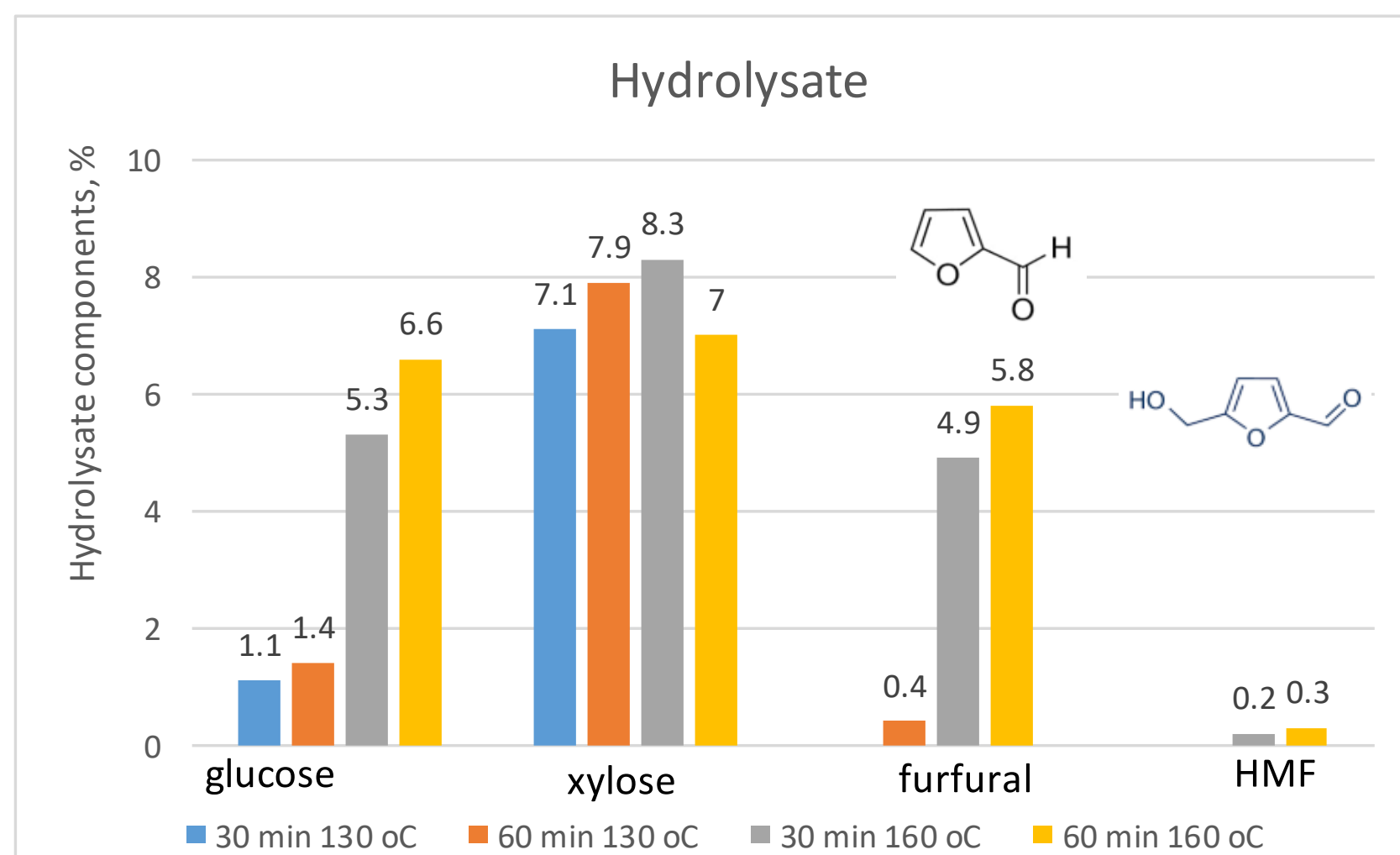


Fig. 1. Chemical composition of the hydrolysate after acid hydrolysis

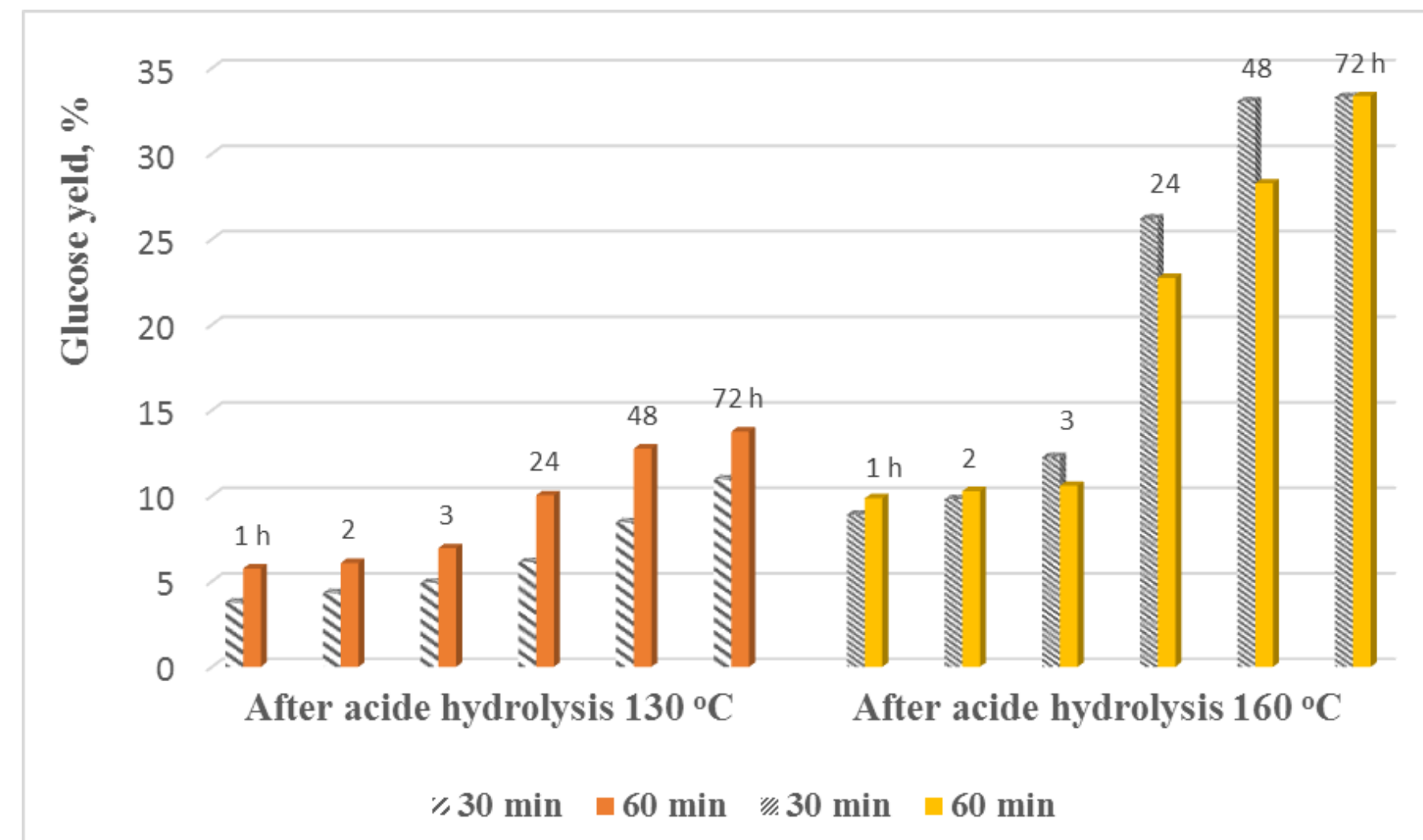


Fig. 2. Glucose yield from enzymatic hydrolysis after acid pretreatment

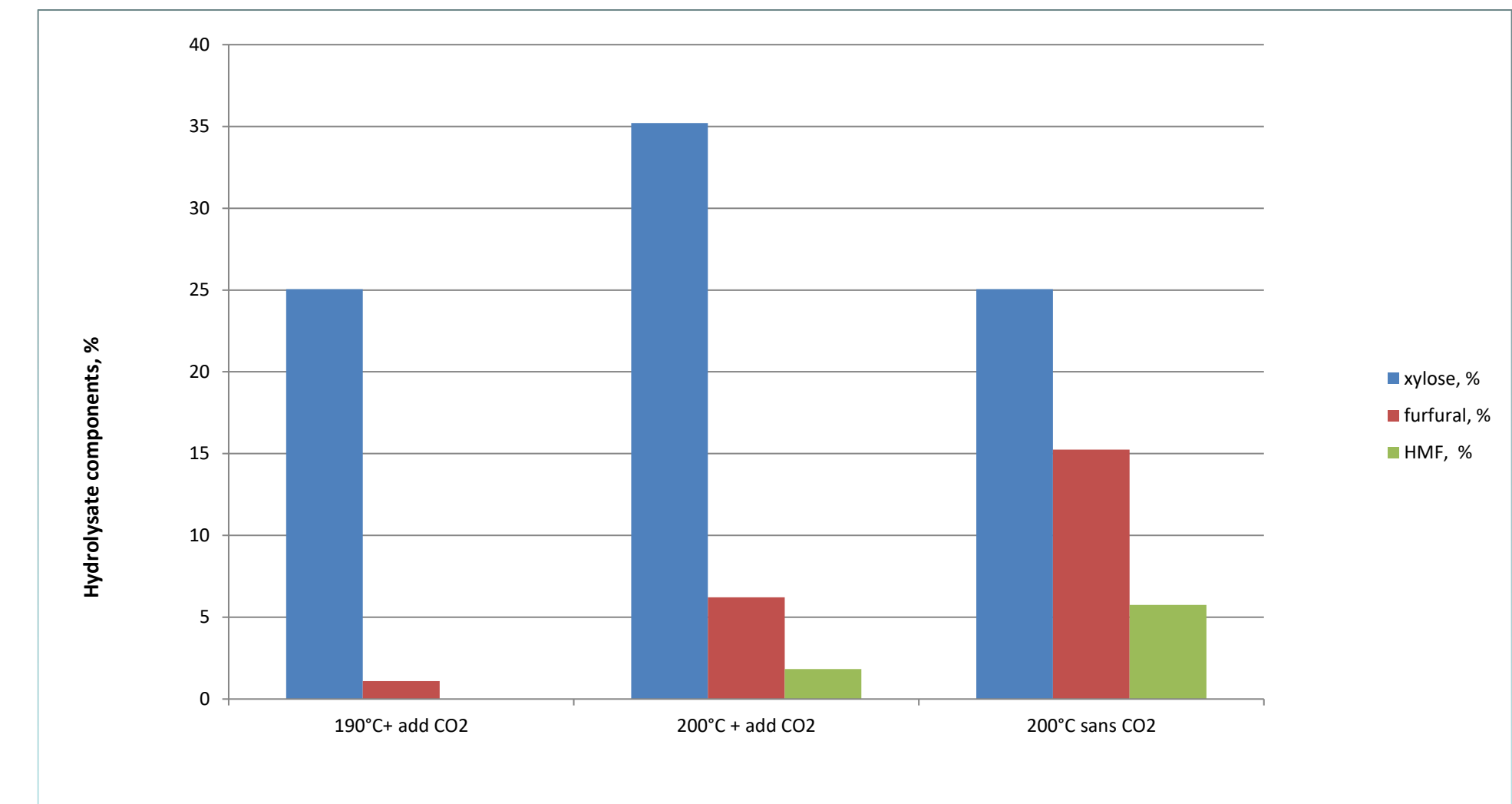


Fig. 3. Chemical composition of the hydrolysate after steam explosion pretreatment

The classic steam explosion method leads to the same glucose yield after enzymatic treatment as after acid pretreatment, but with practically no formation of glucose during the pretreatment stage. The CO₂ steam explosion method provides the highest xylose yield in the pretreatment stage. Due to the mild acid conditions, that pretreatment can be carried out at a lower temperature, increasing the energy efficiency of the process (fig.3 - fig.6).

