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# Investigation and optimization of heat and enzymatic pretreatments of OFMSW and its combination with cellulose

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## BACKGROUND

The feedstock OFMSW is investigated for bioenergy production as it is a low cost, renewable, abundant source of biomass that has been under utilized for biotechnological applications compared to other traditional feedstocks. The main challenge for uptake of OFMSW is the requirement to combine several pre-processing methods such as mechanical, physical, chemical, and biological in order to release a substantial amount of fermentable biomass components. In this study, effects of heat pretreatment on sugar polymers from OFMSW are investigated, as well as enzymatic hydrolysis of thermally pretreated OFMSW together with cellulose fraction from wood pulp.

## RESULTS

- OFMSW has high sugar content **52 g of sugars/100 g DM**, of which **15,4 g is starch**, and **14,1 g of acids/100g DM** of weak acids.
- Cellulose fraction from wood pulp contains **84 g of glucose/100g DM**.

### Heat pretreatment

- The gelatinization of the OFMSW exhibited a **clear correlation between the amount of released starch and reaction conditions** (1-4 hours) and (70-130°C).
- The MLR model predicted 70% of variation in the amount of liberated starch could be explained by changing reaction conditions, more specifically, **prolonging the reaction time and/or increasing the temperature results in a higher liberation of starch** into the liquid fraction.
- The HPLC analysis showed that pretreatment temperatures (100-130°C) are **not statistically significant for sugar yield**.
- **Sugar recovery decreases** with an increase in pretreatment temperature
- The amount of **furfural and HMF was significantly increased** in samples with rising temperature of pretreatment.
- The amount of **weak acids decreases with the increasing temperature** of heat pretreatment.

### Enzymatic hydrolysis

- The free sugar yields are not significantly different for OFMSW and mixtures of OFMSW with cellulose, resulting in **90-100% yields**.
- The pure cellulose fraction resulted in approximately **50% free sugar yield**.
- **The total sugar yields** are not considerably different except for the results of (80/20), which has a yield of 115%.



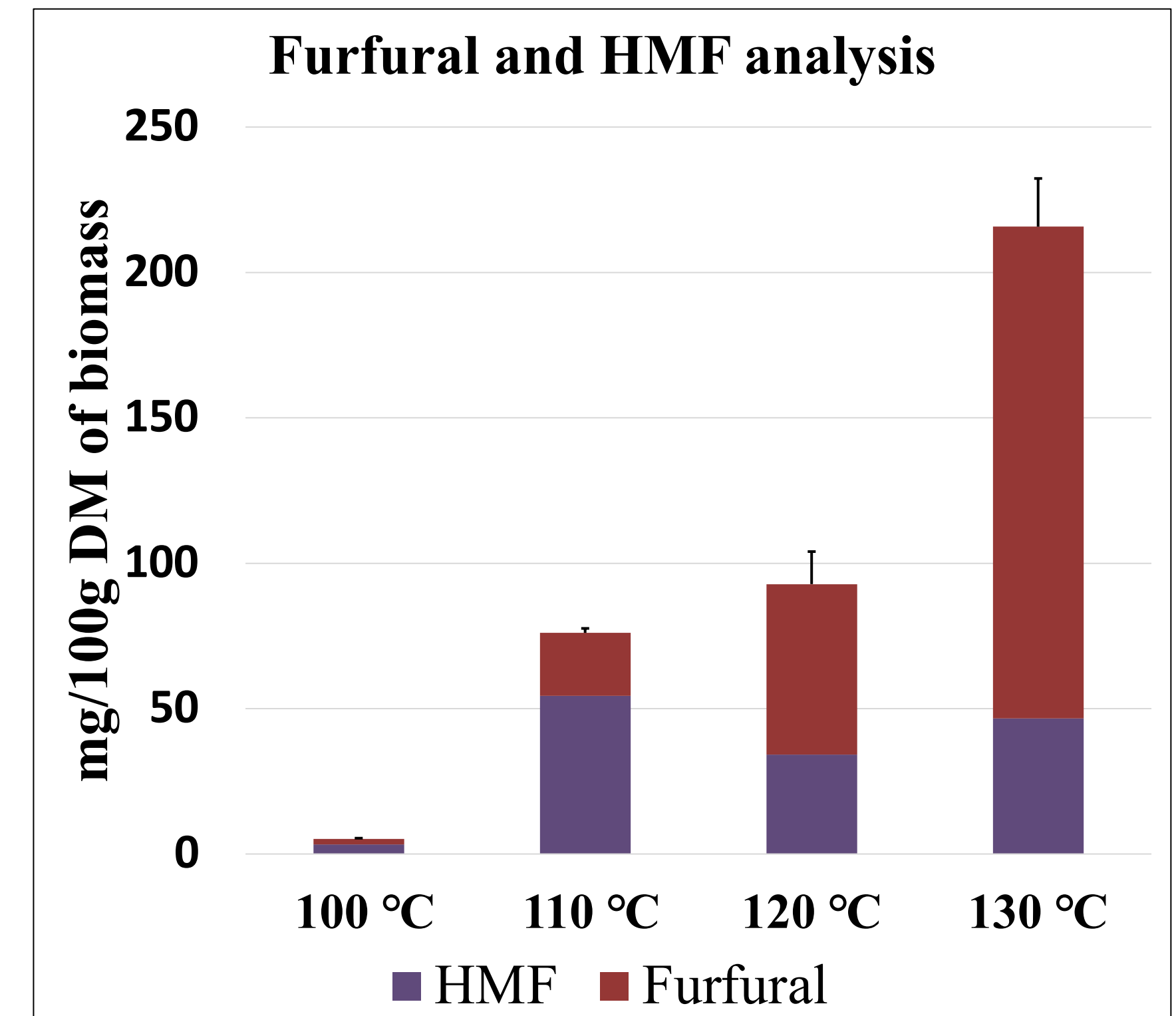
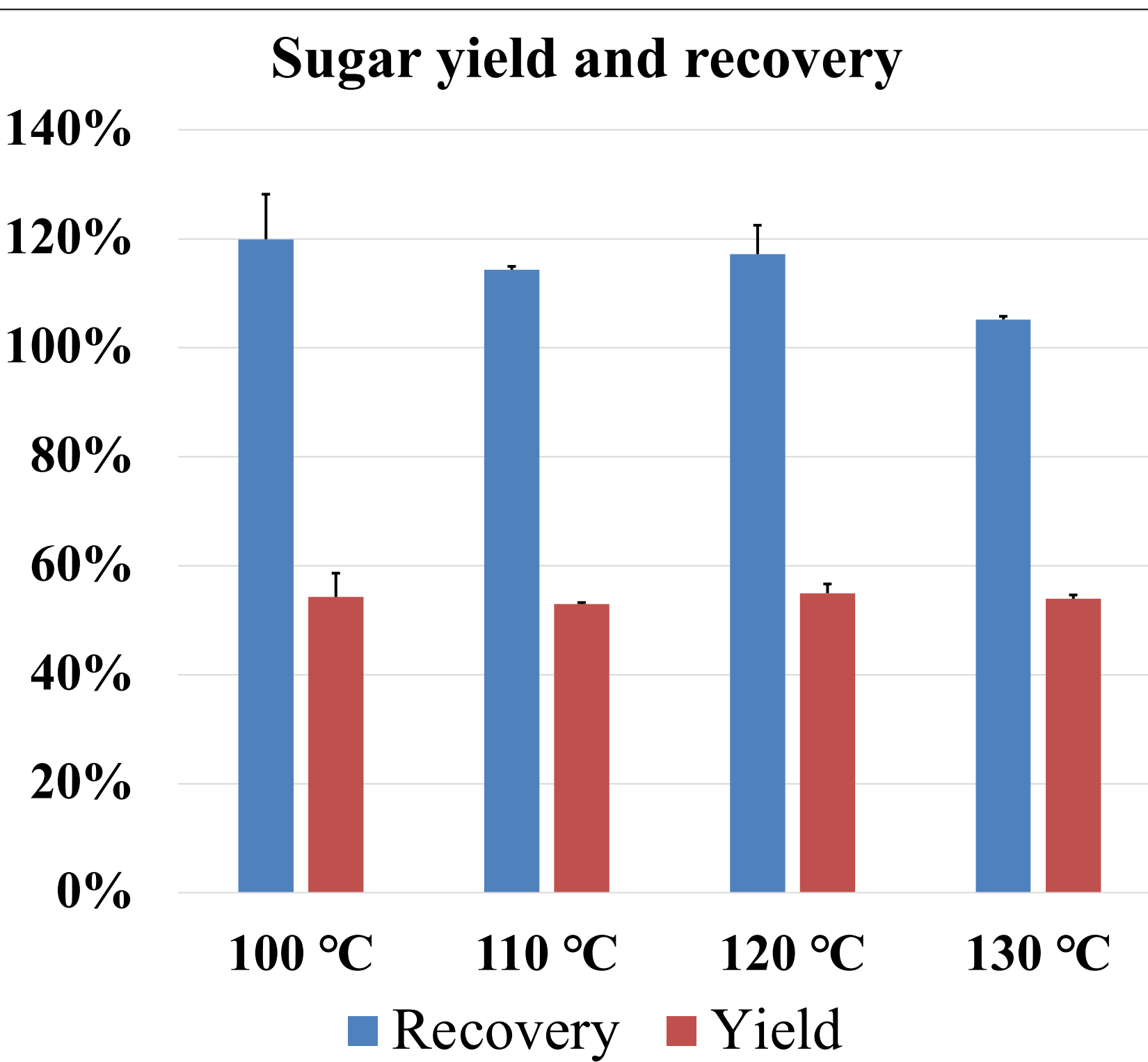