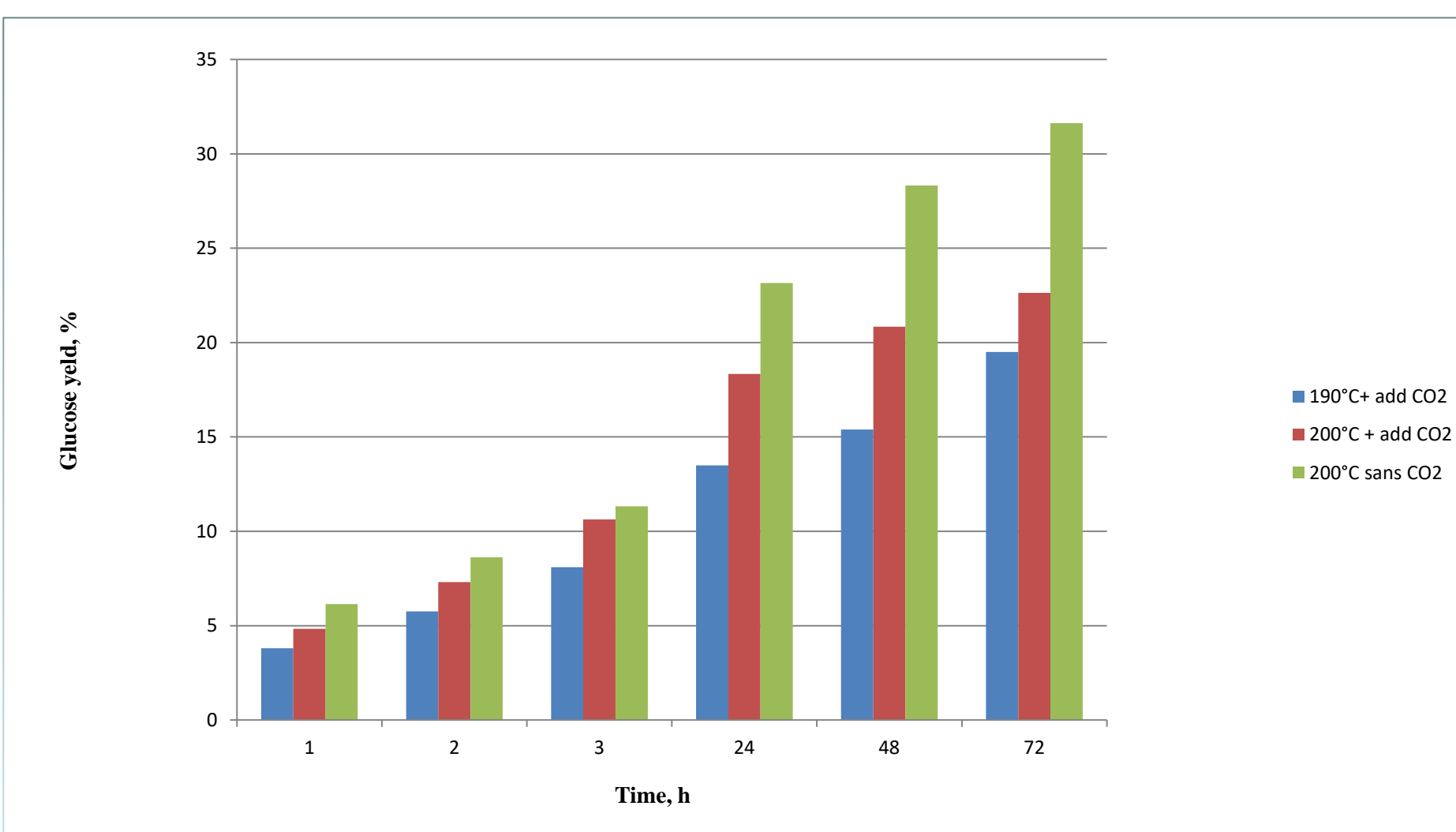


Fig. 4. Glucose yield from enzymatic hydrolysis after steam explosion pretreatment