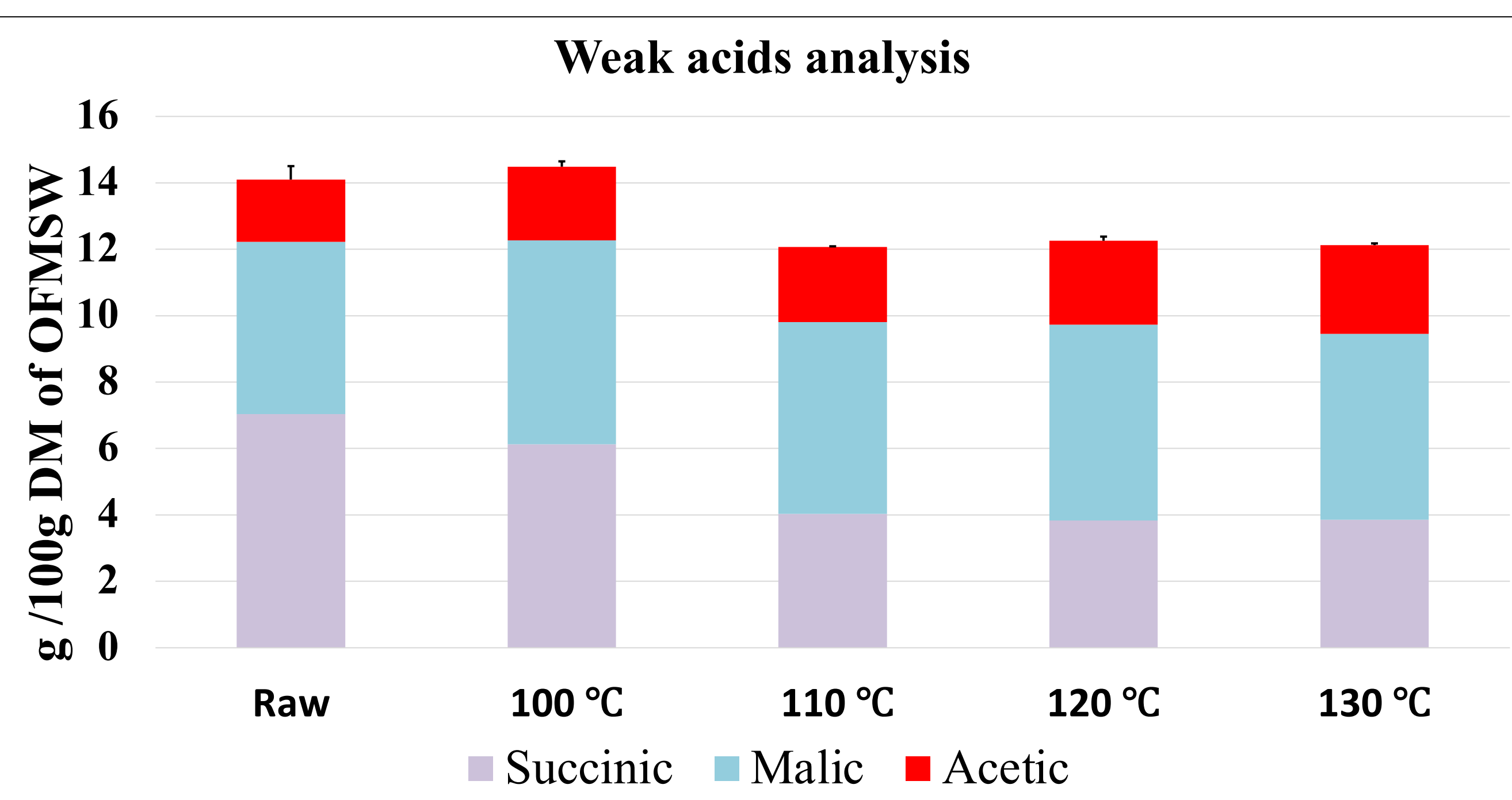