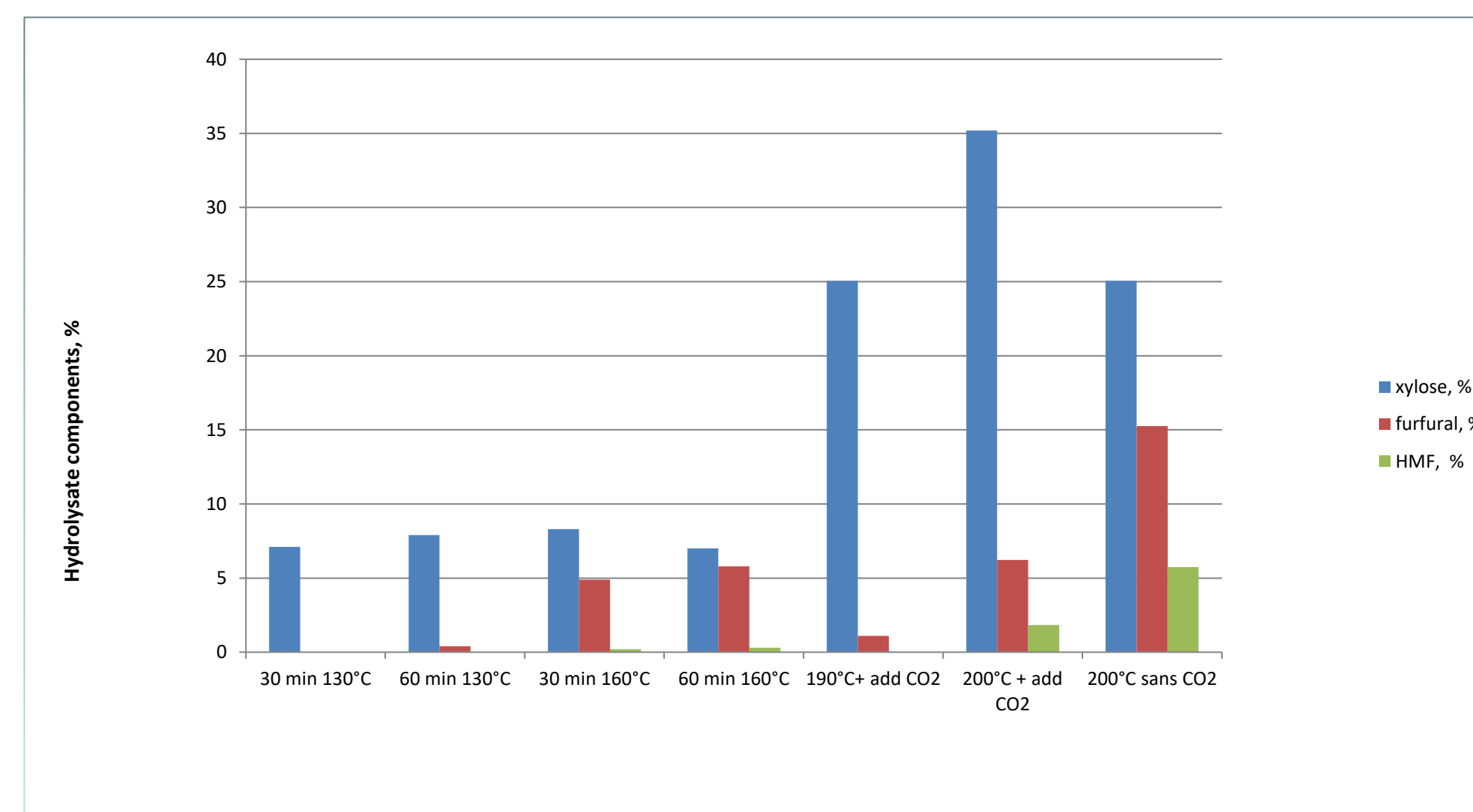


Fig. 5. Comparative of type pretreatment methods on components compound in hydrolysate