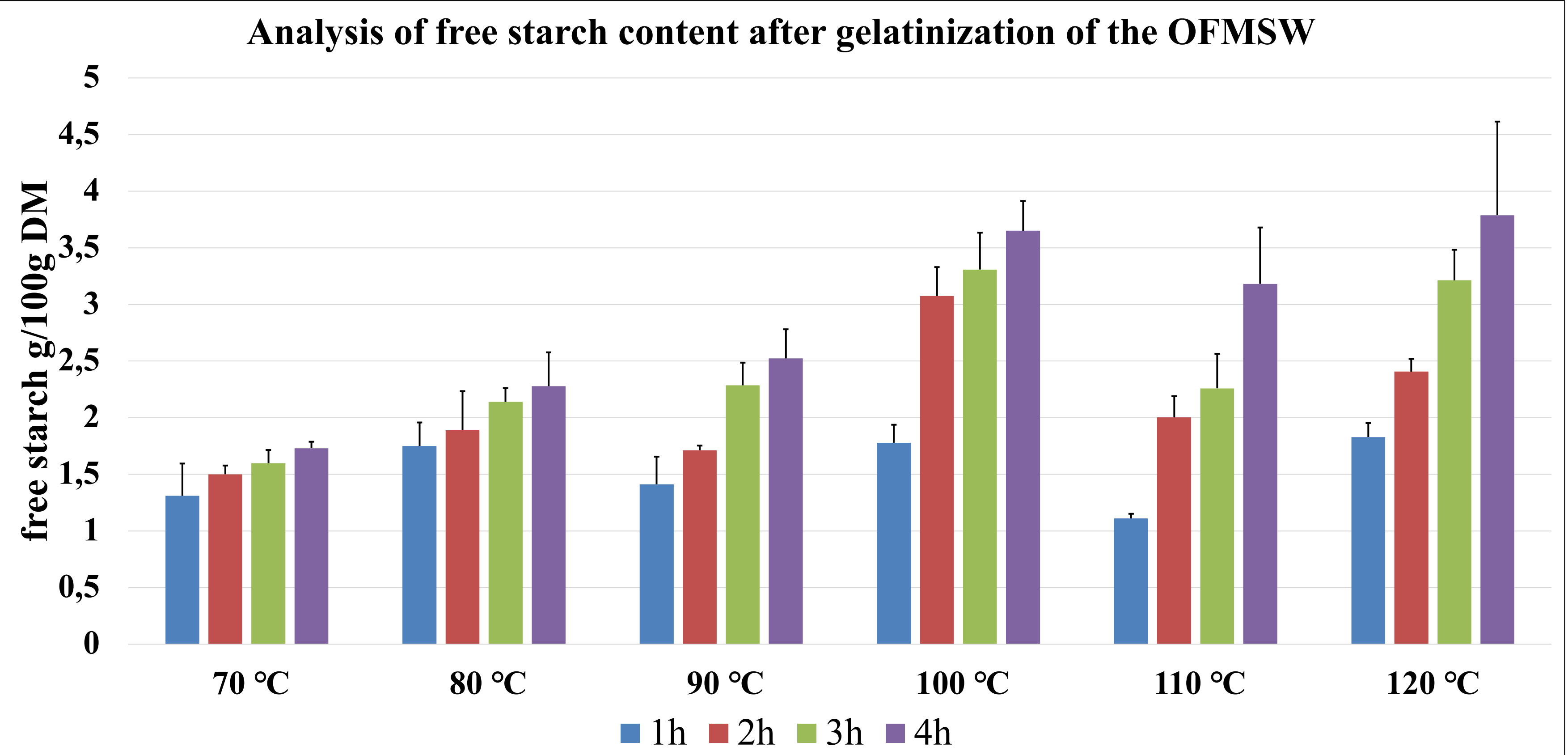
## MATERIALS AND METHODS

The OFMSW was provided by Ragn-Sells Denmark A/S and cellulose from organosolv pretreated wood pulp at 180°C for 60 min with 60% v/v ethanol and 20 mM H<sub>2</sub>SO<sub>4</sub> (liquid-to-solid-ratio of 10; volume to weight) was provided by Lulea University of Technology. The OFMSW and cellulose was hydrolyzed by strong acid (72 w/w % H<sub>2</sub>SO<sub>4</sub>) and examined by HPLC on the total amount of sugars.

**Heat pretreatment:** 1) Starch gelatinization was analyzed by Iodometry and Megazymes Total Starch HK Assay Kit on total and liberated amount of starch.

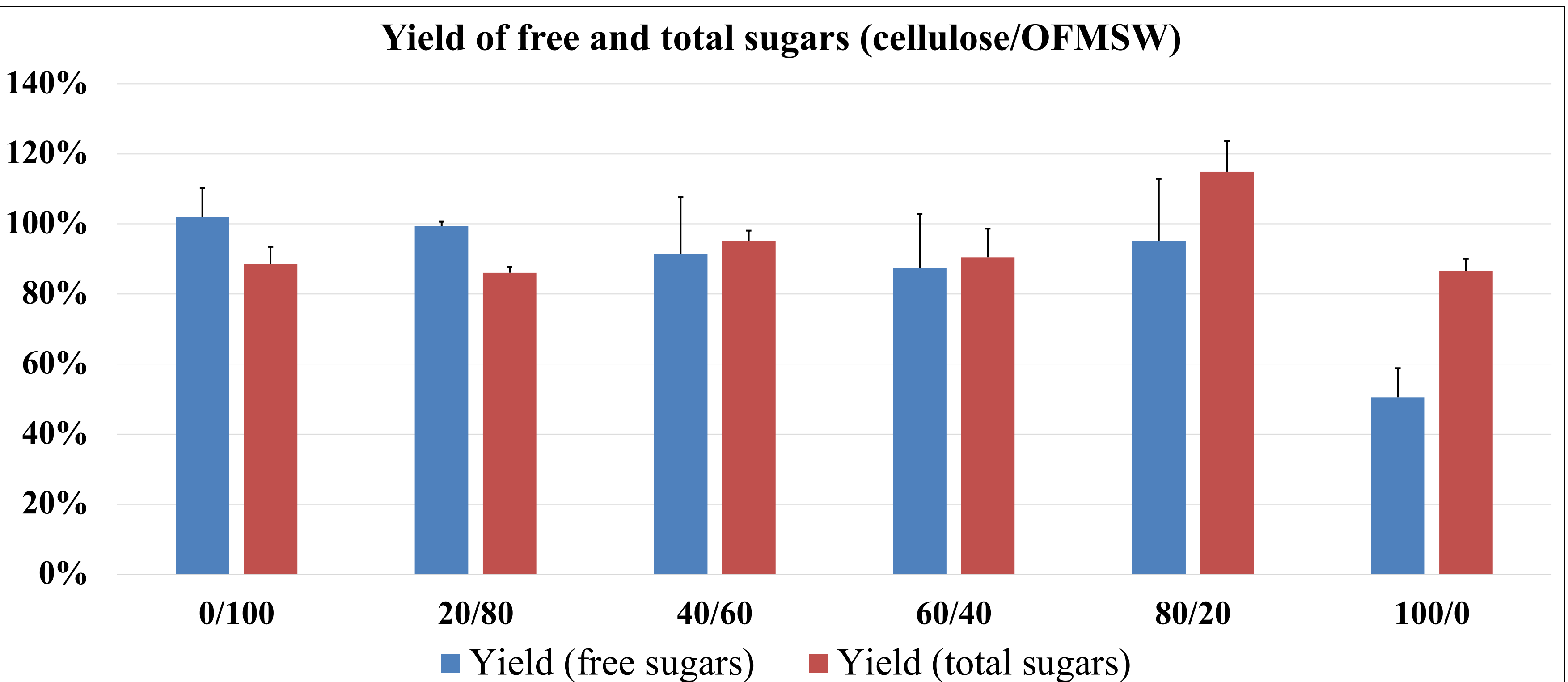
2) The OFMSW was further investigated on glucose, xylose, and arabinose content by HPLC. Raw and pretreated materials were separated into liquid and solid fractions by centrifugation. Liquid fractions were directly analyzed on HPLC for free sugar, weak acids, furfural, and HMF content as well as they underwent weak acid hydrolysis (8 w/w % H<sub>2</sub>SO<sub>4</sub>) for HPLC analysis of total sugar content. Solid fractions prior to HPLC analysis were acidly hydrolyzed (72 w/w % H<sub>2</sub>SO<sub>4</sub>).