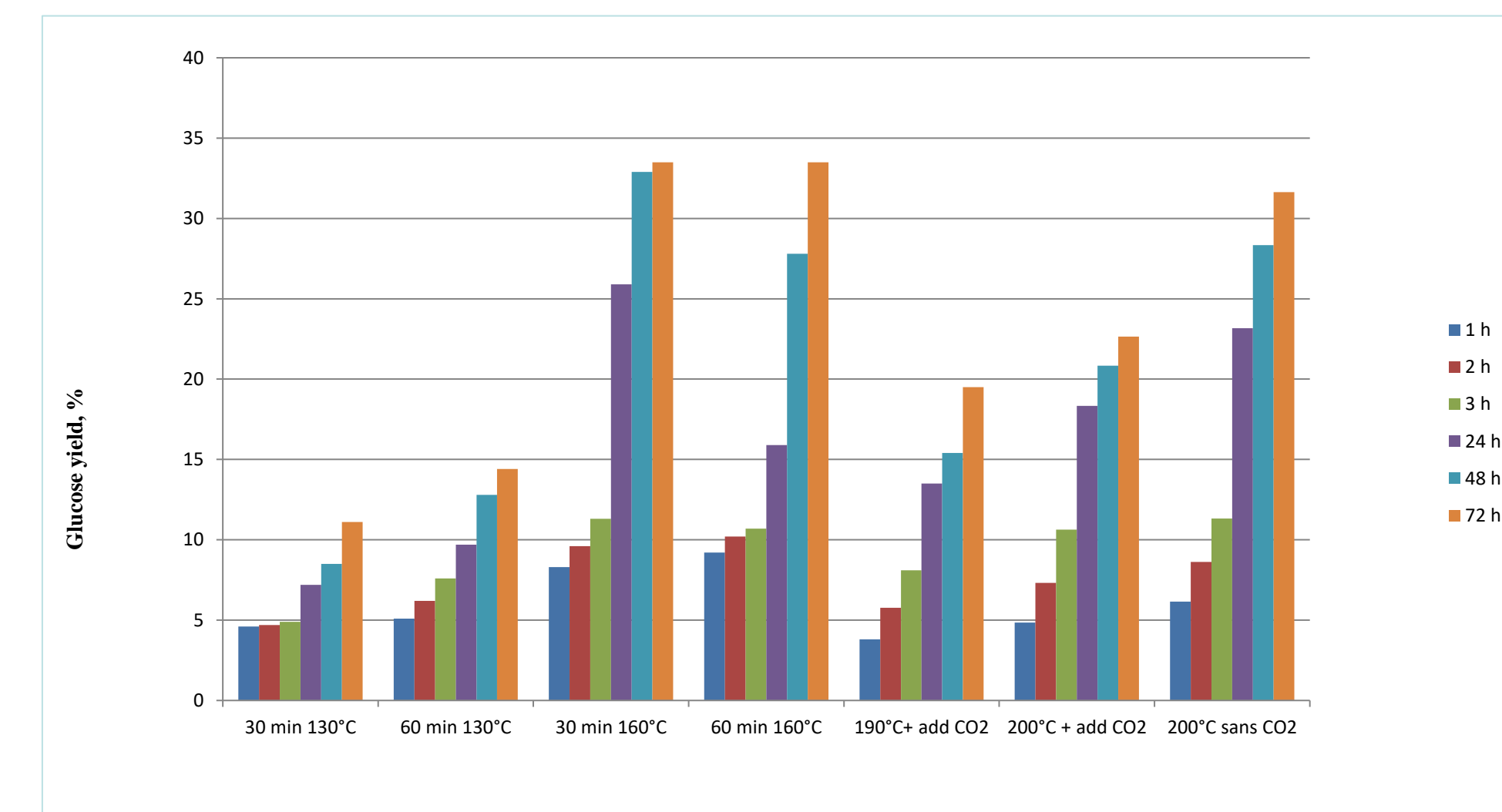


Fig. 6. Comparative of glucose yield from enzyme hydrolysis after different pretreatment methods

CONCLUSION

The potential of hemp residues is similar to that of straw stalks as a raw material and the most suitable method of pretreatment of industrial hemp for enzymatic hydrolysis to glucose for bioethanol is diluted acid hydrolysis, while the xylose yield is a higher after CO₂ steam explosion method.