**Enzymatic hydrolysis** was conducted at (50°C, 24 h, 150 RPM) with Cellic® CTec3 HS (Novozymes) 6 w/w DM % and AMG® 300 L BrewQ (Novozymes) 2 w/w DM % on pretreated OFMSW, cellulose and their mixtures. Liquid fractions of hydrolysates were directly analyzed on HPLC for free sugar, weak acids, furfural, and HMF content as well as they underwent weak acid hydrolysis (8 w/w % H<sub>2</sub>SO<sub>4</sub>) for HPLC analysis of total sugar content.



## CONCLUSIONS

- The OFMSW is **rich in sugars** and can be an excellent feedstock for fermentation if sugars are efficiently liberated.
- The organic waste is already prefermented as it contains substantial amount of weak acids.
- The most suitable heat pretreatment conditions for OFMSW are at **100°C for 4 hours** due to:
  - 1) Low temperature pretreatment, thus requiring **less energy**
  - 2) The amount of **recovered sugars** after pretreatment, which could be subsequently liberated by next preprocessing, is higher at 100°C compared to other temperatures
  - 3) Significantly lower presence of **furfural and HMF**, which are inhibitors to fermentation
- The enzymatic hydrolysis resulted in **90-100% yields**. OFMSW and cellulose fraction can be mixed & processed simultaneously in one step.



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